ASSESSMENT OF CARBON TAX AS A POLICY OPTION FOR REDUCING CARBON-DIOXIDE EMISSIONS IN AUSTRALIA

SUWIN SANDU

Faculty of Engineering

University of Technology, Sydney

A dissertation submitted to the University of Technology, Sydney in fulfilment of the requirements for the degree of Doctor of Philosophy (Energy Planning and Policy)

2007

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree, nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

____

ACKNOWLEDGMENTS

I am grateful to Associate Professor Deepak Sharma, my major supervisor, for his encouragement, guidance and support in carrying out this research. His criticisms and suggestions, throughout this research, are highly valuable. I also benefited greatly from the discussion with him on various issues beyond the scope of this research. I am also grateful to Emeritus Professor Rod Belcher, my co-supervisor, for his advice during this research.

I gratefully thank my uncle, Associate Professor Trichak Sandhu, who has given me a good foundation that allows me to undertake this research. Having no parents, it would have been difficult for me to be where I am now. He is like my father and I know that he would be proud from my achievement.

Thanks to the Faculty of Engineering for providing the right type of environment and financial assistance for carrying out this research. Thanks are also due to the staff of UTS library in assisting me in acquiring valuable information for this dissertation. My particular appreciation also goes to my editor, Ms Pat Skinner.

I would like to especially thank my colleagues in the Energy Planning and Policy Program for their encouragement and cheerful assistance. Particular thanks go to Ms Supannika Wattana and Ms Srichattra Chaivongvilan for providing a consistent support, particularly as a medium of communications with my major supervisor, while I am working in Canberra. Thanks also to Mr Ronnakorn Vaiyavuth for discussion on various aspects, including this research, over a peg of soju.

Finally, I say thank you to my fiancé Nirada Manosorn who has given me the strength, particularly over the last two years of my research. I look forward to our future life together.

ABSTRACT

This research has analysed the economy-wide impacts of carbon tax as a policy option to reduce the rate of growth of carbon-dioxide emissions from the electricity sector in Australia. These impacts are analysed for energy and non-energy sectors of the economy. An energy-oriented Input–Output framework, with '*flexible*' production functions, based on Translog and Cobb-Douglas formulations, is employed for the analysis of various impacts. Further, two alternative conceptions of carbon tax are considered in this research, namely, based on Polluter Pays Principle (PPP) and Shared Responsibility Principle (SRP).

In the first instance, the impacts are analysed, for the period 2005–2020, for tax levels of \$10 and \$20 per tonne of CO_2, in a situation of no *a-priori* limit on CO_2 emissions. The analysis shows that CO_2 emissions from the electricity sector, when carbon tax is based on PPP, would be 211 and 152 Mt, for tax levels of \$10 and \$20, respectively (as compared to 250 Mt in the Base Case scenario, that is, the business-as-usual case). The net economic costs, corresponding with these tax levels, expressed in *present value* terms, would be \$27 and \$49 billion, respectively, over the period 2005–2020. These economic costs are equivalent to 0.43 and 0.78 per cent of the estimated GDP of Australia. Further, most of the economic burden, in this instance, would fall on the electricity sector, particularly coal-fired electricity generators – large consumers of direct fossil fuel. On the other hand, in the case of a carbon tax based on SRP, CO_2 emissions would be 172 and 116 Mt, for tax levels of \$10 and \$20, respectively. The corresponding net economic costs would be \$47 (0.74 per cent of GDP) and \$84 (1.34 per cent of GDP) billion, respectively, with significant burden felt by the commercial sector – large consumers of indirect energy and materials whose production would contribute to CO_2 emissions.

Next, the impacts are analysed by placing an *a-priori* limit on CO_2 emissions from the electricity sector – equivalent to 108 per cent of the 1990 level (that is, 138 Mt), by the year 2020. Two cases are analysed, namely, *early action* (carbon tax introduced in 2005) and *deferred action* (carbon tax introduced in 2010). In the case of early action, the analysis suggests, carbon tax of \$25 and \$15, based on PPP and SRP, respectively,

would be required to achieve the above noted emissions target. The corresponding tax levels in the case of deferred action are \$51 and \$26, respectively. This research also shows that the net economic costs, in the case of early action, would be \$32 billion (for PPP) and \$18 billion (for SRP) higher than those in the case of deferred action. However, this research has demonstrated, that this inference is largely due to the selection of particular indicator (that is, *present value*) and the relatively short time-frame (that is, 2005–2020) for analysis. By extending the time-frame of the analysis to the year 2040, the case for an early introduction of carbon tax strengthens.

Overall, the analysis in this research suggests that an immediate introduction of carbon tax, based on SRP, is the most attractive approach to reduce the rate of growth of CO_2 emissions from the electricity sector and to simultaneously meet economic and social objectives. If the decision to introduce such a tax is deferred, it would be rather difficult to achieve not only environmental objectives but economic and social objectives as well.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS/GLOSSARY

AAEC	Australian Atomic Energy Commission
ABARE	Australian Bureau of Agricultural and Resource Economics
ABRCC	Australian Business Roundtable on Climate Change
ABS	Australian Bureau of Statistics
ACA	Australian Coal Association
ACARP	Australian Coal Association Research Program
AGO	Australian Greenhouse Office
ASFF	Australian Stocks and Flows Framework
BCA	Business Council of Australia
BCSE	Business Council for Sustainable Energy
CCS	Carbon Capture and Sequestration
CES	Constant Elasticity of Substitution
CISS	Coal in a Sustainable Society
COAG	Council of Australian Government
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DITR	Department of Industry, Tourism and Resources
ECNSW	Electricity Commission of New South Wales
ERAA	Energy Retailers Association of Australia
ESAA	Electricity Supply Association of Australia
ESD	Ecologically Sustainable Development
ESI	Electricity Supply Industry
ETSA	Electricity Trust of South Australia
GCP	Greenhouse Challenge Program
GDP	Gross Domestic Product
GHG	Greenhouse-gas
IEA	International Energy Agency
IHA	International Hydro Association
IPCC	Intergovernmental Panel on Climate Change
LCA	Life-cycle Analysis
LETAG	Lower Emissions Technology Advisory Group
LETDF	Low Emissions Technology Demonstration Fund
MARKAL	MARKet ALlocation
MATTER	MATerials Technologies for greenhouse-gas Emission Reduction
MESSAGE	Model for Energy Supply Strategy Alternatives and their General Environmental impacts
MFA	Material Flow Analysis
MIMES	Model for description and optimisation of Integrated Material flows and Energy Systems
MRET	Mandatory Renewable Energy Target
Mt	Million tonnes
NEM	National Electricity Market

NGAP	National Greenhouse Advisory Panel
NGGIC	National Greenhouse Gas Inventory Committee
NGRS	National Greenhouse Response Strategy
NGS	National Greenhouse Strategy
NGSC	National Greenhouse Steering Committee
NIEIR	National Institute of Economic and Industry Research
OECD	Organisation for Economic Co-operation and Development
PJ	Petajoules
ppmv	Parts per million by volume
PPP	Polluter Pays Principle
RBA	Reserve Bank of Australia
RES	Reference Energy System
RMS	Reference Material System
RRI	Resource Research Institute
SECV	State Electricity Commission of Victoria
SMHES	Snowy Mountains Hydro Electric Scheme
SRP	Shared Responsibility Principle
TIC	Techno-Institutional Complex
Translog	Transcendental Logarithmic
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1

INTRODUCTION

1.1 Background

Climate change is one of the most pressing problems facing humanity.[1] It is a result of increase in global temperature (global warming) caused by the release of greenhouse-gases into the atmosphere. The emission of greenhouse-gases is partly a result of natural environmental processes and partly due to human activity. The naturally occurring greenhouse-gases help balance the incoming and outgoing solar radiation, thus maintaining the earth's temperature at an average of about 15°C (2001). Without this natural phenomenon, the earth's average temperature would be 15–20°C below zero, which would make it difficult for living beings to survive. However, it is the human-induced activity that has been the major cause of global warming. Since the beginning of the Industrial Revolution – late eighteenth and early nineteenth centuries – the concentrations of greenhouse-gases in the atmosphere have increased dramatically. Atmospheric concentrations of CO_2 – a major greenhouse-gas – has increased by more than 30 per cent, from 280 ppmv during pre-industrial revolution, to 368 ppmv in the year 2000 (Houghton et al. 2001). The increase in anthropogenic greenhouse-gas concentration in the atmosphere tends to destabilise the naturally occurring *radiative forcing*[2] between the earth and solar system. This has resulted in an increase in the global average temperature by 0.6 ± 0.2°C since the late nineteenth century (Houghton et al. 2001). In Australia, the average temperature has increased by 0.7°C over the last century (Pittock 2003). In the absence of any policy action to reduce

[1] There is of course some scepticism about the enormity of this problem (see, for example, Lomborg (2001). This research however takes the more widely-held view – also endorsed by the IPCC – on climate change, namely, that climate change is indeed a pressing issue.

[2] Radiative forcing, according to Houghton et al. (2001), is a measure of the influence a factor has in altering the balance of incoming and outgoing solar radiation to the earth, and is an index of the importance of the factor as a potential climate change mechanism.

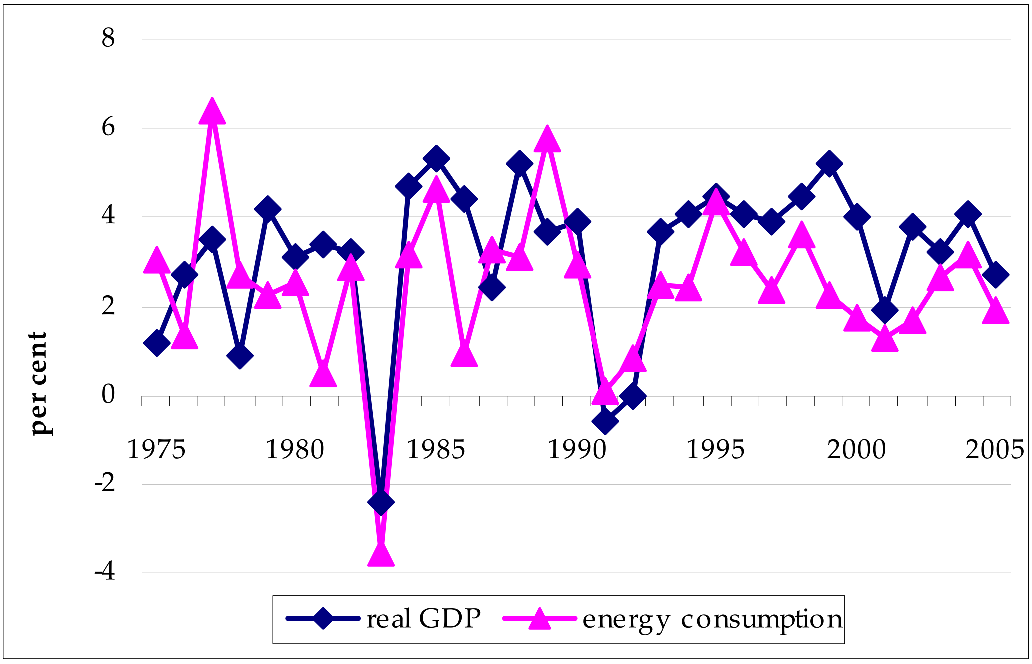
greenhouse-gas emissions, the world emissions are projected to increase substantially. This could lead to an annual average warming of 0.4°C to 2°C over most of Australia by 2030 and 1°C to 6°C by 2070, as compared to 1990 temperature levels (CSIRO 2001).

It is now widely accepted that even a slight increase in temperature would have a significantly detrimental impact on economic, social, and natural ecosystems. As evidenced in 2002, Australia experienced its worst drought since at least 1950 which was the first drought when the impact of human-induced global warming could be clearly observed. This drought not only led to the disruption of ecological system, but also decreased agricultural productivity, which reduced the rate of economic growth in Australia during 2002-03 by 0.75 per cent (Karoly, Risbey & Reynolds 2003). Further, the recent drought of 2006 is also expected to have a similar impact. ABARE (2006b) estimates that this drought could reduce economic growth in Australia for 2006-07 by around 0.7 per cent. According to Pittock (2003), the impact of climate change in Australia include: "*50 per cent decrease in water supply in Perth since 1970s … near-record low water levels in reservoirs in the south-east Australia in 2002-03 due to low rainfall and high temperature … increasing the severity of drought … severe and widespread bleaching on the Great Barrier Reef*". At the international level, the impact of climate change has been significant as well. Selected excerpts from Stern (2006) should substantiate this, "*China experienced losses in 1.2 per cent of GDP in 2004 due to combination of drought and flood … the 2000 flood in West Bengal destroyed significant transport infrastructures … the La Niña drought in Kenya in 1998-99 and 1999-2000 caused damage amounting to 16% of GDP for each year … the drought in Ethiopia between 1998-2000 caused poverty level to increase by 25% … Hurricane Katrina in New Orleans in 2005 costs 1.2% of US GDP … European heatwave in 2003 (2.3°C hotter than average) caused deaths of around 35,000 people across Europe*". In addition, the future impact of climate change is expected to be larger than in the past, mainly due to frequency of extreme weather variations and coastal flooding (ibid).

Emissions of greenhouse-gases come from a variety of sources and locations. The combustion of fossil fuels is the single most important source of anthropogenic CO_2 emissions, contributing about three-quarters of global emissions (Houghton et al.

2001). In Australia, the production and use of energy is the single largest source of CO_2 emissions. For example, in 2004, it accounted for over 85 per cent of total CO_2 emissions and 63 per cent of total greenhouse-gases emissions (AGO 2006). The Australian energy sector is dominated by fossil fuels, which accounted for around 95 per cent of primary energy consumed in 2005 (ABARE 2006a). Also, it is widely agreed that energy is an essential ingredient for economic prosperity. The link between energy consumption and economic growth in Australia is shown in Figure 1-1. This figure shows the annual growth rates of energy consumption and real GDP since 1975. It is noticed that energy consumption grew at a rate that closely matches the rate of growth in GDP. A rapid economic growth will clearly result in large increase in the demand for energy. But this growth will be sustainable only if there is a reliable, uninterrupted supply of energy in a form that does not threaten the environment. In Australia, the primary energy consumption is expected to increase by 46 per cent by 2029-30 to support an economic growth of 2.6 per cent per year (Cuevas-Cubria & Riwoe 2006). Nearly 94 per cent of this increase is likely to come from fossil fuels (ibid).

Figure 1-1 Annual growth in energy consumption and real GDP in Australia



Source: ABARE (2006a), ABS (2006a)

Electricity industry is a major contributor to environmental problems. According to Diesendorf (2003, p. 2), "*About 97 per cent of the electricity industry's greenhouse-gas emissions comes from twenty-four coal-fired power stations … an amount of greenhouse pollution equivalent to the annual emissions from about 40 million cars*". These emissions are equivalent to about half of total Australia's CO_2 emissions. The Australian electricity sector is the largest consumer of fossil energy and historically has been one of the fastest growing sectors (Dickson & Warr 2000). Electricity generation in Australia is dominated by coal-fired power generation. In 2005, about 84 per cent of Australia's electricity was generated from coal (ESAA 2006), compared to 26 per cent in European Union and 50 per cent in the United States (IEA 2006). Furthermore, it is anticipated that the amount of future investments needed to finance the world's burgeoning energy supply will be significantly higher than has occurred in the past. More than $16 trillion needs to be invested in energy supply infrastructure worldwide over the next three decades, out of which $10 trillion would be needed for the development of electricity sector alone (OECD/IEA 2003). Thus, if emissions are to be reduced substantially, the electricity industry will have to undergo profound changes in the technologies that generate electricity. However, unless there is a decisive way to address environmental problem, within a few years, growth in electricity sector emissions will start to drive Australia's greenhouse-gas emissions inexorably upward.

The urgency of reducing CO_2 emissions has begun to influence policy agendas worldwide only in the last decade. This was due to the increasing awareness about the impending dangers from climate change as mentioned earlier. Over the last several years, there have been increasing national and international pressures for countries to show responsibility by limiting CO_2 emissions. The first steps towards confronting the climate change were discussed in Toronto conference in 1988. In this conference, there was a "*call for action*" to reduce global CO_2 emissions. This was followed by the establishment of international environment bodies (such as IPCC and UNFCCC), which later on lead to the formulation of environmental protocol in 1997 (i.e., Kyoto

Protocol). The Kyoto Protocol requires each of the Annex I countries[3] to reduce its greenhouse-gas emissions to at least 5 per cent below 1990 levels in the commitment period 2008-2012. As of February 2007, 84 countries (including Australia) had signed the Kyoto Protocol, and 170 countries had ratified it. Australia has, however, not yet ratified the Protocol.

A range of policy options are being considered by various countries around the world to mitigate greenhouse-gas emissions. These policy measures are based either on command and control (or regulatory) standards, voluntary action, market-based mechanisms, or a combination of these approaches. Regulatory standards require polluters to meet a specific level of emissions target, regardless of the relative costs of meeting this target. This approach, together with voluntary action, have been mainly adopted in Australia, as it can be manipulated to serves commercial interest and achieve the political goal (see Section 3.2 for discussion on this issue). As suggested by ERAA (2004, p. 2), *"the existing policy environment in Australia, which is mainly characterised by regulatory approach, are a fragmented array of short-term State and Federal Government greenhouse-gas abatement measures that tend to be poorly targeted, overly complex and highly inefficient as mechanisms for reducing emissions*". Also, emission reduction from electricity sector are unlikely to happen from voluntary action (MMA 2002).

In contrast, market-based approaches alters market price signals to provide an incentive for consumers to conserve energy and for producers to invest in cleaner energy technologies. This approach is favoured by most economists and some environmentalists because it treats the environmental cost of energy in a transparent manner. Environmental factors are normally *"external"* to the market system, that is, they are not taken into account in the conventional economics oriented decision-

[3] Annex I comprises of 36 countries, including Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, and the United States.

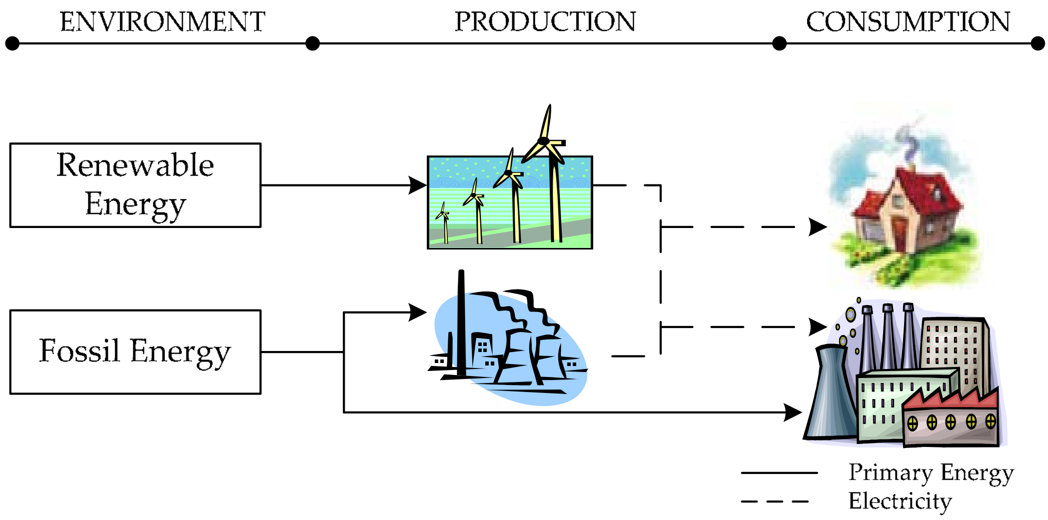
making. A market-based environmental-policy approach instead ensures that these externalities are internalised (in the economic costs); it allows market mechanism to send price signals that can achieve an appropriate balance between economic benefits of energy use and its environmental costs.

Emissions trading and carbon tax are two main market-based instruments that a policy maker can choose to reduce CO_2 emissions .[4] However, these approaches, carbon tax in particular, have not received unqualified support in the past. This is because of the perceived adverse economic impacts of these approaches – carbon tax, in particular. This opposition to the carbon tax option, this research contends, is based on less than complete understanding of the economics and broader dynamics of this option. Much of the discussion on carbon tax, for example, focuses on the formulation of carbon tax on the basis of Polluter Pays Principle (PPP). Based on this principle, the polluter (emitter) is defined as a consumer of primary energy (called direct energy) where combustion takes place. CO_2 emission is, therefore, considered as the sole responsibility of this emitter. The magnitudes of (direct) energy consumption and associated CO_2 emissions, based on PPP, are traditionally determined from an energy-balance approach. A schematic of this approach is shown in Figure 1-2. It shows the unidirectional relationship between energy, economy, and the environment. Here, the flow of energy is relatively straightforward, beginning with the primary energy extraction from the environment, to energy conversion, and ending with its end-uses such as by households and industry. In this approach, the electricity sector is considered as the consumer of primary energy; this energy is used for electricity production. Further, renewable resource based technology is considered as a *zero* emissions technology because it consumes only non-fossil energy. This implies that carbon tax based on PPP tends to penalise big polluters such as fossil fuel industries, particularly coal-based electricity industry. Based on this principle, electricity

[4] Carbon tax, in fact, involves a mixture of regulatory and market-based approaches. It requires government intervention in regulating the tax components to ensure the internalisation of externalities and, at the same time, requires free market principles to send price signals in order to achieve emission reduction.

generated from renewable energy resources would not be penalised at all. In addition, the end-users, such as households and industries, are only responsible for a small amount of direct fossil energy consumption, although they are large consumers of electricity produced from fossil fuels. The application of carbon tax, based on PPP, is considered inequitable by some because it holds fossil fuel consumers as solely responsible for creating emissions.

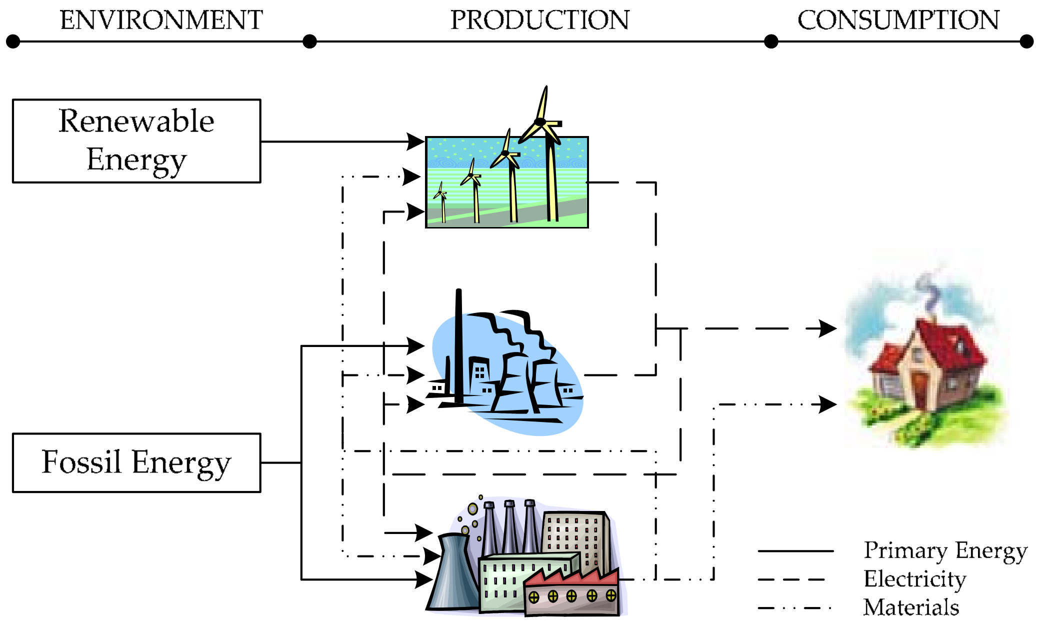
Figure 1-2 Energy-balance



An alternative approach to the formulation of carbon tax is based on Shared Responsibility Principle (SRP). This approach assigns the responsibility for CO_2 emissions not only to the polluters of emissions, but also the consumers of products and services whose production would have caused CO_2 emissions. In this approach, for example, renewable technology (which would have been considered as a zero emission technology in terms of the PPP approach) would be considered responsible for CO_2 emissions to the extent of energy and hence CO_2 emissions embedded in the materials that are used to build and operate this technology, over its lifetime. By a similar reasoning, industries would be liable for CO_2 emissions not only to the extent of their CO_2-emitting direct fuel consumption, but also to the indirect energy embedded in other material inputs they consume in the production process. Similarly, households are responsible for consuming CO_2-emission embedded consumption goods and services.

The task of determining indirect energy (and associated CO_2 emissions) for each economic activity in a society is, however, complex. Reasonably robust policy-useful estimations could, however, be developed by adopting a materials-balance approach.[5] A schematic of materials-balance is shown in Figure 1-3.

Figure 1-3 Materials-balance



The energy-economy-environmental interactions shown in materials-balance are relatively more complex. Take renewable technology as an example. It was considered as a zero emission technology under the PPP (or the energy-balance approach). However, under the materials-balance approach, some emissions are also attributed to this technology, in proportion to the consumption of materials. The increase in demand for renewable electricity will resulted in increase demands for these materials. The production of these materials would require additional energy, which inturn would produce CO_2 emissions. In contrast to the energy-balance, here the renewable electricity is also responsible for creating CO_2 emissions. Using the materials-balance

[5] The materials-balance approach discussed here is adapted from the materials-balance approach developed by Kneese, Ayers and d'Arge (1970). See Section 3.3.3 and Section 4.1 for more discussion.

approach, the environmental impact from the consumption of energy (and emissions) embodied in materials can also be captured. Hence, the responsibility for CO_2 emissions could be appropriately assigned, based on both direct as well as indirect (that is, embedded in the materials) energy consumption.

The application of carbon tax based on materials-balance (rather than the energy-balance) provides a fuller understanding of energy-economy-environmental interactions. Furthermore, this approach provides a foundation for allocating emissions to each economic activity in the economy in a manner that truly reflects environmental impacts of that activity. Despite this advantage, there is a lack of analysis and discussion about various facets of this approach. This is the subject of investigation in this research.

1.2 Research Objectives

Against the above background, the main objective of this research is to examine the appropriateness of carbon tax (designed on the basis of energy-balance and materials-balance approaches) as a policy option to reduce carbon-dioxide emissions from the electricity sector in Australia. In order to achieve this objective, four specific objectives have been set. These are as follows.

I. Review the evolution of the Australian electricity industry with a view to develop a wider perspective on the role of coal in the Australian electricity complex.

II. Provide an overview of the development of greenhouse policy in Australia with a view to examine the forces that have shaped this policy and, in particular, the role that coal–electricity compact has played in shaping this policy.

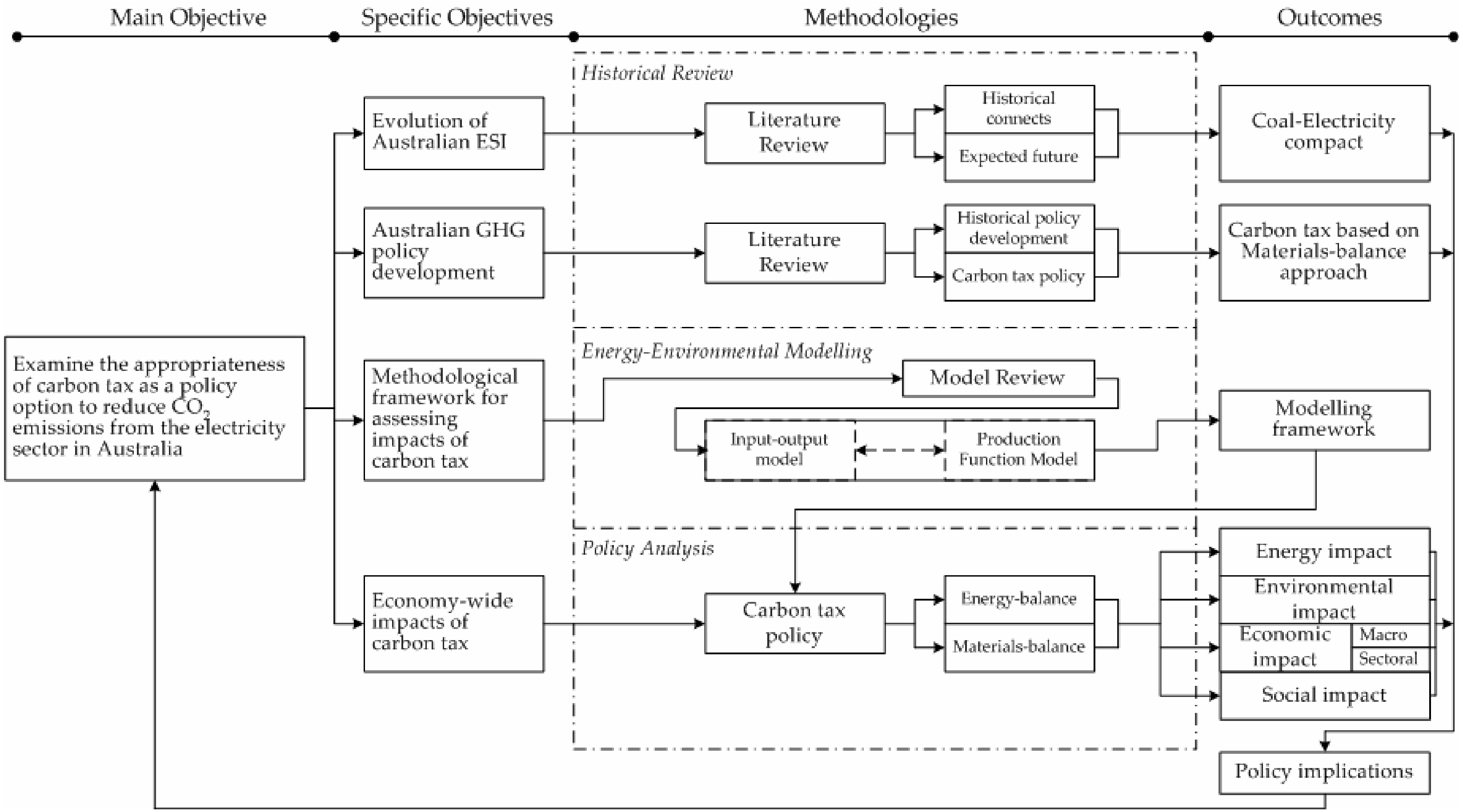
III. Review alternative methodologies available for designing a carbon tax and for determining the impact of carbon tax on the wider economy – and identify a methodological framework to be applied in this research.

IV. Apply the framework identified in III above to assess the economy-wide impacts of carbon tax and analyse the appropriateness of alternative conceptions of carbon tax as policy measures to reduce CO_2 emissions from the electricity sector in the Australian context.

1.3 Research Methodology

The overall methodological framework used in this research is shown in Figure 1-4. A combination of methodologies are applied in this research. These methodologies are divided into three parts – historical review, energy and environmental modelling, and policy analysis. A summarised overview of the salient features of these methodologies is provided in this section. A detailed description for each methodology is provided in relevant chapters of this thesis.

Figure 1-4 Overall research framework



1.3.1 Historical Review

The historical review in this research involves a review of two aspects – the evolution of electricity industry and the development of environmental policy in Australia.

For the first objective, the evolution of the electricity industry is reviewed. Several studies have reviewed the history of the Australian electricity industry, for example, ESAA (1973), McColl (1976), Rosenthal and Russ (1988), Johnson and Rix (1991), Kellow (1996), Sharma and Bartels (1998), Booth (2003), Sharma (2003), and Fathollazadeh (2006). These studies described changes in the electricity industry over time. However, the historical review in this research focuses specifically on the circumstances during the evolution of the electricity industry that lead to the intensification of coal–electricity compact. The review of the Australian electricity industry in this research is divided into five time periods – the origins of the industry (1880s-1900), the genesis of the coal–electricity compact (1900s-1950), the consolidation of the compact (1950s-1980), further strengthening of the compact (1980s-1990s), and the entrenchment of the compact (1990s-present). Further, a review of recent literature on technical, economic, and political aspects of the electricity industry is undertaken in order to indicate how the coal–electricity compact would influence the future development of the electricity industry.

For the second objective, the historical development of the Australian greenhouse policies is reviewed. Several studies have reviewed the evolution of greenhouse policy development in Australia, for example, Taplin (1994), Bulkeley (2001), Hamilton (2001), Hunt (2004), Christoff (2005), and Riedy (2005). The historical review undertaken in this research focuses on understanding the process of how greenhouse policy development has progressed in Australia. Greenhouse policy development in Australia is still in its infancy (as compared with the development of the electricity industry); it only started to exert some policy influence in the 1990s. Consequently, the review in this research particularly emphasises the changing stance of the Australian Government towards the greenhouse policy in the recent past. Further, a review of studies focusing on the application of carbon tax in the Australian context is performed in detail. This review focuses on developing an understanding of the basis (that is, energy-balance approach) on which carbon tax debate was founded in the past. It then proposes an alternative basis (that is, materials-balance) for the design of carbon tax.

1.3.2 Modelling Perspective

This research adopts a materials-balance approach for analysing the impacts of carbon tax. In this approach, the description of energy-economy-environmental interactions is underpinned by a detail representation of energy and material flows in the economy. The formulation of a framework required for such representation is obviously a challenging task. This challenge is addressed in this research in the following manner. First, the conceptual foundations of various methods, that can incorporate material and energy flows are reviewed. These methods are classified into two – methods that are based on physical material flows and those based on embodied energy flows. The purpose of this review is to determine the strengths and weaknesses of different methods, so that the appropriate method for this research can be selected. This review was conducted in the context of the following criteria; the ability to perform analysis at sufficient level of sectoral detail (spatial scope), ability to provide analysis over long time-frame (temporal scope), ability to capture changes in technology and capital investment (dynamics), ability to analyse price impacts of carbon tax (price considerations), and the flexibility in terms of data requirements.

Based on this review, input–output method, with modified production function, is selected for application in this research. The framework based on this method comprises of five interlinked modules. In the first module, CO_2 emissions are allocated across different economic sectors based on energy- as well as materials-balance approaches. Based on these allocations, CO_2 intensities are estimated. In the second module, a carbon tax is assigned based on energy intensities. In the third module, the relative changes in energy and material prices, in response to a carbon tax, are estimated. The sectoral price effects are estimated using input–output price model. In the fourth module, the substitution effects, in response to changes in energy and material prices, are analysed. The design of the production function, for the analysis of these substitution effects, is based on multi-stage estimation procedure developed by Fuss (1977). The substitution possibilities between aggregate factor inputs (capital, labour, electricity, energy, and materials) and energy inputs (coal, oil, and gas) are estimated using Translog cost function; whereas the substitution possibilities between material inputs are estimated using Cobb-Douglas cost function. In the final module, the economy-wide impacts of carbon tax are analysed. These impacts include – energy, environmental, economic, and social. These impacts are analysed using energy-environment oriented input–output model, proposed by Proops et al. (1993).

1.3.3 Policy Analysis

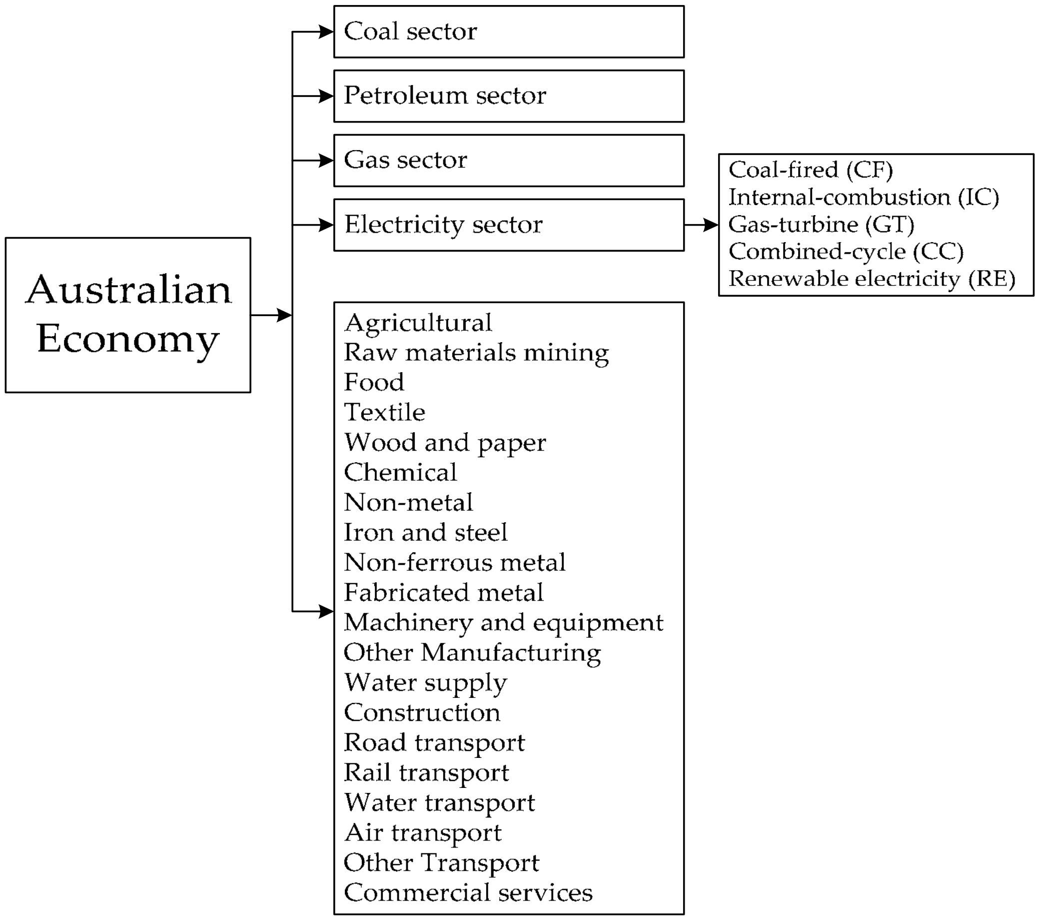
The policy implications of carbon tax (based on both energy- and materials-balance approaches) are analysed with reference to CO_2 emissions.

A base-case scenario is created in this research so that the impacts arising from the application of carbon tax based on energy- and materials-balance approaches could be compared and policy inferences drawn. In the first instance, the economy-wide impacts of carbon tax are assessed without imposing any *a-priori* emissions limits. Two levels of carbon tax are considered, namely, \$10 per tonne and \$20 per tonne of CO_2 emissions. An assessment of the impacts of carbon tax is also undertaken in a situation where there is an *a-priori* restriction on CO_2 emissions from the electricity sector. A comparison is also made between the policy implication of early and delayed introduction of carbon tax.

1.4 Scope of this Research and Data Considerations

This research focuses on Australia. The spatial, temporal, and sectoral scope of analysis has been dictated by the consideration of data availability. The scope of sectoral coverage is shown in Figure 1-5.

Figure 1-5 Sectoral coverage for this research



The Australian economy, in this research, has been organised in terms of eight energy sectors (suppliers of primary and secondary energy) and twenty economic sectors (suppliers of non-energy materials). This sectoral organisation is based on national input–output tables published by the Australian Bureau of Statistics (ABS). The 28 energy and economic sectors (as noted above) are an aggregated version of a number of sectors – ranging between 106 and 113 – represented in the Australian input–output tables. The four energy supply and conversion sectors are adopted directly from input–output tables. The electricity sector has been disaggregated into five generation technologies – namely – conventional coal-fired, internal combustion, gas turbine, combined-cycle, and renewable. Such disaggregation allows for a representation of different characteristic of major electricity generation technologies used in Australia which account for more than 97 per cent of electricity production capacity. This disaggregation is also accord with the annual data published by the Electricity Supply

Association of Australia (ESAA). The renewable electricity technology sector in this research includes hydro, wind, solar thermal, photovoltaic, etc. These technologies do not consume fossil energy directly for electricity production but are highly materials intensive as compared to fossil fuel-based power station.

The aggregation of twenty economic sectors is based on energy intensiveness of each sector. More energy intensive sectors are kept separate while less energy intensive sectors are aggregated into one sector. For example; *iron and steel* and *non-ferrous metal* sectors are kept separate, while the sub-sectors in *agriculture*, *food*, *textile* and *commercial* sectors are combined (see Table 5-5 for the summary of sectoral classification). As a consequence, some sectors comprise a single sector, while others – several. The sectoral classification of this research, as compared to sectoral classification of national input–output tables, is given in Table C-1 (Appendix C, pp. 234-237).

To avoid double counting of CO_2 emissions due to energy consumption, this research has constructed primary energy consumption tables in correspondence with sectoral classification of the input–output tables (as outlined in Figure 1-5). The primary energies considered in this research are – black coal, brown coal, natural gas, and petroleum. The construction of this table is based on primary energy consumption data for 28 sectors, which are published annually by the Australian Bureau of Agricultural and Resource Economics (ABARE 2006a). Further, the CO_2 emissions are estimated on the basis of emission factors for each type of primary energy. These emission factors are taken from NGGIC (1996).

The time period for analysis in this research is 1980 to 2020. The most recent input–output table used in this research is for the year 2002 – published by ABS in July 2006.

As mentioned above, this research requires a wide range of time-series data on energy, economy, and environment. These data are collected from a variety of published sources, and supplemented by personal correspondence with professionals working in these sectors of the economy. The overview of data considerations for each specific objective is shown in Table 1-1. Further details of data sources and preparation (for modelling purposes) for this research are discussed in Section 5.7.

Table 1-1 Data considerations for each specific objective

Objectives	Data requirements	Data Availability	Data Sources	Data gap	Strategies to overcome data gap
1 & 2	Information for electricity sector and environmental policy in the past and expected future	Yes	Books, journal articles, reports, legislation, and policy papers	Partial	
3	(a) Technical IO coefficients	Yes	(a) ABS	No	
	(a) Capital IO coefficients	No		Yes	Secondary data[#]
	(b) Primary energy consumption	Yes	(b) ABARE	No	
	(c) CO_2 emission factor	Yes	(c) AGO	No	
	(d) Electricity capacity by technology	Yes	(d) ESAA	No	
	(d) Electricity generation by technology	Yes		No	
	(e) Factor cost shares for ESI	Incomplete	(e) ABS (input–output tables)	Yes	Data interpolation
	(f) Factor Prices for ESI	Incomplete	(f) ABS (labour and materials prices)	Yes	Data interpolation
			(f) ABARE (non-electric energy price)	No	
			(f) ESAA (electricity price)	No	
			(f) RBA (capital price)	No	
4	(a) GDP growth rate for future	Yes	(a) Commonwealth of Australia	No	
	(a) Labour productivity for future	Yes		No	
	(b) Energy efficiency improvement	No		Yes	Assumption

Note: ABARE-Australian Bureau of Agricultural and Resource Economics; ABS-Australian Bureau of Statistics; AGO-Australian Greenhouse Office; ESAA-Electricity Supply Association of Australia; RBA-Reserve Bank of Australia.

\# Data to develop capital input–output table is not directly available. This is estimated from secondary data (that is, from various other ABS publications).

1.5 Significance of this Research

This research has made a significant contribution to the analysis of one of the most critical issue currently dominating policy debate in Australia, namely, climate change. In particular this research has provided valuable insights into assessing the appropriateness of carbon tax as a policy measure to reduce climate-changing CO_2 emissions.

Traditionally, carbon tax is formulated based on the Polluter Pays Principle. According to this principle, emissions responsibility is allocated to various sectors in the economy by using an energy-balance approach. This approach considers the energy-economy-environmental interactions as arising from the flow of direct energy only and ignores energy embodied in the use of materials. The application of this approach for policy formulation could lead to an incorrect estimation of energy-economy-environmental interactions and hence result in erroneous policy choices. This research proposed an alternative concept for designing carbon tax, namely, based on Shared Responsibility Principle. Under this principle, emissions responsibility is re-allocated across the economy on the basis of a materials-balance approach. This conception of carbon tax – this research has demonstrated – has significantly different (that is, different from those based on Polluter Pays Principle) ramifications on the economy. This demonstration is provided in this research through the development and application of a comprehensive research framework that allows for the capturing of the complexity of the energy-economy-environmental interactions in a detailed manner, at national, sectoral and sub-sectoral levels.

The results of this research might be of interest to the Australian environmental policy-makers, policy analysts and professionals engaged in developing Australia's response to the climate change issue. This research should also be useful for other researchers who might wish to employ this framework to analyse other energy-environmental issues.

1.6 Organisation of the Thesis

This thesis consists of seven chapters.

Chapter 2 describes the evolution of the coal–electricity compact in the Australian context. This description includes a brief historical overview of Australian electricity industry from its inception through to the present time and its likely future evolution.

Chapter 3 provides an overview of the development of greenhouse policy in Australia. The purpose of this review is to demonstrate the government's attitudes towards environmental policy (carbon tax in particular). The rationale and strategy for the use of carbon tax (based on materials-balance approach) as a future policy option is also discussed.

Chapter 4 reviews methods for applying the materials-balance concept, for determining the direct and indirect contribution made by various economic activities to CO_2 emissions. The purpose of this review is to understand the relative strengths and weaknesses of each method in order to select an appropriate method for this research. The methodological framework, for assessing the impacts of carbon tax, is then described in detail in Chapter 5.

In Chapter 6, the economy-wide impacts of carbon tax are analysed. This analysis is carried out separately, based on energy- and materials-balance approaches. Also discussed in this chapter are some of the policy implications of carbon tax in the Australian context. Chapter 7 presents the main conclusions of this research, and provides some recommendations for future research.

CHAPTER 2

EVOLUTION OF THE COAL–ELECTRICITY COMPACT

The electricity industry is one of the most important industries in the Australian economy. In the year 2005, it contributed approximately 1.6 per cent to the gross domestic product, was worth around $100 billion (nominal prices) in assets, employed nearly 40,000 persons, incurred a capital expenditure of over $6 billion (nominal prices), and yielded a sales revenue of over $34 billion (nominal prices) (ABS 2006b). The industry provided over 22 per cent of the total final energy for domestic consumption in 2004, which increased from 14 per cent in 1980 (ABARE 2006a). The electricity industry also has a significant impact on climate change. It contributed nearly 35 per cent of total Australian greenhouse-gas emissions in 2004 (nearly 50 per cent of total CO_2 emissions) (AGO 2006). This is because coal is the dominant fuel for electricity production in Australia, contributing about 84 per cent of the electricity produced in 2004 (ESAA 2006). It is expected that the domination by coal is likely to continue in the years to come. For example, it is estimated that coal will represent about 70 per cent of electricity production in 2030 (Cuevas-Cubria & Riwoe 2006). The environmental consequences (in particular, CO_2 emissions) of such domination should be obvious. By this reasoning, the "role" of coal in the wider electricity context would be a major consideration in any environmental policy initiative taken by the country to contain CO_2 emissions. A deeper understanding of this role is therefore a pre-requisite for developing an insightful perspective on the efficacy of various environmental initiatives for containing CO_2 emissions, including carbon tax – the focus of this research. This chapter is devoted towards that end.

This chapter is organised as follows. Section 2.1 provides a brief historical overview of the Australian electricity industry from its inception to the present. This review is intended to demonstrate why the electricity system in Australia became dominated by coal. This is followed by a discussion on the likely future direction of the electricity industry (Section 2.2), and why coal is likely to continue to play a dominant role in the future. Finally, a summary of the major findings of this chapter is provided in Section 2.3.

2.1 Historical Review of the Australian Electricity Industry

The focus of the review in this section is to demonstrate the circumstances during the historical evolution of the electricity supply industry that have led to the intensification of the coal–electricity compact. There is an extensive literature that reviews the history of the evolution of the Australian electricity industry, for example, ESAA (1973), McColl (1976), Rosenthal andRuss (1988), Johnson and Rix (1991), Kellow (1996), Sharma and Bartels (1998), Booth (2003), Sharma (2003) and Fathollazadeh (2006). Some broad inferences can be drawn from these reviews about the nature of the coal–electricity compact. In this chapter, these inferences are supplemented by additional information in order to develop a more complete picture of this compact. For this purpose, the historical review in this section is divided into five time periods – the origins of the electricity industry (1880s–1900), the genesis of the coal–electricity compact (1901–1950s), the consolidation of the compact (1950s–1980s), further strengthening of the compact (1980s–1990s), and its entrenchment (1990s – present).

2.1.1 Origins of the Electricity Industry (1880s–1900)

Australia is a federation of six states and two territories. The Australian electricity industry started in the late nineteenth century, around state capitals and rural towns. At that time, electricity was relatively more expensive than other energy sources and was considered as a luxury. The technologies that were used for generating electricity in those day were typically distributed, with separate plant supplying electricity to each town and community (Sharma & Bartels 1998). The industry ownership was largely private.

The availability of indigenous coal was an important determinant of the early development of the electricity industry in Australia. Australia possessed abundant reserves of coal, and the coal mining industry was already well established prior to the inception of the electricity industry. For example, New South Wales is well endowed with large reserves of high-quality black coal. In fact, the first coal field in Australia was discovered in New South Wales in the Hunter and Illawarra regions in 1791 (Hargraves 1993). Victoria has significant reserves of brown coal and has mined them, since 1890, in the Latrobe Valley. However, qualitatively this coal is inferior to black coal. This posed many problems in mining and combustion. Victoria has therefore been forced to rely on black coal from New South Wales for electricity generation. Queensland, like New South Wales, has abundant supplies of black coal. South Australia, however, does not have any appreciable coal reserves compared with other states. The only accessible source of coal is available in Leigh Creek. However, it is expensive to mine and transport, difficult to burn, and has ash and salt problems (Booth 2003). South Australia has therefore relied on imported black coal from Britain and New South Wales for electricity generation. Tasmania is the only Australian state that has not relied on coal as a fuel for electricity generation. Tasmania has large hydro reserves, which were the least costly and most flexible form of power generation at that time. Tasmania was also the first state to establish an authority exclusively responsible for electricity supply, when the first power station became operational in 1895 (Rosenthal & Russ 1988). In summary, coal was the most important primary energy fuel for electricity generation in most parts of Australia in the very early years of the development of the electricity industry. Separate, small power stations based on coal therefore became the norm in those years.

2.1.2 Genesis of Coal–Electricity Compact (1901–1950s)

Following the formation of the Australia federation in 1901, energy became one of the residual powers retained by the states (AATSE 1988). The Australian state governments began to realise the development potential and political appeal of electricity (Sharma 2003). Further, it was widely argued that the industry was under increasing return to scale[6] and natural monopoly (Fathollazadeh 2006). Accordingly,

---

[6] According to Eatwell, Milgate and Newman (1998), this means that *"total costs of production are lower when a single firm produces the entire industry output than when any collection of two or more firms divided the total among themselves"*.

state governments began to develop and control their electricity systems. However, it was not until the 1920s that steps were taken towards government ownership and control of the industry, through the enactment of a variety of state legislations.

During this period, the emergence of the coal–electricity compact in many states became clearly visible. The first significant step was taken in Victoria. Major industrial problems on the New South Wales coalfields in 1917 left Victoria with supply shortages of black coal. To deal with this situation, the State Electricity Commission of Victoria (SECV) was formed in 1921, following the establishment of the Victorian Brown Coal Advisory Committee. The SECV was established with a very clear purpose – to develop brown coal resource at Yallourn (the only known coal resource of any significance in Victoria at that time), in order to remove Victoria's reliance on imported New South Wales coal. Despite the difficulty in using brown coal for electricity generation, the government gave support for this development, which would not have occurred had matters been left to the market (Kellow 1996). This led to a rapid development of brown coal mining at Yallourn, where output rose from 79 thousand tons in 1921, to 4.8 million tons in 1944 (Shaw & Bruns 1947). A similar situation occurred in South Australia. Following the Second World War, the supply of coal became critically low and there was a fear of black coal supply disruptions to South Australia. In order to prevent such a situation, the South Australian Government took over all power generation and transmission facilities in 1946, and established the Electricity Trust of South Australia (ETSA). Although it was costly to change the existing electricity system in order to consume state coal, the government announced proposals for the construction of two power stations. Likewise, the New South Wales government had established the Electricity Commission of New South Wales (ECNSW) in 1950, and assigned it the task of building a supply system based primarily on power stations located on the coalfields and transmitting power to the metropolitan areas (Booth 2003).

By the late 1940s, the electricity industry was predominantly owned by the state governments (Sharma 2003). It was also during this period that demand for electricity increased dramatically, from 172 GWh in 1910 to 13,622 GWh in 1954 (Boehm 1955).

The increase in electricity production capacity was associated with economic growth and industrialisation in that period. The political support for indigenous (state, in this context) fuel sources (that is, coal) and the increasing reliance of the Australian economy on electricity during this period resulted in the creation of electricity supply systems that were dominated by coal-fired power plants. This created a system of "lock-in" by coal-based technology (or in other words, a coal-based technological complex), which was to prove difficult to overturn in the later years.

2.1.3 Consolidation of the Compact (1950s–1980s)

From the 1950s to 1980s, the role of state governments in guiding electricity industry development increased substantially. The strong economic growth after the Second World War, combined with technological developments in large electricity generation capacities, propelled the Australian electricity industry into the "*golden age*" (Johnson & Rix 1991). The continuous trends in increasing electricity demand and a series of power shortages during 1949–1953 firmly established the grounds for centralised electricity supply. This led to a vertical integration of the electricity supply industries in all states, controlled by the state statutory authorities. These authorities were responsible for all decisions such as dispatching, pricing, and investment planning. The power plants were dispatched centrally, in terms of their economic merit. Environmental impacts from electricity generation did not influence decisions relating to the scheduling of existing capacity and/or investments in new capacity (Sharma & Sproule 1998). The government decision-making at that time generally disregarded the pollution damage from environmentally inferior technologies, that is, the environmental externalities associated with the use of polluting electricity technologies were implicitly valued at zero dollars (Kline 2001). Further, under centralised control, the number of power stations increased significantly, including large hydro (for example, the Snowy Mountains Hydro Electric Scheme)[7] and many steam-thermal

---

[7] The construction of the SMHES started in 1949 and was completed in 1974. This scheme is the first inter-state co-ordination scheme which was jointly financed and operated by the Australian Capital Territory, New South Wales and Victoria.

power stations. The generating capacity of SMHES is approximately 3,756 MW, producing electricity on average of 4,500 GWh per year. This project consists of 16 large dams and 7 power stations. Many of these investment decisions, especially SMHES, were found to be non-economical and, as suggested by Johnson and Rix (1991, p. 19), "*the private sector would not be interested in constructing such scheme, as it produced a negative net present value*". However, the policy behind such decisions was to provide adequate and reliable energy supply, in order to support economic growth and prosperity.

Further, in 1979, the Australian government encouraged the state electricity authorities to invest heavily in expanding generation capacity in anticipation of the "*mineral boom*" (Saddler 1996). At the same time the possibility of using nuclear energy for electricity generation drew the attention of the Australian electricity authorities. This is because the practicality of nuclear power generation had been well established in many countries, and Australia possessed significant reserves of uranium. The Australian Atomic Energy Commission (AAEC) took the role of promoting the construction of a nuclear reactor in New South Wales. Although initially the government committed to building the reactor, the project was abandoned, as it was considered as being ill conceived and uneconomic (TEC 1984). Once again, abundant supplies of coal had rendered nuclear energy as uneconomic and hence unfeasible in Australia. As a result, a series of coal-fired power stations were established in order to meet electricity needs for an expected "*mineral boom*". These electricity infrastructure projects, as selectively extracted from Booth (2003), include:

> *… in Victoria … the Loy Yang project … eight 500 MW units fed by new open-cut brown coal mine … improve the performance of Hazelwood and much money was spent on successive modification program … developed the Yallourn power station, initially with two 350 MW units, and later extended it by two 375 MW units; … in New South Wales … the ECNSW decided to take the Bayswater project (4 × 660 MW) to completion … proposed an innovative scheme to finance new four 660 MW units at Eraring on Lake Macquarie … to complete 2 × 660 MW project at Mt Piper; … in Queensland … began the development of Gladstone power station project with installed capacity of 1,680 MW*

> *… new generation of power stations based on ten 350 MW unit size installed at Tarong (4 units), Callide B (2 units) and Stanwell (4 units); … in South Australia … additional to 1,280 MW natural gas-fired Torrens Island power plants, the 500 MW Northern power station was developed to make more efficient use of the Leigh Creek coal; … in Western Australia … a series of four 200 MW units … two at an extension to Muja power station operating on Collie coal … two were to be installed at Kwinana and fired by oil … which later converted to coal firing as a response to oil shocks.*

The strategy of moving successive construction projects from coalfield to coalfield was adopted so as to make use of coal from state-owned coal mines and privately owned companies (ibid). Further, these coal-fired power plants benefited from a massive amount of government investment. The accelerated power station construction program placed a significant burden on state financial resources. In several cases state authorities borrowed money from overseas, which led to the worsening of the country's current account deficit, to around 4.5 per cent of GDP (Kelly 1992, p. 198). As previously mentioned, the rationale behind the development of the electricity industry was to provide a cheap and reliable electricity supply; the construction of these coal-fired power plants was therefore heavily subsidised. These subsidies were in the form of government-guaranteed borrowings which gave electricity authorities access to lower-cost debt finance, exemption from paying taxes (such as income tax and other taxes and charges) and other non-taxation financial imposts, in return for those electricity authorities performing community service obligations and allowing differing degrees of control by the minister in each state (Booth 2003). Therefore, the development of the electricity industry during this period created a system of mutually beneficial symbiosis between the political, cultural, social, economical and technical interests; which was used by the political parties in Australia to promote their political agendas and hence to improve their electoral prospects (Sharma 2003). In response to the development mentioned above, the environmental critics of the electricity industry had very quickly recognised that many of the new investments during this period would not be needed and were, therefore, wasteful of public funds and unnecessarily detrimental to the environment (Saddler 1981).

This period clearly consolidated the coal–electricity compact by not only expanding its coal-based technology, but also the associated institutions governing the industry.[8] In other words, this period has firmly established the coal-based technological lock-in and started the creation of the institutional lock-in of the coal–electricity compact in Australia.

2.1.4 Further Strengthening of the Compact (1980s–1990s)

By the early 1980s, the structure of the electricity industry, which was characterised as a "*natural monopoly*", was challenged. As a result of the over-expansion of electricity capacity in the 1970s and early 1980s, the electricity industry was criticised as being inefficient. This inefficiency, according to the Industry Commission (1991b), was due to poor investment decisions that led to overcapacity, overstaffing and pricing inefficiencies. This criticism initiated a process of internal reform of the electricity industry with a view to improving the industry's performance. It is important to note here that although state governments appeared to be a driving force in the development of the electricity industry in past decades, it was electricity authorities that, with the technical knowledge and expertise in the electricity industry, had a high level of control of the industry. Therefore, following the criticism by the Industry Commission, the state governments took this opportunity to intervene in the electricity utilities and at the same time improve their own credentials as responsible economic managers, by adopting legislative and non-legislative measures focusing on better management and control of the industry (Sharma 2003). Such an attempt was first initiated in 1982 by the new government in Victoria to make the SECV more accountable to the government (Johnson & Rix 1991). This process was then followed by other state governments, especially New South Wales and Tasmania. In response to the government's approach, the electricity authorities undertook strategic initiatives to improve their image and to ensure their longer-term survival by adopting a number of

---

[8] The process of technological and institutional lock-in in the energy system is discussed in Unruh (2000; 2002) through the notion of "*Techno-Institutional Complex*" (TIC).

reform measures.[9] This shows that the role of the governments in shaping the electricity industry was further strengthened. This is well observed by Sharma (2003):

> *A review of the history of electricity in Australia also reveals that reform measures actually adopted by the respective state governments (from among those recommended/dictated by various inquiries/economic analyses) were well circumscribed by the political exigencies of the time. Selected excerpts from Kellow (1996) should substantiate this observation: '… in Victoria … the recommendations to ensure public consultation in energy policy were not implemented as they did not find favour with the government … the government did not take initial steps to implement recommendations arising from integrated least-cost planning study … (and) found the electoral attraction of power station construction irresistible … the energy policy document was carefully crafted to woo swinging voters … addressed concerns about employment and environmental protection … decision to proceed with a (particular) project was not based on careful economic analysis but on the fact that it would provide continued employment ... government's flip-flopping before and after the election.' The very political forces which contributed to the development of an inefficient electricity industry in Australia also contributed to the improvements in its efficiency.*

Although this period witnessed a slow growth in electricity demand and changes in industry structure to address the problem of overcapacity, many projects that were under construction in the preceding period were commissioned. This increased the share of coal in electricity generation, at the expense of oil-fired and hydroelectric power plants (see Table 2-1). This shows that even in the era when the industry was faced with a changing course (that is, internal reform), the coal–electricity compact further strengthened its status under the combined influence of technological lock-in and institutional lock-in.

[9] Details of these reform measures can be found in Johnson and Rix (1991) and Kellow (1996).

Table 2-1 Installed capacity, electricity generation and fuel consumption in ESI

	Installed Capacity						Electricity Generation						Fuel consumption					
	Total (MW)	CF (Per Cent)	IC	GT	CC	RE	Total (GWh)	CF (Per Cent)	IC	GT	CC	RE	Total (PJ)	Bl C (Per Cent)	Br C	NG	Oil	RE
1955	3,526	79	5.1	-	-	16	13,853	83	2.6	-	-	14	237	51	29	-	6.1	14
1965	8,455	73	1.8	-	-	25	33,461	74	0.8	-	-	25	464	37	34	-	3.7	25
1975	19,594	69	1.3	1.6	-	29	66,840	76	0.8	0.1	-	23	820	41	29	4.0	3.1	23
1985	32,450	73	1.1	4.2	-	21	111,348	85	0.7	1.0	-	13	1,245	49	25	8.1	1.8	16
1995	38,115	73	0.9	5.8	0.3	20	160,114	88	0.3	1.2	0.4	10	1,623	55	26	8.7	0.4	10
2005	44,889	70	0.3	8.3	4.5	17	216,647	87	0.1	1.4	4.3	7	2,288	53	31	8.4	0.3	7

Sources: ESAA (various).
Note: CF – Coal-fired; IC - Internal combustion; GT – Gas-turbine; CC – Combined-cycle; RE – Renewable electricity; Bl C - Black coal; Br C - Brown coal; NG - Natural Gas.

2.1.5 Further Entrenchment of the Compact (1990s – present)

In the 1990s, the Australian state governments agreed to initiate a broader economic reform program (also known as micro-economic reform or simply market reform). This reform program was based on the belief in the supremacy of "*free market principles*" in enhancing economic efficiency[10] (Sharma 2003). In Australia, the case for electricity industry reform was built on the grounds that it would lead to substantial cost savings, lower electricity prices, and other economic benefits (Hilmer, Raynor & Taperell 1993; Industry Commission 1991b, 1995). Further, taking note of the increasing concerns about environmental issues in the 1970s and 1980s, proponents of reform argued that reform would also be beneficial for the environment. For example, *"a competitive market will provide the right price signal which will ensure that efficiency measures, renewable energy options and demand side measures are adopted where they are more cost effective"* (AGPS 1994). Although there was some questioning[11] of such claims, it was, however, unable to dent the political opinions in favour of change (Sharma 2003).

Accordingly, in 1991, the state governments agreed on a reform package for the electricity industry, which included the creation of the National Electricity Market

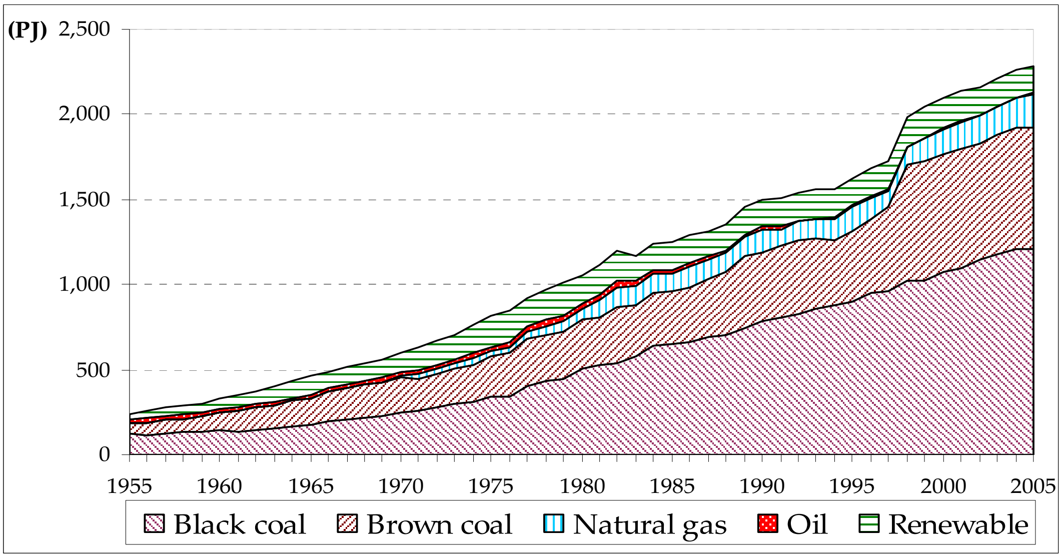
[10] Economic efficiency is often used interchangeably with community welfare and public interest.

[11] For details, see Johnson and Rix (1991) and ESAA (1996).

(NEM)[12]. The NEM was expected to create an environment in which free and fair competition can be achieved. In the NEM, public and privately owned generators greater than 30 MW compete by lodging bids to supply electricity to a common pool on a half-hourly basis. Bids are then ranked and dispatched on the basis of a purely economic criterion, namely, the lowest to the highest bid prices (Sharma 2003). The bid price, therefore, is essentially its short-run marginal cost which depends primarily on the type of fuel used and the nature of fuel procurement contracts between various market players (Sharma & Sproule 1998). Such bidding and dispatching criteria clearly discourage any other considerations, such as technical, social or environmental, which will invariably result in higher costs (Sharma 2003). As brown coal is the cheapest energy source for electricity production, its share of total primary energy consumption, in recent years, has increased to the same level as in the 1960s. Having reached 300 PJ in 1982, consumption of brown coal did not exceed 400 PJ for six years (until 1988), and it did not exceed 500 PJ for another eight years (until 1996). However, within the two years to 1998, the use of brown coal for electricity generation jumped to over 600 PJ (see Figure 2-1).

[12] The NEM was established across all states except Tasmania (which subsequently joined in 2005), Western Australia, and Northern Territory.

Figure 2-1 Primary energy consumption for electricity generation

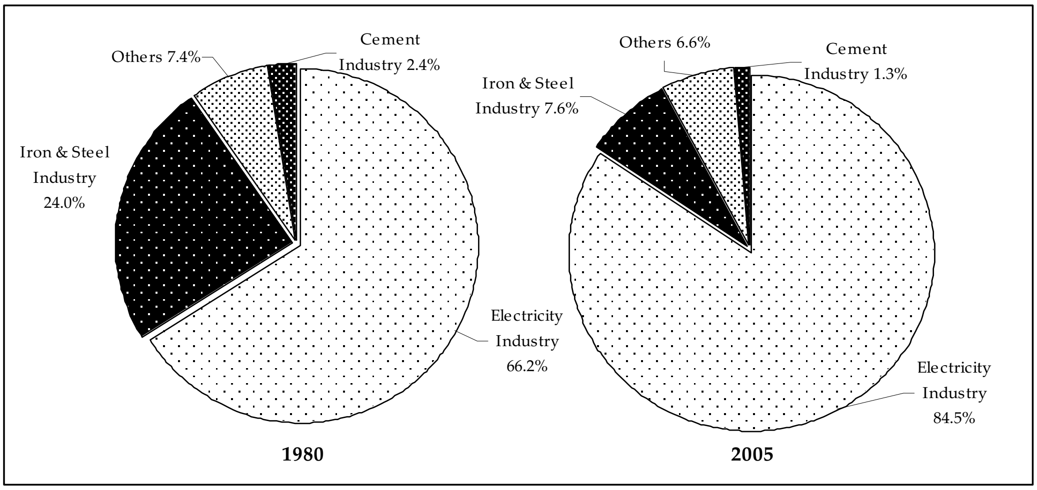


Sources: ESAA (various).

Recent market arrangements also support the development of coal-based electricity generation, which further entrenched the coal–electricity compact. For example, the privatised brown-coal-fired Hazelwood power station in the Latrobe Valley had been refurbished in the late 1990s, which extended its life by another 30 years (Hamilton 2001, p. 28). According to Hamilton (2001), it is likely that a similar strategy – of refurbishing existing brown-coal-fired power stations – would be adopted to meet future electricity demand under current market arrangements. In addition to the refurbishment strategy, new coal-fired power stations were also continuing to develop despite the pressing environmental concerns during that period, particularly from the impacts of climate change from combustion of coal. For example, in 1994, the construction of a new 135 MW coal-fired power station in the Hunter Valley was approved, even though there was a massive overcapacity of electricity generation in New South Wales (ibid, p. 35).

The development of the NEM is also the most important development for the domestic thermal coal market (Productivity Commission 1998). In addition to the increase in electricity production from brown coal (as discussed earlier), the use of black coal for electricity generation also increased significantly. The share of black coal for electricity generation increased from 49 per cent in 1985 to 53 per cent in 2005 (see Table 2-1). This has led the domestic market share of black coal for electricity generation to increase from 66 per cent in 1980 to 85 per cent in 2005, as shown in Figure 2-2.

Figure 2-2 Domestic market share of black coal



Sources: ABARE (various).

The discussion above clearly shows that the recent market arrangements favour the use of black- and brown-coal-fired technology for electricity generation. Such development further solidifies the coal–electricity compact by way of further entrenching the institutional lock-in for the use of coal in the electricity industry.

2.2 Future Direction of the Australian Electricity Industry

Based on the historical review of the Australian electricity industry in Section 2.1, it is clear that coal has traditionally been the dominant energy source for electricity generation in Australia. The electricity industry in Australia is locked into coal-based technology through continuous development of physical structures using this technology. As the coal-based technological system expanded, institutions (through extensive linkages between the coal industry, electricity utilities, and governments) also emerged in a co-evolutionary manner to sustain the well-established technological system. This technological and institutional lock-in of the coal–electricity compact has the ability to withstand external pressures (such as the current environmental pressures) and make the transition to alternative technologies difficult. According to Unruh (2000, p. 818):

> *Techno-Institutional Complex (TIC) developed through a path-dependent, co-evolutionary process involving positive feedbacks among technological infrastructures and the organizations and institutions that create, diffuse and employ them. Once locked-in, TIC are difficult to displace and can lock-out alternative technologies for extended periods, even when the alternatives demonstrate improvements upon established TIC.*

This section discusses the likely future direction of the Australian electricity industry. Future electricity directions are analysed within three arenas – technical, economic, and political – to show why coal is likely to continue to be a dominant electricity resource in the future.

2.2.1 Technical Considerations

Australia has abundant supplies of coal resources, with around 800 years of brown coal and 290 years of black coal deposits (OECD/IEA 2001). In addition to these abundant coal reserves, Australia is also well endowed with renewable resources, especially solar and wind. High and consistent winds are common along the southern coastline and in Tasmania where wind speed exceeds 8 m/s, while average solar radiation exceeds 4.5 kWh/m^2/day in many areas of New South Wales, South Australia, Western Australia, and the Northern Territory (Blakers & Diesendorf 1996). With current electricity demand (of around 220 million MWh per annum), the land area of about 900 km^2 (0.01 per cent of the total land surface) would be required for generating electricity from solar energy.[13] This shows that the opportunity for the development of renewable electricity is not limited by the availability of natural resources. Questions are however raised by some regarding the intermittency of renewable resources, especially solar and wind. It is argued that they can only reliably generate electricity when the sun is shining or the wind is blowing. The example of open-cycle gas turbine,

---

[13] The required land area is estimated using assumptions of average solar radiation of 4.5 kWh/m^2/day with 15 per cent conversion efficiency (Blakers & Diesendorf 1996).

which is an inefficient technology for generating electricity, as a back-up for renewable electricity, is often cited to support the argument. Others however hold a different opinion and argue that renewables, much like coal, are reliable sources of electricity generation. Some Australian scientists have shown that a system of large-scale and geographically dispersed wind power can generate electricity smoothly and as reliable as a conventional base-load coal-fired power plants (Diesendorf 2007; Saddler, Diesendorf & Denniss 2004). With sophisticated grid management technologies and improved wind forecasting models, such a system could play a valuable role in an optimal mix of base-, intermediate-, and peak-load electricity.

Existing hydroelectric power in Australia represents only 49 per cent of the technically feasible hydro resources that have been developed in the country (IHA 2003). However, there are public concerns about the considerable environmental impacts of large dams. It is unlikely that any further large-scale dams with incorporated hydroelectric plants would be built in Australia. Nevertheless, there is potential for increasing hydroelectric generation, through maintaining and refurbishing existing assets. Saddler, Diesendorf and Denniss (2004) estimated that the efficiency of existing plants could be increased by 6 per cent on average and capacities by up to 30 per cent.

Carbon-dioxide Capture and Sequestration (CCS) is another option for reducing greenhouse-gas emissions from power stations. CO_2 can be collected from fossil-fuel-fired power stations, compressed and transported in high-pressure pipelines to the longer-term storage locations, either underground or in the ocean. However, there are significant technological, economic, environmental and political risks associated with this technology (Baer 2003). These include: the limited potential for sufficient CO_2 storage sites, for example, the largest storage potential is in Western Australia while the biggest point-source emitters are in eastern Australia (Diesendorf 2003, p. 9); the cost of capturing CO_2 from existing power stations is uncertain, ranging from \$36 to \$157 per tonne of CO_2 avoided (Saddler, Riedy & Passey 2004, p. 29); and the environmental risk is also uncertain concerning the leakage of CO_2 from either pipelines or reservoirs, due to little knowledge about the geology of the sites, particularly the deep saline aquifers in which geosequestration is proposed for

Australia (Saddler, Riedy & Passey 2004, p. 33). The sudden leakage of a large volume of CO_2 could result in a disruption in the ecological environment and people becoming asphyxiated (Diesendorf 2003).

Electricity generated from nuclear power, like renewable energy, does not emit greenhouse-gas emissions during its operation. Nuclear fission is a proven technology and has already been used as base-load capacity in many countries, contributing nearly 16 per cent to the total world electricity generation in the year 2003 (IEA 2005). Australia has a significant potential for nuclear power, as it has vast reserves of uranium. However, nuclear energy has significant waste disposal problems and has been linked to nuclear weapons proliferation (Fiore 2005). Nuclear fusion has a long-term potential for electricity generation. Such technology can provide cheap electricity, no greenhouse-gas emissions, negligible radioactive wastes and an infinite supply of energy (Fiore 2005). The first fusion power is expected to start operating in southern France in 2016.

2.2.2 Economic Considerations

Table 2-2 summarises the marginal costs and emission rates for different electricity generation technologies. The table shows that currently, conventional coal-fired power stations produce electricity at the lowest cost, within the range of 3 to 4 cents per kWh. Also, the recent expansions in inter-state gas pipeline networks, particularly the development of the Eastern Gas Pipeline, have led to a reduction in real natural gas prices. As a result, the cost of electricity from natural gas-fired power stations has fallen to about 4 to 6.7 cents per kWh. However, it remains at a price disadvantage compared with coal, especially in Victoria and NSW, owing to strong competition from low-cost coal. Renewable electricity in Australia is currently more expensive than traditional electricity supply. Currently, the most competitive renewable energy is wind power, with an estimated cost of 7 to 12 cents per kWh. Over time, the advancement in renewable technologies is expected to reduce this cost.

Table 2-2 Marginal costs and emission rates of electricity generation

Electricity generation technology	Marginal Cost (¢/kWh)	Emission Rate (tons CO_2-e/GWh)
Conventional coal	3.50–4.00	941–1175
Natural gas combined-cycle (NGCC)	4.13–6.67	491–655
Advanced coal (Integrated gasification CC)	5.47–8.13	750–857
Wind	7.30–11.9	13–40
Nuclear (Fission)	7.50–10.5	10–130
Hydro	7.80–15.1	11–44
Solar Thermal	19.9–26.0	n.a.
Wave	20.0–25.0	n.a.
Solar Photovoltaic	44.8–54.9	53–217

Sources: Commonwealth of Australia (2006), MMA (2006a; 2006b).
Notes: † Emission rate shown in this Table include life cycle emissions from electricity generation
n.a. denotes not available.

The differences of electricity supply costs for various electricity supply options do not reflect the true economic value of energy resources. These cost differentials are, as suggested by Riedy (2005), embedded through historical path-dependent processes in the electricity system. Such processes, for example, include subsidy, government investment for a particular technology, and the neglect of the environmental costs associated with technologies (ibid). This historical development provides economic advantage to coal-based electricity technology over other technologies.

Over the years, the government has provided a variety of subsidies for fossil-fuel development. For example, since the end of World War 2, the fossil-fuel industry as a whole has received over $3 billion in direct subsidies, and consumers of fossil fuel have received about $37 billion of subsidies (Sonneborn 2004). Although it can be argued that renewable technologies have also received significant subsidies, as estimated by Riedy (2005), the extent of these subsidies was less than 15 per cent of the total subsidies received by the fossil-fuel industry. For instance, in 1994, out of $180 million of government support for energy sector research and development, only $27 million was provided for the development of renewable energy (NIEIR 1996). While many of these subsidies have been discontinued, they were important in the development of the fossil-fuel industry.

Also, as demonstrated in Section 2.1, coal-based electricity generation technology has a long production history under the ownership of state-owned utilities and, therefore, benefited from significant government investment. These massive government investments helped reduced their costs manyfold. It is difficult for other technologies to be cost-competitive with an established technology that has received far more public funding over time (Riedy 2005).

Further, the electricity costs shown in Table 2-2 do not take into account any environmental externalities. The main environmental externality of burning fossil fuel in electricity generation plants is the cost of climate change. If such costs are included, it is likely that renewable energy sources would be competitive with fossil fuels.

2.2.3 Political Considerations

Coal and electricity industries have traditionally enjoyed significant political power. This has created an institutional barrier for the development of other technologies. The electricity industry also has extensive linkages with the coal industry, either through ownership or equity interest in mines (Productivity Commission 1998). These linkages (and also those discussed earlier in Section 2.1), along with the institutional barriers noted above, inhibit the ability of other contenders to coal to compete with coal. For example, nuclear power, with its technical potential, would be a viable option as a base-load plant to provide electricity; this is, however, hindered by existing legislation. The *Nuclear Activities (Prohibitions) Act 1983* in Victoria and the *Uranium Mining and Nuclear Facilities (Prohibitions) Act 1986* in New South Wales prohibit the construction or operation of any nuclear reactor (UIC 2005).

State governments have an incentive to prefer coal-fired over gas-fired power generation because coal creates more employment and usually attracts a state excise or royalty[14], whereas offshore gas is subject to the Commonwealth Petroleum Resource Rent Tax (PRRT) arrangements (OECD/IEA 2005). One of the recent cases was the

[14] For example, the exploitation of brown coal deposits in Victoria was largely tax-free (ACG & MMA 1999, p. 80).

decision to build the Collie coal-fired power station in Western Australia in 1999. The state government supported the construction of the Collie power station, although it acknowledged that a gas-fired power station would have been more economic. The total additional cost is estimated to be $170 million and, if the government were to attempt to meet the target of CO_2 stabilisation, the additional cost would double, to $330 million (OECD 1997).

The renewable electricity industry is in its infancy, confined to small and fragmented markets located in remote areas. They require support (as coal-based technology had received) in order to help develop into a mature industry. The Australian government has established a Mandatory Renewable Energy Target (MRET) for electricity generation, to limit the growth in emissions and to promote renewable energy industry development. The original aim of the MRET was to increase the proportion of renewable energy in electricity generation by two per cent by 2010, which later was changed to an increase in renewable generation of 9,500 GWh per year until 2010. Since its commencement in 2001, the MRET has contributed significantly in attracting the electricity generation from renewable sources. According to the MRET Review Panel (2003, pp. 12, 14):

> *190 power stations had become accredited under the MRET measure, across a wide range of eligible renewable energy sources … during the first two years of MRET's operation, nearly twice as many Renewable Energy Certificates (RECs) have been created than are initially required by the interim targets.*

With this success, the MRET Review Panel has recommended that the target be extended to 2020, with an increase in renewable electricity generation of 20,000 GWh per year (ibid). Such a policy would allow greater penetration of renewable technologies into the future electricity market. However, the government has decided not to extend the target. This decision shows the continuing political influence of the coal–electricity compact. According to Riedy (2005, p. 211):

> *The decision not to extend the MRET is particularly interesting for what it reveals about the inner working of Federal Cabinet. Media reports (e.g. ABC 2004a) and statements by*

> *the Federal Environment Minister (ABC 2004b) strongly suggest that the Minister argued in Cabinet for an increase to the MRET, but was defeated by other Ministers concerned about the continued subsidisation of the renewable energy industry and the economic impacts of the measure.*

Without such policy support, there will be a lack of investment in the development of renewable energy. Further, the government also ceased the funding for the Cooperative Research Centre devoted to renewable energy – the only research centre that focused on the development of renewable energy (Diesendorf 2003; Riedy 2005). This action left the country without a renewable energy research and development funding agency, for the first time since the oil shocks of the 1970s (Sonneborn 2004). Support for research and development is critical to the development of renewable industry in such a way that it can compete with traditional technologies. This has been expressed by renewable industry representatives in ACG and MMA (1999, p. 62),

> *The sustainable energy industry sees R&D support as critical to its development. It is important to develop longer term R&D funding arrangements for sustainable energy technologies, to ensure that appropriate R&D infrastructure can be built up in a stable policy context.*

Despite increasing environmental concerns, the government's long-term strategies favour the established coal–electricity compact. As stated by DITR (2004, p. 3), *"It is recognised that given Australia's high level of fossil fuel resources, we can be expected to remain substantially reliant on fossil fuels for energy needs for the foreseeable future"*. It is clear that the CCS option seems to be favoured by the Australian government. As stated by Diesendorf (2003, p. 8):

> *The federal government is funding three Cooperative Research Centres (CRCs) devoted to fossil fuel industries, and has just announced that one of these has been renamed the CRC for greenhouse gas technologies, which focused entirely on CCS, and renewed for seven years from 1 July 2003 with an additional $21 million of government funding.*

The continuing increase in coal-mining activities reflects the government's policy preferences. For example, in 2005, four new major coal projects in NSW and QLD, with a capital expenditure of over $1 billion, were completed. These will add over 10 million tonnes of coal production capacity (ACA 2005). Such projects will continue to supply low-cost coal to the electricity market, which will help maintain the coal–electricity compact for extended periods.

2.3 Summary and Conclusions

This chapter has investigated the nature of the relationship between the Australian electricity and coal industries. This investigation suggests that:

- Coal has traditionally played a critical role in the development of the electricity industry in Australia. The abundance of indigenous coal resources provided initial incentive for the establishment of the coal–electricity compact. Consequently, small power stations based on coal became the norm in most parts of Australia during its early development.
- Over time, this compact was strengthened by economic and political interests. By the mid-1900s, the electricity industry was predominantly owned by the state governments, with the intention of developing power stations based on coalfields located within the state rather than importing energy from other states. This marked the beginning of the technological lock-in of coal-based electricity infrastructures. In the second half of the twentieth century, a series of large coal-fired power stations were built with government subsidies, in anticipation of a minerals boom. This consolidated the technological lock-in of coal-based technology.
- The economic and political interests soon transformed the technological lock-in into an institutional lock-in. The use of significant public funds in the form of subsidies in the development of power stations in the earlier period has allowed the direct involvement of political interests into the electricity industry. The influence of these interests became evident in the investment strategies, including the selection of fuel (coal) for electricity generation. Even in the recent development of the electricity industry, rules which govern the national electricity market (particularly dispatching criteria) also favour coal-based

electricity generation. This demonstrates the institutional lock-in of the coal–electricity compact in Australia.

This chapter has also, based on an historical review, attempted to investigate the likely future of the electricity industry. This investigation suggests that:

- The coal–electricity compact is likely to remain dominant in the years to come. Although there is technical potential for the use of alternative fuels for electricity generation in Australia (for example, solar, wind, hydro, and nuclear), the uptake of this potential would be restricted by its economic and political disadvantages.
- The economic advantage of the coal–electricity compact over other technologies has been developed through historical path-dependent processes in the electricity system. These processes include government investment and subsidies for coal-based electricity technology that artificially lowered their cost for electricity production. The exclusion of negative environmental externalities associated with coal-based electricity generation technology also enhances its economic advantage.
- The political connections of the coal–electricity compact has further deepened the economic and political advantages of this compact. It has created an institution barrier (through legislation and financial support) against the development of alternative electricity technologies. The long-term policy directions and political support, particularly for the development of carbon capture and sequestration – are evidence of the continuing sway of the coal–electricity compact.

CHAPTER 3

AUSTRALIAN GREENHOUSE POLICY DEVELOPMENT

Chapter 2 provided an historical review of the evolution of the coal–electricity compact in Australia. It was noticed in this review that the coal industry has played a major role in the development of the electricity industry. It was also argued that this compact is likely to remain strong in the foreseeable future. Australia's coal–electricity compact clearly has significant environmental impacts. By implication, it also has the potential to significantly influence the Australian government's stance on policies to reduce greenhouse-gas emissions.

Against the above background, the objective of this chapter is to provide an overview of the development of greenhouse policy in Australia and to develop a perspective on carbon tax as a policy option to reduce Australia's carbon-dioxide emissions. This chapter is organised as follows. Section 3.1 describes the nexus between electricity production and CO_2 emissions. Section 3.2 describes the development of Australia's greenhouse policy aimed at combating CO_2 emissions. The rationale and strategy for the use of carbon tax as a future policy option is discussed in Section 3.3. Finally, a summary of major findings of this chapter is provided in Section 3.4.

3.1 Electricity Industry and Carbon-dioxide Emissions

3.1.1 Total Carbon-dioxide Emissions

Global warming and climate change are currently the most significant environmental challenges facing humanity. Emissions of greenhouse-gases from the combustion of fossil fuels is the dominant anthropogenic emission contributing to climate change. Greenhouse-gas emissions come from a variety of sources. In Australia, the production and use of energy provides the single largest source of greenhouse-gas emissions. In 2004, Australia's total greenhouse-gas emissions comprised 565 million tonnes of CO_2-

equivalent (Mt CO_2-e), out of which 63 per cent (356 Mt CO_2-e) represented the contribution from fuel combustion alone (AGO 2006).

CO_2 is the largest component of greenhouse-gas emissions, with a share, in 2004, of 73 per cent (415 Mt CO_2-e), followed by CH_4 with 22 per cent, and others (that is, N_2O, HFCs, PFCs and SF_6)[15], 5 per cent (AGO 2006). Therefore, CO_2 is the single largest contributor to climate change. Fossil-fuel combustion is the major source of CO_2; it accounted for over 85 per cent (352 Mt) of CO_2 emissions in 2004. Out of this, electricity generation alone accounted for 55 per cent (194 Mt). The remaining CO_2 from the direct combustion of fossil fuels was contributed by transport (21 per cent), manufacturing and construction (12 per cent), and other energy combustion activities (12 per cent), as shown in Table 3-1.

Table 3-1 Australia's greenhouse-gas emissions

	$CO_{2\text{-}e}$ emissions (Mtonnes)			
	1990		2004	
	CO_2	GHG	CO_2	GHG
Fuel combustion	254	257	352	356
Electricity industry	**129**	**129**	**194**	**195**
Transport	61	62	74	76
Manufacturing and construction	37	38	42	42
Others	28	29	41	42
Fugitive-fuels	6	29	6	31
Industrial processes	18	25	24	30
Agriculture	-	91	-	93
Land use change and forestry	125	129	33	35
Waste	0	19	0	19
Total GHG Emissions	**402**	**551**	**415**	**565**

Sources: AGO (2005; 2006).

During the period 1990–2004, the nationwide CO_2 emissions increased by only 3 per cent, from 402 Mt in 1990, to 415 Mt in 2004. This was due to significant emission reductions (73 per cent) in land-clearing and forestry. However, emissions from fossil-fuel combustion increased by 39 per cent (AGO 2005). More importantly, over this period, CO_2 emissions from electricity generation increased by 51 per cent, from 129

[15] CH_4: methane, N_2O: nitrous-oxide, HFCs: hydro-fluorocarbons, PFCs: per-fluorocarbons, SF_6: sulphur-hexafluoride.

Mt, to 194 Mt. Thus, the future growth in CO_2 emissions from electricity generation, together with the fully utilised reduction potential from land-clearing, will put great pressure on Australia's commitment to reduce total CO_2 emissions.

3.1.2 Carbon-dioxide Emissions from Electricity Generation

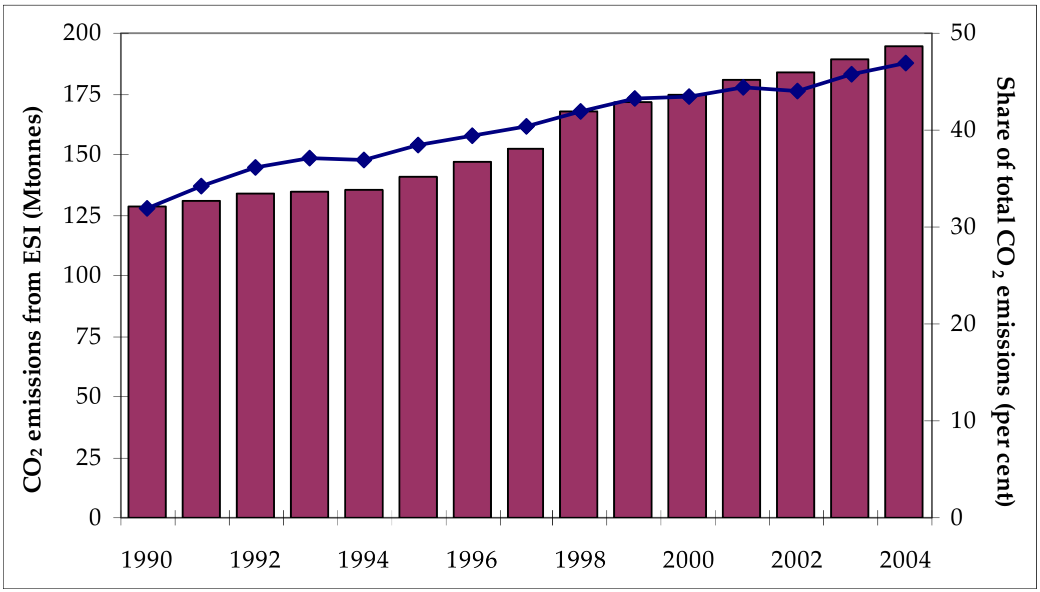
The electricity industry has a very significant effect on the environment. Burning fossil fuel produces CO_2 emissions. The quantity of emissions depends on the carbon and hydrogen content of various fuels. For example, in Australia, burning each GJ of brown coal, black coal, petroleum and natural gas produces, on average[16], 95.7, 90.4, 69.3, and 51.3 kg of CO_2, respectively (NGGIC 1996). Brown coal is the most carbon-intensive fuel for generating electricity in Australia. Renewable energy (for example, wind, solar, hydro, etc.) does not generate any CO_2 emissions during electricity production, although it may be responsible for significant emissions during the manufacture and construction of renewable energy technologies and systems for electricity generation.

Electricity generation accounts for a large proportion of Australia's greenhouse-gas emissions. Its share of total CO_2 emissions has increased dramatically over the last decade – from about 30 per cent of total CO_2 emissions in 1990 to almost 50 per cent in 2004, as shown in Figure 3-1. This is due to the dominance of coal-fired power generation. As Diesendorf (2003, p. 1) states, "*Twenty-four coal power stations are the largest source of greenhouse gas emissions in Australia, pumping out 170 million tonnes of carbon-dioxide every year*". As discussed in Section 2.1.5, coal accounted for nearly 85 per cent of primary energy fuel used for electricity generation in 2004.

---

[16] These emission factors are the averages over the last decade. Emission factors for each year can be found in the cited publication.

Figure 3-1 Carbon-dioxide emissions from electricity generation



Source: AGO (2005).

In Australia, there are no legal requirements on coal-fired power generators to limit their greenhouse-gas emissions (Diesendorf 2003). Further, the introduction of the competitive electricity market in several states has also boosted emissions. CO_2 emissions from electricity generation have been rising gradually since 1990. However, in a single year after the implementation of the NEM Phase 1 (May 1997)[17], the emission increased sharply by 10 per cent, from 152 Mt in 1997, to 167 Mt in 1998 (see Figure 3-1). Following the introduction of the NEM in December 1998, CO_2 emissions continued to grow steadily at an average rate of 3 per cent per annum. The implementation of the NEM has enabled coal-fired electricity generation to increase its share in electricity generation, due to its fuel price advantage (AGO 2005). The share of brown coal has increased from 29 per cent to 34 per cent (or from 497 PJ to 680 PJ) over the single year after the implementation of the competitive electricity market (see Figure 2-1). The increasing dependence on brown coal is because the operation of the NEM causes companies to seek the cheapest sources of electricity, with no

[17] A national electricity generation pool began operation on 5 May 1997, when Victoria and New South Wales began an interstate wholesale electricity trading market. The full operation of the NEM started in December 1998.

consideration for environmental impacts (Beder 2003). Brown coal is cheap but has relatively low energy content per unit of volume; it therefore produces relatively high amount of CO_2 emissions per unit of energy produced. Old brown coal plants that have paid off their loans can therefore produce electricity at low marginal costs but produce higher level of CO_2 emissions (ibid). Brown-coal-fired electricity generation in Victoria displaced black-coal-fired generation in New South Wales and gas-fired generation in South Australia. This is a consequence of the market criterion for plant ranking and dispatching in the NEM, which could bring further adverse environmental impacts from the electricity industry. As noted by AGO (2005, p. 15), "*The introduction of the National Electricity Market in 1998 enabled brown coal power stations to increase their share of the electricity market in the eastern States due to their fuel price advantage*". It is further clear that the electricity industry reforms proved to hinder, rather than help to achieve emission reduction, as was claimed by the government (see Section 2.1.5).

3.2 Development of Australia's Greenhouse Policy

This section provides an overview of the development of greenhouse-gas policies in Australia. It is important to understand how greenhouse policy has been developed in a country where the coal–electricity compact has been strong. Such a review could provide a basis for designing an appropriate greenhouse policy – that takes into account all actors involved in Australian greenhouse-gas discourse. The review in this section draws on a number of previous studies, for example, Taplin (1994), Bulkeley (2001), Hamilton (2001), Hunt (2004), Christoff (2005), and Riedy (2005). This review is divided into five subsections – the pacesetter, the changing stance, reaffirmation of stance, the laggard nation, and entrenchment of the stance – according to the changing position taken by the Australian government towards greenhouse policy.

3.2.1 The Pacesetter

The concerns about the environmental impacts of coal-based electricity production (especially in view of the entrenched nature of the coal–electricity compact, as discussed in Chapter 2) provided the initial spur for developing policy response to mitigate such impacts. The global impact of climate change was first discussed in a conference in Austria in 1985 (Kay 1997). A concern was expressed at the conference that increasing rates of the use of fossil fuels would increase the level of CO_2 emissions, which could worsen the condition of the climate. In 1988, the first steps towards confronting climate change were discussed in Toronto. At this conference, there was a "*call for action*" to reduce global CO_2 emissions by 20 per cent from the 1988 levels by the year 2005 (Toronto target). Later, in the same year, the Intergovernmental Panel on Climate Change (IPCC) was established to investigate the impacts of global warming and to suggest strategies to overcome such problems. Australia's initial response to these developments was highly cooperative and, according to Christoff (2005, p. 39), was "*shaped by an altruistic public discourse focused on global responsibility and with little sense of economic reality*". Consequently, in 1990, the Australian government adopted the "*interim planning target*" to stabilise emissions of greenhouse-gases at the 1988 levels by the year 2000 and then reduce to the agreed level of 20 per cent by 2005. The government considered the establishment of domestic greenhouse policy based on the assessment of such targets through the advice of the Ecologically Sustainable Development (ESD) working groups (consisting of representatives from government, industry, and environment groups) and the Industry Commission. In the meantime, influenced by the findings of the IPCC, the United Nations (1992) adopted the Framework Convention on Climate Change (FCCC) with the objective of:

> *… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.*

Until this stage, Australia took a progressive position during the negotiations of the convention and was one of the eight pacesetter countries to ratify a "*call for action*".

3.2.2 The Changing Stance

Such global leadership in combating climate change was soon undermined by the outcome of the interim target assessment. The Industry Commission (1991a, p. 4) estimated that achieving the Toronto target would lead to a 2.1 per cent decline in Australia's national products with the greatest impact falling on the coal industry. The impact on the coal industry would be due to the reallocation of resources away from carbon-producing and -using industries to other industries (ibid, p. 110). As carbon tax was considered as one of the main policy instruments discussed in the report, it soon became the subject of a scare campaign by the media. This marked the beginning of the debate on carbon tax in Australia. According to Hamilton (2001, p. 33):

> *The fossil-fuel industry reacted with outrage and the carbon tax became the bogeyman for industry in the debate, with both Labor and Coalition governments shunning the measure (i.e. carbon tax) favoured by most economists.*

In contrast, recognising the potential from energy systems in reducing greenhouse-gas emissions, the ESD working groups concluded that "*there was a large range of actions which would be cost-effective on energy grounds alone, so that the additional benefit in greenhouse gas reductions would be free*" (Wilkenfeld, Hamilton & Saddler 1995, p. 9). Because the working group consisted of representatives with different viewpoints, the outcome was seen as the reconciliation of environmental and economic objectives with precautionary measures – particularly no-regrets measures[18] – to respond to climate change. It was also made clear by the ESD working groups that although no-regrets measures would have a negative impact on some industries, this would be compensated by the growth in other industries, such as energy efficiency or renewable energy (Bulkeley 2001, p. 161).

---

[18] This "no-regrets" measure is interpreted as a measure which has economic benefits, or at least no economic losses, as well as achieving a reduction in greenhouse-gas emissions (National Greenhouse Steering Committee 1992).

In 1992, the Council of Australian Government (COAG) released the National Greenhouse Response Strategy (NGRS), which was a comprehensive national approach to reduce greenhouse-gas emissions. Although the NGRS adopted the no-regrets measure, the term no-regrets was interpreted differently from the interpretation of the ESD working groups. As stated by the National Greenhouse Steering Committee (1992, p. 12):

> *Equity consideration should be addressed by ensuring that response measures meet the broad needs of the whole community and that any undue burden of adjustment potentially borne by a particular sector or region is recognised and accounted for.*

This statement was influenced by the Industry Commission findings, which recognised the supremacy of economic over environmental objectives in the development of climate change policy. It implied that any industry sector, including emission-intensive industries, should not be economically worse off. Despite this stance by the government, the NGRS included sufficient measures – particularly on energy supply side – to reduce greenhouse-gas emissions. This, according to the National Greenhouse Steering Committee (1992, p. 16), included:

> *… limit greenhouse gas emissions arising from energy production and distribution wherever economically efficient by minimising greenhouse gas emissions per unit of each type of energy supplied to end users, and by promoting alternative energy sources that have the potential to lower greenhouse gas emissions per unit of energy supplied.*

This declaration was similar to the claim made by the government that the market reform program, which was implemented at the same time, would benefit both economic and environmental objectives (see Section 2.1.5). However, the government failed to implement NGRS and responses were left to ad-hoc government processes and commercial decisions, which were counter to the statement given in the NGRS, as noted above. The following citation from Hamilton (2001, p. 35) substantiates this:

> *Nearly every major energy supply decision taken by state and territories governments in the years subsequent to adoption of the NGRS favoured the options with the higher greenhouse gas emissions, including new coal-fired power stations and extension of the*

electricity grid into areas previously served by remote area power system (RAPS) and where renewable energy sources would have been cheaper. The electricity industry, through its organisation the Electricity Supply Association of Australia (ESAA), has at all times resisted any serious measures to attempt to limit emissions from coal burning.

This, together with the existence of the coal–electricity compact (as discussed in Chapter 2), suggests that the government gave economic priority precedence over the environmental concerns endorsed in the UNFCCC.

3.2.3 Reaffirmation of the Stance

By 1994, it was evident that the NGRS was failing to meet its target. A comprehensive review of the NGRS by Wilkenfeld et al. (1995, p. 1) suggested that the strategy:

… has failed to make any impact on Australia's greenhouse gas emissions. After two years of its operation, there is no evidence that even one tonne of carbon emissions has been saved as a result of the NGRS. Moreover, Australia's excess of emissions over the target of the Framework Convention on Climate Change – to return to 1990 levels by the year 2000 – is likely to be far greater than has been admitted by the Commonwealth Government.

With the increased international pressure[19] arising in response to the failure of the NGRS, the government opted to use an alternative strategy. A package of additional measures, called *Greenhouse 21 C*, was proposed in March 1995. As a part of these measures, a small carbon tax – in the form of greenhouse levy – was also proposed. A tax rate of $1.25 per tonne of CO_2 would have been imposed on the domestic consumption of fossil fuels, with the aim of using part of the revenue from the tax in establishing an Australian Sustainable Energy Authority to promote energy efficiency and renewable energy (Hoerner & Muller 1996). However, given their domination, in the media and policy circles, the fossil-fuel-based industries overcame attempts to

[19] This international pressure was expected to arise in the first Conference of the Parties (COP-1) at the UNFCCC in Berlin in 1995.

establish even a small level of carbon tax (Christoff 2005). As noted by Diesendorf (1996, p. 39):

> *Prices for electricity and fossil fuels do not include the 'external' environment, health and social costs of their use. Although electricity industry restructuring should in theory include the internalisation of these external costs, in practice there is strong resistance from the resource industries. Indeed, in early 1995, following intense lobbying and media campaigning by the resource industries, the Federal government rejected a proposal to introduce a carbon tax/levy on fossil fuels.*

As a result, the government introduced the new Greenhouse Challenge Program (GCP) in October 1995. The GCP is a program that, as an extension to the NGRS, relied on voluntary implementation of no-regrets measures by industries in return for publicity for their green credentials. This program would not undertake those measures that would have an adverse economic impact on the industry. As a result, the GCP attracted considerable support from fossil-fuel-based industries in return for their – government-funded – publicity in response to concern over climate change. The debate over the implementation of carbon tax – that might impose costs on their commercial interests – was again deflected (Bulkeley 2001). In the subsequent years, the GCP has dominated Australia's greenhouse policy development. Also, it was consistently referred to as a program that demonstrated the government's commitment to reduce GHG emissions through government and industries' partnership (Hamilton 2001).

3.2.4 The Laggard Nation

At the international level, it was apparent that voluntary measures were not sufficient to reduce greenhouse-gas emissions. This was reflected at the COP-1 meeting in Berlin in 1995, which was leading towards legally binding negotiations to reduce greenhouse-gas emissions. These negotiations were arguing for legally binding target agreements for each country at COP-3 in Kyoto in 1997, which would become the Kyoto Protocol. During the run-up to Kyoto, the Australian government assumed an aggressive stance in international negotiations over uniform emission reductions of 15 per cent below the 1990 level by 2010 (Christoff 2005). The government made a considerable effort to negotiate for a lenient target. Such negotiation clearly reflected the influence of fossil-fuel-based industries (also the coal–electricity compact) in guiding greenhouse policy in Australia. According to Hamilton (2001, p. 54):

> *… the government argued that due to Australia's heavy reliance on fossil fuels, uniform emission reduction requirements would impose an unfair economic burden on Australia. It advocated a complicated formula for 'differentiated' targets, which would award a more lenient task to Australia than other countries.*

This strong claim by the government was supported by a single modelling study performed by ABARE. The study found that to meet uniform emission reduction, there would be decline in almost all sectoral outputs in the Australian economy, which would lead to an increase in unemployment levels and reduction in wage rates (ABARE 1997). This study, particularly the use of the MEGABARE model, was widely criticised, particularly by some economists, green groups, and some of those within the ranks of the party in power (see also, Bulkeley 2001; Hamilton 2001; Hamilton & Quiggin 1997; Tarlo 1996). It was argued by these critics that this study exaggerated the cost of emission-reduction measures and has compromised its neutrality due to funding by fossil-fuel-based industries (Bulkeley 2001; Hamilton 2001).

Together with the negotiations for "differentiated" targets at the international level, the government assigned the National Greenhouse Advisory Panel (NGAP) the task of reviewing the NGRS. Again, the focus was given to no-regrets measures at an individual level (that is, any industry should not be economically worse off). Just before Kyoto, the government released a package of measures – *Safeguarding the Future* – that constituted the National Greenhouse Strategy (NGS) (Commonwealth of Australia 1998). The NGS was formalised with the objective of legitimising Australia's responsibility towards greenhouse issue at the COP-3 in Kyoto (Christoff 2005). Despite its ineffectiveness in reducing emissions (as with NGRS), there is one policy stated in the NGS specifically identified as going beyond no-regrets – the Mandatory Renewable Energy Target (MRET).

The strong position taken by the government before and during the Kyoto negotiations, particularly the threat to withdraw from the negotiations, attracted wide condemnation (Hamilton 2001, p. 97). However, as a political bargain, Australia was allowed a lenient target of emission levels – 108 per cent above the 1990 level, by the period 2008–2012, together with the inclusion of emissions from land-clearing in greenhouse accounting. Emissions from land-clearing in Australia had declined sharply since 1990; inclusion of them in the base year would allow fossil-fuel emissions to increase to at least 120 per cent of 1990 levels by the year 2010 (Hamilton 2001, p. 88). This agreement clearly provided Australia with room – under the Kyoto target – for substantial growth in emissions and, hence, there was little incentive to address the greenhouse issue.

3.2.5 Entrenchment of the Stance

Since Kyoto, there has been no significant international pressure for Australia to focus on developing an environmental policy. However, domestically, the opinion, particularly among the supporter of the government's voluntary approach to greenhouse policy, began to fragment. As stated by Christoff (2005, p. 40):

> *Late in 2000, ruptures occurred within the Business Council of Australia (BCA), a leading public supporter of government climate policy, when BHP – then Australia's largest company – also decided to support a domestic emissions trading system.*

At that time, the BCA appears to have been thoroughly captured by big mining and fossil industry interests that consistently opposed any government initiative for implementing Australia's Kyoto obligations (Hamilton 2001, p. 134). To moderate the situation, several other measures were incorporated in the existing NGS at the national level. These measures include the MRET, energy efficiency through minimum energy performance standards (for fossil-fuel electricity generation, equipment and appliances, and the Building Code of Australia), and further engaging industry in the voluntary Greenhouse Challenge (Commonwealth of Australia 2000). In contrast, at the state level, the moves towards greenhouse policy were more progressive. These include measures such as the Greenhouse-gas Abatement Scheme in NSW and the 13 per cent Gas Scheme in Queensland. Although these measures were directed to reduce greenhouse-gas emissions by larger amounts, compared with those undertaken at the national level, they were considered as poorly targeted in the sense that they did not allow the market to identify the cost-effective options to reduce emissions (ERAA 2004).

In 2004, Russia ratified the Kyoto Protocol, and this Protocol was back on the agenda. The Australian government, however, reiterated its long-standing refusal to ratify the Protocol. This clearly was meant to protect the competitive advantage enjoyed by the fossil-fuel industry and to hinder (even though by implication) the uptake of renewable energy technologies (Christoff 2005). This was also reflected in the new energy and greenhouse policy statement "*Securing Australia's Energy Future*", released earlier that year[20] (Commonwealth of Australia 2004). The Australian government's entrenched greenhouse policy position was firmly articulated in this White Paper. The government has clearly disadvantaged the renewable industry by its decision not to extend the MRET (also discussed in Section 2.2.3). Further, subsidies were made available to the fossil-fuel industries through a Low Emissions Technology Demonstration Fund (LETDF). According to the White Paper, the LETDF "*support industry-led projects for large-scale demonstration of low emissions technologies that could reduce the cost of technologies with significant long-term abatement potential*" (Commonwealth of Australia 2004, p. 182). Although the LETDF is equally available for all industries, due to the decision not to extend the MRET, it has demonstrated its support for well-established fossil-fuel industries in the development of CCS (BCSE 2004). According to Riedy (2005, p. 212):

> *It is hardly surprising that the White Paper favours established industry sectors, given the extent of their involvement in the development of the policy. The … confidential meeting of the Lower Emissions Technology Advisory Group (LETAG)[21] … with the*

---

[20] This policy statement is commonly referred to as the Energy White Paper.
[21] The LETAG is a group comprising large companies in the energy and resource sectors.

> *Prime Minister and Industry Minister … reveal that the LETDF was specifically developed to accelerate investment in new technologies by established industries.*

The White Paper was later on revealed as a complete endorsement of the "*greenhouse mafia's*"[22] agenda (Pearse 2005, p. 355), whose commercial interests would be affected by any move to reduce greenhouse-gas emissions.

More recently (January 2006), the Australian government came up with a new initiative – the Asia–Pacific Partnership on Clean Development and Climate (also known as AP6).[23] The AP6 aims to achieve emissions reduction through collaboration on the development of existing and emerging clean energy technologies (PM 2006). Although the AP6 does not explicitly support any particular technology, CCS is one of the major technologies the "*partnership*" is highlighting and fostering. Despite being an unproven technology in the context of electricity generation, compared to commercially viable renewable technologies (such as wind, solar and biomass), most of the recent funding under the *"$500 million LETDF*" program has been made for the development of CCS in Australia. Of the total $410 million of funds that have been allocated to date, $335 million have been allocated for the development of CCS (AGO 2007). This shows that such a partnership supports the development of select fossil-based technologies, for example, CCS.

The government decisions in relation to the development of greenhouse policy, as discussed in this section, were overwhelmingly influenced by the strength of the coal–electricity compact. Such influences are likely to prevent the development of greenhouse policy that balances the long-term interests of various segments of the economy. It is also clear from this discussion that without the political will, the opportunities to implement effective greenhouse policy will simply never happen.

---

[22] This term, according to Pearse (2005, p. 341), is a self-descriptor used by some industry lobbyists in reference to the Australian Industry Greenhouse Network (AIGN).

[23] The AP6 countries are Australia, China, India, Japan, South Korea, and the USA.

3.3 A Carbon Tax Policy for Australia

A review of the historical development of Australia's greenhouse policy (as presented in the previous section) suggests that the Australian government has opted to follow a "*wait and see*"[24] approach to the development of this policy. It swings into action only when there is some external (for example, international and/or public) pressure. Further, such policy development has been strongly influenced by the undue power wielded by the fossil-fuel industries. These issues have inhibited the formulation of an effective greenhouse policy (Johnson & Rix 1991, p. 43). Based on the government's current approach to the greenhouse issue, together with the influence of the coal–electricity compact, it is very likely that any future greenhouse targets for Australia will be more difficult to achieve. It is now commonly accepted that in order to reduce greenhouse-gas emissions by any significant amount, the fuel mix for electricity generation must change substantially (Gerlagh & van der Zwaan 2006; Grubb, Carraro & Schellnhuber 2006). This would be possible only – given the focus of the current economic reform emphasising free-market principles – if electricity generation technologies receive appropriate price signals that can achieve an appropriate balance between economic benefits and environmental costs.

This section first discusses various environmental policy options. Then carbon tax policy, as conventionally adopted, is discussed together with its limitations. Finally, an alternative perspective on carbon tax is developed and put forward as a policy option to reduce carbon-dioxide emissions in Australia.

3.3.1 Environmental Policy Options

A range of policy options are being considered by various countries to mitigate greenhouse-gas emissions. These policy options are based either on a command-and-control (or regulatory) approach or a market-based approach. A regulatory approach generally specifies standards and, through regulation, ensures that polluters meet

---

[24] This term is given by Johnson and Rix (1991, p. 41).

these standards, regardless of the relative costs of control. Direct regulation involves the imposition of technical or emission standards through licensing and monitoring. This approach (together with voluntary action) has been the traditional mainstay of the Australian approach to redressing environmental issues. Its attractiveness to the Australian policy-makers arises from the fact that it can be manipulated to serve the commercial interests of the coal–electricity compact while achieving the political goals (see Section 3.2). This approach, however, argue its critics, lacks flexibility and motivation, and does not provide market signals that would encourage the uptake of least-cost options for meeting emission standards (Armstrong 1997; Owen 1992; Pearce 1991). A similar disadvantage in the Australian context was also pointed out by ERAA (2004, p. 2):

> *... the existing policy environment in Australia, which is mainly characterised by regulatory approach, are a fragmented array of short-term State and Federal Government greenhouse gas abatement measures that tend to be poorly targeted, overly complex and highly inefficient as mechanisms for reducing emissions.*

Further, emission reductions from the electricity sector are unlikely to happen under the most favourable approach adopted by the Australian government, namely, voluntary action (MMA 2002). In contrast, the market-based approach, argue the critics of regulatory approach, alters market price signals with the objective of providing incentives for consumers to conserve energy and for producers to invest in cleaner energy technologies. This approach is favoured by most economists and some environmentalists because it treats the environmental cost of energy in a transparent manner (that is, it internalises the negative externality associated with environmental impacts) and allows market mechanisms to send a price signal that can achieve an appropriate balance between the economic benefits of energy use and its environmental costs. Emissions trading and carbon tax are often considered as the two main market-based environmental policy options to achieve reductions in CO_2 emissions (Common & Hamilton 1996; Cornwell & Creedy 1995; Missfeldt & Hauff 2004; Price Waterhouse 1991). A hybrid market-based approach that combines elements of both emissions trading and carbon tax, called a *permit and fee system*, was also recently considered (McKibbin & Wilcoxen 2006). In fact, the "carbon tax" option involves a mixture of regulatory and market-based approaches. It requires government intervention in regulating the tax components to ensure the internalisation of externalities and, at the same time, requires free-market principles to send price signals that would encourage emission reduction.

In order to achieve reductions in CO_2 emission, both regulatory and market-based approaches have often been recommended to be used in combination (Topham & Hennessy 1996). However, as suggested by Price Waterhouse (1991), before combinations of measures can be efficiently adopted, each measure needs to be understood in isolation.

The discussion in Section 3.2 revealed that the carbon tax approach has not received much support in Australia in the past, due to concerns about its likely adverse economic impacts. This research, however, argues that this opposition to carbon tax is based on a less than complete understanding of the various facets of this approach, including alternative principles for the design of appropriate levels of carbon tax, its economy-wide impacts, etc. It is also argued in this research that if these facets of carbon tax are appropriately understood, much of the opposition to it would weaken and that it could in fact be technically, economically and politically an attractive option to reduce CO_2 emissions. One of the key attractiveness of this approach is that it could enable a correct pricing of negative environmental externalities and, hence, allow cleaner electricity production technologies to compete with the traditional technologies. Moreover, a carbon tax policy is deemed by some as being the easiest environmental policy to be implemented and monitored (Owen 1992). Accordingly, in the subsequent subsections, the rationale and strategy for the implementation of a carbon tax policy for reducing Australia's greenhouse-gas emissions is assessed.

3.3.2 Conventional Carbon Tax Approach

A carbon tax is a tax imposed on the total quantity of greenhouse-gas emission. Its main objective is to encourage the use of fuels with lower carbon content. This is achieved by taxing the use of fossil fuels. The level of tax is typically related to the carbon content of the fuel.

Carbon tax is traditionally formulated based on standard neoclassical economic theory of externalities, including *Pigouvian tax*[25] and *Coasean theorem*.[26] The level of tax is based on the former, while the allocation of emissions, is based on the latter. These theories, in essence, define the core of what is known as the Polluter Pays Principle (PPP). Following the adoption of this principle by the OECD in 1972 and European Community in 1975, it occupies a prominent place as a background principle for developing environmental policy measures around the world (Steenge 1999).

According to the PPP, the polluter is defined as the agent who is primarily responsible for taking measures to maintain desired environmental quality levels (OECD 1994). The polluters are treated as consumers of primary energy (called direct energy).[27] Emissions are, therefore, allocated as the sole responsibility of these polluters and, as a result, require these polluters to be responsible for the costs of controlling pollution, by taxing them according to their levels of emissions. Clearly, carbon tax – based on PPP – tends to penalise big polluters such as fossil-fuel industries. The impact on these industries would be directly proportional to the carbon content of each fossil fuel consumed. This means that a coal-fired power station would be penalised more than a gas-fired power station. Electricity generated from renewable energy is assigned zero emissions, as it does not consume any fossil fuel and, hence, will not be penalised at all.

A carbon tax policy, based on the PPP, has been widely debated in Australia since the early 1990s. Such debate was particularly intense during the times of international

---

[25] A Pigouvian tax refers to a lax levied on each unit of a polluter's output, in an amount just equal to the marginal damage it inflicts upon society at the efficient level of output (Pigou 1978).

[26] The Coasean theorem refers to the allocation of property rights and, through the process of bargaining among parties concerned, the market would solve the environmental problem (Coase 1960).

[27] The flow of direct energy can be represented in terms of the energy balance, as shown in Figure 1-2 (Chapter 1).

debate on ways of combating climate change, for example, the Toronto conference in 1988, the COP-1 in Berlin in 1995, and the COP-3 in Kyoto in 1997.

A number of studies were conducted during this period to assess the suitability of carbon tax as a measure to achieve emissions reduction. These studies assessed the economic impact of different levels of carbon tax. This impact was assessed in terms of changes in the gross domestic products as well as changes in the level of outputs from different economic sectors.

Table 3-2 presents a summary of key results of these studies. The table shows that the introduction of carbon tax would significantly impact on the Australian economy and the energy industries. For example, according to the Industry Commission (1991a), a tax of $21.75 per tonne of CO_2 would be required to meet the Toronto target and this level of tax would result in a 2.1 per cent loss in Australian economic growth over the period 1991–2005. According to McDougal (1993), a carbon tax of $19 per tonne of CO_2 would result in a GDP loss of 0.9 per cent over the period 1993–2005. Similarly, according to NIEIR (1995), a tax of $14 per tonne of CO_2 would result in economic losses equivalent to $179 billion over the period 1995–2005.

Table 3-2 Summary of selected carbon tax studies based on PPP for Australia

		Industry Commission (1991a)	McDougal (1993)	Thorpe et al. (1994)	NIEIR (1995)	Common & Hamilton (1996)	McKibbin & Pearce (1996)	ABARE (1997)
CO_2 emissions reduction target		Toronto target[a]	Toronto target[a]	20 per cent of 1990 by 2005, stabilise by 2010	Toronto target[a]		1990 level by 2005	1990 level by 2010 & 10 per cent below 1990 by 2020
Emission tax ($/tonne CO_2)		21.75[b]	19[c]		14[d]	7	1.25-13.8[e]	
Change in GDP		-2.10%	-0.90%		-$179bn[f]	-0.62% to 0.01%[g]	-$61bn[f]	
Sectoral impact (per cent)	Black coal	-26.2	-11.2	-67			-4.3% pa	-24
	Brown coal	-62.3	-20.8	-100				
	Gas	-19.3	-4.4				-1.1% pa	
	Oil	-9.5	-0.5					
	Electricity	-7.6	-4.8			-1.1		-8
	Construction	-3.1	1.3			-0.1		
	Non-ferrous metal		-6.5			-0.3		-60
	Iron and steel							-32
	Manufacturing	-2.2	-2.1 to +0.2			+0.3		+6
	Services	-1.8	+0.2			+0.1		+3

Notes:
a: reduce GHG emissions to 20 per cent below 1988 level by the year 2005;
b: 1988 prices;
c: 1987 prices;
d: considered carbon tax in combination with other policy measures;
e: $1.25/tonne in 1995 and increases gradually until it reaches $13.8/tonne in 2005, then maintained at this rate to 2010;
f: present value with 8 per cent discount rate;
g: reduction of GDP by 0.62 per cent in 2004, 0.13 per cent in 2014, and increase in GDP by 0.01 per cent in 2024.

Further, these studies have shown that the introduction of carbon tax would particularly adversely affect fossil-fuel industries. For example, Thorpe et al. (1994) estimated that, in order to achieve the Toronto target and then stabilise emissions by 2010, the brown-coal sector would be completely phased out by 2010, while the black-coal sector would decline by almost 70 per cent of its total production. Not only would fossil-fuel sectors be heavily affected, fossil-fuel consumption sectors, such as energy-intensive metal-processing and electricity industries, would also be affected by carbon tax. For example, McDougall (1993) estimated that, in response to a carbon tax of $19 per tonne of CO_2, while coal production would decline by about 20 per cent, the outputs of the electricity industry and non-ferrous metal industry would also decline by 5 and 7 per cent, respectively. A similar pattern of results is also suggested by the Industry Commission (1991a). These studies marked the beginning of the debate on carbon tax in Australia. The outcome of these studies invited a strong reaction from the fossil-fuel industries. In response to this reaction, the government released the alternative greenhouse policy statement that was based on the voluntary measures (as discussed in Section 3.2.2).

In the mid-1990s, before the increased international pressure at the COP-1, carbon tax was again being considered by the Australian policy-makers as a policy option to reduce GHG emissions. This time a small amount of tax ($1.25 per tonne of CO_2) was considered as a part of a larger policy package, titled *Greenhouse 21 C* (see Section 3.2.3). McKibbin and Pearce (1996) argued that even this small tax would reduce GDP by $61bn, and the impact on fossil-fuel industries would be severe. These assessments of the negative impacts of carbon tax on fossil-fuel industries, together with their domination within the policy circles, ensured that carbon tax would not be taken up as a policy option to reduce CO_2 emissions (see Section 3.2.3). Similar adverse impacts of carbon tax on fossil fuel industries were also highlighted earlier by ABARE in the run-up to Kyoto (ABARE 1997). However, the study by ABARE showed that the impact would not be confined to fossil-fuel industries; other industries, for example, some export-oriented industries, such as non-ferrous metal and iron and steel, would be adversely impacted upon as well. Consequently, carbon tax policy was continually rejected by the Australian government, on the grounds that it would endanger the survival of the fossil-fuel industries and impede economic growth.

Given the unrivalled political influence of the coal–electricity compact, the politics of climate change has been very intense in Australia. A key element of this policy has been opposition to the imposition of carbon tax. The adoption of such policy would, as mentioned in *The Australian* newspaper, "*penalise the big carbon-dioxide producers such as fossil fuel industry and could cause additional political barrier*" (Murphy 2005). This is the reason why the carbon tax policy has not been received well in Australia.

However, this research argues that the estimates about the adverse economic impacts of carbon tax based on PPP (as discussed above) are flawed. In this approach (that is, PPP), non-fossil-fuel-consuming sectors are not considered as "polluters", even though they use technologies whose manufacture might produce CO_2 emissions. In addition, they consume electricity produced from fossil fuels. The contribution to CO_2 of these sectors is not captured in the PPP. This contribution can, however, be captured if carbon tax is designed on the basis of a modified approach called Shared Responsibility Principle (SRP). This approach is discussed in the next section.

3.3.3 A Modified Carbon Tax Approach

Although the PPP has been widely adopted as the background principle for developing a range of environmental policies, including carbon tax policy, it may not be the most appropriate and effective principle for this purpose. There are two main shortcomings of this principle.

First, the formulation of PPP is based on purely economic theories and does not reflect the real physical world in term of a complete materials balance (see, for example, Ayers 1978; Ayers 1999; Ayers & Kneese 1969; Boulding 1966; Fritsch, Schmidheiny & Seifritz 1994; Georgescu-Roegen 1971; Kneese, Ayers & d'Arge 1970). Essentially, the materials-balance approach holds that all materials (that is, energy and non-energy) extracted from the environment and used in the economy are accounted for by either remaining in the economy as durable goods or disposed of in the environment as emissions (Cordato 2004; Pearce & Turner 1990; Perrings 1987; Pethig 2003; Ruth 1993). This approach therefore implies that environmental problems are a part of economic processes and all goods and services produced in an economy are (directly and indirectly) associated with energy use. In other words, energy is consumed in any economic activity in two ways – directly in the form of primary energy, and indirectly in the form of energy embodied in materials (called indirect energy). This indirect use of energy, according to Spreng (1988, p. 138), includes:

> *… (1) energy embodied in materials consumed during operation of the process; (2) energy embodied in the capital facilities of the system (including the energy embodied in all the manufactured components as well as the energy directly consumed during construction of these components); (3) energy embodied in the capital facilities that produce the materials and components and in the equipment used during construction; and (4) energy required to produce the fuels and electricity consumed directly.*

The indirect energy thus comprises a chain of direct energy requirements leading upstream to raw materials in the ground. Therefore, in order to complete the materials flow and hence accurately represent energy–environment–economic interactions, both direct and indirect energy have to be accounted for. This has also been emphasised by Owen (2004, p. 131) in that, within the context of environmental impact of energy use:

> *… a life cycle approach must be adopted in order to identify and quantify environmental adders associated with the provision of energy services. This approach provides detailed and comprehensive evaluation of energy supply options (based upon both conventional and renewable sources).*

In the case of renewable technologies, while PPP considers them as zero emission technologies, they may in fact consume significant amounts of energy through the use of materials over their entire operating life. This includes, for example, the construction of power plants requiring steel (from the iron and steel industry), copper (from the non-ferrous metal industry), cement (from the construction industry). Moreover, the operation of these technologies may require electronics (from the electronics industry), plastics (from the chemical industry), and so on (Proops et al. 1996, p. 230). The production of these materials requires the burning of various types of fossil fuels, and hence the release of CO_2 emissions.

From the discussion in Section 3.3.2, it is clear that carbon tax based on PPP does not consider the environmental consequences arising from this indirect energy. If this indirect energy is considered, there could be, this research contends, different economy-wide implications of carbon tax policy from the one that is based on PPP.

The second shortcoming (related to the above-noted shortcoming) of designing carbon tax based on PPP is the issue of equity. Because PPP does not consider indirect emissions, the responsibility of controlling pollution rests solely upon fossil-fuel consumers. In this approach, renewable industry, using non-fossil fuel inputs, remains sheltered from environmental responsibility. Accordingly, this could pose an unfair burden on fossil-fuel industries. The message here is that the climate change problem should not be considered as the responsibility of only the fossil fuel consumers (or polluters as they are defined by PPP); it should be the concern of the whole economy.

In light of these shortcomings, a number of principles have been developed as alternatives to PPP. These include *user-should-pay* (UP), *polluter-and-user-should-pay* (PUPP), and *victim-pay* (VP) (Steenge 1999). However, like the PPP, all these principles also have some shortcomings. For example, in the complicated networks of industrial complexes, it is difficult to identify who should be considered as the polluter, user, or victim (Steenge 1999, p. 165). If the liability of maintaining environmental standards is set as the responsibility of any single party, it would inevitably pose an unfair burden on that particular party.

In addition to the above, there is another principle that has recently been mentioned in the European Union Fifth Action Program. This principle is derived from the concept of shared responsibility and, therefore, is called the Shared Responsibility Principle (SRP) in the context of this research. This principle seeks to alter production and consumption patterns in the economy. Such alteration is driven by environmental considerations (for example, CO_2 emissions) of various production and consumption patterns (Steenge 1999). In other words, this principle assigns responsibility for CO_2

emissions to both fossil-fuel consumers and consumers of other products whose production may have consumed CO_2-emitting fossil fuels. Under this principle, both direct fossil fuel consumers and consumers of indirect-fuel that is embodied in materials would be proportionally responsible for CO_2 emissions. By taking into account the interconnections within the economy, only part of the produced pollution from fossil-fuel consumption is imputed to the sector that actually consumes those fossil fuels, with the remaining parts being imputed to the consumers of their products. This way, environmental emissions would be relating more directly to both production and consumption activities in the economy.

This research proposes the use of this principle as a basis for developing carbon tax-based environmental policy. In this alternative principle, the flow of direct and indirect energy in the economy can be examined.[28] These flows reflect the true interactions between an economic activity and its impact on the environment. The environmental impacts from non-fossil-fuel consumers can also be captured. If carbon tax is imposed based on SRP, these indirect energy consumers will also be considered as the polluters and hence would also be liable for environmental responsibilities.

3.3.4 Sectoral Responsibilities of Australian Emissions

In Section 3.3.2 and 3.3.3, two principles that can be used for designing carbon tax policy were discussed. These are the Polluter Pays Principle (PPP) and the Shared Responsibility Principle (SRP). The main difference between these two principles (as was also noted in these sections) is in terms of the procedures for allocating CO_2 emission responsibilities across different sectors in the economy (a numerical example is also given in Appendix A to provide further clarification on this aspect). Once emissions are allocated, however, carbon tax is imposed on the same basis in both cases and the price mechanism influences the behaviour of the economic agents in the same manner.

---

[28] The flow of direct and indirect energy can be represented in terms of the materials-balance, as shown in Figure 1-3 (Chapter 1).

Table 3-3 shows sectoral CO_2 emissions for the Australian economy in 2002. The CO_2 emissions are allocated based on both PPP and SRP (using a method discussed in Chapter 5). The sectoral classification shown in this table is the same as that shown in Figure 1.4.

The table shows that, under PPP, the electricity sector is the largest emitter of CO_2 in the Australian economy. It was responsible for sixty per cent of the total CO_2 emissions in 2002. The commercial sector, accounting for nearly half of the country's production, ranked thirteenth, responsible for just over one per cent of total CO_2 emissions. The table also suggests that, based on PPP, the big fossil-fuel consumers (for example, the electricity sector, road and air transport, iron and steel industry, and non-ferrous metal industry) are responsible for most of the emissions in the economy. On the other hand, when allocation of CO_2 emissions is based on SRP, the electricity sector contributes only 21 per cent of total CO_2 emissions. In this case, the commercial sector is ranked first. It is responsible for 33 per cent of total CO_2 emissions. Although the commercial sector does not consume fossil energy directly, it consumes significant amount of electricity, as well as other materials. These materials and electricity, in turn, are produced from CO_2-emitting fossil fuels.

Table 3-3 Australian CO_2 emissions: PPP vs. SRP

Year 2002

Rank	Polluter Pays Principle (PPP)			Shared Responsibility Principle (SRP)		
	Sector	Mt	%	Sector	Mt	%
1	Electricity sector	187.04	60.47	Commercial sector	102.07	33.00
2	Road transport	20.52	6.64	Electricity sector	65.12	21.05
3	Iron and steel industry	14.89	4.81	Food industry	21.58	6.98
4	Non-ferrous metal industry	14.41	4.66	Non-ferrous metal industry	20.75	6.71
5	Air transport	11.96	3.87	Mining sector	11.02	3.56
6	Coal sector	9.17	2.97	Air transport	10.26	3.32
7	Chemical industry	8.90	2.88	Road transport	10.25	3.31
8	Petroleum sector	7.96	2.57	Coal sector	10.00	3.23
9	Non-metal industry	6.18	2.00	Agriculture sector	7.55	2.44
10	Agriculture sector	5.47	1.77	Other transport	6.72	2.17
11	Mining sector	4.64	1.50	Machinery and equipment industry	6.71	2.17
12	Water transport	3.78	1.22	Petroleum sector	6.65	2.15
13	Commercial sector	3.75	1.21	Chemical industry	6.56	2.12
14	Food industry	2.46	0.79	Iron and steel industry	4.00	1.29
15	Construction sector	1.90	0.62	Wood and paper industry	3.88	1.26
16	Wood and paper industry	1.83	0.59	Water transport	3.55	1.15
17	Railway transport	1.55	0.50	Railway transport	3.47	1.12
18	Other transport	1.02	0.33	Textile industry	3.06	0.99
19	Gas sector	0.93	0.30	Water industry	2.14	0.69
20	Textile industry	0.41	0.13	Construction sector	1.06	0.34
21	Machinery and equipment industry	0.32	0.10	Non-metal industry	1.02	0.33
22	Fabricated metal industry	0.13	0.04	Fabricated metal industry	0.79	0.26
23	Water industry	0.08	0.03	Gas sector	0.67	0.22
24	Other manufacturing industry	0.02	0.01	Other manufacturing industry	0.44	0.14
	Total CO_2 Emissions	**309.32**	**100**	**Total CO_2 Emissions**	**309.32**	**100**

Notes:
- This table presents the results obtained from the application of equation 5-3 for PPP and equation 5-6 for SRP, as detailed in Chapter 5, Section 5.2. For detailed results – see Table D-1 to D-4, Appendix D, pp. 271-274.
- CO_2 emissions from road transport do not include fuel used in private vehicles. Although private road transport is a major source of emissions, the focus of this research is on the production side of the economy.

It is also clear from Table 3-3 that carbon tax policy based on SRP would have certain advantages over that based on PPP. The principle of reallocation of emissions based on SRP is in line with the materials-balance approach. It involves integrating the energy- and non-energy-related emissions and assigning them to a particular economic activity (GWA & ES 2002). In other words, it not only considers emissions from direct use of energy, but also indirect emissions from the use of energy embodied in materials for each good produced. This way, a comprehensive evaluation of energy supply options – fossils and renewable – could be carried out. Also, based on SRP, the responsibility for CO_2 emissions can be fairly attributed across all sectors in the economy (see Table 3-3). Despite these advantages of SRP over PPP, there is a lack of discussion and further investigation of its policy implications in Australia and indeed worldwide. This investigation constitutes a core aspect of this research.

3.4 Summary and Conclusions

The main objective of this chapter was to provide an overview of the development of greenhouse policy in Australia and to develop a perspective on carbon tax as a policy option to reduce Australia's carbon-dioxide emissions. The major conclusions from this chapter are summarised as follows.

- Carbon-dioxide emissions from electricity generation in Australia are substantial and increasing. Its share of total CO_2 emissions increased from 32 per cent (129 Mt) in 1990, to 47 per cent (194 Mt) in 2004 – an increase of 51 per cent as compared with an increase of 3 per cent (from 402 Mt to 415 Mt) of total CO_2 emissions. Specifically, the introduction of the national electricity market has contributed to a considerable increase in emissions. For example, these emissions increased from 152 Mt in 1997 to 167 Mt in 1998. This is due to an increase in the share of brown coal (from 29 per cent in 1997 to 34 per cent in 1998) – the cheapest and dirtiest fuel – for electricity generation. In the absence of any decisive environmental policy, the future growth in CO_2 emissions from electricity generation will place significant pressure on Australia's total CO_2 emissions.
- The climate change policy development in Australia has, in the initial years, been guided by genuine concerns about global warming. In these years, Australia indeed acted as a global leader in proposing strategies to combat climate change. Australia was among the first countries to ratify with the international party and conducted the domestic "*interim planning target*" based mainly on the adoption of carbon tax to reduce CO_2 emissions. Later, however,

as the economic impacts of such policies became clearer, especially on fossil-fuel industries, Australia drastically changed its environmental stance. The release of key policy papers thereafter (for example, National Greenhouse Response Strategy, Greenhouse Challenge Program, and Energy White Paper) firmly established a stance that favours economic objectives over environmental objectives.

- The coal–electricity compact has exerted a strong influence on the evolution of Australia's greenhouse-gas reduction policies. Such policies have relied mainly on voluntary initiatives for the reduction of greenhouse-gases. These policies were, however, characterised by a fragmented array of short-term commercial and economic interests and lacked consideration of long-term environmental sustainability.
- The use of market-based instruments, particularly carbon tax, has been continually rejected by the Australian federal political parties, on the grounds that it would impede economic growth. Its expected impact on Australian industries has created "carbon tax phobia" among coal-electricity interests, which has significantly influenced the government's greenhouse policy development.
- Carbon tax, as traditionally examined, is based on a narrowly defined principle – the Polluter Pays Principle. Emissions based on this principle are considered as the sole responsibility of the consumer of direct energy. This approach, therefore, tends to penalise big fossil-fuel industries.
- There are two main shortcomings of carbon tax that are based on PPP. It ignores indirect energy embodied in materials, and is inequitable in assigning environmental responsibility.
- The Shared Responsibility Principle (SRP) could overcome these shortcomings and hence could be used as an alternative method for the design of a carbon tax policy. This principle considers emissions arising from both direct and indirect energy consumption. Hence, it provides a comprehensive and realistic picture of the real impact of carbon tax on various segments of society. This method

also promotes fairness (in terms of emissions accreditation) between all actors involved in the Australian greenhouse-gas discourse.

- Despite these advantages of SRP, there is a lack of analysis about the application of carbon tax based on this principle. This research devotes specific attention to this issue.

CHAPTER 4

A REVIEW OF MATERIALS-BALANCE FRAMEWORK

In Chapter 3, a case was made for considering a carbon tax policy based on the Shared Responsibility Principle (SRP) as a means to reduce CO_2 emissions. Such consideration would require the representation of various economic activities (for example, electricity production) in terms of their energy and material input requirements, or materials-balance (as also shown in Figure A-2 in Appendix A). There are several methods for developing materials-balances. Each of these methods poses some challenges.

The objective of this chapter is to review methods that incorporate materials-balance, to understand their relative strengths and weaknesses, and to use this understanding to select an appropriate method for this research. Section 4.1 introduces the background of the materials-balance framework and describes the broad contours of two materials-balance frameworks. Before a review of these two materials-balance frameworks is conducted, a set of criteria is outlined in Section 4.2. The method that will be selected from this review must satisfy these criteria. This is followed by a review of studies adopting the materials-balance framework. These studies are grouped into two materials-balance frameworks discussed in Sections 4.3 and 4.4. A summary of the major findings of this chapter are presented in Section 4.5.

4.1 Background of Materials-balance Framework

Since the seminal work by Kneese, Ayers and d'Arge (1970), the need to include all inputs – energy as well as non-energy (materials) – in the production system has been extensively discussed in the context of environmental policy analysis (see for example, Ayers 1978, 1999; Ayers & Kneese 1969; Boulding 1966; Fritsch, Schmidheiny & Seifritz 1994; Georgescu-Roegen 1971; Kneese, Ayers & d'Arge 1970; Pearce & Turner 1990; Perrings 1987; Ruth 1993). This principle is called the materials-balance in literature.

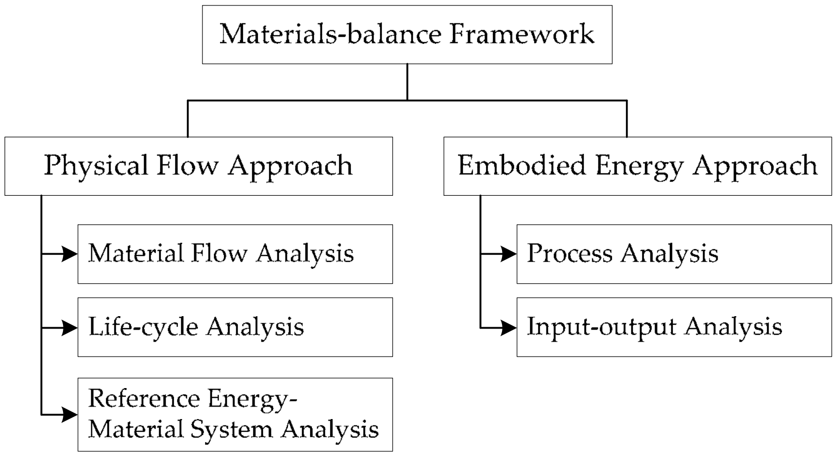
The materials-balance framework is founded on the physical laws of thermodynamics, particularly the law of mass conservation. The law of mass conservation states that energy and materials cannot be created or destroyed, but their characteristics change from one state to another. This law implies that all of the energy and materials are extracted from the environment, flow through the economic system in the form of production and consumption of goods and services, and are disposed of back into the environment in the form of emissions and other waste products. This principle, in contrast with the traditional economic view[29], regards environmental problems as a pervasive and inevitable phenomenon. It regards environmental problems as a part of economic processes that can only be adequately assessed if the complete material flow in the economy is envisioned (Pethig 2003). It focuses on the complete representation of the relationship between the economy and the environment. Every input into an economic activity must be considered in order to understand the true environmental impact associated with that economic activity. The materials-balance framework is also referred to, by Daly (2002), as the representation of materials throughput in the economy.

In its most basic form, the materials-balance can be represented in the form of physical flows of energy and materials, with flows expressed in their original (that is, physical) units. The motivation for the physical flow approach is that the economy is underpinned by a physical world of stocks and flows of energy and materials. These stocks and flows are used to determine the economic choices and social behaviour (Poldy 1998). In order to be better informed about this dimension of the physical world, it is essential to understand these flows in their original forms. This approach is favoured by environmentalists and ecologists, as it represents the *physical* indicators of sustainable development, which cover a "*broader set of social values and amenities and do not have an integrative power of monetary aggregates generated in environmental accounting systems*" (Bartelmus & Vesper 2000). There are three methods that can be classified

[29] In the traditional economic view, an economic system – comprising production and consumption activities – is viewed in complete isolation from the environmental system. The environment is regarded as external to the economic system.

under the physical flow approach – material flow analysis, life-cycle analysis, and reference energy–material system analysis – as shown in Figure 4-1.

Figure 4-1 A classification of materials-balance approaches



Another approach to materials-balance is to employ an embodied energy approach, rather than the physical flow of materials. The embodied energy methods started in the late 1970s, mainly in an effort to address the problem of fossil fuels depletion following the 1973 energy crisis, which was the main concern at that time. A number of studies (for example, Bullard & Herendeen 1975; Chapman 1975; Chapman, Leach & Slesser 1974; Wright 1974, 1975) were initiated at that time; these studies used energy flows in the economy, rather than monetary flows, to analyse the energy used for the production of energy and materials. The embodied energy approach is defined as "*the computation and measurement of energy flows in society, and, in particular, as the quantification of the volume of energy resources sequestered, directly and indirectly, in various commodities*" (IFIAS 1978). The total embodied energy comprises energy required directly for the main process (for example, coal used for electricity production) and the indirect energy embodied in the material inputs to the process (for example, energy used for readying coal needs for electricity production and energy used for the construction of power stations). The embodied energy approach can be used as a ctoral price effects are estimated using input–output price model. In the fourth module, the substitution effects, in response n the materials. The sentiment behind this argument is captured in the following statements by Fritsch, Schmidheiny and Seifritz (1994, p. 186):

> *… If a certain resource is depleted, its material components have not ceased to exist (law of conservation). Rather, this resource or its component parts are not available with the concentration, in the proper place, and at the proper time. This condition can be fulfilled for practically all elements of the system. This, however, requires energy. For this reason, the resource or raw material problem can be reduced to the problem of energy – 'the ultimate resource'.*

Process analysis and input–output analysis can be classified as embodied energy methods (see Figure 4-1).

A number of studies have been carried out using physical flow and embodied energy methods for developing materials-balance frameworks. These methods are reviewed in Sections 4.3 and 4.4.

4.2 Criteria for Examining Methodological Approaches

As shown in Figure 4-1, there are several methods that can be used to develop a materials-balance. A number of studies have incorporated these methods for analysing different environmental issues, with the common single purpose of better understanding the relationship between the economy and the environment. However, before reviewing these studies, a set of criteria needs to be established in order to examine each method against these criteria. The method that will be selected from this review must satisfy these criteria. These criteria are:

i. **Goal:** this research examines the economy-wide impacts of carbon tax as a policy option for reducing CO_2 emissions. Therefore, the selected framework must also be able to analyse carbon tax and assess its impacts on the national economy.

ii. **Spatial scope:** the impact of carbon tax would vary across sectors in the economy, depending on the sectoral contribution to CO_2 emissions. Therefore, the selected framework must allow the analysis to be performed at disaggregated levels.

iii. **Temporal scope:** because of the long-term nature of environmental issues, the framework must allow the analysis over the medium to long term.

iv. **Dynamics:** the dynamism of a model is an important characteristic in any modelling study. Two aspects of dynamism need to be captured in this research. First, the model must capture changing technological characteristics over time. This can be achieved through the substitution of factor inputs in response to changes in factor prices arising as a result of the introduction of a carbon tax. Second, the model must be flexible in allowing capital investment to be adjusted in response to the introduction of carbon tax. This would further improve the ability of the selected framework for long-term analysis because it would allow the model to capture changing investment patterns (for example, in cleaner technologies).

v. **Price consideration:** the inclusion of carbon tax would increase the cost of production from an economic sector to the extent of its contribution to CO_2 emissions, and hence raise the price of output from that sector. Therefore, the selected framework must be able to capture price impacts across various sectors of the economy.

vi. **Data requirement:** the availability of data is always a challenge in any empirical study. This is especially the case in this research, because detailed data on material flows would be required. The framework selected for this research must be open in using the publicly available information.

4.3 Physical Flow Methods

As discussed in Section 4.1, the materials-balance can be represented in terms of the physical flow approach. A number of studies have been conducted in the past, using different methods based on the physical flows. These are: Material Flow Analysis, Life-cycle Analysis, and Reference Energy–Material System analysis (see Figure 4-1). Table 4-1 provides a summary of these studies, which are discussed in detail in the following sub-sections.

Table 4-1 Studies adopting physical flow method

Author (Year[*])	Scope		Study period	Focus	Key Findings
	Country	Sector			
				Material Flow Analysis (MFA)	
Adriaanse et al. (1997)	4 countries	Economy	n.s.	Compare material flows with National Accounts	Use of National Accounts underestimates environmental impacts
Spangenberg et al. (1998)	EU	3 sectors	1990	Develop material flows	Environmental impacts from material flows are significant
Guinée et al. (1999)	Netherlands	Economy	1990	Analyse environmental impacts of metal flows	Emissions from indirect material flows > direct
Bringezu & Schütz (2001)	EU	Economy	1987& 95	Compare total with direct material requirement	Direct material requirements declined, while total material requirements increased
				Life Cycle Analysis (LCA)	
Macdonald et al. (1997)	Canada	Electricity	1990	Determining electricity supply options in market-based economies based on LCA	LCA can be used as an efficient method for internalising environmental externalities
Mann & Spath (2000)	USA	Electricity	n.s.	Compare biomass, coal, and NG electricity	Environmental performance: Biomass > Coal
ACARP (2002)	Australia	Electricity	n.s.	Examine LCA of electricity technologies	Provided a long list of life-cycle emissions
Gagnon et al. (2002)	n.s.	Electricity	n.a.	Compare environmental performance of electricity generations	Environmental performance – hydro>wind>nuclear>gas>coal
GWA & ES (2002)	Australia	Energy	1990& 99	Allocate life cycle emissions to end users	List of life-cycle emissions at end-use level
Meier (2002)	USA	Electricity	n.a.	LCA of natural gas & photovoltaic	Provided life-cycle emissions of NG & PV
Stiegel (2002)	USA	Electricity	n.a.	LCA of gas-fired power plants	Provided life-cycle emissions of gas-fired electricity
Góralczyk (2003)	Poland	Renewable	n.a.	Identify life-cycle environmental impacts	Provided life-cycle emissions of renewable electricity

Author (Year*)	Scope		Study period	Focus	Key Findings
	Country	Sector			
			Reference Energy-Material System Analysis (REMS)		
Hoffman (1980)	USA	Packaging	1977	Minimise materials cost in packaging sector	Cost reduction achieved from changing cost of other inputs, rather than material substitution
Sundberg & Wene (1994)	Sweden	Paper mill	1989	Maximise profit from material reduction	Cost reduction achieved from recycled material
Gielen (1995)	Netherlands	Manufacturing	1990–2040	Analyse CO_2 reduction from energy (E) and materials (M) system improvement	CO_2 reduction costs from E+M are lower than if compared with improvement from E alone
Gielen & Kram (1998)	Europe	Manufacturing	1990–2050	GHG reduction potential from material system	Material system can contribute up to 50% to total emission reduction
Gielen (1999a)	Europe	Iron and Steel	1990–2030	Analyse CO_2 reduction from energy (E) and materials (M) system improvement	CO_2 reduction costs from E+M are lower than if compared with improvement from E alone
Gielen (1999b)	Europe	Construction	1990–2030	Analyse CO_2 reduction from energy (E) and materials (M) system improvement	CO_2 reduction costs from E+M are lower than if compared with improvement from E alone
Nemry et al. (2001)	Belgium	3 products	1990–2010	Evaluate life-cycle GHG emissions	Product substitution significantly reduces life-cycle emissions
OECD (2001)	Europe	Economy	1990–2050	Analyse two-policy scope (Energy and Energy+Material) for emissions reduction	Including material options improve effectiveness & efficiency of GHG mitigation policies

Notes: n.a. = Not applicable, n.s. = Not specified.
* Year of publications.

4.3.1 Material Flow Analysis

Material Flow Analysis (MFA) is similar to the approach favoured by industrial ecologists, for analysing how materials and energy flow within a system. This approach describes the flow of one type of material through different sectors in any given time period (Kandelaars 1999). In this approach, physical quantities of different materials are traced within an industry or a sector in the economy with the use of input and output ratios (Bouman et al. 2000). Because the focus in this approach is a specific material, only sectors that are directly involved in the life cycle of that material are considered in the analysis. Also, the system boundary of this approach ranges from a single industry to the whole economy.

MFA has recently received a lot of attention. Adriaanse et al. (1997) adopted this method to measure the total material requirements for Germany, Japan, Netherlands, and the USA. They found that about 55 to 70 per cent of material flows are not shown in the national accounts, which underestimates the use of natural resources and their environmental impacts. Spangenberg (1998) developed material flows for energy, transport, and construction sectors in the European Union in 1990. These studies showed that material flows in these sectors were significant and so were their environmental impacts. The author suggested some material recycling options as means to reduce environmental impacts. Guinée et al. (1999) analysed the flows of metals in the Netherlands economy. They found that while emissions from direct use of metals had declined, their use as inputs in other products have increased significantly, which led to a net increase in emissions. Bringezu and Schütz (2001) estimated the total material requirement for the European Union in 1985 and 1997. They found that while direct material consumption appeared to be declining, the total material consumption was in fact increasing.

The discussion above shows that MFA is a useful approach for assessing specific technical options in terms of material substitution or recycling in reducing CO_2 emissions from a particular sector. It can be used to identify areas where system improvements would result in increased materials efficiency or reduced waste, or other materials management objectives (Tisdale 2002). However, it requires a high level of detail, incorporating all flows of materials in question. As a result, a large amount of data is required to trace material flows. The data required for such analysis is very expensive and, in many cases, difficult to obtain. Furthermore, MFA is a short-term, static approach used to describe a current material system, which inhibits its ability to capture the changes in economic system.

4.3.2 Life-cycle Analysis

Life-cycle Analysis (LCA) is a method that can be employed to assess the environmental consequences of a product from cradle to grave (Bouman et al. 2000). It is similar to MFA in that it takes a product-focused approach in studying how a particular product (or material) flows. However, LCA does not limit the flow of product within any particular region or time period, but focuses on its whole life cycle. This method was developed on the basis of process analysis (process analysis is discussed in Section 4.4.1). The process analysis method has been refined and expanded to include all types of environmental impacts. LCA can be used for assessing the environmental impacts of each step involved in creating a product. As defined in ISO 14040[30]:

> *Life cycle analysis is a technique for assessing the environmental aspects and potential impacts associated with a product by compiling an inventory of environmentally relevant inputs and outputs of a system, evaluating the potential environmental impacts associated with those inputs and outputs and interpreting the results of the inventory and impact phases in relation to the objectives of the study.*

LCA is a method used for identifying the environmental impacts of various stages of a life cycle. In other words, it attempts to measure the "*cradle-to-grave*" environmental impacts of a product: from materials acquisition and production, through

---

[30] ISO 14040 belongs to the ISO 14000 families of standards concerning environmental management. It provides a clear overview of the practice, applications and limitations of LCA (ISO 1997).

manufacturing, system use and maintenance, and finally through the end of the system's life. In the electricity-generation sector, for instance, such assessment would include processes associated with the extraction, processing and transportation of fuels, the building of power plants, production of electricity and decommissioning of power plants (Gagnon, Bélanger & Uchiyama 2002). The analysis of life cycle is therefore based on the knowledge of accompanying processes.

LCA has been used since the late 1960s for estimating the requirements of natural resources for the production of various commodities. Its application in the electricity sector has only recently begun. Some examples of such applications include Bergerson and Lave (2002), Gagnon, Bélanger and Uchiyama (2002), Góralczyk (2003), Mann and Spath (2000), Meier (2002), and Stiegel(2002). These studies have essentially used LCA to assess a range of environmental impacts of different electricity generation technologies. For example, Macdonald et al. (1997) analysed electricity-supply options in Alberta (in Canada) based on LCA for the year 1990 and found that this method is appropriate for use as an efficient method in internalising environmental externalities. Gagnon et al. (2002) adopted LCA to compare the performance of different electricity-generation technologies in terms of their environmental impacts. The study found that, based on life-cycle emissions, renewable power plants have an excellent environmental performance compared with fossil-fuel power plants. Mann and Spath (2000) also performed life-cycle assessments of biomass-, coal-, and gas-fired power stations and found that biomass provides significant environmental benefits over conventional fossil-based power stations.

The LCA approach has also been applied in Australia to determine total emissions generated from the full fuel-cycle of electricity generation. For example, Coal in a Sustainable Society (CISS) is a major project for examining the cradle-to-grave, or full life-cycle, impacts of current and developing technologies for electricity generation (ACARP 2002). This study has developed life-cycle analysis for several electricity-generation technologies and found that gas-fired electricity generation have similar (or even higher than, in some case) greenhouse emissions to coal-based electricity generation. The study by GWA and ES (2002) has also adopted a similar method, called the fuel-cycle analysis of the energy sector, for each of the Australian states. This study has also included natural gas and petroleum, solid fuels, and electricity sectors. The primary objective of this study was to compute the fuel-cycle of the energy sector that would "*relate greenhouse gas emission more directly to production activities and to the consumption of goods and services, so that the implications of emission reduction strategies can be better planned and understood*" (ibid, p. 8).

Notwithstanding the usefulness of LCA, it suffers from several limitations, for example:

- its inability to perform the analysis for the whole economy – this is due to the arbitrariness associated with the drawing of the boundaries of the system that is being analysed (Fiksel 1996);
- its inability to capture the dynamics of changing markets and technologies (Fiksel 1996);
- the unavailability or poor quality of data to perform the analysis (Lave et al. 1995); and
- its expensiveness (in terms of money and time) arising from the need to source input data and environmental burdens that have to be either empirically gathered or obtained from literature (Hendrikson et al. 1998).

4.3.3 Reference Energy–material System Analysis

The REMS is similar to the Reference Energy System (RES); RES is a method to represent various elements of an energy system from primary energy extraction to end uses. Together with the flow of energy through various stages (for example, extraction, conversion, transport, end use), REMS also includes the flow of materials from their extraction to product development to end use. The energy and material system represented in REMS can be analysed with the help of mathematical programming techniques.

Hoffman (1980) was the first to adopt the REMS approach and use a mathematical programming model to minimise material system cost for a hypothetical packaging sector. Although this method was developed in 1980, it received greater attention in the mid-1990s only, with the development of two models – Model for description and optimisation of Integrated Material flows and Energy Systems (MIMES) and MATerials Technologies for greenhouse-gas Emission Reduction (MATTER). MIMES, developed by Sundberg and Wene (1994), is a static non-linear programming optimisation model used to estimate the optimal condition for the linked energy and material systems. The purpose of developing this model was to examine materials reduction strategy and waste management planning at the individual industry level. MATTER is a linear optimisation model of the energy–materials system for the Western European economy (Gielen, Bos & Gerlagh 1998). This model is the extension of a traditional energy system analysis model – MARKAL (MARKet ALlocation). It considers material flows along with energy flows in the economy. In addition, another energy system optimisation model – MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental impacts) – is also capable of integrating material flows. However, no attempt has been made to date in order to represent material flows with the existing energy flow (Strubegger 2003).

Unlike the optimisation models mentioned above, the Australian Stocks and Flows Framework (ASFF) is a highly disaggregated simulation framework which can keep track of all physical stocks and flows (such as land, livestock, people, buildings, etc.) in the economy (Gault et al. 1987). This framework contains a simulation model and a database, with modules or calculators representing physical processes in the economy. Foran and Poldy (2002) applied this model to analyse the impact of long-term migration policy on the Australian economy and the environmental system. Although comprehensive in its representation of the economy, this model, however, ignores the influence of prices and, hence, does not provide signals for inter-fuel substitution to achieve desirable environmental outcomes.

Although there are many models available for analysing materials flow in REMS, only MARKAL-MATTER is being used widely. Gielen (1995; 1999a; 1999b), Gielen and

Kram (1998), OECD (2001) and Nemry et al. (2001) used this model for analysing emissions reduction potential from energy and material system improvements. All these studies concluded that the inclusion of the material system (along with the energy system) would provide greater opportunities in GHG reduction with lower cost, compared with improvements from the energy system alone (see Table 4-1). Further, MARKAL-MATTER has been used mainly for analysing emissions reduction potential from production processes in manufacturing industries (for example, iron and steel, paper mill, packaging, etc.). Also, due to its huge data requirements, only material chains with a significant potential to reduce GHG emissions are included in the REMS (that is, it includes only GHG-intensive materials such as iron and steel).

The REMS approach is technologically detailed, representing all of the energy–materials relevant processes in each sector of the economy. The energy and material flows between industries are represented in terms of inputs and outputs specified for each technology. This means that each technology has a corresponding set of data that details the incoming materials and outgoing products or materials. Because it incorporates a high resolution of material flows, it is often more suitable for the analysis of a particular process or industry rather than policy analysis for the national economy.

4.3.4 Physical Flow Methods: A Summary of Observations

A review of the studies using physical flow methods (as discussed in Sections 4.3.1 to 4.3.3) shows that each method has its own strengths and weaknesses. Their strengths or weaknesses are summarised in Table 4-2, in accordance with the methodological criteria outlined in Section 4.2.

Table 4-2 Physical Flow Methods: Key Features

Features \ Methods	Material Flow analysis		Life-cycle analysis		Reference Material System analysis	
Goal	Identify key materials flows and potential for material substitution		Evaluate life-cycle environmental impacts of a product		Examine least-cost strategy for emission reduction	
Spatial scope	1 product	(x)	1 product	(x)	Sector specific	(x)
Temporal scope	Short	(x)	Short/Medium	(x)	Long	(✓)
Dynamics	No	(x)	No	(x)	Yes	(✓)
Price consideration	No	(x)	No	(x)	Yes	(✓)
Data requirement	High	(x)	High	(x)	High	(x)

Notes: Symbols in parentheses represent the compatibility with criteria outlined in Section 4.2. '✓' denotes compatible while 'x' denotes incompatible.

From Table 4-2, it is noticed that:

None of the physical flow methods fully satisfies the requirements outlined earlier in Section 4.2. Hence, they are not suitable for the analysis in this research. Some reasoning in support of this observation is provided below.

- In terms of a spatial scope, this research requires analysis for disaggregated sectors for the whole economy. The physical flow methods focus on a narrow range of material flows. MFA and LCA focus on the flow of one product, while REMS focuses on materials flow in any specific sector.

- In terms of temporal scope, this research requires the analysis for a long time-frame. Of all the physical flow methods, REMS is the only method that can be used for this purpose.

- In the physical flow approach, REMS is the only method that can capture economic dynamics. It is capable of capturing both changes in technology as well as allowing for adjustment of capital investment endogenously within the model.

- For this research, price consideration is an important aspect that needs to be captured within the framework. MFA and LCA do not provide an economic rationalising behaviour (that is, they can not be use to analyse the price responsiveness of an economic agent). REMS is a suitable method for this purpose.

- Lastly, data requirements pose a major problem for the physical flow methods. All three methods discussed above require a high level of data for materials flows. In many cases these data are difficult to obtain.

4.4 Embodied Energy Methods

As discussed in Section 4.1, embodied energy methods can be used as an alternative to physical flow methods for developing a materials-balance framework. A number of studies have been conducted using embodied energy methods. These methods can be classified in terms of those that employ process analysis and those that employ input–output analysis. Table 4-3 provides a summary of studies employing these methods. Details are discussed in the following sub-sections.

4.4.1 Process Analysis

Process analysis is the traditional tool of an industrial engineer. It begins with the examination of a process employed to produce a particular product. It then lists all energy and non-energy inputs required to produce this product. The energy and non-energy inputs are further examined to determine the energy and non-energy inputs required for their production. This process continues, tracing all energy consumptions to their origins.

Table 4-3 Modelling studies adopting embodied energy method

Author (Year[*])	Scope		Study period	Focus	Key Findings
	Country	Sector			
				Process Analysis	
Chapman et al. (1974)	UK	Energy industry	1968 & 72	Examine direct & indirect energy consumption	Material recycling & use of renewable energy would reduce energy consumption
Chapman (1975)	UK	Manufacturing	1968	Examine energy costs of materials	Energy & material conservation in product design would reduce its energy costs
RRI (1983)	Japan	Electricity	n.s.	Examine net energy use of renewable electricity	Total energy use: hydro>geothermal>wind>tidal>wave
San Martin (1989)	USA	Electricity	1986	Examine life-cycle emissions	Provided life-cycle emissions
				Input–Output Analysis	
Wright (1974)	USA	363 sectors	1963	Examine total energy in final consumption	Most energy associated with indirect use
Bullard & Herendeen (1975)	USA	357 sectors	1967	Examine energy required in products	Products contained more of indirect energy
Wright (1975)	UK	9 commodities	1963 & 68	Examine energy use in final consumption	Most energy associated with indirect use
Al-Ali (1979)	Scotland	42 sectors	1973	Investigate structure of energy demand	Demand for indirect energy > direct
Carter, Peet & Baines (1981)	New Zealand	Sectoral	1972	Examine energy use in final consumption & investment	Most energy associated with indirect use
Common & Salma (1992)	Australia	Sectoral	1987	Examine energy use in final consumption	Most energy associated with indirect use
Shariful & Morison (1992)	Australia	Sectoral	1974 & 80	Analyse changes in direct - indirect energy	Out of total increase in energy consumption, 31% are associated with indirect energy
Proops et al. (1993)	UK/Germany	Sectoral	1968 & 88	Analyse future scenarios for CO_2 reduction	Domestic CO_2 responsibility < CO_2 emission
Proops et al. (1996)	UK	Electricity	1989	Examine life cycle emissions	Emissions: coal>gas>wind>solar>nuclear
Konijn et al. (1997)	Netherlands	Metal industry	1990	Examine appropriateness of material flows using input–output analysis	Input–output is suitable for calculating total material or energy intensities
Lenzen (1998)	Australia	45 sectors	1993	Examine energy use in final consumption & investment	Most energy associated with indirect use

Author (Year*)	Scope		Study period	Focus	Key Findings
	Country	Sector			
Hybrid Process & Input–Output Analysis					
Bullard et al. (1978)	USA	Economy	1967	Develop hybrid process + Input output model	Combined model can increase accuracy of embodied energy analysis
Herendeen & Plant (1981)	USA	Electricity	1976	Examine net energy use of geothermal electricity	Energy output/input ratio greater than unity
Uchiyama (1992)	n.s.	Electricity	n.s.	Examine life-cycle emissions	Emissions: coal>oil>gas>wave>tide> wind>geothermal>hydro
Nishimura et al. (1996)	Japan	Manufacturing	1985	Embodied energy in product	Existence of substitutability between material used in consumer goods
Treloar et al. (2001)	Australia	Residential building	1993	Analyse total energy requirement	Hybrid approach is better than individual (Process or IO) approach
Production Function Studies					
Berndt & Wood (1975)	USA	Manufacturing	1947–1971	Examine substitution possibility between factor inputs	Material with capital, labour & energy: strong substitution
Fuss (1977)	Canada	Manufacturing	1961–1971	Examine substitution possibility between factor inputs	Material with capital: strong substitution Material with labour: weak substitution Material with energy: complements
Turnovsky et al. (1982)	Australia	Manufacturing	1947–1975	Examine substitution possibility between factor inputs	Material with capital, labour & energy: strong substitution
Truong (1985)	Australia	Manufacturing	1969–1981	Examine substitution possibility between factor inputs	Material with capital: strong substitution Material with labour & energy: weak substitution
Burney & Al-Matrouk (1996)	Kuwait	Electricity & Water	1965–1990	Examine substitution possibility between factor inputs	Strong own-price & weak substitution potential with capital & energy
Weir (2000)	Denmark	Construction	1966–1990	Econometric estimates of substitution between plastic, cement & steel	Existence of substitution possibility between all material; higher between cement & steel

Notes: n.a. = Not applicable, n.s. = Not specified.
* Year of publications.

Several authors have analysed the requirements for natural resources, particularly the energy needed for the production of various commodities, using this approach. For example, Chapman et al. (1974) analysed direct and indirect energy consumption by the energy supply sector. Chapman (1975) analysed total energy costs (including direct and indirect costs for manufacturing industries. Both studies concluded that materials recycling and increasing renewable energy sources would reduce energy consumption and hence its costs. RRI (1983) and San Martin (1989) adopted this method to examine life-cycle energy use and CO_2 emissions for various electricity generation technologies. These studies show that renewable electricity generation also contributes to a significant amount of emissions. IAEA (1994) provides a comprehensive list of studies that have employed process analysis for determining net energy consumption for different electricity-generation technologies.

Process analysis, like MFA and LCA, is a very detailed method for including material flows. It tracks down all inputs that are required to produce a targeted product. Because of the level of detail required, many inputs are often excluded from the flows. Some attempts have been made to improve the accuracy and completeness of process analysis (Bullard, Penner & Pilati 1978). Several studies have adopted a combination of process analysis and input–output analysis (input–output analysis is discussed in the next sub-section) to analyse any particular product or process, for example, Herendeen and Plant (1981), Uchiyama (1992), Nishimura et al. (1996), and Treloar et al. (2001). All these studies adopted a combination of both methods to examine total energy use and its associated emissions. They concluded that hybrid methods could provide a comprehensive representation of the materials chain and more accurately determine the total energy requirements and associated emissions associated with a particular process.

Process analysis has also been applied in Australia, in the form of the OzECCO model. This model is an Australian adaptation of the ECCO[31] model developed by the Resource Use Institute in Edinburg. The model integrates the structure of the national economy and its energy accounts. The capital stocks are expressed in equivalent petajoules of embodied energy rather than in monetary terms (CSIRO 1998). Activities within the economy are expressed as energy flows (in petajoules per year). In this way, all economic activity is converted to physical activity, expressed in energy units, which is consistent with the first and second laws of thermodynamics. All economic transactions are represented by their corresponding physical transformations. Foran and Crane (2000) used this model to investigate the use of bio-fuels in the Australian energy sector, particularly the use of ethanol and methanol in transport and the use of biomass in the electricity sector. The investigation focused on determining forest plantation areas and wood requirements to meet certain level of future bio-fuels demand for these sectors. The analysis found that in order to meet energy demand over the next 50 years, croplands of 17–31 million hectares would be required.

The foregoing discussion shows that process analysis potentially can produce very accurate, reliable and specific results. However, it suffers from the following shortcomings:

- Since process analysis involves tracing the energy content of all energy and non-energy inputs into production processes, the data required for such analysis are very extensive. This data in many cases may be difficult to obtain.
- The application of this method, like LCA, suffers from the issue of the selection of appropriate boundaries for analysis. It invariably leads to the exclusion of several small inputs. It is very difficult to determine all of the upstream

[31] ECCO (originally: Evaluation of Carrying Capacity Options; more recently: Enhancement of Capital Creation Options) is an embodied energy model focusing on identifying feasible rates of change of economies under specified technological assumptions and resource and environmental constraints (Slesser 1992).

processes required indirectly by a process, let alone to quantify their direct energy requirements (Lave et al. 1995).

4.4.2 Input–output Analysis

Input–output analysis can also be used for carrying out embodied energy analysis. This method was first developed by Wassily Leontief in 1936 as a tool to represent the structure of an economy by explicitly representing the interdependencies of economic sectors and industries (Duchin 1998). The inter-industry flows of commodities and raw materials are central to this technique. The input–output method traces the flow of commodities and raw materials across various sectors in the economy. This framework can be adapted to analyse embodied energy flows by converting the economic relationship into estimates of associated direct and indirect energy intensities (Bullard & Herendeen 1975). This application allows for the calculation of embodied energy for any sector in the economy.

Input–output analysis has been applied by many researchers for empirical analysis of embodied energy. For example, Wright (1974; 1975), Bullard and Herendeen (1975), Proops (1977), Al-Ali (1979), Carter, Peet andBaines (1981) and Shariful Islam and Morison (1992) employed this method to examine direct and indirect energy requirements for various economic sectors. Many of these studies found that most of the energy flows are associated with indirect use, to produce goods and services required in the economy. Further, Common and Salma (1992), Gay and Proops (1993), Proops et al. (1996) and Lenzen (1998) employed this method to examine direct and indirect emissions associated with energy use. While many of the above studies focused on the flows of direct–indirect energy to meet end-use demands for final consumption, only Carter, Peet and Baines (1981), Proops et al. (1996) and Lenzen (1998) have focused on these flows to also meet the demand required for capital investment. The input–output method has not only been used to account for direct–indirect energy requirements and associated emissions, Proops, Faber and Wagenhals (1993) and Cruz (2002) applied this method for future scenario analysis to reduce CO_2 emissions. Some of the scenarios focused on analysing technological improvements through changes in energy and material inputs. However, owing to the fact that the input–output method is characterised by fixed coefficients, both studies above have arbitrarily adjusted input coefficients to reflect the changes in input structure, without any economic rationality.

The underlying production function of the traditional input–output method is characterised by Leontief's production function. This type of production function assumes "*zero*" elasticity of substitution, which does not allow one input to be substituted with another input. Due to this limitation, some question the appropriateness of input–output method for analysing the impact of carbon tax on the entire economy (which is a focus of this research) and instead support the application of a general equilibrium framework for this purpose. But one can also argue that the general equilibrium framework is after all basically supported by input–output representation of the economy! As noted by Dixon et al. (1992, p. 19) that, "*The prototype for modern applied general equilibrium models is Leontief's input–output model*". Moreover, input–output coefficients can be endogenously determined rather than exogenously given as fixed parameters (that is, changes from Leontief's to other type of production function). Such modification should enable the input–output framework to incorporate economic rationality in terms of substitution in response to price changes, as is the case in a general equilibrium framework. This issue will be discussed in greater detail in Chapter 5.

To date, there exists no study that uses the input–output method, employing alternative production function specifications, for embodied energy analysis. However, some studies have adopted other types of production functions in incorporating the materials-balance approach in another context. For example, Gross and Veendorp (1990) adopted the Cobb-Douglas production function that satisfies the materials-balance to show that such a function sets a limit to growth for the case of an economy that obtains its material inputs from non-renewable resources. Weir (2000) studied the use of plastic, cement and steel in the Danish construction industry, by employing an econometric model to evaluate the substitution possibilities between different materials, in response to changes in material prices. Own- and cross-price elasticities were used to represent the potential for substitution between different materials. The study shows that there are substantial substitution possibilities in the construction sector, particularly between the use of concrete and metal. Other studies have used alternative production functions to estimate elasticities of substitution between aggregate variables – material, energy, capital and labour (for example, Ernst R. Berndt & Wood 1975; Burney & Al-Matrouk 1996; Fuss 1977; Hudson & Jorgenson 1974; Truong 1985; and Turnovsky, Folie & Ulph 1982). These studies employed Translog type of production function to estimate substitution possibilities. It was found that, at an aggregate level, material inputs can be substituted with almost all other factor inputs. These results implied that assumed "*zero*" substitution possibilities for input coefficients in input–output analysis are inappropriate and other flexible types of production functions should be employed.

An advantage of adopting approaches based on input–output analysis is that they could make use of readily available input–output tables; statistical offices in most countries periodically produce such tables. Although such tables may not contain information at the level of individual companies or processes (IAEA 1994), they can provide sufficient detail at disaggregate levels which could be adapted to the further level of detail required for analysis. The inclusion of embodied energy flows at such disaggregated levels ensures that all emissions are accounted for in the economy. Further, the input–output method is flexible in the sense that it allows longer-term analysis, by replacing Leontief's type with other forms of production function. The replacement of production function does not capture only changes in the behaviour of the agents in response to changes in prices; it can also capture changes in the input structures of technologies used for production. Also, the input–output model is capable of adjusting capital requirement within the model, which makes this method appropriate for long-term analysis (further discussion on these issues is provided in Section 5.5.2).

4.4.3 Embodied Energy Methods: A Summary of Observations

The review of studies using embodied energy methods (as discussed in Sections 4.4.1 and 4.4.2) shows that both methods – process and input–output – have their strengths and weaknesses. Their strengths or weaknesses are summarised in Table 4-4, in accordance with certain criteria outlined in Section 4.2.

Table 4-4 Embodied Energy Methods: Key Features

Features \ Methods	Process analysis	Leontief's Input–output analysis	Flexible Input–output analysis[a]
Goal	Identify life-cycle environmental impacts of a product or process	Examine economy-wide impact of energy-environmental policy	Examine economy-wide impact of energy-environmental policy
Spatial scope	1 product (x)	Sectoral (✓)	Sectoral (✓)
Temporal scope	Short (x)	Short/Medium (x)	Long (✓)
Dynamics	No (x)	Partly[b] (x)	Yes (✓)
Price consideration	No (x)	No (x)	Yes (✓)
Data requirement	High (x)	Low/Medium (✓)	Low/Medium (✓)

Notes: Symbols in parentheses represent the compatibility with criteria outlined in Section 4.2. '✓' denotes compatible while 'x' denotes incompatible.
[a] The term 'flexible' refers to the use of other type of production function.
[b] This 'partly-dynamism' characteristic of Leontief's input–output analysis reflect only treatment of capital investment and not technological change as a part of the model.

From Table 4-4, it is noticed that:

Amongst the embodied energy methods, the input–output method, with more flexible type of production function, satisfies all the criteria outlined earlier in Section 4.2. Some points in support of this selection are noted below.

- In terms of a spatial scope, this research requires analysis at disaggregated levels of the economy. Input–output is an appropriate method for this purpose. Although most of the published input–output tables do not provide much detail, the user can further disaggregate it to the level of detail required for analysis.

- In terms of a temporal scope, this research requires the analysis for a long time-frame. A "flexible" input–output is the only method that is suitable for this purpose. A "traditional" input–output has limitations for long-term analysis due to its assumption of fixed input–output coefficients. Replacing "flexible" forms of the production function with the "*Leontief's*" production function would allow the analysis to be performed over the long term.

- A "flexible" input–output method can satisfactorily capture economic dynamics. It is capable of capturing changes in technology (in terms of a flexible production function) and allowing for adjustment of capital investment endogenously.

- For this research, particularly in the context of analysing the impacts of carbon tax, price consideration is an important aspect that needs to be captured within the framework. A "flexible" input–output satisfies this criterion. This is because the replacement of Leontief with other forms of production functions allows the economic agents to make their decisions based on changes in prices.

- Finally, regarding data requirements, input–output has an advantage over other methods. All information required for the analysis can be obtained from the national statistical offices.

Therefore, the input–output method, with a more flexible type of production function, is selected as a framework use for the analysis in this research.

4.5 Summary and Conclusions

This chapter has reviewed various methodologies that have been employed to develop the materials-balance framework. The purpose of this review was to analyse their strengths and weaknesses and to use these insights to select an appropriate method for this research. The main findings of this chapter include:

- The methodologies that can be used for developing materials-balance framework can be classified into two – physical flow and embodied energy. The physical flow method represents the flow of energy and materials in their original units. The embodied energy method represents energy flows in the same way as the physical flow method, but represents materials flows as the flows of indirect energy.

- The physical flow approach can be classified into three categories – Material Flow Analysis (MFA), Life-cycle Analysis (LCA), and Reference Energy–material System analysis (REMS).
  - MFA is not a suitable method for this research. The spatial and temporal scope of this method is limited, that is, it focuses on the flow of one product over a short period of time. This method does not allow for technological changes and does not allow for capital adjustment in response to price changes (that is, for example, induced by the introduction of carbon tax). Also, data requirements for this method are high.
  - LCA is very similar to MFA and, therefore, not suitable for this research. Although the time-period considered in LCA is longer than in the MFA, it focuses on the flow of one product over its entire life. This method also does not capture technological changes, neither does it allow for any capital adjustments. The data requirements for this method as well are high.
  - Of the physical-flow methods, REMS is the most appropriate method for this research. It can capture price-induced effects, allows for autonomous technological change, and has a mechanism for capital adjustments and, therefore, is appropriate for long-term analysis. It, however, suffers from intense data requirements, which limits its use for an economy-wide analysis.
- The embodied energy approach can be classified into two: process analysis and input–output analysis.
  - Process analysis is not a suitable method for this research. The sectoral scope of this method is limited, that is, it focuses on the flow of various types of energy and materials to produce one product. This method does not allow for technological changes and for capital adjustment. Also, data requirements for this method are high.

- The traditional Leontief's input–output method is appropriate for the analysis of disaggregated economic sectors, by making use of input–output tables which are publicly available. The "dynamic" version of input–output method also allows for capital adjustments in response to price changes induced by carbon tax. However, in order to capture other aspects of economic reality (for example, producer/consumer behaviour in relation to prices), the underlying Leontief production function must be replaced with other flexible forms of production functions. Such replacement of production functions could allow input–output analysis to be used for analysing the impacts of a price-driven policy like carbon tax.

• Based on the review in this chapter, the input–output method with a flexible form of production function is selected as the methodological framework for this research. Further details of this methodological framework are provided in the next chapter.

CHAPTER 5

METHODOLOGICAL FRAMEWORK FOR THIS RESEARCH

In Chapter 4, various methodologies for developing a materials-balance framework were reviewed. Based on this review, it was concluded that the input–output method, with a modified production function, would be the method for this research – in order to analyse the economy-wide impacts of a carbon tax. This method has the potential to consider the indirect energy embodied in materials; perform the analysis at disaggregated sectoral levels; analyse the price impacts of carbon tax; and provide an analysis over a long time-frame. Moreover, it is relatively less burdensome in terms of data requirements.

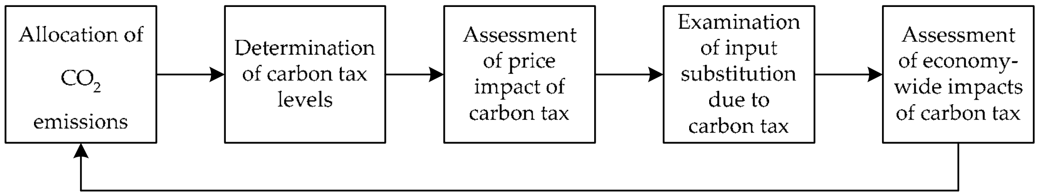
The objective of this chapter is therefore to provide details of this methodological framework. This chapter is divided into eight sections. Section 5.1 briefly introduces the overall methodological framework employed in this research. This framework comprises five modules, namely, emission allocation, tax imposition, price impact, input substitution, and economy-wide impacts. Sections 5.2 to 5.6 provide details of each of these five modules. Section 5.7 provides a description of data sources and data preparation for this method. Finally, Section 5.8 summarises the main findings of this chapter.

5.1 Overall Methodological Framework

This section presents an overview of the proposed methodological framework for analysing the impacts of carbon tax in this research. This framework is developed based on the input–output model with a flexible form of production function, as suggested in Chapter 4.

The framework comprises five interlinked functional modules (Figure 5-1).

Figure 5-1 Schematic diagram of the overall methodological framework



A brief description of these modules, particularly the linkages of each module, is provided below (details are provided in Sections 5.2 to 5.6).

- The first module forms the core of the analysis in this research. It allocates CO_2 emissions to responsible sectors of the economy, based on both the Polluter Pays Principle (PPP), using an energy-balance approach; and Shared Responsibility Principle (SRP), using an energy–materials balance approach (see Section 3.3 for a discussion on these principles). CO_2 emissions are calculated from input–output tables for the base year (2004). CO_2 emission intensities[32] are also estimated based on these emissions. A detailed discussion and mathematical description for this stage is presented in Section 5.2.

- The second module assigns a carbon tax for various CO_2-emitting sectors of the economy, as identified in the previous module. For the PPP, carbon tax is applied on the basis of direct emission intensity, and, for SRP, carbon tax is applied on the basis of total (that is, direct and indirect) emission intensity. The outcome of this stage is the specification of carbon tax rates for PPP and SRP for the base year. The mathematical specification for determining the appropriate level of carbon tax is provided in Section 5.3.

- In the third module, the relative changes in energy and material prices in response to the carbon tax are estimated. The outcome of this stage is the new

[32] CO_2 emission intensity of each sector refers to the amount of CO_2 emitted per dollar value of that sector output.

price levels (for 2005) obtained as a consequence of the introduction of the carbon tax. These sectoral price effects of carbon tax are estimated using the input–output price model. The mathematical specifications of the price impact module are detailed in Section 5.4.

- Next, the substitution effect in response to changes in energy and material prices is analysed. The own- and cross-price elasticities are employed for this purpose. These elasticities are estimated by assuming Translog and Cobb-Douglas production functions to examine the relationship between factor inputs, such as fossil energy, electricity, non-energy materials, capital, and labour. These elasticities are then used to modify the base-year input–output technical coefficients in order to give a new economic structure. The mathematical specifications of the substitution module together with estimated parameters are provided in Section 5.5.

- In the final module, the economy-wide impacts of carbon tax are analysed. These impacts include energy, environmental, economic, and social. The new economic structure (output of the previous module) would lead to different patterns of energy consumption and associated emissions. These impacts are analysed using an energy-environment-oriented input–output model. The mathematical specifications of this module are presented in Section 5.6. The results from this module, that is, the economy-wide impacts due to the introduction of carbon tax, are presented and discussed in Chapter 6.

5.2 Allocation of Carbon-dioxide Emissions

As mentioned in Section 5.1, this section provides a detailed discussion on the methodology used to calculate CO_2 emissions from various sectors of the economy and to develop estimates of associated CO_2 intensities, employing both Polluter-pays and Shared Responsibility Principles.

5.2.1 Emissions Allocation: Polluter Pays Principle

The allocation of CO_2 emissions based on PPP is straightforward. As introduced in Section 3.3.2, CO_2 emissions are based on the quantities and types of fossil fuels used directly at the point of combustion. Accordingly, CO_2 intensities can be measured by the amount of CO_2 emitted per unit of output.

To begin with, let F_{fi} be the fossil fuel of type f consumed by production sector i. Also, the total output (X_i) of production sector i goes to satisfy intermediate and final demands (discussed in Section B.1.2, Appendix B, p. 217). Therefore, energy intensity of sector i – denoted by c_{fi} – can be expressed as:

$$c_{fi} = \frac{F_{fi}}{X_i} \tag{5-1}$$

This expression can be written in a matrix notation as:

$$C = F \cdot X^{-1} \tag{5-2}$$

where

C: matrix of energy intensities (PJ per \$);

F: matrix of total fossil fuel use (PJ); and

X: vector of total output (\$).

Equation 5-2 estimates energy intensity based on PPP, or "direct energy intensity".

CO_2 emissions from a particular activity can be determined by multiplying energy consumption by that activity with fuel emission factors (that is, $E = eF$), that is,

$$E_{PPP} = eCX \tag{5-3}$$

where

E_{PPP}: vector of CO_2 emissions from each sector based on PPP (Mt); and

e: vector of fixed CO_2 emission factor for each type of fuel (Mt per PJ).

Similar to energy intensities, CO_2 intensities (W) can be derived by dividing CO_2 emissions by sectoral outputs X. Therefore, CO_2 intensity based on direct energy inputs (W_{PPP}) can be written as:

$$W_{PPP} = eC \tag{5-4}$$

Equations 5-3 and 5-4 are used to determine CO_2 emissions and CO_2 intensities, respectively, based on PPP.

5.2.2 Emissions Allocation: Shared Responsibility Principle

The allocation of CO_2 emissions based on SRP is comparatively more complicated. As introduced in Section 3.3.3, CO_2 emissions, according to this principle, also take into account the indirect energy used by a sector, that is, the energy embodied in the supply of other materials and services. The framework adopted in this research for such allocation is based on the input–output model. The fundamental description of the input–output model is provided in Section B.1, Appendix B, p. 216.

The detailed manner in which the input–output model can be used for examining economic activities opens the way for studies that deal not only with industrial production, but increasingly with other aspects of human activities as well (Duchin & Steenge 1999). Input–output tables provide a useful framework for tracing energy use and environmental pollution for economic activities, through the extension of the Leontief input–output model (Miller & Blair 1985). Energy and environmental dimensions can be incorporated into the standard model in order to determine embodied energy and associated emissions from any sector.

Energy and associated emission intensities can be calculated either by using the "*hybrid-unit*" approach or the "*energy-coefficient*" approach. In the hybrid-unit approach, energy flows, which are expressed in the input–output table in monetary units, are simply replaced by flows expressed in physical units (Bullard & Herendeen 1975). In order to relate monetary value in the input–output table to the physical quantity of energy, price assumptions are required (Miller & Blair 1985). The Leontief's inverse is then calculated from this updated input–output table, whereby energy flows are expressed in physical units and non-energy flows are expressed in monetary units. However, Dietzenbacher and Stage (2006) have shown that this approach can sometime produce arbitrary results.

The energy-coefficient approach, on the other hand, requires a satellite energy account, corresponding with the sector outlined in the input–output table (Proops, Faber & Wagenhals 1993). This satellite energy account (called the energy dissipation table) allows the calculation of energy consumed in the economy through the inter-sectoral relationships within the economy, without making any adjustment to the input–output table, thus avoiding the need for arbitrary price assumptions. Therefore, the energy coefficient approach is the preferred method in this research to determine CO_2 emissions and intensities.

The mathematical specification of the energy coefficient approach is discussed as follows. From equation 5-2, the energy requirement for the production sectors can be represented as:

$$F = CX \tag{5-5}$$

Now, by substituting the identity of total output $X = \left[I - \left(A + \bar{B}\right)\right]^{-1} \cdot Y^{*}$ (see Section B.1.5, Appendix B, p. 223, for the derivation of this identity) into equation 5-5, the sectoral energy requirement can be written as:

$$F = C \cdot \left[I - \left(A + \bar{B}\right)\right]^{-1} \cdot Y^{*} \tag{5-6}$$

where

A: matrix of input–output technical coefficients;

$\bar{B}$: matrix of weighted-mean capital coefficients; and

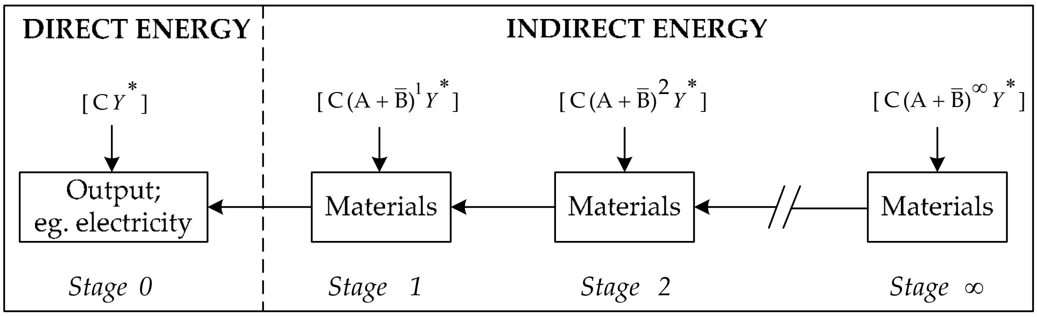
Y^{*}: vector of final demands (excluding demand for capital investment).

The term $C\left[I - \left(A + \bar{B}\right)\right]^{-1}$ in equation 5-6 represents sectoral energy intensities based on SRP. The total energy consumption presented in equation 5-6 can be disaggregated into energy used directly to produce a sector's output and the infinite series of indirect energy embodied in the use of materials (see equations B-7 to B-9, Appendix B, p. 221, for the procedure of this decomposition).

$$F = CY^* + C\left(A+\overline{B}\right)Y^* + C\left(A+\overline{B}\right)^2 Y^* + \ldots + C\left(A+\overline{B}\right)^\infty Y^* \tag{5-7}$$

In equation 5-7, CY^* – the entity on the right-hand side of the equation represents direct energy consumption, whereas the rest of the entities represent an infinite series of indirect energy consumption. In fact, all these indirect energy consumptions are derived from energy consumed for the production of materials at each downstream level, as shown in Figure 5-2.

Figure 5-2 Representation of direct and indirect energy consumption



Note: Adapted from Boustead and Hancock (1979), cited in Treloar (1998).

As mentioned above, CO_2 emissions associated with the combustion of fossil fuels can be obtained by multiplying energy consumption by associated fuels' emission factors (that is, $E = eF$). Therefore, using energy consumption from equation 5-6, CO_2 emissions based on SRP can be written as:

$$E_{SRP} = e \cdot C \cdot \left[I - \left(A+\overline{B}\right)\right]^{-1} \cdot Y^* \tag{5-8}$$

Similar to direct–indirect energy consumption, equation 5-8 can be decomposed into direct CO_2 emissions and an infinite series of indirect CO_2 emissions as:

$$E = eCY^* + eC(A+\overline{B})Y^* + eC(A+\overline{B})^2 Y^* + \ldots + eC(A+\overline{B})^\infty Y^* \tag{5-9}$$

In equation 5-9, 'eCY^*' – the entity on the right-hand side of the equation represents direct CO_2 emissions, whereas the rest of the entities represent indirect CO_2 emissions.

Also, the term $eC\left[I-\left(A+\overline{B}\right)\right]^{-1}$ in equation 5-8 represents sectoral CO_2 intensities that take into account both direct energy and energy embodied in the use of materials. Therefore, CO_2 intensities based on SRP (W_{SRP}) can be written as:

$$W_{SRP}=e\cdot C\cdot\left[I-\left(A+\overline{B}\right)\right]^{-1} \tag{5-10}$$

Equations 5-8 and 5-10 are used in this research to determine CO_2 emissions and CO_2 intensities, based on SRP.

5.3 Determination of Carbon Tax

Carbon tax, either based on PPP or SRP, is applied in this research on the same basis, namely, in proportion to sectoral CO_2 intensities (estimated in the previous step).

For determining the level of carbon tax, this research has adopted a procedure similar to the one employed by Symons et al. (1994), Cornwell and Creedy (1995; 1996; 1997), and Creedy and Martin (2000). Accordingly, it is assumed that the carbon tax is fully transferred through energy and material prices.[33] As a result, carbon tax increases the price of factor inputs in proportion to their CO_2 emissions. These price changes can be regarded as being equivalent to indirect taxes (Cornwell & Creedy 1995). The ad-valorem tax rates (t), which is a percentage of the tax-exclusive value of energy and materials goods, can be determined from:

$$t_n=\mu\cdot W_{PPP_o} \tag{5-11}$$
$$t_n=\mu\cdot W_{SRP_o} \tag{5-12}$$

where

t_n: ad-valorem tax rate for industry i in the current year;

[33] The assumption of full shifting requires competitive market and constant returns to scale. However, it is the standard assumption used in partial equilibrium analyses of indirect taxes (Creedy 1997).

μ: level of tax on CO_2 emissions (measured in dollars per tonne of CO_2)[34];

W_{PPP_o} : CO_2 intensity based on PPP in the previous year, as calculated from Equation 5-4 (measured in tonnes of CO_2 per dollar of sectoral production);

W_{SRP_o} : CO_2 intensity based on SRP in the previous year, as calculated from Equation 5-10 (measured in tonnes of CO_2 per dollar of sectoral production).

The term t_n can be considered as equivalent to a set of indirect taxes imposed on each sector i, which will be used (in price impact module) to determine the impact of carbon tax on increases in energy and material prices.

5.4 Assessment of Price Impact of Carbon Tax

In this module, the increase in energy and material prices, as a result of the introduction of carbon tax, is estimated. The introduction of carbon tax would have a similar impact to other indirect taxes, that is, it would increase the sectoral value-added costs. This sectoral price effect of carbon tax is estimated using the input–output price model (see Section B.1.4, Appendix B, p. 221, for theoretical discussion of the input–output price model).

Because carbon tax would increase the energy and material prices through increases in sectoral value-added costs, the change in these prices can be determined from equation 5-13:

$$P = \left(I - A'\right)^{-1} V \tag{5-13}$$

Equation 5-13 is the standard Leontief's input–output price model (see equation B-13, Appendix B, p. 223, for the derivation of this equation). This equation is appropriate for use in this research as it can be used to "*assess the impact on prices throughout the economy of an increase in value-added costs in one or more sectors*' (Dixon & Rimmer 2000; Kula 1998; Melvin 1979; Miller & Blair 1985, p. 356).

---

[34] For example, μ = 0.01 implies a tax of \$10 per tonne of carbon dioxide.

First, the base-year price level needs to be calculated. When applying equation 5-13 with base-year data (including base-year input–output technical coefficients and sectoral value-added), one obtains a vector of base-year prices for all sectors equal to one.

Next, the sectoral ad-valorem carbon tax rate (which is obtained from the tax imposition module, from equation 5-11 and 5-12) is imposed on the sectoral value-added. The new energy and material prices can be endogenously determined by adding the ad-valorem tax rate, obtained from the previous module, to the base year value-added, as shown in equation 5-14.

$$P_n = \left(I - A_o'\right)^{-1} \cdot \left(V_o + t_n\right) \qquad (5\text{-}14)$$

where

P_n: vector of new sectoral price level;

A_o: matrix of input–output technical coefficients for base year;

V_o: matrix of sectoral value-added by total output for base year; and

t_n: vector of new sectoral ad-valorem carbon tax rate (calculated from Equations 5-11 and 5-12).

This would give the index of changes in prices of energy and materials compared to the base year:

$$\frac{\dot{P}}{P} = \frac{P_n - P_o}{P_o} \qquad (5\text{-}15)$$

Equation 5-15 can also be interpreted as changes in the price of the sector that supplies energy and materials to the economy. It is also worthwhile to mention here that, according to Valadkhani and Mitchell (2002), the weighted-mean of prices from all sectors would represent a series of consumer price indices (inflation).

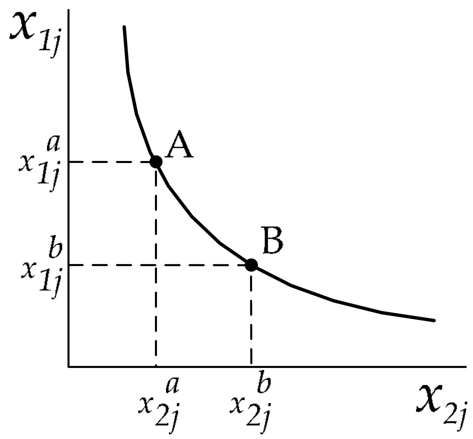
5.5 Examination of Factor Substitution due to Carbon Tax

When energy and material inputs prices increase, based on microeconomic theory, the producer seeks to substitute these inputs with one another or with other factor inputs such as capital and labour. However, this substitution effect cannot be captured within the traditional Leontief input–output model (see Section B.2.1, Appendix B, p. 226, for comparison between Leontief and neoclassical production functions). The input–output model does not provide a mechanism for evaluating the impact of changes in technology (through its technical coefficients). This is due to its underlying assumption about the fixed proportionality of input–output coefficients. In reality, these coefficients are likely to undergo continual changes, for example, due to new innovations, changes in consumer/producer preferences, and policy-induced changes (Rose 1984). These changes would have an impact on input prices and hence changes in technology through changes in factor inputs. Therefore, if one is to assess how carbon tax would influence technological change, one must make the input–output coefficients responsive to price changes. The method to modify these input–output technical coefficients is discussed in Section 5.5.1. Further, this research assumes that the substitution between factor inputs is limited only to the electricity industry (for modelling producers' behaviour) and final demand category, including consumption and exports (for modelling consumer behaviour). The modelling of the electricity industry and final demand is discussed in Sections 5.5.2 and 5.5.3, respectively. Finally, the econometric specification and parameter estimation for the electricity industry and final demand are discussed in Section 5.5.4.

5.5.1 Modification of Input–output Coefficients

The underlying theory of Input–output analysis is represented in terms of perfect complements (shown as right-angled isoquants in Figure B-2 (a) in Appendix B, p. 227) which ignore the substitution effect. In reality, an increase in the price of one production input will cause substitution between various inputs and hence will affect the overall input mix through substitution between various inputs. This economic reality can be captured in neoclassical production functions that allow for substitution between various inputs. Such a production function is shown in Figure 5-3. For instance, when the price of commodity 1 increases, its demand will decrease and it will be substituted with commodity 2. The proportions of inputs 1 and 2 are shown as a movement from point A to B. This movement in the use of factor inputs can be econometrically estimated in terms of elasticities of substitution, which can then be used to modify input–output coefficients (Rose 1984). The process of such a modification of input–output technical coefficients, used in this research, is based on the method proposed by Wu and Chen (1990). This is outlined below.

Figure 5-3 Substitution effect in neoclassical economic theory



Suppose that the production function for the production of output j (X_j) from inputs *1* and *2* is $X_j = f(x_1, x_2)$. According to the cost minimisation theory of input use (Varian 1987), the constant-output to produce j depends on the prices of its inputs. This can be shown as:

$$X_j = g\left(P_i, P_j\right) \tag{5-16}$$

By differentiating equation 5-16 with regard to time, gives:

$$\frac{\partial X_j}{\partial t} = \dot{X}_j = \left(\frac{\partial X_j}{\partial P_i} \cdot \frac{\partial P_i}{\partial t}\right) + \left(\frac{\partial X_j}{\partial P_j} \cdot \frac{\partial P_j}{\partial t}\right) \tag{5-17}$$

Dividing both sides of equation 5-17 by X_j, gives:

$$\frac{\dot{X}_j}{X_j} = \left(\frac{\partial X_j}{X_j} \cdot \frac{P_i}{\partial P_i} \right) \cdot \frac{\dot{P}_i}{P_i} + \left(\frac{\partial X_j}{X_j} \cdot \frac{P_j}{\partial P_j} \right) \cdot \frac{\dot{P}_j}{P_j} \tag{5-18}$$

The terms in brackets represent cross-price and own-price elasticities *(η)*, respectively. By substituting these terms with their respective elasticities, equation 5-18 can be written as:

$$\frac{\dot{X}_j}{X_j} = \eta_{ij} \cdot \frac{\dot{P}_i}{P_i} + \eta_{jj} \cdot \frac{\dot{P}_j}{P_j} \tag{5-19}$$

where

$\frac{\dot{X}_j}{X_j}$: percentage change in demand for input *j*;

$\frac{\dot{P}_i}{P_i}$: percentage change in price of *i* used as input to produce *j*; and

$\frac{\dot{P}_j}{P_j}$: percentage change in price of *j* used as input to produce *j*.

When incorporating such effects into the input–output model, according to Wu and Chen (1990), the input–output technical coefficients can be modified as:

$$a_{ij}^n = a_{ij}^o \left(1 - \frac{\dot{X}_j}{X_j} \right) \tag{5-20}$$

where

a_{ij}^o: matrix of input–output technical coefficients for the previous year; and

a_{ij}^n: an updated matrix of input–output technical coefficients.

Equations 5-19 and 5-20 make it particularly clear that if own- and cross-price elasticities of each input are available, the technical coefficients in the input–output model can be adjusted in response to the relative changes in factor costs (that is, their own prices and prices of other inputs) brought about as a result of the introduction of carbon tax. The percentage changes in input prices are derived in this research in the price impact module discussed earlier in Section 5.4. The own- and cross-price elasticities of substitution can be derived by assuming other types of production function rather than the Leontief production function. This is the main purpose of this module. Once the new sets of input–output technical coefficients are derived, these will be used in the next module for analysing the economy-wide impacts of a carbon tax.

5.5.2 Modelling of Electricity Generation Mix

The input–output technical coefficients mentioned above should, ideally, be modified for all sectors. That is to say that this method should be applied to all 28 sectors (including five electricity generation technologies), as listed in Figure 1-5. However, due to the excessive calculations involved, this research assumes that there is no substitution between various inputs for other production sectors, except for electricity generation (substitution between consumers' goods and services is discussed in Section 5.5.3). This means that except for five electricity generation technologies, all other production sectors assumed zero elasticity of substitution based on the underlying Leontief production function. This assumption of zero elasticity of substitution for other sectors means that it will underestimate the CO_2 reduction potential and overestimate the economic costs to the economy.[35] This is because such an assumption does not allow other production sectors (except the electricity sector) to substitute their emissions-intensive expensive inputs (due to carbon tax) with low-emission cheaper inputs. The high-price emission-intensive inputs in these sectors are continuously used in the same (Leontief) proportion in which they were used before the carbon tax is imposed.

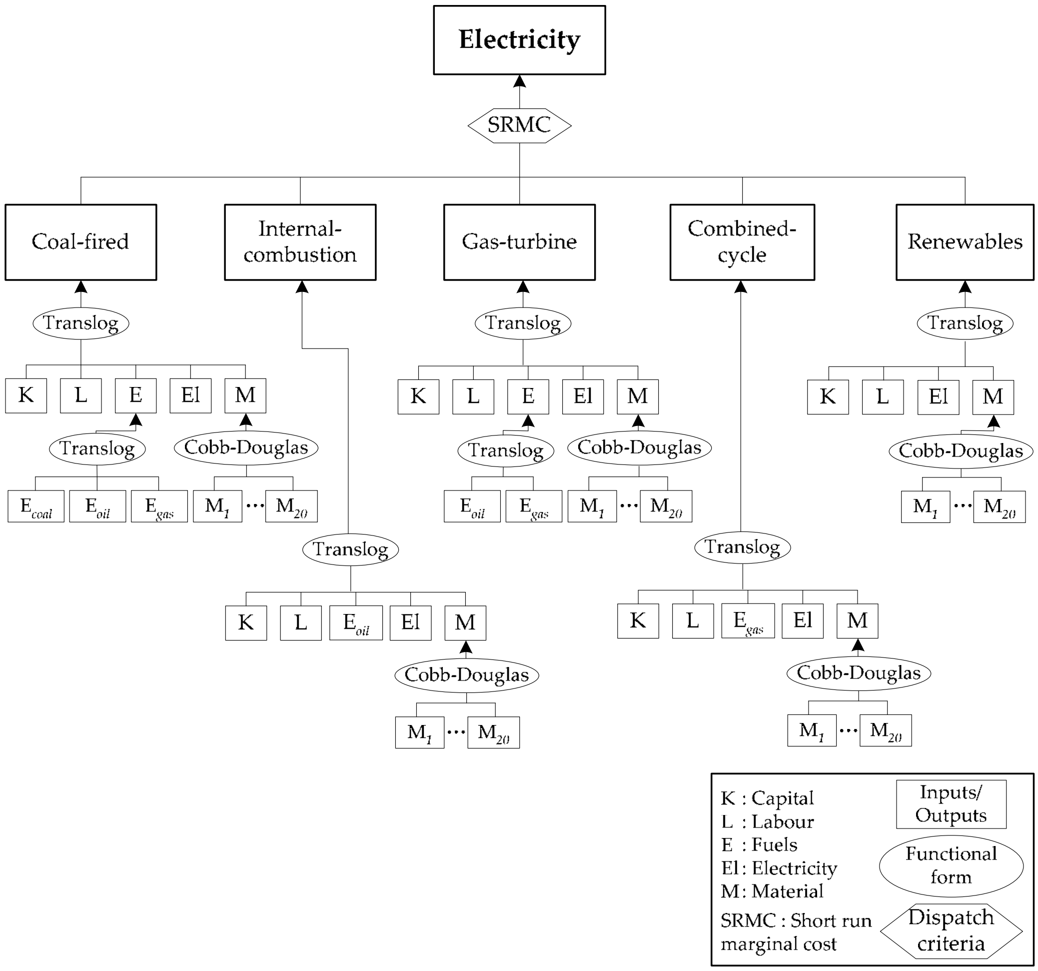
In this research, five types of electricity generating technologies – conventional coal-fired (CF), internal-combustion (IC), gas-turbine (GT), combined-cycle (CC), and

---

[35] A model was also run, as a test, by assuming other production sectors to be perfect substitutes in the use of factor inputs in response to changes in price due to the carbon tax. The results show that, for the carbon tax of \$10 per tonne, the model developed for this research overestimates the total economic costs (GDP) by about 0.09 per cent (\$5.6 billion in 1990 prices) and underestimates the CO_2 reduction potential by about 15 per cent (58 Mt).

renewable electricity (RE) – have been considered. These are the major current and likely technologies for electricity production in Australia. The factor input mix for various electricity technologies considered in this research is shown in Figure 5-4.

Figure 5-4 Input structure of the electricity industry



These technologies differ from each other in terms of their use of inputs. Each technology is characterised by five factor inputs – capital, labour, electricity, fossil energy, and materials. Further, there are three types of fossil fuels (that is, coal, oil, and gas) and twenty types of materials used as inputs for electricity production. These materials are provided by twenty non-energy sectors, as outlined earlier in Figure 1-5. Because a large number of inputs are included, the application of the production function can be burdensome. Therefore, the use of all these inputs for any electricity technology is constructed based on a nested structure, as suggested by Fuss (1977). Based on this input structure, the use of the production function limits the direct substitution between major factor inputs with any particular energy or materials. For example, it does not allow a direct substitution between capital and coal or labour and steel. However, it allows an inter-fuel substitution (for example, between coal and gas) and inter-factor substitution (for example, between capital and aggregate energy). The application of the nested input structure and the selection of the appropriate production function are discussed in detail in Section 5.5.4.

After accounting for substitution (or modification of input–output technical coefficients) for each electricity generation technology, the electricity industry then combines outputs from these five technologies to meet the electricity demand. The share of electricity produced from each technology in the total electricity supply is determined on the basis of short-run marginal costs (SRMC).[36] The average SRMC for each technology for the base year is predetermined from information provided in Table 2-2. These SRMCs for ST, CC, GT, IC, and RE for the base year are 3.6, 5.8, 6.8, 12 and 15 ¢/kWh, respectively. The new sets of input–output technical coefficients for the electricity industry, together with the contributed shares of electricity production from each technology, are then used for analysing the economy-wide impacts of carbon tax.

5.5.3 Modelling of Final Demand

Final demand comprises demand for final consumption, net exports, and investment. In this research, only final consumption and net exports are considered in terms of consumers' response to changes in prices. Demand for investment is, however, modelled using a "dynamic" version of input–output analysis (see Section 5.6).

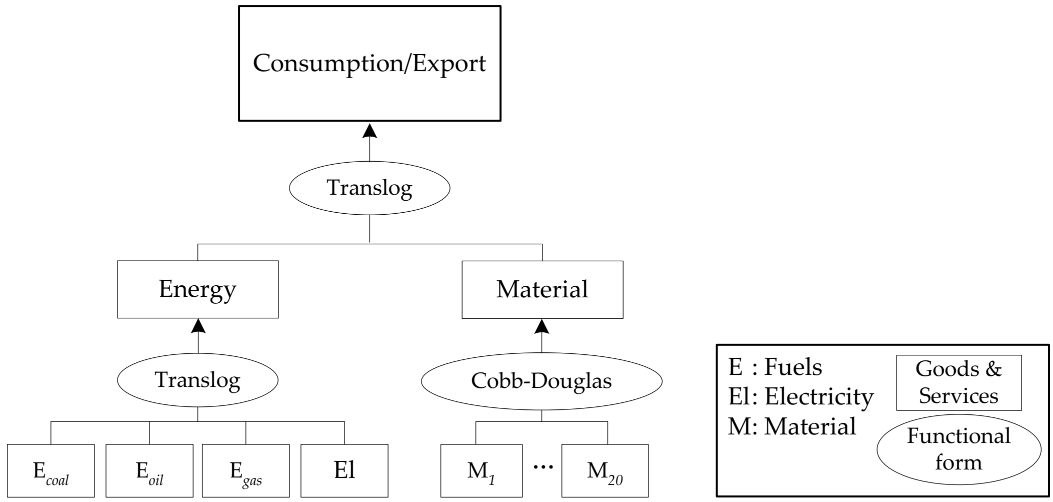
The final consumption and exports are modelled in a similar way to the electricity sector, in the form of nested structure of demand. However, instead of estimating elasticities from the production (cost) function, the utility (expenditure) function for

---

[36] This basis is currently used in determining the share of electricity production in the NEM (see Sections 2.1.5 and 2.2.2 for further discussion).

each demand category is constructed. The consumption of goods and services (in the form of energy and materials) for both demand categories is shown in Figure 5-5.

Figure 5-5 Consumption pattern for final demand



At the top level, demands for energy and material are characterised by the Translog function. Further, there are four types of fuels (that is, coal, oil, gas, and electricity) consumed as a final energy, which are also characterised by the Translog function. Also, there are twenty types of materials from which the consumer can choose. However, because of a large number of materials considered in this research, its demand is assumed to be characterised as the Cobb-Douglas function. The application of this nested demand pattern to estimate elasticities is discussed in Section 5.5.4.

5.5.4 Econometric Specification and Parameter Estimation

This section presents the econometric specification for estimating own- and cross-price elasticities of substitutions, based on the input mix of the electricity industry, as shown in Figure 5-4, and the demand pattern for consumption and export, as shown in Figure 5-5 (See Section B.2 in Appendix B, p. 225, for a detailed discussion of the econometric specifications adopted in this section). As mentioned in the previous section, the input mix for each type of electricity generation technology is based on a two-level nested production function. The first nesting level is called an inter-factor model comprising capital, labour, electricity, aggregate energy, and aggregate material inputs. The second nesting level is the inter-fuel or energy sub-model (comprising coal, oil, and gas) and inter-material or material sub-model (comprising twenty materials). Similarly, the demand pattern of final demand is also based on a two-level nested structure. The first nesting level is called an inter-factor model comprising energy and material (as goods and services). The second nesting level consists of the energy sub-model (comprising coal, oil, gas, and electricity) and material sub-model (comprising twenty materials).

In order to perform an empirical analysis with this nested production/consumption structure, it is necessary to impose *a priori* weak homothetic separability restriction in energy and materials inputs. Weak homothetic separability requires that the macro-production/utility function (inter-factor model) be weakly separable[37] and that the micro-production/utility functions (energy and material sub-models) be homothetic. This restriction means that the marginal rate of substitution between each type of energy or material inputs is independent of the quantities of capital and labour demanded. Also, the imposition of this restriction opens up the possibility for two-stage optimisation (1977, p. 91). This implies that the mix of inputs within each aggregate at the bottom level of the nested production structure (that is, energy and material sub-models) is optimised in the first stage, and then this result is used together with other inputs (such as capital, labour, and electricity) to estimate the inter-factor model in the second stage. This procedure, in the context of this research, is explained below.

From Figure 5-4 and Figure 5-5, the production function for all types of electricity generation technologies (*X*) and the utility function for final demand (*Y*) can be written as:

---

[37] According to Berndt and Christensen (1973, p. 404), "*a production function $x=f(a, b)$ is weakly separable with respect to a given partition of the set of all inputs into – $a^1, a^2, \ldots, a^m$ – if the marginal rate of technical substitution between a_i and a_j, which are elements of the same separable input vector a^r, is independent of the quantities of all factors outside that aggregate, i.e., independent of factor b.*"

$$X = f\left[K, L, E\left(E_{coal}, E_{oil}, E_{gas}\right), El, M\left(M_1, \ldots, M_{20}\right)\right]$$
$$Y = f\left[E\left(E_{coal}, E_{oil}, E_{gas}, E_{electricity}\right), M\left(M_1, \ldots, M_{20}\right)\right] \quad (5\text{-}21)$$

Here $E\left(E_i\right)$ and $M\left(M_i\right)$ are aggregator functions for both energy and material sub-models, respectively, which need to be optimised in the first stage. Subsequently, the dual cost (expenditure) function of equation 5-21 is also weakly separable to the same inputs and can be written as:

$$G = g\left[P_K, P_L, P_E\left(P_{E_{coal}}, P_{E_{oil}}, P_{E_{gas}}\right), P_{El}, P_M\left(P_{M_1}, \ldots, P_{M_{20}}\right)\right]$$
$$H = g\left[P_E\left(P_{E_{coal}}, P_{E_{oil}}, P_{E_{gas}}, P_{E_{electricity}}\right), P_M\left(P_{M_1}, \ldots, P_{M_{20}}\right)\right] \quad (5\text{-}22)$$

Here P_E and P_M represent aggregate energy and material price indices. From equation 5-22, the complete Translog cost (expenditure) functions[38] for the inter-factor model and energy sub-model and Cobb-Douglas cost (expenditure) function[39] for material sub-model are then expressed in equations 5-23 to 5-25, respectively.

$$\ln G_{elec} = \ln \alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \quad , i, j \in \left\{K, L, E, El, M\right\} \quad (5\text{-}23)$$

$$\ln P_E = \ln \alpha_0 + \sum_i \alpha_i \ln P_{E_i} + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln P_{E_i} \ln P_{E_j} \quad , i, j \in \left\{coal, oil, gas\right\} \quad (5\text{-}24)$$

$$\ln P_M = \ln \alpha_0 + \sum_i \alpha_i \ln P_{M_i} \quad , i \in \left\{M_1, \ldots, M_{20}\right\} \quad (5\text{-}25)$$

The material sub-model above is constrained by the Cobb-Douglas function because the parameters estimated from the Translog function are statistically insignificant (from the author's calculation). Therefore, it is not appropriate to employ the Translog production (utility) function for the material sub-model.

Using Shephard's Lemma, the associated cost (expenditure) share equations for the inter-factor model and the energy- and material- sub-models can be written as:

---

[38] For detail on the derivation of Translog cost function, see equation B-25, Appendix B, p. 228.

[39] For detail on the derivation of the Cobb-Douglas cost function, see equation B-29, Appendix B, p. 229.

$$S_i^{elec} = \alpha_i + \sum_j \gamma_{ij} \ln P_j \qquad , \; i, j \in \{K, L, E, El, M\} \tag{5-26}$$

$$S_i^{E} = \alpha_i + \sum_j \gamma_{ij} \ln P_j \qquad , \; i, j \in \{coal, oil, gas\} \tag{5-27}$$

$$S_i^{M} = \alpha_i \qquad , \; i \in \{M_1, \ldots, M_{20}\} \tag{5-28}$$

where

S_i : cost shares for the inter-factor (*elec*) model and, energy- (*E*) and material- (*M*) sub-models.

The estimation of the complete model as shown in equation 5-22 is then accomplished using the following three-stage procedure:

i. In the first stage, each electricity generator chooses an optimal quantity of fossil fuels among coal, oil, and gas which minimises the overall cost of energy inputs to produce a specified quantity of electricity. Similarly, for final demand, both demand categories choose an optimal quantity of energy mix among coal, oil, gas, and electricity, which minimises their expenditure on energy. Given the price indices of individual energy types and their associated cost shares, parameters α and γ can be estimated from equation 5-27. These parameters are then used to endogenously determine the aggregate energy price index by substituting parameters and energy price indices into equation 5-24. This aggregate energy price index serves as an instrumental variable in the third stage.

ii. In the second stage, each electricity generator and final demand category chooses an optimal quantity of each material component ($M_1, \ldots, M_{20}$) within the material composite. Because the material sub-model employs the Cobb-Douglas cost function, there is no need for parameter estimation. As shown in equation 5-28, cost shares for each material can be used as parameters to estimate aggregate material prices in equation 5-25. Like the first stage, this aggregate material price index serves as an instrumental variable in the third stage.

iii. In the third stage, each electricity generator chooses an optimal mix of capital, labour, electricity, aggregate energy, and aggregate material to minimise the cost of electricity production. Similarly, consumers choose a mix of energy and materials to minimise their budget on goods and services. Aggregate energy and material prices indices determined in the previous stages, together with capital, labour, electricity price indices and their associated cost shares, are used to estimate parameters from equation 5-26.

The parameters for each cost (expenditure) share equation are estimated using the three-stage ordinary least squares (3OLS) method. Eviews version 5.1 – an econometrics software program – was used for this purpose (Lilien et al. 2005). Since the factor cost (expenditure) share equations must sum to unity, the sum of the disturbances across all equations will be zero for each observation. As a result, the disturbance covariance matrix will be singular and one equation must be deleted from the system of equations. Barten (1969) has shown that the maximum likelihood estimates of a system of share equations with one equation deleted are invariant to whichever equation is dropped. Therefore, in this research, the decision was made to omit equations of the gas share in total energy, of M_{20} in total materials, and the aggregate material share in the total factor from the energy and material sub-models and inter-factor model, respectively. The remaining *n*-1 factor cost share equations are estimated jointly as a multivariate regression system by iteration of a Zellner-efficient procedure until convergence is achieved (Zellner 1962).

Using the procedure outlined above, the parameters estimated for the energy sub-model and inter-factor model for the electricity sector are shown in Table 5-1 and Table 5-2, respectively. Because the parameters for the material sub-model are taken directly from their cost shares, this information (cost shares for the material sub-model) is provided in Appendix C, pp. 263-269, together with cost shares for the energy sub-model and inter-factor model.

Table 5-1 Parameter estimates for electricity sector: energy sub-model

(1980–1999)

	ESI	Coal-fired	Internal-combustion	Gas-turbine	Combined-cycle	Renewable
			Intercept coefficients (α_i)			
Coal	**0.6643*** ***(647.27)***	0.7180* *(319.70)*	-	-	-	-
Oil	**0.1206*** ***(36.37)***	0.0763* *(34.21)*	-	0.1061* *(7.99)*	-	-
Gas	**0.2151**	0.2057	-	0.8939	-	-
			Slope coefficients (γ_{ij})			
Coal , Coal	**-0.0292*** ***(-2.10)***	-0.1998* *(-8.12)*	-	-	-	-
Oil , Oil	**0.2973*** ***(50.49)***	0.2214* *(14.91)*	-	0.0725* *(2.18)*	-	-
Gas , Gas	**0.0980**	0.0899	-	0.0725	-	-
Coal , Oil	**-0.0851*** ***(-17.53)***	0.0342 *(1.56)*	-	-	-	-
Coal , Gas	**0.1143**	0.1656	-	-	-	-
Oil , Gas	**-0.2123**	-0.2556	-	-0.0725	-	-

Notes: Figures in parentheses are t-statistics
* Significant at 95 per cent level of confidence
\- Not Available
Detailed results for energy sub-model are shown in Table E-2, Appendix E, pp. 283-286.

Table 5-1 presents the results for coal-fired and gas-turbine only, as these technologies use more than one type of energy input for electricity production. Internal combustion and combined-cycle consume only one type of energy input, that is, oil and gas, respectively; whereas renewable does not consume any fossil energy. The results indicate that the energy sub-model performs considerably well, since almost all estimates are significant at a 95 per cent level of confidence. Further, these parameters are also satisfied for positivity and monotonicity conditions[40], since all α_i are positive and the estimation of cost shares from these parameters is also positive for all observations.

[40] See Section B.2.3 in Appendix B, p. 228, for assumptions of the production cost function model.

Table 5-2 Parameter estimates for electricity sector: inter-factor model

(1980–1999)

	ESI	Coal-fired	Internal-combustion	Gas-turbine	Combined-cycle	Renewable
			Intercept coefficients (α_i)			
K	**0.4052***	0.3413*	0.2747*	0.4580*	0.2202*	0.6960*
	(15.94)	*(15.44)*	*(19.28)*	*(7.96)*	*(24.23)*	*(23.43)*
L	**0.1953***	0.2139*	0.0381*	0.1197*	0.2070*	0.1553*
	(15.16)	*(18.69)*	*(4.75)*	*(4.14)*	*(20.84)*	*(7.74)*
E	**0.1786***	0.2027*	0.5873*	0.2775*	0.4014*	-
	(15.54)	*(16.77)*	*(38.85)*	*(9.92)*	*(30.16)*	
El	**0.0679***	0.0699*	0.0167*	0.0494*	0.0940*	0.0333*
	(30.70)	*(28.83)*	*(4.72)*	*(7.03)*	*(60.79)*	*(2.70)*
M	**0.1530**	0.1722	0.0831	0.0954	0.0774	0.1154
			Slope coefficients (γ_{ij})			
K , K	**0.0415**	0.0024	0.1037*	0.1457	0.0457*	0.0047
	(0.86)	*(0.06)*	*(4.70)*	*(1.34)*	*(2.78)*	*(0.09)*
L , L	**-0.0952***	-0.0972*	-0.0607*	-0.2539*	-0.2735*	-0.0801*
	(-3.05)	*(-3.02)*	*(-3.33)*	*(-5.50)*	*(-9.72)*	*(-2.11)*
E , E	**0.1483***	0.1569*	0.1209*	0.0001	0.1448*	-
	(7.55)	*(7.43)*	*(5.04)*	*(0.00)*	*(2.38)*	
El , El	**0.0648***	0.0676*	0.0342*	-0.0402*	0.0079*	0.1018*
	(6.20)	*(5.15)*	*(2.26)*	*(-5.57)*	*(2.07)*	*(2.95)*
M , M	**0.1043**	0.1201	0.0117	-0.2826	0.0244	0.1311
K , L	**0.0059**	0.0269	-0.0084	-0.0564	-0.0051	-0.0093
	(0.24)	*(1.25)*	*(-0.59)*	*(-1.04)*	*(-0.31)*	*(-0.26)*
K , E	**-0.0619***	-0.0621*	-0.1370*	-0.0911	-0.0922*	-
	(-2.97)	*(-2.85)*	*(-7.72)*	*(-1.72)*	*(-3.52)*	
K , El	**-0.0060**	-0.0083	0.0084	-0.0063	0.0157*	-0.0325
	(-1.34)	*(-1.74)*	*(0.95)*	*(-0.48)*	*(5.46)*	*(-1.35)*
K , M	**0.0205**	0.0411	0.0334	0.0081	0.0358	0.0372
L , E	**0.0336***	0.0282*	0.0187	0.1345*	0.1483*	-
	(2.41)	*(1.97)*	*(1.59)*	*(3.71)*	*(5.52)*	
L , El	**0.0360***	0.0436*	0.0318*	-0.0779*	-0.0315*	0.0942*
	(4.08)	*(4.66)*	*(2.62)*	*(-6.73)*	*(-4.53)*	*(4.53)*
L , M	**0.0198**	-0.0015	0.0186	0.2537	0.1617	-0.0048
E , El	**-0.0351***	-0.0331*	-0.0066	0.0301*	0.0145	-
	(-4.77)	*(-4.17)*	*(-0.87)*	*(2.97)*	*(1.93)*	
E , M	**-0.0849**	-0.0899	0.0041	-0.0736	-0.2154	-
El , M	**-0.0597**	-0.0697	-0.0678	0.0944	-0.0066	-0.1635

Notes: *K* – Capital; *L* – Labour; *E* – Energy; *El* – Electricity; *M* – Materials
Figures in parentheses are t-statistics
* Significant at 95 per cent level of confidence
\- Not Available
Detailed results for Inter-factor model are shown in Table E-1, Appendix E, pp. 276-282.

The inter-factor model, as shown in Table 5-2, also performs reasonably well, as indicated by a large number of statistically significant coefficients at a 95 per cent level of confidence. The slope coefficients of capital–labour and capital–electricity for most of the generation technologies are statistically insignificant; therefore, such results must be interpreted with some caution. Again, the positivity and monotonicity conditions are satisfied for each observation.

Similar to the electricity sector, the parameters estimated for the energy sub-model and inter-factor model for final demand are shown in Table 5-3 and Table 5-4, respectively. Because the parameters for the material sub-model are taken directly from their cost shares, this information (cost shares for the material sub-model) is provided in Appendix C, pp. 263-269, together with the cost shares for the energy sub-model and inter-factor model.

Table 5-3 Parameter estimates for final demand: energy sub-model

(1980–1999)

	Final consumption	Export
	Intercept coefficients (α_i)	
Coal	0.0129* *(2.49)*	0.8593* *(123.57)*
Oil	0.3900* *(24.31)*	0.1042* *(12.03)*
Electricity	0.4774* *(52.62)*	0.0035* *(14.90)*
Gas	0.1197	0.0330
	Slope coefficients (γ_{ij})	
Coal , Coal	-0.0219 *(-0.58)*	-0.2453* *(-7.37)*
Oil , Oil	0.1484* *(3.51)*	0.1723* *(6.49)*
Electricity, Electricity	-0.3453* *(-3.41)*	-0.0006 *(-0.18)*
Gas , Gas	-0.3470	-0.0571
Coal , Oil	0.0351* *(1.71)*	0.0043 *(0.17)*
Coal , Electricity	-0.1398* *(-2.63)*	0.0051* *(2.55)*
Coal , Gas	0.1266	0.2360
Oil , Electricity	0.0406 *(1.26)*	-0.0011* *(-2.22)*
Oil , Gas	-0.2241	-0.1755
Electricity , Gas	0.4445	-0.0034

Notes: Figures in parentheses are t-statistics
* Significant at 95 per cent level of confidence
\- Not Available
Detailed results for Energy sub-model are shown in Table E-2, Appendix E, pp. 283-286.

Table 5-3 presents the results for energy consumption and exports. The results indicate that the energy sub-model performs considerably well, since almost all estimates are significant at a 95 per cent level of confidence. Further, these parameters are also satisfied for positivity and monotonicity conditions, since all α_i are positive and the estimation of expenditure shares from these parameters are also positive for all observations.

Table 5-4 Parameter estimates for final demand: inter-factor model

(1980–1999)

	Final consumption	Export
	Intercept coefficients (α_i)	
Energy	0.0260* *(63.77)*	0.1306* *(55.59)*
Materials	0.9740	0.8694
	Slope coefficients (γ_{ij})	
Energy , Energy	0.0247* *(14.37)*	0.0086* *(1.42)*
Materials , Materials	0.0247	0.0086
Energy, Materials	-0.0247	-0.0086

Notes: *E* – Energy; *M* – Materials
Figures in parentheses are t-statistics
* Significant at 95 per cent level of confidence
\- Not Available
Detailed results for Inter-factor model are shown in Table E-1, Appendix E, pp. 276-282.

The inter-factor model, as shown in Table 5-4, also performs reasonably well, as indicated by a large number of statistically significant coefficients at a 95 per cent level of confidence. Again, the positivity and monotonicity conditions are satisfied for each observation.

All estimated parameters shown above can be used to determine price elasticities of demand, as outlined in detail in Section B.2.5, Appendix B, p. 231. In brief, this can be achieved using the method similar to Berndt and Wood's (1975), as:

$$\eta_{ii} = S_i \sigma_{ii} \qquad \text{where } \sigma_{ii} = \frac{\gamma_{ii} + S_i^2 - S_i}{S_i^2} \tag{5-29}$$

$$\eta_{ij} = S_j \sigma_{ij} \qquad \text{where } \sigma_{ij} = \frac{\gamma_{ij} + S_i S_j}{S_i S_j} \tag{5-30}$$

To complete the substitution module, the own- and cross-price elasticities of substitution are then used in equations 5-19 and 5-20, as discussed earlier, for modifying the input–output technical coefficients.

5.6 Economy-wide Impact Module

As mentioned in Section 5.1, in this final module, the economy-wide impacts of a carbon tax are analysed. These impacts are analysed using an energy-environment-oriented input–output framework specifically developed for this research.

Following the substitution module, after the input–output technical coefficients, electricity generation mix, and final demand response have been modified, these changes will be incorporated into the base-year input–output model to generate different types of economy-wide impacts. These impacts, which include economic, energy, environmental, and social aspects, would be generated for the carbon tax, based on both PPP and SRP for the succeeding year. The result will then be fed into the first module again and impacts would be determined for the next year. The same procedure would be followed until impacts are determined for all years to the end of the study period, that is, 2020. The mathematical specifications for this module are discussed below. The derivation and detailed explanation of the input–output model are provided in Section B.1.3 and Section B.1.5 in Appendix B.

First, the economic impacts of carbon tax are determined. These impacts are quantified in terms of changes in gross domestic product, sectoral output/production, and inflation. These variables are selected because they constitute major areas of concern from economic and political perspectives. The starting point for this analysis (of economic impacts) is the basic input–output identity, namely:

$$X = \left(I - A_n\right)^{-1} Y \tag{5-31}$$

where

X: column vector of sectoral outputs;

A_n: matrix of updated input–output technical coefficients; and

Y: column vector of sectoral final demands.

Equation 5-31 can be directly applied for the extension of energy, environmental, and social attributes. However, as discussed earlier in Section 5.5.2, the electricity generation mix would be endogenously determined within the model. In order to allow the model to explicitly account for this investment, it would be more appropriate to treat investment demand, which is traditionally located as a part of final demand *Y*, to be endogenously determined within the input–output model as well. Following the method proposed by Lenzen (1998), this can be written as:

$$X = \left[I - \left(A_n + \overline{B} \right) \right]^{-1} \cdot Y^* \tag{5-32}$$

where

$\overline{B}$: matrix of weighted-mean capital coefficients; and

Y^*: vector of sectoral final demand, excluding demand for capital investment.

Another conventional yet important variable for analysing economic impact is economic growth, which is measured by the growth in GDP. By definition, GDP comprises domestic consumption, investment, government spending (for consumption and investment) and net exports. However, in this research, government spending is included with private consumption and investment. The changes in GDP, estimated in this research, would be influenced by changes in domestic consumption and net exports (from the substitution module) and changes in demand for capital investment. The demand (and supply) for capital investment can be determined from:

$$\text{Investment demand } = \sum_i \overline{B} \cdot X \tag{5-33}$$

$$\text{Investment supply } = \sum_j \overline{B} \cdot X \tag{5-34}$$

Consequently, adding the investment demand determined from equation 5-33 to other domestic consumption and net exports would determine the GDP for each year. Therefore, the differences in the GDP, sectoral outputs, and inflation (which was determined in the price impact module) for both types of carbon tax (that is, based on PPP and SRP) can be compared and analysed.

Once the economic impact is determined, this information (particularly sectoral output variable) will be used to calculate energy, environmental, and social impacts. The basic economic input–output framework will be extended to explicitly determine these other impacts following the method developed by Proops et al. (1993).

The primary energy consumption can be easily determined by referring back to equation 5-2, where energy intensity was defined. By reorganising the term, the primary energy requirement in the economy can be given as:

$$F = CX \tag{5-35}$$

The CO_2 emissions can also be easily determined by using the expression given in equation 5-3. The extension of that equation, by substituting energy consumption from equation 5-34, can be written as:

$$E = eF = eCX \tag{5-36}$$

Further, a similar extension is also applied for analysing the social impacts. In this research, social impacts are assessed in terms of changes in the level of employment triggered by the introduction of a carbon tax. Although the level of employment is not the only factor that reflects social impacts (other impacts could include, for example, income distribution, poverty level, etc.), it is often considered as the core of the above noted and several other social problems (Atkinson et al. 1997). Therefore, it is appropriate to assess the social impact of carbon tax in terms of employment.

The impact of carbon tax on employment can be straightforwardly assessed by extending the economic input–output model, in a similar way as was done for the assessment of energy impact. Like energy intensity, labour intensity (or labour-output ratio) can be defined as the amount of labour for the production of one unit of economic output. This can be represented as:

$$l = \frac{L}{X} \tag{5-37}$$

where

l: matrix representing people employed per unit of output in each sector;

L: vector representing the level of employment; and

X: vector representing sectoral output.

By assuming a specific rate of improvement in labour productivity[41], the sectoral employment in the economy can be determined by:

$$L = lX \tag{5-38}$$

The results from this module are presented and discussed in the next chapter.

5.7 Data Sources and Preparation

The methodological framework as outlined in this chapter consists of two types of core models, namely, input–output and production function models. As a result, two sets of data are needed in this research, one for the input–output model and the other for the production function model. This section provides a description of data sources and preparation of data for use in these models.

5.7.1 Data Preparation for Input–output Model

In order to obtain data required for the input–output model which is used for emission allocation and determination of price and other economy-wide impacts, it is necessary to estimate e, C, A, B, and l from published statistics. These data were generally not directly available in an appropriate or consistent form. A considerable amount of data preparation effort was therefore required before the analysis could commence.

a) The thirteen yearly input–output tables used in this research were published by the Australian Bureau of Statistics (ABS) (ABS various). These represent the years 1980 to 1984, 1987, 1990, 1993 to 1995, 1997, 1999 and 2002. The inter-industry matrix in these tables ranged between 106 and 113 sectors. To make meaningful comparisons, the input–output tables needed to be adjusted for price variations over time using price indices obtained from the ABS (2003). Furthermore, the tables needed to be aggregated in order to ensure sectoral consistency and coherence with other data sources. This, however, required a

---

[41] Labour productivity is a reciprocal of labour-output ratio. It represents the output that can be produced by one person.

considerable effort in terms of investigating the changes that have taken place in sector definitions and classification systems over the period 1980–2002. In view of the focus of this research, various sectors were grouped in accordance with their energy intensiveness, that is, the highly energy-intensive sectors are kept separate, while less energy-intensive sectors are aggregated into one sector. These groupings are also made consistent with the ANZSIC[42] sectoral classification defined by ABS. Therefore, some groups comprise a single sector, while others comprise as many as 24 sectors (as in the case of the commercial sector). A summary of these groupings, which shows the number of sub-sectors that are aggregated into 28 sectors considered in this research, is presented in Table 5-5 (with details of each sub-sector shown in Table C-1, Appendix C, pp. 234-237).

Table 5-5 Summary of sectoral classification

<table>
<tr><th>Sector considered in this research</th><th>No. of sub-sectors</th><th>Sector considered in this research</th><th>No. of sub-sectors</th></tr>
<tr><td>1 Coal sector</td><td>1</td><td>15 Non-metal industry</td><td>6</td></tr>
<tr><td>2 Petroleum and coal products</td><td>1</td><td>16 Iron and steel industry</td><td>1</td></tr>
<tr><td>3 Gas sector</td><td>1</td><td>17 Non-ferrous metal industry</td><td>1</td></tr>
<tr><td rowspan="5">4 Renewable electricity
5 Coal-fired electricity
6 Internal-combustion electricity
7 Gas-turbine electricity
8 Combined-cycle electricity</td><td rowspan="5">1</td><td>18 Fabricated metal industry</td><td>3</td></tr>
<tr><td>19 Machinery & equipment industry</td><td>11</td></tr>
<tr><td>20 Other manufacturing industry</td><td>2</td></tr>
<tr><td>21 Water supply</td><td>1</td></tr>
<tr><td>22 Construction</td><td>3</td></tr>
<tr><td>9 Agriculture</td><td>10</td><td>23 Road transport</td><td>1</td></tr>
<tr><td>10 Raw materials mining</td><td>4</td><td>24 Railway transport</td><td>1</td></tr>
<tr><td>11 Food industry</td><td>12</td><td>25 Water transport</td><td>1</td></tr>
<tr><td>12 Textile industry</td><td>6-11</td><td>26 Air transport</td><td>1</td></tr>
<tr><td>13 Wood and paper industry</td><td>7-9</td><td>27 Other transport</td><td>3</td></tr>
<tr><td>14 Chemical industry</td><td>9</td><td>28 Commercial services</td><td>17-24</td></tr>
</table>

b) The electricity supply sector, as shown in Section 3.1, is a major contributor to CO_2 emissions in Australia. This, however, currently appears as a single sector in the input–output tables. Given its importance in the estimation of CO_2

[42] This is referred to as the 1993 version of Australia-New Zealand Standard Industry Classification.

emissions, and in order to be able to examine alternative scenarios for electricity generation, this sector is disaggregated into five sub-sectors based on the technologies used for electricity generation. The five electricity-generation technologies considered in this research are conventional coal-fired, internal-combustion, gas-turbine, combined-cycle, and renewable. The renewable electricity generation is used as a proxy for other types of electricity-generation technologies available in Australia, such as hydro, wind and photovoltaic. These renewable technologies do not consume energy directly for electricity production and also are highly material intensive, compared to fossil-fuel power stations. Such a disaggregation of electricity supply sector in this research has allowed the inclusion of more than 97 per cent of electricity production capacity in Australia. The only data available for such disaggregation represent energy consumption by the type of electricity generation technology (as published annually by the Electricity Supply Association of Australia). No data on the consumption of materials by these generation technologies are available. Hence, this research has disaggregated capital, labour and different materials input in the electricity sector on the basis of the recommendations made by Gay and Proops (1993), Proops et al. (1993), Timilsina (2001), and Cruz (2002) as follows:

- Capital input is apportioned to each electricity generation technology based on its capital cost distribution factor.

- Labour input is apportioned to each electricity generation technology in proportion to its share in electricity production.

- Inputs of materials are varied, depending on the type of material.

  - Materials from agricultural, food, textiles, wood and paper, and water sectors are apportioned the same way as labour inputs, that is, in proportion to shares in electricity production;

- Materials from the transport sector are apportioned based on the transport task provided to different electricity generation technologies (Apelbaum Consulting Group 1997);

- Materials from raw materials mining, chemical, non-metal, iron and steel, non-ferrous metal, fabricated metal, machinery and equipment, and commercial sectors are apportioned based on the "operation and maintenance (O&M) cost" distribution factor of each technology; and

- Material from construction sector is apportioned on the same basis as capital input, that is, disaggregate based on the capital cost distribution factor of each electricity-generation technology.

While the disaggregation and apportioning based on shares in electricity generation and transport needs are relatively straightforward; these are more complicated when based on capital and O&M distribution factors. These factors need to be constructed, based on the economic and technical characteristics of different electricity-generation technologies, as shown in Table 5-6.

Table 5-6 Economic and technical characteristics of power plants

	(units)	CF	IC	GT	CC	RE
Initial investment cost†	($A/kW)	1 430	1 500	475	870	2 020
Annual O&M cost†	($A/kW/year)	37	39	9	12	32
Plant life†	(years)	30	30	28	30	50
Capital recovery factor‡	(per cent)	8.9	8.9	9.1	8.9	8.2
Annual capital cost‡	($A/kW/year)	127	133	43	77	165
Capacity O&M cost*	($A Mn/year)	1 094	9	26	8	236
Total capacity cost*	($A Mn/year)	3 757	32	123	53	1 217
Installed capacity in 2002	(MW)	31 366	268	4 313	1 441	7 387
O&M distribution factor*		**0.793**	**0.007**	**0.026**	**0.012**	**0.162**
Capital distribution factor*		**0.720**	**0.006**	**0.034**	**0.020**	**0.220**

Notes: CF: Coal-fired, IC: Internal-combustion, GT: Gas-turbine, CC: Combined-cycle, RE: Renewable; Interest rate = 8 per cent [Follow: Naughten (2003)];
† Jones, Peng & Naughten (1994); Naughten (2003); Dalziell, Noble & Ofei-Mensah (1993);
‡ Author's calculation;
* Author's calculation for the capacity in 2002 (see Table C-2, Appendix C, pp. 238-239 for capital and O&M distribution factors for 1980–2002).

The capital costs of the existing capacity are calculated based on the installed capacity in that year, initial investment cost for the technology, and its expected plant life. The capital distribution factor for each technology is expressed as its share in the total annual capacity cost of the electricity sector. The O&M costs for existing capacity are calculated based on the installed capacity in that year and the annual O&M cost of the technology. The O&M distribution factor for any technology is expressed as its share in the total annual O&M costs of the existing electricity capacity in Australia. Table 5-6 shows the capital and O&M distribution factors for various technologies, using installed capacity in 2002 as an example. Detailed lists of these factors for each technology for all other years are provided in Table C-2, Appendix C, pp. 238-239.

The discussion so far has focused on the aggregation and disaggregation of published input–output tables, into the sectoral classification required for this research. This has resulted in the creation of a 28-sector input–output table for this research. The main driver in this aggregation/disaggregation was the energy intensiveness of various sectors, that is, energy intensive sectors were kept as separate sectors (and in fact, in some cases, disaggregated, for example, the electricity sector), whereas less-energy intensive sectors were aggregated (see Table 5-5). This is only a part of the effort for reorganising the input–output tables required for constructing input–output technical coefficients (matrix A). The detailed technical coefficients derived from each of the 28-sector input–output table are shown in Table C-3, Appendix C, pp. 240-252). However, in order to endogenously determine the demand for capital investment, matrix B also needs to be constructed.

c) Regarding the construction of the capital coefficient (B) matrix, the use of gross fixed capital formation by industries had to be estimated from aggregated data available from ABS (Lenzen 1998). The Australian input–output tables provide, as part of the final demand, a vector Y_b (=BX) – of total sectoral supplies used as gross fixed capital expenditures by the private sector, public enterprises and the general government. These expenditures were allocated across the respective industry divisions at the broadest levels (that is, at the ANZSIC 1-digit level) according to aggregated data on the consumption of fixed capital (ABS 2004f).

This was further disaggregated into the 28 sectors required for this research, according to data on the gross fixed capital expenditures of different industries (ABS 2004a, 2004e, 2004g, 2004h, 2004j). This assumption might seem unsatisfactory, but the error associated with this disaggregation of gross fixed capital expenditures is relatively small in most cases, since these expenditures constitute only a small share (about 7 per cent) of total output (Lenzen 1998). The weighted mean of the capital coefficients matrix from twelve input–output tables is shown in Table C-4, Appendix C, p. 253.

d) Regarding the construction of the sectoral energy intensities (*C*) matrix, information on primary energy use (*F*) – including black and brown coal, natural gas, and petroleum – measured in physical units was required. This is available from annual sectoral energy consumption data published by ABARE (ABARE 2006a). Again, the primary energy consumed in each type of electricity generation technology is not directly available from ABARE. However, this can be estimated by apportioning the energy consumed in the electricity sector from ABARE, using the proportion of each fuel type consumed by each technology obtained from ESAA. In addition, energy consumed by the road transport sector, as published by ABARE, includes both private and corporate vehicles (Akmal et al. 2004). In order to relate energy data from ABARE with the corresponding input–output tables, it was required to separate these figures on the basis of the estimates of energy consumption from other sources (ABS 2004l). This would result in energy consumption tables (in PJ) which consist of four types of primary energies consumed in each of the 28 sectors. These energy consumption tables will be divided with sectoral outputs from input–output tables to obtain the energy intensities (*C*) matrix. These matrices of historical energy intensities (matrix *C*) are shown in Table C-5, Appendix C, pp. 254-256.

e) Furthermore, the emission factor for each primary energy is obtained from the Australian Greenhouse Office (NGGIC 1996). These are 95.7, 90.4, 69.3, and 51.3 kg of CO_2 for each GJ of brown coal, black coal, petroleum, and natural gas, respectively (also see Section 3.1.2).

f) Finally, the matrix of the labour-output ratio can be constructed by using the number of employees in each sector divided by the output of the sector. These sectoral employment figures are directly available from ABS (ABS 2004i).

5.7.2 Data Preparation for Production Function Model

In order to obtain data required for the production function model, which is used in the substitution module, it is necessary to construct time-series data on the factor cost shares and prices of each input required by the electricity sector for the period 1980–1999. These data are required for all models, namely, the inter-factor model, energy sub-model and material sub-model (presented in Section 5.5.4). These data were however, generally not directly available in an appropriate or consistent form. A considerable amount of data preparation effort was therefore required before the analysis could commence. These data are compiled from three major sources – ABS, ABARE, and ESAA.

a) For cost shares of the inter-factor model and material sub-model, factor inputs (excluding energy) for each electricity supply technology are taken from twelve input–output tables published during the period 1980–1999 by ABS (ABS 2003, 2004b, 2004c). This is on the grounds that each column of input–output technical coefficients in the table denotes the cost structure of the industry. Each column of the input–output table describes the composition of inputs required by a particular industry. These inputs are supplied from the outputs of other industries (in the form of intermediate inputs) and primary factors of production (in the form of value-added) (also see Section B.1.2, Appendix B, p.217). The details of the organisation of these input–output tables, consistent with this research, have been discussed in the previous sub-section. ABS does not publish input–output tables on an annual basis and, therefore, cost shares for the missing years (namely, 1985, 1986, 1988, 1989, 1991, 1992, 1996, and 1998) were calculated on the basis of averages between the first and last year for which an input–output table is available. For cost shares of the energy sub-model, the shares of energy inputs are taken from time-series of annual data published by ESAA (ESAA various).

For factor prices of the inter-factor model, the time-series data are required for the prices of capital, labour, and electricity. The prices of aggregate energy and aggregate material are endogenously determined from the energy sub-model and material sub-model, respectively (see Section 5.5.4).

b) The price of capital is estimated on the basis suggested by the Industry Commission (1992), using the following equation:

$$P_k = P_{ik}(I + \delta) \tag{5-39}$$

where

P_k: capital price index;

P_{ik}: implicit capital price index;

I: real interest rate; and

δ: depreciation rate.

The implicit capital price index is taken directly from ABS (ABS 2004d). The interest rates used in this research are real rates, which take into account inflation, obtained from the Reserve Bank of Australia (RBA 2004). Although, in reality, each industry should have been attached to different interest rates, due to the difficulty in obtaining data, this research assumes common interest rates across all industries. Economic depreciation is chosen, in this research, to be 6.7 per cent per annum. This rate is chosen based on a study by Burbridge et al. (2000); in this study this value is assumed as an average depreciation rate used for depreciating the value of the electricity industry's infrastructures in Australia.

c) The price of labour is determined by dividing the total labour cost with the total number of persons employed in the electricity industry (Westoby & McGuire 1984). The labour cost for each industry is available from input–output tables published by ABS, while data for the number of employees are taken from ABS (ABS 2004i) and ESAA (ESAA various).

d) For electricity prices, the time-series of electricity price indices are developed from electricity prices published by ESAA (ESAA various). For prices of non-electric energy, the prices of various forms of primary energies are obtained from ABARE (ABARE various; Tedesco et al. 2004).

e) For material prices, this research has used the producer price indices for each industry, published by ABS (ABS 2004k), as a proxy for prices of material inputs. Unfortunately, ABS does not publish the producer price index for agriculture or the water industry. The price indices for these two industries are assumed to be equal to the consumer price indices.

All factor prices discussed above have been assumed as the same across all electricity-generation sub-sectors and also converted into time-series of indices, with 1990 as the base year. The details of costs shares and price indices of all factor inputs used in this research are presented in Table C-6 to Table C-8, Appendix C, pp. 257-269.

5.8 Summary and Conclusions

The objectives of this chapter were i) to develop a methodological framework based on an input–output model with a modified production function – for the analysis of the impact of carbon tax on the wider economy, and ii) describe the sources of data as well as the methodology used in this research to develop raw data into a form that could be employed for constructing various empirical analyses in this research. The major conclusions from this chapter are summarised as follows:

- The methodological framework developed in this research comprises five interlinked functional modules.

  a) In the first module, the sectoral carbon-dioxide emissions and intensities are calculated, based on both the Polluter Pays Principle (PPP) and Shared Responsibility Principle (SRP). The CO_2 emissions and intensities for the

PPP are simply calculated, based on direct energy consumption represented in the traditional energy balance. On the other hand, the CO_2 emissions and intensities for SRP are calculated from direct as well as indirect energy consumption, represented in materials-balance. CO_2 emissions and intensities for SRP are determined from the energy-oriented input–output method developed on the basis of the "*energy-coefficient*" approach.

b) In the second module, a carbon tax is introduced based on sectoral carbon-dioxide intensities. This tax is introduced on the top of the existing value-added tax.

c) In the third module, the impact of carbon tax, in terms of changes in sectoral prices, is estimated. This is estimated using the standard Leontief's input–output price model, which is appropriate for analysing changes in value-added tax.

d) In the fourth module, the electricity sector is allowed to substitute its factor inputs in response to changes in sectoral prices brought about by the application of a carbon tax. This is achieved by assuming a nested input structure for each electricity-generation technology and replacement of the Leontief's production function with the Translog and Cobb-Douglas production functions. Further, the final demand category (including final consumption and exports) is also allowed to change its consumption patterns in response to increases in energy and material prices due to the introduction of a carbon tax. It is also assumed that the input–output relationships for other production sectors remain constant.

e) In the final module, based on the new input–output coefficients, the economy-wide impacts of carbon tax are assessed. These impacts are classified into energy, environmental, economic, and social impacts. The result of these impacts is discussed in the next chapter.

CHAPTER 6

ASSESSMENT OF THE IMPACTS OF CARBON TAX

In Chapter 5, a methodological framework for assessing the impacts of carbon tax was developed. The objective of this chapter is to employ this framework to assess the energy, environmental, economic and social impacts of carbon tax on the Australian economy. This assessment will be carried out separately, based on two approaches, namely, the energy-balance approach (underpinned by PPP) and materials-balance approach (underpinned by SRP). The method for carrying out the assessment by the first approach was explained in Section 5.2.1 and for the second, in Section 5.2.2.

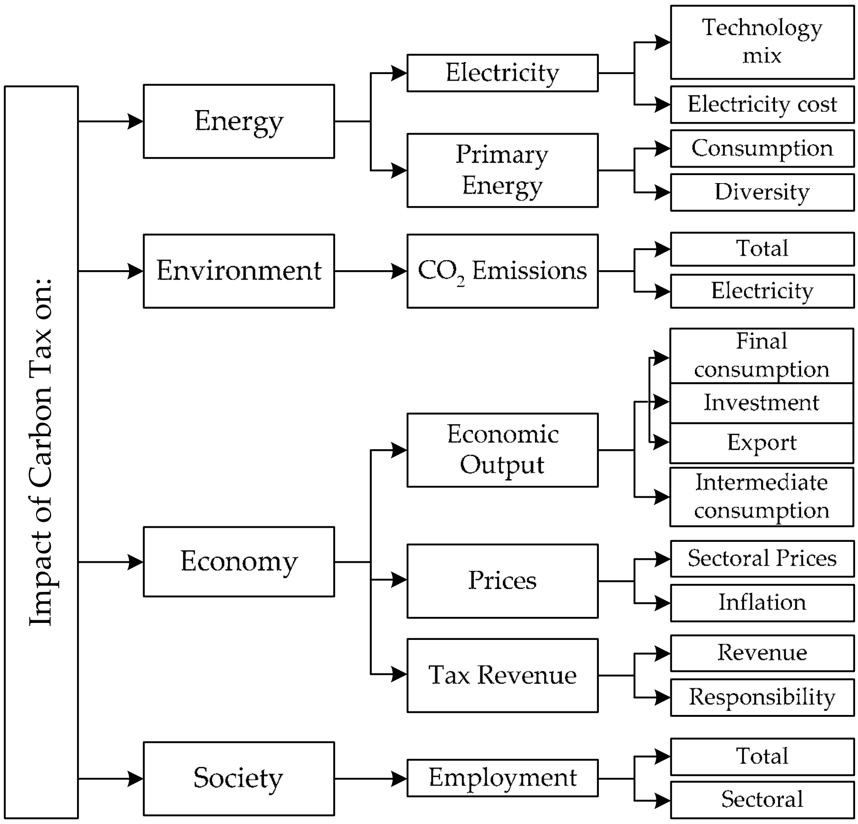
This chapter is organised as follows. Section 6.1 presents the outline of the generic framework used in this research for the assessment of the impacts of carbon tax. In particular, this outline shows the attributes in terms of which various impacts will be measured. Section 6.2 describes the range of carbon tax levels analysed in this research, along with the underlying assumptions. Section 6.3 presents and analyses the results, in terms of the attributes noted above, of various levels of carbon tax. While the analyses in Section 6.3 focuses on assessing the energy, environmental (CO_2 emissions), economic, and social impacts of various levels of carbon tax in a situation in which there is no *a-priori* limit of CO_2 emissions, Section 6.4 places an *a-priori* limit on CO_2 emissions (equivalent to the Kyoto protocol level) and assesses the energy, economic, and social impacts of meeting this emission limit. Section 6.5 provides a comparison of these results (particularly the results of Section 6.4) with those of other studies. Section 6.6 provides further analyses of these results in a wider policy context. Section 6.7 summarises the major findings of this Chapter.

6.1 Framework for Assessing Impacts of Carbon Tax

This section provides an outline of the framework for assessing the energy, environmental, economic, and social impacts of carbon tax. It was discussed in Chapter

5 (especially in Section 5.5.2), that the application of a carbon tax would result in a change in the composition of fuel and technology-mix for electricity generation. The impact of this change would then become evident in the wider realms, for example, changes in primary energy requirements, CO_2 emissions, economic output, and employment. The key attributes employed in this research to measure these impacts are shown in Figure 6-1.

Figure 6-1 Attributes for assessing impacts of carbon tax



It is also important to note that the impact of carbon tax analysed in Section 6.3 is not meant to demonstrate how much emission reduction is possible in response to carbon tax. Instead, it is meant to demonstrate how the electricity industry would be impacted upon in response to different carbon tax rates, both from energy-balance (PPP) and materials-balance (SRP) approaches. The economy-wide impacts of different carbon tax approaches for achieving a pre-determined emissions level (that is, Kyoto target) is discussed in Section 6.4 (as noted earlier).

6.2 Alternative Carbon Tax Regimes

A key focus of this research is to analyse the impacts of carbon tax based on the materials-balance approach (that is, Shared Responsibility Principle)[43] and on the energy-balance approach (that is, Polluter Pays Principle). These impacts are compared with the impacts that would be experienced in the business-as-usual state of affairs, that is, when present trends continue and no carbon tax is introduced. This business-as-usual situation is called, in this research, the Base Case scenario (BC). Two levels of carbon tax rates are analysed in this research, for each of these approaches. These are $10 and $20 per tonne of CO_2 emissions. These carbon tax rates are in a similar range to those considered in previous carbon tax studies (see Table 3-2).

The Base Case scenario (BC) is based on the following assumptions:

i. The economy would grow at an annual rate of 3.1 per cent between 2004 to 2010 and 2.3 per cent between 2010 to 2020 (Costello 2002). In this research, these rates are applied to estimate increased consumption levels and net exports only (as investment, which is a part of economic growth, is endogenously determined within the model);

ii. Energy efficiency would improve by 0.5 per cent per annum over the period 2004 to 2020, across all energy consumption sectors. This rate of growth is applied to determine changes in energy intensities (*C* matrix). This rate is in accord with those adopted by most developed countries (for example, Cruz 2002; Hoeller, Dean & Nicolaisen 1991; Nakicenovic & Swart 2000);

iii. Labour productivity would improve by 1.7 per cent per year in the 2000s and 1.75 per cent in the 2010s (Costello 2002). These rates are applied to develop the labour-output ratios (that is, matrix *l*); and

---

[43] See Section 3.3.3 for a discussion of carbon tax, based on the Shared Responsibility Principle.

iv. The existing nation-based Mandatory Renewable Energy Target (MRET) scheme would expire in 2010. This is in accord with the current government's intention of not extending the scheme. The MRET requires electricity retailers to source 2 per cent of total electricity from renewable sources (Roarty 2001).

Further, it should be noted here that the Base Case (noted above) is developed in this research with the sole objective of providing a basis for comparing the impacts of a carbon tax based on PPP and SRP principles, that is, it acts as a comparison benchmark.

In addition to the above cases (that is, PPP_1, SRP_1, PPP_2, and SRP_2)[44], analysis is performed in Section 6.4 to assess the impacts of achieving a pre-determined CO_2 emissions reduction target. This target is set to allow total CO_2 emissions from the electricity sector to increase to 108 per cent of 1990 levels by the year 2020. This emissions target is set, in this research, to be achieved from the electricity sector alone because of the focus of this research, namely, that the electricity sector would reorient its technology and fuel mix for electricity generation in response to a carbon tax. For other production sectors, this research assumed a zero elasticity of substitution, which implies that these sectors will not adjust their production levels in response to the introduction of a carbon tax. This assumption means that the analysis will underestimate the CO_2 reduction potential and overestimate the economic costs to the economy.[45] This is because such an assumption does not allow other production sectors (except the electricity sector) to substitute their emission-intensive expensive inputs (due to the carbon tax) with low-emission cheaper inputs. The high-price emission-intensive inputs in these sectors are continuously used in the same (Leontief) proportion in which they were used before the carbon tax is imposed.

---

[44] Defined in Section 6.3

[45] A model was also run, as a test, by assuming other production sectors to be perfect substitutes in the use of factor inputs in response to changes in price due to the carbon tax. The results show that, in the case of PPP_1, the model overestimates total economic costs (GDP) by 0.09 per cent ($5.6 billion in 1990 prices) and underestimates CO_2 reduction potential by 15 per cent (58 Mt).

The target, analysed in this research, is deliberately selected reflecting the level required for the Australian economy to meet the international obligations of the Kyoto Protocol.[46]

6.3 Analysis of the Impacts of Alternative Carbon Tax Regimes

This section analyses energy, environmental, economic, and social impacts of alternative carbon tax regimes. This analysis is carried out separately for energy-balance (Polluter Pays Principle) and materials-balance (Shared Responsibility Principle) approaches. Four cases, denoted PPP_1, SRP_1, PPP_2, and SRP_2, are analysed in this research. PPP_1 and SRP_1 refer to the case of a carbon tax of \$10 per tonne of CO_2 emissions, based on the energy-balance (PPP) and materials-balance (SRP) approaches, respectively. PPP_2 and SRP_2 refer to the case of a carbon tax of \$20 per tonne of CO_2 emissions, based on the energy-balance (PPP) and materials-balance (SRP) approaches, respectively. Section 6.3.1 discusses energy and environmental impacts. The economic and social impacts are discussed in Section 6.3.2. These impacts are assessed based on attributes presented earlier in Figure 6-1.

6.3.1 Energy and Environmental Impacts

This section estimates changes in primary energy requirements and associated CO_2 emissions in response to the introduction of carbon tax. These estimations are based on the application of equations 5-34 and 5-35, as discussed in Section 5.6. As mentioned earlier, the introduction of a carbon tax would result in changes in the composition of the fuel and technology-mix for electricity generation. These changes would then influence the primary energies required to produce electricity, and hence CO_2 emissions. Therefore this section commences with a discussion of changes that a carbon tax would induce in the composition of electricity-generation technology and fuel mix

[46] The Kyoto target required the Australian economy to reach this level by 2008–12. However, this research extends this target to 2020, so that more realistic analysis can be performed (that is, meeting the target in 15 years).

(Section 6.3.1.1). This is followed by an analysis of the changes in primary energy requirements (Section 6.3.1.2). The issue of energy diversity is briefly discussed in Section 6.3.1.3. Finally, the environmental impacts, in terms of CO_2 emissions, of each carbon tax regime are analysed in Section 6.3.1.4.

6.3.1.1 Changes in the Composition of Electricity Generation Technology

The technology-mix for electricity generation would be influenced by the introduction of carbon tax. Each approach to carbon tax (that is, based on PPP and SRP) would, however, result in a different level of increase in the cost of electricity generation and hence a different level of change in the technology-mix. The increase in the cost of electricity would clearly depend on the CO_2-intensiveness of various inputs used for electricity production. The determination of the shares of electricity production by different technologies (as defined in Table 5-6) is based on the least-cost criteria, that is, the lowest cost technology would be selected first, and highest, the last. The change in electricity generation technology-mix in response to the introduction of carbon tax, in this research, includes a switch from high-emission technology (such as coal-fired) to low-emission technology (such as combined-cycle) or renewable generation. Electricity generated from internal combustion is assumed, in this research, to retain its share of the overall generation, as this technology supplies electricity mainly in remote areas where electricity demand is rather insignificant. Further, the rate of switch between various technologies is constrained, in this research, to a maximum of 2.6 per cent per year. This rate is used because this is the average rate of annual capacity replacement in Australia over the last 30 years (Creedy & Martin 2000).

The technology-mix for electricity generation under different carbon tax rates is presented in Table 6-1.

Table 6-1 Technology-mix for electricity generation

(Per cent)

	2005	**2010**					**2015**					**2020**				
	BC	BC	PPP_1	SRP_1	PPP_2	SRP_2	BC	PPP_1	SRP_1	PPP_2	SRP_2	BC	PPP_1	SRP_1	PPP_2	SRP_2
CF	85.8	84.2	84.2	84.2	84.2	81.9	84.2	84.2	76.4	73.8	68.9	84.2	73.8	63.4	60.8	55.9
IC	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
GT	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
CC	3.6	3.6	3.6	3.6	3.6	5.9	3.6	3.6	11.4	8.8	13.7	3.6	14.0	21.8	8.8	13.7
RE	8.6	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	15.4	15.4	10.2	10.2	12.8	28.4	28.4

Notes:
- BCs for the years 2010, 2015 and 2020 are different from the year 2005 because of the expiration of the MRET scheme in 2010;
- CF: Coal-fired, IC: Internal-combustion, GT: Gas-turbine, CC: Combined-cycle, RE: Renewable electricity;
- BC: Base Case; PPP_1 & PPP_2: carbon tax of $10 and $20 per tonne of CO_2 emissions, based on the PPP (or energy-balance approach); SRP_1 & SRP_2: carbon tax of $10 and $20 per tonne of CO_2 emissions, based on SRP (or materials-balance approach);
- This table is obtained from detailed results presented in Tables F-8, Appendix F, p. 343.

The table shows that:

i. In general, the introduction of a carbon tax would cause the share of coal-fired power generation to decrease. This is because the increase in the carbon tax rate would increase the cost of electricity generated from coal-fired technology at a higher rate compared to other less-CO_2-intensive technologies. For example, for the case PPP_1, the share of coal-fired power generation would decrease by 12 per cent (from 85.8 per cent in 2005, to 73.8 per cent in 2020); whereas for the case PPP_2, it would decrease by 25 per cent (to 60.8 per cent in 2020).

ii. A carbon tax based on SRP would generally lead to a larger reduction in coal-fired power generation compared to that based on PPP, for the same level of tax. For example, for a carbon tax of \$20 per tonne of CO_2, the share of coal-fired power generation would decrease to 55.9 and 60.8 per cent for the cases SRP_2 and PPP_2, respectively. Further, in the case of SRP_2, the share of coal-fired power generation would start to decline as early as 2009 (see Table 6-2), which shows a reduction of 3.9 per cent (from 85.8 per cent in 2005, to 81.9 per cent in 2010).

iii. A carbon tax of \$10 per tonne of CO_2, applied on the basis of PPP, does not result in the introduction of renewable power generation in the electricity market. For example, the share of renewable electricity in 2010, 2015, 2020 remains at 10.2 per cent. This is because renewable technology is unable to compete with any other technology at this tax rate. A tax of \$20 per tonne of CO_2, on the other hand, while having no effect for the year 2010 (with a share of 10.2 per cent), would result in a sharp increase after the year 2013 (see Table 6-2). The share of renewable electricity, in the case of PPP_2, would reach 28.4 per cent in the year 2020.

iv. A carbon tax based on SRP has more potential in attracting cleaner electricity generation technology to the electricity market compared to that based on PPP. For example, for a carbon tax of \$10 per tonne of CO_2, the shares of renewable electricity would increase, from 8.6 per cent in 2005, to 12.8 and 10.2 per cent in

2020 for the cases SRP_1 and PPP_1, respectively. The corresponding increases in the shares of combined-cycle electricity for the cases SRP_1 and PPP_1 are from 3.6 per cent in 2005 to 21.8 and 14 per cent, respectively.

These reductions in coal-fired technology are due to the cost disadvantage this technology would suffer as a result of carbon tax. This cost disadvantage would result in their replacement by either natural-gas-based combined-cycle or renewable-based technologies.

The foregoing discussion also suggests that the question of changes in the electricity technology-mix should be discussed together with the increase in electricity supply costs because the costs associated with changes in technology-mix are likely to be reflected in the changes in the cost of electricity. The cost of electricity is expected to increase when the entry of new coal-fired plants (which is currently the least-cost technology) is restricted due to the carbon tax and/or MRET scheme. It is also important to note here that the cost of electricity, considered in this research, does not take into account the autonomous cost reduction of new technologies as they become more mature in the future. In reality, it is expected that the future renewable technology would be cheaper than that at the present time.

The impact of the different cases of carbon tax on total electricity supply costs is presented in Table 6-2.

Table 6-1 and 6-2 shows that:

i. In the Base Case (BC), the reduction in the share of coal-fired power generation from 85.8 per cent in 2005 to 84.2 per cent in each of the years 2010, 2015 and 2020 is due to a modest penetration by renewable technology, driven mainly by the MRET scheme. The increase in cost, over the period 2004–2020, of 0.22 ¢/kWh (from 4.7 ¢/kWh in 2004 to 4.92 ¢/kWh in 2020) (Table 6-2), in this case is attributed only to the replacement of cheaper technology with the expensive technology through enforcement.[47]

Table 6-2 Electricity supply costs

(¢/kWh, 2004 prices)

	BC		PPP_1		SRP_1		PPP_2		SRP_2	
2004	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70
2005	CF	4.74	CF	5.30	CF	5.59	CF	5.89	CF	6.48
2006	CF	4.77	CF	5.89	CF	6.46	CF	7.07	CF	8.20
2007	CF	4.81	CF	6.47	CF	7.32	CF	8.22	CF	9.87
2008	CF	4.84	CF	7.04	CF	8.15	CF	9.35	CF	11.48
2009	CF	4.88	CF	7.60	CF	8.97	CF	10.45	CF	13.04
2010	CF	4.92	CF	8.16	CF	9.77	CF	11.54	CC	14.53
2011	CF	4.92	CF	8.71	CF	10.56	CF	12.61	CC	15.96
2012	CF	4.92	CF	9.26	CF	11.34	CC	13.65	CC	17.32
2013	CF	4.92	CF	9.80	CC	12.08	CC	14.67	CC	18.63
2014	CF	4.92	CF	10.34	CC	12.81	RE	15.64	RE	19.86
2015	CF	4.92	CF	10.87	CC	13.51	RE	16.56	RE	21.02
2016	CF	4.92	CF	11.39	CC	14.18	RE	17.43	RE	22.12
2017	CF	4.92	CC	11.91	CC	14.84	RE	18.27	RE	23.15
2018	CF	4.92	CC	12.41	CC	15.47	RE	19.06	RE	24.12
2019	CF	4.92	CC	12.90	CC	16.09	RE	19.82	RE	25.03
2020	CF	4.92	CC	13.38	RE	16.67	RE	20.53	RE	25.90

Notes:
- CF: Coal-fired, IC: Internal-combustion, GT: Gas-turbine, CC: Combined-cycle, RE: Renewable;
- BC: Base Case; PPP_1 & PPP_2: carbon tax of \$10 and \$20 per tonne of CO_2 emissions, based on the PPP; SRP_1 & SRP_2: carbon tax of \$10 and \$20 per tonne of CO_2 emissions, based on SRP;
- For each case, the first column is the technology that presents the least-cost technology for that year and the second column is the total electricity supply cost;
- This table is obtained from detailed results presented in Tables F-9, Appendix F, p. 345.

ii. For PPP_1, the combined-cycle-based electricity becomes cost-competitive compared with coal-fired electricity in the year 2017. As a result, its share increases by 10.4 per cent (from 3.6 per cent in the year 2005 to 14 per cent in the year 2020) (see Table 6-1). The replacement of coal-fired with the combined-

[47] This increase in cost of 0.22 ¢/kWh in the BC case does not reflect the market-based selection of electricity generation technology and, hence, the real cost is hidden somewhere in the economy.

cycle would increase the cost of electricity by 8.7 ¢/kWh (from 4.7 to 13.4 ¢/kWh) over the period 2004–2020.

iii. For the case of PPP_2, combined-cycle and renewable technologies would penetrate in the market in the years 2012 and 2014, respectively. This would result in an increase in the share of combined-cycle by 5.2 per cent (from 3.6 per cent in 2005 to 8.8 per cent in the year 2020), and renewable by 19.8 per cent (from 8.6 per cent in the year 2005 to 28.4 per cent in 2020) (Table 6-1). This change in electricity technology-mix would increase its cost by 15.8 ¢/kWh (from 4.7 ¢/kWh in 2004, to 20.5 ¢/kWh in 2020) (Table 6-2).

iv. For the case of SRP_1, combined-cycle and renewable electricity would become competitive in the years 2013 and 2020, respectively. As a result, the share of combined-cycle electricity would increase by 18.2 per cent (from 3.6 per cent in 2005 to 21.8 per cent in 2020), and renewable by 4.2 per cent (from 8.6 per cent in 2005 to 12.8 per cent in 2020) (Table 6-1). The replacement of coal-fired with combined-cycle and renewable would increase the electricity supply cost by 12 ¢/kWh over the period 2004–2020 (from 4.7 ¢/kWh in 2004 to 16.7 ¢/kWh in 2020) (Table 6-2).

v. For SRP_2, combined-cycle and renewable electricity would penetrate in the market in the years 2010 and 2014, respectively. As a result, the share of combined-cycle would increase by 10.1 per cent (from 3.6 per cent in 2005 to 13.7 per cent in 2020), and renewable by 19.8 per cent (from 8.6 per cent in 2005 to 28.4 per cent in 2020) (Table 6-1). This change in electricity technology-mix would increase its cost by 22.2 ¢/kWh over the period 2004–2020 (from 4.7 ¢/kWh in 2004 to 25.9 ¢/kWh in 2020) (Table 6-2).

It can also be seen that when a higher level of tax (that is, \$20 per tonne of CO_2) is imposed based on the direct use of fossil fuel (that is, PPP_2), there would be an early change in the composition of the electricity technology-mix. For example, electricity produced from combined-cycle technology becomes a cost-effective option in 2012 and 2013 and, in 2014, it loses its position to renewable technology. In contrast, when carbon tax is imposed based on the materials-balance approach (that is, SRP_2), there is a steady transition from highly polluting coal-fired technology to less polluting combined-cycle and then to renewable technology. This happens because the marginal costs of electricity generated from both combined-cycle (4.1–6.7 ¢/kWh) and other fossil-fuel-based technologies (3.5–4.0 ¢/kWh) are very small (see also Table 2-2). When a carbon tax is introduced, the threshold of competition between different fossil-fuel technologies is also small, particularly when comparing them with the marginal cost of renewable technologies (7.3–54.9 ¢/kWh). If a tax of more than $20 is introduced, it would clearly show that – based on the energy-balance approach – combined-cycle would never become a competing technology.

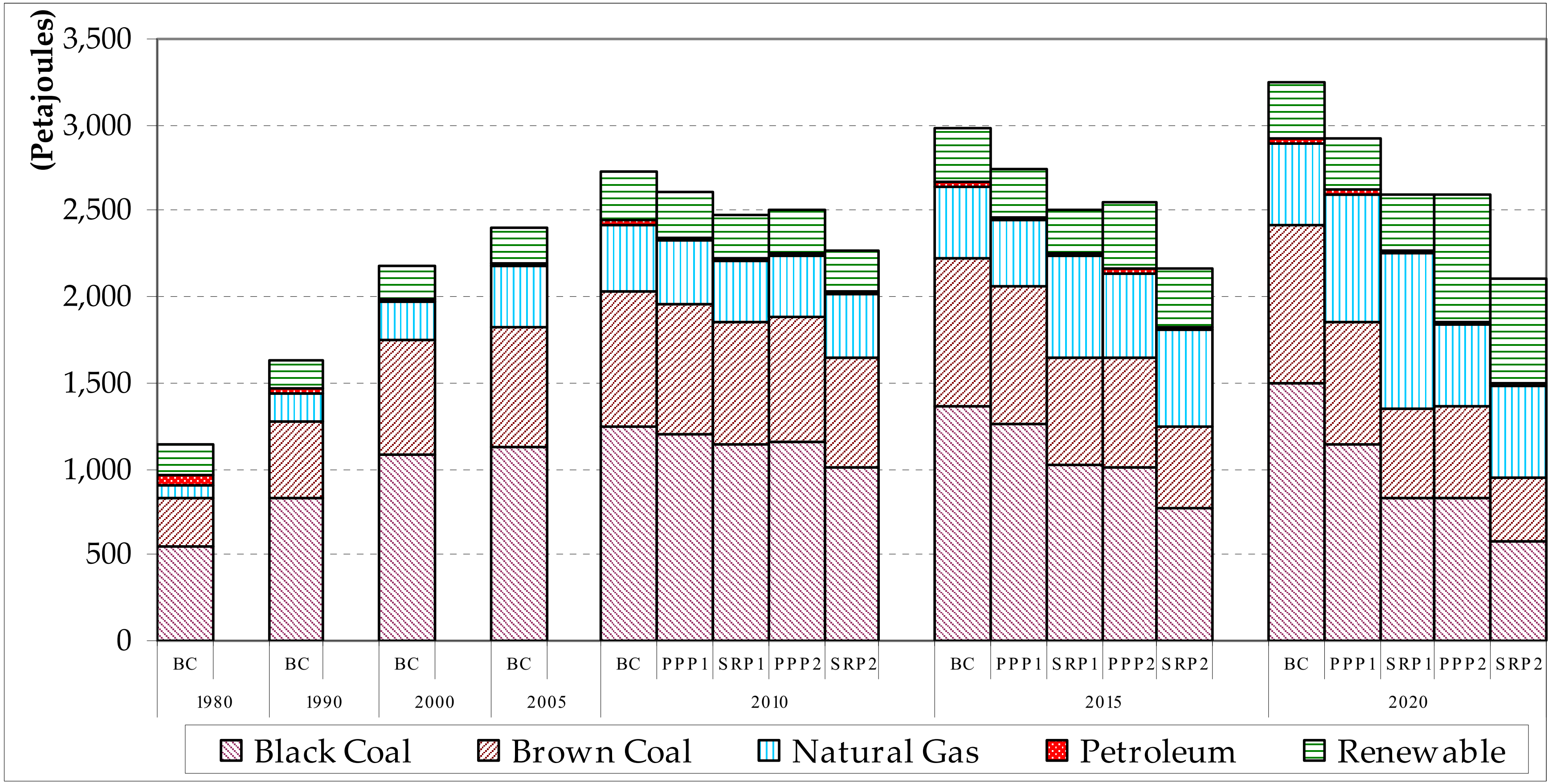
It is clear from discussion in this sub-section that changes in the composition of the electricity technology-mix, brought about by the application of different carbon tax approaches, would have different ramifications in terms of the fuel-mix for electricity generation, primary energy requirements, CO_2 emissions and the consequential economy-wide impacts. These impacts are discussed in the following sub-sections.

6.3.1.2 Primary Energy Consumption

Over the past 25 years (1980 to 2005), primary energy consumption for electricity production has been increasing at an average rate of about 3 per cent per annum, from 1,138 PJ in 1980 to 2,404 PJ in 2005 (see Figure 6-2). This increasing trend is likely to continue to the year 2020 in the BC, although the rate of annual growth is likely to be 2 per cent between 2004 and 2020. This is equivalent to 3,248 PJ of primary energy in 2020 (see Figure 6-2). This reduction in the rate of growth from 3 per cent over the period 1980–2004 to 2 per cent over the period 2004–2020 is due to: i) a slowdown in economic activity from 3.3 per cent per year during 1980–2004 to 2.5 per cent per year during 2004–2020; and ii) improvements in energy efficiency of 0.5 per cent per year (see assumptions in Section 6.2).

Figure 6-2 compares the primary energy mix for electricity production for various cases analysed in this research.

Figure 6-2 Primary energy consumption for electricity production



Notes: - This figure presents the summary of results obtained from the application of equation 5-34, as detailed in Chapter 5, Section 5.6. For detail results – see Tables F-10, Appendix F, pp. 346-348.

The figure shows that:

i. In the BC scenario (without carbon tax), coal continues to play an important role in the electricity industry.[48] For example, it accounts for 75 per cent of the total primary energy consumed in 2020 (that is, 2422 out of 3248 PJ).

ii. The impact of carbon tax on primary energy consumption is very significant. For example, the introduction of carbon tax would result in a reduction of 10.2 (330 PJ), 19.9 (647 PJ), 20.1 (653 PJ), and 35.4 (1148 PJ) per cent for PPP_1, SRP_1, PPP_2, and SRP_2, respectively, as compared to the BC (3248 PJ). This is due to a switch from high-emission to low-emission fossil-fuel technology for electricity production.

iii. The role of coal in electricity production is considerably reduced with the introduction of a carbon tax. For example, a carbon tax of $10 and $20 per tonne, based on the energy-balance approach (PPP_1 and PPP_2) would reduce the share of coal by 13 and 24 per cent, respectively, from the year 2005 when coal accounted for 76 per cent of total primary energy consumed for electricity production. When a carbon tax is imposed based on the materials-balance approach, the share of coal would decrease by 24 and 31 per cent, respectively, for SRP_1 and SRP_2. This shows that the rate of reduction in the use of coal is faster when tax is imposed on total fuel use (that is, materials-balance), which would result in substantial increase in natural gas (from 15 per cent in 2005 to 35 per cent in 2020 in the case SRP_1) and renewable (from 9 per cent in 2005 to 28 per cent in 2020 in the case SRP_2).

iv. The extent of substitution of coal with either natural gas or renewable varies, depending on the rate of technology penetration in each carbon tax case. For example, in the case PPP_1, the use of natural gas would be 282 PJ higher than the BC. This is because of the increased share of natural gas-based combined-cycle in the total electricity generation. In contrast, the use of renewable energy

[48] This result reinforces the influence of the coal–electricity compact, as discussed in Chapter 2.

in the case PPP_2 would be 406 PJ higher than the BC due to an increase in the share of renewable technology for electricity production. Similarly, in the case of SRP_1, the use of natural gas would be 441 PJ higher than the BC; while the use of renewable energy in the case of SRP_2 would be 265 PJ higher than the BC.

6.3.1.3 Energy Diversity

Energy diversity plays an important role, not just in relation to the security of energy supply, but also in terms of the level of environmental emissions. This section analyses the impact of various carbon tax regimes (PPP_1, SRP_1, PPP_2 and SRP_2) on energy diversity.

The composition of primary energy consumption (for electricity production) is used as a main indicator for assessing energy diversity. A simple diversity index, based on the classic Herfindahl measure of market concentration, is used to quantify energy diversity (Neff 1997). The Herfindahl diversification index is expressed as:

$$H = \sum_i x_i^2 \qquad (6\text{-}1)$$

where

H: Herfindahl energy diversification index; and

x_i: a fraction of total energy supply from each *i* source.

The Herfindahl index ranges between 0 and 1, with a number closer to zero signifying large diversity, and number closer to 1 a low diversity.

In this research, five type of primary energies are considered. These include black coal, brown coal, natural gas, petroleum, and renewable energy.

Table 6-3 Primary energy consumption and energy diversity

	1980	2000	2020				
			BC	PPP_1	SRP_1	PPP_2	SRP_2
Primary Energy Consumption (PJ)	1,138	2,180	3,248	2,918	2,601	2,595	2,100
Black coal (%)	*47.9*	*49.8*	*45.9*	*39.1*	*31.8*	*32.2*	*27.7*
Brown coal (%)	*25.3*	*30.5*	*28.6*	*24.3*	*19.8*	*20.1*	*17.3*
Natural gas (%)	*6.7*	*10.0*	*14.4*	*25.6*	*34.9*	*18.6*	*26.0*
Petroleum (%)	*4.5*	*1.1*	*0.9*	*0.8*	*0.7*	*0.7*	*0.7*
Renewable (%)	*15.6*	*8.6*	*10.2*	*10.2*	*12.8*	*28.4*	*28.4*
Herfindahl Index	0.57	0.66	0.59	0.48	0.40	0.39	0.35

The fractions of different types of primary energy consumption for electricity production and associated energy diversity index are summarised in Table 6-3. The table shows that:

i. During the period 1980–2000, the share of fossil fuels (that is, black and brown coal, natural gas, and petroleum) in total electricity production increased from 84 per cent in 1980, to 91 per cent in 2000. Over this period, the share of coal in electricity production increased from 73 per cent to 80 per cent, and of gas from 7 to 10 per cent. The share of oil decreased from 4 per cent in 1980 to 1 per cent in 2000. These changes in the shares of fossil fuels have resulted in an increase in the value of the Herfindahl index from 0.57 in 1980, to 0.66 in 2000.

ii. The shares of various fuels in electricity production – in the BC scenario – are likely to change only slightly by 2020. These changes are expected to be partly due to the increasing use of natural gas in the recent years as combined-cycle power plants enter the electricity market, and partly to the increase in renewable electricity, due to the MRET scheme. This change in fuel mix would result in a Herfindahl index of 0.59 in the year 2020, thus signifying a small improvement in energy diversity.

iii. Each of the carbon tax cases would result in decreased shares of fossil fuels, particularly coal. This is replaced by natural gas and renewable for all cases, except an increase in renewable energy in the case of PPP_1. This would result in fuel diversity indices of 0.48, 0.40, 0.39, and 0.35 for PPP_1, SRP_1, PPP_2, and SRP_2, respectively.

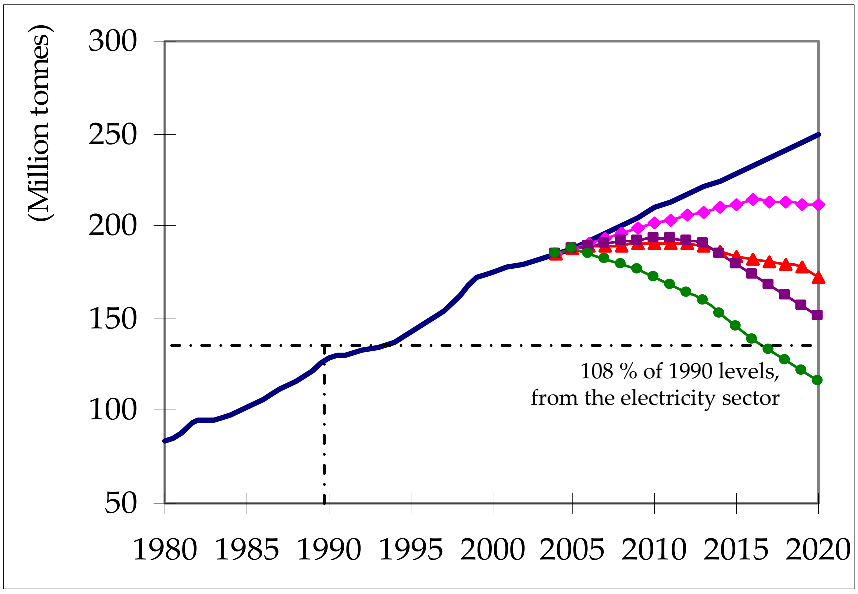
iv. The most notable result of the analysis in this section is that the higher the level of carbon tax, the higher the energy diversity. For example, for the case PPP_1, the Herfindahl index would be 0.48 (compared to 0.59 in the BC case). When the level of tax is raised to $20 per tonne ($PPP_2$), energy diversity would increase, (the value of index would be 0.39).

v. Also, a higher energy diversity would be achieved in the case of SRP as compared to the PPP. For example, the diversity indices in the case of SRP_1 and SRP_2 are 0.4 and 0.35, respectively (the corresponding values for PPP_1 and PPP_2 are 0.48 and 0.39, respectively).

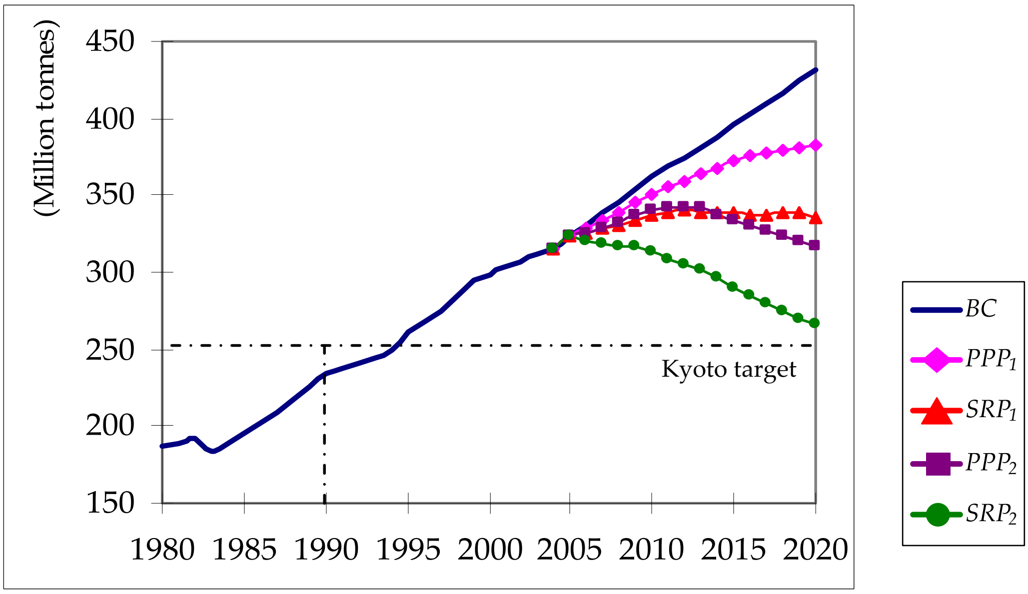
6.3.1.4 Carbon-dioxide Emissions

In this section the impact of carbon tax on CO_2 emissions is presented. Included in this presentation are CO_2 emissions for the four cases, namely, PPP_1, SRP_1, PPP_2, and SRP_2. These emissions are then compared with the emissions in the BC scenario. Also included in the presentation is a comparison of four cases of CO_2 emissions with CO_2 emissions at the 1990 level (that is, Kyoto targets). This would enable an assessment to be made of how each of the four cases of carbon tax compares with the Kyoto targets. The results are shown in Figure 6-3 and Table 6-4.

Figure 6-3 Carbon-dioxide emissions from fossil fuel combustion



a) Electricity sector



b) Economy

Notes: - This figure present the summary of results obtained from the application of equation 5-35, as detailed in Chapter 5, Section 5.6. For detailed results, see Tables F-11, Appendix F, pp. 351-352.

Table 6-4 Percentage changes in carbon-dioxide emissions

	BC	PPP_1	SRP_1	PPP_2	SRP_2	BC	PPP_1	SRP_1	PPP_2	SRP_2
	Electricity sector					**Economy-wide**				
	Comparison with BC scenario									
2005		–	–	–	–		–	–	–	–
2010		-3.9	-8.9	-7.6	-17.7		-3.1	-6.9	-6.0	-13.5
2015		-7.5	-19.6	-21.9	-36.4		-5.9	-14.5	-15.5	-26.6
2020		-15.6	-31.2	-39.3	-53.5		-11.2	-22.4	-26.6	-38.3
	Comparison with 1990 level									
2005	47	47	47	47	44	38	38	38	38	38
2010	63	57	49	51	35	54	50	44	45	34
2015	78	65	44	39	14	69	59	44	43	24
2020	95	65	34	18	-9	84	64	43	35	14

Notes: - This table presents the percentage changes in CO_2 emissions, calculated from information contained in Figure 6.3. For background data and further details, see Tables F-11, Appendix F, pp. 251-252.

Figure 6-3 and Table 6-4 show that:

i. In 1990, CO_2 emissions from fossil fuel combustion in Australia (as estimated from equation 5-35) totalled 234 Mt. The electricity industry accounted for over 50 per cent of these emissions (128 Mt).[49]

ii. In the BC scenario, total CO_2 emissions from fossil fuel combustion are expected to increase significantly, reaching 432 Mt by 2020. This represents 184 per cent of 1990 emissions level (234 Mt). CO_2 emissions from the electricity sector would increase to 250 Mt, which is approximately 58 per cent of total CO_2 emissions. The strong growth in electricity-sector CO_2 emissions occurs even under the existing MRET scheme.

iii. The growth rate of CO_2 emissions reduces substantially due to the introduction of a carbon tax. For example, the CO_2 emissions from the electricity sector would be 211, 172, 152, and 116 Mt, respectively, for PPP_1, SRP_1, PPP_2, and SRP_2 – thus representing a reduction in the range of 15.6 to 53.5 per cent from the BC

[49] National Greenhouse Gas Inventory estimates of CO_2 emissions in 1990 from fuel combustion activity were 254 Mt, with the electricity sector contributing to 129 Mt (AGO 2005). However, this research is concerned with percentage reduction and the small difference in the estimates does not affect the results.

scenario. This is because the application of carbon tax induces a shift away from carbon-intensive energy.

iv. Also, CO_2 emissions reduce more when a carbon tax is applied based on SRP, compared with when it is based on PPP. For example, CO_2 emissions from the electricity sector decline, by 2020, by 31.2 and 53.5 per cent of the BC level, for SRP_1 and SRP_2. The corresponding figures for PPP_1 and PPP_2 are 15.6 and 39.3 per cent, respectively. Further, it is noticed that the rate of CO_2 emission reduction from SRP_1 is closer to the emissions reduction achieved from PPP_2. This is so because a carbon tax based on SRP also takes into account of energy embodied in materials and, therefore, penalise the emitters from indirect energy consumption. The introduction of such tax would increase the cost of electricity production at a higher rate than if a carbon tax is imposed under PPP (see Table 6-2). As a result, it would allow cleaner electricity production technology to penetrate the market earlier than if carbon tax is based on PPP.

v. Except for SRP_2, the impact in terms of CO_2 emission reduction for other cases (that is, PPP_1, SRP_1, and PPP_2), will begin to be felt only in the years after 2010. For example, in the case PPP_2, CO_2 emissions from the electricity sector in 2010 would be 51 per cent (a net increase of 65 Mt) above the 1990 emission level, but would decline to 39 per cent (a net increase of 50 Mt) in 2015 and 18 per cent in 2020 (a net increase of 23 Mt compared with 1990). This is because, in the case PPP_2, combined-cycle and renewable technologies would penetrate in the electricity market in 2012 and 2014, respectively.

vi. In the case SRP_2, CO_2 emissions from the electricity sector fall below the Kyoto target. For example, the total CO_2 emissions from the electricity sector from SRP_2 in 2020 would be 91 per cent (116 Mt) of the 1990 level. In contrast, in the case PPP_2, CO_2 emissions would be 118 per cent (152 Mt) of the 1990 level. This implies that, in order to achieve the Kyoto target of 108 per cent (138 Mt) of the 1990 level from the electricity sector, a higher level of carbon tax (more than \$20 per tonne) would be required if carbon tax is based on PPP than when the carbon tax is based on SRP (this point is further discussed in Section 6.4).

vii. Further, changes in the mix of electricity technology alone, when a carbon tax of \$20 per tonne of CO_2 is applied based on SRP, would almost achieve total economy-wide Kyoto target of 108 per cent (253 Mt) of the 1990 level (234 Mt). At this rate, economy-wide CO_2 emissions would be just 14 Mt above the Kyoto target (or 114 per cent of the 1990 level). This implies that if the response of carbon tax from other sectors is also captured (that is, by employing flexible production function for other sectors instead of the Leontief's), it would have shown that even a carbon tax of less than \$20 would be able to achieve the economy-wide Kyoto target, when a carbon tax is based on SRP.

6.3.2 Economic and Social Impacts

This section analyses economic and social impacts of carbon tax (based on the application of equations 5-32 and 5-37, discussed in Section 5.6). These impacts, like energy and environmental impacts (analysed in Section 6.3.1), are mainly driven by the changes in investment demand due to the application of a carbon tax that is expected to result in a change in electricity-generation technology and fuel mix. This section starts with a discussion on the economic impacts of carbon tax, both on the overall economy and on individual economic sectors (Section 6.3.2.1). Then, the social impacts (that is, the impact on employment) of each carbon tax case are presented in Section 6.3.2.2.

6.3.2.1 Economic Impacts

The results obtained, using the methodology explained in Chapter 5 (Section 5.6), are presented in Table 6-5 and Figures 6-4 to 6-10. The following discussion analyses these results.

Overall Economic Output: the total economic output, as mentioned in Section 5.6, refers to the sum of the output of each economic sector to fulfil the demand for domestic final as well as intermediate consumption, investment, and net exports. However, intermediate consumption is not included in GDP account. The impact of a carbon tax on economic output, in this research, is assumed to be influenced by the changes in various final demand categories. This impact is shown in Table 6-5 and Figure 6-4.

Table 6-5 Impacts of carbon tax on economic output: 2005–2020

	BC	PPP_1	SRP_1	PPP_2	SRP_2	PPP_1	SRP_1	PPP_2	SRP_2
	($Billion 1990)					(percentage changes from BC)			
GDP†	**6,325**	**6,270**	**6,205**	**6,223**	**6,106**	**-0.88**	**-1.90**	**-1.62**	**-3.46**
Total output‡	**12,592**	**12,446**	**12,279**	**12,321**	**12,023**	**-1.16**	**-2.49**	**-2.16**	**-4.52**
Final consumption	4,940	4,887	4,822	4,842	4,725	-1.08	-2.39	-2.00	-4.37
Investment	1,666	1,665	1,663	1,666	1,663	-0.08	-0.21	-0.03	-0.20
Exports	1,135	1,113	1,086	1,091	1,045	-2.01	-4.31	-3.88	-7.96
Imports	1,417	1,395	1,367	1,376	1,326	-1.55	-3.52	-2.90	-6.41
Intermediate consumption	6,267	6,177	6,075	6,098	5,917	-1.45	-3.07	-2.71	-5.59

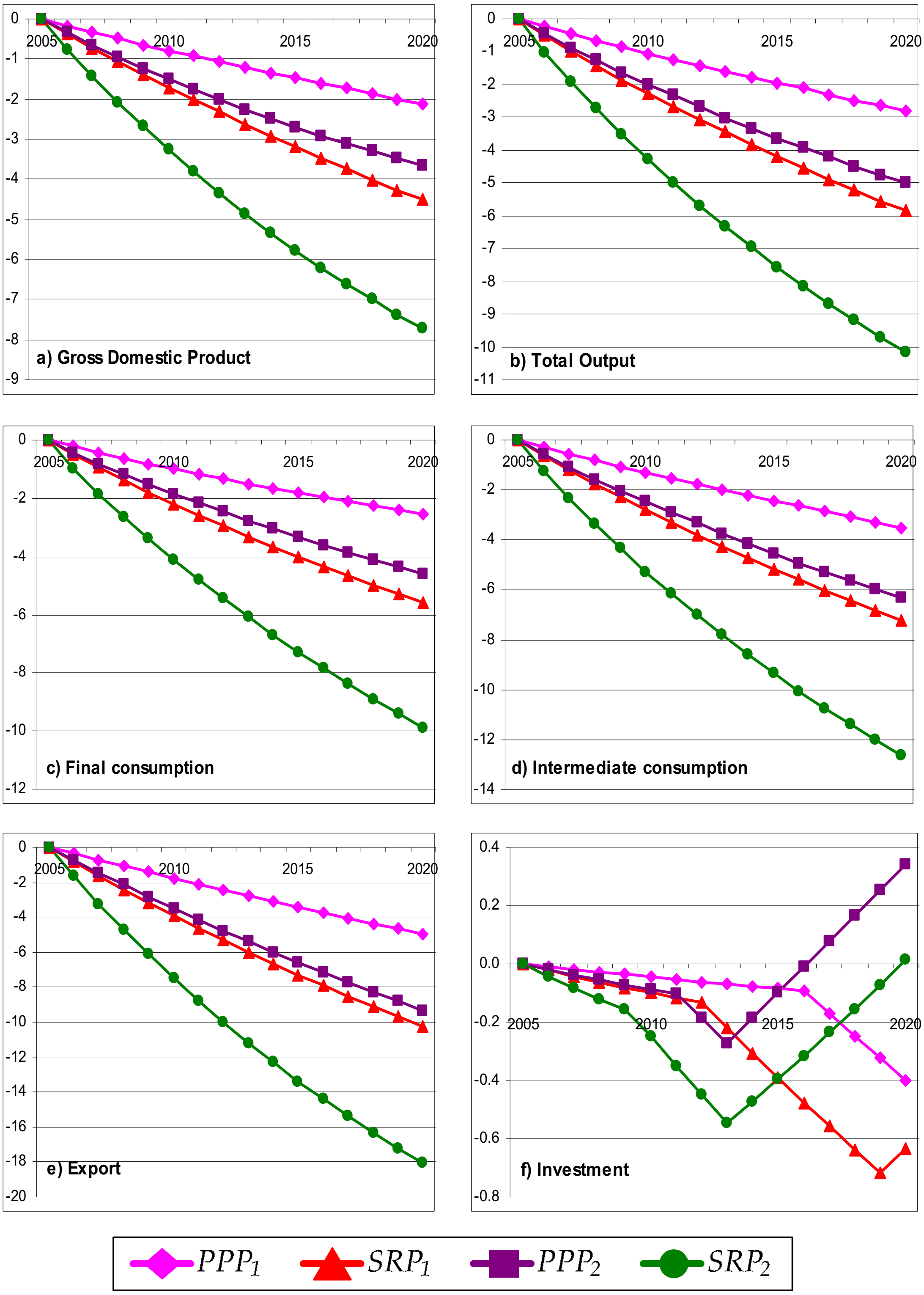
Notes: † GDP = Final consumption + Investment + (Exports – Imports)
‡ Total output = GDP + Intermediate consumption
- This table summarises the present value of each of the economic variable, for the period 2005–2020, using a discount rate of 8 per cent;
- The results presented in this table are calculated from information contained in Tables F-1 to F-5, Appendix F, pp. 288-332, using equation 5-32 as detailed in Chapter 5, Section 5.6.

The result suggest that:

i. In general, the introduction of a carbon tax would lead to a slowdown in economic activity (that is, GDP), with a significantly greater impact occurring at a higher tax rate (that is, $20 per tonne) (Figure 6-4a). For example, a carbon tax based on PPP_1 would cause GDP over the period 2005–2020 to reduce by $56 billion (0.88 per cent), compared to the BC scenario; whereas, in the case PPP_2, the economy would lose $102 billion (1.62 per cent) of GDP.[50] Also, a carbon tax based on SRP would cause a higher negative impact on economic growth, compared with the one based on PPP. For example, at a carbon tax rate of $10 per tonne, GDP in the case SRP_1 would decline by $120 billion (1.9 per cent), and by $219 billion (3.46 per cent) in the case of SRP_2.

[50] The economic impact in the case of PPP, calculated in this research, is of an order of magnitude that is comparable to other studies shown in Table 3-2, Chapter 3.

Figure 6-4 Annual percentage changes in economic parameters



Notes: - These figures show annual percentage change of each carbon tax case compared with the BC;
- For detailed results, see Table F-1 to F-5, Appendix F, pp. 288-332.

ii. The introduction of a carbon tax would have a larger effect on industry (in terms of intermediate consumption, Figure 6-4d) than on households (in terms of final consumption, Figure 6-4c). This would be the case for both types of carbon taxes (that is, PPP and SRP). For example, as shown in Table 6-5, when a carbon tax of $10 per tonne is imposed based on PPP, households and industries would reduce their consumption, over the period 2005–2020, by 1.08 and 1.45 per cent, respectively. The corresponding figures for such a tax based on SRP are 2.39 and 3.07 per cent, respectively.

iii. The impact of a carbon tax would be most significant (in percentage terms) for the export sector (Figure 6-4e). For example, in the case PPP_1, while the economic output (GDP) over the period 2005–2020 declines by 0.88 per cent, exports reduce by 2.01 per cent. Also, a carbon tax based on SRP would have higher impact on exports than a tax that is based on PPP. When a carbon tax of $10 per tonne is imposed based on SRP (i.e., SRP_1), exports would decline by 4.31 per cent (compared with 2.01 per cent in the case PPP_1).

iv. In contrast to the impact of carbon tax on exports and consumption, investment would be least affected by the introduction of carbon tax. For example, over the period 2005–2020, the value of investment would reduce by just 0.08 ($1 billion) and 0.21 ($3 billion) per cent for the cases PPP_1 and SRP_1, respectively. This is because a reduction in coal-fired electricity, due to the introduction of carbon tax, would be replaced by an investment in cleaner technologies, such as combined-cycle and renewable electricity. Interestingly, when the level of carbon tax increases, the impact on investment would be even lower (for example, it would be 0.03 per cent in the case of PPP_2). This is because an increase in the level of carbon tax would significantly accelerate the investment in cleaner electricity technologies (at rates faster than the case with lower levels of carbon tax) (see Table 6-2).

v. It is also noticed from Figure 6-4 that the economic impact of a carbon tax of $10 per tonne based on SRP is of a similar magnitude to that of a tax of $20 per tonne based on PPP. For example, a $10 per tonne of carbon tax based on SRP would cause GDP over the period 2005–2020 to reduce by 1.9 per cent, compared to the BC scenario; whereas, in the case PPP_2, the GDP would decline by 1.62 per cent. This is so because a carbon tax based on PPP would be imposed on direct fuel consumption only; whereas, for SRP, it would impose on direct as well as indirect fuel consumption. As a result, a smaller tax rate based on SRP would have a similar impact on the economy, compared with a higher tax rate based on PPP.

Sectoral Economic Outputs: The impact of carbon tax on economic activity (GDP), as discussed above, is the aggregate of impacts on individual sectors of the economy. As discussed above, a carbon tax would result in a reduction in economic growth. However, not all sectors of the economy would be equally affected. The outputs of some sectors would, in fact, increase in response to the introduction of a carbon tax. The results of the impacts on individual sectoral outputs are presented in Figures 6-5 to 6-10.

Figure 6-5 Sectoral outputs

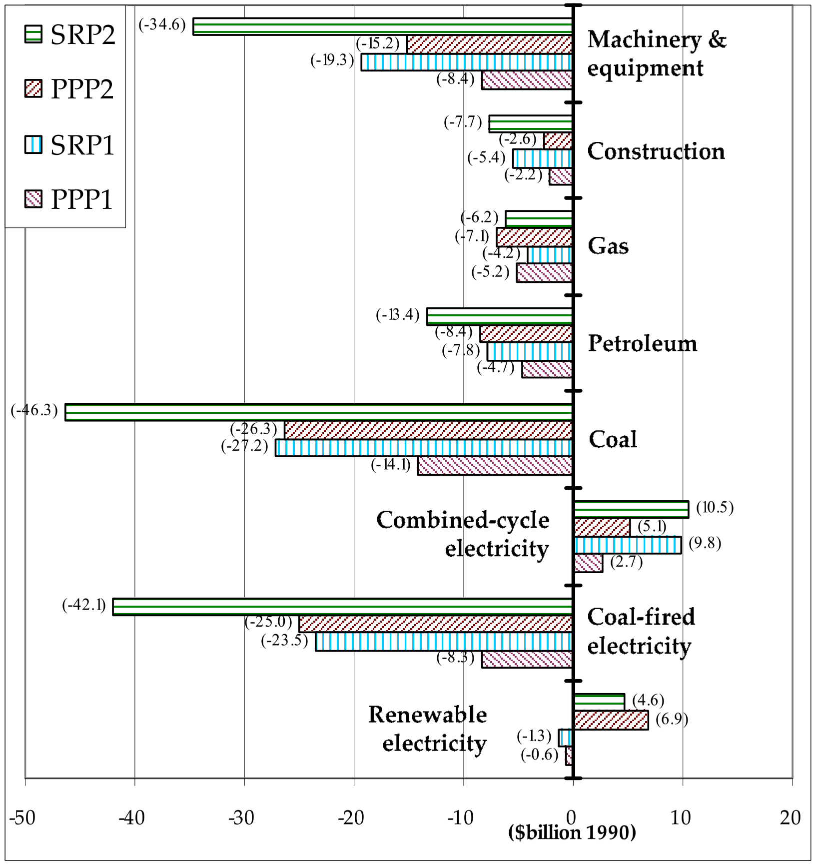
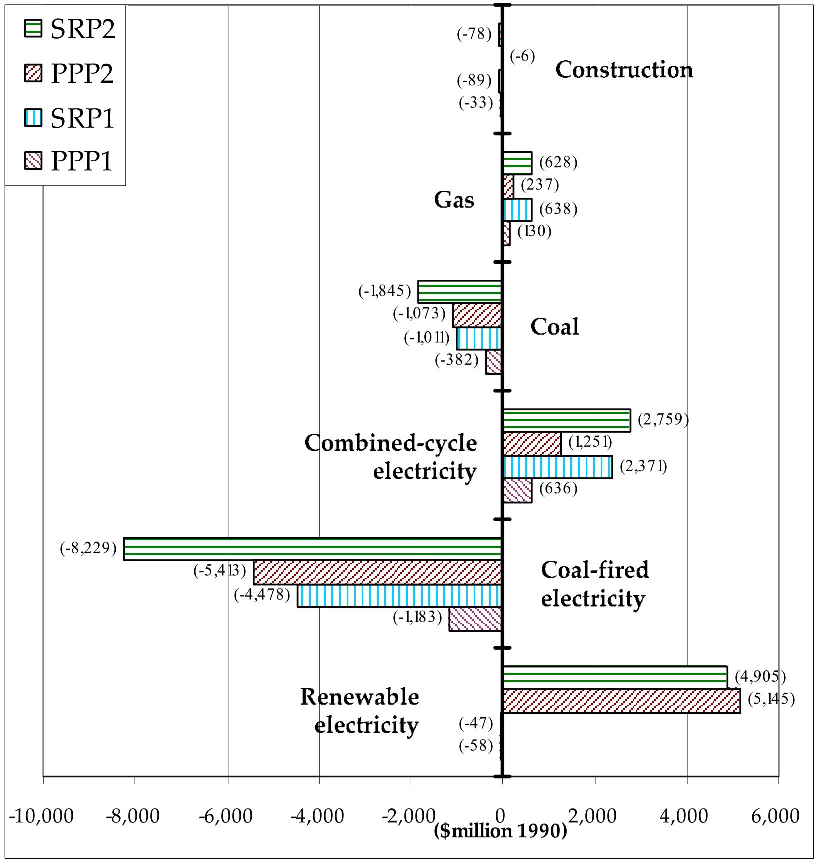


Figure 6-6 Sectoral demand for investment



Notes:
- These figures show changes in present values (estimated at 8 per cent discount rate) over the period 2005–2020, corresponding to each carbon tax scenario, as compared with BC scenario
- These figures are developed from information contained in Tables F-1 to F-5, Appendix F, pp. 288-332.

Figure 6-7 Sectoral outputs for final consumption

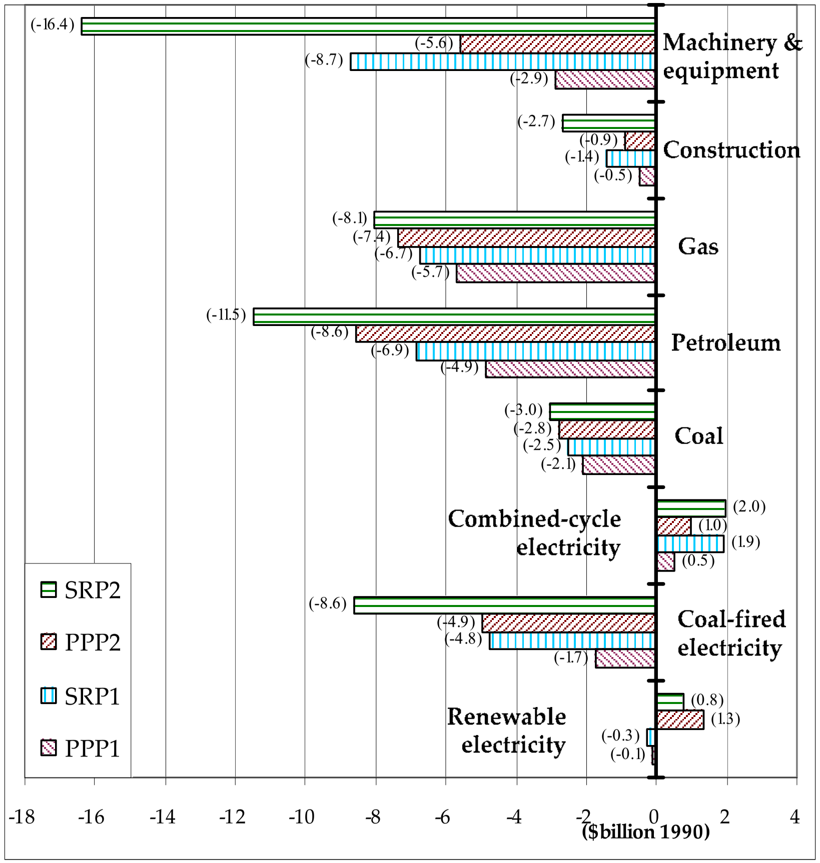
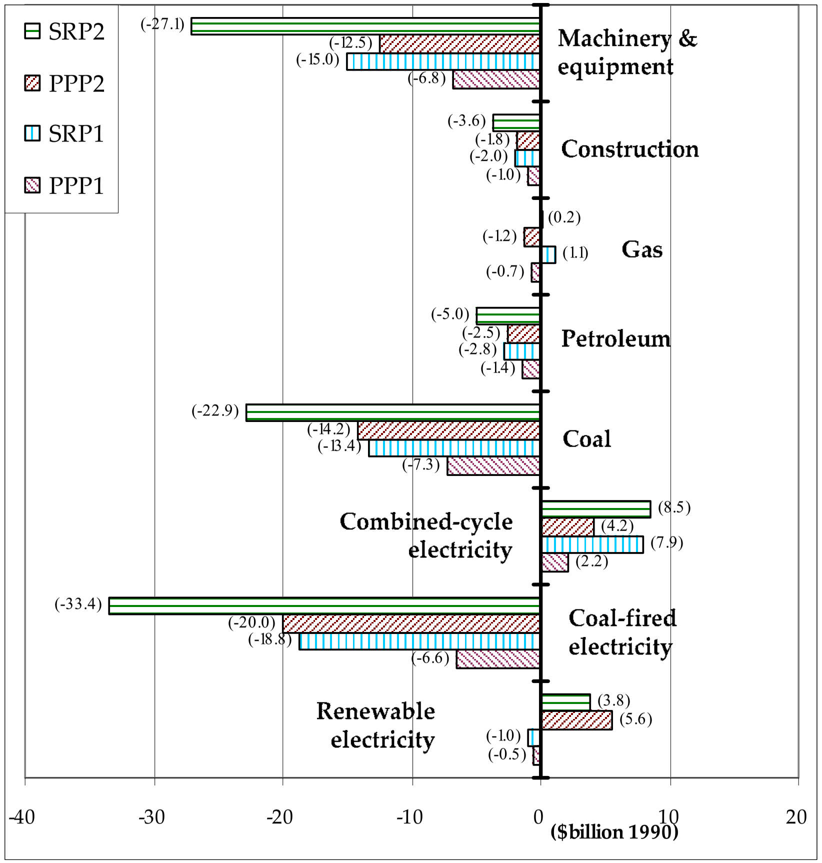


Figure 6-8 Sectoral outputs for intermediate consumption



Notes:
- These figures show changes in present values (estimated at 8 per cent discount rate) over the period 2005–2020, corresponding to each carbon tax scenario, as compared with BC scenario
- These figures are developed from information contained in Tables F-1 to F-5, Appendix F, pp. 288-332.

Figure 6-9 Sectoral outputs for exports

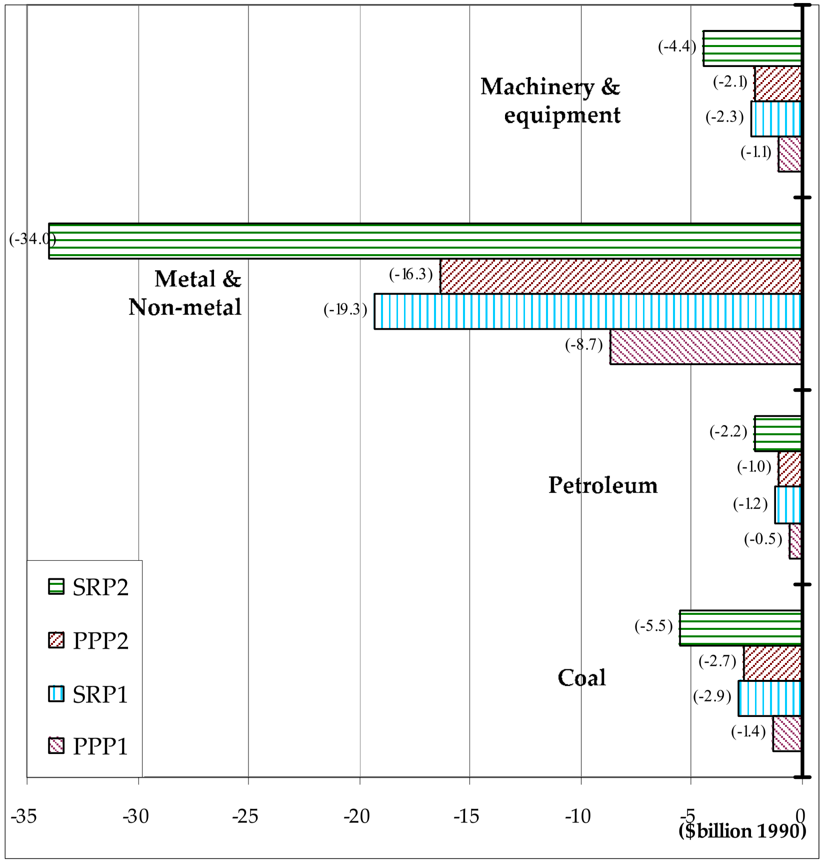
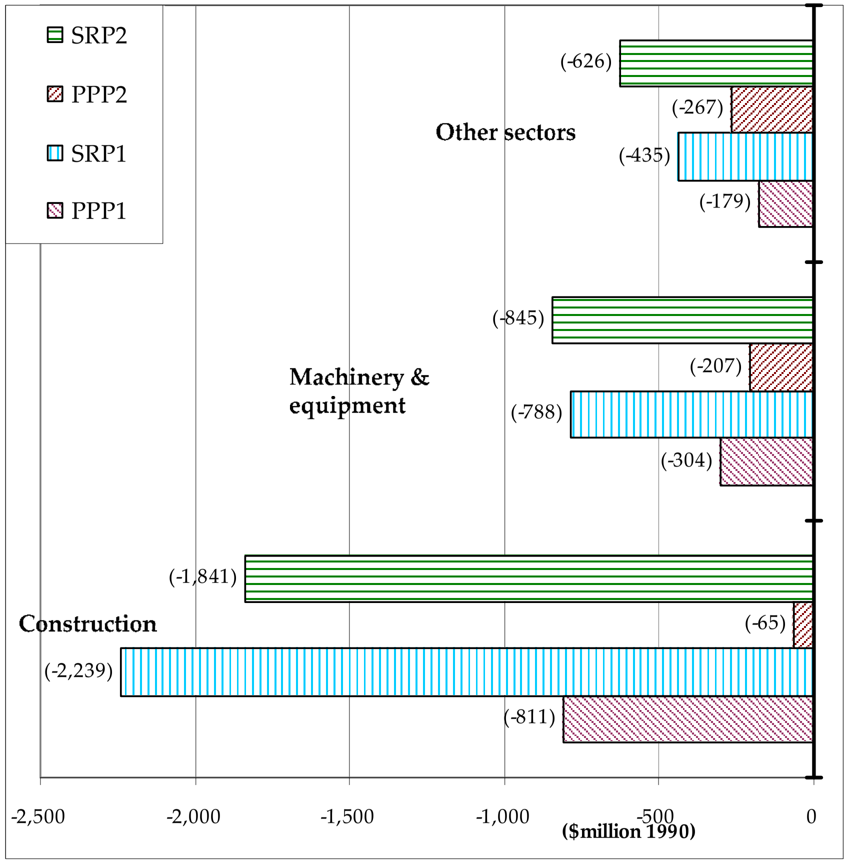


Figure 6-10 Sectoral supply of investment goods



Notes:
- These figures show changes in present values (estimated at 8 per cent discount rate) over the period 2005–2020, corresponding to each carbon tax scenario, as compared with BC scenario
- These figures are developed from information contained in Tables F-1 to F-5, Appendix F, pp. 288-332.

The following observations can be drawn from the above-noted figures (Figures 6-5 to 6-10):

i. Carbon tax would mainly affect the outputs of coal, gas, electricity, and construction sectors. For example, in the case PPP_1, the total output of the coal sector, over the period 2005–2020, would reduce by $14 billion (1990 prices) (Figure 6-5) as compared with the output in the BC scenario. Of this, over $7 billion would be due to the reduced demand for coal by other industries (Figure 6-8), $1.4 billion due to the reduction in exports (Figure 6-9), and $2.1 billion due to the reduction in household consumption (Figure 6-7).

   Although the total output of the gas sector, over the period 2005–2020, would also reduce by $5.2 billion (Figure 6-5), its use by other industries would only reduce by $0.7 billion (Figure 6-8), as compared to the BC scenario. In fact, the demand for gas by other industries would increase after the year 2017 when combined-cycle technology penetrates the market (see Table 6-2). In a single year, in 2020, the demand for gas by other industries would increase by $515 million ($4090 million from PPP_1 less $3575 million from BC scenario, see Table F-5, Appendix F, pp. 324-325). The reduction in the use of domestic coal and increase in the use of gas are due partly to the replacement of conventional coal-fired with natural gas-based combined-cycle electricity generation technology. For example, in the case of PPP_1, the output of electricity produced from coal-fired technology would reduce by $8.3 billion, while the electricity produced from combined-cycle would increase by $2.7 billion, as compared to the BC scenario (Figure 6-5). Also, in the case of PPP_2, while the output of electricity produced from coal-fired technology would reduce by $25 billion, it would be replaced with electricity produced from combined-cycle ($5.1 billion) and renewable technologies ($6.9 billion), respectively, as compared to the BC scenario (Figure 6-5). Because of these shifts in electricity generation technologies, there would be changes in the pattern of demand for investment. For example, over the period 2005–2020, renewable and combined-cycle electricity technologies would require investments of $5.1 and $1.3 billion, respectively, while the demand for investment in coal-fired power generation would reduce by $5.4 billion (Figure 6-6). As renewable power generation technology is the most capital intensive technology amongst the existing electricity technologies (see Table 5-6), its substitution for coal-fired technology would require increased outputs from construction and machinery and equipment sectors. However, such increases would not occur until after 2016, after renewable electricity penetrates into the electricity market. For example, over the period 2005–2020, the present values of outputs from the construction and the machinery and equipment sectors would decrease by about $65 and $207 million, respectively (Figure 6-10). However, in the year 2020 alone, the requirement of outputs from both – construction and machinery-equipment – sectors would increase by $660 and $109 million, respectively ($121142 less $120482 million for construction sector and $53803 less $53694 million for machinery-equipment sector, see Table F-3, Appendix F, pp. 306 and 310).

ii. By a similar reasoning, the introduction of carbon tax based on SRP would also affect the output of various sectors. For example, in the case of SRP_1, the total output of the coal sector, over the period 2005–2020, would reduce by $27 billion (Figure 6-5) as compared with the BC scenario. Of this, almost $14 billion would be due to the reduced demand for coal by other industries (Figure 6-8), $2.9 billion due to the reduction in exports (Figure 6-9), and $2.5 billion due to the reduction in household consumption (Figure 6-7).

Although the total output of the gas sector, over the period 2005–2020, would also reduce by $4.2 billion (Figure 6-5), its use by other industries would in fact increase by $1.1 billion (Figure 6-8), as compared to the BC scenario. The reduction in the use of domestic coal and increase in the use of gas are due to the substitution of electricity produced from conventional coal-fired technology with natural gas-based combined-cycle technology. For example, the output of electricity produced from coal-fired technology would reduce by $23 billion, while the electricity produced from combined-cycle technology would increase by $9.8 billion, as compared to the BC (Figure 6-5). Because of this, there would be changes in the annual investment demand. For example, over the period 2005–2020, combined-cycle electricity generation technologies would require an investment of about \$2.4 billion, while the demand for investment in coal-fired power generation technology would reduce by \$4.5 billion (Figure 6-6). As conventional coal power plant is more capital intensive as compared with natural gas based-power plant (see Table 5-6), this would also result in reductions in the value of outputs from the construction and machinery and equipment sectors. For example, over the period 2005–2020, the present values of outputs from the construction and the machinery and equipment sectors would decrease by \$2.2 and \$0.7 billion, respectively (Figure 6-10).

iii. Irrespective of the method used for applying carbon tax (i.e., PPP or SRP), CO_2 emission intensive sectors would have higher negative impacts than the ones with less emissions intensive inputs. However, the magnitude of these impacts would vary depending on which method is adopted for determining carbon tax. For example, while the output of coal and petroleum sectors, and coal-fired electricity generation sector would decline in both cases, the decline in the case of carbon tax based on SRP is almost twice of the corresponding decline when carbon tax is based on PPP (Figure 6-5).

Further, the output of the gas sector, used by other industries, would increase in both cases. However, the magnitude of this increase would depend on the level of penetration by natural gas based combined-cycle electricity generation. For example, the output of electricity from gas-fired combined-cycle would increase by about \$9.8 billion in the case SRP_1, and by \$2.7 billion in the case PPP_1 (Figure 6-5). This would require the output of gas sector to increase by \$1.1 and \$0.5 billion, for SRP_1 and PPP_1, respectively (Figure 6-8).

The changes in the outputs of construction and machinery and equipment sectors would depend on how carbon tax changes the cost competitiveness of various electricity options and how this induces a shift in electricity generation technologies. If capital intensive technology, such as renewable, becomes competitive, as happen in the case of PPP_2, then the outputs from both construction ($424 million) and machinery and equipment ($15 million) sectors would also increase (Figure 6-10). On the other hand, the increased penetration by less capital intensive technology such as combined-cycle, as in the case of SRP_2, would result in a reduction in outputs from construction and machinery and equipment sectors, by $1.8 and $0.8 billion, respectively (Figure 6-10).

Sectoral Prices and Inflation: The introduction of carbon tax would result in an increase in sectoral prices. Such increase would depend on the carbon-intensiveness of energy and materials that flow in the economy. Also, the weighted average of these sectoral prices can be used as an indicator of inflation in the economy (Valadkhani & Mitchell 2002). This section discusses the impact of carbon tax on the prices of sectoral outputs and, more generally, inflation. The percentage increases in prices for the outputs of various sectors over the period 2005–2020 are presented in Table 6-6. The increase in general inflation over this period is shown in Figure 6-11.

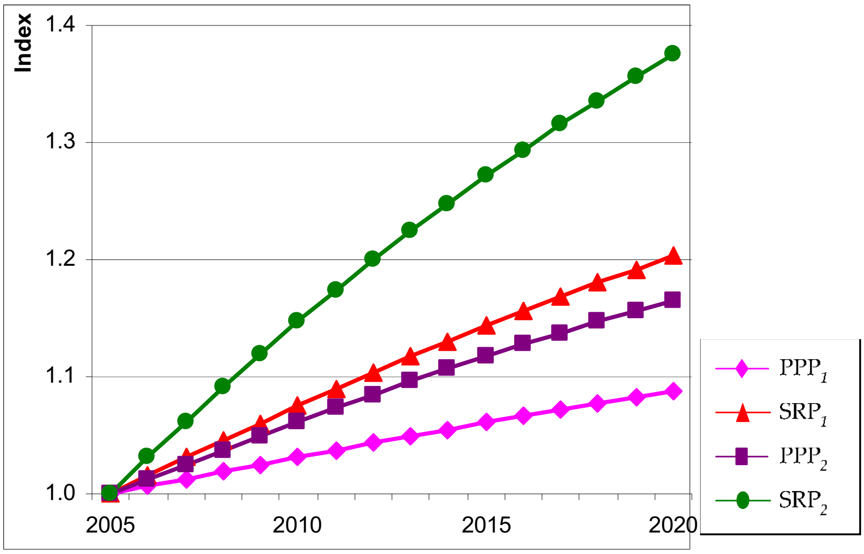
Table 6-6 Increase in sectoral prices: 2005–2020

(Per cent)

	PPP_1	SRP_1	PPP_2	SRP_2
Coal sector	12.1	23.9	23.5	45.1
Petroleum sector	21.9	44.3	43.1	85.1
Gas sector	8.0	21.7	15.6	41.0
Electricity sector	184.6	254.7	336.9	450.9
Agriculture, forestry and fishing	6.3	18.1	12.2	34.2
Mining	10.6	27.2	20.2	50.6
Food, beverages and tobacco	7.6	23.9	14.4	44.7
Textile, clothing, footwear and leather	3.9	12.3	7.4	22.9
Wood, paper and printing products	6.0	18.0	11.4	33.7
Basic chemicals	9.1	19.3	17.7	36.7
Non-metallic mineral products	16.7	36.7	32.3	69.3
Basic iron and steel	34.1	65.6	66.6	125.1
Basic non-ferrous metals	37.6	75.4	73.1	142.3
Fabricated metal products	11.2	34.5	21.6	65.3
Machinery and equipment	4.0	12.9	7.7	24.2
Miscellenous manufacturing	2.0	7.0	3.9	13.1
Water, sewerage and drainage	7.6	22.7	14.1	41.6
Construction	5.4	18.1	10.4	34.3
Road transport	21.1	31.7	41.8	61.7
Railway transport	11.3	28.5	21.6	52.9
Water transport	25.0	44.8	49.6	87.4
Air transport	17.6	26.6	35.1	51.9
Other transport, services and storage	5.5	17.5	10.3	32.0
Commercial services	3.4	12.5	6.3	23.2

Notes:
- This table presents the results obtained from the application of equations 5-14 and 5-15, as detailed in Chapter 5, Section 5.4, p. 106. For detailed results, see Table F-6, Appendix F, p.333.
- The values in this table refer to the percentage changes in sectoral prices, over the period 2005–2020. For example, electricity price for PPP_1 in 2020 is 184.6 per cent higher than the price in 2005.

Figure 6-11 Increases in inflation rates



Notes: - This figure presents the results obtained from the application of equations 5-14 and 5-15, as detailed in Chapter 5, Section 5.4, p. 106. For detailed results, see Table F-6, Appendix F, p.334.

- The index values in this figure can be interpreted as a percentage changes in inflation from the base year, 2005. For example, the index value of 1.203 in the case of SRP_1 in 2020, is read as an increase of 20.3 per cent from the year 2005.

The results suggest that:

i. In general, carbon tax based on PPP would have a lesser impact on sectoral prices and inflation rate than that based on SRP. For example, when carbon tax of $10 per tonne is applied, it would cause inflation to increase, over the period 2005–2020, by 8.8 and 20.3 per cent, for PPP_1 and SRP_1, respectively (Figure 6-11). The corresponding figures for PPP_2 and SRP_2 are 16.5 and 37.5 per cent, respectively.

ii. The increases in the prices of energy, manufacturing (particularly chemicals, metal, and non-metal industry), and transport sectors are significantly higher in the case of SRP as compared with PPP. For example, electricity price would increase by 185 per cent in the case of PPP_1 and 255 per cent in the case of SRP_1 (Table 6-6). Also, prices for road transport, based on PPP_1, would increase by 21 per cent, compared to 32 per cent for SRP_1. A similar impact occurs in the iron and steel industry, where prices would increase by 34 per cent for PPP_1 and 66 per cent for SRP_1. This is due to the direct use of fossil energy as inputs for sectoral activities (such as coal for electricity production and steel making processes, and petroleum used in road transport). The price increases in these sectors also reflect their contribution to CO_2 emissions when applying the Polluter Pays Principle (see Table 3-3).

iii. When carbon tax is imposed based on SRP, the commercial, food and textile industry, agriculture, mining, and water sectors become more susceptible to price increases. Further, the increase in prices of these sectors is much higher than the increases that would take place when carbon tax is based on PPP. For example, prices of the commercial sector output would increase by 3 and 6 per cent for PPP_1 and PPP_2, respectively; the corresponding increases for SRP_1 and SRP_2 are 12.5 and 23 per cent, respectively (Table 6-6). Also, food prices, based on PPP_1, would increase by 8 per cent, compared to an increase of 24 per cent for SRP_1. A similar magnitude is also observed for the water sector, where water prices increase by 8 per cent for PPP_1 and 23 per cent for SRP_1. This is because these sectors consume lesser amounts of direct fossil energy as inputs and more of indirect energy embodied in materials for undertaking their sectoral activities. The price increases from these sectors also reflect their contribution to CO_2 emissions when applying the Shared Responsibility Principle (see Table 3-3).

Carbon Tax Revenue: The introduction of carbon tax is likely to generate significant revenue for the government. This (fiscal) revenue can be estimated by multiplying the ad-valorem tax rate faced by each industry (equations 5-11 and 5-12) with its sectoral output (equation 5-32). The estimates of this fiscal revenue, over the period 2005–2020, expressed in terms of present values (in 1990 prices), are shown in Table 6-7.

Table 6-7 Fiscal revenue from carbon tax: 2005–2020

	PPP_1	SRP_1	PPP_2	SRP_2	PPP_1	SRP_1	PPP_2	SRP_2
	($Million 1990 prices)				(percentage contribution)			
1. Coal	900	1,671	1,671	2,856	3.2	2.3	3.1	2.1
2. Petroleum	644	1,312	1,215	2,358	2.3	1.8	2.3	1.7
3. Gas	56	172	103	306	0.2	0.2	0.2	0.2
4. Renewable Electricity	0	523	0	1,147	0.0	0.7	0.0	0.9
5. Coal-fired Electricity	15,241	19,699	27,375	33,715	53.8	26.7	51.3	25.0
6. Internal-combustion Electricity	45	53	87	98	0.2	0.1	0.2	0.1
7. Gas-turbine Electricity	302	326	586	608	1.1	0.4	1.1	0.5
8. Combined-cycle Electricity	640	1,275	1,550	2,603	2.3	1.7	2.9	1.9
9. Agriculture, forestry and fishing	422	1,630	830	3,045	1.5	2.2	1.6	2.3
10. Mining	417	1,778	819	3,282	1.5	2.4	1.5	2.4
11. Food, beverages and tobacco	279	2,773	549	5,109	1.0	3.8	1.0	3.8
12. Textile, clothing, footwear and leather	45	443	88	812	0.2	0.6	0.2	0.6
13. Wood, paper and printing products	187	1,526	368	2,834	0.7	2.1	0.7	2.1
14. Basic chemicals	1,029	2,222	2,026	4,175	3.6	3.0	3.8	3.1
15. Non-metallic mineral products	497	1,294	979	2,438	1.8	1.8	1.8	1.8
16. Basic iron and steel	1,381	2,724	2,720	5,158	4.9	3.7	5.1	3.8
17. Basic non-ferrous metals	1,419	3,005	2,792	5,647	5.0	4.1	5.2	4.2
18. Fabricated metal products	38	1,365	75	2,558	0.1	1.8	0.1	1.9
19. Machinery and equipment	56	2,568	110	4,761	0.2	3.5	0.2	3.5
20. Miscellenous manufacturing	2	57	3	105	0.0	0.1	0.0	0.1
21. Water, sewerage and drainage	7	333	14	601	0.0	0.5	0.0	0.4
22. Construction	334	3,204	660	6,014	1.2	4.3	1.2	4.5
23. Road transport	1,985	2,533	3,911	4,841	7.0	3.4	7.3	3.6
24. Railway transport	169	585	329	1,067	0.6	0.8	0.6	0.8
25. Water transport	382	599	750	1,139	1.3	0.8	1.4	0.8
26. Air transport	1,414	1,841	2,790	3,532	5.0	2.5	5.2	2.6
27. Other transport, services and storage	78	2,236	153	4,076	0.3	3.0	0.3	3.0
28. Commercial services	388	16,089	769	29,971	1.4	21.8	1.4	22.2
Total fiscal revenue from carbon tax	**28,356**	**73,834**	**53,320**	**134,857**	**100.0**	**100.0**	**100.0**	**100.0**

Notes: - This table summarises the present values of carbon tax revenue that is likely to be collected during the period 2005–2020, using a discount rate of 8 per cent. For detailed results, see Table F-7, Appendix F, pp. 335-338.

The table shows that:

i. A PPP-based carbon tax of \$10 and \$20 per tonne of CO_2 would yield revenues for the government of \$28.4 and \$53.3 billion, respectively, over the period 2005–2020. Out of this, approximately 54 per cent would be collected from the electricity industry alone, particularly from coal-fired generators. Renewable electricity generators would understandably not yield any revenue for the government as they do not use coal. The commercial sector would contribute just over 1 per cent (\$388 and \$769 million for PPP_1 and PPP_2, respectively) to the total tax revenue. In general, based on PPP, the contribution by various sectors to carbon tax revenue is in proportion to their contribution to CO_2.

ii. When carbon tax is based on SRP, carbon tax revenues of $73.8 and $134.9 billion are expected to be generated over the period 2005–2020, at tax rates of $10 and $20 per tonne of CO_2, respectively. Here, the electricity industry would be responsible for approximately 25 per cent of the total tax revenue. Although coal-fired generators would still be responsible for most of the revenue paid by the electricity industry ($19.7 and $33.7 billion for SRP_1 and SRP_2, respectively), renewable electricity generators would also have to pay tax on account of their use of materials whose manufacture produces CO_2 emissions. These revenues would be approximately $523 and $1147 million for SRP_1 and SRP_2, respectively. The commercial sector, which is a large consumer of electricity, due to its large value added, would contribute over 20 per cent to the total tax revenue.

iii. When a higher level of carbon tax is applied, the contribution to total tax revenue from the electricity industry would reduce. For example, when a carbon tax rate is increased from $10 to $20 per tonne of CO_2, the contribution to tax revenue from coal-fired electricity would reduce from 54 to 51 per cent in the case of PPP, and 27 to 25 per cent in the case of SRP. This is because a higher level of tax would cause a higher reduction in output from coal-fired technology, which inturn leads to a higher reduction in CO_2 emissions. As a result, the share of revenue that would be collected from coal-fired technology would also reduce.

The above analysis shows that the revenues from carbon tax are substantial and they could be used by the government for either subsidising or financing various sustainable development projects. However, the analysis of the use of carbon tax revenue and its associated impacts is not in the scope of this research.[51]

[51] For an analysis of the use of tax revenue, see, for example, Whalley and Wigle (1991) Cornwell and Creedy (1997).

<u>Net Impact of Carbon Tax</u>: The net impact of carbon tax on the overall economy is shown in Table 6-8.

Table 6-8 Net economic impacts of carbon tax: 2005–2020

	PPP_1	SRP_1	PPP_2	SRP_2	PPP_1	SRP_1	PPP_2	SRP_2
	($Billion 1990)				(Per cent)			
Loss of GDP†	-55.6	-120.4	-102.2	-218.7	-0.88	-1.90	-1.65	-3.51
Carbon tax revenue	28.4	73.8	53.3	134.9				
Net Economic Impacts‡	-27.2	-46.6	-48.9	-83.9	-0.43	-0.74	-0.78	-1.34

Notes: This table summarises results presented in Tables 6-5 (GDP) and 6-7 (carbon tax revenue).
† GDP loss, as compared with the BC outcome.
‡ Net economic impacts refer to net of carbon tax revenue and GDP loss.

The table shows that:

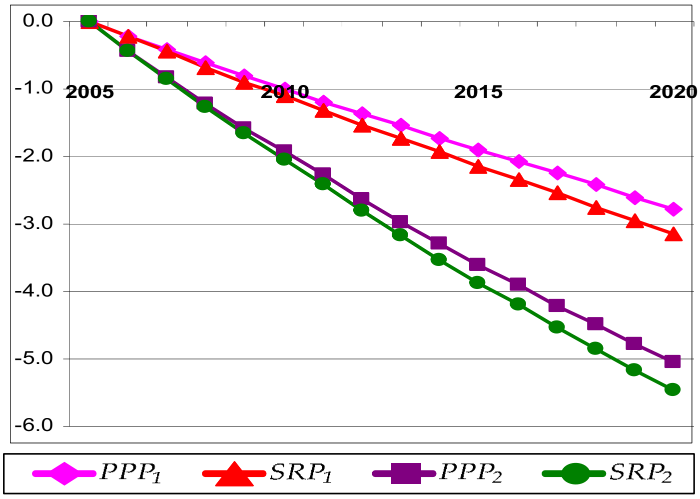
i. The overall economic impact of carbon tax would be significantly lower when gains from tax revenue are also considered. For example, in the case of PPP_1, while the economy would lose total of $55.6 billion of GDP, it would also gains $28.4 billion of tax revenue over the period 2005–2020. The net loss to the economy would therefore be only $27.2 billion, which is approximately 0.43 per cent of the GDP in the base year. The corresponding values of net losses to the economy for PPP_2, SRP_1, and SRP_2 are 0.78, 0.74, and 1.34 per cent, respectively.

ii. Further, it is noticed that while the net impact on the economy is higher in the case of SRP as compared with the PPP (0.78 and 0.43 per cent, respectively, for tax of $10 per tonne), overall the impact of SRP-based carbon tax is still low for an economy of Australia's size and strength.

6.3.2.2 *Social Impacts*

As mentioned in Section 5.6, social impacts are analysed in this research in terms of the level of employment. The underlying logic is as follows: the application of carbon tax would cause changes in the level and composition of sectoral outputs, which would inturn influence the employment required to produce those outputs. The results obtained, by using the methodology explained in Chapter 5 (Section 5.6), are presented in Figure 6-12 and Figure 6-13.

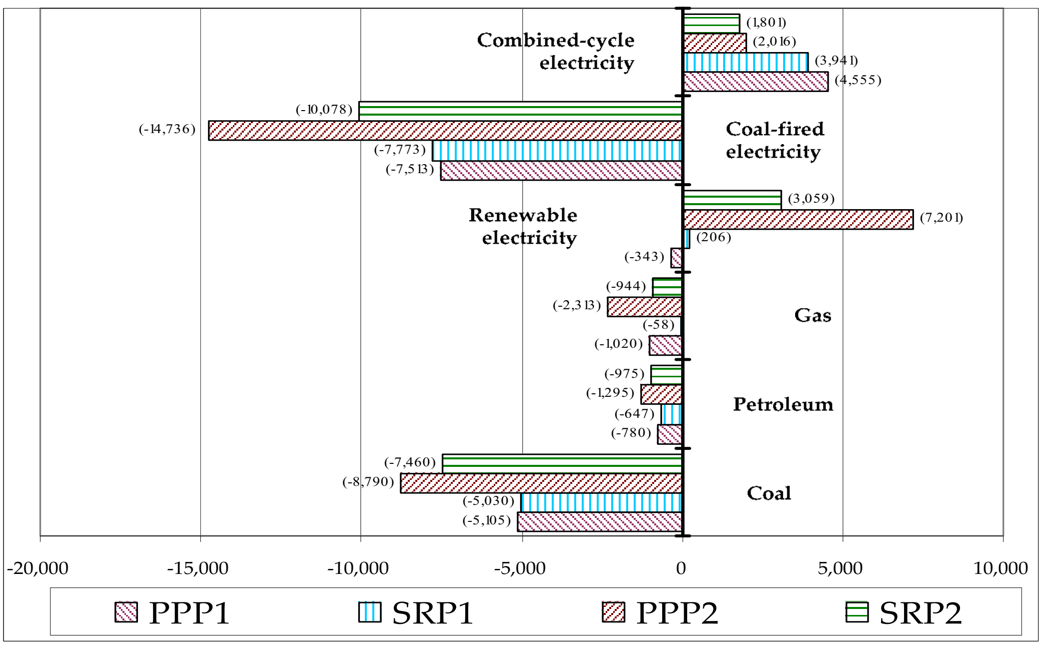
Figure 6-12 Percentage changes in total employment



Notes: - This figure shows percentage changes in the level of employment, over the period 2005–2020, for each carbon tax case, as compared with the BC scenario. It presents results obtained from the application of equation 5-37, as detailed in Chapter 5, Section 5.6. For detail results, see Table F-12, Appendix F, p. 353.

Figure 6-13 Changes in sectoral employment

(persons)



Notes: - This figure shows changes in the level of employment (in persons), over the period 2005–2020, for each carbon tax case, compared with the BC. It presents results obtained from the application of equation 5-37, as detailed in Chapter 5, Section 5.6. For detail results, see Table F-12, Appendix F, p. 354.

These figures show that:

i. The introduction of carbon tax has a marked impact on employment levels (Figure 6-4a). For example, in the BC scenario (that is, no carbon tax), the level of employment in the year 2020 would be 9,444,354 persons (an increase of 12 per cent from 2005) (Table F-12, Appendix F, p. 353). The introduction of carbon tax would however reduce the employment levels in the range of 2.8 to 5.5 per cent (Figure 6-12).

ii. A carbon tax based on PPP would have less impact on the level of employment as compared to the case of SRP. For example, at carbon tax of $10 per tonne, the employment levels would reduce by 2.8 and 3.2 per cent in the case of PPP and SRP, respectively. This is equivalent to about 34,000 jobs. At a carbon tax of $20 per tonne, job losses would be 5.1 and 5.5 per cent for the PPP and SRP, respectively. This is also equivalent to 35,000 jobs. The impact on the level of employment is lower in the case of PPP because of the higher penetration of cleaner electricity technologies, such as combined-cycle and renewable electricity (Figure 6-13).

iii. When a carbon tax is introduced, employment would shift from the coal sector to the gas sector. For example, the employment in the coal sector would decline in the range of 4,500 to 8,800 persons (Figure 6-13). Some of the labour from the coal sector (50-2,000 persons) would shift to the gas sector. However, most of the labour from the coal sector would be reduced in response to a reduction in coal consumption and exports (see Figure 6-7 and Figure 6-9).

iv. There would be a shift of employment within the electricity sector (that is, from conventional coal-fired to combined-cycle and renewable). For example, due to a large increase in combined-cycle power plants in SRP_1, approximately 4,000 persons from coal-fired sector would be shifted to the combined-cycle sector. Likewise, a large increase in the share of renewable energy in electricity production, in the cases PPP_2 and SRP_2, would cause a shift of 7,000 and 3,000 persons, respectively, from conventional coal to renewable power plants.

6.4 Carbon Tax to Achieve An *A-priori* Emission Target

In the previous section, the energy, environmental, economic, and social impacts of carbon tax, based on PPP and SRP, were analysed. In that analysis, no *a-priori* limit was placed on the level of CO_2 emissions. In this section, an *a-priori* limit is placed on CO_2 emissions. This limit is broadly equivalent to Kyoto target, namely, 108 per cent increase in CO_2 emissions from the electricity sector as compared with 1990 levels, by the year 2020.[52] This emissions target is set only for the electricity sector because, in this research, only electricity sector is assumed to adapt (through changes in mix of technologies and fuels) in response to carbon tax. It was noted in the previous section that CO_2 emissions from the electricity sector were 128 Mt in 1990. To achieve the specified target, the emissions would be allowed to increase to 138 Mt by 2020. This amount is equivalent to a reduction of 45 per cent of CO_2 emissions as compared with the BC scenario (in the BC, total emissions from the electricity sector are expected to be 250 Mt).

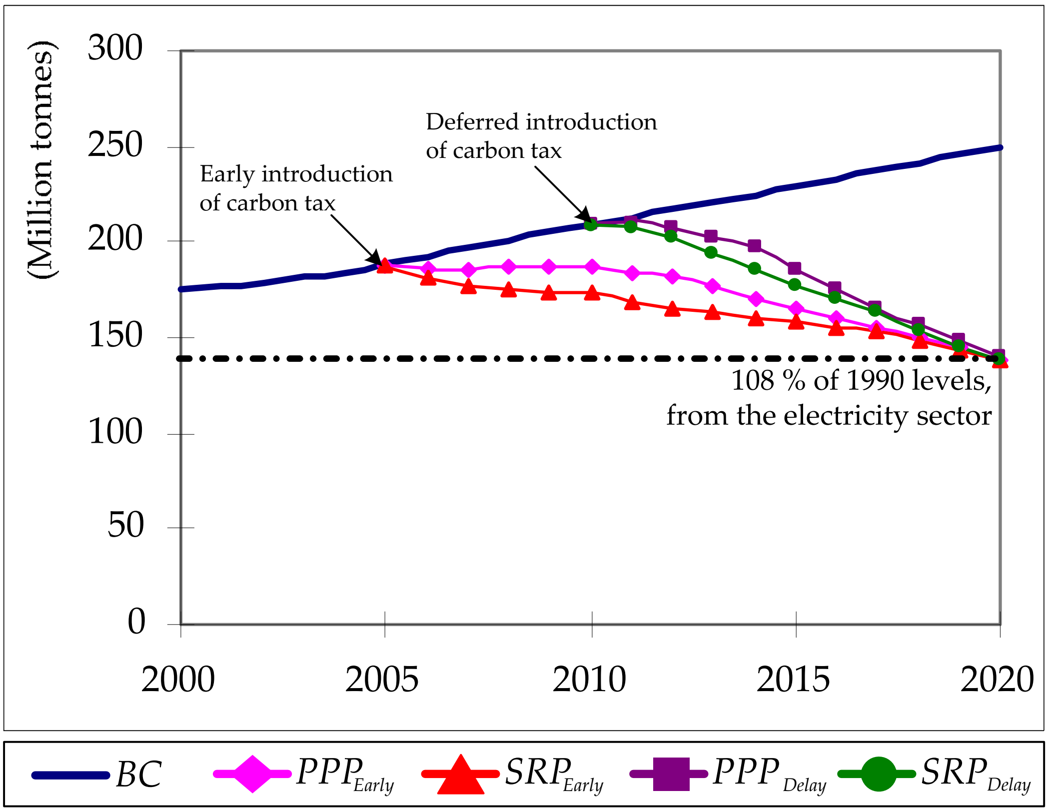
Analysis is then carried out, in this research, to determine the level of carbon tax that would be required in order to meet this target, and the consequential economic and social impacts. The methodology underpinning this assessment was explained in Section 5.6, Chapter 5. Two sets of analyses are carried out in this research. In the first set (Section 6.4.1), the level of carbon tax and associated impacts are determined in a situation where an early introduction of carbon tax is envisaged (in the year 2005)[53]. In the second set of analysis (Section 6.4.2), the introduction of carbon tax is deferred to the year 2010, in recognition of the political difficulty of introducing a carbon tax in the near future (that is, in the year 2005). As an illustration, emissions pathways of achieving an *a-priori* limit from these two sets, for both types of carbon tax (that is, PPP and SRP), is shown in Figure 6-14.

---

[52] In fact, the Kyoto target requires the level of emissions to be achieved by 2008-12. This target is assumed to be extended to 2020 in this research, in order to allow a longer time-frame for the analysis.

[53] The selection of this year is in accord with the stage-wise progress of this doctoral dissertation.

Figure 6-14 Emissions pathway of achieving *a-priori* CO_2 limit



The results of analyses in this Section are presented in Table 6-9 and Figure 6-15.

Table 6-9 Impacts of carbon tax to achieve an *a-priori* emission target

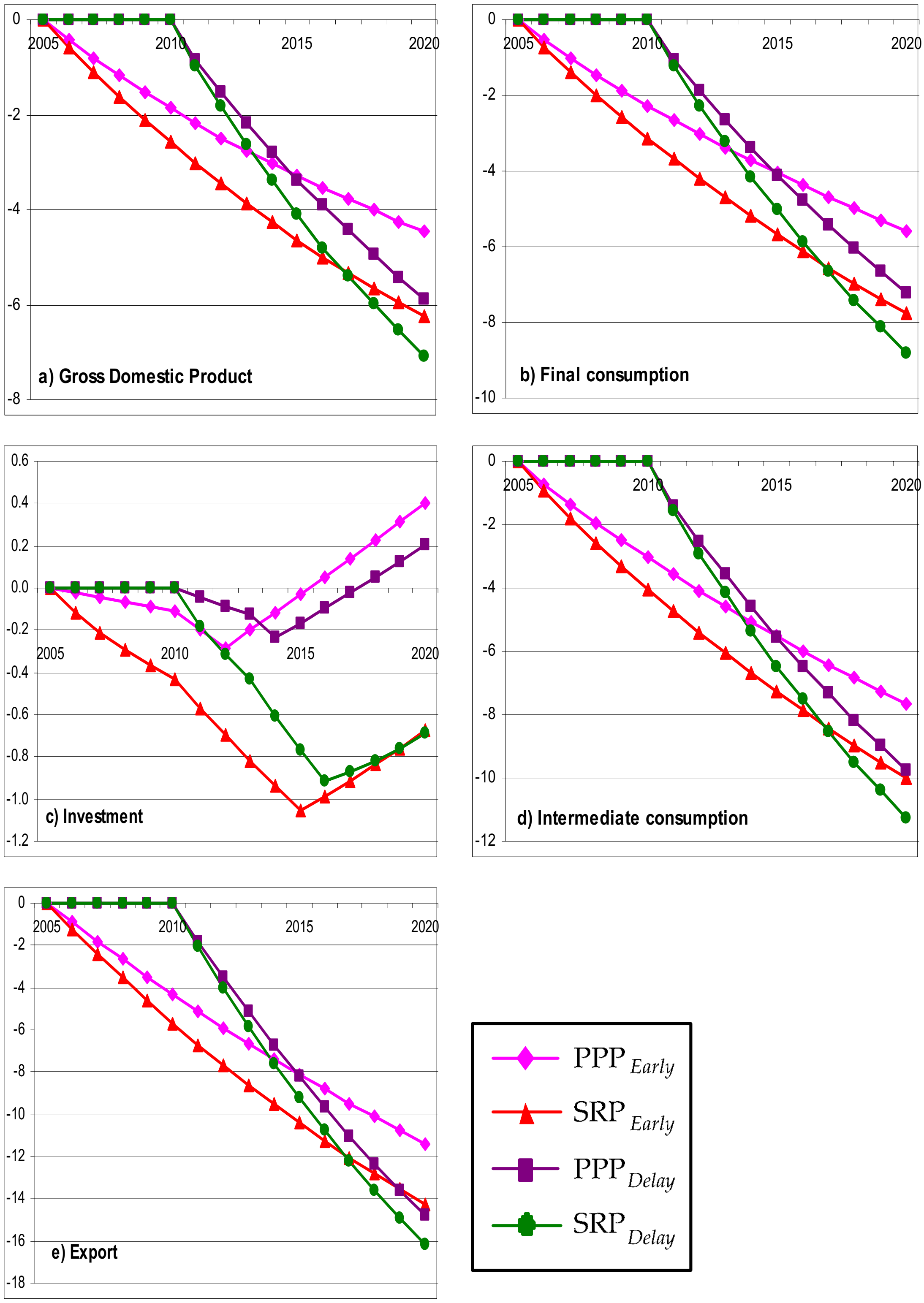
	BC	Early action				Deferred action			
		PPP		SRP		PPP		SRP	
Tax rate ($/tonne)	0	25		15		51		26	
CO_2 emissions[† $] (Mtonnes)									
Electricity sector	250	138	*(8)*	138	*(8)*	139	*(8)*	138	*(8)*
Economy	432	300	*(28)*	294	*(25)*	296	*(26)*	291	*(24)*
Electricity technology mix[† ξ] (per cent)									
Coal-fired	84.2	58.2	*(2005)*	58.2	*(2005)*	66.0	*(2005)*	66.0	*(2005)*
Combined-cycle	3.6	8.8	*(2011)*	16.6	*(2011)*	6.2	*(2014)*	11.4	*(2014)*
Renewable	10.2	31.0	*(2013)*	23.2	*(2016)*	25.8	*(2015)*	20.6	*(2017)*
Cost of electricity[† #] (¢/kWh)	5	24	*(380)*	21	*(320)*	31	*(520)*	24	*(380)*
Share of primary energy for electricity production[† #]									
Black coal	45.9	30.7	*(-15)*	29.0	*(-17)*	35.5	*(-10)*	34.0	*(-12)*
Brown coal	28.6	19.1	*(-10)*	18.1	*(-11)*	22.1	*(-7)*	21.2	*(-7)*
Oil	0.9	0.7	*(-0.2)*	0.7	*(-0.2)*	0.8	*(-0.1)*	0.7	*(-0.1)*
Gas	14.4	18.5	*(4)*	29.0	*(15)*	15.9	*(2)*	23.5	*(9)*
Renewable	10.2	31.0	*(21)*	23.2	*(13)*	25.8	*(16)*	20.6	*(10)*
Economic Impact ($Bn 1990)									
GDP[‡ #]	6,325	6,200	*(-2.0)*	6,155	*(-2.7)*	6,225	*(-1.6)*	6,207	*(-1.9)*
Carbon tax Revenue[‡]	0	65		135		73		102	
Electricity sector[‡ §]	0	36	*(55)*	25	*(19)*	40	*(54)*	29	*(29)*
Commercial sector[‡ §]	0	1	*(1)*	48	*(35)*	1	*(2)*	23	*(22)*
Net economic growth[‡ #]	6,325	6,266	*(-0.9)*	6,290	*(-0.5)*	6,298	*(-0.4)*	6,308	*(-0.3)*
Net economic cost		***-60***		***-35***		***-27***		***-17***	
Sectoral output[‡ #] ($Bn)									
Electricity	58	55	*(-5.7)*	54	*(-7.9)*	55	*(-4.6)*	55	*(-5.6)*
Steam turbine	49	43	*(-12.3)*	42	*(-14.2)*	46	*(-7.7)*	45	*(-8.5)*
Renewables	6	7	*(30.5)*	6	*(5.2)*	6	*(14.8)*	6	*(2.7)*
Combined cycle	2	3	*(52.4)*	4	*(104.1)*	2	*(14.6)*	3	*(40.8)*
Coal	85	71	*(-17.0)*	66	*(-22.1)*	74	*(-13.1)*	72	*(-15.2)*
Other energy (oil and gas)	35	22	*(-37.4)*	22	*(-36.2)*	26	*(-26.4)*	27	*(-23.8)*
Water	32	31	*(-3.6)*	30	*(-6.5)*	31	*(-2.9)*	31	*(-4.6)*
Agriculture	121	117	*(-3.4)*	115	*(-5.1)*	118	*(-2.8)*	117	*(-3.6)*
Mining	114	111	*(-3.2)*	110	*(-4.0)*	111	*(-2.6)*	111	*(-2.9)*
Manufacturing	1,152	1,128	*(-2.1)*	1,112	*(-3.4)*	1,132	*(-1.7)*	1,124	*(-2.4)*
Construction	970	970	*(-0.1)*	966	*(-0.4)*	970	*(-0.1)*	968	*(-0.2)*
Transport	332	322	*(-3.2)*	314	*(-5.3)*	324	*(-2.6)*	320	*(-3.7)*
Services	3,424	3,375	*(-1.4)*	3,365	*(-1.7)*	3,383	*(-1.2)*	3,382	*(-1.2)*
Inflation (Index)[Ŧ]	1.00	1.21		1.30		1.29		1.36	
Employment[† #]									
Electricity (persons)	47,399	40,629	*(-14.3)*	41,533	*(-12.4)*	39,494	*(-16.7)*	41,563	*(-12.3)*
Coal-fired	40,713	22,443	*(-44.9)*	23,225	*(-43.0)*	25,045	*(-38.5)*	26,578	*(-34.7)*
Renewable	4,925	14,615	*(196.7)*	11,283	*(129.1)*	11,969	*(143.0)*	10,110	*(105.3)*
Combined-cycle	1,760	3,571	*(102.8)*	7,026	*(299.1)*	2,480	*(40.9)*	4,875	*(176.9)*
Total ('000 persons)	9,444	8,890	*(-6)*	9,135	*(-3)*	8,719	*(-8)*	9,090	*(-4)*

Notes: Information contained in this table is assembled from various Tables in Appendix F

- † Result for the year 2020
- Ŧ Result over the period 2005–2020
- ‡ Present value, for the period 2005–2020, using a discount rate of 8 per cent
- $ Numbers in brackets show percentage increase from the 1990 level
- \# Numbers in brackets show percentage changes from the BC
- ξ Numbers in brackets represent year in which the particular technology becomes cost efficient
- § Numbers in brackets show contributions of the sector to the total
- ¥ see further discussion on economic impacts in Section 6.5.

Figure 6-15 Economic impacts of achieving emissions target from electricity sector

(Annual, per cent)



Notes: - These figures show annual percentage changes as compared with the BC;
- For detailed results, see Table F-1 to F-5, Appendix F, pp. 288-332.

6.4.1 Early Introduction of Carbon Tax

For the case of **early action**, the results from Table 6-9 and Figure 6-15 suggest that:

i. A carbon tax of $25, based on PPP, would be required in order to limit CO_2 emissions from the electricity sector to 138 Mt by 2020 (*a-priori* limit set in this research). In this case, total nationwide CO_2 emissions from fossil fuel combustion would increase by 28 per cent (300 Mt) of 1990 level (234 Mt). On the other hand, based on SRP, a carbon tax of $15 per tonne of CO_2 would be required to achieve *a-priori* CO_2 emissions (that is, 138 Mt from the electricity sector). In this case, economy wide emissions in the 2020 would be 294 Mt – 25 per cent of 1990 levels. These reductions in CO_2 emissions look rather favourable when compared with the increase (of 84 per cent) that would happen if no carbon tax is introduced.

ii. In the case of carbon tax based on PPP, combined-cycle and renewable electricity would become competitive by the years 2011 and 2013, respectively. By 2020, the share of electricity produced from coal-fired technology would be reduced by 26 per cent (from 84 per cent in 2005, to 58 per cent in 2020). The reduction in coal-fired electricity would be replaced by renewable (21 per cent) and natural-gas-fired combined-cycle (5 per cent) electricity. Consequently, the cost of electricity supply would increase by almost four-times as compared to the BC value (5 ¢/kWh), reaching 24 ¢/kWh in 2020. These changes in technology-mix would influence changes in demand for primary energy used for electricity production. The demand for brown coal and black coal would reduce by 10 and 15 per cent, respectively. The demand for renewable energy and natural gas resources would however increase by 21 and 4 per cent, respectively. Further, this tax (i.e., $25 per tonne) would cause the present value of GDP, over the period 2005–2020, to decrease by 2 per cent ($125 billion), as compared to the BC scenario (also see Figure 6-15). Most of a reduction in GDP ($120 billion) would come from final consumption. The changing mix of electricity generation technologies would result in a small reduction ($400 million) in demand for investment, over the period 2005–2020. In fact, the demand for investment would increase following the penetration of renewable electricity in the electricity market in 2013 (also see Figure 6-15). Also, this tax (that is, \$25 per tonne of CO_2) would cause employment level in 2020 to be 6 per cent below the employment level in BC (that is, no carbon tax). Further, this tax would generate \$65 billion of fiscal revenue for the government, of which 55 per cent (\$36 billion) would be collected from the electricity sector alone. This also suggests that the net overall impact of a carbon tax of \$25 per tonne, based on PPP, would be approximately \$60 billion (\$125 billion loss in GDP and \$65 gain in fiscal revenue).

iii. For a carbon tax based on the SRP (\$15 per tonne, as noted above), the responsibility for CO_2 emissions is fairly distributed across all (goods and services) sectors of the economy. In this case, the analysis shows, the combined-cycle and renewable electricity would become competitive by the years 2011 and 2016, respectively. By 2020, the share of electricity produced from coal would be reduced by 26 per cent (from 84 per cent in 2005, to 58 per cent in 2020). Such reduction in coal-fired electricity is exactly the same as for PPP because, in both cases (that is PPP and SRP), this technology would start to phase-out from the electricity market at the same time in 2011 when combined-cycle technology becomes cost competitive. However, unlike PPP, the reduction in coal-fired technology, in the case of SRP, would be equally replaced by combined-cycle and renewable (both 13 per cent) technology. Because of the large increase in electricity produced from combined-cycle (in this case as compared to the PPP), the demand for natural gas would also increase, providing 29 per cent of total primary energy requirements in the electricity sector in 2020. Consequently, the cost of electricity supply would increase by approximately just above three-times as compared to the BC scenario, reaching 21 ¢/kWh in 2020. Further, this tax (that is, \$15 per tonne) would cause GDP, over the period 2005–2020, to decrease by 2.7 per cent (\$170 billion), as compared to the BC (also see Figure 6-15). The impact on GDP in the case of SRP is higher than that in the case of PPP because a carbon tax based on PPP would affect economic sectors based on their direct fuel consumption only;

whereas, for SRP, it would be based on direct as well as indirect fuel consumption. Most of a reduction in GDP would come from a reduction in final consumption ($167 billion). The changing mix of electricity generation technologies would result in a small reduction ($3.7 billion) in demand for investment. However, as shown in Figure 6-15c, the trend in demand for investment would increase after 2015, as capital intensive renewable electricity generation penetrates the electricity market. Also, this tax would reduce the employment in 2020 by 3 per cent of the BC level. A total tax revenue of $135 billion would be collected by the government, out of which 35 per cent ($48 billion) would be collected from the commercial sector. The net cost of this policy would therefore be $35 billion ($170 billion loss of GDP minus $135 billion gains in tax revenue).

iv. A comparison of a carbon tax based on PPP and SRP suggests that, in order to meet an *a-priori* CO_2 emissions target for the electricity sector, a carbon tax based on SRP is preferable than the one based on PPP. It would need a lower level of carbon tax to be introduced (that is, $15 per tonne as compared with $25 per tonne for PPP). Although a carbon tax based on SRP would cause high inflation[54] (1.9 per cent per year), as compared to the PPP (1.3 per cent per year), the cost of electricity in the case of SRP would be lower (21 ¢/kWh), compared with PPP (24 ¢/kWh). The net economic impacts of carbon tax based on SRP would be $25 billion lower than those based on PPP ($60 billion for PPP minus $35 billion losses for SRP). A carbon tax based on SRP would also have a milder impact in terms of job losses; 3 per cent jobs will be lost in SRP as compared with 6 per cent in the case of PPP, over the period 2005–2020.

[54] The inflation is the weighted-mean of price increases from all sectors over the period 2005–2020, as calculated from Equation 5-15.

6.4.2 Deferred Introduction of Carbon Tax

When the implementation of carbon tax is deferred to the year 2010, the cost of meeting emissions target would be considerably higher as compared with the case when carbon tax is introduced early (in 2005) as discussed above. The impact of **delaying the implementation of carbon tax** is also shown in Table 6-9 and Figure 6-15. The main results are discussed below:

i. The tax rates required for achieving the target (i.e., 138 Mt of CO_2 emissions from the electricity sector in 2020) would be much higher – $51 and $26 per tonne of CO_2 in the case of PPP and SRP, respectively (the corresponding values in the case of early introduction of carbon tax were $25 and $15, respectively).

ii. For a carbon tax based on PPP, renewable electricity generation would become competitive by the year 2015, whereas combined-cycle would penetrate the electricity market only in 2014. This is because the marginal cost of electricity production from combined-cycle (4.1-6.7 ¢/kWh) is only slightly higher than conventional coal technology (3.5-4.0 ¢/kWh). Applying carbon tax directly on fuel consumption would increase the cost of electricity from conventional coal-fired plants at a slightly higher rate than from combined-cycle plants. Therefore, the threshold between these technologies is smaller than when compared with renewable technologies (7.3-54.9 ¢/kWh). Therefore, by 2020, the share of electricity produced from coal would be reduced by 18 per cent (from 84 per cent in 2005, to 66 per cent in 2020). The reduction in the share of coal-fired electricity would be almost made up by the increased share of renewable electricity (16 per cent). Accordingly, it would increase the cost of electricity supply by more than five-times as compared to the BC scenario, reaching 31 ¢/kWh in 2020. Further, this tax (i.e., $51 per tonne) would cause GDP, over the period 2005–2020, to decrease by 1.6 per cent ($100 billion), as compared to the BC. Most of a reduction in GDP would come from a reduction in final consumption ($96 billion). The changing mix of electricity generation technologies would result in a negligible reduction ($415 million) in demand for investment. Also, this tax would cause employment in 2020 to be 8 per cent below the employment in BC (that is, no carbon tax). The total revenue for the government would be $73 billion, out of which 54 per cent ($40 billion) would be collected from the electricity sector alone. This also suggests that the net overall impact of a carbon tax of $51 per tonne, based on PPP, would be approximately $27 billion ($100 billion loss in GDP and $73 gain in fiscal revenue).

iii. On the other hand, based on SRP, a carbon tax of $25 per tonne would be required to achieve the same environmental goal (i.e., 138 Mt of CO_2 emissions from the electricity sector in 2020). This tax level is lower than the previous case (that is, based on PPP) because, in this case, fossil fuel intensive industries are not considered as solely responsible for CO_2 emissions. Instead the responsibility is fairly attributed across all (goods and services) consuming sectors of the economy. The analysis shows that combined-cycle and renewable electricity would become competitive by the years 2014 and 2017, respectively. By 2020, the share of electricity produced from coal would be reduced by 18 per cent (from 84 per cent in 2005, to 66 per cent in 2020). A reduction in coal-fired electricity would be replaced by renewable (10 per cent) and combined-cycle (8 per cent). Consequently, the cost of electricity supply would increase by almost four-times as compared to the BC, reaching 24 ¢/kWh in 2020. Further, this tax (i.e., $26 per tonne) would cause GDP, over the period 2005–2020, to decrease by 1.9 per cent ($118 billion), as compared to the BC. The impact on GDP in the case of SRP is higher than PPP because a carbon tax based on PPP would affect economic sectors based on their direct fuel consumption only; whereas, for SRP, it would impose based on direct as well as indirect fuel consumption. Most of a reduction in GDP would come from a reduction in demand for final consumption ($116 billion). Similar to PPP, the change in the mix of electricity generation technologies would result in a small reduction ($2 billion) in demand for investment. However, as shown in Figure 6-15c, the trend in demand for investment increases beyond 2017, when capital intensive renewable technology begins to penetrate the market. Also, this tax would cause the employment in 2020 to be 4 per cent below what it would have been if no carbon tax is introduced. The total revenue that the government can collect from carbon tax in this case would be $102 billion, out of which 29 per cent ($29 billion) would come from the electricity sector and 22 per cent ($23 billion) would come from the commercial sector. The net cost of this policy would therefore be $17 billion ($118 billion loss of GDP minus $102 billion gains in tax revenue).

iv. A comparison of a carbon tax based on PPP and SRP suggests that, in order to meet an *a-priori* CO_2 emissions target for the electricity sector, a carbon tax based on SRP is preferable than the one based on PPP. It would need a lower level of carbon tax to be introduced (that is, $26 per tonne as compared with $51 per tonne for PPP). Although a carbon tax based on SRP would cause high inflation[55] (2.2 per cent per year), as compared to the PPP (1.8 per cent per year), the cost of electricity in the case of SRP would be lower (24 ¢/kWh), compared with PPP (31 ¢/kWh). The net economic impacts of carbon tax based on SRP would be $10 billion lower than those based on PPP ($27 billion for PPP minus $17 billion losses for SRP). A carbon tax based on SRP would also have a milder impact in terms of job losses; 4 per cent jobs will be lost in SRP as compared with 8 per cent in the case of PPP, over the period 2005–2020.

6.4.3 Early Action vs Deferred Action: Some Early Results

A review of the impacts of early and deferred introduction of carbon tax (in order to achieve an *a-priori* reduction in emissions from the electricity sector) – as presented in Sections 6.4.1 and 6.4.2 – appears to provide somewhat contradictory messages. For example, an early introduction of carbon tax seems to be desirable from the considerations of electricity price increases, inflation and employment levels. The electricity prices, in the year 2020, for example, are likely to be 24 ¢/kWh and 21 ¢/kWh as compared with the Base Case price of 4.9 ¢/kWh, for PPP and SRP, respectively, in

[55] The inflation is the weighted-mean of price increases from all sectors over the period 2005–2020, as calculated from Equation 5-15.

the case of early action. In the case of deferred action, these prices are likely to be 31 and 24 ¢/kWh for PPP and SRP, respectively. Similarly, early action is likely to result in lower inflationary pressures (21 and 30 per cent), as compared with deferred action (29 and 36 per cent), for PPP and SRP, respectively. In terms of the levels of employment, the job losses in the case of early action are likely to be lower – 6 and 3 per cent, as compared with 8 and 4 per cent, for PPP and SRP, respectively.

From the perspective of the entire economy though, it appears that deferred introduction of carbon tax is more desirable. The net economic cost of deferred action are $27 and $17 billion, for PPP and SRP, respectively. In comparison, the corresponding net economic cost of early action are $60 and $35 billion (Table 6-9).

These results however present only one possible interpretation of the underlying argument and hence need to be interpreted with caution. For example, it is noticed from Figure 6-15a that the annual economic cost of carbon tax in the case of early action would be higher than the deferred action only in the period prior to 2015 (for PPP) and 2017 (for SRP). But after 2015 (for PPP) and 2017 (for SRP), the cost of deferred action would be higher than the case of early action. Clearly, the short- and long-term impacts of early and deferred action appear to be different. Could a longer term analysis provide different outcomes?

Moreover, a question also arises about the influence of specific approach (for example, *Net Present Value*) on the final results. For example, if the results were presented in *Future Value* terms (rather than the *Present Value* terms) would the results be similar? Answering these questions would require some further analysis. Such analysis is carried out in the next section.

6.4.4 Early Action vs Deferred Action: Some Further Analysis

The analysis in the previous section showed that in *present value* terms the economic cost, over the period 2005–2020, of deferred action is $27 billion as compared with $60 billion for early action, in the case of PPP. However, it is also clear from Figure 6-15a that, during the period 2005–2010, when carbon tax has not yet been introduced (deferred action), the economic cost of such inaction would appear as an economic benefit (in terms of no loss in GDP). In contrast, when carbon tax is adopted in 2005, the economy would immediately face economic losses. One can therefore argue that the use of *present value* as an indicator of economic cost favours deferred action. Theoretically, the concept of *present value* gives more importance (or weights) to the values that are closer to the present period than to the values that would occur in the later periods. This means that the further into the future the cost occurs (which is likely to be the case for global warming induced impacts), the lower the weight attached to it. For example, any hypothetical cost that occurs in 2020 would be valued at 32 per cent in 2005, assuming discount rate of 8 per cent.[56] Referring to Figure 6-15a, this means that the cost of early action during the period 2005–2010 would be much higher than the cost of deferred action during the period 2015–2020.

In contrast, the concept of *future value* gives more importance to the values in the future years, than to the values in the earlier years. If economic impacts are measured in terms of their *future values*, it is possible that the cost of early action would be less than the case of deferred action. However, as shown in Table 6-10, the cost of deferred action would still be less than that of early action. But the gap between early and deferred action becomes narrower when impacts are assessed in terms of their *future value*. For example, in *present value* terms, the cost of early action is 119 per cent higher than the cost of deferred action, in the case of PPP. However, the difference reduces to 44 per cent when expressed in *future value* terms. The corresponding figures for SRP would be 109 and 55 per cent, respectively.

---

[56] The present value in 2005 is achieved by multiplying the future value in 2020 with Present Value Factor (*PVF*) using the discount rate (i) of 8 per cent for the period (t) of 15 years.

Table 6-10 Comparison of economic costs: Present and Future values

		Early action	Deferred action	Percentage difference
		($billion)		(Early - Deferred)
PPP	Present value	-60	-27	119
	Future value	-456	-317	44
SRP	Present value	-35	-17	109
	Future value	-445	-287	55

Notes:
- *Present value* refers to the year 2005; *Future value* refers to the year 2020.
- Both *present* and *future values* are calculated, for the period 2005–2020, assuming a discount rate of 8 per cent.
- *Present value* for each category is taken from Table 6-9; *Future value* is calculated from net of GDP and tax revenue for each carbon tax case, contained in Table F-13, Appendix F, p. 355.

Further, it is also clear from Figure 6-15a that the *rate of increase* in net economic costs of deferred action is higher than in the case with early action. Although the cost of deferred action emerges five years later (that is, in 2010, instead of 2005 for early action), it is expected to overtake the annual cost of early action by 2015 and 2017, for PPP and SRP, respectively. This implies that if the time period for analysis is further extended, the *present value* of the cost of deferred action would be higher than the corresponding costs of early action. An analysis is carried out in this research by extending the time-frame to the year 2040. It is assumed that after meeting the *a-priori* emissions target in 2020 (equivalent to 138 Mt of CO_2 emissions from the electricity sector), a carbon tax in each case (that is, PPP and SRP for early and deferred actions) is retained at their existing levels in order to maintain CO_2 emissions at this level (that is, 138 Mt) until 2040. The results of this analysis are shown in Table 6-11.

Table 6-11 Comparison of economic costs: Short-term (2020) and Long-term (2040)

		Early action ($billion)	Deferred action ($billion)	Difference ($billion)	
PPP	Short-term	-60	-27	-32	
	Long-term	-303	-327	24	(10)
SRP	Short-term	-35	-17	-18	
	Long-term	-333	-352	18	(8)

Notes:
- Short-term refers to the period 2005–2020; Long-term refers to the period 2005–2040.
- Value in brackets, in the case of long-term, are adjusted values, to allow a direct comparison with the values for the short-term. The value of $10 billion, for example, is obtained by dividing $24 billion with the number of years over the long-term (that is, 35 years) and then multiplying it with the number of years for the short-term (that is, 15 years).
- Both short- and long-term impacts are calculated in terms of *present values*, over the specified period, assuming a discount rate of 8 per cent.
- *Present value* for short-term is taken from Table 6-9; *Present value* for long-term is calculated from net of GDP and tax revenue for each carbon tax case, contained in Table F-13, Appendix F, p. 355.

The table shows that while the net economic cost of early action, during the short-term (that is, over the period 2005–2020), would be higher than the cost of deferred action, over the long-term (that is, over the period 2005–2040), the cost of deferred action would become higher. For example, in the case of PPP, the net economic cost of early action would be $32billion higher than the cost of deferred action, when considering these costs over the short-term. However, over the long-term, the cost of early action would be $24 billion less than the cost of deferred action. Similar situation would also occur in the case of SRP, with the cost of early action $18 billion less than that of deferred action (see Table 6-11). To allow a comparison of economic costs from different carbon tax regimes discussed throughout in this Chapter (that is, PPP_1, PPP_2, SRP_1, SRP_2, PPP_{Early}, PPP_{Delay}, SRP_{Early}, and SRP_{Delay}), the net economic costs over the long-term are adjusted so that they reflects the net costs that would occur over the period 2005–2020. The adjusted economic costs of early action, over the period 2005–2020, would therefore be $10 and $8 billion less than the cost of deferred action, in the case of PPP and SRP, respectively.

To summarise, over the short-term (that is, the period up to 2020), the economic cost of early action would be higher than the cost of deferred action. This is because the zero economic loss during the period 2005–2010 from deferred action would not be felt by the economy, to any appreciable extent, during the period 2010–2020. This impact would however begin to accelerate closer to the year 2020 and would overtake the cost due to early action in the years beyond 2020. Overall, therefore, early action appears to be more desirable than deferred action.

6.5 Comparison with Other Studies

This section compares the impacts of carbon tax, estimated in this research in Section 6.4, with other studies. Table 6-12 provides a summary of these results.

The table shows that, in general, the introduction of carbon tax would have a negative impact on the Australian economy. These impacts are within the range of 0.3 to 2.5 per cent reduction in GDP, compared with the base scenario of each study. For example, according to Industry Commission (1991a), a tax of \$21.75 per tonne of CO_2 would be required to meet the Toronto target and that this level of tax would result in a 2.1 per cent loss of the Australian economic growth over the period 1991-2005. According to McDougal (1993), a carbon tax of \$19 per tonne of CO_2 would result in a GDP loss of 0.9 per cent over the period 1993-2005. This research has also shown that, to meet the Kyoto target (which is set only for the electricity sector), the GDP would reduce by 0.9 per cent (for PPP) and 0.6 per cent (for SRP).

Table 6-12 Comparisons of research results from carbon tax studies for Australia

		A	**B**	**C**	**D**	**E**		**F** (for PPP)		**F** (for SRP)	
						Early (implement in 2010)	Delay (implement in 2030)	Early (implement in 2005)	Delay (implement in 2010)	Early (implement in 2005)	Delay (implement in 2010)
CO_2 emissions reduction		Toronto target[a]	Toronto target[a]	Toronto target[a]	1990 level by 2005	-40% by 2050	-35% by 2050	30% of 1990 level by 2020	31% of 1990 level by 2020	32% of 1990 level by 2020	32% of 1990 level by 2020
Emission tax (\$/tonne CO_2)		21.75[b]	19[c]	14	1.25-13.8[d]	99[e]	77[e]	25[f]	51[f]	15[f]	26[f]
Change in GDP		-2.1%	-0.9%	\$(179bn)[g]	\$(61bn)[g]	-2.5%	-1.7%	-0.9%	-0.4%	-0.6%	-0.3%
Electricity mix	Coal					46	45	58	66	58	66
	Gas					26	26	9	6	17	11
	Renewable					27	28	31	26	23	21
Sectoral output (%)	Coal	-26.2	-20.8		-4.3% pa	-22	-22	-17	-13.1	-22	-15.2
	Electricity	-7.6	-4.8			-14	-14	-5.7	-4.6	-7.9	-5.6
	Construction	-3.1	1.3					-0.1	-0.1	-0.7	-0.4
	Non-ferrous metal		-6.5			-24	-22	-3.7	-3.1	-5.6	-4.0
	Manufacturing	-2.2	-2.1 to 0.2			1	1	-2.1	-1.7	-3.6	-2.5
	Services	-1.8	0.2			-1	-1	-1.4	-1.2	-1.8	-1.2

Sources: **A**: Industry Commission (1991a); **B**: McDougall (1993); **C**: NIEIR (1995); **D**: McKibbin and Pearce (1996); **E**: Ahammad et al. (2006); **F**: This research (Table 6-9).

Notes: **a**: reduce GHG emissions to 20 per cent below 1988 level by the year 2005; **b**: 1988 prices; **c**: 1987 prices; **d**: considered carbon tax in combination with other policy measures; **e**: \$1.25/tonne in 1995 and increases gradually until it reaches \$13.8/tonne in 2005, then maintained at this rate to 2010; **f**: present value with 8 per cent discount rate; **g**: reduction of GDP by 0.62 per cent in 2004, 0.13 per cent in 2014, and increase in GDP by 0.01 per cent in 2024

Further, these studies have shown that the introduction of carbon tax would particularly adversely affect fossil fuel industries. For example, Ahammad et al. (2006) estimated that, by 2050, coal-fired electricity generation would represent around 45 to 46 per cent of electricity generation. Most of the reduction in coal-fired electricity would be replaced by renewable electricity; renewable would account for 27 to 28 per cent of total electricity production. Despite this shift in electricity mix, the same study estimated that the overall electricity production would decline by 14 per cent. This research has also shown that the electricity production would reduce by 5 to 9 per cent, with substantial reduction in coal-fired power generation (approximately 58 and 66 per cent for early and delayed action, respectively). The reduction in coal-fired electricity would be replaced largely by gas-fired electricity (for SRP) and renewable electricity (for PPP). Industry Commission (1991a) and McDougall (1993) also estimated reductions in coal-based electricity of 26 and 21 per cent, respectively.

Not only would the fossil fuel production sectors be heavily affected, fossil fuel consumption sectors, such as energy intensive metals processing industries, would also be affected by carbon tax. For example, McDougall (1993) estimated that, in response to a carbon tax of $19 per tonne of CO_2, the outputs of non-ferrous metal industry would decline by 6.5 per cent. Ahammad et al. (2006) also estimated that the outputs of non-ferrous metal industry would decline by 22 to 24 per cent. This research estimated that the outputs of this industry would reduce in the range of 3 to 7 per cent. While the outputs of the energy-intensive industries faced significant decline in most cases, the output of the construction sector would have a negligible impact. For example, McDougall (1993) estimated that the outputs of this sector would increase by 1.3 per cent. This research estimated that the construction sector would face a reduction in output, over the period 2005–2020, of between 0.1 and 0.7 per cent. The Industry Commission's (1991a) analysis indicates a 3.1 per cent reduction in the output of the construction sector.

One of the results of this research, namely, that early introduction of carbon tax is less desirable than its deferred introduction (as discussed in Section 6.4.3), resonates with the results of Ahammad et al. (2006). According to Ahammad et al. (2006), the cost of early action would be higher (2.5 per cent GDP loss) than that of the delayed action (1.7 per cent GDP loss).

Further analysis however showed that this (in the context of this research) was due mainly to the use of the concept of *present value* to express the net costs of carbon tax, and also due to the rather short time-period (that is, 2005–2020) considered in this research. The analysis also showed that an extension in the time-period for analysis, to the year 2040, would make it attractive to introduce carbon tax early.

6.6 Policy Implications of Carbon Tax: Some additional discussion

In the previous sections of this chapter, the economy-wide impacts of a carbon tax, based on PPP and SRP, were assessed. These impacts were assessed without imposing any *a-priori* limits on the amounts of CO_2 emissions (Section 6.3). Also assessed (in Section 6.4) were the economy-wide impacts of a carbon tax, based on PPP and SRP, for meeting an *a-priori* emission target – equivalent to 108 per cent increase in CO_2 emissions from the electricity sector, as compared with 1990 levels, by the year 2020. In this section, the implications of these taxes is further analysed within a wider policy context.

In the PPP approach, direct fossil fuel consumers are considered as solely responsible for CO_2 emissions. The electricity sector is responsible for most (about 50 per cent) of the total CO_2 emissions. Adopting a carbon tax based on this principle implies that, within the electricity sector, electricity produced from coal-fired technology would be taxed more than that produced from combined-cycle technology. Renewable electricity technologies do not consume fossil fuels and, therefore, attract no penalty. Therefore, the adoption of this type of carbon tax would trigger big changes in investment patterns, especially in the form of investments in cleaner electricity production technologies, within a short-run. This would bring a significant short-term reduction in CO_2 emissions. However, because of the sudden change in technology-mix for electricity production, it would significantly drive-up the electricity prices. It would be difficult for the economy and society to adapt quickly to such a change. This would further provoke the opposition to carbon tax and delay its introduction, as has always been the case in Australia (see Section 3.2, Chapter 3 for more discussion).

Based on the SRP approach, indirect fossil fuel consumers are also considered as a responsible party for CO_2 emissions. In this approach, the electricity sector is responsible for about 20-30 per cent of total nationwide CO_2 emissions. The commercial sector, a major consumer of materials and electricity, is responsible for one-third of CO_2 emissions. Renewable electricity technologies are also considered as responsible for CO_2 emissions on account of the emissions that are embedded in the materials used to build these technologies and the materials consumed by these technologies during their operation. Adopting a carbon tax based on this principle implies that the climate change problem is not the concern of direct polluters of CO_2 only, but the responsibility of the whole economy. This type of carbon tax provides fairness; it penalises each sector based on their direct and indirect contribution to CO_2 emissions. By implementing this type of carbon tax, there would be an incentive for all sectors to seek cleaner energy sources. Therefore, the adoption of this type of carbon tax would lead to significantly higher reduction in CO_2 emissions, as compared with an equivalent tax based on PPP. Adopting this type of carbon tax would, however, have higher economic and social impacts, but these impacts, for an economy of Australia's size and strength, should not be considered high, especially if one takes note of the fact that this tax would result in higher reduction in CO_2 emissions. Table 6-13 also shows that the economic and social impacts arising from a SRP-based carbon tax are in fact lower than would be the case of a tax based on PPP – \$83 million (565 minus 482) less in net economic costs and 2299 (5291 minus 2992) less jobs losses, for a carbon tax of \$10 per tonne of CO_2.

Further, the analyses has shown that if an *a-priori* limit (roughly equal to Kyoto target) is set for CO_2 emissions from the electricity sector, a much higher level of carbon tax would be needed in the case of PPP (\$25 per tonne) and much lower level of carbon tax would be needed in the case of SRP (\$15 per tonne). While the net economic cost of a carbon tax based on PPP would be considerable (\$60 billion, over the period 2005–

2020), such cost in the case of SRP would be lower ($35 billion, over the period 2005–2020). The analyses in this research also show that delaying the introduction of carbon tax has considerably higher economic and social costs. In contrast, the unquestioning pursuance of economic growth objectives (as in the BC scenario) would cause significant increase in CO_2 emissions (84 per cent above the 1990 levels).

It is always difficult to choose among competing objectives and options. This research has attempted to develop insights into the tradeoffs between economic, environmental, and social objectives that might assist the policy makers as they endeavour to make policy choices to achieve a balanced and sustainable growth. Select such tradeoffs are summarised in Table 6-13.

Table 6-13 Summary of environmental-economic-social tradeoffs

	$10 per tonne		$20 per tonne		*a-priori* (Early)		*a-priori* (Delay)	
	PPP	SRP	PPP	SRP	PPP	SRP	PPP	SRP
Total CO_2 savings (Mtonnes)	48 *(11)*	97 *(22)*	115 *(27)*	165 *(38)*	131 *(30)*	138 *(32)*	135 *(31)*	140 *(33)*
Net economic costs ($Bn)	27 *(0.4)*	47 *(0.7)*	49 *(0.8)*	84 *(1.3)*	60 *(0.9)*	35 *(0.5)*	70 *(1.1)*	43 *(0.7)*
Loss in employment ('000 persons)	255 *(2.7)*	289 *(3.1)*	455 *(4.8)*	490 *(5.2)*	555 *(5.9)*	309 *(3.3)*	726 *(7.7)*	355 *(3.8)*
Net economic costs ($Mn/Mt)	565	482	426	507	454	252	516	303
Loss in employment (persons/Mt)	5291	2992	3965	2963	4234	2239	5360	2528

Notes:
- The information contained in the first three-rows in this table is assembled from various tables in this Chapter.
- The last two-rows summarise environmental-economic-social tradeoffs. For example, under a carbon tax of $10 per tonne in the case of PPP, 1 Mtonne of reduction in CO_2 would imply $565 million of net economic cost, and 5291 foregone jobs.
- Number in brackets indicates percentage differences as compared with the BC scenario.

The table shows that the early introduction of carbon tax based on SRP principle offers a relatively more attractive approach to simultaneously meeting environmental, economic, and social objectives. Adopting this approach would lead to highest emissions reductions, from lowest money spent, and the lowest number of jobs foregone. For example, every million tonne of reduction of CO_2 would incur an economic loss of $252 million and a loss of 2239 jobs. Further, introducing carbon tax based on SRP in 2010 (that is, deferred action) would still be superior to other approaches. For example, every million tonne of reduction in CO_2 would incur an economic loss of $303 million and loss of 2528 jobs in the economy. However, compared to the early action, a reduction of every million tonne of CO_2, in the deferred action, would cost $51 million (303 minus 252) more and 289 (2528 minus 2239) more jobs losses. If carbon tax based on PPP is adopted immediately, it would cost an additional $202 (454 minus 252) million and result in 1995 (4234 minus 2239) more jobs losses for every million tonne of reduction in CO_2.

Therefore, a carbon tax based on SRP principle should be adopted immediately. If the decision for adopting carbon tax is deferred, it would be rather difficult to achieve not only environmental objectives but economic and social objectives as well.

6.7 Summary and Conclusions

In this chapter, a carbon tax policy based on two different principles – Polluter-pays (PPP) and Shared-responsibility (SRP) – is analysed, and its impact on energy, environment, economy, and society are assessed. The major conclusions of this chapter are summarised as follows:

- In the absence of carbon tax (BC scenario), total CO_2 emissions from the electricity sector are expected to increase, by the year 2020, by 95 per cent (to 250 Mt) above the 1990 level (128 Mt). Electricity produced from coal is expected to dominate the electricity-mix in 2020, contributing nearly 84 per cent to total electricity generation. The small increase in the share of renewable electricity due to the ongoing MRET scheme would increase the cost of electricity production from 4.7 ¢/kWh in 2004, to 4.92 ¢/kWh in 2020. The economy would grow at an average rate of 2.57 per cent per year to the year 2020, reaching $808 billion (1990 prices) in 2020. The economy-wide employment would increase at an annual average rate of 0.8 per cent reaching 9,444 thousand persons in 2020.
- The analysis of the impacts of carbon tax, using a uniform tax rate, based on PPP and SRP shows that:
    - A carbon tax based on SRP would result in an increase in the cost of electricity at a higher rate than that based on PPP. For a carbon tax of $20

per tonne, the cost of electricity production would reach, in the year 2020, 20.5 ¢/kWh in the case of PPP, and 25.9 ¢/kWh in the case of SRP (in 2004 prices) (Table 6-2). This is because, in the case of PPP, the electricity sector (a direct fossil fuel consumer) is considered as the main responsible party for CO_2 emissions, whereas in the case of SRP, indirect fossil fuel consumers, including renewable electricity sector, are also considered responsible for CO_2 emissions.

- The introduction of carbon tax would yield, for the government, revenues of \$28 and \$53 billion (1990 prices), for PPP_1 and PPP_2, respectively, over the period2005–2020. The corresponding figures for SRP_1 and SRP_2 are \$74 and \$135 billion (see Table 6-7). Of these, the electricity sector would be responsible for approximately 50 and 20 per cent of total revenue, in the case of PPP and SRP, respectively. The revenue from carbon tax is higher in the case of SRP because, in this case, revenue would be collected from both direct as well as indirect fossil fuel consumers, compared with the collection of revenue from just direct fossil fuel consumers in the case of PPP.

- A carbon tax based on SRP would cause a larger reduction in coal-fired power generation than would be the case with PPP. For example, for a carbon tax of \$20 per tonne based on SRP, coal-fired electricity would reduce by 28 per cent as compared to the BC scenario, representing 56 per cent of total electricity generation in 2020. The same carbon tax rate in the case of PPP would instead cause the share of coal-fired electricity to reduce by 23 per cent.

- The growth rate of CO_2 emissions reduces substantially due to the introduction of carbon tax, with more reductions forthcoming when carbon tax is applied based on SRP, as compared with the case when it is applied based on PPP. For example, for a carbon tax of \$20 per tonne, CO_2 emissions from the electricity sector would decline by 53 per cent (or 134 Mt) from the BC level, when carbon tax is applied based on SRP. The corresponding figure for the PPP is 39.3 per cent (98 Mt). This is so because a carbon tax based on SRP also takes into account the energy embodied in materials and, therefore, penalises the emitters from indirect energy consumption. The introduction of such a tax would increase the cost of electricity production at a higher rate than if a carbon tax is imposed under PPP (see Table 6-2). As a result, it would allow cleaner electricity production technology to penetrate the market earlier than if carbon tax is based on PPP.

- The application of $10 per tonne of carbon tax would have net economic cost, over the period 2005–2020, of 0.4 and 0.7 per cent, in the case of PPP and SRP, respectively. The corresponding values for a tax of $20 per tonne are 0.8 and 1.3 per cent. This is because, when a higher level of carbon tax is imposed, the cost of electricity from coal would increase considerably, which would induce more investment in cleaner electricity technologies. Because of this investment, carbon tax based on PPP would have slightly less economic impact than that based on SRP.

- A reduction in economic output from the introduction of carbon tax would also cause a reduction in the level of employment, in the range of 2.8 to 5.5 per cent, with slightly more reduction in the case of SRP than in the case of PPP. For a carbon tax of $10 per tonne, the employment would reduce by 2.8 per cent (from the BC scenario) for the PPP, while it would reduce by 3.2 per cent for the SRP. However, the changes in technology-mix induced by carbon tax would cause a shift of employment from the coal to the gas sector and from coal-fired electricity technology to combined-cycle and renewable technology.

• If an *a-priori* emissions limit (equivalent to 108 per cent of 1990 level) is set for the electricity sector (that is, if CO_2 emissions from the electricity sector are limited to 138 Mt by 2020), tax rates of $25 and $15 per tonne of CO_2 would be required in the case of PPP and SRP approaches, respectively. The total economy-wide CO_2 emissions in these cases would range between 291 (SRP) and 300 (PPP) Mt – approximately 24 (SRP) and 28 (PPP) per cent higher than the 1990 economy-wide CO_2 emissions (234 Mt) and about 30 per cent less than the BC scenario (432 Mt).

- A higher level of tax would be required in the case of PPP because, based on this principle, only direct fossil fuel consumers would be penalised; whereas, in the case of SRP, both direct and indirect fossil fuel consumers would be penalised. Therefore, a higher level of tax is needed for PPP to accelerate investment in cleaner electricity technology.

- The accelerated rate of investment in cleaner electricity technology in the case of PPP would cause the cost (in 2004 prices) of electricity to increase, by the year 2020, to 24 ¢/kWh as compared with 21 ¢/kWh in the case of SRP.

- A carbon tax based on PPP would have higher net economic and social impacts as compared with a tax based on SRP. The net economic losses in the case of PPP ($60 billion) would exceed such losses in the case of SRP ($35 billion) by $25 billion. Further, 245 thousand more jobs (2.6 per cent) would be lost under the PPP case, as compared with the SRP.

- If the introduction of carbon tax is deferred by 5 years (that is, the tax is introduced in the year 2010), the overall impacts would be much higher. For example, to achieve the *a-priori* limit, a tax of $51 per tonne in the case of PPP, and $26 per tonne in the case of SRP would be required. This would further accelerate investment in cleaner electricity technologies. Consequently, the cost of electricity would be higher than would be the case if carbon tax is introduced immediately. The cost of electricity, in the case of PPP and SRP, are expected to reach 31 and 24 ¢/kWh by the year 2020, compared with 24 and 21 ¢/kWh in the case of early action.

- The social impacts of deferred action would be higher, with 45,000 and 171,000 more jobs losses, in the case of SRP and PPP, respectively. In terms of the economic impacts, an initial estimate, using *present value* for the period 2005–2020, shows that delaying the introduction of carbon tax would save $18 and $32 billion, for SRP and PPP, respectively.

- This research has also demonstrated the pitfalls associated with the use of conventional methods for quantifying the impacts of carbon tax. For example, this research has shown that the use of the concepts of *present value* and *future value* are likely to provide significantly different policy recommendations. In a similar vein, the extension of the life-span of analysis to the year 2040 is likely to result in the strengthening of the case for an early introduction of carbon tax.
- The analysis in this chapter suggests that a carbon tax based on SRP offers a relatively more attractive approach to simultaneously meeting environmental, economic, and social objectives. By adopting such an approach immediately, every million tonne of reduction in CO_2 would incur a cost $252 million and would result in 2239 job losses. If however the adoption of such an approach is deferred, it would cost an additional $51 million and result in 289 more jobs losses to achieve every million tonne of reduction of CO_2. If a carbon tax, based on PPP, is adopted immediately, it would cost an additional $202 million and result in 1995 more job losses for every million tonne of CO_2 reduction.
- Therefore, a carbon tax, based on SRP principle, should be introduced immediately. If this decision is deferred, it would be rather difficult to achieve not only environmental objectives but economic and social objectives as well.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

7.1 Conclusions

The major conclusions of this research, in summary, are as follows:

- Carbon-dioxide emissions (a major greenhouse-gas) from the electricity industry in Australia are substantial and increasing.

  - In 1990, CO_2 emissions from fossil fuel combustion in Australia totalled 234 Mt. The electricity industry accounted for 55 per cent (128 Mt) of these emissions. The contribution of electricity industry to total CO_2 emissions increased to 58 per cent in 2004 (184 Mt). This represents an increase of 44 per cent (from 128 to 184 Mt in CO_2 emissions from the electricity sector), as compared with an increase of 35 per cent (from 234 to 316 Mt) in CO_2 emissions from fossil fuel combustion.

  - If current trends continue, CO_2 emissions from fossil fuel combustion would reach 432 Mt by the year 2020 – an increase of 84 per cent above the 1990 level. Over the same period, CO_2 emissions from the electricity sector are expected to increase by 95 per cent (to 250 Mt) above the 1990 level.

- Coal-fired power stations account for approximately 95 per cent of total CO_2 emissions from the electricity sector.

  - Coal has always been the dominant fuel for electricity production in Australia, accounting, on average, for about 80 per cent of total electricity production over the last several decades. If present policy trends (for example, a continuing government funding for the development of carbon capture technology with a relatively small mandatory target for renewable energy) continue, the share of coal is expected to decline only slightly by the year 2020 – to 75 per cent.

- The abundance of indigenous coal resources provided initial incentive for the establishment of the coal–electricity compact. Over time, this compact was strengthened by economic and political interests. By the mid-1900s, the ownership of the earlier part-private electricity interests in various states in Australia had transferred to the state governments. These governments developed their power stations based on coalfields located within the state. This marked the beginning of the technological lock-in of coal-based infrastructures. In the second half of the twentieth century, a series of large coal-fired power stations were built, with government subsidies, in anticipation of a minerals boom. This further consolidated the technological lock-in of coal-based technology.

- The economic and political interests soon transformed the technological lock-in into an institutional lock-in. The use of significant public funds in the form of subsidies in the development of power stations in the earlier decades has allowed the direct involvement of political interests into the electricity industry. The influence of these interests became evident in the investment strategies, including the selection of fuel (coal) for electricity generation. Even in the recent restructure of the electricity industry, rules which govern the national electricity market (for example, dispatching criteria) indirectly favour coal-based electricity generation. This demonstrates the significance of the institutional lock-in of the coal–electricity compact in Australia.

• The coal–electricity compact has traditionally exerted a strong influence on the development of environmental policies in Australia, including the greenhouse-gas reduction policies.

- In the initial years of the international dialogue regarding climate change issue, Australia acted as a global leader in proposing strategies to combat this problem. A carbon tax was among the initial strategies that the Australian government had considered in its "*interim planning target*", in the early 1990s, for reducing greenhouse-gases. Later, however, as the economic impacts of carbon tax became clearer, especially on fossil fuel industries, Australia drastically changed its environmental stance.

- The key policy initiatives thereafter (for example, *National Greenhouse Response Strategy*, *Greenhouse Challenge Program*, and *Energy White Paper*) firmly established the stance that favoured economic objectives over environmental objectives. Such initiatives have relied mainly on voluntary initiatives for the reduction of greenhouse-gases. Overall, Australia's greenhouse-gas reduction policies were characterised by a fragmented array of short-term commercial and economic interests and generally lacked consideration of long-term environmental sustainability.

- The use of market-based approach, particularly carbon tax, has been continually rejected by the Australian federal political parties, on the grounds that it would impede economic growth. Perspectives on these expected impacts have created a "carbon tax phobia" among the coal-electricity interests, which have significantly influenced the government's greenhouse policy thinking.

• A major premise of this research is that the opposition to carbon tax in Australia is based on less than adequate understanding about its various facets, including alternative conceptions of carbon tax and its economy-wide impacts.

  - Traditionally, the notion of carbon tax – as generally debated – is formulated on the basis of Polluter Pays Principle (PPP). Based on this principle, the polluter (emitter) is defined as the consumer of primary energy (called direct energy) where combustion takes place. CO_2 emissions resulting from the combustion processes are therefore considered as the sole responsibility of such a consumer. A carbon tax, by this reasoning, is expected to result in changing the behaviour of such a consumer (for example, coal-based electricity industry) – away from the use of CO_2-producing fuels. The application of carbon tax, based on this principle, is considered inequitable by some on the grounds that it tends to penalise big fossil-fuel industries (such as coal-based electricity industry) and not industries who consume the output produced by such products (for example, households and commercial sectors).

- This criticism could be overcome to a large extent, it is argued in this research, by considering an alternative conception of carbon tax – based on Shared Responsibility Principle (SRP). This principle assigns the responsibility for CO_2 emissions not only to the consumer of primary energy, but also the consumer of the products and services (for example, electricity consumed by commercial sectors or material inputs used by electricity sector for electricity production) whose production would have caused CO_2 emissions (such inputs are called indirect energy inputs). This principle therefore provides a more complete representation of energy-economy-environmental interactions. This method also promotes fairness (in terms of emissions accreditation) between all actors involved.

• Against this background, this research analysed the economy-wide impacts of carbon tax, based on PPP and SRP, for reducing CO_2 emissions in Australia. These impacts included impacts on energy and non-energy sectors of the economy.

  - The energy impacts are analysed in terms of the changes in the composition of fuel- and technology-mix for electricity generation, arising from the increases in the cost of electricity due to the introduction of carbon tax. These changes are quantified in terms of primary energies required to produce electricity, and hence CO_2 emissions.

- Non-energy economy-wide impacts are analysed in terms of net economic costs (that is, the net of loss of GDP and fiscal revenue gain), inflation, and employment.

- Two cases are considered in this research:

   a) no *a-priori* limit on CO_2 emissions. For this case, four sub-cases denoted PPP_1, SRP_1, PPP_2, and SRP_2, are analysed. PPP_1 and SRP_1 refer to the case of a carbon tax of $10 per tonne of CO_2 emissions, based on PPP and SRP, respectively. PPP_2 and SRP_2 refer to the case of a carbon tax of $20 per tonne of CO_2 emissions, based on PPP and SRP, respectively.

   b) *a-priori* limit – equivalent to 108 per cent of CO_2 emissions from the electricity sector, as compared with 1990 level (that is 138 Mt), by the year 2020.

- The various impacts are quantified, in this research, in terms of differences from the values that would be obtained in the business-as-usual state of affairs, called the Base Case scenario (BC).

• The major impacts of carbon tax (based on PPP and SRP) on the energy sector in a situation of **no *a-priori*** emissions limit are presented below:

  - The **technology-mix** for electricity generation would be appreciably influenced by the introduction of carbon tax. Particularly, carbon tax would result in a decline in the share of coal-fired electricity technology. A carbon tax based on SRP would generally lead to a larger reduction (between 21 and 28 per cent) in coal-fired power generation, compared to that based on PPP, for the same level of tax. For example, in the Base Case (BC), coal-fired generation is expected to comprise 84 per cent of total generation in the year 2020. In the case of SRP_1 and SRP_2, this percentage is expected to reduce to 63 and 56 per cent, respectively. The corresponding values for PPP are 74 and 61 per cent.

- The reduction in coal-fired electricity would be replaced mainly by renewable technology. For example, in the case of a carbon tax of $20, for both PPP_2 and SRP_2, the share of renewable is expected to increase to 28 per cent in 2020 (as compared with 10 per cent in BC). On the other hand, in the case of a carbon tax of $10 (for both PPP_1 and SRP_1), coal-fired technology would be replaced mainly by natural-gas based combined-cycle technology; the share of combined-cycle technology would, in the year 2020, be 14 per cent for PPP_1 and 22 per cent for SRP_1 (as compared with 4 per cent in BC).

- These changes in technology-mix would significantly increase the **cost of electricity**, more in the case of SRP, especially at higher tax rates. For example, in the case of PPP, the cost of electricity, in 2020, would increase from 4.7 ¢/kWh in 2004, to 13.4 (PPP_1) and 20.5 (PPP_2) ¢/kWh. The BC value in 2020 is estimated to be 4.9 ¢/kWh. The corresponding values for SRP_1 and SRP_2 are expected to be 16.7 and 25.9 ¢/kWh, respectively.

- Carbon tax is expected to result in a significant decline in the requirements of **primary energy** for electricity production. Such declines are estimated to be 10.2, 19.9, 20.1, and 35.4 per cent for PPP_1, SRP_1, PPP_2, and SRP_2, respectively.

- The use of coal (both black- and brown-coal) in electricity production would reduce considerably, with more reductions in the case of SRP (24 and 31 per cent, for SRP_1 and SRP_2, respectively) than in the case of PPP (13 and 24 per cent, for PPP_1 and PPP_2, respectively). The extent of substitution of coal with either natural gas or renewable varies, depending on the rate of change in technology-mix for each case of carbon tax. For example, in the case PPP_1, the use of natural gas would be 282 PJ higher than the BC. This is because of the increased share of natural gas-based combined-cycle in the total electricity generation. In contrast, the use of renewable energy in the case PPP_2 would be 406 PJ higher than the BC due to an increase in the share of renewable technology for electricity production. Similarly, in the case of SRP_1, the use of natural gas would be 441 PJ higher than the BC; while the use of renewable energy in the case of SRP_2 would be 265 PJ higher than the BC.

- The growth rate of **CO_2 emissions** from the electricity sector would reduce substantially due to the introduction of carbon tax, with more reductions forthcoming when carbon tax is applied based on SRP, as compared with the case when it is applied based on PPP. In the case SRP_2, for example, the CO_2 emissions from the electricity sector (116 Mt) would fall below even the Kyoto target (138 Mt). In contrast, CO_2 emissions in the case PPP_2 would be 118 per cent (152 Mt) of the 1990 level. This implies that, in order to achieve the Kyoto target of 108 per cent (138 Mt) of the 1990 level from the electricity sector, a higher level of carbon tax (more than \$20 per tonne) would be required if carbon tax is based on PPP than when the carbon tax is based on SRP.

• Major **non-energy impacts** of carbon tax, based on PPP and SRP, with **no *a-priori*** CO_2 emissions limit are summarised below:

- In general, the introduction of carbon tax would lead to a slowdown in **economic activity** (that is, GDP). For example, in the case of SRP, carbon tax would cause the economic output to reduce in the range of 1.9 (\$120 billion) to 3.5 (\$219 billion) per cent of its expected value in the BC (\$6325 billion), over the period 2005–2020. The corresponding reductions for PPP are 0.9 (\$56 billion) and 1.6 (\$102 billion) per cent.

- However, over this period, the introduction of carbon tax would yield, for the government, a **tax revenue** of between \$28 and \$53 billion in the case of PPP, and \$74 to \$135 billion, in the case of SRP. For a carbon tax based on PPP, more than 50 per cent of tax revenue would be collected from the electricity sector alone, particularly from coal-fired generators. In the case of SRP, the commercial sector (a major electricity and materials consumer) would be penalised significantly. Its share of tax revenue would increase from 1 per cent (for PPP) to over 20 per cent for SRP.

- Considering both economic impacts, namely, the reduction in GDP and gain in tax revenue, the **net economic costs** from the introduction of carbon tax would be in the range of $27 to $49 billion for PPP, and $47 to $84 billion for SRP.

- A reduction in economic output due to the introduction of carbon tax would also cause a reduction in the level of **employment**, in the range of 2.8 to 5.5 per cent, with slightly more reduction in the case of SRP than in the case of PPP. For a carbon tax of $10 per tonne, the employment would be 2.8 per cent less, as compared with the BC scenario, for PPP, and 3.2 per cent less for SRP. Further, the technology-mix induced by the introduction of carbon tax would cause a shift of employment from the coal sector to the gas sector, and from coal-fired electricity sector, to combined-cycle and renewable electricity sectors.

- The major impacts of carbon tax – in a situation of an ***a-priori* CO_2 emissions limit** equivalent to 108 per cent CO_2 emissions from the electricity sector as compared with 1990 level (that is 138 Mt) by the year 2020 – are noted below:

  - When a carbon tax is introduced in 2005 (***early action***), tax rates of $25 and $15 per tonne of CO_2 would be required in the PPP and SRP approaches, respectively. The total economy-wide CO_2 emissions in these cases would range between 291 (SRP) and 300 (PPP) Mt – approximately 24 (SRP) and 28 (PPP) per cent higher than the 1990 economy-wide CO_2 emissions (234 Mt) and about 30 per cent less than the BC scenario (432 Mt). This carbon tax (both PPP and SRP) would cause the share of coal-fired power generation to reduce to 58 per cent of total generation. In the case of PPP, the share of renewable and natural-gas-fired combined-cycle electricity would increase to 31 and 9 per cent, respectively. The corresponding shares in the case of SRP would be 23 and 17 per cent. Consequently, this would cause the cost of electricity to increase to 23.9 ¢/kWh, in the case of PPP, and 21.3 ¢/kWh in the case of SRP. Carbon tax based on SRP would have relatively milder net economic and social impacts as compared with a tax based on PPP. This is because, for SRP, the higher impact on GDP ($170 billion reduction) would be offset by high revenues ($135 billion) received by the Government. The overall net economic losses would be $35 and $60 billion, for SRP and PPP, respectively. Further, 245 thousand more jobs (2.6 per cent) would be lost under the PPP, as compared with SRP.

- When a carbon tax is introduced in 2010 (***deferred action***), the impacts would be much higher – a tax of $51 per tonne would be needed in the case of PPP to achieve the *a-priori* CO_2 emissions target. In the case of SRP, a tax of $26 per tonne would be needed to meet the CO_2 emissions target. The cost of electricity, in the case of PPP and SRP, are expected to reach 30.8 and 24.3 ¢/kWh in the year 2020, compared with 23.9 and 21.3 ¢/kWh in the case of early action. The social impacts of deferred action would also be higher. Nearly 45,000 and 171,000 more jobs losses would occur in the case of SRP and PPP, respectively. However, the overall economic impacts of deferred action, expressed in *present value* terms, for the period 2005–2020, are $18 and $32 billion lower as compared with the case of early action, for SRP and PPP, respectively. One might therefore infer that a delayed introduction of carbon tax is more desirable. Such inference would however be erroneous, this research has shown. For example, if the overall economic impacts are expressed in *future value* terms, or if the period of analysis is extended to the year 2040, entirely different inferences could be drawn – such analysis suggests that the early introduction of carbon tax is a better proposition.

- Overall, the analysis in this research suggests that a carbon tax based on SRP offers a relatively more attractive approach to simultaneously meeting environmental, economic, and social objectives. By adopting such an approach immediately, every million tonne of reduction in CO_2 would incur a cost $252 million and would result in 2239 job losses. If however the adoption of such an approach is deferred, it would cost an additional $51 million and result in 289 more jobs losses to achieve every million tonne of reduction of CO_2. If a carbon tax, based on PPP, is adopted immediately, it would cost an additional $202 million and result in 1995 more job losses for every million tonne of CO_2 reduction.

- Therefore, this research recommends an early introduction of a carbon tax, based on SRP. If the decision for introducing such a tax is deferred, it would be rather difficult to achieve not only environmental objectives but economic and social objectives as well.

7.2 Some Recommendations for Further Research

Some suggestions for further research include the following:

a) The economic impacts of carbon tax analysed in this research presents only one side of the story, that is, costs imposed on the economy if a carbon tax is introduced, or simply – the cost of *action*. The cost of *inaction*, and the consequential damage that could be caused by increased global warming, was not considered in this research. Such cost may include cost of remedy or economic adaptation to the new environmental settings which would result from the climate change. It is suggested that future research should analyse both – the economic and environmental costs of *action* as well as *inaction*. This would enhance the policy maker's appreciation for the wide impacts of their policy choices.

b) This research has applied essentially top-down approaches (for example, Input–output and Production function) for the analysis of the impacts of carbon tax. The energy system has been represented in the form of energy and material flows in the economy. An integration of bottom-up approach (such as Reference Energy-Material System Analysis, see Section 4.3.3), with top-down approaches developed in this research, could allow a wide range of environmental policy options (for example, supply- and demand-side management, material substitution, material recycling, etc.) to be assessed. However, lack of data may be a major challenge for such an approach.

c) The analysis of embodied energy has been computed, in this research, from monetary input–output tables. For more accurate analysis, Input–Output tables expressed in physical units (for example, kWh, ton, m^3, m^2, etc.) should be used. However, this level of detail is currently unavailable for Australia.

d) The multi-level production (cost) function model employed in this research was applied for the electricity industry only. Although the utility (expenditure) function model was also applied in this research to allow for the changes in final demand (such as consumption and exports), this still limits the assessment of full economic response to the introduction of carbon tax. Future research should employ such analysis for all production sectors of the economy (not just electricity). This can be done by applying a "*flexible*" form of production function for all production sectors (as was done, in this research, for the electricity sector).

e) In this research, the electricity sector has been disaggregated into five generation technologies to allow for technological shifts between emission-intensive and cleaner technologies. Similar approach of disaggregation for other economic sectors could also be considered. This would deepen the scope of technological adjustments in the economy, for example, in response to the increases in the prices of emission-intensive technologies due to the introduction of carbon tax. For example, road transport can be disaggregated into different types of vehicle modes, such as cars, buses, trucks, trains, etc., in order to allow shifts between different types of vehicles in response to a carbon tax.

f) This research used a common interest rate to estimates the price of capital (for use in the production function model) for different types of electricity technologies (see Section 5.7.2, p. 132). In reality, different types of technologies are likely to be faced with different interest rates. The use of such rates would improve the quality of analysis.

g) This research has analysed carbon tax based on CO_2 emissions. It is recommended that other types of emissions (such as SO_2, N_2O, NO_x, CH_4, etc.) should also be included in the analysis. Further, if all types of environmental emissions (and negative externalities) are considered, it would be worthwhile to analyse the impact of replacing existing tax system (that is, tax based on labour or income) with a comprehensive environmental tax (that is, tax based on environmental disruptions).

h) The possible alternative uses of carbon tax revenue have not been analysed in this research. Such analysis could provide valuable insights for formulating policy priorities for developing sustainability enhancing projects.

i) This research has considered the impacts arising from the introduction of a (domestic) carbon tax in Australia. For climate change (which is a global problem), a worldwide analysis should be carried out; this could provide better insights for developing multilateral responses to redress the environmental problems.

j) Although this research has analysed the impacts of carbon tax, the ideas developed in this research (that is, the idea of Shared Responsibility Principle based on materials-balance framework) could also be applied to analyse alternative environmental policies, such as, emissions trading. In this case, it can be done via the concept of "*re-allocation*" of permits and the impacts of such re-allocation.

APPENDIX A

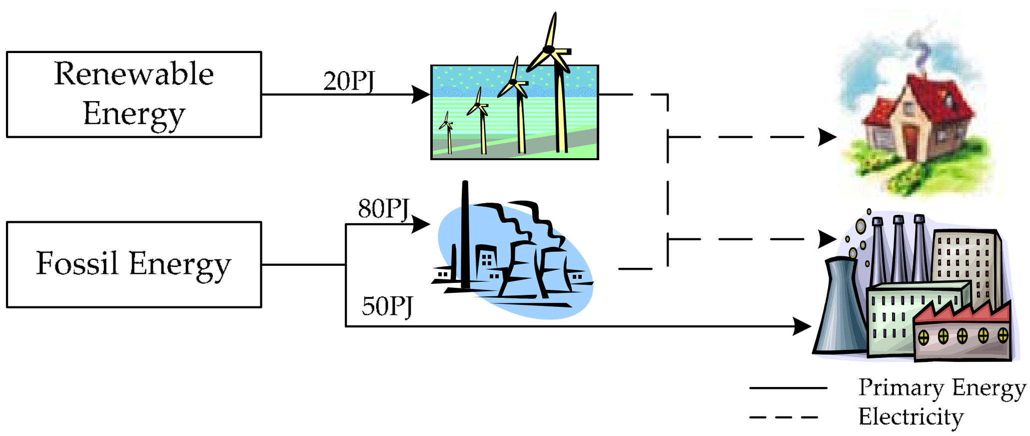
Example of Emissions Allocation: PPP vs. SRP

This appendix presents a simplified numerical example for apportioning the responsibility for CO_2 emissions to various economic sectors based on the Polluter Pays Principle (PPP) and the Shared Responsibility Principle (SRP).

Assumes a hypothetical economy consisting of four sectors: primary energy, electricity, industry (I), and household (H). Two types of primary energy – fossil (F) and renewable (R) – are available in the economy. Electricity is produced from this hypothetical economy using two types of technologies – fossil-fuel-based (ESI_F) and renewable-based (ESI_R). Emissions factors for fossil and renewable energy are assumed to be 100 and 0 ktonnes per PJ, respectively.

With reference to PPP, as discussed in Section 3.3.2, energy consumed in the economy can be represented in an energy-balance framework, as shown in Figure A-1. Here, the flow of energy is relatively straightforward, beginning with primary energy extraction from the environment, to energy conversion (in power plants), and ending with its consumptions in various end-uses (for example, cooking in households, motive power in industries).

Figure A-1 Energy-balance framework



Emissions, based on PPP, are as follows:

$$ESI_R = 20PJ \times 0\frac{kt}{PJ} = \underline{0}Mt$$

$$ESI_F = 80PJ \times 100\frac{kt}{PJ} = \underline{8}Mt$$

$$I = 50PJ \times 100\frac{kt}{PJ} = \underline{5}Mt$$

$$H = \underline{0}Mt$$

Total Emissions = 13 Mt

As shown in the above calculation, fossil-fuel consumers are responsible for most of the emissions in the economy (that is, fossil-fuel based electricity production sector is responsible for 62 per cent (8 Mt), and industrial sector for 38 per cent (5 Mt), of emissions).

In contrast, emissions allocation according to SRP can be represented in an materials-balance framework, as shown in Figure A-2. Here, in addition to energy flows as shown in energy-balance framework, material flows in the economy are also shown. For example, renewable electricity industry is shown as the consumer of primary renewable energy, electricity from its own production, and materials from industrial output. For simplicity, it is assumed that the production of primary energy does not require any input. The input pattern of each production and consumption sector within materials-balance frameowrk is shown in Figure A-3.

Figure A-2 Materials-balance framework

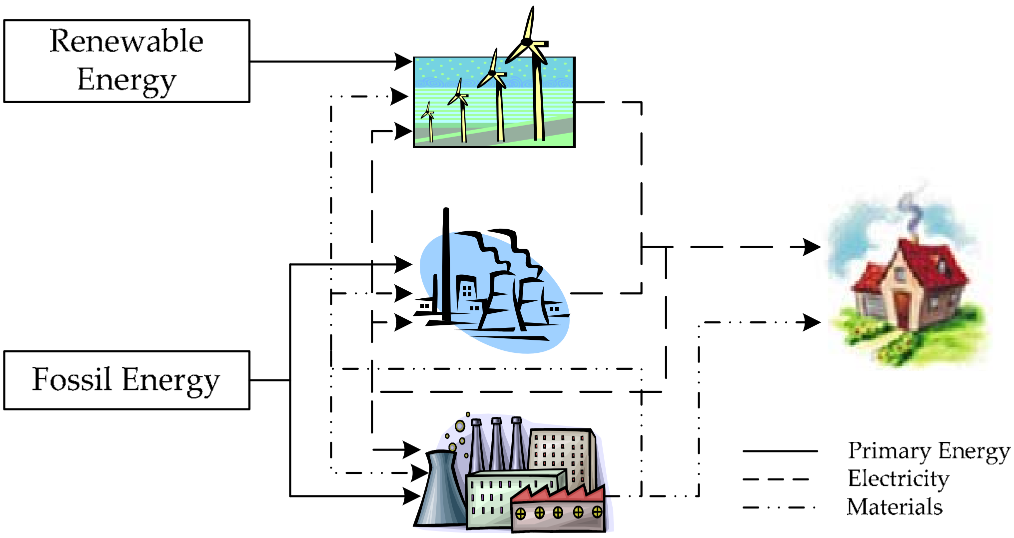
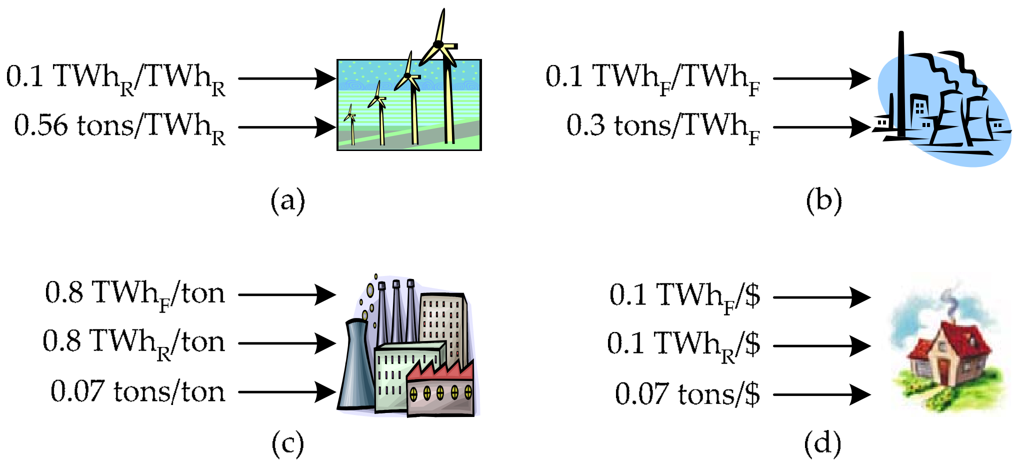


Figure A-3 Specification of production/consumption pattern



From Figure A-3, in order to produce 1TWh of electricity from renewable technology, 0.1TWh of electricity and 0.56tons of material are consumed; fossil-fuel based technology consumes 0.1TWh of electricity and 0.3tons of material; one ton of material production would require 1.6TWh of electricity and 0.07tons of material; and each household would consume 0.2TWh of electricity and 0.07tons of material for $1 of their consumption expenditure.

Emissions, based on SRP, are as follows:

$$ESI_R = \left[\left(20PJ \times 0\frac{kt}{PJ} \times 0.1\right) + \left(50PJ \times 100\frac{kt}{PJ} \times 0.56\right)\right] = \underline{3.1}Mt$$

$$ESI_F = \left[\left(80PJ \times 100\frac{kt}{PJ} \times 0.1\right) + \left(50PJ \times 100\frac{kt}{PJ} \times 0.3\right)\right] = \underline{2.1}Mt$$

$$I = \left[\left(80PJ \times 100\frac{kt}{PJ} \times 0.8\right) + \left(20PJ \times 0\frac{kt}{PJ} \times 0.8\right) + \left(50PJ \times 100\frac{kt}{PJ} \times 0.07\right)\right] = \underline{6.7}Mt$$

$$H = \left[\left(80PJ \times 100\frac{kt}{PJ} \times 0.1\right) + \left(20PJ \times 0\frac{kt}{PJ} \times 0.1\right) + \left(50PJ \times 100\frac{kt}{PJ} \times 0.07\right)\right] = \underline{1.1}Mt$$

Total Emissions = <u>13</u> Mt

As shown in the above calculation, emissions based on SRP are allocated differently from emissions that are based on PPP. SRP considers both direct and indirect energy consumption. Here, industrial, renewable electricity, fossil-fuel based electricity, and households are responsible for 52, 24, 16, and 8 per cent, respectively of total emissions in the economy. The contribution to emissions of renewable electricity is greater than fossil-fuel based electricity. This is because the former consumes more emission-intensive materials per unit of electricity produced than the latter.

APPENDIX B

Description of Input–output and Production Function Models

This appendix describes the key elements of input–output model and production function model – two models used in this research.

B.1 Input–output Model

This section presents the fundamental structure of input–output model. This structure serves as the basis for all input–output analysis in this research. The description in this section mainly draws from well-established literature on this topic, for example, Miernyk (1965), Bulmer-Thomas (1982), and Miller & Blair (1985). First, a brief background of input–output model is provided. Then, the relationship between input–output table and national accounts is discussed. This is followed by a discussion of basic input–output model. Next, the input–output price model is discussed. Finally, a dynamic version of input–output model is presented.

B.1.1 Background of Input–output Model

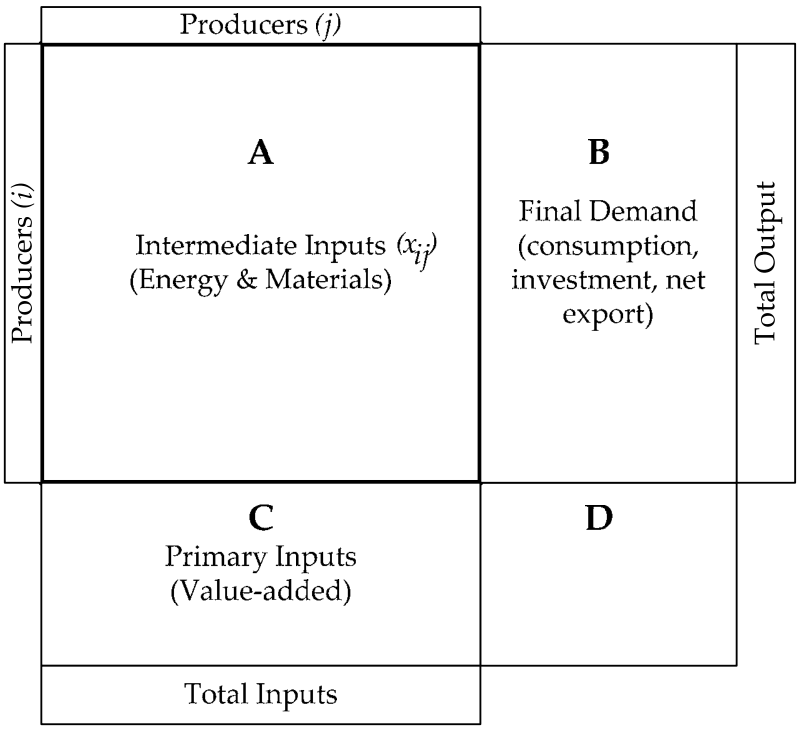
Input–output model has its origins in the eighteenth century – '*Tableau Économique*' of François Quesnay (1758). Quesnay showed how sales and expenditures could be traced in an economy in a systematic way. The next major contribution in this regard was made by Léon Walras (1874), who developed a general equilibrium model in an attempt to solve simultaneously the demand and supply balance of all economic sectors. This work employed a set of production coefficients that related the quantities of factors required to produce a unit of a particular product to the levels of total production of that product. Both works demonstrated the practical usefulness of being able to describe inter-industry linkages. However, the lack of sophisticated methods to compile comprehensive data required for analysis and the difficulties in manipulating vast amounts of information limited the potential usefulness of this type of analysis. It was only when Wassily Leontief (1936) presented an input–output system of the US economy and developed a more rigorous analytical framework that the use of this technique became popular. So much so that over the years this method has become one of the most widely applied method in economics.

B.1.2 Input–output Table and National Accounts

The basic Leontief input–output analysis is generally constructed from observed economic data for a specific geographic region. It includes the activities of industries that both produce goods (outputs) and consume goods from other industries (inputs) in the process of production. The fundamental information with which one deals in input–output analysis is contained in input–output table.

The input–output table constitutes a concise and systematic database that provides useful information on a complete set of income- and products-account in an economy. This input–output table describes the flow of goods and services between all the individual sectors of an economy over a particular time period. The schematic of input–output table is presented in Figure B-1.

Figure B-1 Schematic representation of Input–output table



Each rows of this table describes the allocation of a sector's output throughout the economy. The output of sectors from row *i* that are distributed to other production sectors in each column *j* are called intermediate goods. This is located in quadrant 'A' of input–output table. This interindustry flow is regarded as the core of input–output analysis. Further, the output of sector *i* that distributed to final markets (such as output required for final consumption, investment, and exports) are called final demand goods. These final demand sectors represent household consumption, government consumption, consumption for investment purposes, and exports. This final demand category constitutes the gross national product of the economy and is located in quadrant 'B' of input–output table. If the economy is divided into *n* sectors, the relationship of each row in Figure B-1 can be expressed as:

$$X_i = \sum_{j=1}^{n} x_{ij} + Y_i \tag{B-1}$$

where

X_i: total output (production) of sector *i;*

x_{ij}: output of sector *i* used by sector *j* (or intermediate goods)*;* and

Y_i: total final demand for sector *i*.

On the other hand, each column of the input–output table describes the composition of inputs required by a particular industry. These inputs are supplied by other industries (in the form of intermediate inputs), from primary factors of production (in the form of value-added), and from imports. The primary production factor and purchases of imported inputs are located in quadrant 'C'. If the imports row in quadrant 'C' is moved to the appropriate exports column in quadrant 'B' to make a 'net' exports, the only remaining value-added would represents the gross national income (i.e., income to the owners of primary production factors) in the economy. Similar to equation B-1, the relationship of each column in Figure B-1 can be expressed as:

$$X_j = \sum_{i=1}^{n} x_{ij} + V_j \tag{B-2}$$

where

X_j: total input of sector *j*;

x_{ij}: output of sector *i* used by sector *j* (or intermediate goods); and

V_j: total value-added for sector *j*.

The expressions in equation B-1 and equation B-2 constitute the relationship between input–output table and the national account in terms of gross national income and gross national products. This relationship would allow the analysis to be carried out at a disaggregated microeconomic level and at an aggregate macroeconomic level at the same time (Proops, Faber & Wagenhals 1993).

In order to complete the discussion on the structure of input–output table, it is worth mentioning that the elements in quadrant 'D' (the intersection of the final demand column and the value-added row) represent payments by final consumers for value-added items (Miller & Blair 1985).

B.1.3 Basic Input–output Model

The expression in equation B-1 provides a useful representation of economic activities at disaggregate levels. However, it is insufficient for the purpose of empirical economic analysis (Proops, Faber & Wagenhals 1993). For example, it is not possible for using expression in equation B-1 to determine the sectoral output and input requirements to meet a certain level of economic growth from demand-side policy initiatives.

In order to make use of the expression in equation B-1 for empirical economic analysis, it is necessary to modify the economic representation in input–output table into an appropriate functional form. This is typically accomplished by assuming a linear production function[57] called Leontief production function (further discussion on production function is presented in Section B.2).

[57] In basic microeconomics theory, a production function denotes that maximum output that could be produced from a given set of inputs with the help of the existing technology (Miller & Blair 1985).

This assumption implies that there exists a fixed relationship between a sector's output and its inputs. In other words, it implies a fixed proportionality of inputs with outputs in each sector. As a result, the input–output model ignores the economies of scale in production as well as the possibility of substitution between factors of production.

Assuming Leontief production function, the inputs to a particular sector can be expressed by the linear relations:

$$x_{ij} = a_{ij} X_j \Leftrightarrow a_{ij} = \frac{x_{ij}}{X_j} \tag{B-3}$$

where

a_{ij}: Input–output (technical or technological) coefficients.

These coefficients define the inputs purchased by sector j from sector i per monetary unit of sector's j output. The technical coefficients are assumed to be constant in input–output analysis.

By substituting relationship B-3 into equation B-1, the output equation becomes:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i \tag{B-4}$$

Here the output of sector i is the sum of final demand for that sector and its intermediate demand required by sector j. The equation B-4 illustrates the interdependence between all sectors in an economy in terms of interindustry flows (Miller & Blair 1985). For a n sector economy, equation B-4 will have a system of n (linear) simultaneous equations, describing the use of each sector's output in the economy. The system of n simultaneous equations for expression B-4 can be written in a matrix form as:

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} \tag{B-5}$$

The equation B-5 can be simplified in its condensed matrix form as:

$$X = AX + Y \Leftrightarrow X - AX = Y \tag{B-6}$$

where

X: column vectors of sectoral outputs;

Y: column vectors of sectoral final demand;

A: matrix of technical coefficients.

Using the basic concepts of matrix algebra, with 'I' as the unit identity matrix, equation B-5 can be reorganised to give:

$$X = \left(I - A\right)^{-1} Y \tag{B-7}$$

Equation B-7 is the fundamental matrix representation of input–output model. The inverse matrix $(I - A)^{-1}$ is known as the 'Leontief inverse matrix'. This matrix is a complicated expression indicating all of the direct and indirect requirements for production in the economy (Cruz 2002). To make the above statement clearer, equation B-7 is decomposed into infinite series of matrix products as:

$$X = \left(I + A + A^2 + A^3 + \ldots + A^\infty\right) \cdot Y \tag{B-8}$$

$$X = Y + AY + A^2Y + A^3Y + \ldots + A^\infty Y \tag{B-9}$$

As pointed out by Proops et al. (1993, p. 112), Y – the entity on the right hand side to the equation B-9 – represents the direct effect required to fulfil the increase in the final demand, whereas the rest of the entities represent indirect effect of the increase in final demand.

B.1.4 Prices in Input–output Model

The discussion of input–output model in Section B.1.3 focused on output identity (that is, it focused on total output derived from equation B-1). In fact, the specification of input–output model allows the consideration of duality – quantity and price – problem. The flows within the input–output table, as discussed earlier, are represented in value terms (that is, quantity x price). Therefore, the price identity can also be represented in the input–output model.

Using primal-dual relationship within input–output model, equation B-2 can be written in price form as:

$$P_j = \sum_{i=1}^{n} a_{ij} P_i + V_j \tag{B-10}$$

where

P_j: prices of sector j products;

P_i: price of input i paid by sector j; and

V_j: ratio of sector's j value-added to its total output.

From equation B-10, the price of any particular sector j depends on the use of intermediate inputs and the use of primary inputs as a factor of production.

Similar to equation B-5, the complete price system can be written in matrix notation as:

$$\begin{bmatrix} P_1 \\ P_2 \\ \vdots \\ P_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{21} & \cdots & a_{n1} \\ a_{12} & a_{22} & \cdots & a_{n2} \\ \vdots & \vdots & \ddots & \vdots \\ a_{1n} & a_{2n} & \cdots & a_{nn} \end{bmatrix} \cdot \begin{bmatrix} P_1 \\ P_2 \\ \vdots \\ P_n \end{bmatrix} + \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_n \end{bmatrix} \tag{B-11}$$

Equation B-11 can be simplified in its condensed matrix form, similar to equation B-6 as:

$$P = A'P + V \Leftrightarrow P - A'P = V \tag{B-12}$$

where

P: vector of sectoral price indices; and

V: matrix whose generic elements – v_{ij} – represent the ratio of sectoral value added to total output.

Using the basic concepts of matrix algebra, with 'I' as the identity matrix, equation B-12 can be reorganised as:

$$P = \left(I - A'\right)^{-1} V \tag{B-13}$$

Equation B-13 is the Leontief's price model. This model can be used to '*assess the impact on prices throughout the economy of an increase in value-added costs in one or more sectors*' (Dixon & Rimmer 2000; Kula 1998; Melvin 1979; Miller & Blair 1985, p. 356).

Additionally, the impact of changes in the cost of a particular product (instead of value-added costs) on other sector prices can be analysed within input–output model. This can be done by exogenously specifying such product prices and excluding them from the traditional Leontief's price model discussed above (Miller & Blair 1985; Valadkhani & Mitchell 2002). For instance, the impact of changes in energy price (P_E) on other material prices (P_M) can be analysed by assuming P_E as exogenous and estimating P_M endogenously. Thus, according to Valadkhani and Mitchell (2002), equation B-12 can be separated into exogenous and endogenous components:

$$\begin{bmatrix} P_E \\ P_M \end{bmatrix} = \begin{bmatrix} A'_{EE} & A'_{ME} \\ A'_{EM} & A'_{MM} \end{bmatrix} \cdot \begin{bmatrix} P_E \\ P_M \end{bmatrix} + \begin{bmatrix} V_E \\ V_M \end{bmatrix} \tag{B-14}$$

With P_E omitted from the traditional price model, in order to find P_M, equation B-14 can be written as:

$$P_M = A'_{EM} P_E + A'_{MM} P_M + V_M \tag{B-15}$$

Similar to equation B-13, equation B-15 can be written as:

$$P_M = \left[\left(I - A'_{MM}\right)^{-1} A'_{EM} P_E\right] + \left[\left(I - A'_{MM}\right)^{-1} V_M\right] \tag{B-16}$$

Equation B-16 can be used to assess the impact of changes in price of one or more sector throughout the economy.

B.1.5 Capital Stocks in Input–output Model

The discussion of input–output model so far has focused on current flows of goods, needed for current production. The technical coefficients '*A*' reflect the (fixed) relationship between these current flows. However, goods produced in the economy at a particular time not only fulfil current demand but also contribute to the build-up of capital stock. In the basic input–output model, this capital stock is considered as a part of final demand (in quadrant 'B', in Figure B-1). It is lumped together in a single sector called "gross fixed capital expenditure (investment)". Since these investment goods are ultimately used as inputs in production processes, they can be treated as a part of intermediate demand (for capital) rather than of final demand. Following the method proposed by Lenzen (1998), the investment vector needs to be internalised into the intermediate demand matrix and subtracted from the final demand matrix.

Let the output of sector i that is held by sector j as capital stock be denoted as z_{ij}. An extension of equation B-1, by explicitly considering investment, can be written as:

$$X_i = \sum_{j=1}^{n} x_{ij} + \sum_{j=1}^{n} z_{ij} + Y_i^* \qquad \text{(B-17)}$$

Here, Y_i^* refers to all final demand categories excluding the demand for investment.

Again, assuming a Leontief production function, the capital stock held by a particular sector can be expressed by the linear relations:

$$z_{ij} = k_{ij} X_j \Leftrightarrow k_{ij} = \frac{z_{ij}}{X_j} \qquad \text{(B-18)}$$

where

k_{ij}: capital coefficients.

These capital coefficients are defined as the quantities of capital required by sector j that are supplied from sector i per monetary unit of sector's j output (Miernyk 1965). Similar to the table of technical coefficients, a table of capital coefficients shows capital requirements per unit of capacity by industry of origin, for each industry in the input–output model.

By substituting relationship B-18 into equation B-17, the output equation becomes:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + \sum_{j=1}^{n} k_{ij} X_j + Y_i^* \qquad \text{(B-19)}$$

Here the output of sector i is the sum final demand for that sector, the output required for production demand for all sectors, and the output required for investment demand for all sectors.

For a n sector economy, equation B-19 will have a system of n (linear) simultaneous equations, describing the use of each sector's output throughout the economy. This can be written in a condensed matrix form as:

$$X = AX + KX + Y^{*} \Leftrightarrow X - AX - KX = Y^{*} \qquad \text{(B-20)}$$

where

X: column vectors of sectoral outputs;

Y^{*}: column vectors of sectoral final demand excluding demand for investment;

A: matrix of technical coefficients; and

K: matrix of capital coefficients.

Using the basic concepts of matrix algebra, with 'I' as the unit identity matrix, equation B-20 can be reorganised to give:

$$X = \left[I - \left(A + K\right)\right]^{-1} \cdot Y^{*} \qquad \text{(B-21)}$$

Because the 'K' matrix, derived from input–output table, gives the origin of investment inputs to each sector in the year of the survey, there can be severe distortions in the analysis if this matrix is adopted for one year. To avoid such distortion, Miernyk (1965) and Peet (1993) suggested the use of weighted mean capital coefficients derived from several input–output tables. This would levelise the use of investment input, over a certain period, for various production processes in the economy.

B.2 Production Function Model

This section describes the conceptual underpinnings of the production function model employed in this research. The model describes in this section mainly draws from well-known literature on production function models, for example, Christensen et al. (1971; 1973), Binswanger (1974), Berndt and Wood (1975), and Jorgenson (2000). First, a comparison is made between the general Leontief production function and other neoclassical production functions. Then, a brief background of neoclassical production function is given. This is followed by a discussion of production function model that could use the concept of duality between 'cost' and 'production' for empirical analysis. Then the econometric specification of the cost function model employed in this research is discussed. Finally, the derivation of elasticities from the cost function model is presented.

B.2.1 Leontief vs. Neoclassical Production Functions

In microeconomics theory, a production function denotes that maximum output that could be produced from a given set of inputs with the help of the existing technology (Miller & Blair 1985). A general form of production function which relates the inputs of capital, labour, energy, and materials to the production in any sector (or any column of input–output table) can be written as:

$$X = f\left(x_K, x_L, x_E, x_M\right) \tag{B-22}$$

where

X: total sectoral output;

x_K: capital input;

x_L: labour input;

x_E: energy input; and

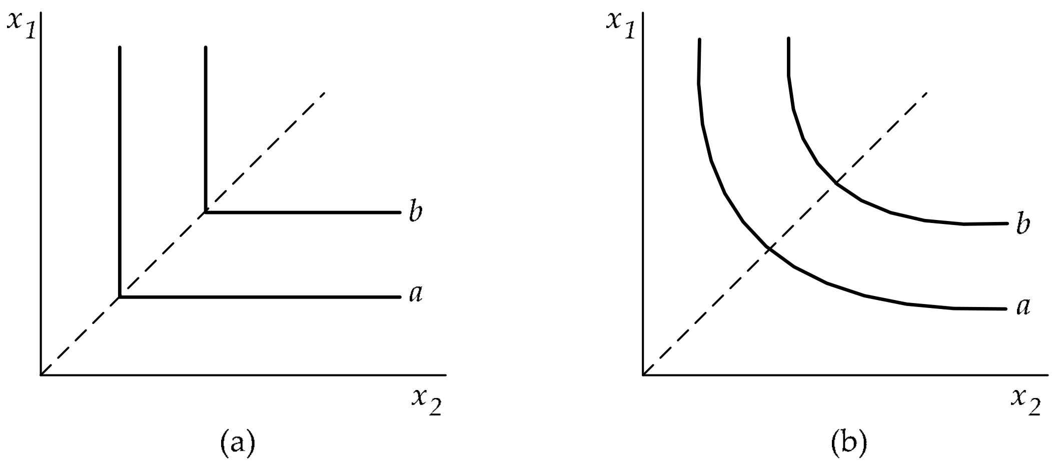
x_M: material input.

As mentioned in Section B.1, the input–output model assumes a fixed proportionality of input–output (technical) coefficients. This assumption implies a linear (and fixed) relationship between a sector's output and its inputs. This type of production function is called a Leontief production function. From the definition of technical coefficients in equation B-3, the Leontief production function can be written as:

$$X = f\left(\frac{x_K}{c_K}, \frac{x_L}{c_L}, \frac{x_E}{a_E}, \frac{x_M}{a_M}\right) = \min\left(\frac{x_K}{c_K}, \frac{x_L}{c_L}, \frac{x_E}{a_E}, \frac{x_M}{a_M}\right) \tag{B-23}$$

For the production function given in equation B-23, when the denominator is not zero, the ratios of all elements will be constant and equal to *X*. This clearly reflects the assumption of constant return to scale. This Leontief production function is shown in Figure B-2 (a). The isoquants (curve of constant output), using a combination of two inputs, are shown as right-angled straight lines. Here, the proportion of inputs x_1 and x_2 to produce a particular level of output is constant. Input substitution is not possible. When one factor input is decreased, it cannot be substituted with other input. Rather, the producer has to decrease the level of production, for instance, shift of isoquant from '*b*' to '*a*'.

Figure B-2 Production functions: (a) Leontief; (b) Neoclassical



On the other hand, a neoclassical production function can be represented as in Figure B-2 (b). Here, in contrast with the Leontief production function, input substitution is possible. This is indicated by the isoquant showing alternative input combinations that can produce the same amount of output. The negative slopes of the isoquants means that when one input is decreased, it will be substituted with other input in order to maintain the same level of production.

Hence, the neoclassical production function is more flexible than the Leontief production function. It reflects economic rationalising behaviour particularly in that it allows the producer (and consumer) to substitutes one input with another.

B.2.2 Background of Neoclassical Production Function

The neoclassical production function was first developed by Cobb and Douglas in the year 1928 (Cobb & Douglas 1928). The Cobb-Douglas production function relates physical output to capital and labour inputs. This type of production function has a constant (equal to 1) elasticity of substitution. The next major contribution was made by Arrow et al. in the year 1961 (Arrow et al. 1961). The production function developed by Arrow et al. also has a constant elasticity of substitution, but it was not restricted to unity. This type of production function is known as the Constant Elasticity of Substitution (CES) production function. The limitation of both functional forms (Cobb-Douglas and CES), especially the underlying constant elasticity of substitution, have arbitrarily restricted the patterns of producer behaviour (Jorgenson 2000). This limitation has led to the development of a more flexible form of production function that allows the elasticity of substitution between inputs to vary. This type of production function is called the Transcendental Logarithmic (Translog) production function developed by Christensen et al. (1971; 1973). Since its inception, the Translog has become the most frequently applied functional form for estimating the elasticities of substitution.

B.2.3 Production Cost Function

Rather than to directly employ a production function which describes the relationship between quantity of output and input (see equation B-22), it is more useful to use the dual cost function which sets up such relationship in terms of costs and prices. This is mainly because each production sector chooses its level of output based on factor prices. Therefore factor prices, rather than quantities of inputs, should be considered as independent variables. Also, the cost-price data are easily available as compared to quantity data. If the factor prices are available, the theory of duality between cost and production (Shephard 1953) implies that, given cost-minimising behaviour, the characteristics of production implied by equation (B-22) can be represented by a unit-output cost function in the form of:

$$G = g\left(P_K, P_L, P_E, P_M\right) \tag{B-24}$$

where

G: cost of producing 1 unit of output;

P_K: price of capital;

P_L: price of labour;

P_E: price of energy; and

P_M: price of material.

The cost function is theoretically consistent if it satisfies the following assumptions (Jorgenson 2000):

- Positivity: The cost function is positive for positive input prices and a positive level of output. This means that the fitted cost shares in input demand function are non-negative.

- Homogeneity: The cost function is homogenous of degree one in the input prices. This means that an equi-proportionate increase in the factor prices of all inputs will increase costs by the same proportionate amount.

- Monotonicity: The cost function is non-decreasing in the input prices and in the level of output. This implies that parameters estimated from cost function must be positive.

- Concavity: The cost function is concave in the factor prices. This implies that the Hessian matrix within the range of factor prices is negative semi-definite, i.e. estimated own-price elasticity must be negative.

B.2.4 Econometric Specification

The Translog cost function is a second-order approximation in logarithms to an arbitrary cost function and it imposes no prior restrictions on the elasticities of substitution and the price elasticities of demand. The function in equation B-24 can be expressed as:

$$\ln G = \ln \alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \quad , \ i, j \in \{K, L, E, M\} \tag{B-25}$$

where

G: unit cost;

P_i, P_j: factor prices; and

α, γ : parameters to be estimated.

The assumption of linear homogeneity in factor prices, as discussed earlier, imposes the following parameter restrictions:

$$\begin{aligned} &\sum_i \alpha_i = 1, \\ &\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0, \\ &\gamma_{ij} \neq \gamma_{ji}, \qquad i \neq j \end{aligned} \tag{B-26}$$

By logarithmically differentiating equation B-25, we get:

$$\frac{\partial \ln G}{\partial \ln P_i} = \frac{\partial G}{\partial P_i} \cdot \frac{P_i}{G} = \alpha_i + \sum_j \gamma_{ij} \ln P_j \qquad , \ i, j \in \{K, L, E, M\} \tag{B-27}$$

Shephard's Lemma deals with the partial derivative of the cost function with respect to the price of the i^{th} input, i.e., $\partial G / \partial P_i = X_i$ (Diewert 1974). Applying this lemma to equation B-27 leads to the factor share system:

$$\frac{P_i X_i}{G} = S_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j \qquad , \ i, j \in \{K, L, E, M\} \tag{B-28}$$

where

S_i: cost shares of the i^{th} input for unit production.

Due to the restriction of linear homogeneity in factor prices, all cost shares also sum up to unity, i.e., $\sum_i S_i = 1$ when $i = K, L, E, M$.

It is also worthwhile to further mention here that the Translog cost function turns into the Cobb-Douglas form if substitution elasticities are restricted to unity. This, according to Binswanger (1974), arises when parameters γ_{ij} in equation B-25 equal to zero. Accordingly, the logarithmic cost function in Cobb-Douglass form can be written as:

$$\ln G = \ln \alpha_0 + \sum_i \alpha_i \ln P_i \qquad , \; i,j \in \{K,L,E,M\} \tag{B-29}$$

Again, by logarithmically differentiating equation B-29, we get:

$$\frac{\partial \ln G}{\partial \ln P_i} = \frac{\partial G}{\partial P_i} \cdot \frac{P_i}{G} = \alpha_i \qquad , \; i,j \in \{K,L,E,M\} \tag{B-30}$$

Applying Shephard's Lemma to equation B-30, cost shares equation yields:

$$\frac{P_i X_i}{G} = S_i = \alpha_i \qquad , \; i,j \in \{K,L,E,M\} \tag{B-31}$$

B.2.5 Elasticities

After all parameters discussed in the previous section have been estimated, the own- and cross-prices elasticities of substitution can be derived from Allen partial Elasticities of Substitution (AES).

Uzawa (1962) proposed that AES between inputs *i* and *j* is:

$$\sigma_{ij} = \frac{G \cdot G_{ij}}{G_i \cdot G_j} \qquad , \; \sigma_{ij} = \sigma_{ji} \tag{B-32}$$

where

$$G_i = \frac{\partial G}{\partial P_i} \quad \text{and} \quad G_{ij} = \frac{\partial^2 G}{\partial P_i \partial P_j}$$

Therefore, the AES derived from the Translog cost function can be defined as;

$$\begin{aligned} \sigma_{ii} &= \frac{\gamma_{ii} + S_i^2 - S_i}{S_i^2} \\ \sigma_{ij} &= \frac{\gamma_{ij} + S_i S_j}{S_i S_j} \end{aligned} \qquad , \; i,j \in \{K,L,E,M\} \text{ and } i \neq j \tag{B-33}$$

From equation B-33, it shows that these AES are not constrained to be constant with parameters γ_{ij}, but it varies with the values of cost shares.

Berndt and Wood (1975) suggested that the price elasticity of demand (η) derived from the Translog cost function can be expressed as;

$$\begin{aligned} \eta_{ii} &= S_i \sigma_{ii} \\ \eta_{ij} &= S_j \sigma_{ij} \end{aligned} \quad , \; i, j \in \{K, L, E, M\} \qquad \text{(B-34)}$$

Contrarily to equation B-34, Binswanger (1974) suggested that the price elasticities of demand derived from Cobb-Douglas cost function can be expressed as:

$$\begin{aligned} \eta_{ii} &= \sigma_i - 1 = S_i - 1 \\ \eta_{ij} &= \sigma_j = S_j \end{aligned} \quad , \; i, j \in \{K, L, E, M\} \qquad \text{(B-35)}$$

Although the price elasticities of demand derived from Cobb-Douglas production function have limitations as compared with those derived on the basis of Translog function, they are still superior than assuming zero elasticities as is the case with Leontief production function.

APPENDIX C

Data-sets required for This Research

This appendix presents all dataset required for this research. The data sources and preparation method is discussed in Section 5.7. It contains the following Tables:

Table C-1 Sectoral classification of 28 sector groups for Australian national input–output tables

SECTORS	1980-1983	1984-1990	1993	1994-1999	2002
1 Primary energy	1200 Coal, oil and gas	1200 Coal, oil and gas	1100 Coal;oil and gas	1100 Coal;oil and gas	1100 Coal;oil and gas
2 Petroleum refining	2708 Petroleum, coal products	2708 Petroleum, coal products	2501 Petroleum and coal	2501 Petroleum and coal	2501 Petroleum and coal
3 Gas Industry	3602 Gas	3602 Gas	3602 Gas supply	3602 Gas supply	3602 Gas supply
4 Renewable electricity	3601 Electricity	3601 Electricity	3601 Electricity	3601 Electricity	3601 Electricity
5 Coal-fired electricity					
6 Internal-combustion					
7 Gas-turbine					
8 Combined-cycle					
9 Agriculture	0101 Sheep	0101 Sheep	0101 Sheep	0101 Sheep	0101 Sheep
	0102 Cereal grains	0102 Cereal grains	0102 Grains	0102 Grains	0102 Grains
	0103 Meat cattle	0103 Meat cattle	0103 Beef cattle	0103 Beef cattle	0103 Beef cattle
	0104 Milk cattle and pigs	0104 Milk cattle and pigs	0104 Dairy cattle	0104 Dairy cattle	0104 Dairy cattle
			0105 Pigs	0105 Pigs	0105 Pigs
	0105 Poultry	0105 Poultry	0106 Poultry	0106 Poultry	0106 Poultry
	0106 Agriculture nec	0106 Agriculture nec	0107 Other agriculture	0107 Other agriculture	0107 Other agriculture
	0200 Services to agriculture	0200 Services to agriculture	0200 Services to	0200 Services to	0200 Services to
	0300 Forestry and logging	0300 Forestry and logging	0300 Forestry and logging	0300 Forestry and logging	0300 Forestry and logging
	0400 Fishing and hunting	0400 Fishing and hunting	0400 Commercial fishing	0400 Commercial fishing	0400 Commercial fishing
10 Raw materials mining	1101 Ferrous metal ores	1101 Ferrous metal ores	1301 Iron ores	1301 Iron ores	1301 Iron ores
	1102 Non-ferrous metal ores	1102 Non-ferrous metal ores	1302 Non-ferrous metal ores	1302 Non-ferrous metal ores	1302 Non-ferrous metal ores
	1400 Other minerals	1400 Minerals nec	1400 Other mining	1400 Other mining	1400 Other mining
	1600 Services to mining nec	1600 Services to mining nec	1500 Services to mining	1500 Services to mining	1500 Services to mining
11 Food industry	2101 Meat products	2101 Meat products	2101 Meat and meat products	2101 Meat and meat products	2101 Meat and meat products
	2102 Milk products	2102 Milk products	2102 Dairy products	2102 Dairy products	2102 Dairy products
	2103 Fruit, vegetable products	2103 Fruit, vegetable products	2103 Fruit and vegetable	2103 Fruit and vegetable	2103 Fruit and vegetable
	2104 Margarine; oils, fats nec	2104 Margarine; oils, fats nec	2104 Oils and fats	2104 Oils and fats	2104 Oils and fats
	2105 Flour mill, cereal products	2105 Flour mill, cereal products	2105 Flour mill products and	2105 Flour mill products and	2105 Flour mill products and
	2106 Bread, cakes, biscuits	2106 Bread, cakes, biscuits	2106 Bakery products	2106 Bakery products	2106 Bakery products
	2107 Confectionery, etc products	2107 Confectionery, etc products	2107 Confectionery	2107 Confectionery	2107 Confectionery
	2108 Food products nec	2108 Food products nec	2108 Other food products	2108 Other food products	2108 Other food products
	2109 Soft drinks, cordials etc	2109 Soft drinks, cordials etc	2109 Soft drinks, cordials and	2109 Soft drinks, cordials and	2109 Soft drinks, cordials and
	2110 Beer and malt	2110 Beer and malt	2110 Beer and malt	2110 Beer and malt	2110 Beer and malt
	2111 Alcoholic beverages nec	2111 Alcoholic beverages nec	2111 Wine and spirits	2111 Wine and spirits	2113 Wine, spirits and tobacco
	2201 Tobacco products	2201 Tobacco products	2112 Tobacco products	2112 Tobacco products	

(continued on next page)

Table C-1 Sectoral classification of 28 sector groups for Australian national input–output tables (continued)

SECTORS (Cont.)	1980-1983	1984-1990	1993	1994-1999	2002
12 Textile industry	2301 Cotton ginning etc	2301 Cotton ginning etc	2201 Wool scouring		
	2302 Man-made fibres etc	2302 Man-made fibres etc	2202 Textile fibres, yarns and	2201 Textile fibres, yarns and	2201 Textile fibres, yarns and
	2303 Cotton fabrics etc	2303 Cotton fabrics etc			
	2304 Wool, worsted fabrics etc	2304 Wool, worsted fabrics etc			
	2305 Textile finishing	2305 Textile finishing			
	2306 Floor coverings etc	2306 Floor coverings etc			
	2307 Textile products nec	2307 Textile products nec	2203 Textile products	2202 Textile products	2202 Textile products
	2401 Knitting mills	2401 Knitting mills	2204 Knitting mill products	2203 Knitting mill products	2203 Knitting mill products
	2402 Clothing	2402 Clothing	2205 Clothing	2204 Clothing	2204 Clothing
	2403 Footwear	2403 Footwear	2206 Footwear	2205 Footwear	2205 Footwear
	3401 Leather products	3401 Leather products	2207 Leather and leather	2206 Leather and leather	2206 Leather and leather
13 Wood & paper industry	2501 Sawmill products	2501 Sawmill products	2301 Sawmill products	2301 Sawmill products	2301 Sawmill products
	2502 Veneers, mfd. wood boards	2502 Veneers, mfd. wood boards	2302 Plywood, veneer and		
	2503 Joinery, wood products nec	2503 Joinery, wood products nec	2303 Other wood products	2302 Other wood products	2302 Other wood products
	2504 Furniture and mattresses	2504 Furniture and mattresses	2902 Furniture	2902 Furniture	2902 Furniture
	2601 Pulp, paper, paperboard	2601 Pulp, paper, paperboard	2304 Pulp, paper and	2303 Pulp, paper and	2303 Pulp, paper and
	2602 Bags and containers	2602 Bags and containers	2305 Paperboard	2304 Paper containers and	2304 Paper containers and
	2603 Paper products nec	2603 Paper products nec	2306 Other paper products		
	2604 Publishing, printing	2604 Publishing, printing	2401 Printing and services to	2401 Printing and services to	2401 Printing and services to
	2605 Printing, stationery etc	2605 Printing, stationery etc	2402 Publishing;recorded media	2402 Publishing;recorded media	2402 Publishing;recorded media
14 Basic chemicals	2701 Chemical fertilisers	2701 Chemical fertilisers	2502 Fertilisers		
	2702 Basic chemicals nec	2702 Basic chemicals nec	2503 Other basic chemicals	2502 Basic chemicals	2502 Basic chemicals
	2703 Paints	2703 Paints	2504 Paints	2503 Paints	2503 Paints
	2704 Pharmaceuticals nec	2704 Pharmaceuticals nec	2505 Medicinal and	2504 Medicinal and	2504 Medicinal and
	2705 Soap and detergents nec	2705 Soap and detergents nec	2506 Soap and other detergents	2505 Soap and detergents	2505 Soap and detergents
	2706 Cosmetics etc	2706 Cosmetics etc	2507 Cosmetics and toiletry	2506 Cosmetics and toiletry	2506 Cosmetics and toiletry
	2707 Chemical products nec	2707 Chemical products nec	2508 Other chemical products	2507 Other chemical products	2507 Other chemical products
	3402 Rubber products	3402 Rubber products	2509 Rubber products	2508 Rubber products	2508 Rubber products
	3403 Plastic, related products	3403 Plastic, related products	2510 Plastic products	2509 Plastic products	2509 Plastic products
15 Non-metallic mineral products	2801 Glass and glass products	2801 Glass and glass products	2601 Glass and glass products	2601 Glass and glass products	2601 Glass and glass products
	2802 Clay products, refractories	2802 Clay products, refractories	2602 Ceramic products	2602 Ceramic products	2602 Ceramic products
	2803 Cement	2803 Cement	2603 Cement and lime	2603 Cement, lime and concrete	2603 Cement, lime and concrete
	2804 Ready mixed concrete	2804 Ready mixed concrete	2604 Concrete slurry		
	2805 Concrete products	2805 Concrete products	2605 Plaster and other concrete	2604 Plaster and other concrete	2604 Plaster and other concrete
	2806 Non-metallic min. products	2806 Non-metallic min. products	2606 Other non-metallic	2605 Other non-metallic	2605 Other non-metallic

(continued on next page)

Table C-1 Sectoral classification of 28 sector groups for Australian national input–output tables (continued)

SECTORS (Cont.)	1980-1983	1984-1990	1993	1994-1999	2002
16 Basic iron and steel	2901 Basic iron and steel	2901 Basic iron and steel	2701 Iron and steel	2701 Iron and steel	2701 Iron and steel
17 Basic non-ferrous metals	2902 Non-ferrous metals etc	2902 Non-ferrous metals etc	2702 Basic non-ferrous metal	2702 Basic non-ferrous metal	2702 Basic non-ferrous metal
18 Fabricated metal products	3101 Structural metal products	3101 Structural metal products	2703 Structural metal products	2703 Structural metal products	2703 Structural metal products
	3102 Sheet metal products	3102 Sheet metal products	2704 Sheet metal products	2704 Sheet metal products	2704 Sheet metal products
	3103 Metal products nec	3103 Metal products nec	2705 Fabricated metal products	2705 Fabricated metal products	2705 Fabricated metal products
19 Machinery and	3201 Motor vehicles nec	3201 Motor vehicles nec	2801 Motor vehicles and	2801 Motor vehicles and	2801 Motor vehicles and
equipment	3202 Ships and boats	3202 Ships and boats	2802 Ships and boats	2802 Ships and boats	2802 Ships and boats
	3203 Railway rollingstock etc	3203 Railway rollingstock etc	2803 Railway equipment	2803 Railway equipment	2803 Railway equipment
	3204 Aircraft	3204 Aircraft	2804 Aircraft	2804 Aircraft	2804 Aircraft
	3301 Scientific etc equipment	3301 Scientific etc equipment	2805 Photographic and	2805 Photographic and	2805 Photographic and
	3302 Electronic equipment	3302 Electronic equipment	2806 Electronic equipment	2806 Electronic equipment	2806 Electronic equipment
	3303 Household appliances	3303 Household appliances	2807 Household appliances	2807 Household appliances	2807 Household appliances
	3304 Electrical equipment nec	3304 Electrical equipment nec	2808 Other electrical equipment	2808 Other electrical equipment	2808 Other electrical equipment
	3305 Agricultural machinery	3305 Agricultural machinery	2809 Agricultural machinery	2809 Agricultural, mining and c	2809 Agricultural, mining and c
	3306 Construction etc machinery	3306 Construction etc machinery	2810 Mining and construction		
	3307 Machinery, equipment etc	3307 Machinery, equipment nec	2811 Other machinery and	2810 Other machinery and	2810 Other machinery and
20 Miscellenous	3404 Signs, writing equipment	3404 Signs, writing equipment			
manufacturing	3405 Manufacturing nec	3405 Manufacturing nec	2903 Other manufacturing	2903 Other manufacturing	2903 Other manufacturing
21 Water, sewerage &	3701 Water, sewerage, drainage	3701 Water, sewerage, drainage	3701 Water supply;sewerage	3701 Water supply;sewerage	3701 Water supply;sewerage
drainage			and drainage services	and drainage services	and drainage services
22 Construction	4101 Residential building	4101 Residential building	4101 Residential building	4101 Residential building	4101 Residential building
	4102 Construction nec	4102 Construction nec	4102 Other construction	4102 Other construction	4102 Other construction
					4201 Construction trade services
			2901 Prefabricated buildings	2901 Prefabricated buildings	2901 Prefabricated buildings
23 Road transport	5101 Road transport	5101 Road transport	6101 Road transport	6101 Road transport	6101 Road transport
24 Railway transport	5201 Rail, transport nec	5201 Rail, transport nec	6201 Rail, pipeline and other	6201 Rail, pipeline and other	6201 Rail, pipeline and other
25 Water transport	5301 Water transport	5301 Water transport	6301 Water transport	6301 Water transport	6301 Water transport
26 Air Transport	5401 Air transport	5401 Air transport	6401 Air and space transport	6401 Air and space transport	6401 Air and space transport
27 Other transport, services		5701 Services to transport	6601 Services to	6601 Services to	6601 Services to
and storage	4901 Mechanical repairs	4901 Mechanical repairs	5401 Mechanical repairs	5401 Mechanical repairs	4502 Wholesale mechanical
					5101 Retail mechanical repairs
	4902 Repairs nec	4902 Repairs nec	5402 Other repairs	5402 Other repairs	4503 Other wholesale repairs
					5103 Other retail repairs

(continued on next page)

Table C-1 Sectoral classification of 28 sector groups for Australian national input–output tables (continued)

SECTORS (Cont.)		1980-1983		1984-1990		1993		1994-1999		2002	
28	Commercial services	4701	Wholesale trade	4701	Wholesale trade	4501	Wholesale trade	4501	Wholesale trade	4501	Wholesale trade
		4801	Retail trade	4801	Retail trade	5101	Retail trade	5101	Retail trade	5101	Retail trade
		5601	Communication	5901	Communication	7101	Communication services	7101	Communication services	7101	Communication services
		6101	Banking	6101	Banking	7301	Banking	7301	Banking	7301	Banking
		6102	Non-bank finance	6102	Non-bank finance	7302	Non-bank finance	7302	Non-bank finance	7302	Non-bank finance
		6103	Investment etc	6103	Investment etc	7303	Financial asset investors				
		6104	Insurance etc	6104	Insurance etc	7401	Insurance	7401	Insurance	7401	Insurance
		6105	Business services nec	6105	Business services nec	7501	Services to finance, investm	7501	Services to finance, investm	7501	Services to finance,
		6106	Ownership of dwellings	6106	Ownership of dwellings	7701	Ownership of dwellings	7701	Ownership of dwellings	7701	Ownership of dwellings
						7702	Other property services	7702	Other property services	7702	Other property services
						7801	Scientific research, technica	7801	Scientific research, technica	7801	Scientific research,
						7802	Legal, accounting, marketir	7802	Legal, accounting, marketir	7802	Legal, accounting,
						7803	Other business services	7803	Other business services	7803	Other business services
		7101	Public administration	7101	Public administration	8101	Government administratior	8101	Government administratior	8101	Government
		7201	Defence	7201	Defence	8201	Defence	8201	Defence	8201	Defence
		8101	Health	8101	Health	8601	Health services	8601	Health services	8601	Health services
		8201	Education, libraries etc	8201	Education, libraries etc	8401	Education	8401	Education	8401	Education
						9201	Libraries, museums and the	9201	Libraries, museums and the	9201	Libraries, museums and
		8301	Welfare etc services	8301	Welfare etc services	8701	Community services	8701	Community services	8701	Community services
		9101	Entertainment etc	9101	Entertainment etc	9101	Motion picture, radio and te	9101	Motion picture, radio and te	9101	Motion picture, radio and
						9301	Sport, gambling and recreat	9301	Sport, gambling and recreat	9301	Sport, gambling and
		9201	Restaurants, hotels, clubs	9201	Restaurants, hotels, clubs	5701	Accommodation, cafes and	5701	Accommodation, cafes and	5701	Accommodation, cafes and
		9301	Personal services	9301	Personal services	9501	Personal services	9501	Personal services	9501	Personal services
						9601	Other services	9601	Other services	9601	Other services

Note: The column on the left-hand-side of this Table represents sectoral classification in this research. The other columns represent sectoral classification (with codes and titles) taken from the Australian Bureau of Statistics (ABS various).

Table C-2 Capital distribution factors for each electricity generation technology

	CF	IC	GT	CC	RE
1980	0.6623	0.0118	0.0129	-	0.3129
1981	0.6765	0.0126	0.0120	-	0.2989
1982	0.6901	0.0123	0.0147	-	0.2829
1983	0.6958	0.0126	0.0146	-	0.2770
1984	0.7062	0.0117	0.0143	-	0.2678
1985	0.7080	0.0110	0.0139	-	0.2672
1986	0.7103	0.0109	0.0136	-	0.2652
1987	0.7142	0.0110	0.0142	-	0.2606
1988	0.7120	0.0102	0.0140	0.0016	0.2622
1989	0.7136	0.0102	0.0140	0.0016	0.2606
1990	0.7054	0.0111	0.0160	0.0016	0.2658
1991	0.7002	0.0107	0.0171	0.0017	0.2704
1992	0.6965	0.0105	0.0196	0.0016	0.2718
1993	0.7072	0.0093	0.0190	0.0016	0.2629
1994	0.7153	0.0093	0.0194	0.0015	0.2544
1995	0.7205	0.0089	0.0193	0.0016	0.2497
1996	0.7205	0.0089	0.0193	0.0016	0.2497
1997	0.7231	0.0085	0.0204	0.0020	0.2459
1998	0.7277	0.0066	0.0204	0.0019	0.2435
1999	0.7250	0.0062	0.0237	0.0102	0.2349
2000	0.7218	0.0073	0.0261	0.0101	0.2347
2001	0.7222	0.0062	0.0253	0.0168	0.2294
2002	0.7195	0.0064	0.0337	0.0201	0.2203

Notes:
- CF: Coal-fired, IC: Internal-combustion, GT: Gas-turbine, CC: Combined-cycle, RE: Renewable;
- The information contained in this Table is calculated from economic and technical characteristics of power plants (given in Table 5-6) and annual installed capacity of each technology, published by the Electricity Supply Association of Australia (ESAA various).

Table C-2 O&M distribution factors for each electricity generation technology

	CF	IC	GT	CC	RE
1980	0.7428	0.0134	0.0104	-	0.2335
1981	0.7545	0.0141	0.0096	-	0.2218
1982	0.7658	0.0137	0.0117	-	0.2088
1983	0.7704	0.0140	0.0115	-	0.2041
1984	0.7792	0.0130	0.0113	-	0.1966
1985	0.7808	0.0122	0.0110	-	0.1961
1986	0.7827	0.0121	0.0107	-	0.1945
1987	0.7859	0.0121	0.0111	-	0.1908
1988	0.7845	0.0113	0.0110	0.0009	0.1922
1989	0.7858	0.0113	0.0111	0.0009	0.1910
1990	0.7787	0.0123	0.0127	0.0010	0.1953
1991	0.7746	0.0118	0.0135	0.0010	0.1991
1992	0.7715	0.0117	0.0155	0.0010	0.2003
1993	0.7806	0.0103	0.0150	0.0009	0.1931
1994	0.7872	0.0103	0.0153	0.0009	0.1863
1995	0.7915	0.0098	0.0152	0.0009	0.1825
1996	0.7915	0.0098	0.0152	0.0009	0.1825
1997	0.7938	0.0094	0.0160	0.0012	0.1796
1998	0.7980	0.0073	0.0160	0.0011	0.1776
1999	0.7968	0.0068	0.0186	0.0060	0.1718
2000	0.7938	0.0081	0.0205	0.0059	0.1717
2001	0.7953	0.0069	0.0199	0.0099	0.1681
2002	0.7930	0.0071	0.0265	0.0118	0.1615

Notes:
- CF: Coal-fired, IC: Internal-combustion, GT: Gas-turbine, CC: Combined-cycle, RE: Renewable;
- The information contained in this Table is calculated from economic and technical characteristics of power plants (given in Table 5-6) and annual electricity generation from each technology, published by the Electricity Supply Association of Australia (ESAA various).

Table C-3 Matrix of input–output technical coefficients (*A*)

(1980)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0280	0.3524	0.1540	-	0.0853	-	-	-	0.0000	0.0009	0.0007	0.0002	0.0010	0.0011	0.0092	0.0442	0.0118	0.0001	0.0001	0.0056	0.0005	0.0001	0.0002	0.0073	0.0070	-	-	0.0005
2	0.0047	0.0813	0.0214	-	0.0273	0.3295	0.0280	-	0.0396	0.0309	0.0076	0.0049	0.0090	0.0145	0.0263	0.0202	0.0410	0.0056	0.0022	0.0053	0.0220	0.0151	0.1131	0.0297	0.0910	0.1401	0.0083	0.0071
3	0.0000	0.0006	0.0005	-	0.0077	-	0.1183	-	0.0001	0.0001	0.0011	0.0005	0.0006	0.0023	0.0104	0.0010	0.0008	0.0015	0.0006	0.0003	-	0.0003	0.0009	0.0002	0.0009	0.0004	0.0003	0.0008
4	0.0018	0.0006	0.0008	0.2056	-	-	-	-	0.0010	0.0040	0.0013	0.0011	0.0013	0.0019	0.0032	0.0046	0.0031	0.0011	0.0006	0.0009	0.0049	0.0002	0.0003	0.0017	0.0019	0.0004	0.0021	0.0014
5	0.0097	0.0034	0.0042	-	0.2705	-	-	-	0.0051	0.0211	0.0069	0.0056	0.0071	0.0102	0.0169	0.0241	0.0165	0.0056	0.0033	0.0046	0.0258	0.0011	0.0017	0.0092	0.0103	0.0019	0.0109	0.0072
6	0.0001	0.0000	0.0000	-	-	0.1288	-	-	0.0000	0.0002	0.0001	0.0000	0.0001	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001
7	0.0002	0.0001	0.0001	-	-	-	0.2565	-	0.0001	0.0004	0.0001	0.0001	0.0001	0.0002	0.0003	0.0004	0.0003	0.0001	0.0001	0.0001	0.0004	0.0000	0.0000	0.0002	0.0002	0.0000	0.0002	0.0001
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0042	0.0000	0.0000	0.0001	0.0002	0.0001	0.0002	-	0.0656	0.0003	0.3280	0.0475	0.0248	0.0006	0.0001	0.0001	0.0000	0.0001	0.0000	0.0020	0.0001	0.0011	0.0002	0.0030	0.0001	0.0003	0.0001	0.0010
10	0.0538	0.0015	-	-	-	-	-	-	0.0004	0.0797	0.0004	-	0.0004	0.0072	0.0971	0.0414	0.3570	0.0001	0.0002	0.0765	0.0005	0.0110	0.0004	0.0006	0.0004	-	-	0.0001
11	0.0009	0.0002	0.0003	0.0003	0.0004	0.0002	0.0003	-	0.0404	0.0045	0.1515	0.0058	0.0016	0.0147	0.0010	0.0034	0.0002	0.0008	0.0008	0.0008	0.0011	0.0012	0.0011	0.0016	0.0006	0.0016	0.0012	0.0027
12	0.0008	0.0004	0.0003	0.0001	0.0001	0.0001	0.0001	-	0.0020	0.0010	0.0028	0.2764	0.0136	0.0124	0.0019	0.0036	0.0003	0.0064	0.0037	0.0124	0.0003	0.0018	0.0045	0.0148	0.0089	0.0022	0.0008	0.0032
13	0.0032	0.0006	0.0012	0.0008	0.0011	0.0005	0.0010	-	0.0065	0.0036	0.0233	0.0052	0.2329	0.0141	0.0142	0.0030	0.0008	0.0100	0.0092	0.0186	0.0037	0.0626	0.0034	0.0350	0.0103	0.0161	0.0032	0.0267
14	0.0105	0.0130	0.0033	0.0006	0.0005	0.0006	0.0004	-	0.0461	0.0210	0.0319	0.0274	0.0416	0.2765	0.0415	0.0130	0.0115	0.0239	0.0324	0.0698	0.0190	0.0290	0.0377	0.0043	0.0062	0.0060	0.0091	0.0124
15	0.0005	0.0000	0.0007	0.0004	0.0004	0.0004	0.0003	-	0.0004	0.0016	0.0089	0.0008	0.0035	0.0048	0.0893	0.0177	0.0035	0.0052	0.0033	0.0005	0.0054	0.1056	0.0010	0.0002	-	-	0.0024	0.0019
16	0.0053	0.0001	0.0005	0.0012	0.0009	0.0011	0.0007	-	0.0001	0.0103	0.0007	0.0001	0.0065	0.0021	0.0180	0.2490	0.0047	0.2322	0.0386	0.0108	0.0013	0.0254	0.0003	0.0017	0.0003	-	0.0001	0.0013
17	0.0001	0.0012	0.0003	0.0001	0.0001	0.0001	0.0000	-	0.0001	0.0011	0.0003	0.0004	0.0047	0.0070	0.0035	0.0385	0.1321	0.0768	0.0315	0.0118	0.0004	0.0083	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003
18	0.0037	0.0000	0.0121	0.0010	0.0008	0.0009	0.0006	-	0.0010	0.0086	0.0289	0.0019	0.0051	0.0075	0.0032	0.0118	0.0029	0.0831	0.0279	0.0135	0.0279	0.0971	0.0005	0.0039	0.0029	0.0008	0.0038	0.0063
19	0.0207	0.0007	0.0017	0.0071	0.0056	0.0066	0.0044	-	0.0116	0.0498	0.0033	0.0012	0.0089	0.0024	0.0040	0.0071	0.0008	0.0092	0.1745	0.0041	0.0111	0.0743	0.0550	0.0739	0.0311	0.0640	0.1951	0.0171
20	0.0001	0.0000	0.0005	0.0003	0.0002	0.0003	0.0002	-	0.0008	0.0003	0.0013	0.0005	0.0017	0.0018	0.0010	0.0018	0.0055	0.0007	0.0010	0.0473	0.0004	0.0003	0.0003	0.0013	0.0005	0.0004	0.0004	0.0022
21	0.0005	0.0006	0.0017	0.0008	0.0010	0.0005	0.0009	-	0.0071	0.0020	0.0032	0.0005	0.0009	0.0023	0.0042	0.0026	0.0006	0.0009	0.0004	0.0003	-	0.0013	0.0001	0.0050	0.0081	0.0000	0.0015	0.0126
22	0.0069	0.0002	0.0006	0.0021	0.0011	0.0013	0.0012	-	0.0019	0.0141	0.0017	0.0010	0.0013	0.0012	0.0026	0.0005	0.0001	0.0008	0.0004	0.0003	0.0111	-	0.0006	0.0634	0.0006	0.0000	-	0.0110
23	0.0071	0.0042	0.0012	0.0015	0.0041	0.0115	0.0043	-	0.0147	0.0196	0.0254	0.0070	0.0210	0.0155	0.0682	0.0151	0.0088	0.0096	0.0073	0.0070	0.0033	0.0305	0.0186	0.0048	0.0038	0.0054	0.0069	0.0054
24	0.0056	0.0010	0.0418	0.0032	0.0094	0.0021	0.0043	-	0.0030	0.0078	0.0086	0.0020	0.0039	0.0029	0.0131	0.0140	0.0217	0.0037	0.0022	0.0057	0.0008	0.0035	0.0024	0.0024	0.0073	0.0463	0.0020	0.0043
25	0.0006	0.0053	0.0003	0.0010	0.0027	0.0034	0.0019	-	0.0009	0.0163	0.0009	0.0010	0.0021	0.0024	0.0058	0.0284	0.0055	0.0039	0.0013	0.0011	0.0003	0.0017	0.0009	0.0008	0.1333	0.0007	0.0007	0.0013
26	0.0019	0.0002	0.0009	0.0004	0.0005	0.0002	0.0005	-	0.0019	0.0080	0.0016	0.0029	0.0023	0.0022	0.0028	0.0008	0.0012	0.0018	0.0020	0.0052	0.0021	0.0016	0.0015	0.0037	0.0012	0.0612	0.0009	0.0053
27	0.0027	0.0001	0.0006	0.0004	0.0010	0.0003	0.0049	-	0.0141	0.0087	0.0034	0.0003	0.0019	0.0011	0.0025	0.0006	0.0002	0.0015	0.0009	0.0006	0.0011	0.0031	0.0425	0.0132	0.0010	0.0014	0.0006	0.0062
28	0.0300	0.0249	0.0904	0.1060	0.0838	0.0987	0.0653	-	0.0653	0.1286	0.0844	0.0784	0.0878	0.0772	0.0641	0.0421	0.0304	0.0679	0.0581	0.0689	0.0877	0.0918	0.1290	0.1079	0.1154	0.0892	0.1254	0.1598

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1980, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1981)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0479	0.3806	0.2041	-	0.1202	-	-	-	0.0002	0.0014	0.0009	0.0002	0.0010	0.0015	0.0108	0.0464	0.0120	0.0005	0.0002	0.0064	0.0006	0.0003	0.0028	0.0013	0.0078	-	-	0.0008
2	0.0052	0.0319	0.0505	-	0.0360	0.4598	0.0091	-	0.0396	0.0384	0.0085	0.0091	0.0132	0.0235	0.0254	0.0314	0.0539	0.0068	0.0023	0.0058	0.0242	0.0197	0.0994	0.0346	0.0827	0.1506	0.0073	0.0080
3	0.0000	0.0001	0.0009	-	0.0099	-	0.1579	-	0.0001	0.0001	0.0014	0.0007	0.0006	0.0025	0.0114	0.0011	0.0009	0.0016	0.0005	0.0004	-	0.0004	0.0008	0.0003	0.0011	0.0005	0.0004	0.0009
4	0.0018	0.0001	0.0012	0.2161	-	-	-	-	0.0010	0.0043	0.0014	0.0017	0.0015	0.0020	0.0034	0.0046	0.0034	0.0011	0.0006	0.0009	0.0063	0.0002	0.0003	0.0021	0.0021	0.0004	0.0020	0.0015
5	0.0091	0.0003	0.0063	-	0.2562	-	-	-	0.0050	0.0221	0.0073	0.0090	0.0077	0.0105	0.0175	0.0238	0.0173	0.0054	0.0030	0.0048	0.0323	0.0013	0.0014	0.0107	0.0106	0.0019	0.0103	0.0076
6	0.0001	0.0000	0.0001	-	-	0.1088	-	-	0.0000	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001
7	0.0003	0.0000	0.0002	-	-	-	0.3094	-	0.0002	0.0007	0.0002	0.0003	0.0002	0.0003	0.0005	0.0007	0.0005	0.0002	0.0001	0.0001	0.0010	0.0000	0.0000	0.0003	0.0003	0.0001	0.0003	0.0002
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0034	0.0000	0.0000	0.0002	0.0002	0.0001	0.0002	-	0.0879	0.0003	0.3239	0.0397	0.0235	0.0007	0.0001	0.0001	0.0000	0.0001	0.0000	0.0023	0.0001	0.0010	0.0002	0.0028	0.0000	0.0004	0.0001	0.0009
10	0.0595	0.0001	-	-	-	-	-	-	0.0004	0.0944	0.0004	-	0.0005	0.0093	0.1004	0.0330	0.3074	0.0001	0.0002	0.0571	0.0006	0.0107	0.0004	0.0007	0.0005	-	-	0.0002
11	0.0008	0.0000	0.0005	0.0005	0.0005	0.0002	0.0007	-	0.0440	0.0042	0.1507	0.0156	0.0015	0.0125	0.0010	0.0030	0.0002	0.0008	0.0007	0.0008	0.0013	0.0013	0.0009	0.0017	0.0006	0.0018	0.0011	0.0026
12	0.0007	0.0000	0.0004	0.0002	0.0002	0.0001	0.0002	-	0.0021	0.0011	0.0029	0.2690	0.0122	0.0122	0.0015	0.0034	0.0003	0.0062	0.0031	0.0194	0.0004	0.0022	0.0037	0.0175	0.0094	0.0024	0.0008	0.0031
13	0.0029	0.0000	0.0019	0.0013	0.0016	0.0007	0.0019	-	0.0063	0.0039	0.0230	0.0056	0.2245	0.0138	0.0143	0.0027	0.0007	0.0094	0.0078	0.0188	0.0043	0.0628	0.0027	0.0398	0.0101	0.0189	0.0030	0.0257
14	0.0129	0.0010	0.0044	0.0010	0.0008	0.0007	0.0004	-	0.0506	0.0242	0.0328	0.0253	0.0418	0.2735	0.0393	0.0124	0.0166	0.0221	0.0286	0.0690	0.0220	0.0312	0.0411	0.0044	0.0059	0.0066	0.0092	0.0124
15	0.0004	0.0000	0.0009	0.0006	0.0005	0.0005	0.0002	-	0.0003	0.0016	0.0091	0.0002	0.0034	0.0048	0.0849	0.0174	0.0037	0.0044	0.0025	0.0005	0.0061	0.1019	0.0007	0.0003	-	-	0.0018	0.0018
16	0.0059	0.0000	0.0009	0.0024	0.0019	0.0018	0.0010	-	0.0001	0.0137	0.0010	0.0001	0.0076	0.0032	0.0196	0.2412	0.0052	0.2355	0.0365	0.0117	0.0016	0.0285	0.0005	0.0020	0.0005	-	0.0001	0.0016
17	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0000	-	0.0001	0.0032	0.0004	0.0004	0.0053	0.0084	0.0038	0.0487	0.1669	0.0822	0.0303	0.0120	0.0004	0.0085	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
18	0.0036	0.0000	0.0178	0.0013	0.0010	0.0010	0.0005	-	0.0008	0.0086	0.0281	0.0007	0.0053	0.0072	0.0029	0.0121	0.0038	0.0813	0.0241	0.0126	0.0330	0.1005	0.0004	0.0041	0.0033	0.0009	0.0037	0.0056
19	0.0228	0.0001	0.0022	0.0104	0.0081	0.0079	0.0041	-	0.0116	0.0568	0.0035	0.0013	0.0088	0.0023	0.0036	0.0068	0.0009	0.0086	0.1615	0.0042	0.0138	0.0731	0.0526	0.0783	0.0319	0.0680	0.2043	0.0188
20	0.0001	0.0000	0.0007	0.0004	0.0003	0.0003	0.0002	-	0.0008	0.0004	0.0013	0.0005	0.0016	0.0018	0.0009	0.0015	0.0049	0.0006	0.0010	0.0478	0.0004	0.0005	0.0002	0.0014	0.0005	0.0005	0.0003	0.0021
21	0.0004	0.0000	0.0023	0.0011	0.0014	0.0006	0.0016	-	0.0060	0.0020	0.0031	0.0005	0.0008	0.0020	0.0041	0.0023	0.0006	0.0008	0.0003	0.0002	-	0.0013	0.0001	0.0051	0.0073	0.0000	0.0012	0.0127
22	0.0073	0.0000	0.0008	0.0030	0.0016	0.0015	0.0011	-	0.0015	0.0196	0.0017	0.0016	0.0013	0.0011	0.0026	0.0004	0.0001	0.0007	0.0004	0.0003	0.0128	-	0.0005	0.0672	0.0005	0.0000	-	0.0108
23	0.0069	0.0011	0.0031	0.0024	0.0061	0.0159	0.0068	-	0.0149	0.0247	0.0266	0.0088	0.0209	0.0166	0.0726	0.0163	0.0102	0.0100	0.0068	0.0074	0.0037	0.0307	0.0161	0.0052	0.0034	0.0055	0.0068	0.0054
24	0.0064	0.0005	0.0404	0.0059	0.0156	0.0032	0.0091	-	0.0030	0.0072	0.0106	0.0019	0.0039	0.0029	0.0141	0.0147	0.0190	0.0038	0.0020	0.0060	0.0009	0.0038	0.0020	0.0018	0.0075	0.0471	0.0019	0.0046
25	0.0005	0.0046	0.0006	0.0014	0.0037	0.0043	0.0029	-	0.0009	0.0226	0.0010	0.0010	0.0022	0.0023	0.0058	0.0233	0.0060	0.0041	0.0012	0.0012	0.0003	0.0018	0.0008	0.0005	0.1182	0.0007	0.0007	0.0011
26	0.0047	0.0000	0.0013	0.0006	0.0007	0.0003	0.0009	-	0.0015	0.0096	0.0016	0.0032	0.0025	0.0021	0.0025	0.0008	0.0012	0.0017	0.0018	0.0050	0.0025	0.0018	0.0012	0.0041	0.0012	0.0628	0.0009	0.0050
27	0.0032	0.0000	0.0009	0.0006	0.0015	0.0004	0.0081	-	0.0132	0.0107	0.0038	0.0003	0.0022	0.0011	0.0027	0.0007	0.0002	0.0015	0.0009	0.0007	0.0013	0.0038	0.0339	0.0150	0.0010	0.0017	0.0006	0.0061
28	0.0308	0.0115	0.0619	0.0489	0.0384	0.0374	0.0196	-	0.0690	0.1629	0.0915	0.0896	0.0960	0.0834	0.0656	0.0446	0.0424	0.0709	0.0565	0.0724	0.0613	0.1112	0.1709	0.1279	0.1114	0.0920	0.1273	0.1666

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1981, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (A) (continued)

(1982)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0330	0.3856	0.1963	-	0.1296	-	-	-	0.0001	0.0015	0.0008	0.0002	0.0011	0.0012	0.0106	0.0544	0.0176	0.0003	0.0001	0.0063	0.0006	0.0002	0.0011	0.0011	0.0088	-	-	0.0006
2	0.0072	0.0550	0.0686	-	0.0383	0.4805	0.0219	-	0.0555	0.0455	0.0077	0.0109	0.0129	0.0225	0.0234	0.0298	0.0796	0.0072	0.0024	0.0056	0.0191	0.0112	0.0712	0.0491	0.0737	0.1364	0.0071	0.0084
3	0.0000	0.0002	0.0020	-	0.0147	-	0.1848	-	0.0001	0.0002	0.0015	0.0009	0.0009	0.0031	0.0147	0.0015	0.0020	0.0020	0.0007	0.0004	-	0.0005	0.0005	0.0004	0.0014	0.0004	0.0004	0.0010
4	0.0018	0.0004	0.0024	0.2435	-	-	-	-	0.0012	0.0034	0.0011	0.0008	0.0014	0.0015	0.0026	0.0055	0.0053	0.0010	0.0006	0.0005	0.0065	0.0003	0.0002	0.0028	0.0024	0.0003	0.0020	0.0015
5	0.0099	0.0024	0.0133	-	0.2658	-	-	-	0.0065	0.0189	0.0061	0.0041	0.0076	0.0080	0.0146	0.0303	0.0290	0.0053	0.0031	0.0029	0.0355	0.0014	0.0009	0.0152	0.0132	0.0014	0.0109	0.0083
6	0.0001	0.0000	0.0001	-	-	0.1237	-	-	0.0001	0.0002	0.0001	0.0000	0.0001	0.0001	0.0001	0.0003	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001
7	0.0003	0.0001	0.0004	-	-	-	0.2934	-	0.0002	0.0006	0.0002	0.0001	0.0002	0.0002	0.0005	0.0009	0.0009	0.0002	0.0001	0.0001	0.0011	0.0000	0.0000	0.0005	0.0004	0.0000	0.0003	0.0003
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0036	0.0000	0.0001	0.0002	0.0002	0.0001	0.0002	-	0.0920	0.0004	0.3041	0.0382	0.0230	0.0006	0.0001	0.0001	0.0000	0.0001	0.0000	0.0022	0.0001	0.0009	0.0001	0.0032	0.0001	0.0002	0.0001	0.0009
10	0.0847	0.0004	-	-	-	-	-	-	0.0006	0.1188	0.0004	-	0.0005	0.0082	0.0940	0.0274	0.2614	0.0001	0.0002	0.0374	0.0006	0.0104	0.0003	0.0008	0.0007	-	-	0.0001
11	0.0009	0.0000	0.0009	0.0006	0.0007	0.0003	0.0008	-	0.0428	0.0051	0.1557	0.0107	0.0018	0.0102	0.0011	0.0035	0.0005	0.0008	0.0006	0.0008	0.0013	0.0013	0.0005	0.0023	0.0006	0.0013	0.0010	0.0025
12	0.0009	0.0001	0.0007	0.0002	0.0002	0.0001	0.0003	-	0.0023	0.0014	0.0031	0.2616	0.0111	0.0131	0.0011	0.0037	0.0005	0.0059	0.0029	0.0098	0.0004	0.0021	0.0023	0.0213	0.0100	0.0017	0.0007	0.0030
13	0.0031	0.0002	0.0037	0.0018	0.0020	0.0009	0.0022	-	0.0066	0.0049	0.0240	0.0062	0.2211	0.0142	0.0170	0.0030	0.0013	0.0100	0.0083	0.0186	0.0043	0.0655	0.0016	0.0521	0.0114	0.0133	0.0031	0.0264
14	0.0166	0.0037	0.0084	0.0013	0.0009	0.0009	0.0005	-	0.0527	0.0327	0.0324	0.0258	0.0411	0.2717	0.0382	0.0145	0.0279	0.0214	0.0291	0.0624	0.0197	0.0309	0.0257	0.0052	0.0078	0.0043	0.0090	0.0126
15	0.0004	0.0000	0.0017	0.0008	0.0006	0.0005	0.0003	-	0.0003	0.0020	0.0099	0.0004	0.0037	0.0049	0.0934	0.0163	0.0055	0.0048	0.0025	0.0005	0.0057	0.1000	0.0004	0.0004	-	-	0.0016	0.0016
16	0.0068	0.0000	0.0014	0.0031	0.0023	0.0021	0.0012	-	0.0001	0.0163	0.0008	0.0001	0.0078	0.0028	0.0174	0.2615	0.0102	0.2290	0.0333	0.0112	0.0014	0.0307	0.0002	0.0016	0.0004	-	0.0000	0.0012
17	0.0002	0.0004	0.0005	0.0001	0.0001	0.0001	0.0000	-	0.0001	0.0011	0.0002	0.0004	0.0057	0.0062	0.0024	0.0313	0.1524	0.0663	0.0237	0.0089	0.0003	0.0083	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
18	0.0038	0.0000	0.0191	0.0017	0.0012	0.0011	0.0007	-	0.0008	0.0093	0.0271	0.0012	0.0052	0.0070	0.0030	0.0126	0.0074	0.0901	0.0221	0.0116	0.0310	0.1051	0.0002	0.0048	0.0028	0.0005	0.0030	0.0051
19	0.0315	0.0002	0.0031	0.0130	0.0094	0.0088	0.0051	-	0.0141	0.0684	0.0034	0.0017	0.0091	0.0026	0.0035	0.0069	0.0013	0.0090	0.1707	0.0033	0.0108	0.0746	0.0341	0.0716	0.0308	0.0570	0.1921	0.0157
20	0.0001	0.0000	0.0013	0.0004	0.0003	0.0003	0.0002	-	0.0009	0.0004	0.0013	0.0005	0.0016	0.0018	0.0009	0.0012	0.0056	0.0007	0.0009	0.0457	0.0004	0.0003	0.0001	0.0019	0.0005	0.0003	0.0003	0.0020
21	0.0005	0.0002	0.0039	0.0014	0.0015	0.0007	0.0017	-	0.0059	0.0022	0.0028	0.0005	0.0009	0.0020	0.0043	0.0024	0.0010	0.0008	0.0003	0.0002	-	0.0012	0.0000	0.0058	0.0072	0.0000	0.0010	0.0108
22	0.0024	0.0000	0.0013	0.0035	0.0017	0.0016	0.0013	-	0.0014	0.0067	0.0015	0.0021	0.0013	0.0010	0.0025	0.0004	0.0002	0.0007	0.0003	0.0003	0.0108	-	0.0002	0.0736	0.0005	0.0000	-	0.0126
23	0.0075	0.0024	0.0050	0.0028	0.0063	0.0169	0.0067	-	0.0162	0.0258	0.0307	0.0088	0.0207	0.0164	0.0702	0.0164	0.0119	0.0097	0.0067	0.0102	0.0032	0.0284	0.0212	0.0065	0.0101	0.0081	0.0061	0.0065
24	0.0066	0.0005	0.0311	0.0055	0.0132	0.0029	0.0071	-	0.0034	0.0078	0.0104	0.0013	0.0040	0.0028	0.0134	0.0135	0.0152	0.0034	0.0018	0.0052	0.0009	0.0026	0.0012	0.0023	0.0072	0.0445	0.0016	0.0046
25	0.0008	0.0046	0.0008	0.0018	0.0042	0.0053	0.0032	-	0.0011	0.0360	0.0012	0.0010	0.0021	0.0019	0.0056	0.0232	0.0065	0.0042	0.0012	0.0012	0.0003	0.0020	0.0006	0.0006	0.1363	0.0007	0.0007	0.0013
26	0.0046	0.0001	0.0026	0.0008	0.0009	0.0004	0.0010	-	0.0017	0.0115	0.0015	0.0032	0.0027	0.0023	0.0028	0.0008	0.0022	0.0019	0.0018	0.0049	0.0025	0.0018	0.0007	0.0051	0.0013	0.0444	0.0007	0.0049
27	0.0034	0.0000	0.0017	0.0009	0.0019	0.0006	0.0086	-	0.0143	0.0125	0.0036	0.0003	0.0023	0.0011	0.0029	0.0007	0.0003	0.0016	0.0009	0.0007	0.0013	0.0040	0.0199	0.0191	0.0011	0.0011	0.0007	0.0059
28	0.0336	0.0194	0.1103	0.0680	0.0495	0.0463	0.0269	-	0.0744	0.2168	0.0904	0.0888	0.0967	0.0858	0.0702	0.0464	0.0482	0.0730	0.0570	0.0667	0.0622	0.1033	0.1129	0.1558	0.1249	0.0680	0.1255	0.1642

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1982, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1983)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0288	0.3538	0.2386	-	0.1167	-	-	-	0.0002	0.0012	0.0007	0.0002	0.0012	0.0013	0.0108	0.0568	0.0160	0.0004	0.0001	0.0051	0.0004	0.0003	0.0009	0.0012	0.0068	-	-	0.0005
2	0.0075	0.0824	0.0764	-	0.0322	0.5115	0.0275	-	0.0693	0.0406	0.0079	0.0080	0.0140	0.0226	0.0254	0.0338	0.0740	0.0083	0.0025	0.0065	0.0177	0.0121	0.0577	0.0525	0.0731	0.1225	0.0071	0.0082
3	0.0001	0.0007	0.0024	-	0.0202	-	0.2031	-	0.0001	0.0002	0.0017	0.0010	0.0012	0.0038	0.0179	0.0021	0.0023	0.0026	0.0008	0.0005	-	0.0006	0.0004	0.0005	0.0015	0.0006	0.0004	0.0010
4	0.0018	0.0005	0.0002	0.2372	-	-	-	-	0.0016	0.0030	0.0011	0.0008	0.0015	0.0017	0.0028	0.0048	0.0050	0.0010	0.0006	0.0005	0.0060	0.0003	0.0001	0.0029	0.0024	0.0003	0.0021	0.0015
5	0.0118	0.0030	0.0015	-	0.2801	-	-	-	0.0105	0.0195	0.0071	0.0051	0.0100	0.0110	0.0183	0.0312	0.0326	0.0066	0.0037	0.0033	0.0391	0.0020	0.0008	0.0189	0.0156	0.0022	0.0135	0.0097
6	0.0001	0.0000	0.0000	-	-	0.1182	-	-	0.0001	0.0002	0.0001	0.0000	0.0001	0.0001	0.0002	0.0003	0.0003	0.0001	0.0000	0.0000	0.0003	0.0000	0.0000	0.0002	0.0001	0.0000	0.0001	0.0001
7	0.0002	0.0001	0.0000	-	-	-	0.2522	-	0.0002	0.0003	0.0001	0.0001	0.0002	0.0002	0.0003	0.0006	0.0006	0.0001	0.0001	0.0001	0.0007	0.0000	0.0000	0.0003	0.0003	0.0000	0.0002	0.0002
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0029	0.0000	0.0001	0.0002	0.0003	0.0001	0.0002	-	0.1093	0.0004	0.2886	0.0415	0.0222	0.0005	0.0001	0.0001	0.0000	0.0001	0.0000	0.0019	0.0001	0.0007	0.0001	0.0027	0.0001	0.0003	0.0001	0.0009
10	0.1000	0.0008	-	-	-	-	-	-	0.0004	0.1095	0.0003	-	0.0005	0.0081	0.0981	0.0432	0.2764	0.0001	0.0001	0.0310	0.0004	0.0106	0.0002	0.0008	0.0007	-	-	0.0001
11	0.0013	0.0001	0.0010	0.0007	0.0008	0.0003	0.0007	-	0.0592	0.0049	0.1572	0.0124	0.0021	0.0125	0.0012	0.0045	0.0005	0.0010	0.0007	0.0008	0.0012	0.0014	0.0004	0.0023	0.0006	0.0018	0.0010	0.0023
12	0.0009	0.0002	0.0007	0.0002	0.0002	0.0001	0.0002	-	0.0025	0.0012	0.0028	0.2697	0.0089	0.0105	0.0009	0.0039	0.0004	0.0063	0.0026	0.0113	0.0003	0.0018	0.0016	0.0185	0.0083	0.0019	0.0006	0.0027
13	0.0037	0.0004	0.0044	0.0021	0.0025	0.0010	0.0022	-	0.0081	0.0044	0.0243	0.0068	0.2202	0.0164	0.0193	0.0041	0.0014	0.0121	0.0086	0.0195	0.0042	0.0595	0.0014	0.0539	0.0112	0.0184	0.0033	0.0245
14	0.0173	0.0082	0.0079	0.0013	0.0009	0.0008	0.0007	-	0.0547	0.0240	0.0308	0.0250	0.0424	0.2707	0.0360	0.0170	0.0224	0.0225	0.0273	0.0638	0.0153	0.0301	0.0178	0.0047	0.0066	0.0049	0.0078	0.0113
15	0.0007	0.0000	0.0017	0.0008	0.0006	0.0005	0.0004	-	0.0002	0.0017	0.0099	0.0004	0.0036	0.0058	0.0989	0.0186	0.0047	0.0052	0.0023	0.0005	0.0050	0.0920	0.0003	0.0003	-	-	0.0015	0.0014
16	0.0078	0.0000	0.0012	0.0021	0.0015	0.0013	0.0011	-	0.0001	0.0140	0.0006	0.0001	0.0072	0.0020	0.0197	0.2607	0.0068	0.2205	0.0266	0.0100	0.0012	0.0303	0.0001	0.0015	0.0002	-	0.0000	0.0010
17	0.0002	0.0007	0.0005	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0014	0.0002	0.0005	0.0051	0.0057	0.0023	0.0295	0.1517	0.0642	0.0216	0.0076	0.0003	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
18	0.0043	0.0000	0.0169	0.0017	0.0012	0.0011	0.0009	-	0.0009	0.0072	0.0262	0.0010	0.0050	0.0074	0.0026	0.0135	0.0066	0.0862	0.0199	0.0105	0.0251	0.1010	0.0001	0.0042	0.0028	0.0005	0.0026	0.0046
19	0.0361	0.0008	0.0036	0.0160	0.0109	0.0098	0.0083	-	0.0141	0.0588	0.0050	0.0028	0.0122	0.0045	0.0044	0.0083	0.0015	0.0106	0.1730	0.0034	0.0122	0.0769	0.0246	0.0757	0.0427	0.0561	0.1819	0.0173
20	0.0001	0.0000	0.0014	0.0005	0.0004	0.0003	0.0003	-	0.0012	0.0004	0.0013	0.0005	0.0019	0.0021	0.0011	0.0016	0.0064	0.0008	0.0009	0.0518	0.0004	0.0004	0.0001	0.0020	0.0005	0.0004	0.0003	0.0019
21	0.0007	0.0004	0.0048	0.0016	0.0019	0.0008	0.0017	-	0.0085	0.0023	0.0033	0.0006	0.0012	0.0025	0.0056	0.0035	0.0012	0.0010	0.0003	0.0003	-	0.0016	0.0000	0.0066	0.0079	0.0000	0.0012	0.0116
22	0.0042	0.0001	0.0015	0.0045	0.0021	0.0018	0.0022	-	0.0019	0.0082	0.0017	0.0014	0.0016	0.0013	0.0029	0.0006	0.0002	0.0008	0.0004	0.0003	0.0105	-	0.0002	0.0808	0.0005	0.0000	-	0.0129
23	0.0086	0.0043	0.0049	0.0023	0.0057	0.0149	0.0053	-	0.0219	0.0216	0.0320	0.0099	0.0211	0.0173	0.0695	0.0177	0.0114	0.0101	0.0064	0.0099	0.0028	0.0274	0.0187	0.0064	0.0093	0.0087	0.0058	0.0059
24	0.0067	0.0006	0.0306	0.0044	0.0113	0.0023	0.0050	-	0.0044	0.0068	0.0105	0.0018	0.0042	0.0029	0.0147	0.0140	0.0142	0.0033	0.0017	0.0050	0.0008	0.0028	0.0009	0.0022	0.0067	0.0463	0.0016	0.0035
25	0.0008	0.0044	0.0008	0.0014	0.0036	0.0042	0.0023	-	0.0014	0.0298	0.0012	0.0011	0.0021	0.0018	0.0061	0.0276	0.0066	0.0038	0.0010	0.0011	0.0003	0.0018	0.0004	0.0005	0.1289	0.0006	0.0006	0.0011
26	0.0056	0.0002	0.0031	0.0010	0.0012	0.0005	0.0010	-	0.0021	0.0105	0.0018	0.0037	0.0034	0.0029	0.0035	0.0012	0.0026	0.0024	0.0019	0.0056	0.0025	0.0022	0.0006	0.0055	0.0014	0.0475	0.0008	0.0048
27	0.0044	0.0001	0.0020	0.0010	0.0023	0.0006	0.0088	-	0.0178	0.0120	0.0039	0.0004	0.0027	0.0013	0.0033	0.0010	0.0003	0.0019	0.0008	0.0007	0.0013	0.0046	0.0160	0.0207	0.0011	0.0015	0.0007	0.0056
28	0.0447	0.0316	0.1236	0.0819	0.0561	0.0503	0.0425	-	0.0947	0.2092	0.0972	0.0955	0.1135	0.0981	0.0817	0.0572	0.0522	0.0866	0.0605	0.0749	0.0620	0.1147	0.0891	0.1658	0.1359	0.0831	0.1290	0.1664

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1983, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (A) (continued)

(1984)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.0358	0.3112	0.2439	-	0.1140	-	-	-	0.0001	0.0006	0.0007	0.0002	0.0013	0.0013
2	0.0068	0.0940	0.0284	-	0.0272	0.4923	0.0166	-	0.0642	0.0248	0.0059	0.0028	0.0071	0.0214
3	0.0001	0.0018	0.0047	-	0.0070	-	0.0803	-	0.0002	0.0001	0.0022	0.0015	0.0023	0.0037
4	0.0020	0.0005	0.0002	0.2190	-	-	-	-	0.0012	0.0029	0.0011	0.0007	0.0015	0.0016
5	0.0136	0.0035	0.0013	-	0.2783	-	-	-	0.0086	0.0205	0.0078	0.0051	0.0101	0.0114
6	0.0001	0.0000	0.0000	-	-	0.1227	-	-	0.0001	0.0002	0.0001	0.0000	0.0001	0.0001
7	0.0002	0.0001	0.0000	-	-	-	0.2796	-	0.0001	0.0003	0.0001	0.0001	0.0002	0.0002
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0033	0.0000	0.0003	0.0002	0.0003	0.0001	0.0003	-	0.0711	0.0004	0.2847	0.0402	0.0236	0.0010
10	0.1063	0.0047	-	-	-	-	-	-	0.0006	0.1359	0.0001	-	0.0013	0.0061
11	0.0016	0.0001	0.0016	0.0013	0.0016	0.0007	0.0016	-	0.0412	0.0044	0.1414	0.0063	0.0031	0.0093
12	0.0011	0.0008	0.0010	0.0003	0.0004	0.0002	0.0004	-	0.0027	0.0010	0.0029	0.2724	0.0147	0.0103
13	0.0040	0.0009	0.0051	0.0026	0.0033	0.0015	0.0033	-	0.0054	0.0035	0.0261	0.0077	0.1989	0.0143
14	0.0193	0.0196	0.0106	0.0020	0.0014	0.0012	0.0013	-	0.0453	0.0240	0.0332	0.0242	0.0424	0.2597
15	0.0006	0.0000	0.0018	0.0012	0.0009	0.0008	0.0008	-	0.0002	0.0013	0.0123	0.0002	0.0038	0.0048
16	0.0102	0.0037	0.0014	0.0011	0.0008	0.0007	0.0007	-	0.0001	0.0095	0.0007	0.0003	0.0056	0.0026
17	0.0002	0.0018	0.0005	0.0002	0.0001	0.0001	0.0001	-	0.0001	0.0014	0.0003	0.0003	0.0042	0.0075
18	0.0044	0.0001	0.0205	0.0025	0.0018	0.0015	0.0016	-	0.0009	0.0070	0.0260	0.0029	0.0084	0.0061
19	0.0292	0.0016	0.0055	0.0193	0.0139	0.0118	0.0123	-	0.0110	0.0374	0.0037	0.0008	0.0107	0.0018
20	0.0001	0.0000	0.0024	0.0008	0.0006	0.0005	0.0005	-	0.0010	0.0003	0.0007	0.0016	0.0012	0.0017
21	0.0008	0.0007	0.0071	0.0028	0.0036	0.0016	0.0036	-	0.0089	0.0028	0.0025	0.0005	0.0017	0.0014
22	0.0025	0.0002	0.0007	0.0024	0.0011	0.0010	0.0014	-	0.0006	0.0053	0.0007	0.0006	0.0009	0.0005
23	0.0080	0.0070	0.0031	0.0017	0.0045	0.0122	0.0045	-	0.0136	0.0186	0.0268	0.0092	0.0174	0.0121
24	0.0042	0.0068	0.0224	0.0049	0.0136	0.0029	0.0068	-	0.0022	0.0030	0.0073	0.0012	0.0019	0.0012
25	0.0003	0.0127	0.0002	0.0002	0.0005	0.0006	0.0003	-	0.0003	0.0158	0.0003	0.0003	0.0007	0.0006
26	0.0029	0.0002	0.0045	0.0016	0.0021	0.0009	0.0021	-	0.0019	0.0081	0.0017	0.0032	0.0027	0.0031
27	0.0138	0.0053	0.0033	0.0016	0.0043	0.0012	0.0182	-	0.0173	0.0129	0.0092	0.0010	0.0088	0.0045
28	0.0508	0.0390	0.1454	0.0955	0.0690	0.0585	0.0610	-	0.0788	0.1505	0.1087	0.1013	0.1181	0.1013

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0089	0.0338	0.0091	0.0005	0.0001	0.0024	0.0004	0.0002	0.0003	0.0012	0.0038	-	-	0.0009
2	0.0101	0.0069	0.1190	0.0048	0.0016	0.0031	0.0381	0.0111	0.0701	0.0738	0.0882	0.1097	0.0108	0.0109
3	0.0209	0.0061	0.0144	0.0017	0.0007	0.0003	-	0.0007	0.0001	0.0002	0.0000	0.0002	0.0006	0.0018
4	0.0027	0.0034	0.0052	0.0010	0.0006	0.0005	0.0029	0.0002	0.0003	0.0030	0.0001	0.0002	0.0022	0.0017
5	0.0187	0.0236	0.0365	0.0068	0.0042	0.0036	0.0202	0.0016	0.0021	0.0207	0.0009	0.0015	0.0156	0.0116
6	0.0002	0.0002	0.0003	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0001
7	0.0003	0.0004	0.0006	0.0001	0.0001	0.0001	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000	0.0003	0.0002
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0001	0.0001	0.0000	0.0001	0.0000	0.0038	0.0000	0.0006	0.0000	0.0038	0.0000	0.0005	0.0000	0.0010
10	0.0746	0.0499	0.2269	0.0019	0.0003	0.0311	0.0004	0.0143	0.0002	0.0042	0.0007	-	-	0.0002
11	0.0013	0.0002	0.0001	0.0009	0.0004	0.0017	0.0007	0.0013	0.0002	0.0027	0.0006	0.0008	0.0007	0.0030
12	0.0011	0.0035	0.0003	0.0095	0.0036	0.0157	0.0002	0.0017	0.0011	0.0045	0.0034	0.0012	0.0008	0.0037
13	0.0300	0.0035	0.0016	0.0106	0.0074	0.0219	0.0019	0.0555	0.0039	0.0291	0.0129	0.0090	0.0022	0.0274
14	0.0427	0.0119	0.0124	0.0264	0.0303	0.0716	0.0104	0.0282	0.0209	0.0078	0.0050	0.0091	0.0055	0.0116
15	0.1126	0.0100	0.0012	0.0069	0.0044	0.0083	0.0026	0.0909	0.0001	0.0003	-	-	0.0006	0.0013
16	0.0254	0.2673	0.0029	0.2039	0.0294	0.0082	0.0007	0.0269	0.0000	0.0016	0.0000	-	0.0001	0.0008
17	0.0033	0.0364	0.1725	0.0734	0.0205	0.0069	0.0001	0.0076	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
18	0.0030	0.0132	0.0038	0.0896	0.0196	0.0113	0.0128	0.0889	0.0022	0.0100	0.0068	0.0006	0.0015	0.0051
19	0.0044	0.0045	0.0011	0.0113	0.1677	0.0037	0.0043	0.0608	0.0145	0.1939	0.0483	0.0638	0.0900	0.0169
20	0.0011	0.0008	0.0026	0.0003	0.0010	0.0301	0.0002	0.0003	0.0006	0.0025	0.0004	0.0003	0.0003	0.0022
21	0.0012	0.0019	0.0012	0.0002	0.0003	0.0001	-	0.0016	0.0000	0.0000	0.0032	0.0000	0.0007	0.0125
22	0.0010	0.0002	0.0000	0.0003	0.0001	0.0001	0.0020	-	0.0034	0.0757	0.0100	0.0037	0.0119	0.0107
23	0.0505	0.0114	0.0086	0.0096	0.0052	0.0093	0.0020	0.0244	0.0037	0.0072	0.0056	0.0044	0.0078	0.0061
24	0.0091	0.0145	0.0141	0.0019	0.0008	0.0013	0.0004	0.0012	0.0006	0.0010	0.0012	0.0009	0.0023	0.0005
25	0.0023	0.0121	0.0119	0.0011	0.0003	0.0003	0.0001	0.0005	0.0001	0.0011	0.0874	0.0002	0.0002	0.0007
26	0.0025	0.0010	0.0009	0.0025	0.0018	0.0038	0.0016	0.0022	0.0015	0.0007	0.0020	0.0025	0.0030	0.0054
27	0.0157	0.0119	0.0066	0.0043	0.0024	0.0062	0.0010	0.0058	0.0425	0.0156	0.1085	0.0891	0.0239	0.0140
28	0.0965	0.0577	0.0691	0.0957	0.0640	0.0778	0.0434	0.0974	0.1168	0.1212	0.1220	0.0907	0.1367	0.1663

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1984, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1987)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0180	0.2042	0.2845	-	0.1382	-	-	-	0.0003	0.0015	0.0015	0.0004	0.0014	0.0037	0.0110	0.0164	0.0141	0.0012	0.0004	0.0039	0.0001	0.0002	0.0005	0.0022	0.0014	-	-	0.0007
2	0.0052	0.1172	0.0050	-	0.0190	0.4666	0.0278	-	0.0570	0.0166	0.0037	0.0010	0.0053	0.0083	0.0095	0.0074	0.0710	0.0034	0.0011	0.0018	0.0250	0.0092	0.0557	0.0680	0.0792	0.0891	0.0083	0.0092
3	0.0001	0.0023	0.0009	-	0.0244	-	0.1358	-	0.0001	0.0002	0.0025	0.0015	0.0019	0.0037	0.0216	0.0092	0.0286	0.0016	0.0006	0.0003	-	0.0003	0.0000	0.0001	0.0000	0.0001	0.0003	0.0008
4	0.0019	0.0004	0.0001	0.2018	-	-	-	-	0.0014	0.0026	0.0010	0.0006	0.0013	0.0013	0.0022	0.0028	0.0059	0.0008	0.0005	0.0004	0.0027	0.0003	0.0003	0.0031	0.0002	0.0003	0.0023	0.0015
5	0.0150	0.0032	0.0007	-	0.2617	-	-	-	0.0104	0.0198	0.0079	0.0049	0.0097	0.0097	0.0173	0.0214	0.0455	0.0060	0.0036	0.0031	0.0209	0.0020	0.0021	0.0240	0.0012	0.0021	0.0178	0.0118
6	0.0001	0.0000	0.0000	-	-	0.0962	-	-	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001
7	0.0001	0.0000	0.0000	-	-	-	0.1291	-	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0030	0.0004	0.0001	0.0002	0.0003	0.0001	0.0001	-	0.0789	0.0006	0.2867	0.0640	0.0206	0.0008	0.0001	0.0001	0.0000	0.0001	0.0000	0.0028	0.0000	0.0004	0.0000	0.0036	0.0000	0.0007	0.0000	0.0030
10	0.0344	0.0252	-	-	-	-	-	-	0.0006	0.1018	0.0003	-	0.0013	0.0064	0.0535	0.0637	0.2376	0.0011	0.0003	0.0458	0.0002	0.0095	0.0001	0.0028	0.0005	-	-	0.0001
11	0.0018	0.0011	0.0006	0.0008	0.0011	0.0004	0.0005	-	0.0423	0.0043	0.1285	0.0202	0.0032	0.0143	0.0011	0.0002	0.0000	0.0007	0.0004	0.0010	0.0005	0.0009	0.0002	0.0021	0.0007	0.0008	0.0006	0.0061
12	0.0020	0.0070	0.0010	0.0003	0.0004	0.0002	0.0002	-	0.0045	0.0013	0.0027	0.2624	0.0204	0.0121	0.0015	0.0076	0.0004	0.0128	0.0041	0.0370	0.0001	0.0013	0.0014	0.0060	0.0099	0.0013	0.0011	0.0033
13	0.0055	0.0081	0.0024	0.0023	0.0029	0.0011	0.0014	-	0.0059	0.0041	0.0199	0.0041	0.1998	0.0132	0.0358	0.0038	0.0013	0.0101	0.0070	0.0175	0.0019	0.0533	0.0037	0.0285	0.0155	0.0099	0.0025	0.0283
14	0.0267	0.0882	0.0048	0.0016	0.0011	0.0012	0.0016	-	0.0575	0.0297	0.0301	0.0134	0.0374	0.2412	0.0429	0.0133	0.0100	0.0264	0.0302	0.0631	0.0083	0.0302	0.0144	0.0072	0.0056	0.0105	0.0053	0.0121
15	0.0007	0.0003	0.0010	0.0012	0.0009	0.0009	0.0012	-	0.0002	0.0016	0.0119	0.0001	0.0039	0.0041	0.1166	0.0119	0.0007	0.0084	0.0050	0.0043	0.0022	0.0882	0.0001	0.0004	-	-	0.0009	0.0013
16	0.0154	0.0040	0.0006	0.0008	0.0005	0.0006	0.0008	-	0.0001	0.0086	0.0006	0.0002	0.0045	0.0026	0.0235	0.2713	0.0021	0.1850	0.0241	0.0068	0.0006	0.0251	0.0000	0.0013	0.0000	-	0.0001	0.0007
17	0.0002	0.0081	0.0003	0.0002	0.0001	0.0001	0.0002	-	0.0001	0.0030	0.0003	0.0002	0.0044	0.0073	0.0041	0.0494	0.1574	0.0817	0.0208	0.0053	0.0001	0.0079	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
18	0.0066	0.0010	0.0082	0.0021	0.0015	0.0016	0.0021	-	0.0009	0.0083	0.0246	0.0013	0.0074	0.0056	0.0031	0.0149	0.0027	0.0851	0.0200	0.0080	0.0123	0.0813	0.0019	0.0103	0.0093	0.0007	0.0017	0.0052
19	0.0369	0.0142	0.0030	0.0192	0.0133	0.0146	0.0191	-	0.0099	0.0415	0.0032	0.0005	0.0124	0.0018	0.0055	0.0065	0.0009	0.0127	0.1472	0.0031	0.0038	0.0760	0.0091	0.1598	0.0827	0.0636	0.0873	0.0203
20	0.0002	0.0004	0.0010	0.0007	0.0005	0.0005	0.0007	-	0.0016	0.0004	0.0007	0.0011	0.0013	0.0018	0.0013	0.0011	0.0028	0.0003	0.0012	0.0234	0.0002	0.0004	0.0005	0.0023	0.0004	0.0004	0.0003	0.0023
21	0.0013	0.0063	0.0034	0.0023	0.0030	0.0011	0.0015	-	0.0093	0.0037	0.0022	0.0003	0.0018	0.0013	0.0013	0.0022	0.0009	0.0002	0.0003	0.0001	-	0.0017	0.0000	0.0000	0.0039	0.0000	0.0008	0.0110
22	0.0031	0.0013	0.0002	0.0015	0.0007	0.0007	0.0014	-	0.0005	0.0056	0.0004	0.0001	0.0006	0.0004	0.0007	0.0001	0.0000	0.0002	0.0001	0.0001	0.0013	-	0.0014	0.0712	0.0067	0.0025	0.0066	0.0101
23	0.0113	0.0340	0.0016	0.0018	0.0049	0.0122	0.0030	-	0.0169	0.0239	0.0284	0.0143	0.0181	0.0123	0.0524	0.0139	0.0086	0.0105	0.0050	0.0096	0.0019	0.0249	0.0037	0.0079	0.0072	0.0059	0.0073	0.0071
24	0.0023	0.0007	0.0972	0.0061	0.0169	0.0031	0.0042	-	0.0014	0.0045	0.0078	0.0009	0.0011	0.0011	0.0076	0.0145	0.0086	0.0019	0.0005	0.0010	0.0002	0.0008	0.0003	0.0006	0.0007	0.0005	0.0017	0.0004
25	0.0009	0.0243	0.0001	0.0001	0.0004	0.0004	0.0001	-	0.0004	0.0053	0.0004	0.0003	0.0006	0.0006	0.0022	0.0115	0.0131	0.0012	0.0003	0.0002	0.0001	0.0005	0.0001	0.0006	0.0497	0.0002	0.0004	0.0007
26	0.0027	0.0017	0.0016	0.0010	0.0014	0.0005	0.0007	-	0.0017	0.0077	0.0012	0.0017	0.0021	0.0024	0.0021	0.0010	0.0006	0.0020	0.0014	0.0023	0.0011	0.0019	0.0010	0.0008	0.0018	0.0022	0.0020	0.0051
27	0.0154	0.0083	0.0017	0.0017	0.0046	0.0011	0.0097	-	0.0198	0.0143	0.0071	0.0015	0.0069	0.0033	0.0118	0.0044	0.0030	0.0038	0.0020	0.0032	0.0009	0.0057	0.0372	0.0196	0.1832	0.0781	0.0153	0.0146
28	0.0517	0.1457	0.0783	0.0787	0.0546	0.0601	0.0785	-	0.0928	0.1340	0.1122	0.0960	0.1249	0.1074	0.1134	0.0628	0.0605	0.1079	0.0715	0.0700	0.0402	0.0996	0.1237	0.1179	0.1543	0.1097	0.1493	0.1775

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1987, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (A) (continued)

(1990)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0098	0.3850	0.3712	-	0.1350	-	-	-	0.0000	0.0022	0.0008	0.0003	0.0011	0.0018	0.0041	0.0095	0.0143	0.0002	0.0001	0.0003	0.0002	0.0001	0.0001	0.0008	0.0013	-	-	0.0002
2	0.0039	0.0531	0.0036	-	0.0109	0.2889	0.0054	-	0.0242	0.0140	0.0022	0.0011	0.0033	0.0068	0.0082	0.0093	0.0160	0.0021	0.0008	0.0008	0.0191	0.0105	0.0543	0.0289	0.0323	0.0932	0.0038	0.0042
3	0.0001	0.0020	0.0016	-	0.0365	-	0.2847	0.3447	0.0001	0.0003	0.0022	0.0015	0.0015	0.0036	0.0228	0.0038	0.0198	0.0014	0.0007	0.0002	-	0.0010	0.0002	0.0002	0.0000	0.0002	0.0004	0.0013
4	0.0014	0.0002	0.0001	0.1654	-	-	-	-	0.0013	0.0021	0.0008	0.0005	0.0011	0.0009	0.0019	0.0009	0.0046	0.0005	0.0003	0.0003	0.0053	0.0004	0.0006	0.0034	0.0002	0.0002	0.0018	0.0013
5	0.0122	0.0016	0.0008	-	0.2601	-	-	-	0.0112	0.0179	0.0070	0.0046	0.0095	0.0078	0.0164	0.0076	0.0391	0.0045	0.0028	0.0026	0.0454	0.0037	0.0056	0.0294	0.0014	0.0020	0.0157	0.0113
6	0.0000	0.0000	0.0000	-	-	0.0946	-	-	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000
7	0.0002	0.0000	0.0000	-	-	-	0.1733	-	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0005	0.0001	0.0000	0.0000	0.0006	0.0000	0.0001	0.0004	0.0000	0.0000	0.0002	0.0001
8	0.0001	0.0000	0.0000	-	-	-	-	0.2834	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001
9	0.0030	0.0001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0004	0.0910	0.0012	0.2884	0.0339	0.0192	0.0025	0.0011	0.0002	0.0017	0.0004	0.0001	0.0021	0.0001	0.0009	0.0001	0.0052	0.0000	0.0019	0.0001	0.0030
10	0.0479	0.0031	-	-	-	-	-	-	0.0013	0.0885	0.0000	0.0000	0.0009	0.0091	0.0675	0.0606	0.2531	0.0039	0.0003	0.0603	0.0016	0.0085	0.0000	0.0000	0.0000	-	-	0.0003
11	0.0016	0.0004	0.0008	0.0008	0.0012	0.0004	0.0008	0.0013	0.0415	0.0045	0.1321	0.0077	0.0032	0.0160	0.0005	0.0002	0.0001	0.0008	0.0005	0.0005	0.0015	0.0013	0.0004	0.0035	0.0008	0.0005	0.0006	0.0066
12	0.0009	0.0010	0.0008	0.0002	0.0003	0.0001	0.0002	0.0003	0.0047	0.0010	0.0016	0.2335	0.0120	0.0060	0.0008	0.0051	0.0002	0.0085	0.0031	0.0135	0.0002	0.0018	0.0023	0.0121	0.0081	0.0002	0.0006	0.0031
13	0.0037	0.0031	0.0024	0.0016	0.0025	0.0009	0.0017	0.0027	0.0044	0.0043	0.0194	0.0104	0.1917	0.0168	0.0232	0.0035	0.0011	0.0150	0.0117	0.0131	0.0039	0.0429	0.0068	0.0279	0.0097	0.0055	0.0015	0.0268
14	0.0230	0.0666	0.0120	0.0019	0.0014	0.0020	0.0012	0.0004	0.0549	0.0412	0.0252	0.0247	0.0447	0.2110	0.0311	0.0200	0.0184	0.0235	0.0356	0.0465	0.0313	0.0217	0.0274	0.0111	0.0057	0.0102	0.0049	0.0120
15	0.0010	0.0001	0.0021	0.0025	0.0019	0.0027	0.0015	0.0005	0.0039	0.0029	0.0083	0.0000	0.0034	0.0032	0.1175	0.0174	0.0017	0.0095	0.0031	0.0051	0.0074	0.0878	0.0006	0.0004	-	-	0.0009	0.0024
16	0.0153	0.0011	0.0006	0.0007	0.0005	0.0007	0.0004	0.0001	0.0000	0.0078	0.0001	0.0004	0.0075	0.0023	0.0090	0.1586	0.0038	0.1690	0.0436	0.0202	0.0011	0.0276	0.0000	0.0018	0.0000	-	0.0000	0.0008
17	0.0002	0.0007	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0002	0.0026	0.0010	0.0004	0.0031	0.0124	0.0021	0.1164	0.1371	0.0749	0.0176	0.0164	0.0001	0.0049	0.0000	0.0001	0.0000	0.0000	0.0000	0.0002
18	0.0079	0.0006	0.0098	0.0016	0.0012	0.0017	0.0010	0.0003	0.0008	0.0197	0.0183	0.0015	0.0118	0.0058	0.0124	0.0063	0.0020	0.1048	0.0230	0.0163	0.0206	0.0748	0.0023	0.0463	0.0104	0.0006	0.0021	0.0046
19	0.0330	0.0019	0.0029	0.0124	0.0090	0.0131	0.0075	0.0025	0.0162	0.0439	0.0015	0.0009	0.0100	0.0012	0.0022	0.0040	0.0005	0.0093	0.1039	0.0056	0.0086	0.0705	0.0546	0.0554	0.0577	0.0517	0.1067	0.0195
20	0.0001	0.0002	0.0007	0.0005	0.0003	0.0005	0.0003	0.0001	0.0015	0.0003	0.0002	0.0022	0.0008	0.0011	0.0004	0.0010	0.0023	0.0002	0.0012	0.0262	0.0003	0.0010	0.0011	0.0019	0.0003	0.0003	0.0002	0.0016
21	0.0003	0.0002	0.0035	0.0018	0.0029	0.0010	0.0019	0.0031	0.0100	0.0019	0.0007	0.0008	0.0013	0.0008	0.0004	0.0022	0.0008	0.0001	0.0004	0.0000	-	0.0005	0.0000	0.0000	0.0044	0.0000	0.0006	0.0117
22	0.0029	0.0006	0.0002	0.0013	0.0006	0.0009	0.0007	0.0003	0.0005	0.0082	0.0001	0.0009	0.0005	0.0002	0.0003	0.0001	0.0000	0.0002	0.0001	0.0000	0.0027	0.0001	0.0055	0.0658	0.0097	0.0029	0.0068	0.0054
23	0.0110	0.0122	0.0014	0.0015	0.0048	0.0129	0.0034	0.0044	0.0195	0.0346	0.0326	0.0140	0.0226	0.0148	0.0718	0.0171	0.0093	0.0115	0.0061	0.0101	0.0045	0.0315	0.0066	0.0055	0.0063	0.0066	0.0076	0.0062
24	0.0017	0.0003	0.0874	0.0047	0.0157	0.0028	0.0053	0.0084	0.0011	0.0033	0.0051	0.0006	0.0008	0.0008	0.0043	0.0124	0.0062	0.0019	0.0006	0.0004	0.0003	0.0006	0.0004	0.0004	0.0004	0.0005	0.0014	0.0003
25	0.0005	0.0210	0.0000	0.0001	0.0003	0.0003	0.0001	0.0002	0.0003	0.0079	0.0003	0.0002	0.0003	0.0003	0.0010	0.0176	0.0059	0.0011	0.0001	0.0001	0.0001	0.0003	0.0003	0.0009	0.0745	0.0006	0.0002	0.0006
26	0.0048	0.0013	0.0028	0.0013	0.0021	0.0008	0.0014	0.0023	0.0025	0.0139	0.0010	0.0017	0.0025	0.0017	0.0012	0.0012	0.0008	0.0015	0.0017	0.0019	0.0037	0.0012	0.0044	0.0009	0.0034	0.0035	0.0031	0.0076
27	0.0142	0.0051	0.0012	0.0009	0.0027	0.0007	0.0078	0.0098	0.0146	0.0128	0.0032	0.0011	0.0060	0.0024	0.0035	0.0043	0.0016	0.0032	0.0019	0.0019	0.0015	0.0084	0.0615	0.0196	0.2024	0.0584	0.0133	0.0125
28	0.0528	0.0628	0.1153	0.0741	0.0540	0.0784	0.0450	0.0148	0.0924	0.1218	0.0898	0.1178	0.1218	0.1053	0.0790	0.0667	0.0511	0.1102	0.0715	0.0833	0.0766	0.1214	0.1811	0.1190	0.1854	0.1164	0.1173	0.2105

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1990, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1993)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0053	0.5064	0.3914	-	0.0775	-	-	-	0.0002	0.0018	0.0029	0.0006	0.0020	0.0039	0.0101	0.0137	0.0297	0.0012	0.0003	0.0020	0.0000	0.0001	0.0003	0.0008	0.0001	-	0.0000	0.0002
2	0.0095	0.0903	0.0028	-	0.0059	0.1997	0.0034	-	0.0355	0.0297	0.0061	0.0010	0.0045	0.0113	0.0099	0.0127	0.0307	0.0032	0.0011	0.0019	0.0263	0.0064	0.0562	0.0210	0.0307	0.0844	0.0135	0.0048
3	0.0001	0.0008	0.0022	-	0.0180	-	0.1378	0.2219	0.0002	0.0027	0.0027	0.0010	0.0013	0.0033	0.0247	0.0037	0.0225	0.0015	0.0006	0.0004	-	0.0005	0.0001	0.0001	0.0000	0.0002	0.0005	0.0012
4	0.0022	0.0001	0.0002	0.2187	-	-	-	-	0.0012	0.0040	0.0009	0.0004	0.0008	0.0008	0.0017	0.0007	0.0044	0.0004	0.0003	0.0003	0.0043	0.0002	0.0004	0.0014	0.0001	0.0002	0.0020	0.0011
5	0.0174	0.0005	0.0015	-	0.3495	-	-	-	0.0097	0.0320	0.0070	0.0028	0.0065	0.0061	0.0134	0.0058	0.0353	0.0033	0.0021	0.0026	0.0349	0.0013	0.0032	0.0117	0.0008	0.0016	0.0163	0.0088
6	0.0001	0.0000	0.0000	-	-	0.1495	-	-	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
7	0.0002	0.0000	0.0000	-	-	-	0.1809	-	0.0001	0.0003	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001
8	0.0001	0.0000	0.0000	-	-	-	-	0.3958	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000
9	0.0016	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0780	0.0012	0.2717	0.0664	0.0187	0.0051	0.0016	0.0003	0.0023	0.0005	0.0003	0.0029	0.0002	0.0005	0.0001	0.0031	0.0000	0.0030	0.0001	0.0036
10	0.0321	0.0020	-	-	-	-	-	-	0.0005	0.0872	0.0000	0.0000	0.0005	0.0027	0.0835	0.0613	0.2700	0.0061	0.0004	0.0577	0.0025	0.0069	0.0004	0.0000	0.0007	-	0.0000	0.0004
11	0.0006	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0417	0.0020	0.1209	0.0134	0.0031	0.0123	0.0004	0.0002	0.0001	0.0007	0.0005	0.0012	0.0011	0.0007	0.0003	0.0015	0.0004	0.0007	0.0006	0.0068
12	0.0010	0.0005	0.0003	0.0001	0.0001	0.0000	0.0000	0.0001	0.0047	0.0014	0.0031	0.2191	0.0098	0.0076	0.0018	0.0039	0.0002	0.0077	0.0018	0.0154	0.0003	0.0020	0.0015	0.0043	0.0036	0.0007	0.0019	0.0031
13	0.0026	0.0020	0.0023	0.0003	0.0005	0.0002	0.0003	0.0006	0.0066	0.0035	0.0256	0.0130	0.1869	0.0217	0.0224	0.0043	0.0014	0.0189	0.0128	0.0231	0.0050	0.0464	0.0051	0.0143	0.0056	0.0060	0.0027	0.0254
14	0.0184	0.0340	0.0148	0.0038	0.0030	0.0046	0.0035	0.0008	0.0659	0.0367	0.0336	0.0226	0.0476	0.2231	0.0453	0.0265	0.0274	0.0270	0.0315	0.0552	0.0406	0.0141	0.0147	0.0067	0.0048	0.0125	0.0053	0.0122
15	0.0008	0.0000	0.0021	0.0039	0.0032	0.0048	0.0036	0.0009	0.0071	0.0037	0.0091	0.0001	0.0042	0.0049	0.1173	0.0223	0.0025	0.0092	0.0046	0.0094	0.0102	0.0930	0.0004	0.0006	-	-	0.0014	0.0026
16	0.0053	0.0008	0.0007	0.0008	0.0006	0.0010	0.0007	0.0002	0.0001	0.0075	0.0001	0.0004	0.0096	0.0026	0.0112	0.1771	0.0051	0.1261	0.0457	0.0457	0.0020	0.0188	0.0000	0.0015	0.0000	-	0.0000	0.0008
17	0.0001	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0021	0.0016	0.0005	0.0046	0.0088	0.0017	0.0774	0.0771	0.0605	0.0150	0.0190	0.0001	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
18	0.0069	0.0003	0.0024	0.0011	0.0008	0.0013	0.0010	0.0002	0.0025	0.0168	0.0239	0.0021	0.0102	0.0121	0.0168	0.0078	0.0030	0.1543	0.0260	0.0328	0.0274	0.0615	0.0022	0.0366	0.0083	0.0009	0.0025	0.0044
19	0.0247	0.0014	0.0005	0.0120	0.0096	0.0147	0.0110	0.0027	0.0172	0.0428	0.0028	0.0014	0.0148	0.0016	0.0030	0.0064	0.0009	0.0088	0.1094	0.0465	0.0120	0.0695	0.0317	0.0345	0.0488	0.0655	0.1080	0.0178
20	0.0001	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001	0.0000	0.0029	0.0003	0.0016	0.0022	0.0012	0.0017	0.0008	0.0016	0.0040	0.0009	0.0023	0.0156	0.0005	0.0008	0.0013	0.0016	0.0003	0.0004	0.0005	0.0016
21	0.0005	0.0001	0.0056	0.0038	0.0061	0.0026	0.0032	0.0069	0.0109	0.0034	0.0009	0.0004	0.0014	0.0008	0.0004	0.0024	0.0011	0.0002	0.0008	0.0000	-	0.0003	0.0000	0.0000	0.0034	0.0000	0.0007	0.0119
22	0.0021	0.0001	0.0000	0.0048	0.0026	0.0039	0.0041	0.0013	0.0057	0.0100	0.0001	0.0000	0.0003	0.0001	0.0001	0.0001	0.0000	0.0034	0.0001	0.0002	0.0013	0.0003	0.0019	0.0143	0.0027	0.0013	0.0042	0.0060
23	0.0044	0.0057	0.0012	0.0007	0.0024	0.0083	0.0014	0.0024	0.0295	0.0156	0.0336	0.0076	0.0179	0.0076	0.0801	0.0163	0.0100	0.0097	0.0042	0.0065	0.0052	0.0218	0.0049	0.0028	0.0024	0.0067	0.0092	0.0054
24	0.0010	0.0002	0.0793	0.0040	0.0137	0.0029	0.0036	0.0076	0.0024	0.0021	0.0035	0.0015	0.0007	0.0006	0.0030	0.0109	0.0063	0.0022	0.0006	0.0006	0.0004	0.0005	0.0004	0.0002	0.0001	0.0005	0.0023	0.0003
25	0.0008	0.0428	0.0006	0.0001	0.0004	0.0004	0.0001	0.0002	0.0005	0.0095	0.0003	0.0002	0.0003	0.0005	0.0007	0.0063	0.0082	0.0008	0.0001	0.0002	0.0002	0.0003	0.0003	0.0013	0.1686	0.0004	0.0005	0.0012
26	0.0037	0.0007	0.0044	0.0005	0.0008	0.0004	0.0004	0.0009	0.0035	0.0114	0.0016	0.0017	0.0033	0.0021	0.0018	0.0016	0.0012	0.0015	0.0021	0.0025	0.0047	0.0009	0.0042	0.0005	0.0030	0.0048	0.0063	0.0079
27	0.0119	0.0060	0.0053	0.0012	0.0039	0.0011	0.0097	0.0162	0.0293	0.0184	0.0070	0.0011	0.0127	0.0040	0.0074	0.0081	0.0015	0.0048	0.0027	0.0048	0.0035	0.0092	0.0574	0.0196	0.0897	0.0728	0.0353	0.0156
28	0.0852	0.0414	0.0946	0.0311	0.0250	0.0380	0.0285	0.0069	0.1101	0.1418	0.1148	0.0795	0.1292	0.1029	0.0866	0.1294	0.0938	0.0970	0.0769	0.0947	0.0923	0.1476	0.1544	0.1154	0.1223	0.1035	0.1595	0.2207

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1993, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1994)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0052	0.5012	0.0150	-	0.0954	-	-	-	0.0007	0.0023	0.0042	0.0015	0.0023	0.0062	0.0266	0.0164	0.0451	0.0019	0.0005	0.0010	0.0000	0.0001	0.0007	0.0008	0.0002	0.0001	0.0002	0.0009
2	0.0042	0.0633	0.0019	-	0.0060	0.2032	0.0041	-	0.0364	0.0156	0.0032	0.0009	0.0034	0.0094	0.0070	0.0099	0.0203	0.0027	0.0007	0.0004	0.0189	0.0065	0.0627	0.0164	0.0286	0.1084	0.0072	0.0052
3	0.0001	0.0007	0.0054	-	0.0069	-	0.0499	0.0870	0.0002	0.0022	0.0022	0.0008	0.0011	0.0024	0.0298	0.0030	0.0187	0.0011	0.0005	0.0002	-	0.0000	0.0001	0.0003	0.0000	0.0001	0.0003	0.0011
4	0.0014	0.0000	0.0001	0.1910	-	-	-	-	0.0010	0.0025	0.0008	0.0004	0.0007	0.0007	0.0015	0.0006	0.0043	0.0004	0.0002	0.0001	0.0043	0.0002	0.0006	0.0016	0.0001	0.0002	0.0014	0.0012
5	0.0120	0.0003	0.0011	-	0.3293	-	-	-	0.0081	0.0215	0.0066	0.0035	0.0059	0.0062	0.0127	0.0053	0.0367	0.0031	0.0016	0.0010	0.0363	0.0016	0.0051	0.0132	0.0010	0.0017	0.0115	0.0097
6	0.0001	0.0000	0.0000	-	-	0.1245	-	-	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
7	0.0001	0.0000	0.0000	-	-	-	0.1474	-	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001
8	0.0001	0.0000	0.0000	-	-	-	-	0.4922	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000
9	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0934	0.0002	0.2813	0.0421	0.0274	0.0046	0.0016	0.0002	0.0026	0.0005	0.0001	0.0014	0.0001	0.0011	0.0001	0.0038	0.0000	0.0006	0.0001	0.0034
10	0.0522	0.0012	-	-	-	-	-	-	0.0002	0.1421	0.0000	0.0000	0.0005	0.0082	0.0790	0.0660	0.2038	0.0078	0.0025	0.0804	0.0028	0.0076	0.0002	0.0000	0.0004	-	0.0000	0.0005
11	0.0004	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0334	0.0015	0.1146	0.0109	0.0020	0.0080	0.0003	0.0002	0.0000	0.0005	0.0004	0.0005	0.0010	0.0002	0.0004	0.0013	0.0007	0.0004	0.0005	0.0062
12	0.0007	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0001	0.0034	0.0009	0.0037	0.2386	0.0074	0.0081	0.0020	0.0028	0.0002	0.0067	0.0013	0.0056	0.0003	0.0033	0.0020	0.0027	0.0036	0.0008	0.0014	0.0032
13	0.0016	0.0009	0.0014	0.0002	0.0004	0.0002	0.0002	0.0005	0.0054	0.0025	0.0277	0.0119	0.1778	0.0208	0.0209	0.0031	0.0012	0.0173	0.0102	0.0097	0.0047	0.0481	0.0075	0.0156	0.0102	0.0064	0.0020	0.0267
14	0.0148	0.0190	0.0103	0.0053	0.0043	0.0063	0.0056	0.0013	0.0598	0.0305	0.0373	0.0288	0.0490	0.2185	0.0421	0.0245	0.0262	0.0246	0.0261	0.0259	0.0439	0.0164	0.0247	0.0070	0.0062	0.0116	0.0044	0.0122
15	0.0007	0.0000	0.0016	0.0048	0.0039	0.0058	0.0051	0.0012	0.0022	0.0035	0.0087	0.0001	0.0046	0.0045	0.1105	0.0218	0.0022	0.0096	0.0026	0.0025	0.0098	0.0946	0.0005	0.0007	-	-	0.0011	0.0026
16	0.0042	0.0001	0.0004	0.0005	0.0004	0.0006	0.0006	0.0001	0.0001	0.0096	0.0002	0.0004	0.0121	0.0020	0.0084	0.2199	0.0061	0.1368	0.0400	0.0217	0.0017	0.0138	0.0000	0.0019	0.0001	-	0.0001	0.0009
17	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0008	0.0010	0.0004	0.0067	0.0097	0.0056	0.0771	0.1636	0.0471	0.0131	0.0087	0.0003	0.0011	0.0000	0.0001	0.0000	0.0000	0.0001	0.0003
18	0.0060	0.0003	0.0018	0.0012	0.0010	0.0015	0.0013	0.0003	0.0039	0.0129	0.0248	0.0027	0.0119	0.0136	0.0159	0.0073	0.0020	0.1305	0.0231	0.0161	0.0311	0.0681	0.0054	0.0554	0.0331	0.0028	0.0030	0.0053
19	0.0260	0.0007	0.0004	0.0194	0.0156	0.0232	0.0205	0.0046	0.0207	0.0382	0.0032	0.0015	0.0180	0.0019	0.0027	0.0092	0.0011	0.0112	0.1206	0.0210	0.0118	0.0534	0.0357	0.0615	0.0349	0.0397	0.1074	0.0201
20	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034	0.0001	0.0011	0.0015	0.0009	0.0015	0.0009	0.0009	0.0018	0.0005	0.0015	0.0053	0.0003	0.0016	0.0005	0.0010	0.0002	0.0001	0.0003	0.0012
21	0.0003	0.0000	0.0036	0.0026	0.0043	0.0020	0.0023	0.0055	0.0049	0.0018	0.0008	0.0004	0.0011	0.0006	0.0003	0.0018	0.0009	0.0002	0.0007	0.0000	-	0.0009	0.0000	0.0000	0.0037	0.0000	0.0007	0.0116
22	0.0028	0.0000	0.0000	0.0019	0.0010	0.0015	0.0018	0.0006	0.0089	0.0109	0.0000	0.0000	0.0003	0.0000	0.0001	0.0000	0.0000	0.0037	0.0000	0.0000	0.0005	0.0003	0.0021	0.0179	0.0024	0.0009	0.0013	0.0061
23	0.0034	0.0037	0.0011	0.0008	0.0026	0.0090	0.0015	0.0029	0.0252	0.0126	0.0314	0.0075	0.0170	0.0087	0.0849	0.0164	0.0091	0.0107	0.0036	0.0033	0.0055	0.0228	0.0060	0.0029	0.0025	0.0076	0.0050	0.0056
24	0.0009	0.0006	0.0836	0.0043	0.0147	0.0035	0.0040	0.0093	0.0025	0.0016	0.0044	0.0030	0.0009	0.0028	0.0046	0.0092	0.0090	0.0024	0.0008	0.0005	0.0003	0.0004	0.0004	0.0007	0.0002	0.0006	0.0010	0.0007
25	0.0004	0.0356	0.0004	0.0001	0.0003	0.0004	0.0001	0.0002	0.0006	0.0199	0.0003	0.0002	0.0003	0.0006	0.0007	0.0017	0.0091	0.0005	0.0001	0.0001	0.0001	0.0002	0.0003	0.0011	0.1711	0.0006	0.0002	0.0013
26	0.0016	0.0003	0.0025	0.0003	0.0005	0.0003	0.0003	0.0007	0.0023	0.0067	0.0013	0.0017	0.0024	0.0017	0.0012	0.0011	0.0010	0.0011	0.0013	0.0008	0.0036	0.0008	0.0048	0.0004	0.0029	0.0035	0.0023	0.0068
27	0.0075	0.0035	0.0047	0.0010	0.0031	0.0010	0.0079	0.0143	0.0356	0.0173	0.0067	0.0011	0.0118	0.0037	0.0063	0.0063	0.0015	0.0035	0.0019	0.0019	0.0035	0.0223	0.0716	0.0164	0.1164	0.0741	0.0146	0.0175
28	0.0591	0.0256	0.0725	0.0278	0.0224	0.0333	0.0295	0.0066	0.1115	0.1479	0.1018	0.0750	0.1164	0.0999	0.0732	0.1162	0.0789	0.0901	0.0681	0.0523	0.0907	0.1507	0.2014	0.0973	0.1338	0.1030	0.1120	0.2260

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1994, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(1995)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0097	0.5823	0.0125	-	0.1354	-	-	-	0.0011	0.0016	0.0023	0.0011	0.0024	0.0039	0.0192	0.0229	0.0219	0.0008	0.0004	0.0009	0.0001	0.0001	0.0009	0.0015	0.0002	0.0001	0.0002	0.0011
2	0.0117	0.0603	0.0019	-	0.0043	0.1819	0.0031	-	0.0234	0.0318	0.0015	0.0003	0.0023	0.0085	0.0069	0.0070	0.0083	0.0014	0.0003	0.0006	0.0113	0.0034	0.0318	0.0097	0.0137	0.0944	0.0054	0.0030
3	0.0001	0.0012	0.0066	-	0.0061	-	0.0747	0.0748	0.0004	0.0008	0.0019	0.0005	0.0014	0.0016	0.0184	0.0032	0.0099	0.0005	0.0002	0.0007	-	0.0000	0.0000	0.0005	0.0000	0.0001	0.0002	0.0007
4	0.0011	0.0005	0.0004	0.2133	-	-	-	-	0.0007	0.0019	0.0007	0.0005	0.0009	0.0010	0.0016	0.0019	0.0057	0.0006	0.0004	0.0003	0.0015	0.0001	0.0003	0.0035	0.0001	0.0002	0.0013	0.0007
5	0.0099	0.0047	0.0035	-	0.3264	-	-	-	0.0060	0.0167	0.0067	0.0042	0.0078	0.0089	0.0142	0.0165	0.0505	0.0057	0.0040	0.0025	0.0130	0.0013	0.0029	0.0309	0.0005	0.0014	0.0112	0.0059
6	0.0000	0.0000	0.0000	-	-	0.1305	-	-	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
7	0.0001	0.0001	0.0000	-	-	-	0.1270	-	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0007	0.0001	0.0001	0.0000	0.0002	0.0000	0.0000	0.0004	0.0000	0.0000	0.0001	0.0001
8	0.0000	0.0000	0.0000	-	-	-	-	0.5107	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000
9	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1216	0.0004	0.2648	0.0728	0.0149	0.0062	-	0.0000	0.0004	0.0000	0.0001	0.0062	0.0002	0.0011	0.0001	0.0030	0.0000	0.0000	0.0002	0.0041
10	0.0262	0.0017	-	-	-	-	-	-	0.0006	0.0819	0.0041	0.0000	0.0001	0.0034	0.0998	0.0688	0.2503	0.0037	0.0009	0.0490	0.0074	0.0133	0.0001	0.0000	0.0001	-	0.0000	0.0007
11	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0368	0.0009	0.1103	0.0118	0.0003	0.0076	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0013	0.0002	0.0004	0.0013	0.0005	0.0007	0.0005	0.0147
12	0.0004	0.0003	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0019	0.0005	0.0024	0.2467	0.0087	0.0061	0.0014	0.0010	0.0004	0.0037	0.0007	0.0112	0.0004	0.0027	0.0010	0.0028	0.0008	0.0005	0.0012	0.0031
13	0.0013	0.0016	0.0027	0.0009	0.0013	0.0007	0.0012	0.0017	0.0049	0.0027	0.0203	0.0064	0.1917	0.0139	0.0126	0.0022	0.0024	0.0118	0.0054	0.0109	0.0058	0.0573	0.0051	0.0181	0.0073	0.0058	0.0027	0.0269
14	0.0122	0.0206	0.0224	0.0076	0.0055	0.0094	0.0075	0.0016	0.0645	0.0229	0.0253	0.0176	0.0459	0.2284	0.0148	0.0142	0.0149	0.0193	0.0194	0.0605	0.0568	0.0156	0.0223	0.0080	0.0038	0.0066	0.0048	0.0106
15	0.0005	0.0000	0.0003	0.0055	0.0039	0.0068	0.0054	0.0012	0.0015	0.0027	0.0067	0.0001	0.0025	0.0019	0.1262	0.0121	0.0086	0.0111	0.0029	0.0012	0.0165	0.0954	0.0004	0.0004	-	-	0.0007	0.0022
16	0.0031	-	0.0007	0.0009	0.0006	0.0011	0.0008	0.0002	0.0001	0.0070	0.0000	0.0004	0.0089	0.0005	0.0073	0.2198	0.0076	0.1701	0.0420	0.0223	0.0028	0.0180	0.0000	0.0036	0.0001	-	0.0001	0.0009
17	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0012	0.0001	0.0005	0.0032	0.0024	0.0019	0.0135	0.1954	0.0557	0.0141	0.0092	0.0005	0.0015	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
18	0.0045	0.0003	0.0070	0.0013	0.0009	0.0016	0.0013	0.0003	0.0055	0.0122	0.0211	0.0010	0.0122	0.0047	0.0134	0.0064	0.0035	0.1295	0.0149	0.0154	0.0391	0.0705	0.0066	0.0590	0.0132	0.0019	0.0030	0.0046
19	0.0350	0.0009	0.0007	0.0317	0.0226	0.0391	0.0310	0.0068	0.0336	0.0639	0.0018	0.0014	0.0092	0.0051	0.0049	0.0060	0.0075	0.0131	0.1337	0.0204	0.0172	0.0681	0.0553	0.0787	0.0387	0.0603	0.0927	0.0187
20	0.0000	0.0002	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000	0.0017	0.0001	0.0005	0.0005	0.0006	0.0018	0.0013	0.0006	0.0020	0.0003	0.0001	0.0045	0.0002	0.0013	0.0004	0.0009	0.0001	0.0001	0.0005	0.0015
21	0.0003	0.0014	0.0034	0.0052	0.0077	0.0039	0.0071	0.0097	0.0049	0.0011	0.0022	0.0015	0.0012	0.0018	0.0012	0.0019	0.0012	0.0010	0.0006	0.0005	-	0.0007	0.0000	0.0000	0.0019	0.0000	0.0003	0.0042
22	0.0035	0.0000	0.0000	0.0018	0.0009	0.0015	0.0016	0.0005	0.0080	0.0110	0.0000	0.0000	0.0003	0.0000	0.0001	0.0000	0.0000	0.0044	0.0000	0.0000	0.0006	0.0005	0.0017	0.0228	0.0010	0.0006	0.0021	0.0065
23	0.0084	0.0065	0.0009	0.0005	0.0016	0.0071	0.0017	0.0018	0.0287	0.0249	0.0513	0.0110	0.0222	0.0116	0.1010	0.0159	0.0123	0.0121	0.0032	0.0039	0.0057	0.0184	0.1285	0.0024	0.0016	0.0050	0.0093	0.0083
24	0.0569	0.0016	0.0061	0.0030	0.0095	0.0024	0.0045	0.0060	0.0044	0.0057	0.0063	0.0039	0.0021	0.0051	0.0166	0.0223	0.0313	0.0017	0.0009	0.0012	0.0001	0.0002	0.0004	0.0012	0.0001	0.0004	0.0037	0.0023
25	0.0000	0.0127	0.0001	0.0000	0.0001	0.0001	0.0000	0.0001	0.0002	0.0121	0.0001	0.0001	0.0001	0.0002	0.0002	0.0248	0.0038	0.0022	0.0000	0.0000	0.0000	0.0000	0.0001	0.0011	0.1495	0.0002	0.0000	0.0009
26	0.0017	0.0019	0.0047	0.0013	0.0019	0.0010	0.0017	0.0024	0.0030	0.0052	0.0025	0.0046	0.0057	0.0033	0.0015	0.0011	0.0016	0.0031	0.0020	0.0014	0.0057	0.0007	0.0018	0.0005	0.0023	0.0724	0.0022	0.0093
27	0.0101	0.0048	0.0252	0.0014	0.0042	0.0015	0.0174	0.0182	0.0271	0.0127	0.0121	0.0035	0.0227	0.0126	0.0073	0.0049	0.0029	0.0127	0.0020	0.0038	0.0041	0.0188	0.0455	0.0181	0.1298	0.1130	0.0226	0.0226
28	0.0877	0.0368	0.2663	0.0629	0.0450	0.0776	0.0615	0.0136	0.1378	0.1584	0.1073	0.0922	0.1248	0.1165	0.0685	0.0946	0.0730	0.0853	0.0822	0.0657	0.1281	0.1543	0.2393	0.1974	0.0957	0.1337	0.1398	0.2653

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1995, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (A) (continued)

(1997)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0164	0.6226	0.0505	-	0.1301	-	-	-	0.0007	0.0021	0.0025	0.0020	0.0017	0.0088	0.0188	0.0309	0.0155	0.0008	0.0004	0.0005	0.0002	0.0001	0.0007	0.0010	0.0003	0.0001	0.0002	0.0009
2	0.0138	0.0361	0.0019	-	0.0045	0.1969	0.0027	-	0.0197	0.0316	0.0016	0.0004	0.0023	0.0057	0.0054	0.0145	0.0078	0.0024	0.0004	0.0004	0.0106	0.0048	0.0313	0.0087	0.0157	0.1172	0.0050	0.0033
3	0.0001	0.0011	0.0241	-	0.0105	-	0.1884	0.2064	0.0002	0.0006	0.0019	0.0006	0.0010	0.0011	0.0163	0.0036	0.0070	0.0005	0.0002	0.0005	-	0.0000	0.0000	0.0003	0.0000	0.0001	0.0001	0.0005
4	0.0014	0.0006	0.0002	0.2123	-	-	-	-	0.0005	0.0018	0.0011	0.0007	0.0009	0.0010	0.0019	0.0028	0.0054	0.0008	0.0006	0.0003	0.0026	0.0002	0.0003	0.0030	0.0001	0.0002	0.0012	0.0006
5	0.0121	0.0054	0.0021	-	0.3295	-	-	-	0.0045	0.0161	0.0100	0.0058	0.0076	0.0086	0.0168	0.0249	0.0475	0.0070	0.0052	0.0023	0.0233	0.0015	0.0025	0.0266	0.0006	0.0014	0.0108	0.0056
6	0.0000	0.0000	0.0000	-	-	0.1009	-	-	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
7	0.0002	0.0001	0.0000	-	-	-	0.1138	-	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0006	0.0001	0.0001	0.0000	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000	0.0001	0.0001
8	0.0001	0.0000	0.0000	-	-	-	-	0.4297	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000
9	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.1183	0.0004	0.2341	0.0698	0.0123	0.0043	-	0.0000	0.0003	0.0001	0.0001	0.0058	0.0003	0.0020	0.0001	0.0022	0.0000	0.0000	0.0003	0.0033
10	0.0433	0.0012	-	-	-	-	-	-	0.0005	0.1029	0.0026	0.0000	0.0002	0.0025	0.0894	0.0794	0.2499	0.0033	0.0012	0.0253	0.0057	0.0115	0.0003	0.0000	0.0005	-	0.0000	0.0005
11	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0409	0.0007	0.0999	0.0096	0.0002	0.0056	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0009	0.0002	0.0002	0.0009	0.0004	0.0004	0.0003	0.0100
12	0.0009	0.0004	0.0002	0.0003	0.0004	0.0002	0.0003	0.0005	0.0025	0.0010	0.0029	0.1926	0.0077	0.0053	0.0014	0.0027	0.0015	0.0073	0.0013	0.0090	0.0006	0.0027	0.0016	0.0062	0.0019	0.0007	0.0021	0.0037
13	0.0023	0.0020	0.0022	0.0011	0.0017	0.0007	0.0013	0.0019	0.0056	0.0044	0.0215	0.0093	0.1754	0.0136	0.0113	0.0041	0.0024	0.0145	0.0069	0.0114	0.0054	0.0477	0.0055	0.0148	0.0062	0.0048	0.0044	0.0258
14	0.0167	0.0293	0.0183	0.0105	0.0076	0.0130	0.0090	0.0022	0.0660	0.0256	0.0329	0.0167	0.0540	0.2237	0.0198	0.0198	0.0166	0.0250	0.0212	0.0350	0.0601	0.0160	0.0205	0.0071	0.0041	0.0054	0.0043	0.0095
15	0.0006	0.0000	0.0001	0.0080	0.0058	0.0100	0.0069	0.0017	0.0011	0.0027	0.0056	0.0002	0.0023	0.0016	0.1269	0.0121	0.0063	0.0113	0.0031	0.0007	0.0106	0.0863	0.0005	0.0001	-	-	0.0010	0.0015
16	0.0034	-	0.0006	0.0009	0.0006	0.0011	0.0007	0.0002	0.0000	0.0099	0.0000	0.0004	0.0086	0.0003	0.0059	0.1939	0.0034	0.1506	0.0449	0.0157	0.0022	0.0181	0.0000	0.0034	0.0001	-	0.0001	0.0006
17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0002	0.0005	0.0027	0.0031	0.0014	0.0249	0.2317	0.0503	0.0109	0.0075	0.0001	0.0006	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001
18	0.0077	0.0006	0.0040	0.0036	0.0026	0.0045	0.0031	0.0007	0.0052	0.0169	0.0198	0.0021	0.0110	0.0054	0.0174	0.0084	0.0020	0.0977	0.0186	0.0149	0.0298	0.0647	0.0090	0.0664	0.0281	0.0032	0.0044	0.0043
19	0.0383	0.0008	0.0005	0.0281	0.0204	0.0349	0.0241	0.0058	0.0210	0.0585	0.0033	0.0019	0.0090	0.0045	0.0061	0.0082	0.0063	0.0151	0.1406	0.0168	0.0160	0.0685	0.0369	0.0906	0.0274	0.0592	0.0772	0.0168
20	0.0001	0.0002	0.0001	0.0002	0.0002	0.0003	0.0002	0.0000	0.0016	0.0002	0.0007	0.0056	0.0010	0.0026	0.0021	0.0039	0.0147	0.0004	0.0003	0.0074	0.0002	0.0015	0.0003	0.0004	0.0001	0.0001	0.0009	0.0014
21	0.0004	0.0016	0.0072	0.0040	0.0058	0.0025	0.0043	0.0064	0.0038	0.0010	0.0030	0.0020	0.0012	0.0017	0.0013	0.0028	0.0011	0.0013	0.0008	0.0005	0.0688	0.0006	0.0000	0.0000	0.0020	0.0000	0.0004	0.0037
22	0.0047	0.0000	0.0000	0.0019	0.0009	0.0016	0.0015	0.0005	0.0053	0.0101	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0035	0.0000	0.0000	0.0005	0.0003	0.0010	0.0193	0.0009	0.0005	0.0015	0.0050
23	0.0096	0.0066	0.0012	0.0007	0.0021	0.0085	0.0018	0.0021	0.0251	0.0189	0.0502	0.0110	0.0207	0.0106	0.1070	0.0201	0.0105	0.0135	0.0039	0.0032	0.0042	0.0159	0.1085	0.0051	0.0012	0.0065	0.0079	0.0071
24	0.0191	0.0015	0.0197	0.0024	0.0075	0.0016	0.0028	0.0041	0.0033	0.0025	0.0052	0.0044	0.0013	0.0046	0.0153	0.0199	0.0208	0.0017	0.0010	0.0007	0.0001	0.0002	0.0002	0.0009	0.0001	0.0006	0.0010	0.0013
25	0.0005	0.0148	0.0008	0.0002	0.0006	0.0009	0.0003	0.0004	0.0003	0.0057	0.0007	0.0007	0.0006	0.0004	0.0011	0.0023	0.0056	0.0011	0.0002	0.0007	0.0000	0.0001	0.0001	0.0001	0.2017	0.0003	0.0001	0.0004
26	0.0023	0.0023	0.0040	0.0017	0.0024	0.0010	0.0018	0.0027	0.0024	0.0067	0.0030	0.0078	0.0076	0.0034	0.0020	0.0018	0.0017	0.0039	0.0032	0.0014	0.0054	0.0008	0.0016	0.0004	0.0027	0.0634	0.0021	0.0091
27	0.0111	0.0060	0.0234	0.0023	0.0066	0.0022	0.0289	0.0327	0.0230	0.0145	0.0176	0.0053	0.0267	0.0143	0.0094	0.0086	0.0033	0.0168	0.0031	0.0043	0.0042	0.0159	0.0598	0.0100	0.1347	0.0870	0.0294	0.0268
28	0.0805	0.0245	0.2407	0.1011	0.0734	0.1259	0.0868	0.0209	0.1178	0.1576	0.1291	0.1107	0.1427	0.1225	0.0792	0.0988	0.0613	0.1179	0.0706	0.0533	0.1616	0.1607	0.2319	0.1904	0.0893	0.1484	0.1612	0.2554

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1997, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

(continued on next page)

Table C-3 Matrix of input–output technical coefficients (A) (continued)

(1999)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0249	0.5914	0.0895	-	0.1704	-	-	-	0.0003	0.0024	0.0022	0.0023	0.0019	0.0054	0.0241	0.0324	0.0103	0.0008	0.0003	0.0003	0.0002	0.0001	0.0002	0.0005	0.0003	0.0001	0.0003	0.0008
2	0.0099	0.0458	0.0021	-	0.0050	0.2652	0.0024	-	0.0130	0.0211	0.0012	0.0003	0.0017	0.0042	0.0053	0.0139	0.0052	0.0018	0.0003	0.0003	0.0071	0.0044	0.0184	0.0051	0.0103	0.0584	0.0052	0.0026
3	0.0002	0.0024	0.0645	-	0.0159	-	0.2405	0.3723	0.0003	0.0011	0.0032	0.0010	0.0019	0.0016	0.0302	0.0063	0.0096	0.0008	0.0004	0.0005	-	0.0000	0.0000	0.0004	-	0.0001	0.0004	0.0008
4	0.0012	0.0007	0.0003	0.2154	-	-	-	-	0.0004	0.0019	0.0010	0.0006	0.0008	0.0007	0.0018	0.0025	0.0038	0.0007	0.0005	0.0001	0.0023	0.0001	0.0002	0.0023	0.0001	0.0001	0.0015	0.0006
5	0.0124	0.0073	0.0034	-	0.3067	-	-	-	0.0042	0.0194	0.0104	0.0060	0.0084	0.0074	0.0178	0.0257	0.0385	0.0068	0.0046	0.0014	0.0233	0.0014	0.0023	0.0235	0.0006	0.0007	0.0156	0.0059
6	0.0000	0.0000	0.0000	-	-	0.1048	-	-	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
7	0.0001	0.0001	0.0000	-	-	-	0.0989	-	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0005	0.0001	0.0001	0.0000	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000	0.0002	0.0001
8	0.0003	0.0002	0.0001	-	-	-	-	0.1293	0.0001	0.0004	0.0002	0.0001	0.0002	0.0002	0.0004	0.0005	0.0008	0.0001	0.0001	0.0000	0.0005	0.0000	0.0000	0.0005	0.0000	0.0000	0.0003	0.0001
9	0.0004	-	-	0.0000	0.0000	0.0000	0.0000	0.0001	0.1105	0.0006	0.2252	0.0598	0.0146	0.0050	-	-	0.0003	-	0.0000	0.0015	0.0003	0.0019	0.0000	0.0022	-	-	0.0004	0.0041
10	0.0390	0.0011	-	-	-	-	-	-	0.0004	0.0988	0.0025	-	0.0002	0.0037	0.0660	0.0678	0.3380	0.0023	0.0025	0.0528	0.0045	0.0069	0.0000	-	-	-	0.0000	0.0003
11	0.0004	0.0001	-	0.0001	0.0001	0.0000	0.0001	0.0001	0.0431	0.0009	0.1230	0.0103	0.0003	0.0062	0.0001	-	-	0.0001	0.0001	-	0.0011	0.0002	0.0002	0.0010	-	0.0003	0.0007	0.0152
12	0.0005	0.0007	0.0021	0.0002	0.0003	0.0002	0.0002	0.0004	0.0034	0.0005	0.0044	0.1946	0.0079	0.0040	0.0038	0.0025	0.0006	0.0048	0.0010	0.0049	0.0006	0.0015	0.0019	0.0034	0.0025	0.0019	0.0014	0.0028
13	0.0023	0.0023	0.0036	0.0013	0.0019	0.0010	0.0011	0.0023	0.0049	0.0037	0.0241	0.0069	0.1593	0.0119	0.0120	0.0041	0.0016	0.0142	0.0046	0.0057	0.0053	0.0456	0.0046	0.0114	0.0047	0.0024	0.0055	0.0233
14	0.0142	0.0424	0.0279	0.0097	0.0066	0.0104	0.0077	0.0029	0.0676	0.0239	0.0299	0.0176	0.0618	0.1988	0.0193	0.0198	0.0134	0.0222	0.0194	0.0263	0.0569	0.0158	0.0169	0.0060	0.0044	0.0028	0.0068	0.0101
15	0.0006	-	0.0003	0.0082	0.0056	0.0088	0.0066	0.0025	0.0011	0.0026	0.0049	0.0002	0.0020	0.0013	0.1424	0.0121	0.0052	0.0125	0.0027	0.0003	0.0096	0.0846	0.0004	-	-	-	0.0026	0.0013
16	0.0038	-	0.0012	0.0010	0.0007	0.0011	0.0008	0.0003	0.0001	0.0079	-	0.0004	0.0088	0.0002	0.0074	0.2168	0.0032	0.1396	0.0360	0.0077	0.0024	0.0142	0.0000	0.0027	-	-	0.0001	0.0005
17	0.0000	-	-	-	-	-	-	-	-	0.0006	0.0002	0.0005	0.0029	0.0027	0.0012	0.0257	0.1729	0.0547	0.0097	0.0041	0.0002	0.0007	-	0.0001	-	-	0.0000	0.0001
18	0.0084	0.0006	0.0071	0.0038	0.0026	0.0041	0.0031	0.0012	0.0051	0.0153	0.0177	0.0018	0.0101	0.0050	0.0180	0.0078	0.0014	0.0979	0.0151	0.0064	0.0269	0.0669	0.0060	0.0542	0.0201	0.0013	0.0047	0.0042
19	0.0358	0.0013	0.0009	0.0261	0.0179	0.0280	0.0209	0.0079	0.0220	0.0489	0.0031	0.0016	0.0051	0.0032	0.0081	0.0086	0.0062	0.0095	0.1299	0.0098	0.0168	0.0538	0.0258	0.0751	0.0470	0.0448	0.0991	0.0182
20	0.0000	-	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0003	0.0001	0.0003	0.0025	0.0002	0.0004	0.0002	0.0019	0.0055	0.0002	0.0001	0.0013	0.0002	0.0012	0.0002	0.0008	-	0.0001	0.0003	0.0014
21	0.0003	0.0017	0.0089	0.0032	0.0048	0.0024	0.0029	0.0060	0.0107	0.0009	0.0024	0.0017	0.0010	0.0012	0.0011	0.0022	0.0006	0.0009	0.0006	0.0003	0.0534	0.0005	-	-	0.0016	-	0.0006	0.0025
22	0.0119	-	-	0.0027	0.0012	0.0019	0.0020	0.0010	0.0060	0.0375	-	-	0.0004	-	-	-	-	0.0035	-	-	0.0006	0.0004	0.0010	0.0663	0.0009	0.0003	0.0032	0.0056
23	0.0066	0.0059	0.0015	0.0008	0.0023	0.0085	0.0017	0.0025	0.0216	0.0113	0.0333	0.0095	0.0143	0.0069	0.0582	0.0136	0.0064	0.0096	0.0029	0.0015	0.0024	0.0093	0.0680	0.0042	0.0009	0.0054	0.0081	0.0054
24	0.0441	0.0014	0.0211	0.0024	0.0076	0.0019	0.0023	0.0046	0.0029	0.0024	0.0040	0.0046	0.0013	0.0032	0.0131	0.0143	0.0161	0.0013	0.0009	0.0005	-	0.0003	0.0001	0.0008	-	0.0004	0.0013	0.0010
25	0.0004	0.0171	0.0009	0.0001	0.0005	0.0006	0.0002	0.0004	0.0002	0.0033	0.0003	0.0004	0.0005	0.0002	0.0007	0.0025	0.0055	0.0009	0.0001	0.0003	-	0.0000	0.0001	0.0001	0.2444	0.0002	0.0001	0.0003
26	0.0020	0.0027	0.0053	0.0015	0.0022	0.0011	0.0013	0.0027	0.0020	0.0049	0.0022	0.0052	0.0059	0.0027	0.0018	0.0015	0.0011	0.0033	0.0024	0.0005	0.0047	0.0007	0.0012	0.0004	0.0022	0.0319	0.0025	0.0077
27	0.0201	0.0105	0.0603	0.0059	0.0166	0.0062	0.0563	0.0898	0.0431	0.0220	0.0274	0.0075	0.0453	0.0211	0.0157	0.0130	0.0044	0.0246	0.0095	0.0044	0.0075	0.0277	0.1171	0.0123	0.2372	0.0894	0.0714	0.0353
28	0.0649	0.0386	0.3043	0.1101	0.0754	0.1181	0.0880	0.0332	0.1055	0.1401	0.1175	0.0827	0.1325	0.1221	0.0857	0.1083	0.0559	0.1258	0.0701	0.0544	0.1602	0.1780	0.2304	0.1864	0.1006	0.0998	0.1964	0.2633

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 1999, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

Table C-3 Matrix of input–output technical coefficients (*A*) (continued)

(2002)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0.0069	0.6177	0.0011	-	0.2708	-	-	-	0.0005	0.0021	0.0049	0.0035	0.0041	0.0082	0.0498	0.0317	0.0147	0.0019	0.0007	0.0021	0.0002	0.0000	0.0001	0.0009	0.0003	0.0001	0.0007	0.0034
2	0.0252	0.0610	0.0022	-	0.0102	0.4056	0.1649	-	0.0310	0.0509	0.0021	0.0007	0.0031	0.0099	0.0076	0.0091	0.0034	0.0025	0.0005	0.0007	0.0165	0.0045	0.0907	0.0246	0.0677	0.1053	0.0107	0.0049
3	0.0001	0.0010	-	-	0.0087	-	0.1213	0.0558	0.0003	0.0008	0.0024	0.0015	0.0021	0.0020	0.0286	0.0065	0.0073	0.0010	0.0004	0.0012	-	0.0000	-	0.0005	-	0.0001	0.0004	0.0009
4	0.0009	0.0003	0.0002	0.0282	-	-	-	-	0.0003	0.0012	0.0007	0.0004	0.0007	0.0012	0.0012	0.0021	0.0023	0.0006	0.0003	0.0002	0.0019	0.0002	0.0002	0.0019	0.0000	0.0000	0.0012	0.0005
5	0.0105	0.0030	0.0022	-	0.2510	-	-	-	0.0029	0.0131	0.0076	0.0049	0.0076	0.0136	0.0131	0.0233	0.0257	0.0069	0.0038	0.0025	0.0219	0.0024	0.0020	0.0215	0.0005	0.0004	0.0132	0.0055
6	0.0000	0.0000	0.0000	-	-	0.0194	-	-	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
7	0.0002	0.0001	0.0000	-	-	-	0.1074	-	0.0001	0.0003	0.0001	0.0001	0.0001	0.0003	0.0003	0.0005	0.0005	0.0001	0.0001	0.0000	0.0004	0.0000	0.0000	0.0004	0.0000	0.0000	0.0003	0.0001
8	0.0004	0.0001	0.0001	-	-	-	-	0.0663	0.0001	0.0005	0.0003	0.0002	0.0003	0.0006	0.0005	0.0010	0.0011	0.0003	0.0002	0.0001	0.0009	0.0001	0.0001	0.0009	0.0000	0.0000	0.0006	0.0002
9	0.0005	-	-	0.0000	0.0002	0.0000	0.0001	0.0001	0.1958	0.0007	0.2861	0.0894	0.0214	0.0083	-	-	0.0003	-	0.0001	0.0128	0.0005	0.0009	0.0002	0.0030	-	-	0.0005	0.0044
10	0.0853	0.0002	-	-	-	-	-	-	0.0002	0.1423	0.0027	-	0.0005	0.0029	0.0542	0.0819	0.4579	0.0033	0.0008	0.0404	0.0013	0.0023	-	-	-	-	-	0.0002
11	0.0003	0.0001	0.0004	0.0000	0.0002	0.0000	0.0001	0.0001	0.0371	0.0008	0.1172	0.0066	0.0008	0.0068	0.0001	0.0001	-	0.0011	0.0007	0.0043	0.0016	0.0023	0.0012	0.0010	0.0012	0.0011	0.0010	0.0222
12	0.0016	0.0004	0.0022	0.0002	0.0014	0.0001	0.0006	0.0004	0.0024	0.0012	0.0035	0.1521	0.0107	0.0052	0.0029	0.0029	0.0007	0.0062	0.0013	0.0081	0.0011	0.0053	0.0028	0.0045	0.0029	0.0014	0.0020	0.0034
13	0.0035	0.0010	0.0025	0.0006	0.0055	0.0004	0.0023	0.0014	0.0052	0.0048	0.0302	0.0080	0.1902	0.0165	0.0125	0.0096	0.0034	0.0146	0.0094	0.0205	0.0060	0.0350	0.0061	0.0143	0.0078	0.0030	0.0059	0.0277
14	0.0194	0.0311	0.0185	0.0048	0.0186	0.0045	0.0135	0.0017	0.0843	0.0220	0.0282	0.0289	0.0729	0.2098	0.0307	0.0141	0.0086	0.0273	0.0176	0.0576	0.0614	0.0255	0.0171	0.0074	0.0052	0.0506	0.0085	0.0140
15	0.0010	-	0.0007	0.0031	0.0120	0.0029	0.0087	0.0011	0.0008	0.0020	0.0070	0.0008	0.0039	0.0043	0.1469	0.0089	0.0034	0.0120	0.0051	0.0024	0.0111	0.0550	0.0005	-	-	-	0.0030	0.0019
16	0.0070	-	0.0011	0.0007	0.0026	0.0006	0.0019	0.0002	0.0002	0.0106	0.0001	0.0007	0.0130	0.0005	0.0173	0.1991	0.0087	0.1437	0.0426	0.0250	0.0038	0.0170	0.0001	0.0045	-	-	0.0002	0.0011
17	0.0004	-	0.0011	0.0001	0.0005	0.0001	0.0003	0.0000	0.0006	0.0010	0.0004	0.0018	0.0051	0.0047	0.0032	0.0342	0.2045	0.0500	0.0111	0.0152	0.0008	0.0008	0.0003	0.0006	-	-	0.0003	0.0003
18	0.0085	0.0001	0.0098	0.0018	0.0068	0.0016	0.0049	0.0006	0.0041	0.0114	0.0113	0.0023	0.0125	0.0128	0.0085	0.0084	0.0029	0.0979	0.0144	0.0183	0.0336	0.0453	0.0032	0.0338	0.0058	0.0003	0.0036	0.0057
19	0.0447	0.0051	0.0047	0.0177	0.0682	0.0165	0.0495	0.0064	0.0221	0.0358	0.0052	0.0033	0.0103	0.0066	0.0138	0.0079	0.0040	0.0121	0.1575	0.0549	0.0227	0.0363	0.0358	0.0998	0.0915	0.0783	0.1260	0.0225
20	-	-	0.0007	0.0001	0.0004	0.0001	0.0003	0.0000	0.0003	-	0.0002	0.0008	0.0002	0.0009	0.0025	0.0008	0.0014	0.0001	0.0002	0.0064	0.0006	0.0019	0.0003	0.0011	-	0.0001	0.0011	0.0010
21	0.0003	0.0010	0.0015	0.0004	0.0034	0.0003	0.0015	0.0009	0.0078	0.0019	0.0023	0.0027	0.0014	0.0020	0.0012	0.0031	0.0007	0.0006	0.0006	0.0005	0.0311	0.0014	0.0056	0.0005	0.0006	0.0001	0.0035	0.0032
22	0.0205	0.0234	0.0617	0.0283	0.0725	0.0175	0.0735	0.0127	0.0065	0.0223	0.0021	0.0005	0.0015	0.0025	0.0028	0.0020	0.0013	0.0056	0.0007	0.0012	0.0379	0.2910	0.0016	0.1005	0.0023	0.0006	0.0079	0.0125
23	0.0057	0.0042	0.0007	0.0006	0.0112	0.0056	0.0070	0.0026	0.0210	0.0094	0.0355	0.0082	0.0195	0.0097	0.0522	0.0294	0.0123	0.0123	0.0046	0.0059	0.0046	0.0135	0.0346	0.0088	0.0038	0.0087	0.0055	0.0053
24	0.0306	0.0010	0.0004	0.0014	0.0262	0.0010	0.0056	0.0034	0.0013	0.0024	0.0026	0.0030	0.0018	0.0040	0.0180	0.0215	0.0167	0.0031	0.0014	0.0012	0.0003	0.0007	0.0003	0.0009	0.0003	0.0004	0.0009	0.0013
25	0.0013	0.0218	0.0018	0.0002	0.0034	0.0006	0.0012	0.0006	0.0004	0.0074	0.0015	0.0015	0.0014	0.0010	0.0021	0.0029	0.0061	0.0021	0.0004	0.0019	-	0.0001	0.0003	0.0003	0.1983	0.0003	0.0001	0.0009
26	0.0014	0.0008	0.0022	0.0004	0.0037	0.0003	0.0016	0.0010	0.0013	0.0035	0.0017	0.0037	0.0042	0.0020	0.0010	0.0012	0.0006	0.0024	0.0017	0.0012	0.0035	0.0009	0.0009	0.0005	0.0015	0.0206	0.0018	0.0062
27	0.0217	0.0071	0.0283	0.0015	0.0224	0.0013	0.0543	0.0258	0.0227	0.0175	0.0262	0.0168	0.0375	0.0234	0.0151	0.0137	0.0039	0.0248	0.0082	0.0098	0.0140	0.0191	0.1385	0.0271	0.2398	0.0592	0.0555	0.0352
28	0.0837	0.0812	0.3282	0.0508	0.1956	0.0475	0.1419	0.0183	0.1190	0.1590	0.1466	0.1179	0.1773	0.1458	0.1136	0.1686	0.0605	0.1772	0.1146	0.0882	0.1900	0.1860	0.2790	0.2028	0.1254	0.0914	0.3025	0.3492

Sources: ABS (various)

Notes:
- Input–output coefficients shown in this Table is calculated from an adapted version of input–output table, for the year 2002, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

Table C-4 Weighted mean capital coefficients matrix (*B*)

(1980-1999)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	0.0009	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0007	0.0009	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0001	0.0002	0.0003	0.0002	0.0004	0.0018	0.0003	0.0009	0.0008	0.0006
10	0.0026	0.0002	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0019	0.0003	0.0002	0.0004	0.0004	0.0005	0.0004	0.0011	0.0004	0.0002	0.0004	0.0005	0.0003	0.0003	0.0013	0.0003	0.0006	0.0004	0.0010
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0.0006	0.0000	0.0006	0.0012	0.0006	0.0007	0.0008	0.0004	0.0005	0.0003	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0006	0.0001	0.0003	0.0013	0.0002	0.0006	0.0005	0.0004
13	0.0043	0.0005	0.0027	0.0032	0.0016	0.0020	0.0021	0.0012	0.0034	0.0036	0.0007	0.0003	0.0007	0.0007	0.0010	0.0007	0.0013	0.0007	0.0004	0.0008	0.0031	0.0007	0.0015	0.0079	0.0016	0.0034	0.0024	0.0027
14	0.0006	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000	0.0005	0.0004	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0002	0.0001	0.0002
15	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001
16	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0069	0.0004	0.0022	0.0053	0.0027	0.0032	0.0035	0.0019	0.0056	0.0040	0.0009	0.0004	0.0009	0.0009	0.0013	0.0010	0.0028	0.0008	0.0006	0.0006	0.0020	0.0009	0.0012	0.0056	0.0010	0.0028	0.0024	0.0031
19	0.0727	0.0063	0.0594	0.1496	0.0769	0.0909	0.0986	0.0527	0.0583	0.0510	0.0105	0.0046	0.0111	0.0107	0.0152	0.0110	0.0253	0.0100	0.0067	0.0094	0.0577	0.0101	0.0186	0.0954	0.0182	0.0429	0.0334	0.0368
20	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0001	0.0001	0.0001
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	0.1355	0.0114	0.1553	0.5569	0.2861	0.3385	0.3669	0.1960	0.1091	0.0937	0.0193	0.0085	0.0205	0.0199	0.0284	0.0208	0.0489	0.0188	0.0124	0.0176	0.1544	0.0197	0.0567	0.2853	0.0537	0.1316	0.1056	0.0782
23	0.0016	0.0001	0.0007	0.0022	0.0011	0.0014	0.0015	0.0009	0.0013	0.0011	0.0002	0.0001	0.0002	0.0002	0.0003	0.0002	0.0006	0.0002	0.0001	0.0002	0.0008	0.0002	0.0004	0.0018	0.0004	0.0008	0.0006	0.0008
24	0.0004	0.0000	0.0001	0.0006	0.0003	0.0004	0.0004	0.0002	0.0003	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0003	0.0000	0.0001	0.0001	0.0001
25	0.0002	0.0000	0.0001	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001
26	0.0002	0.0000	0.0002	0.0006	0.0003	0.0004	0.0004	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0002	0.0000	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001
27	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0004	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0004	0.0001	0.0002	0.0001	0.0003
28	0.0366	0.0036	0.0151	0.0269	0.0139	0.0167	0.0180	0.0104	0.0290	0.0290	0.0056	0.0025	0.0060	0.0058	0.0080	0.0059	0.0116	0.0058	0.0034	0.0058	0.0173	0.0054	0.0075	0.0396	0.0083	0.0164	0.0114	0.0181

Sources: ABS (various)

Notes:
- Capital coefficients shown in this Table are a weighted average of capital coefficients for various input–output tables, published by the Australian Bureau of Statistics, in accordance with sectoral classification in this research;
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

Table C-5 Matrix of sectoral energy intensities (C)

(1980)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0001	-	0.0006	-	0.0702	-	-	-	-	0.0000	0.0002	0.0000	0.0003	0.0002	0.0036	0.0220	0.0035	0.0000	0.0000	0.0000	0.0001	-	-	0.0000	-	-	-	0.0000
Brown Coal	0.0026	-	-	-	0.0371	-	-	-	-	0.0001	-	-	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0022	0.0004	0.0217	-	0.0077	-	0.1269	-	-	0.0001	0.0004	0.0004	0.0009	0.0019	0.0082	0.0009	0.0029	0.0004	0.0001	0.0000	0.0001	-	-	-	-	-	0.0004	0.0001
Petroleum	0.0005	0.0066	0.0045	-	0.0052	0.2069	0.0075	-	0.0016	0.0030	0.0006	0.0002	0.0006	0.0040	0.0019	0.0020	0.0086	0.0001	0.0001	-	0.0002	0.0011	0.0165	0.0052	0.0171	0.0122	0.0001	0.0001
Energy	0.0053	0.0070	0.0268	-	0.1202	0.2069	0.1344	-	0.0016	0.0031	0.0012	0.0006	0.0020	0.0061	0.0137	0.0249	0.0150	0.0005	0.0002	0.0000	0.0004	0.0011	0.0165	0.0052	0.0171	0.0122	0.0005	0.0002

(1981)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0001	-	0.0006	-	0.0700	-	-	-	-	0.0000	0.0002	0.0000	0.0003	0.0002	0.0038	0.0238	0.0036	0.0000	0.0000	0.0000	0.0001	-	-	0.0000	-	-	-	0.0000
Brown Coal	0.0020	-	-	-	0.0347	-	-	-	-	0.0001	-	-	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0018	0.0006	0.0183	-	0.0093	-	0.1148	-	-	0.0001	0.0005	0.0004	0.0009	0.0020	0.0090	0.0016	0.0032	0.0004	0.0002	0.0000	0.0001	0.0000	-	-	-	-	0.0004	0.0001
Petroleum	0.0003	0.0058	0.0038	-	0.0046	0.2128	0.0011	-	0.0017	0.0024	0.0004	0.0001	0.0005	0.0036	0.0017	0.0012	0.0087	0.0001	0.0000	-	0.0002	0.0010	0.0161	0.0048	0.0176	0.0117	0.0001	0.0001
Energy	0.0042	0.0064	0.0227	-	0.1186	0.2128	0.1160	-	0.0017	0.0025	0.0011	0.0006	0.0018	0.0057	0.0145	0.0266	0.0155	0.0005	0.0002	0.0001	0.0003	0.0010	0.0161	0.0048	0.0176	0.0117	0.0005	0.0002

(1982)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0001	-	0.0002	-	0.0644	-	-	-	-	0.0000	0.0002	0.0000	0.0003	0.0002	0.0038	0.0216	0.0041	0.0000	0.0000	0.0000	-	-	-	0.0000	-	-	-	0.0000
Brown Coal	0.0017	-	-	-	0.0369	-	-	-	-	0.0001	-	-	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0019	0.0009	0.0160	-	0.0108	-	0.1180	-	-	0.0001	0.0005	0.0004	0.0008	0.0019	0.0078	0.0018	0.0038	0.0004	0.0001	0.0000	0.0001	0.0000	-	-	-	-	0.0005	0.0001
Petroleum	0.0003	0.0053	0.0030	-	0.0046	0.1763	0.0027	-	0.0019	0.0020	0.0003	0.0001	0.0004	0.0034	0.0013	0.0007	0.0089	0.0001	0.0000	-	0.0002	0.0009	0.0161	0.0045	0.0128	0.0125	0.0001	0.0001
Energy	0.0039	0.0062	0.0192	-	0.1167	0.1763	0.1208	-	0.0019	0.0021	0.0011	0.0005	0.0017	0.0055	0.0129	0.0240	0.0167	0.0005	0.0002	0.0000	0.0003	0.0009	0.0161	0.0046	0.0128	0.0125	0.0006	0.0002

(1983)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0001	-	0.0001	-	0.0587	-	-	-	-	0.0000	0.0002	0.0000	0.0004	0.0002	0.0039	0.0205	0.0045	0.0000	0.0000	0.0000	-	-	-	0.0000	0.0001	-	-	0.0000
Brown Coal	0.0012	-	-	-	0.0293	-	-	-	-	0.0001	-	-	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0022	0.0008	0.0150	-	0.0093	-	0.1079	-	-	0.0001	0.0005	0.0004	0.0008	0.0026	0.0078	0.0020	0.0049	0.0004	0.0001	0.0000	0.0001	0.0000	-	-	-	-	0.0006	0.0001
Petroleum	0.0003	0.0049	0.0022	-	0.0033	0.1708	0.0037	-	0.0021	0.0017	0.0003	0.0001	0.0003	0.0032	0.0009	0.0004	0.0075	0.0001	0.0000	-	0.0002	0.0008	0.0166	0.0043	0.0142	0.0121	0.0000	0.0001
Energy	0.0038	0.0057	0.0174	-	0.1005	0.1708	0.1116	-	0.0021	0.0018	0.0010	0.0005	0.0017	0.0060	0.0126	0.0229	0.0168	0.0005	0.0002	0.0000	0.0002	0.0008	0.0166	0.0043	0.0143	0.0121	0.0007	0.0002

(1984)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0001	-	0.0001	-	0.0564	-	-	-	-	0.0000	0.0003	0.0000	0.0004	0.0002	0.0032	0.0192	0.0041	0.0000	0.0000	0.0000	-	-	-	0.0000	0.0013	-	-	0.0000
Brown Coal	0.0013	-	-	-	0.0253	-	-	-	-	0.0000	-	-	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0029	0.0008	0.0134	-	0.0089	-	0.1019	-	-	0.0001	0.0006	0.0004	0.0009	0.0025	0.0073	0.0022	0.0041	0.0004	0.0001	0.0000	0.0001	0.0000	-	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0004	0.0052	0.0019	-	0.0028	0.1659	0.0020	-	0.0020	0.0015	0.0003	0.0001	0.0002	0.0035	0.0008	0.0003	0.0082	0.0001	0.0000	-	0.0001	0.0007	0.0194	0.0055	0.0228	0.0134	0.0000	0.0000
Energy	0.0048	0.0060	0.0153	-	0.0935	0.1659	0.1040	-	0.0020	0.0016	0.0011	0.0005	0.0016	0.0062	0.0114	0.0217	0.0164	0.0005	0.0002	0.0000	0.0002	0.0007	0.0194	0.0055	0.0240	0.0134	0.0004	0.0002

(continued on next page)

Table C-5 Matrix of sectoral energy intensities (C) (continued)

(1987)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0002	-	-	-	0.0578	-	-	-	-	0.0000	0.0003	0.0001	0.0004	0.0002	0.0026	0.0204	0.0052	0.0000	0.0000	-	-	-	-	0.0000	0.0015	-	-	0.0000
Brown Coal	0.0013	0.0000	-	-	0.0303	-	-	-	-	0.0001	-	-	0.0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0035	0.0006	0.0112	-	0.0097	-	0.1287	-	-	0.0003	0.0007	0.0004	0.0008	0.0023	0.0083	0.0037	0.0073	0.0004	0.0001	0.0001	0.0001	0.0000	-	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0005	0.0057	0.0008	-	0.0015	0.1581	0.0068	-	0.0021	0.0016	0.0002	0.0001	0.0002	0.0031	0.0006	0.0002	0.0046	0.0001	0.0000	-	0.0001	0.0007	0.0176	0.0058	0.0210	0.0126	0.0000	0.0000
Energy	0.0055	0.0064	0.0120	-	0.0993	0.1581	0.1355	-	0.0021	0.0021	0.0012	0.0005	0.0015	0.0056	0.0114	0.0243	0.0171	0.0005	0.0002	0.0001	0.0002	0.0007	0.0176	0.0058	0.0225	0.0126	0.0003	0.0002

(1990)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0004	-	-	-	0.0620	-	-	-	-	0.0001	0.0003	0.0001	0.0004	0.0001	0.0029	0.0180	0.0040	0.0000	0.0000	-	-	-	-	0.0000	0.0015	-	-	0.0000
Brown Coal	0.0010	0.0000	-	-	0.0322	-	-	-	-	0.0002	0.0000	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0049	0.0013	0.0073	-	0.0100	-	0.1344	0.0411	0.0000	0.0011	0.0007	0.0004	0.0008	0.0023	0.0072	0.0026	0.0065	0.0004	0.0001	0.0001	0.0001	0.0000	-	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0005	0.0083	0.0006	-	0.0022	0.2443	0.0021	-	0.0018	0.0019	0.0002	0.0001	0.0001	0.0032	0.0006	0.0002	0.0040	0.0001	0.0000	-	0.0001	0.0008	0.0166	0.0054	0.0228	0.0120	0.0000	0.0000
Energy	0.0068	0.0096	0.0080	-	0.1064	0.2443	0.1365	0.0411	0.0018	0.0033	0.0011	0.0005	0.0013	0.0057	0.0107	0.0207	0.0146	0.0004	0.0002	0.0001	0.0002	0.0008	0.0166	0.0054	0.0243	0.0120	0.0004	0.0002

(1993)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0003	-	-	-	0.0611	-	-	-	-	0.0001	0.0003	0.0000	0.0003	0.0001	0.0023	0.0194	0.0053	-	0.0000	-	-	-	-	0.0000	0.0010	-	-	0.0000
Brown Coal	0.0005	-	-	-	0.0307	-	-	-	-	0.0002	-	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0046	0.0010	0.0060	-	0.0078	-	0.1281	0.0360	0.0000	0.0015	0.0007	0.0005	0.0007	0.0020	0.0056	0.0026	0.0101	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	-	0.0002	0.0001
Petroleum	0.0006	0.0080	0.0005	-	0.0015	0.1828	0.0020	-	0.0022	0.0019	0.0002	0.0001	0.0001	0.0033	0.0005	0.0002	0.0042	0.0001	0.0000	-	0.0001	0.0007	0.0178	0.0050	0.0103	0.0130	0.0000	0.0000
Energy	0.0060	0.0090	0.0066	-	0.1010	0.1828	0.1301	0.0360	0.0022	0.0037	0.0011	0.0006	0.0012	0.0054	0.0084	0.0222	0.0196	0.0004	0.0002	0.0001	0.0002	0.0008	0.0178	0.0050	0.0114	0.0130	0.0003	0.0002

(1994)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0002	-	-	-	0.0629	-	-	-	-	0.0001	0.0003	0.0000	0.0003	0.0001	0.0024	0.0183	0.0053	-	-	-	-	-	-	-	0.0009	-	-	0.0000
Brown Coal	0.0005	-	-	-	0.0316	-	-	-	-	0.0002	-	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0044	0.0010	0.0080	-	0.0087	-	0.1266	0.0301	0.0000	0.0019	0.0007	0.0005	0.0007	0.0021	0.0057	0.0027	0.0106	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0006	0.0088	0.0005	-	0.0015	0.1714	0.0022	-	0.0021	0.0020	0.0002	0.0001	0.0001	0.0033	0.0005	0.0002	0.0041	0.0001	0.0000	-	0.0001	0.0008	0.0182	0.0046	0.0095	0.0139	0.0000	0.0000
Energy	0.0057	0.0099	0.0085	-	0.1047	0.1714	0.1288	0.0301	0.0021	0.0042	0.0012	0.0006	0.0012	0.0055	0.0087	0.0212	0.0201	0.0004	0.0001	0.0001	0.0002	0.0008	0.0182	0.0046	0.0104	0.0139	0.0003	0.0001

(1995)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0004	-	-	-	0.0664	-	-	-	-	0.0001	0.0003	0.0000	0.0003	0.0001	0.0022	0.0146	0.0049	-	-	-	-	-	-	-	0.0011	-	-	0.0000
Brown Coal	0.0006	-	-	-	0.0336	-	-	-	-	0.0001	-	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0058	0.0011	0.0101	-	0.0096	-	0.1689	0.0307	0.0000	0.0010	0.0007	0.0004	0.0007	0.0021	0.0052	0.0024	0.0098	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0007	0.0104	0.0007	-	0.0017	0.2158	0.0019	-	0.0021	0.0020	0.0002	0.0001	0.0001	0.0032	0.0005	0.0002	0.0037	0.0001	0.0000	-	0.0001	0.0007	0.0133	0.0033	0.0165	0.0127	0.0000	0.0000
Energy	0.0076	0.0115	0.0108	-	0.1113	0.2158	0.1708	0.0307	0.0021	0.0032	0.0011	0.0005	0.0010	0.0054	0.0079	0.0172	0.0184	0.0004	0.0001	0.0001	0.0002	0.0007	0.0133	0.0033	0.0177	0.0127	0.0003	0.0001

(continued on next page)

Table C-5 Matrix of sectoral energy intensities (C) (continued)

(1997)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.0004	-	-	-	0.0679	-	-	-	-	0.0000	0.0003	0.0000	0.0003	0.0001	0.0022	0.0153	0.0049	-	0.0000	-	-	-	-	0.0000	0.0013	-	-	0.0000
Brown Coal	0.0006	-	-	-	0.0363	-	-	-	-	0.0001	-	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.0059	0.0013	0.0097	-	0.0070	-	0.2275	0.0540	0.0000	0.0008	0.0006	0.0005	0.0008	0.0024	0.0053	0.0026	0.0101	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	-	0.0003	0.0001
Petroleum	0.0009	0.0088	0.0007	-	0.0014	0.2037	0.0016	-	0.0020	0.0022	0.0001	0.0001	0.0001	0.0023	0.0005	0.0002	0.0039	0.0001	0.0000	-	0.0001	0.0007	0.0145	0.0037	0.0170	0.0137	0.0000	0.0000
Energy	0.0078	0.0101	0.0105	-	0.1126	0.2037	0.2291	0.0540	0.0020	0.0032	0.0011	0.0006	0.0012	0.0047	0.0080	0.0181	0.0189	0.0004	0.0001	0.0001	0.0002	0.0007	0.0145	0.0037	0.0183	0.0137	0.0003	0.0001

(1999)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.000	-	-	-	0.066	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.002	0.015	0.005	-	-	-	-	-	-	-	0.001	-	-	0.000
Brown Coal	0.000	-	-	-	0.040	-	-	-	-	0.000	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.006	0.002	0.004	-	0.007	-	0.234	0.168	0.000	0.001	0.001	0.000	0.001	0.002	0.005	0.002	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000
Petroleum	0.001	0.010	0.000	-	0.001	0.164	0.001	-	0.002	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.004	0.000	0.000	-	0.000	0.001	0.017	0.004	0.014	0.013	0.000	0.000
Energy	0.008	0.012	0.005	-	0.115	0.164	0.236	0.168	0.002	0.003	0.001	0.001	0.001	0.005	0.007	0.017	0.018	0.000	0.000	0.000	0.000	0.001	0.017	0.004	0.015	0.013	0.000	0.000

(2002)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Black Coal	0.000	-	-	-	0.048	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.002	-	-	-	-	-	-	-	0.001	-	-	0.000
Brown Coal	0.000	-	-	-	0.026	-	-	-	-	0.000	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	0.002	0.001	0.005	-	0.004	-	0.142	0.111	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000
Petroleum	0.000	0.004	0.000	-	0.000	0.157	0.010	-	0.001	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.008	0.002	0.013	0.020	0.000	0.000
Energy	0.003	0.004	0.005	-	0.078	0.157	0.152	0.111	0.001	0.002	0.000	0.000	0.000	0.002	0.004	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.008	0.002	0.014	0.020	0.000	0.000

Sources: ABARE (2006a) and ABS (various).

Notes:
- The energy intensities presented in these Tables are calculated based on Equation 5-2, from energy consumption (published by the Australian Bureau of Agricultural and Resource Economics) and sectoral output data (published by the Australian Bureau of Statistics);
- see Table C-1, pp. 234-237 for description of sector 1 to 28.

Table C-6 Input factor costs and prices for Inter-factor model: Coal-fired

	P_K	P_L	P_E	P_{El}	P_M	S_K	S_L	S_E	S_{El}	S_M
1980	0.4347	0.8279	1.3139	1.0024	0.8678	0.2621	0.2276	0.3104	0.0703	0.1296
1981	0.5530	0.8910	1.3405	1.0314	0.8872	0.2915	0.2262	0.3103	0.0732	0.0989
1982	0.6591	1.0793	1.5234	1.0961	0.9018	0.2185	0.2541	0.3428	0.0717	0.1130
1983	0.5731	1.1096	1.5455	1.2334	0.9400	0.2190	0.2662	0.3128	0.0755	0.1265
1984	0.6020	0.9930	1.3963	1.2120	0.9285	0.2549	0.2444	0.2721	0.0744	0.1542
1985	0.7633	1.0207	1.3846	1.1983	0.9387	0.2697	0.2409	0.2595	0.0773	0.1526
1986	0.8500	1.0491	1.2866	1.1547	0.9490	0.2849	0.2370	0.2471	0.0802	0.1507
1987	0.8126	1.0796	1.1421	1.1039	0.9603	0.3011	0.2324	0.2352	0.0831	0.1483
1988	0.8201	1.0520	0.9502	1.0708	0.9725	0.3291	0.2083	0.2349	0.0817	0.1460
1989	1.0981	1.0252	0.9312	1.0402	0.9849	0.3578	0.1858	0.2334	0.0799	0.1430
1990	1.0000	1.0000	1.0000	1.0000	1.0000	0.3882	0.1669	0.2291	0.0773	0.1385
1991	0.7923	1.0184	0.9966	0.9919	1.0026	0.4056	0.1678	0.2241	0.0776	0.1248
1992	0.6037	1.0371	0.9689	1.0070	1.0053	0.4229	0.1683	0.2187	0.0777	0.1123
1993	0.5457	1.0567	0.9865	0.9995	1.0105	0.4398	0.1680	0.2126	0.0774	0.1022
1994	0.5769	0.9831	0.9291	0.9729	0.9738	0.4580	0.1552	0.2058	0.0766	0.1043
1995	0.6793	1.2883	0.8466	0.9134	1.0714	0.3716	0.1874	0.2023	0.0781	0.1606
1996	0.6508	1.3696	0.8995	0.8574	1.0965	0.3702	0.1696	0.2018	0.0742	0.1843
1997	0.5506	1.4617	0.8499	0.8261	1.1240	0.3647	0.1534	0.1990	0.0699	0.2130
1998	0.5328	1.4392	0.8421	0.8536	1.1331	0.3628	0.1468	0.1931	0.0745	0.2229
1999	0.5361	1.4175	0.7949	0.8655	1.1446	0.3600	0.1403	0.1871	0.0796	0.2331

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Cost share of factor i;
- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

Table C-6 Input factor costs and prices for Inter-factor model: Internal-combustion

	P_K	P_L	P_E	P_{El}	P_M	S_K	S_L	S_E	S_{El}	S_M
1980	0.4347	0.8279	1.7791	1.0024	0.8935	0.1481	0.0522	0.7158	0.0161	0.0677
1981	0.5530	0.8910	1.8878	1.0314	0.9134	0.1438	0.0490	0.7468	0.0158	0.0446
1982	0.6591	1.0793	1.9332	1.0961	0.8998	0.1133	0.0658	0.7463	0.0185	0.0561
1983	0.5731	1.1096	2.1410	1.2334	0.9249	0.1065	0.0612	0.7567	0.0174	0.0583
1984	0.6020	0.9930	2.1122	1.2120	0.9436	0.1113	0.0557	0.7553	0.0170	0.0607
1985	0.7633	1.0207	2.0665	1.1983	0.9493	0.1495	0.0621	0.6935	0.0198	0.0751
1986	0.8500	1.0491	1.2626	1.1547	0.9550	0.1963	0.0677	0.6225	0.0227	0.0908
1987	0.8126	1.0796	1.0997	1.1039	0.9615	0.2671	0.0692	0.5319	0.0247	0.1071
1988	0.8201	1.0520	0.8137	1.0708	0.9734	0.2843	0.0534	0.5397	0.0212	0.1014
1989	1.0981	1.0252	0.8870	1.0402	0.9855	0.3009	0.0410	0.5445	0.0181	0.0954
1990	1.0000	1.0000	1.0000	1.0000	1.0000	0.3166	0.0343	0.5438	0.0159	0.0894
1991	0.7923	1.0184	1.1911	0.9919	1.0080	0.2817	0.0305	0.6093	0.0141	0.0645
1992	0.6037	1.0371	1.1991	1.0070	1.0161	0.2458	0.0265	0.6697	0.0122	0.0457
1993	0.5457	1.0567	1.2030	0.9995	1.0268	0.2126	0.0229	0.7172	0.0106	0.0368
1994	0.5769	0.9831	1.1055	0.9729	1.0178	0.2157	0.0235	0.7110	0.0116	0.0382
1995	0.6793	1.2883	1.0190	0.9134	1.0711	0.1553	0.0234	0.7569	0.0097	0.0547
1996	0.6508	1.3696	1.0672	0.8574	1.0886	0.1626	0.0203	0.7416	0.0089	0.0666
1997	0.5506	1.4617	1.0976	0.8261	1.1076	0.1692	0.0179	0.7212	0.0081	0.0836
1998	0.5328	1.4392	0.9282	0.8536	1.1195	0.1812	0.0208	0.6951	0.0104	0.0925
1999	0.5361	1.4175	1.0637	0.8655	1.1342	0.1933	0.0246	0.6655	0.0139	0.1026

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Cost share of factor i;
- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

(continued on next page)

Table C-6 Input factor costs and prices for Inter-factor model: Gas-turbine

	P_K	P_L	P_E	P_{El}	P_M	S_K	S_L	S_E	S_{El}	S_M
1980	0.4347	0.8279	0.8923	1.0024	0.9512	0.2607	0.1975	0.3916	0.0610	0.0892
1981	0.5530	0.8910	0.9330	1.0314	0.9726	0.1938	0.2557	0.4058	0.0827	0.0620
1982	0.6591	1.0793	0.9964	1.0961	0.9816	0.1579	0.2676	0.4280	0.0755	0.0710
1983	0.5731	1.1096	1.1739	1.2334	1.0157	0.2183	0.2264	0.3996	0.0642	0.0915
1984	0.6020	0.9930	1.2568	1.2120	0.9481	0.2497	0.1951	0.3831	0.0594	0.1127
1985	0.7633	1.0207	1.2736	1.1983	0.9568	0.3274	0.1581	0.3354	0.0515	0.1276
1986	0.8500	1.0491	1.1873	1.1547	0.9656	0.4128	0.1232	0.2822	0.0429	0.1389
1987	0.8126	1.0796	1.0855	1.1039	0.9752	0.5058	0.0959	0.2264	0.0343	0.1376
1988	0.8201	1.0520	1.0355	1.0708	0.9828	0.4822	0.0999	0.2557	0.0387	0.1234
1989	1.0981	1.0252	0.9741	1.0402	0.9903	0.4566	0.1034	0.2868	0.0434	0.1098
1990	1.0000	1.0000	1.0000	1.0000	1.0000	0.4264	0.1051	0.3218	0.0487	0.0980
1991	0.7923	1.0184	1.1022	0.9919	1.0035	0.4724	0.0921	0.3018	0.0426	0.0912
1992	0.6037	1.0371	1.0781	1.0070	1.0070	0.5186	0.0799	0.2805	0.0369	0.0841
1993	0.5457	1.0567	1.0924	0.9995	1.0128	0.5638	0.0700	0.2573	0.0322	0.0767
1994	0.5769	0.9831	1.0495	0.9729	0.9619	0.6043	0.0601	0.2287	0.0297	0.0773
1995	0.6793	1.2883	1.0315	0.9134	1.0348	0.4048	0.0996	0.3373	0.0415	0.1167
1996	0.6508	1.3696	1.0602	0.8574	1.0552	0.3857	0.0822	0.3632	0.0361	0.1328
1997	0.5506	1.4617	1.0422	0.8261	1.0775	0.3624	0.0692	0.3861	0.0315	0.1508
1998	0.5328	1.4392	0.8993	0.8536	1.0797	0.3792	0.0621	0.3554	0.0318	0.1715
1999	0.5361	1.4175	0.8818	0.8655	1.0838	0.3921	0.0557	0.3252	0.0316	0.1954

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Cost share of factor i;
- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

Table C-6 Input factor costs and prices for Inter-factor model: Combined-cycle

	P_K	P_L	P_E	P_{El}	P_M	S_K	S_L	S_E	S_{El}	S_M
1980	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-
1988	0.8201	1.0520	1.0625	1.0708	0.9595	0.2150	0.2082	0.3989	0.0968	0.0811
1989	1.0981	1.0252	0.9845	1.0402	0.9776	0.2164	0.2036	0.4084	0.0945	0.0771
1990	1.0000	1.0000	1.0000	1.0000	1.0000	0.2176	0.1990	0.4179	0.0922	0.0733
1991	0.7923	1.0184	1.0918	0.9919	1.0009	0.2189	0.1944	0.4274	0.0899	0.0694
1992	0.6037	1.0371	1.0640	1.0070	1.0019	0.2200	0.1898	0.4369	0.0876	0.0658
1993	0.5457	1.0567	1.0794	0.9995	1.0048	0.2208	0.1852	0.4463	0.0853	0.0625
1994	0.5769	0.9831	1.0429	0.9729	0.9391	0.2274	0.1780	0.4496	0.0879	0.0572
1995	0.6793	1.2883	1.0330	0.9134	1.0873	0.1786	0.2022	0.4566	0.0843	0.0783
1996	0.6508	1.3696	1.0594	0.8574	1.1208	0.1716	0.1682	0.4977	0.0739	0.0886
1997	0.5506	1.4617	1.0356	0.8261	1.1580	0.1614	0.1417	0.5329	0.0646	0.0993
1998	0.5328	1.4392	0.8959	0.8536	1.1586	0.1842	0.1326	0.4891	0.0676	0.1265
1999	0.5361	1.4175	0.8608	0.8655	1.1622	0.2064	0.1209	0.4392	0.0686	0.1648

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Cost share of factor i;
- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

(continued on next page)

Table C-6 Input factor costs and prices for Inter-factor model: Renewable electricity

	P_K	P_L	P_E	P_{El}	P_M	S_K	S_L	S_E	S_{El}	S_M
1980	0.4347	0.8279	-	1.0024	0.8969	0.6190	0.2157	-	0.0667	0.0986
1981	0.5530	0.8910	-	1.0314	0.9080	0.6407	0.2201	-	0.0712	0.0680
1982	0.6591	1.0793	-	1.0961	0.9192	0.5465	0.2831	-	0.0798	0.0906
1983	0.5731	1.1096	-	1.2334	0.9579	0.5588	0.2634	-	0.0747	0.1031
1984	0.6020	0.9930	-	1.2120	0.9434	0.5996	0.2185	-	0.0665	0.1154
1985	0.7633	1.0207	-	1.1983	0.9507	0.6193	0.2053	-	0.0661	0.1094
1986	0.8500	1.0491	-	1.1547	0.9581	0.6385	0.1926	-	0.0655	0.1034
1987	0.8126	1.0796	-	1.1039	0.9662	0.6564	0.1810	-	0.0647	0.0979
1988	0.8201	1.0520	-	1.0708	0.9765	0.6998	0.1485	-	0.0587	0.0930
1989	1.0981	1.0252	-	1.0402	0.9869	0.7390	0.1207	-	0.0528	0.0875
1990	1.0000	1.0000	-	1.0000	1.0000	0.7689	0.1024	-	0.0474	0.0813
1991	0.7923	1.0184	-	0.9919	1.0094	0.7783	0.1024	-	0.0473	0.0720
1992	0.6037	1.0371	-	1.0070	1.0188	0.7868	0.1023	-	0.0472	0.0637
1993	0.5457	1.0567	-	0.9995	1.0308	0.7937	0.1019	-	0.0469	0.0575
1994	0.5769	0.9831	-	0.9729	0.9970	0.8086	0.0915	-	0.0452	0.0548
1995	0.6793	1.2883	-	0.9134	1.0752	0.7306	0.1199	-	0.0500	0.0996
1996	0.6508	1.3696	-	0.8574	1.0983	0.7272	0.1099	-	0.0480	0.1149
1997	0.5506	1.4617	-	0.8261	1.1237	0.7188	0.1009	-	0.0460	0.1344
1998	0.5328	1.4392	-	0.8536	1.1276	0.7207	0.0928	-	0.0473	0.1391
1999	0.5361	1.4175	-	0.8655	1.1331	0.7214	0.0859	-	0.0487	0.1439

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Cost share of factor i;

- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

Table C-6 Input factor costs and prices for Inter-factor model: Final demand

	Final consumption				Export			
	P_E	P_M	S_E	S_M	P_E	P_M	S_E	S_M
1980	1.2740	0.9358	0.0339	0.9661	1.3996	0.7312	0.1017	0.8983
1981	1.3301	0.9508	0.0353	0.9647	1.4216	0.7840	0.1134	0.8866
1982	1.3953	0.9575	0.0352	0.9648	1.6338	0.8294	0.1259	0.8741
1983	1.5570	0.9838	0.0371	0.9629	1.6241	0.9158	0.1551	0.8449
1984	1.5390	0.9638	0.0358	0.9642	1.4304	0.9046	0.1559	0.8441
1985	1.5173	0.9691	0.0349	0.9651	1.4140	0.9303	0.1533	0.8467
1986	1.2025	0.9745	0.0340	0.9660	1.3094	0.9567	0.1507	0.8493
1987	1.1023	0.9803	0.0331	0.9669	1.1541	0.9870	0.1482	0.8518
1988	0.9616	0.9866	0.0308	0.9692	0.9221	0.9895	0.1353	0.8647
1989	0.9711	0.9929	0.0286	0.9714	0.9192	0.9925	0.1234	0.8766
1990	1.0000	1.0000	0.0268	0.9732	1.0000	1.0000	0.1136	0.8864
1991	1.0752	1.0052	0.0268	0.9732	0.9798	1.0362	0.1230	0.8770
1992	1.0836	1.0104	0.0268	0.9732	0.9524	1.0692	0.1330	0.8670
1993	1.0826	1.0166	0.0268	0.9732	0.9703	1.1174	0.1449	0.8551
1994	1.0277	0.9891	0.0247	0.9753	0.9088	1.0658	0.1251	0.8749
1995	0.9607	1.0313	0.0220	0.9780	0.8134	1.2232	0.1237	0.8763
1996	0.9514	1.0459	0.0213	0.9787	0.8705	1.2428	0.1254	0.8746
1997	0.9432	1.0616	0.0206	0.9794	0.8179	1.2621	0.1271	0.8729
1998	0.8851	1.0542	0.0213	0.9787	0.8322	1.2705	0.1232	0.8768
1999	0.9387	1.0477	0.0220	0.9780	0.7838	1.2881	0.1194	0.8806

Sources: ABS (2004d; 2004i; various), (ESAA various).

Notes: - P_i = Price of factor i, S_i = Expenditure share of factor i;

- K = Capital, L = Labour, E = Primary energy, El = Electricity, M = Materials.

Table C-7 Input factor costs and prices for Energy sub-model: Electricity sector

				Steam			Internal combustion			Gas turbine			Combined cycle			Renewable		
	P_{Coal}	P_{Oil}	P_{Gas}	S_{Coal}	S_{Oil}	S_{Gas}	S_{Coal}	S_{Oil}	S_{Gas}	S_{Coal}	S_{Oil}	S_{Gas}	S_{Coal}	S_{Oil}	S_{Gas}	S_{Coal}	S_{Oil}	S_{Gas}
1980	1.3536	1.7791	0.8012	0.6338	0.3027	0.0635	-	1.0000	-	-	0.2953	0.7047	-	-	-	-	-	-
1981	1.3545	1.8878	0.8353	0.6292	0.2894	0.0814	-	1.0000	-	-	0.0669	0.9331	-	-	-	-	-	-
1982	1.6211	1.9332	0.8994	0.6476	0.2623	0.0900	-	1.0000	-	-	0.1361	0.8639	-	-	-	-	-	-
1983	1.5504	2.1410	1.0720	0.6433	0.2459	0.1108	-	1.0000	-	-	0.1765	0.8235	-	-	-	-	-	-
1984	1.3309	2.1122	1.1648	0.6153	0.2461	0.1386	-	1.0000	-	-	0.1023	0.8977	-	-	-	-	-	-
1985	1.3209	2.0665	1.1876	0.6557	0.2152	0.1291	-	1.0000	-	-	0.1626	0.8374	-	-	-	-	-	-
1986	1.3230	1.2626	1.1785	0.6980	0.1268	0.1752	-	1.0000	-	-	0.1177	0.8823	-	-	-	-	-	-
1987	1.1647	1.0997	1.0838	0.7355	0.0877	0.1769	-	1.0000	-	-	0.1449	0.8551	-	-	-	-	-	-
1988	0.9262	0.8137	1.0625	0.7325	0.0513	0.2162	-	1.0000	-	-	0.0926	0.9074	-	-	1.0000	-	-	-
1989	0.9199	0.8870	0.9845	0.7411	0.0729	0.1860	-	1.0000	-	-	0.1060	0.8940	-	-	1.0000	-	-	-
1990	1.0000	1.0000	1.0000	0.7059	0.1176	0.1766	-	1.0000	-	-	0.0737	0.9263	-	-	1.0000	-	-	-
1991	0.9545	1.1911	1.0918	0.7049	0.1466	0.1485	-	1.0000	-	-	0.1065	0.8935	-	-	1.0000	-	-	-
1992	0.9234	1.1991	1.0640	0.7750	0.0609	0.1641	-	1.0000	-	-	0.0558	0.9442	-	-	1.0000	-	-	-
1993	0.9427	1.2030	1.0794	0.7653	0.0599	0.1748	-	1.0000	-	-	0.1099	0.8901	-	-	1.0000	-	-	-
1994	0.8856	1.1055	1.0429	0.7563	0.0512	0.1926	-	1.0000	-	-	0.0953	0.9047	-	-	1.0000	-	-	-
1995	0.7917	1.0190	1.0330	0.7341	0.0486	0.2173	-	1.0000	-	-	0.0934	0.9066	-	-	1.0000	-	-	-
1996	0.8487	1.0672	1.0594	0.7619	0.0638	0.1743	-	1.0000	-	-	0.0787	0.9213	-	-	1.0000	-	-	-
1997	0.7898	1.0976	1.0356	0.7903	0.0456	0.1641	-	1.0000	-	-	0.0867	0.9133	-	-	1.0000	-	-	-
1998	0.8197	0.9282	0.8959	0.8111	0.0363	0.1525	-	1.0000	-	-	0.1941	0.8059	-	-	1.0000	-	-	-
1999	0.7510	1.0637	0.8608	0.8048	0.0513	0.1439	-	1.0000	-	-	0.1613	0.8387	-	-	1.0000	-	-	-

Sources: ABARE (various), ESAA (various), Tedesco et al. (2004).
Note: - P_i = Price of factor i, S_i = Cost share of factor i.

Table C-7 Input factor costs and prices for Energy sub-model: Final demand

					Final consumption				Export			
	P_{Coal}	P_{Oil}	$P_{Electricity}$	P_{Gas}	S_{Coal}	S_{Oil}	$S_{Electricity}$	S_{Gas}	S_{Coal}	S_{Oil}	$S_{Electricity}$	S_{Gas}
1980	1.3536	1.7791	1.0024	0.8012	0.0050	0.5553	0.3722	0.0675	0.7277	0.2681	0.0042	-
1981	1.3545	1.8878	1.0314	0.8353	0.0099	0.5525	0.3736	0.0640	0.7260	0.2695	0.0045	-
1982	1.6211	1.9332	1.0961	0.8994	0.0079	0.5416	0.3795	0.0710	0.7387	0.2547	0.0066	-
1983	1.5504	2.1410	1.2334	1.0720	0.0071	0.5233	0.4013	0.0683	0.7622	0.2324	0.0054	-
1984	1.3309	2.1122	1.2120	1.1648	0.0063	0.5009	0.4298	0.0630	0.7880	0.2087	0.0033	-
1985	1.3209	2.0665	1.1983	1.1876	0.0072	0.4950	0.4327	0.0651	0.8249	0.1719	0.0032	-
1986	1.3230	1.2626	1.1547	1.1785	0.0081	0.4892	0.4356	0.0671	0.8566	0.1404	0.0030	-
1987	1.1647	1.0997	1.1039	1.0838	0.0095	0.4830	0.4381	0.0694	0.8807	0.1164	0.0028	-
1988	0.9262	0.8137	1.0708	1.0625	0.0076	0.4600	0.4582	0.0741	0.8754	0.1212	0.0033	-
1989	0.9199	0.8870	1.0402	0.9845	0.0061	0.4370	0.4779	0.0790	0.8699	0.1262	0.0039	-
1990	1.0000	1.0000	1.0000	1.0000	0.0053	0.4166	0.4945	0.0836	0.8647	0.1307	0.0046	-
1991	0.9545	1.1911	0.9919	1.0918	0.0072	0.3988	0.5038	0.0902	0.8795	0.1170	0.0035	-
1992	0.9234	1.1991	1.0070	1.0640	0.0097	0.3810	0.5122	0.0971	0.8929	0.1045	0.0026	-
1993	0.9427	1.2030	0.9995	1.0794	0.0153	0.3618	0.5178	0.1051	0.9071	0.0909	0.0020	-
1994	0.8856	1.1055	0.9729	1.0429	0.0653	0.3384	0.5378	0.0586	0.9100	0.0879	0.0021	-
1995	0.7917	1.0190	0.9134	1.0330	0.0465	0.3241	0.5821	0.0473	0.9266	0.0708	0.0026	-
1996	0.8487	1.0672	0.8574	1.0594	0.0501	0.3082	0.5923	0.0494	0.9096	0.0878	0.0026	-
1997	0.7898	1.0976	0.8261	1.0356	0.0541	0.2932	0.6012	0.0515	0.8803	0.1171	0.0025	0.0001
1998	0.8197	0.9282	0.8536	0.8959	0.0452	0.3126	0.5751	0.0671	0.9072	0.0903	0.0024	0.0001
1999	0.7510	1.0637	0.8655	0.8608	0.0371	0.3305	0.5357	0.0966	0.9241	0.0735	0.0023	0.0001

Sources: ABARE (various), ABS (various), ESAA (various), Tedesco et al. (2004).

Note: - P_i = Price of factor i, S_i = Expenditure share of factor i.

Table C-8 Input factor prices for Material sub-model

	P_{M1}	P_{M2}	P_{M3}	P_{M4}	P_{M5}	P_{M6}	P_{M7}	P_{M8}	P_{M9}	P_{M10}	P_{M11}	P_{M12}	P_{M13}	P_{M14}	P_{M15}	P_{M16}	P_{M17}	P_{M18}	P_{M19}	P_{M20}
1980	0.6508	0.7709	0.6804	0.5914	0.7384	0.7580	0.7442	0.5883	0.7868	0.6448	0.8977	0.6424	0.8842	0.8263	0.6997	0.5158	0.1700	0.7905	1.5547	1.0166
1981	0.7167	0.7873	0.7213	0.6649	0.7747	0.8036	0.7996	0.6154	0.9776	0.6659	0.8995	0.7162	0.7382	0.8419	0.8150	0.5780	0.1772	0.8423	1.6842	1.0138
1982	0.7671	0.8041	0.7796	0.6766	0.7815	0.8245	0.8294	0.6790	1.3105	0.6745	0.9013	0.6986	0.8406	0.8291	0.6321	0.6588	0.1982	0.7353	1.7398	1.0165
1983	0.9743	0.8213	0.8268	0.8003	0.9249	0.9721	1.0396	1.0035	1.4932	0.8620	0.9639	0.8050	0.7762	0.9042	0.5704	0.7322	0.2390	0.8313	1.7411	1.0206
1984	0.7935	0.8388	0.8728	0.7792	0.9109	0.9432	1.0889	0.8989	1.3201	0.9361	0.9978	0.7875	0.5541	0.8837	0.7421	0.7904	0.4379	0.9813	0.9678	1.0013
1985	0.8532	0.8567	0.9118	0.7756	0.9209	0.9517	1.1263	0.9572	1.3067	0.9688	0.9999	0.7790	0.5583	0.8986	0.7478	0.8300	0.5104	1.0050	0.9900	0.9994
1986	0.9174	0.8749	0.9525	0.7720	0.9310	0.9603	1.1649	1.0192	1.2935	1.0026	1.0020	0.7707	0.5625	0.9137	0.7535	0.8716	0.5949	1.0293	1.0127	0.9975
1987	0.9944	0.8936	0.9979	0.7684	0.9415	0.9691	1.2069	1.0918	1.2806	1.0395	1.0041	0.7626	0.5667	0.9295	0.7594	0.9187	0.7196	1.0551	1.0367	0.9956
1988	0.9963	0.9209	0.9986	0.8359	0.9604	0.9792	1.1313	1.0598	1.1750	1.0261	1.0028	0.8315	0.6740	0.9521	0.8291	0.9447	0.7985	1.0363	1.0243	0.9971
1989	0.9981	0.9526	0.9993	0.9093	0.9797	0.9895	1.0603	1.0288	1.0781	1.0128	1.0014	0.9066	0.8016	0.9753	0.9051	0.9714	0.8861	1.0177	1.0120	0.9985
1990	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1991	1.0893	1.0418	1.0449	0.9718	1.0204	1.0056	1.0719	1.2019	1.1736	1.0744	1.0324	1.0682	1.0403	1.0928	1.0118	0.9583	0.7617	0.9723	0.9732	0.9996
1992	1.1865	1.0505	1.0918	0.9444	1.0412	1.0113	1.1490	1.4446	1.3773	1.1544	1.0658	1.1410	1.0822	1.1942	1.0238	0.9184	0.5802	0.9455	0.9471	0.9992
1993	1.3071	1.0690	1.1441	0.9189	1.0631	1.0171	1.2407	1.8325	1.6833	1.2502	1.1021	1.2270	1.1284	1.3210	1.0361	0.8824	0.4892	0.9204	0.9227	0.9989
1994	1.2529	1.0702	1.0697	0.8663	0.9705	0.9939	1.1474	1.6863	1.5166	1.1792	1.0332	0.8534	1.0814	1.2903	1.2654	0.8027	0.4790	0.9048	0.7241	0.9863
1995	1.6276	1.0934	1.2490	1.1476	1.0829	1.1835	1.3607	1.5468	1.8529	1.3634	1.1206	1.0604	1.6134	1.4296	1.3862	1.1906	0.5673	1.1729	0.8137	0.9792
1996	1.5309	1.1215	1.2891	1.2475	1.1561	1.2012	1.5022	1.6919	1.9034	1.4642	1.1204	0.8312	1.8309	1.4561	1.4091	1.2549	0.5971	1.2217	0.8301	0.9886
1997	1.4452	1.1300	1.3318	1.3658	1.2397	1.2195	1.6753	1.8659	1.9566	1.5807	1.1203	0.6882	2.1126	1.4836	1.4328	1.3264	0.6303	1.2746	0.8472	0.9982
1998	1.4573	1.1257	1.3106	1.2883	1.2333	1.2172	1.6677	2.0121	2.0225	1.6718	1.1174	0.7017	2.1940	1.5108	1.5570	1.3928	0.8596	1.0766	0.8252	0.9931
1999	1.4695	1.1347	1.2901	1.2194	1.2269	1.2149	1.6601	2.1823	2.0930	1.7737	1.1145	0.7158	2.2818	1.5390	1.7042	1.4661	1.3048	0.9343	0.8043	0.9880

Source: ABS (2004k).

Notes:
- P_i = Price of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Coal-fired electricity

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.0015	-	0.0029	0.0011	0.0083	0.0043	0.0032	0.0082	0.0006	0.0068	0.0503	0.0020	0.0079	0.0086	0.0328	0.0744	0.0217	0.0039	0.0081	0.7535
1981	0.0020	-	0.0060	0.0022	0.0172	0.0094	0.0060	0.0233	0.0010	0.0123	0.1011	0.0038	0.0149	0.0175	0.0673	0.1722	0.0410	0.0080	0.0165	0.4782
1982	0.0021	-	0.0065	0.0022	0.0188	0.0098	0.0061	0.0241	0.0008	0.0129	0.1007	0.0033	0.0143	0.0164	0.0602	0.1262	0.0406	0.0086	0.0179	0.5287
1983	0.0023	-	0.0072	0.0021	0.0220	0.0090	0.0057	0.0145	0.0009	0.0117	0.1093	0.0037	0.0174	0.0185	0.0507	0.1012	0.0320	0.0103	0.0209	0.5606
1984	0.0024	-	0.0120	0.0027	0.0247	0.0119	0.0074	0.0064	0.0010	0.0148	0.1158	0.0046	0.0266	0.0085	0.0336	0.1021	0.0038	0.0156	0.0320	0.5740
1985	0.0024	-	0.0111	0.0030	0.0250	0.0114	0.0077	0.0059	0.0010	0.0146	0.1196	0.0046	0.0264	0.0074	0.0364	0.1145	0.0035	0.0141	0.0343	0.5570
1986	0.0024	-	0.0102	0.0033	0.0251	0.0110	0.0079	0.0055	0.0010	0.0144	0.1232	0.0045	0.0260	0.0065	0.0393	0.1281	0.0033	0.0128	0.0368	0.5388
1987	0.0024	-	0.0094	0.0037	0.0251	0.0105	0.0081	0.0051	0.0010	0.0141	0.1260	0.0043	0.0255	0.0058	0.0424	0.1448	0.0031	0.0116	0.0393	0.5178
1988	0.0026	-	0.0100	0.0034	0.0244	0.0116	0.0104	0.0050	0.0007	0.0133	0.1132	0.0040	0.0259	0.0058	0.0432	0.1452	0.0031	0.0136	0.0336	0.5308
1989	0.0029	-	0.0106	0.0031	0.0237	0.0128	0.0134	0.0050	0.0005	0.0126	0.1014	0.0038	0.0261	0.0058	0.0439	0.1451	0.0030	0.0160	0.0285	0.5420
1990	0.0032	-	0.0112	0.0029	0.0228	0.0143	0.0188	0.0048	0.0004	0.0118	0.0915	0.0035	0.0261	0.0057	0.0441	0.1435	0.0029	0.0192	0.0250	0.5483
1991	0.0013	-	0.0026	0.0020	0.0147	0.0207	0.0258	0.0062	0.0001	0.0126	0.1102	0.0019	0.0379	0.0096	0.0414	0.1626	0.0036	0.0164	0.0325	0.4978
1992	0.0005	-	0.0006	0.0014	0.0091	0.0290	0.0339	0.0076	0.0000	0.0130	0.1276	0.0010	0.0528	0.0156	0.0374	0.1773	0.0042	0.0135	0.0408	0.4348
1993	0.0005	-	0.0011	0.0011	0.0071	0.0434	0.0452	0.0090	0.0000	0.0121	0.1377	0.0008	0.0787	0.0334	0.0313	0.1767	0.0046	0.0108	0.0497	0.3568
1994	0.0003	-	0.0008	0.0011	0.0047	0.0591	0.0539	0.0060	0.0001	0.0136	0.2163	0.0003	0.0536	0.0125	0.0324	0.1848	0.0039	0.0067	0.0395	0.3104
1995	0.0003	-	0.0009	0.0014	0.0117	0.0527	0.0380	0.0060	0.0001	0.0092	0.2188	0.0008	0.0672	0.0075	0.0142	0.0835	0.0006	0.0164	0.0364	0.4344
1996	0.0003	-	0.0008	0.0019	0.0117	0.0556	0.0413	0.0053	0.0000	0.0129	0.1817	0.0010	0.0499	0.0070	0.0146	0.0636	0.0012	0.0166	0.0410	0.4935
1997	0.0003	-	0.0007	0.0030	0.0111	0.0558	0.0427	0.0045	0.0000	0.0192	0.1495	0.0012	0.0386	0.0062	0.0143	0.0499	0.0042	0.0160	0.0443	0.5385
1998	0.0003	-	0.0006	0.0024	0.0117	0.0512	0.0416	0.0047	0.0000	0.0190	0.1380	0.0010	0.0347	0.0071	0.0148	0.0499	0.0035	0.0151	0.0645	0.5399
1999	0.0003	-	0.0006	0.0020	0.0119	0.0461	0.0394	0.0048	0.0000	0.0183	0.1249	0.0008	0.0307	0.0079	0.0149	0.0484	0.0030	0.0139	0.1058	0.5261

Source: ABS (various).

Notes:
- S_i = Cost share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Internal-combustion

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.0006	-	0.0013	0.0005	0.0037	0.0044	0.0032	0.0084	0.0006	0.0070	0.0517	0.0020	0.0035	0.0093	0.0846	0.0157	0.0252	0.0017	0.0024	0.7742
1981	0.0009	-	0.0029	0.0010	0.0082	0.0098	0.0063	0.0242	0.0010	0.0128	0.1051	0.0039	0.0072	0.0191	0.1986	0.0394	0.0537	0.0038	0.0054	0.4967
1982	0.0011	-	0.0034	0.0011	0.0098	0.0097	0.0060	0.0239	0.0008	0.0127	0.0998	0.0033	0.0075	0.0171	0.1810	0.0315	0.0563	0.0045	0.0061	0.5243
1983	0.0011	-	0.0036	0.0011	0.0110	0.0090	0.0057	0.0145	0.0009	0.0117	0.1095	0.0037	0.0087	0.0195	0.1578	0.0246	0.0440	0.0051	0.0068	0.5615
1984	0.0014	-	0.0069	0.0016	0.0143	0.0125	0.0078	0.0067	0.0010	0.0156	0.1220	0.0049	0.0154	0.0095	0.1201	0.0288	0.0058	0.0090	0.0120	0.6046
1985	0.0012	-	0.0056	0.0016	0.0128	0.0124	0.0083	0.0065	0.0011	0.0159	0.1299	0.0050	0.0135	0.0086	0.1194	0.0291	0.0048	0.0071	0.0114	0.6059
1986	0.0011	-	0.0045	0.0016	0.0114	0.0123	0.0089	0.0062	0.0011	0.0162	0.1380	0.0050	0.0118	0.0077	0.1185	0.0293	0.0040	0.0056	0.0108	0.6060
1987	0.0010	-	0.0039	0.0015	0.0103	0.0122	0.0094	0.0059	0.0012	0.0164	0.1469	0.0050	0.0105	0.0071	0.1171	0.0294	0.0034	0.0048	0.0103	0.6037
1988	0.0010	-	0.0038	0.0013	0.0092	0.0137	0.0122	0.0059	0.0008	0.0157	0.1335	0.0048	0.0098	0.0072	0.1129	0.0270	0.0032	0.0052	0.0081	0.6249
1989	0.0010	-	0.0037	0.0011	0.0081	0.0152	0.0158	0.0059	0.0006	0.0150	0.1208	0.0045	0.0090	0.0072	0.1084	0.0247	0.0029	0.0056	0.0063	0.6441
1990	0.0010	-	0.0036	0.0009	0.0073	0.0171	0.0226	0.0058	0.0005	0.0142	0.1097	0.0042	0.0083	0.0072	0.1033	0.0227	0.0027	0.0061	0.0053	0.6576
1991	0.0005	-	0.0010	0.0007	0.0051	0.0250	0.0311	0.0075	0.0001	0.0153	0.1332	0.0023	0.0125	0.0122	0.1052	0.0268	0.0034	0.0055	0.0072	0.6054
1992	0.0002	-	0.0003	0.0005	0.0035	0.0355	0.0416	0.0094	0.0000	0.0160	0.1574	0.0012	0.0181	0.0200	0.1043	0.0308	0.0042	0.0049	0.0095	0.5423
1993	0.0002	-	0.0004	0.0004	0.0027	0.0554	0.0576	0.0115	0.0001	0.0154	0.1757	0.0010	0.0298	0.0449	0.0947	0.0331	0.0051	0.0041	0.0129	0.4551
1994	0.0001	-	0.0003	0.0005	0.0019	0.0722	0.0658	0.0073	0.0001	0.0166	0.2642	0.0003	0.0222	0.0160	0.0977	0.0377	0.0043	0.0028	0.0107	0.3790
1995	0.0001	-	0.0003	0.0005	0.0043	0.0614	0.0443	0.0070	0.0001	0.0107	0.2548	0.0010	0.0246	0.0092	0.0447	0.0152	0.0007	0.0060	0.0092	0.5059
1996	0.0001	-	0.0002	0.0007	0.0038	0.0634	0.0471	0.0060	0.0000	0.0148	0.2062	0.0012	0.0156	0.0084	0.0426	0.0099	0.0013	0.0054	0.0099	0.5634
1997	0.0001	-	0.0002	0.0009	0.0033	0.0627	0.0480	0.0051	0.0000	0.0215	0.1679	0.0014	0.0115	0.0073	0.0390	0.0074	0.0040	0.0048	0.0103	0.6047
1998	0.0001	-	0.0002	0.0008	0.0039	0.0581	0.0471	0.0053	0.0000	0.0215	0.1564	0.0011	0.0119	0.0084	0.0410	0.0084	0.0035	0.0051	0.0161	0.6110
1999	0.0001	-	0.0002	0.0008	0.0047	0.0534	0.0456	0.0055	0.0000	0.0212	0.1446	0.0010	0.0122	0.0097	0.0426	0.0095	0.0031	0.0055	0.0311	0.6091

Source: ABS (various).

Notes:
- S_i = Cost share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Gas-turbine

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.0018	-	0.0037	0.0014	0.0105	0.0041	0.0030	0.0078	0.0005	0.0065	0.0482	0.0019	0.0100	0.0124	0.0449	0.0457	0.0199	0.0049	0.0516	0.7211
1981	0.0035	-	0.0109	0.0039	0.0310	0.0066	0.0042	0.0164	0.0007	0.0086	0.0710	0.0027	0.0269	0.0185	0.1117	0.1503	0.0486	0.0144	0.1343	0.3357
1982	0.0035	-	0.0109	0.0037	0.0315	0.0075	0.0046	0.0184	0.0006	0.0098	0.0766	0.0025	0.0240	0.0188	0.0970	0.1029	0.0464	0.0144	0.1246	0.4024
1983	0.0027	-	0.0085	0.0025	0.0258	0.0082	0.0052	0.0132	0.0008	0.0107	0.0997	0.0034	0.0204	0.0255	0.0616	0.0589	0.0266	0.0121	0.1029	0.5113
1984	0.0026	-	0.0131	0.0030	0.0270	0.0106	0.0066	0.0057	0.0009	0.0132	0.1028	0.0041	0.0291	0.0114	0.0366	0.0554	0.0028	0.0171	0.1484	0.5097
1985	0.0019	-	0.0084	0.0025	0.0197	0.0115	0.0077	0.0060	0.0010	0.0147	0.1197	0.0046	0.0206	0.0114	0.0319	0.0469	0.0019	0.0106	0.1183	0.5606
1986	0.0013	-	0.0052	0.0020	0.0140	0.0123	0.0087	0.0062	0.0011	0.0160	0.1359	0.0050	0.0142	0.0112	0.0272	0.0388	0.0013	0.0064	0.0919	0.6013
1987	0.0011	-	0.0042	0.0016	0.0112	0.0125	0.0097	0.0061	0.0012	0.0169	0.1511	0.0052	0.0113	0.0104	0.0231	0.0324	0.0010	0.0052	0.0750	0.6209
1988	0.0014	-	0.0055	0.0019	0.0136	0.0134	0.0121	0.0058	0.0008	0.0153	0.1296	0.0046	0.0143	0.0101	0.0281	0.0405	0.0013	0.0074	0.0823	0.6120
1989	0.0019	-	0.0071	0.0022	0.0165	0.0142	0.0150	0.0054	0.0005	0.0137	0.1099	0.0041	0.0179	0.0096	0.0338	0.0501	0.0015	0.0104	0.0894	0.5967
1990	0.0028	-	0.0099	0.0025	0.0203	0.0147	0.0193	0.0050	0.0004	0.0122	0.0941	0.0036	0.0233	0.0089	0.0414	0.0642	0.0018	0.0171	0.0947	0.5638
1991	0.0007	-	0.0007	0.0014	0.0097	0.0219	0.0272	0.0066	0.0001	0.0134	0.1169	0.0020	0.0299	0.0153	0.0328	0.0622	0.0019	0.0118	0.1124	0.5330
1992	0.0002	-	0.0000	0.0007	0.0045	0.0313	0.0367	0.0083	0.0000	0.0142	0.1390	0.0011	0.0369	0.0252	0.0248	0.0577	0.0019	0.0078	0.1275	0.4821
1993	0.0003	-	0.0006	0.0006	0.0039	0.0491	0.0511	0.0102	0.0000	0.0137	0.1557	0.0009	0.0436	0.0570	0.0192	0.0491	0.0018	0.0060	0.1337	0.4035
1994	0.0001	-	0.0004	0.0006	0.0025	0.0698	0.0636	0.0071	0.0001	0.0160	0.2552	0.0003	0.0280	0.0222	0.0185	0.0485	0.0014	0.0035	0.0960	0.3661
1995	0.0002	-	0.0006	0.0010	0.0086	0.0523	0.0377	0.0059	0.0001	0.0091	0.2173	0.0008	0.0492	0.0113	0.0114	0.0307	0.0003	0.0120	0.1200	0.4314
1996	0.0002	-	0.0005	0.0013	0.0080	0.0535	0.0397	0.0051	0.0000	0.0125	0.1731	0.0010	0.0330	0.0101	0.0110	0.0212	0.0006	0.0113	0.1424	0.4755
1997	0.0002	-	0.0004	0.0019	0.0071	0.0519	0.0397	0.0042	0.0000	0.0178	0.1390	0.0011	0.0246	0.0087	0.0102	0.0160	0.0019	0.0102	0.1642	0.5008
1998	0.0002	-	0.0003	0.0013	0.0064	0.0460	0.0374	0.0043	0.0000	0.0171	0.1240	0.0009	0.0185	0.0097	0.0096	0.0137	0.0014	0.0082	0.2146	0.4866
1999	0.0001	-	0.0003	0.0009	0.0056	0.0397	0.0339	0.0041	0.0000	0.0157	0.1075	0.0007	0.0145	0.0103	0.0088	0.0115	0.0010	0.0066	0.2858	0.4528

Source: ABS (various).
Notes: - S_i = Cost share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Combined-cycle

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	0.0163	-	0.0695	0.0103	0.0889	0.0031	0.0051	0.0016	0.0006	0.0059	0.0355	0.0038	0.0237	0.0012	0.0921	0.1303	0.0028	0.0560	0.0965	0.3567
1989	0.0111	-	0.0429	0.0084	0.0693	0.0050	0.0073	0.0021	0.0004	0.0063	0.0428	0.0027	0.0384	0.0028	0.0897	0.1480	0.0034	0.0505	0.1370	0.3320
1990	0.0071	-	0.0251	0.0064	0.0513	0.0076	0.0101	0.0026	0.0002	0.0063	0.0489	0.0019	0.0589	0.0061	0.0828	0.1595	0.0040	0.0432	0.1847	0.2932
1991	0.0025	-	0.0041	0.0042	0.0300	0.0107	0.0133	0.0032	0.0000	0.0064	0.0562	0.0009	0.0831	0.0099	0.0747	0.1732	0.0047	0.0346	0.2410	0.2473
1992	0.0008	-	0.0006	0.0025	0.0163	0.0140	0.0163	0.0036	0.0000	0.0060	0.0600	0.0004	0.1092	0.0152	0.0627	0.1749	0.0052	0.0258	0.2926	0.1939
1993	0.0009	-	0.0020	0.0019	0.0127	0.0180	0.0188	0.0037	0.0000	0.0050	0.0572	0.0003	0.1419	0.0275	0.0492	0.1567	0.0051	0.0194	0.3317	0.1481
1994	0.0006	-	0.0016	0.0024	0.0098	0.0270	0.0246	0.0027	0.0001	0.0062	0.0988	0.0001	0.1120	0.0113	0.0591	0.1905	0.0050	0.0140	0.2924	0.1418
1995	0.0007	-	0.0019	0.0030	0.0259	0.0262	0.0189	0.0030	0.0001	0.0046	0.1089	0.0004	0.1488	0.0074	0.0277	0.0913	0.0008	0.0363	0.2778	0.2163
1996	0.0007	-	0.0016	0.0042	0.0248	0.0276	0.0205	0.0026	0.0000	0.0064	0.0896	0.0005	0.1033	0.0068	0.0272	0.0651	0.0016	0.0352	0.3373	0.2449
1997	0.0006	-	0.0013	0.0059	0.0221	0.0268	0.0205	0.0022	0.0000	0.0092	0.0717	0.0006	0.0766	0.0059	0.0248	0.0487	0.0051	0.0317	0.3883	0.2582
1998	0.0005	-	0.0009	0.0034	0.0181	0.0229	0.0187	0.0021	0.0000	0.0086	0.0619	0.0004	0.0510	0.0064	0.0200	0.0375	0.0031	0.0226	0.4780	0.2438
1999	0.0003	-	0.0007	0.0024	0.0145	0.0189	0.0161	0.0020	0.0000	0.0075	0.0511	0.0003	0.0374	0.0064	0.0159	0.0291	0.0022	0.0170	0.5627	0.2154

Source: ABS (various).

Notes:
- S_i = Cost share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Renewable electricity

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.0018	-	0.0036	0.0014	0.0104	0.0045	0.0033	0.0085	0.0006	0.0071	0.0524	0.0021	0.0099	0.0266	0.0194	0.0419	0.0124	0.0049	0.0049	0.7844
1981	0.0028	-	0.0085	0.0030	0.0243	0.0101	0.0065	0.0250	0.0010	0.0132	0.1084	0.0040	0.0211	0.0558	0.0452	0.1092	0.0266	0.0113	0.0117	0.5123
1982	0.0029	-	0.0090	0.0030	0.0262	0.0102	0.0064	0.0252	0.0008	0.0135	0.1054	0.0035	0.0199	0.0511	0.0400	0.0790	0.0261	0.0119	0.0125	0.5534
1983	0.0028	-	0.0087	0.0026	0.0267	0.0094	0.0059	0.0152	0.0009	0.0123	0.1148	0.0039	0.0211	0.0579	0.0299	0.0564	0.0183	0.0125	0.0124	0.5884
1984	0.0028	-	0.0143	0.0033	0.0295	0.0125	0.0078	0.0068	0.0011	0.0156	0.1221	0.0049	0.0318	0.0268	0.0196	0.0563	0.0021	0.0186	0.0187	0.6053
1985	0.0028	-	0.0131	0.0036	0.0297	0.0122	0.0082	0.0064	0.0011	0.0157	0.1280	0.0049	0.0313	0.0238	0.0210	0.0631	0.0020	0.0168	0.0198	0.5965
1986	0.0028	-	0.0120	0.0040	0.0297	0.0119	0.0086	0.0060	0.0011	0.0157	0.1339	0.0049	0.0308	0.0211	0.0226	0.0705	0.0019	0.0151	0.0209	0.5866
1987	0.0028	-	0.0111	0.0044	0.0296	0.0116	0.0089	0.0056	0.0011	0.0156	0.1397	0.0048	0.0301	0.0190	0.0242	0.0799	0.0017	0.0137	0.0221	0.5739
1988	0.0030	-	0.0114	0.0038	0.0276	0.0129	0.0116	0.0056	0.0008	0.0149	0.1265	0.0045	0.0293	0.0192	0.0237	0.0769	0.0016	0.0156	0.0183	0.5926
1989	0.0031	-	0.0116	0.0034	0.0257	0.0144	0.0150	0.0056	0.0006	0.0142	0.1141	0.0042	0.0284	0.0194	0.0231	0.0738	0.0015	0.0176	0.0151	0.6093
1990	0.0033	-	0.0117	0.0030	0.0238	0.0161	0.0213	0.0055	0.0005	0.0134	0.1035	0.0039	0.0273	0.0193	0.0223	0.0702	0.0014	0.0200	0.0130	0.6204
1991	0.0014	-	0.0029	0.0022	0.0159	0.0236	0.0293	0.0070	0.0001	0.0143	0.1251	0.0021	0.0406	0.0327	0.0216	0.0817	0.0018	0.0177	0.0173	0.5625
1992	0.0006	-	0.0007	0.0015	0.0102	0.0329	0.0385	0.0086	0.0000	0.0146	0.1442	0.0010	0.0576	0.0529	0.0199	0.0908	0.0022	0.0149	0.0220	0.4867
1993	0.0006	-	0.0012	0.0011	0.0076	0.0468	0.0487	0.0097	0.0000	0.0130	0.1483	0.0008	0.0849	0.1073	0.0163	0.0890	0.0023	0.0116	0.0264	0.3843
1994	0.0003	-	0.0009	0.0013	0.0053	0.0667	0.0608	0.0068	0.0001	0.0153	0.2440	0.0003	0.0602	0.0419	0.0176	0.0972	0.0021	0.0075	0.0218	0.3501
1995	0.0003	-	0.0009	0.0014	0.0121	0.0561	0.0404	0.0063	0.0001	0.0098	0.2328	0.0009	0.0693	0.0239	0.0072	0.0404	0.0003	0.0169	0.0188	0.4621
1996	0.0003	-	0.0008	0.0020	0.0121	0.0586	0.0435	0.0056	0.0000	0.0136	0.1911	0.0011	0.0517	0.0219	0.0074	0.0309	0.0006	0.0172	0.0214	0.5203
1997	0.0003	-	0.0007	0.0031	0.0116	0.0585	0.0448	0.0048	0.0000	0.0201	0.1567	0.0013	0.0403	0.0194	0.0072	0.0244	0.0021	0.0167	0.0236	0.5645
1998	0.0003	-	0.0006	0.0024	0.0118	0.0545	0.0442	0.0050	0.0000	0.0202	0.1469	0.0011	0.0349	0.0224	0.0073	0.0236	0.0017	0.0152	0.0341	0.5737
1999	0.0003	-	0.0006	0.0020	0.0118	0.0502	0.0429	0.0052	0.0000	0.0199	0.1360	0.0009	0.0304	0.0258	0.0072	0.0225	0.0014	0.0138	0.0562	0.5729

Source: ABS (various).

Notes:
- S_i = Cost share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Final consumption

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.0158	0.0003	0.1117	0.0397	0.0170	0.0160	0.0014	0.0001	0.0002	0.0030	0.0470	0.0060	0.0015	0.0000	0.0207	0.0074	0.0021	0.0165	0.0199	0.6738
1981	0.0150	0.0003	0.1099	0.0387	0.0171	0.0149	0.0014	0.0001	0.0002	0.0030	0.0447	0.0055	0.0018	0.0000	0.0209	0.0076	0.0019	0.0164	0.0187	0.6821
1982	0.0152	0.0004	0.1031	0.0367	0.0176	0.0146	0.0013	0.0001	0.0002	0.0029	0.0438	0.0049	0.0014	0.0180	0.0181	0.0090	0.0022	0.0158	0.0177	0.6769
1983	0.0145	0.0004	0.1032	0.0328	0.0161	0.0135	0.0011	0.0000	0.0002	0.0025	0.0391	0.0046	0.0014	0.0203	0.0181	0.0099	0.0022	0.0157	0.0179	0.6866
1984	0.0135	0.0002	0.0905	0.0363	0.0163	0.0130	0.0011	0.0000	0.0002	0.0022	0.0413	0.0039	0.0014	0.0207	0.0150	0.0090	0.0015	0.0134	0.0227	0.6979
1985	0.0137	0.0002	0.0876	0.0358	0.0167	0.0131	0.0011	0.0000	0.0002	0.0024	0.0380	0.0041	0.0015	0.0204	0.0150	0.0085	0.0013	0.0137	0.0222	0.7045
1986	0.0140	0.0002	0.0847	0.0352	0.0171	0.0131	0.0011	0.0000	0.0002	0.0026	0.0349	0.0044	0.0015	0.0200	0.0151	0.0080	0.0011	0.0141	0.0217	0.7107
1987	0.0143	0.0002	0.0817	0.0346	0.0176	0.0132	0.0011	0.0000	0.0002	0.0029	0.0321	0.0047	0.0016	0.0197	0.0151	0.0076	0.0010	0.0146	0.0211	0.7167
1988	0.0139	0.0002	0.0808	0.0334	0.0179	0.0133	0.0010	0.0000	0.0002	0.0030	0.0329	0.0044	0.0010	0.0179	0.0153	0.0072	0.0010	0.0142	0.0209	0.7215
1989	0.0134	0.0002	0.0797	0.0322	0.0182	0.0134	0.0010	0.0000	0.0003	0.0030	0.0337	0.0042	0.0007	0.0162	0.0155	0.0069	0.0011	0.0139	0.0207	0.7258
1990	0.0130	0.0002	0.0785	0.0309	0.0185	0.0134	0.0009	0.0000	0.0003	0.0031	0.0345	0.0039	0.0005	0.0147	0.0157	0.0066	0.0012	0.0135	0.0204	0.7299
1991	0.0133	0.0002	0.0793	0.0284	0.0168	0.0138	0.0008	0.0000	0.0002	0.0019	0.0308	0.0038	0.0006	0.0099	0.0155	0.0065	0.0016	0.0132	0.0246	0.7388
1992	0.0136	0.0002	0.0797	0.0259	0.0153	0.0142	0.0007	0.0000	0.0002	0.0012	0.0274	0.0036	0.0006	0.0067	0.0152	0.0063	0.0021	0.0127	0.0295	0.7449
1993	0.0137	0.0003	0.0795	0.0236	0.0139	0.0144	0.0006	0.0000	0.0002	0.0009	0.0245	0.0034	0.0006	0.0054	0.0149	0.0061	0.0034	0.0122	0.0372	0.7450
1994	0.0130	0.0003	0.0762	0.0247	0.0184	0.0150	0.0009	0.0000	0.0002	0.0015	0.0228	0.0047	0.0017	0.0054	0.0140	0.0064	0.0035	0.0113	0.0353	0.7449
1995	0.0130	0.0003	0.0666	0.0244	0.0163	0.0187	0.0008	0.0000	0.0002	0.0015	0.0313	0.0051	0.0095	0.0065	0.0117	0.0061	0.0028	0.0106	0.0341	0.7404
1996	0.0130	0.0003	0.0701	0.0222	0.0157	0.0189	0.0008	0.0000	0.0002	0.0017	0.0303	0.0046	0.0088	0.0071	0.0117	0.0068	0.0029	0.0110	0.0336	0.7403
1997	0.0130	0.0003	0.0741	0.0202	0.0151	0.0191	0.0008	0.0000	0.0003	0.0020	0.0293	0.0041	0.0081	0.0077	0.0116	0.0078	0.0030	0.0115	0.0331	0.7391
1998	0.0126	0.0003	0.0687	0.0199	0.0157	0.0191	0.0005	0.0000	0.0000	0.0015	0.0336	0.0042	0.0081	0.0071	0.0120	0.0053	0.0030	0.0113	0.0311	0.7460
1999	0.0122	0.0003	0.0632	0.0195	0.0164	0.0190	0.0004	0.0000	0.0000	0.0012	0.0396	0.0043	0.0082	0.0065	0.0124	0.0040	0.0030	0.0111	0.0289	0.7498

Source: ABS (various).

Notes:
- S_i = Expenditure share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

(continued on next page)

Table C-8 Input factor costs for Material sub-model: Export

	S_{M1}	S_{M2}	S_{M3}	S_{M4}	S_{M5}	S_{M6}	S_{M7}	S_{M8}	S_{M9}	S_{M10}	S_{M11}	S_{M12}	S_{M13}	S_{M14}	S_{M15}	S_{M16}	S_{M17}	S_{M18}	S_{M19}	S_{M20}
1980	0.2068	0.0892	0.1864	0.0227	0.0132	0.0167	0.0019	0.0302	0.1288	0.0066	0.0385	0.0031	0.0002	0.0000	0.0215	0.0304	0.0810	0.0352	0.0005	0.0869
1981	0.1892	0.0896	0.1941	0.0257	0.0154	0.0182	0.0022	0.0255	0.1131	0.0062	0.0450	0.0038	0.0002	0.0000	0.0234	0.0336	0.0852	0.0394	0.0005	0.0897
1982	0.1869	0.1015	0.1675	0.0265	0.0137	0.0190	0.0021	0.0225	0.1109	0.0079	0.0506	0.0040	0.0002	0.0000	0.0242	0.0339	0.0863	0.0416	0.0002	0.1005
1983	0.1532	0.1257	0.1673	0.0291	0.0135	0.0203	0.0019	0.0232	0.1169	0.0065	0.0461	0.0035	0.0001	0.0000	0.0262	0.0359	0.0840	0.0436	0.0002	0.1029
1984	0.1814	0.1198	0.1447	0.0266	0.0140	0.0195	0.0021	0.0176	0.1254	0.0060	0.0503	0.0046	0.0001	0.0000	0.0218	0.0429	0.0400	0.0372	0.0420	0.1042
1985	0.1743	0.1215	0.1444	0.0290	0.0144	0.0189	0.0022	0.0176	0.1212	0.0068	0.0513	0.0044	0.0001	0.0000	0.0220	0.0425	0.0360	0.0412	0.0413	0.1108
1986	0.1672	0.1229	0.1438	0.0315	0.0148	0.0184	0.0022	0.0175	0.1169	0.0078	0.0523	0.0042	0.0001	0.0000	0.0222	0.0421	0.0323	0.0457	0.0405	0.1177
1987	0.1583	0.1237	0.1420	0.0350	0.0152	0.0177	0.0022	0.0172	0.1114	0.0094	0.0531	0.0039	0.0001	0.0009	0.0222	0.0412	0.0288	0.0521	0.0393	0.1262
1988	0.1442	0.1331	0.1400	0.0329	0.0149	0.0190	0.0022	0.0199	0.1189	0.0123	0.0537	0.0039	0.0001	0.0009	0.0230	0.0383	0.0248	0.0494	0.0392	0.1292
1989	0.1307	0.1426	0.1373	0.0309	0.0145	0.0203	0.0022	0.0228	0.1262	0.0159	0.0540	0.0039	0.0001	0.0010	0.0237	0.0354	0.0213	0.0466	0.0389	0.1318
1990	0.1169	0.1531	0.1324	0.0284	0.0140	0.0217	0.0022	0.0270	0.1338	0.0235	0.0535	0.0038	0.0001	0.0011	0.0242	0.0322	0.0183	0.0432	0.0380	0.1327
1991	0.1065	0.1546	0.1388	0.0279	0.0146	0.0241	0.0025	0.0253	0.1301	0.0153	0.0604	0.0046	0.0001	0.0011	0.0251	0.0328	0.0183	0.0492	0.0358	0.1328
1992	0.0964	0.1550	0.1446	0.0273	0.0153	0.0267	0.0029	0.0234	0.1257	0.0098	0.0677	0.0056	0.0002	0.0012	0.0259	0.0331	0.0183	0.0555	0.0334	0.1320
1993	0.0865	0.1532	0.1493	0.0262	0.0158	0.0299	0.0034	0.0214	0.1195	0.0078	0.0771	0.0071	0.0002	0.0012	0.0264	0.0330	0.0179	0.0639	0.0308	0.1292
1994	0.0872	0.1563	0.1513	0.0287	0.0161	0.0342	0.0035	0.0231	0.0993	0.0082	0.0797	0.0072	0.0002	0.0005	0.0241	0.0288	0.0209	0.0674	0.0297	0.1337
1995	0.0738	0.1269	0.1440	0.0322	0.0159	0.0323	0.0034	0.0219	0.1013	0.0078	0.0797	0.0070	0.0001	0.0018	0.0211	0.0150	0.0145	0.0553	0.0218	0.2243
1996	0.0834	0.1352	0.1343	0.0323	0.0161	0.0332	0.0036	0.0207	0.0947	0.0074	0.0845	0.0069	0.0001	0.0014	0.0216	0.0145	0.0139	0.0505	0.0218	0.2240
1997	0.0963	0.1444	0.1238	0.0320	0.0162	0.0341	0.0038	0.0193	0.0875	0.0070	0.0897	0.0068	0.0001	0.0012	0.0219	0.0139	0.0132	0.0457	0.0216	0.2217
1998	0.0936	0.1474	0.1239	0.0284	0.0166	0.0352	0.0033	0.0182	0.0904	0.0056	0.0823	0.0086	0.0001	0.0008	0.0234	0.0176	0.0122	0.0518	0.0234	0.2172
1999	0.0900	0.1491	0.1228	0.0250	0.0168	0.0361	0.0029	0.0170	0.0928	0.0046	0.0749	0.0116	0.0001	0.0006	0.0250	0.0239	0.0113	0.0595	0.0255	0.2106

Source: ABS (various).

Notes:
- S_i = Expenditure share of factor i;
- M_1 to M_{20} corresponds to sector 9 to 28. See Table C-1 pp. 234-237 for description of sector 9 to 28.

APPENDIX D

CO_2 Emissions for PPP and SRP

This appendix presents the result of CO_2 emissions and percentage responsibility of these emissions based on PPP and SRP. It contains the following Tables:

Table D-1 CO_2 emissions: PPP

('000 tonnes)

	1980	1981	1982	1983	1984	1987	1990	1993	1994	1995	1997	1999	2002
1. Coal sector	4,337	3,868	3,779	3,491	4,093	4,737	5,463	6,112	5,620	7,657	9,178	9,341	9,174
2. Petroleum sector	6,969	6,652	6,701	6,259	6,460	6,292	6,587	7,063	7,287	7,452	6,912	7,216	7,958
3. Gas sector	1,383	1,327	1,380	1,368	1,369	1,229	1,022	844	783	771	737	690	931
4. Renewable electricity	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Coal-fired electricity	82,697	85,153	91,781	92,921	95,465	110,358	126,105	132,824	135,018	140,143	151,026	168,101	178,187
6. Internal-combustion electricity	677	818	817	873	957	583	671	486	490	553	457	399	607
7. Gas-turbine electricity	910	1,584	1,804	1,049	1,037	368	1,076	779	712	1,224	1,669	1,811	3,374
8. Combined-cycle electricity	na	na	na	na	na	na	294	317	315	334	546	2,358	4,868
9. Agriculture, forestry and fishing	2,919	3,019	3,316	3,012	3,444	3,422	3,384	3,580	3,696	3,812	3,974	4,151	5,465
10. Raw materials Mining	2,365	1,764	1,545	1,389	1,226	1,693	3,341	3,721	4,615	3,510	3,911	3,913	4,644
11. Food, beverages and tobacco	2,842	2,624	2,465	2,280	2,359	2,501	2,580	2,671	2,839	2,935	2,900	2,859	2,458
12. Textile, clothing, footwear and leather	525	478	446	396	415	489	462	459	467	493	478	450	410
13. Wood, paper and printing products	2,538	2,406	2,451	2,349	2,307	2,357	2,113	1,955	2,100	2,112	2,308	2,171	1,826
14. Basic chemicals	7,774	7,312	7,170	6,909	7,561	7,752	8,636	9,269	9,510	9,890	8,949	9,448	8,898
15. Non-metallic mineral products	5,242	5,487	5,581	5,021	4,628	4,844	5,372	4,822	5,086	5,210	4,869	5,070	6,182
16. Basic iron and steel	21,855	22,925	20,613	15,937	16,274	17,529	18,337	17,635	18,108	18,049	17,635	17,013	14,894
17. Basic non-ferrous metals	10,392	10,261	9,452	8,748	9,788	11,070	12,127	13,255	13,559	13,697	13,797	13,899	14,406
18. Fabricated metal products	336	337	321	286	271	300	337	313	322	358	351	372	131
19. Machinery and equipment	544	511	491	430	432	425	485	463	472	507	521	542	322
20. Miscellenous manufacturing	6	7	6	4	5	7	13	12	15	15	15	15	16
21. Water, sewerage and drainage	108	82	58	48	47	44	55	54	56	58	63	69	84
22. Construction	2,647	2,599	2,696	2,411	2,296	2,408	2,832	2,875	2,971	3,058	3,142	3,365	1,905
23. Road transport	12,720	12,958	13,503	13,436	14,070	15,162	16,868	17,234	17,740	18,249	19,145	19,848	20,524
24. Railway transport	1,966	1,951	1,935	1,760	1,891	1,981	1,733	1,630	1,595	1,545	1,555	1,733	1,554
25. Water transport	6,764	6,705	5,096	5,162	4,802	4,077	3,926	3,193	3,261	4,357	4,288	3,577	3,779
26. Air transport	5,583	5,565	5,947	5,763	5,754	6,716	7,525	9,652	10,010	11,238	12,630	12,415	11,961
27. Other transport, services and storage	171	175	196	225	255	249	281	313	371	414	453	550	1,018
28. Commercial services	2,702	2,503	2,496	2,374	2,329	2,538	2,808	3,011	3,036	3,181	3,305	3,542	3,748
Total	**186,974**	**189,070**	**192,046**	**183,903**	**189,534**	**209,132**	**234,437**	**244,544**	**250,054**	**260,820**	**274,817**	**294,918**	**309,323**

Note: This Table shows the results obtained by the application of Equation 5-3, as detailed in Section 5.2.1, p. 101.

Table D-2 CO_2 responsibility: PPP

(per cent)

	1980	1981	1982	1983	1984	1987	1990	1993	1994	1995	1997	1999	2002
1. Coal sector	2.32	2.05	1.97	1.90	2.16	2.27	2.33	2.50	2.25	2.94	3.34	3.17	2.97
2. Petroleum sector	3.73	3.52	3.49	3.40	3.41	3.01	2.81	2.89	2.91	2.86	2.51	2.45	2.57
3. Gas sector	0.74	0.70	0.72	0.74	0.72	0.59	0.44	0.35	0.31	0.30	0.27	0.23	0.30
4. Renewable electricity	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Coal-fired electricity	44.23	45.04	47.79	50.53	50.37	52.77	53.79	54.31	54.00	53.73	54.96	57.00	57.61
6. Internal-combustion electricity	0.36	0.43	0.43	0.47	0.50	0.28	0.29	0.20	0.20	0.21	0.17	0.14	0.20
7. Gas-turbine electricity	0.49	0.84	0.94	0.57	0.55	0.18	0.46	0.32	0.28	0.47	0.61	0.61	1.09
8. Combined-cycle electricity	na	na	na	na	na	na	0.13	0.13	0.13	0.13	0.20	0.80	1.57
9. Agriculture, forestry and fishing	1.56	1.60	1.73	1.64	1.82	1.64	1.44	1.46	1.48	1.46	1.45	1.41	1.77
10. Raw materials Mining	1.27	0.93	0.80	0.76	0.65	0.81	1.43	1.52	1.85	1.35	1.42	1.33	1.50
11. Food, beverages and tobacco	1.52	1.39	1.28	1.24	1.24	1.20	1.10	1.09	1.14	1.13	1.06	0.97	0.79
12. Textile, clothing, footwear and leather	0.28	0.25	0.23	0.22	0.22	0.23	0.20	0.19	0.19	0.19	0.17	0.15	0.13
13. Wood, paper and printing products	1.36	1.27	1.28	1.28	1.22	1.13	0.90	0.80	0.84	0.81	0.84	0.74	0.59
14. Basic chemicals	4.16	3.87	3.73	3.76	3.99	3.71	3.68	3.79	3.80	3.79	3.26	3.20	2.88
15. Non-metallic mineral products	2.80	2.90	2.91	2.73	2.44	2.32	2.29	1.97	2.03	2.00	1.77	1.72	2.00
16. Basic iron and steel	11.69	12.13	10.73	8.67	8.59	8.38	7.82	7.21	7.24	6.92	6.42	5.77	4.81
17. Basic non-ferrous metals	5.56	5.43	4.92	4.76	5.16	5.29	5.17	5.42	5.42	5.25	5.02	4.71	4.66
18. Fabricated metal products	0.18	0.18	0.17	0.16	0.14	0.14	0.14	0.13	0.13	0.14	0.13	0.13	0.04
19. Machinery and equipment	0.29	0.27	0.26	0.23	0.23	0.20	0.21	0.19	0.19	0.19	0.19	0.18	0.10
20. Miscellenous manufacturing	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01
21. Water, sewerage and drainage	0.06	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
22. Construction	1.42	1.37	1.40	1.31	1.21	1.15	1.21	1.18	1.19	1.17	1.14	1.14	0.62
23. Road transport	6.80	6.85	7.03	7.31	7.42	7.25	7.20	7.05	7.09	7.00	6.97	6.73	6.64
24. Railway transport	1.05	1.03	1.01	0.96	1.00	0.95	0.74	0.67	0.64	0.59	0.57	0.59	0.50
25. Water transport	3.62	3.55	2.65	2.81	2.53	1.95	1.67	1.31	1.30	1.67	1.56	1.21	1.22
26. Air transport	2.99	2.94	3.10	3.13	3.04	3.21	3.21	3.95	4.00	4.31	4.60	4.21	3.87
27. Other transport, services and storage	0.09	0.09	0.10	0.12	0.13	0.12	0.12	0.13	0.15	0.16	0.16	0.19	0.33
28. Commercial services	1.44	1.32	1.30	1.29	1.23	1.21	1.20	1.23	1.21	1.22	1.20	1.20	1.21

Note: This Table shows the percentage of sectoral CO_2 emissions, calculated from Table D-1.

Table D-3 CO_2 emissions: SRP

('000 tonnes)

	1980	1981	1982	1983	1984	1987	1990	1993	1994	1995	1997	1999	2002
1. Coal sector	3,416	3,220	3,477	4,135	4,523	6,322	5,401	7,349	6,111	7,329	9,333	9,850	9,995
2. Petroleum sector	5,094	4,417	4,788	4,745	4,533	5,245	5,075	4,488	3,961	5,096	5,190	6,247	6,650
3. Gas sector	886	856	970	835	693	684	668	780	306	292	329	585	670
4. Renewable electricity	300	343	352	324	285	254	180	175	166	185	198	193	195
5. Coal-fired electricity	31,004	32,267	35,000	35,412	35,117	38,723	42,057	49,715	49,417	53,257	55,900	58,481	61,890
6. Internal-combustion electricity	256	311	316	337	357	209	171	150	136	174	162	142	212
7. Gas-turbine electricity	358	642	734	426	395	132	351	360	336	439	590	630	1,153
8. Combined-cycle electricity	na	na	na	na	na	na	249	270	253	273	414	831	1,674
9. Agriculture, forestry and fishing	6,465	5,597	6,606	5,564	7,302	6,588	7,688	6,158	5,989	5,450	7,006	6,798	7,553
10. Raw materials Mining	3,884	3,855	4,204	4,189	3,442	4,581	6,962	9,426	9,017	7,087	8,281	10,204	11,025
11. Food, beverages and tobacco	20,863	21,551	19,567	19,814	18,148	17,615	17,059	18,852	19,668	19,049	21,790	20,622	21,582
12. Textile, clothing, footwear and leather	3,088	3,770	2,828	2,651	2,560	3,048	2,846	2,363	2,409	3,126	3,093	2,924	3,055
13. Wood, paper and printing products	2,377	2,632	2,594	2,321	2,395	2,681	3,046	2,554	2,999	3,074	2,926	3,831	3,882
14. Basic chemicals	3,862	3,805	3,336	3,121	3,323	3,209	3,847	4,823	5,037	6,606	6,391	6,581	6,565
15. Non-metallic mineral products	650	630	733	466	365	462	611	457	629	714	832	905	1,019
16. Basic iron and steel	6,645	5,105	2,875	790	2,673	2,779	4,243	3,293	4,265	3,994	3,555	4,257	4,001
17. Basic non-ferrous metals	11,641	10,071	10,175	9,395	10,960	12,362	14,891	16,145	15,319	19,930	19,830	19,693	20,748
18. Fabricated metal products	1,353	1,416	1,356	724	858	1,330	1,948	787	700	1,008	1,265	805	790
19. Machinery and equipment	5,669	5,351	5,265	3,455	3,346	3,279	4,816	4,047	3,739	5,638	6,333	6,693	6,710
20. Miscellenous manufacturing	571	561	416	350	385	380	427	677	512	659	535	422	437
21. Water, sewerage and drainage	215	308	253	248	156	188	131	137	394	1,556	1,915	2,026	2,141
22. Construction	-	-	2,994	3,215	2,904	2,963	2,401	785	786	1,051	1,259	1,067	1,065
23. Road transport	7,354	7,374	6,494	6,146	6,580	6,520	7,982	8,412	8,840	6,984	7,616	9,885	10,246
24. Railway transport	2,821	2,991	3,604	3,670	4,308	4,426	4,199	3,091	3,102	3,199	3,920	3,450	3,467
25. Water transport	6,859	6,592	5,376	5,257	3,653	2,979	2,644	2,376	2,624	3,003	3,610	3,366	3,549
26. Air transport	6,319	6,357	6,341	6,095	5,382	7,029	6,859	8,605	9,482	9,290	10,241	10,428	10,260
27. Other transport, services and storage	1,932	1,856	1,808	1,806	2,875	3,155	3,249	5,981	4,441	4,661	4,813	6,262	6,718
28. Commercial services	53,095	57,193	59,585	58,412	62,018	71,987	84,437	82,288	89,418	87,696	87,492	97,742	102,073
Total	**186,974**	**189,070**	**192,046**	**183,903**	**189,534**	**209,132**	**234,437**	**244,544**	**250,054**	**260,820**	**274,817**	**294,918**	**309,323**

Note: This Table shows the results obtained by the application of Equation 5-8, as detailed in Section 5.2.2, p. 104.

Table D-4 CO_2 responsibility: SRP

(per cent)

	1980	1981	1982	1983	1984	1987	1990	1993	1994	1995	1997	1999	2002
1. Coal sector	1.83	1.70	1.81	2.25	2.39	3.02	2.30	3.00	2.44	2.81	3.40	3.34	3.23
2. Petroleum sector	2.72	2.34	2.49	2.58	2.39	2.51	2.16	1.84	1.58	1.95	1.89	2.12	2.15
3. Gas sector	0.47	0.45	0.51	0.45	0.37	0.33	0.28	0.32	0.12	0.11	0.12	0.20	0.22
4. Renewable electricity	0.16	0.18	0.18	0.18	0.15	0.12	0.08	0.07	0.07	0.07	0.07	0.07	0.06
5. Coal-fired electricity	16.58	17.07	18.22	19.26	18.53	18.52	17.94	20.33	19.76	20.42	20.34	19.83	20.01
6. Internal-combustion electricity	0.14	0.16	0.16	0.18	0.19	0.10	0.07	0.06	0.05	0.07	0.06	0.05	0.07
7. Gas-turbine electricity	0.19	0.34	0.38	0.23	0.21	0.06	0.15	0.15	0.13	0.17	0.21	0.21	0.37
8. Combined-cycle electricity	na	na	na	na	na	na	0.11	0.11	0.10	0.10	0.15	0.28	0.54
9. Agriculture, forestry and fishing	3.46	2.96	3.44	3.03	3.85	3.15	3.28	2.52	2.40	2.09	2.55	2.30	2.44
10. Raw materials Mining	2.08	2.04	2.19	2.28	1.82	2.19	2.97	3.85	3.61	2.72	3.01	3.46	3.56
11. Food, beverages and tobacco	11.16	11.40	10.19	10.77	9.58	8.42	7.28	7.71	7.87	7.30	7.93	6.99	6.98
12. Textile, clothing, footwear and leather	1.65	1.99	1.47	1.44	1.35	1.46	1.21	0.97	0.96	1.20	1.13	0.99	0.99
13. Wood, paper and printing products	1.27	1.39	1.35	1.26	1.26	1.28	1.30	1.04	1.20	1.18	1.06	1.30	1.26
14. Basic chemicals	2.07	2.01	1.74	1.70	1.75	1.53	1.64	1.97	2.01	2.53	2.33	2.23	2.12
15. Non-metallic mineral products	0.35	0.33	0.38	0.25	0.19	0.22	0.26	0.19	0.25	0.27	0.30	0.31	0.33
16. Basic iron and steel	3.55	2.70	1.50	0.43	1.41	1.33	1.81	1.35	1.71	1.53	1.29	1.44	1.29
17. Basic non-ferrous metals	6.23	5.33	5.30	5.11	5.78	5.91	6.35	6.60	6.13	7.64	7.22	6.68	6.71
18. Fabricated metal products	0.72	0.75	0.71	0.39	0.45	0.64	0.83	0.32	0.28	0.39	0.46	0.27	0.26
19. Machinery and equipment	3.03	2.83	2.74	1.88	1.77	1.57	2.05	1.66	1.50	2.16	2.30	2.27	2.17
20. Miscellenous manufacturing	0.31	0.30	0.22	0.19	0.20	0.18	0.18	0.28	0.20	0.25	0.19	0.14	0.14
21. Water, sewerage and drainage	0.11	0.16	0.13	0.13	0.08	0.09	0.06	0.06	0.16	0.60	0.70	0.69	0.69
22. Construction	-	-	1.56	1.75	1.53	1.42	1.02	0.32	0.31	0.40	0.46	0.36	0.34
23. Road transport	3.93	3.90	3.38	3.34	3.47	3.12	3.40	3.44	3.54	2.68	2.77	3.35	3.31
24. Railway transport	1.51	1.58	1.88	2.00	2.27	2.12	1.79	1.26	1.24	1.23	1.43	1.17	1.12
25. Water transport	3.67	3.49	2.80	2.86	1.93	1.42	1.13	0.97	1.05	1.15	1.31	1.14	1.15
26. Air transport	3.38	3.36	3.30	3.31	2.84	3.36	2.93	3.52	3.79	3.56	3.73	3.54	3.32
27. Other transport, services and storage	1.03	0.98	0.94	0.98	1.52	1.51	1.39	2.45	1.78	1.79	1.75	2.12	2.17
28. Commercial services	28.40	30.25	31.03	31.76	32.72	34.42	36.02	33.65	35.76	33.62	31.84	33.14	33.00

Note: This Table shows the percentage of sectoral CO_2 emissions, calculated from Table D-3.

APPENDIX E

Computer Program Output for Production Function Model

This appendix presents the output of Eviews program for the application Translog cost function for five electricity generation technologies – coal-fired, internal combustion, gas-turbine, combined-cycle, and renewable – and two final demand categories – final consumption and export. It contains the following Tables:

Table E-1 Inter-factor model: Coal-fired electricity generation

System: ST_KLEM
Estimation Method: Three-Stage Least Squares
Date: 05/10/05 Time: 16:51
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 100
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.341274	0.022098	15.443940	0.0000
C(6)	0.002371	0.041725	0.056823	0.9548
C(7)	0.026931	0.021534	1.250598	0.2145
C(8)	-0.062110	0.021807	-2.848145	0.0055
C(9)	-0.008275	0.004756	-1.739860	0.0855
C(2)	0.213863	0.011443	18.689290	0.0000
C(11)	-0.097195	0.032152	-3.023023	0.0033
C(12)	0.028219	0.014294	1.974128	0.0516
C(13)	0.043551	0.009346	4.659846	0.0000
C(3)	0.202706	0.012089	16.767580	0.0000
C(15)	0.156924	0.021127	7.427672	0.0000
C(16)	-0.033098	0.007946	-4.165156	0.0001
C(4)	0.069920	0.002425	28.829910	0.0000
C(18)	0.067566	0.013123	5.148619	0.0000
Determinant residual covariance		3.81E-24		

Equation: SK = C(1) + C(6)*LOG(PK) + C(7)*LOG(PL) + C(8)*LOG(PE) + C(9)*LOG(PEL)
+ (-(C(6)+C(7)+C(8)+C(9)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.848170	Mean dependent var	0.336620
Adjusted R-squared	0.829016	S.D. dependent var	0.070929
S.E. of regression	0.065431	Sum squared resid	0.064219
Durbin-Watson stat	1.335308		

Equation: SL = C(2) + C(7)*LOG(PK) + C(11)*LOG(PL) + C(12)*LOG(PE) + C(13)*LOG(PEL)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.910381	Mean dependent var	0.197330
Adjusted R-squared	0.879816	S.D. dependent var	0.040240
S.E. of regression	0.031690	Sum squared resid	0.015063
Durbin-Watson stat	1.562673		

Equation: SE = C(3) + C(8)*LOG(PK) + C(12)*LOG(PL) + C(15)*LOG(PE) + C(16)*LOG(PEL)
+ (-(C(8)+C(12)+C(15)+C(16)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.868023	Mean dependent var	0.241605
Adjusted R-squared	0.806163	S.D. dependent var	0.045638
S.E. of regression	0.024739	Sum squared resid	0.009180
Durbin-Watson stat	1.611085		

Equation: SEL = C(4) + C(9)*LOG(PK) + C(13)*LOG(PL) + C(16)*LOG(PE) + C(18)*LOG(PEL)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.784782	Mean dependent var	0.076510
Adjusted R-squared	0.768057	S.D. dependent var	0.003579
S.E. of regression	0.004366	Sum squared resid	0.000286
Durbin-Watson stat	1.814149		

Equation: SM = (1 - (C(1)+C(2)+C(3)+C(4))) + (-(C(6)+C(7)+C(8)+C(9)))*LOG(PK)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PL) + (-(C(8)+C(12)+C(15)+C(16)))*LOG(PE)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PEL) + (-((-(C(6)+C(7)+C(8)+C(9))) +(-(C(7)+C(11)+C(12)
+C(13)))+(-(C(8)+C(12)+C(15)+C(16)))+(-(C(9)+C(13)+C(16)+C(18)))))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.827909	Mean dependent var	0.147940
Adjusted R-squared	0.808288	S.D. dependent var	0.039066
S.E. of regression	0.061870	Sum squared resid	0.022968
Durbin-Watson stat	1.287121		

Table E-1 Inter-factor model: Internal-combustion electricity generation

System: IC_KLEM
Estimation Method: Three-Stage Least Squares
Date: 05/10/05 Time: 17:47
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 100
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.274725	0.014247	19.282880	0.0000
C(6)	0.103652	0.022054	4.699826	0.0000
C(7)	-0.008415	0.014363	-0.585858	0.5595
C(8)	-0.137018	0.017750	-7.719166	0.0000
C(9)	0.008393	0.008851	0.948238	0.3457
C(2)	0.038132	0.008035	4.745692	0.0000
C(11)	-0.060663	0.018200	-3.333131	0.0013
C(12)	0.018685	0.011781	1.585988	0.1164
C(13)	0.031825	0.012165	2.616200	0.0105
C(3)	0.587325	0.015119	38.845680	0.0000
C(15)	0.120893	0.023985	5.040244	0.0000
C(16)	-0.006641	0.007673	-0.865393	0.3892
C(4)	0.016725	0.003541	4.722773	0.0000
C(18)	0.034174	0.015091	2.264541	0.0261
Determinant residual covariance		3.53E-25		

Equation: SK = C(1) + C(6)*LOG(PK) + C(7)*LOG(PL) + C(8)*LOG(PE) + C(9)*LOG(PEL)
+ (-(C(6)+C(7)+C(8)+C(9)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.809896	Mean dependent var	0.197755
Adjusted R-squared	0.732534	S.D. dependent var	0.065594
S.E. of regression	0.039762	Sum squared resid	0.023716
Durbin-Watson stat	1.849748		

Equation: SL = C(2) + C(7)*LOG(PK) + C(11)*LOG(PL) + C(12)*LOG(PE) + C(13)*LOG(PEL)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.905126	Mean dependent var	0.041100
Adjusted R-squared	0.846493	S.D. dependent var	0.018473
S.E. of regression	0.016035	Sum squared resid	0.003857
Durbin-Watson stat	1.627766		

Equation: SE = C(3) + C(8)*LOG(PK) + C(12)*LOG(PL) + C(15)*LOG(PE) + C(16)*LOG(PEL)
+ (-(C(8)+C(12)+C(15)+C(16)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.965889	Mean dependent var	0.674215
Adjusted R-squared	0.876792	S.D. dependent var	0.080241
S.E. of regression	0.052200	Sum squared resid	0.040873
Durbin-Watson stat	1.676302		

Equation: SEL = C(4) + C(9)*LOG(PK) + C(13)*LOG(PL) + C(16)*LOG(PE) + C(18)*LOG(PEL)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.896719	Mean dependent var	0.015335
Adjusted R-squared	0.862511	S.D. dependent var	0.004711
S.E. of regression	0.003762	Sum squared resid	0.000212
Durbin-Watson stat	1.020955		

Equation: SM = (1 - (C(1)+C(2)+C(3)+C(4))) + (-(C(6)+C(7)+C(8)+C(9)))*LOG(PK)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PL) + (-(C(8)+C(12)+C(15)+C(16)))*LOG(PE)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PEL) + (-((-(C(6)+C(7)+C(8)+C(9))) +(-(C(7)+C(11)+C(12)
+C(13)))+(-(C(8)+C(12)+C(15)+C(16)))+(-(C(9)+C(13)+C(16)+C(18)))))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.807753	Mean dependent var	0.071590
Adjusted R-squared	0.788781	S.D. dependent var	0.022470
S.E. of regression	0.035590	Sum squared resid	0.007600
Durbin-Watson stat	1.409083		

Table E-1 Inter-factor model: Gas-turbine electricity generation

System: GT_KLEM
Estimation Method: Three-Stage Least Squares
Date: 05/11/05 Time: 14:33
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 100
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.458010	0.057537	7.960307	0.0000
C(6)	0.145719	0.108343	1.344971	0.1822
C(7)	-0.056441	0.054153	-1.042246	0.3002
C(8)	-0.091127	0.052867	-1.723705	0.0884
C(9)	-0.006290	0.013148	-0.478419	0.6336
C(2)	0.119654	0.028927	4.136385	0.0001
C(11)	-0.253854	0.046172	-5.497960	0.0000
C(12)	0.134530	0.036259	3.710238	0.0004
C(13)	-0.077934	0.011584	-6.727491	0.0000
C(3)	0.277487	0.027973	9.919891	0.0000
C(15)	0.000131	0.045034	0.002915	0.9977
C(16)	0.030061	0.010108	2.974029	0.0038
C(4)	0.049438	0.007030	7.032161	0.0000
C(18)	-0.040218	0.007217	-5.572764	0.0000
Determinant residual covariance		7.71E-24		

Equation: SK = C(1) + C(6)*LOG(PK) + C(7)*LOG(PL) + C(8)*LOG(PE) + C(9)*LOG(PEL)
+ (-(C(6)+C(7)+C(8)+C(9)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.870281	Mean dependent var	0.388745
Adjusted R-squared	0.857644	S.D. dependent var	0.123737
S.E. of regression	0.134278	Sum squared resid	0.270460
Durbin-Watson stat	1.395485		

Equation: SL = C(2) + C(7)*LOG(PK) + C(11)*LOG(PL) + C(12)*LOG(PE) + C(13)*LOG(PEL)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.887505	Mean dependent var	0.124940
Adjusted R-squared	0.829160	S.D. dependent var	0.067282
S.E. of regression	0.068256	Sum squared resid	0.069883
Durbin-Watson stat	1.439771		

Equation: SE = C(3) + C(8)*LOG(PK) + C(12)*LOG(PL) + C(15)*LOG(PE) + C(16)*LOG(PEL)
+ (-(C(8)+C(12)+C(15)+C(16)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.947993	Mean dependent var	0.327595
Adjusted R-squared	0.879209	S.D. dependent var	0.061111
S.E. of regression	0.063485	Sum squared resid	0.060456
Durbin-Watson stat	1.538049		

Equation: SEL = C(4) + C(9)*LOG(PK) + C(13)*LOG(PL) + C(16)*LOG(PE) + C(18)*LOG(PEL)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.890397	Mean dependent var	0.045810
Adjusted R-squared	0.852163	S.D. dependent var	0.015363
S.E. of regression	0.016490	Sum squared resid	0.004079
Durbin-Watson stat	1.499896		

Equation: SM = (1 - (C(1)+C(2)+C(3)+C(4))) + (-(C(6)+C(7)+C(8)+C(9)))*LOG(PK)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PL) + (-(C(8)+C(12)+C(15)+C(16)))*LOG(PE)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PEL) + (-((-(C(6)+C(7)+C(8)+C(9))) +(-(C(7)+C(11)+C(12)
+C(13)))+(-(C(8)+C(12)+C(15)+C(16)))+(-(C(9)+C(13)+C(16)+C(18)))))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.857954	Mean dependent var	0.112910
Adjusted R-squared	0.841478	S.D. dependent var	0.034925
S.E. of regression	0.038914	Sum squared resid	0.009086
Durbin-Watson stat	1.756093		

Table E-1 Inter-factor model: Combined-cycle electricity generation

System: CC_KLEM
Estimation Method: Three-Stage Least Squares
Date: 05/11/05 Time: 14:47
Sample: 1988 1999
Included observations: 12
Total system (balanced) observations 60
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.220200	0.009089	24.226140	0.0000
C(6)	0.045698	0.016425	2.782258	0.0078
C(7)	-0.005053	0.016177	-0.312376	0.7562
C(8)	-0.092215	0.026179	-3.522459	0.0010
C(9)	0.015730	0.002881	5.459862	0.0000
C(2)	0.206960	0.009931	20.840380	0.0000
C(11)	-0.273499	0.028134	-9.721330	0.0000
C(12)	0.148319	0.026875	5.518749	0.0000
C(13)	-0.031467	0.006952	-4.526143	0.0000
C(3)	0.401449	0.013309	30.164640	0.0000
C(15)	0.144785	0.060750	2.383303	0.0213
C(16)	0.014494	0.007501	1.932279	0.0595
C(4)	0.093999	0.001546	60.790880	0.0000
C(18)	0.007851	0.003795	2.068732	0.0442
Determinant residual covariance		5.67E-28		

Equation: SK = C(1) + C(6)*LOG(PK) + C(7)*LOG(PL) + C(8)*LOG(PE) + C(9)*LOG(PEL)
+ (-(C(6)+C(7)+C(8)+C(9)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 12

R-squared	0.903423	Mean dependent var	0.203192
Adjusted R-squared	0.833950	S.D. dependent var	0.022698
S.E. of regression	0.029889	Sum squared resid	0.006253
Durbin-Watson stat	1.809763		

Equation: SL = C(2) + C(7)*LOG(PK) + C(11)*LOG(PL) + C(12)*LOG(PE) + C(13)*LOG(PEL)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 12

R-squared	0.908620	Mean dependent var	0.176983
Adjusted R-squared	0.827832	S.D. dependent var	0.029813
S.E. of regression	0.026198	Sum squared resid	0.004804
Durbin-Watson stat	1.547499		

Equation: SE = C(3) + C(8)*LOG(PK) + C(12)*LOG(PL) + C(15)*LOG(PE) + C(16)*LOG(PEL)
+ (-(C(8)+C(12)+C(15)+C(16)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 12

R-squared	0.886778	Mean dependent var	0.450075
Adjusted R-squared	0.863509	S.D. dependent var	0.039202
S.E. of regression	0.035206	Sum squared resid	0.008676
Durbin-Watson stat	1.941757		

Equation: SEL = C(4) + C(9)*LOG(PK) + C(13)*LOG(PL) + C(16)*LOG(PE) + C(18)*LOG(PEL)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 12

R-squared	0.915463	Mean dependent var	0.082767
Adjusted R-squared	0.867156	S.D. dependent var	0.011169
S.E. of regression	0.004071	Sum squared resid	0.000116
Durbin-Watson stat	1.376993		

Equation: SM = (1 - (C(1)+C(2)+C(3)+C(4))) + (-(C(6)+C(7)+C(8)+C(9)))*LOG(PK)
+ (-(C(7)+C(11)+C(12)+C(13)))*LOG(PL) + (-(C(8)+C(12)+C(15)+C(16)))*LOG(PE)
+ (-(C(9)+C(13)+C(16)+C(18)))*LOG(PEL) + (-((-(C(6)+C(7)+C(8)+C(9))) +(-(C(7)+C(11)+C(12)
+C(13)))+(-(C(8)+C(12)+C(15)+C(16)))+(-(C(9)+C(13)+C(16)+C(18)))))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PE) LOG(PEL) LOG(PM) C
Observations: 12

R-squared	0.740004	Mean dependent var	0.086992
S.D. dependent var	0.030764	Sum squared resid	0.002707
Durbin-Watson stat	1.277807		

Table E-1 Inter-factor model: Renewable electricity generation

System: RE_KLEM
Estimation Method: Three-Stage Least Squares
Date: 05/11/05 Time: 16:42
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 80
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.696047	0.029709	23.428720	0.0000
C(6)	0.004691	0.054898	0.085447	0.9321
C(7)	-0.009330	0.036465	-0.255852	0.7988
C(9)	-0.032514	0.024044	-1.352280	0.1806
C(2)	0.155272	0.020058	7.741284	0.0000
C(11)	-0.080099	0.037929	-2.111804	0.0382
C(13)	0.094229	0.020799	4.530461	0.0000
C(4)	0.033256	0.012339	2.695307	0.0088
C(18)	0.101763	0.034530	2.947095	0.0043
Determinant residual covariance		1.00E-19		

Equation: SK = C(1) + C(6)*LOG(PK) + C(7)*LOG(PL) + C(9)*LOG(PEL) + (-(C(6)+C(7)+C(9)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.892588	Mean dependent var	0.693630
Adjusted R-squared	0.877552	S.D. dependent var	0.078962
S.E. of regression	0.081967	Sum squared resid	0.107496
Durbin-Watson stat	1.210336		

Equation: SL = C(2) + C(7)*LOG(PK) + C(11)*LOG(PL) + C(13)*LOG(PEL) + (-(C(7)+C(11)+C(13)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.844972	Mean dependent var	0.152940
Adjusted R-squared	0.822155	S.D. dependent var	0.063191
S.E. of regression	0.055731	Sum squared resid	0.049695
Durbin-Watson stat	1.301576		

Equation: SEL = C(4) + C(9)*LOG(PK) + C(13)*LOG(PL) + C(18)*LOG(PEL) + (-(C(9)+C(13)+C(18)))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.936649	Mean dependent var	0.057035
Adjusted R-squared	0.909770	S.D. dependent var	0.011219
S.E. of regression	0.008322	Sum squared resid	0.001108
Durbin-Watson stat	1.759978		

Equation: SM = (1 - (C(1)+C(2)+C(4))) + (-(C(6)+C(7)+C(9)))*LOG(PK) + (-(C(7)+C(11)+C(13)))*LOG(PL) + (-(C(9)+C(13)+C(18)))*LOG(PEL) + (-((-(C(6)+C(7)+C(9)))+(-(C(7)+C(11)+C(13)))+(-(C(9) +C(13)+C(18)))))*LOG(PM)
Instruments: LOG(PK) LOG(PL) LOG(PEL) LOG(PM) C
Observations: 20

R-squared	0.876104	Mean dependent var	0.096405
Adjusted R-squared	0.847816	S.D. dependent var	0.025726
S.E. of regression	0.040658	Sum squared resid	0.018184
Durbin-Watson stat	1.300820		

Table E-1 Inter-factor model: Final consumption

System: EM_CONSUMPTION
Estimation Method: Three-Stage Least Squares
Date: 02/25/07 Time: 03:53
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 40
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	0.025993	0.000408	63.774988	0.000000
C(7)	0.024696	0.001718	14.370906	0.000000
Determinant residual covariance		0.000000		

Equation: SE = C(2) + C(7)*LOG(PE) + (-(C(7)))*LOG(PM)
Instruments: LOG(PE) LOG(PM) C
Observations: 20

R-squared	0.837743	Mean dependent var	0.028890
Adjusted R-squared	0.828729	S.D. dependent var	0.005707
S.E. of regression	0.002362	Sum squared resid	0.000100
Durbin-Watson stat	1.533159		

Equation: SM = (1-(C(2))) + (-(C(7)))*LOG(PE) + (C(7))*LOG(PM)
Instruments: LOG(PE) LOG(PM) C
Observations: 20

R-squared	0.837743	Mean dependent var	0.971110
Adjusted R-squared	0.828729	S.D. dependent var	0.005707
S.E. of regression	0.002362	Sum squared resid	0.000100
Durbin-Watson stat	1.533159		

Table E-1 Inter-factor model: Export

System: EM_EXPORT
Estimation Method: Three-Stage Least Squares
Date: 02/25/07 Time: 05:22
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 40
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	0.130592	0.002349	55.585228	0.000000
C(7)	0.008560	0.006015	1.423244	0.032824
Determinant residual covariance		0.000000		

Equation: SE = C(2) + C(7)*LOG(PE) + (-(C(7)))*LOG(PM)
Instruments: LOG(PE) LOG(PM) C
Observations: 20

R-squared	0.848200	Mean dependent var	0.131065
Adjusted R-squared	0.804678	S.D. dependent var	0.015469
S.E. of regression	0.015505	Sum squared resid	0.004327
Durbin-Watson stat	1.542990		

Equation: SM = (1-(C(2))) + (-(C(7)))*LOG(PE) + (C(7))*LOG(PM)
Instruments: LOG(PE) LOG(PM) C
Observations: 20

R-squared	0.848200	Mean dependent var	0.868935
Adjusted R-squared	0.804678	S.D. dependent var	0.015469
S.E. of regression	0.015505	Sum squared resid	0.004327
Durbin-Watson stat	1.542990		

Table E-2 Energy sub-model: Coal-fired electricity generation

System: ST_ENERGY
Estimation Method: Three-Stage Least Squares
Date: 05/06/05 Time: 13:57
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 60
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.717991	0.002246	319.697700	0.0000
C(4)	-0.199790	0.024618	-8.115529	0.0000
C(5)	0.034164	0.021953	1.556223	0.1254
C(2)	0.076284	0.002230	34.208880	0.0000
C(7)	0.221408	0.014854	14.906050	0.0000
Determinant residual covariance		2.26E-15		

Equation: E1 = C(1) + C(4)*LOG(P1) + C(5)*LOG(P2) + (-(C(4)+C(5)))*LOG(P3)
Instruments: LOG(P1) LOG(P2) LOG(P3) C
Observations: 20

R-squared	0.888702	Mean dependent var	0.717080
Adjusted R-squared	0.862667	S.D. dependent var	0.061670
S.E. of regression	0.040783	Sum squared resid	0.028275
Durbin-Watson stat	1.961381		

Equation: E2 = C(2) + C(5)*LOG(P1) + C(7)*LOG(P2) + (-(C(5)+C(7)))*LOG(P3)
Instruments: LOG(P1) LOG(P2) LOG(P3) C
Observations: 20

R-squared	0.868327	Mean dependent var	0.129105
Adjusted R-squared	0.852836	S.D. dependent var	0.093914
S.E. of regression	0.036027	Sum squared resid	0.022066
Durbin-Watson stat	1.693205		

Equation: E3 = (1-(C(1)+C(2))) + (-(C(4)+C(5)))*LOG(P1) + (-(C(5)+C(7)))*LOG(P2)
+ (-((-(C(4)+C(5)))+(-(C(5)+C(7)))))*LOG(P3)
Instruments: LOG(P1) LOG(P2) LOG(P3) C
Observations: 20

R-squared	0.789991	Mean dependent var	0.153820
Adjusted R-squared	0.777989	S.D. dependent var	0.041888
S.E. of regression	0.035593	Sum squared resid	0.019003
Durbin-Watson stat	1.007455		

Table E-2 Energy sub-model: Gas-turbine electricity generation

System: GT_ENERGY
Estimation Method: Three-Stage Least Squares
Date: 05/11/05 Time: 14:13
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 40
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	0.106130	0.013279	7.992205	0.0000
C(7)	0.072482	0.033198	2.183339	0.0353
Determinant residual covariance		0		

Equation: E2 = C(2) + C(7)*LOG(P2) + (-(C(7)))*LOG(P3)
Instruments: LOG(P2) LOG(P3) C
Observations: 20

R-squared	0.892473	Mean dependent var	0.122815
Adjusted R-squared	0.847610	S.D. dependent var	0.055451
S.E. of regression	0.051195	Sum squared resid	0.047177
Durbin-Watson stat	1.976739		

Equation: E3 = (1-(C(2))) + (-(C(7)))*LOG(P2) + (C(7))*LOG(P3)
Instruments: LOG(P2) LOG(P3) C
Observations: 20

R-squared	0.892473	Mean dependent var	0.877185
Adjusted R-squared	0.847610	S.D. dependent var	0.055451
S.E. of regression	0.051195	Sum squared resid	0.047177
Durbin-Watson stat	1.976739		

Table E-2 Energy sub-model: Final consumption

System: FINAL_CONSUMPTION
Estimation Method: Three-Stage Least Squares
Date: 02/25/07 Time: 02:05
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 80
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.012923	0.005198	2.486259	0.015264
C(5)	-0.021889	0.037623	-0.581808	0.562539
C(6)	0.035129	0.020567	1.708062	0.091994
C(7)	-0.139821	0.053228	-2.626817	0.010552
C(2)	0.389976	0.016045	24.305824	0.000000
C(9)	0.148386	0.042307	3.507396	0.000789
C(10)	0.040564	0.032217	1.259116	0.212113
C(3)	0.477390	0.009072	52.622505	0.000000
C(12)	-0.345279	0.101119	-3.414566	0.001060
Determinant residual covariance		6.09E-17		

Equation: S1 = C(1) + C(5)*LOG(P1) + C(6)*LOG(P2) + C(7)*LOG(P3) + (-(C(5)+C(6)+C(7)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.713738	Mean dependent var	0.020450
Adjusted R-squared	0.703813	S.D. dependent var	0.020226
S.E. of regression	0.016876	Sum squared resid	0.004557
Durbin-Watson stat	1.127280		

Equation: S2 = C(2) + C(6)*LOG(P1) + C(9)*LOG(P2) + C(10)*LOG(P3) + (-(C(6)+C(9)+C(10)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.866219	Mean dependent var	0.425200
Adjusted R-squared	0.884885	S.D. dependent var	0.089733
S.E. of regression	0.064403	Sum squared resid	0.066364
Durbin-Watson stat	2.075819		

Equation: S3 = C(3) + C(7)*LOG(P1) + C(10)*LOG(P2) + C(12) *LOG(P3) + (-(C(7)+C(10)+C(12)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.855803	Mean dependent var	0.482650
Adjusted R-squared	0.828766	S.D. dependent var	0.074084
S.E. of regression	0.030656	Sum squared resid	0.015037
Durbin-Watson stat	1.846605		

Equation: S4 = (1 - (S1+S2+S3))
Observations: 20

R-squared	0.998370	Mean dependent var	0.071700
Adjusted R-squared	0.998452	S.D. dependent var	0.016073
S.E. of regression	0.000632	Sum squared resid	0.000008
Durbin-Watson stat	1.375000		

Table E-2 Energy sub-model: Export

System: EXPORT
Estimation Method: Three-Stage Least Squares
Date: 02/25/07 Time: 02:36
Sample: 1980 1999
Included observations: 20
Total system (balanced) observations 80
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.859332	0.006954	123.567943	0.000000
C(5)	-0.245345	0.033311	-7.365364	0.000000
C(6)	0.004316	0.025337	0.170358	0.865365
C(7)	0.005070	0.001985	2.553837	0.013510
C(2)	0.104191	0.008660	12.031253	0.000000
C(9)	0.172348	0.026570	6.486448	0.000000
C(10)	-0.001146	0.000944	-2.215023	0.029643
C(3)	0.003474	0.000233	14.897789	0.000000
C(12)	-0.000553	0.003138	-0.176200	0.860796
Determinant residual covariance		4.75E-46		

Equation: S1 = C(1) + C(5)*LOG(P1) + C(6)*LOG(P2) + C(7)*LOG(P3) + (-(C(5)+C(6)+C(7)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.890951	Mean dependent var	0.852605
Adjusted R-squared	0.870505	S.D. dependent var	0.067154
S.E. of regression	0.024166	Sum squared resid	0.009344
Durbin-Watson stat	1.799922		

Equation: S2 = C(2) + C(6)*LOG(P1) + C(9)*LOG(P2) + C(10)*LOG(P3) + (-(C(6)+C(9)+C(10)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.791911	Mean dependent var	0.144000
Adjusted R-squared	0.752894	S.D. dependent var	0.066223
S.E. of regression	0.032919	Sum squared resid	0.017339
Durbin-Watson stat	1.708313		

Equation: S3 = C(3) + C(7)*LOG(P1) + C(10)*LOG(P2) + C(12) *LOG(P3) + (-(C(7)+C(10)+C(12)))*LOG(P4)
Instruments: LOG(P1) LOG(P2) LOG(P3) LOG(P4) C
Observations: 20

R-squared	0.867510	Mean dependent var	0.003370
Adjusted R-squared	0.805168	S.D. dependent var	0.001191
S.E. of regression	0.000748	Sum squared resid	0.000009
Durbin-Watson stat	1.863667		

Equation: S4 = (1 - (S1+S2+S3))
Observations: 20

R-squared	0.997740	Mean dependent var	0.082400
Adjusted R-squared	0.997442	S.D. dependent var	0.017177
S.E. of regression	0.000432	Sum squared resid	0.000008
Durbin-Watson stat	1.680000		

APPENDIX F

Results from Economy-wide Impact of Carbon Tax

This appendix presents the result from the application of carbon tax based on PPP and SRP for various cases discussed in Chapter 6. It contains the following Tables:

Table F-1 Sectoral outputs for final consumption: BC scenario ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**4,034**	352	363	375	386	398	411	420	430	440	450	460	471	481	492	504	515
Petroleum sector	**35,902**	3,137	3,234	3,334	3,437	3,544	3,654	3,738	3,824	3,912	4,002	4,094	4,188	4,284	4,383	4,484	4,587
Gas sector	**10,488**	916	945	974	1,004	1,035	1,067	1,092	1,117	1,143	1,169	1,196	1,223	1,252	1,280	1,310	1,340
Renewable Electricity	**5,624**	437	467	499	532	567	603	617	631	646	661	676	691	707	724	740	757
Coal-fired Electricity	**49,306**	4,362	4,480	4,602	4,727	4,855	4,987	5,102	5,219	5,339	5,462	5,587	5,716	5,847	5,982	6,119	6,260
Internal-combustion Electricity	**145**	13	13	13	14	14	15	15	15	16	16	17	17	17	18	18	19
Gas-turbine Electricity	**996**	87	90	92	95	98	101	104	106	109	111	114	116	119	122	124	127
Combined-cycle Electricity	**2,119**	185	191	197	203	209	216	221	226	231	236	242	247	253	259	265	271
Agriculture, forestry and fishing	**58,828**	5,139	5,299	5,463	5,632	5,807	5,987	6,125	6,266	6,410	6,557	6,708	6,862	7,020	7,181	7,347	7,516
Mining	**1,259**	110	113	117	121	124	128	131	134	137	140	144	147	150	154	157	161
Food, beverages and tobacco	**305,403**	26,681	27,508	28,361	29,240	30,146	31,081	31,796	32,527	33,275	34,041	34,824	35,625	36,444	37,282	38,140	39,017
Textile, clothing, footwear and leather	**94,372**	8,245	8,500	8,764	9,035	9,315	9,604	9,825	10,051	10,282	10,519	10,761	11,008	11,261	11,520	11,785	12,056
Wood, paper and printing products	**79,222**	6,921	7,136	7,357	7,585	7,820	8,062	8,248	8,438	8,632	8,830	9,033	9,241	9,454	9,671	9,893	10,121
Basic chemicals	**91,996**	8,037	8,286	8,543	8,808	9,081	9,363	9,578	9,798	10,023	10,254	10,490	10,731	10,978	11,230	11,489	11,753
Non-metallic mineral products	**1,838**	161	166	171	176	181	187	191	196	200	205	210	214	219	224	229	235
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**224**	20	20	21	21	22	23	23	24	24	25	26	26	27	27	28	29
Fabricated metal products	**5,782**	505	521	537	554	571	588	602	616	630	644	659	674	690	706	722	739
Machinery and equipment	**191,523**	16,732	17,251	17,785	18,337	18,905	19,491	19,940	20,398	20,867	21,347	21,838	22,341	22,854	23,380	23,918	24,468
Miscellenous manufacturing	**20,596**	1,799	1,855	1,913	1,972	2,033	2,096	2,144	2,194	2,244	2,296	2,348	2,402	2,458	2,514	2,572	2,631
Water, sewerage and drainage	**39,488**	3,450	3,557	3,667	3,781	3,898	4,019	4,111	4,206	4,302	4,401	4,503	4,606	4,712	4,820	4,931	5,045
Construction	**31,353**	2,739	2,824	2,912	3,002	3,095	3,191	3,264	3,339	3,416	3,495	3,575	3,657	3,741	3,827	3,915	4,005
Road transport	**60,061**	5,247	5,410	5,577	5,750	5,929	6,112	6,253	6,397	6,544	6,694	6,848	7,006	7,167	7,332	7,501	7,673
Railway transport	**19,105**	1,669	1,721	1,774	1,829	1,886	1,944	1,989	2,035	2,082	2,129	2,178	2,229	2,280	2,332	2,386	2,441
Water transport	**14,465**	1,264	1,303	1,343	1,385	1,428	1,472	1,506	1,541	1,576	1,612	1,649	1,687	1,726	1,766	1,806	1,848
Air transport	**53,480**	4,672	4,817	4,966	5,120	5,279	5,443	5,568	5,696	5,827	5,961	6,098	6,238	6,382	6,529	6,679	6,832
Other transport, services and storage	**139,731**	12,207	12,586	12,976	13,378	13,793	14,221	14,548	14,882	15,224	15,575	15,933	16,299	16,674	17,058	17,450	17,851
Commercial services	**3,623,056**	316,521	326,333	336,450	346,880	357,633	368,720	377,200	385,876	394,751	403,830	413,118	422,620	432,340	442,284	452,457	462,863
Total	**4,940,397**	**431,608**	**444,988**	**458,783**	**473,005**	**487,668**	**502,786**	**514,350**	**526,180**	**538,282**	**550,663**	**563,328**	**576,284**	**589,539**	**603,098**	**616,970**	**631,160**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed constant, according to fixed Leontief coefficients presented in quadrant B of Figure B-1, p. 217;
- The share of electricity-mix in final consumption reflects changes due to MRET scheme.

Table F-1 Sectoral outputs for final consumption: PPP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,922**	352	302	260	225	194	169	146	126	109	95	82	72	62	55	48	42
Petroleum sector	**31,044**	3,137	3,146	3,157	3,170	3,183	3,198	3,189	3,180	3,173	3,166	3,160	3,155	3,151	3,148	3,147	3,148
Gas sector	**4,783**	916	774	656	557	475	406	345	294	251	214	184	158	136	117	102	88
Renewable Electricity	**5,484**	437	466	495	526	558	591	602	613	625	637	649	661	674	686	700	713
Coal-fired Electricity	**47,583**	4,362	4,461	4,563	4,668	4,775	4,884	4,976	5,070	5,166	5,263	5,363	5,465	5,397	5,324	5,247	5,165
Internal-combustion Electricity	**142**	13	13	13	14	14	14	15	15	15	16	16	16	16	17	17	17
Gas-turbine Electricity	**972**	87	89	92	94	97	99	101	103	105	107	109	111	113	115	118	120
Combined-cycle Electricity	**2,633**	185	190	195	200	206	211	215	219	223	228	232	236	413	596	786	983
Agriculture, forestry and fishing	**57,945**	5,139	5,285	5,434	5,587	5,746	5,908	6,029	6,152	6,277	6,406	6,537	6,671	6,807	6,947	7,090	7,236
Mining	**1,240**	110	113	116	120	123	126	129	132	134	137	140	143	146	149	152	155
Food, beverages and tobacco	**300,819**	26,681	27,434	28,209	29,007	29,828	30,673	31,298	31,937	32,589	33,255	33,935	34,630	35,340	36,066	36,807	37,566
Textile, clothing, footwear and leather	**92,955**	8,245	8,477	8,717	8,963	9,217	9,478	9,671	9,869	10,070	10,276	10,486	10,701	10,920	11,145	11,374	11,608
Wood, paper and printing products	**78,033**	6,921	7,116	7,318	7,524	7,737	7,957	8,119	8,284	8,454	8,626	8,803	8,983	9,167	9,355	9,548	9,745
Basic chemicals	**90,615**	8,037	8,264	8,497	8,738	8,985	9,240	9,428	9,620	9,817	10,017	10,222	10,432	10,645	10,864	11,087	11,316
Non-metallic mineral products	**1,810**	161	165	170	175	179	185	188	192	196	200	204	208	213	217	221	226
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**221**	20	20	21	21	22	23	23	23	24	24	25	25	26	26	27	28
Fabricated metal products	**5,695**	505	519	534	549	565	581	593	605	617	630	642	656	669	683	697	711
Machinery and equipment	**188,648**	16,732	17,204	17,690	18,191	18,706	19,236	19,628	20,028	20,437	20,855	21,281	21,717	22,162	22,617	23,082	23,558
Miscellenous manufacturing	**20,286**	1,799	1,850	1,902	1,956	2,012	2,069	2,111	2,154	2,198	2,243	2,289	2,335	2,383	2,432	2,482	2,533
Water, sewerage and drainage	**38,895**	3,450	3,547	3,647	3,751	3,857	3,966	4,047	4,129	4,214	4,300	4,388	4,478	4,569	4,663	4,759	4,857
Construction	**30,882**	2,739	2,816	2,896	2,978	3,062	3,149	3,213	3,279	3,346	3,414	3,484	3,555	3,628	3,702	3,779	3,856
Road transport	**59,230**	5,247	5,396	5,550	5,708	5,871	6,038	6,163	6,290	6,420	6,552	6,687	6,826	6,967	7,111	7,259	7,410
Railway transport	**18,824**	1,669	1,716	1,765	1,815	1,866	1,919	1,959	1,999	2,040	2,081	2,124	2,168	2,212	2,258	2,304	2,352
Water transport	**14,251**	1,264	1,299	1,336	1,374	1,413	1,453	1,483	1,513	1,544	1,576	1,608	1,641	1,674	1,709	1,744	1,780
Air transport	**52,724**	4,672	4,805	4,941	5,082	5,227	5,375	5,486	5,599	5,714	5,831	5,951	6,074	6,200	6,328	6,459	6,593
Other transport, services and storage	**137,708**	12,207	12,553	12,909	13,275	13,652	14,041	14,328	14,622	14,922	15,228	15,541	15,860	16,187	16,521	16,862	17,210
Commercial services	**3,601,547**	316,521	325,992	335,748	345,799	356,153	366,821	374,879	383,117	391,538	400,147	408,947	417,944	427,141	436,545	446,160	455,991
Total	**4,886,891**	**431,608**	**444,015**	**456,833**	**470,066**	**483,722**	**497,809**	**508,362**	**519,163**	**530,215**	**541,523**	**553,090**	**564,921**	**577,019**	**589,397**	**602,058**	**615,008**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: SRP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,526**	352	272	212	166	131	104	82	66	52	42	34	28	23	20	16	14
Petroleum sector	**29,036**	3,137	3,100	3,066	3,035	3,007	2,982	2,936	2,893	2,852	2,816	2,783	2,753	2,727	2,704	2,684	2,666
Gas sector	**3,758**	916	687	520	396	304	235	181	140	110	86	69	55	45	36	30	25
Renewable Electricity	**5,350**	437	463	489	516	544	574	581	589	597	605	613	621	630	639	648	825
Coal-fired Electricity	**44,556**	4,362	4,434	4,508	4,585	4,662	4,742	4,804	4,868	4,780	4,690	4,598	4,503	4,405	4,303	4,199	4,091
Internal-combustion Electricity	**137**	13	13	13	13	14	14	14	14	15	15	15	15	15	16	16	16
Gas-turbine Electricity	**941**	87	89	91	92	94	96	98	99	100	102	103	104	106	107	109	110
Combined-cycle Electricity	**4,012**	185	189	193	197	201	205	208	210	366	525	688	857	1,029	1,207	1,389	1,409
Agriculture, forestry and fishing	**56,144**	5,139	5,253	5,371	5,491	5,615	5,742	5,828	5,915	6,004	6,095	6,189	6,285	6,383	6,484	6,587	6,693
Mining	**1,202**	110	112	115	118	120	123	125	127	128	130	132	135	137	139	141	143
Food, beverages and tobacco	**291,468**	26,681	27,272	27,881	28,506	29,149	29,810	30,253	30,706	31,168	31,642	32,128	32,627	33,138	33,662	34,198	34,747
Textile, clothing, footwear and leather	**90,066**	8,245	8,427	8,615	8,809	9,007	9,212	9,348	9,488	9,631	9,778	9,928	10,082	10,240	10,402	10,567	10,737
Wood, paper and printing products	**75,607**	6,921	7,075	7,232	7,395	7,561	7,733	7,848	7,965	8,085	8,208	8,334	8,463	8,596	8,732	8,871	9,013
Basic chemicals	**87,799**	8,037	8,215	8,398	8,587	8,781	8,980	9,113	9,249	9,389	9,531	9,678	9,828	9,982	10,140	10,301	10,467
Non-metallic mineral products	**1,754**	161	164	168	172	175	179	182	185	188	190	193	196	199	203	206	209
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**214**	20	20	20	21	21	22	22	23	23	23	24	24	24	25	25	25
Fabricated metal products	**5,518**	505	516	528	540	552	564	573	581	590	599	608	618	627	637	647	658
Machinery and equipment	**182,784**	16,732	17,103	17,484	17,877	18,280	18,694	18,972	19,256	19,546	19,843	20,148	20,461	20,781	21,110	21,446	21,790
Miscellenous manufacturing	**19,656**	1,799	1,839	1,880	1,922	1,966	2,010	2,040	2,071	2,102	2,134	2,167	2,200	2,235	2,270	2,306	2,343
Water, sewerage and drainage	**37,686**	3,450	3,526	3,605	3,686	3,769	3,854	3,912	3,970	4,030	4,091	4,154	4,219	4,285	4,352	4,422	4,493
Construction	**29,922**	2,739	2,800	2,862	2,926	2,992	3,060	3,106	3,152	3,200	3,248	3,298	3,349	3,402	3,456	3,511	3,567
Road transport	**57,423**	5,247	5,365	5,487	5,611	5,740	5,872	5,961	6,052	6,145	6,240	6,338	6,438	6,541	6,646	6,754	6,865
Railway transport	**18,248**	1,669	1,706	1,745	1,784	1,825	1,866	1,894	1,923	1,952	1,982	2,013	2,044	2,076	2,109	2,143	2,178
Water transport	**13,810**	1,264	1,292	1,321	1,350	1,381	1,412	1,433	1,455	1,477	1,499	1,523	1,546	1,571	1,596	1,621	1,647
Air transport	**51,107**	4,672	4,777	4,885	4,995	5,109	5,226	5,305	5,386	5,468	5,552	5,639	5,728	5,819	5,912	6,007	6,105
Other transport, services and storage	**133,583**	12,207	12,482	12,764	13,055	13,353	13,660	13,867	14,079	14,295	14,516	14,744	14,976	15,215	15,459	15,710	15,966
Commercial services	**3,579,125**	316,521	325,616	334,982	344,626	354,557	364,784	372,403	380,189	388,146	396,282	404,603	413,111	421,810	430,705	439,800	449,099
Total	**4,822,431**	**431,608**	**442,809**	**454,434**	**466,470**	**478,912**	**491,757**	**501,090**	**510,650**	**520,436**	**530,467**	**540,744**	**551,268**	**562,043**	**573,071**	**584,357**	**595,904**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,260**	352	242	167	117	82	58	42	30	22	16	12	9	7	5	4	3
Petroleum sector	**27,329**	3,137	3,059	2,986	2,918	2,855	2,796	2,719	2,646	2,579	2,517	2,462	2,413	2,370	2,332	2,300	2,272
Gas sector	**3,117**	916	603	401	269	183	125	86	59	41	29	21	16	12	9	7	5
Renewable Electricity	**6,949**	437	464	491	519	548	579	587	596	605	770	941	1,117	1,298	1,484	1,677	1,875
Coal-fired Electricity	**44,365**	4,362	4,442	4,525	4,609	4,695	4,783	4,854	4,773	4,690	4,604	4,514	4,422	4,326	4,226	4,123	4,016
Internal-combustion Electricity	**138**	13	13	13	14	14	14	14	15	15	15	15	15	16	16	16	16
Gas-turbine Electricity	**950**	87	89	91	93	95	97	99	100	102	103	105	106	108	110	111	113
Combined-cycle Electricity	**3,108**	185	189	193	198	202	207	210	365	525	533	541	549	557	566	575	584
Agriculture, forestry and fishing	**57,113**	5,139	5,270	5,405	5,543	5,685	5,832	5,936	6,042	6,150	6,261	6,375	6,492	6,611	6,734	6,859	6,988
Mining	**1,222**	110	113	116	119	122	125	127	129	132	134	136	139	141	144	147	150
Food, beverages and tobacco	**296,496**	26,681	27,360	28,058	28,777	29,515	30,274	30,814	31,365	31,928	32,504	33,095	33,700	34,321	34,957	35,609	36,278
Textile, clothing, footwear and leather	**91,620**	8,245	8,454	8,670	8,892	9,120	9,355	9,522	9,692	9,866	10,044	10,227	10,414	10,606	10,802	11,004	11,210
Wood, paper and printing products	**76,912**	6,921	7,097	7,278	7,465	7,656	7,853	7,993	8,136	8,282	8,432	8,585	8,742	8,903	9,068	9,237	9,410
Basic chemicals	**89,313**	8,037	8,242	8,452	8,668	8,891	9,119	9,282	9,448	9,618	9,791	9,969	10,152	10,339	10,530	10,727	10,928
Non-metallic mineral products	**1,784**	161	165	169	173	178	182	185	189	192	196	199	203	207	210	214	218
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**218**	20	20	21	21	22	22	23	23	23	24	24	25	25	26	26	27
Fabricated metal products	**5,613**	505	518	531	545	559	573	583	594	604	615	627	638	650	662	674	687
Machinery and equipment	**185,937**	16,732	17,158	17,596	18,046	18,509	18,985	19,324	19,669	20,023	20,384	20,754	21,134	21,523	21,922	22,331	22,750
Miscellenous manufacturing	**19,995**	1,799	1,845	1,892	1,941	1,990	2,042	2,078	2,115	2,153	2,192	2,232	2,273	2,315	2,357	2,401	2,446
Water, sewerage and drainage	**38,336**	3,450	3,538	3,628	3,721	3,816	3,914	3,984	4,055	4,128	4,203	4,279	4,357	4,438	4,520	4,604	4,691
Construction	**30,438**	2,739	2,809	2,880	2,954	3,030	3,108	3,163	3,220	3,278	3,337	3,398	3,460	3,523	3,589	3,656	3,724
Road transport	**58,447**	5,247	5,383	5,523	5,666	5,814	5,966	6,075	6,186	6,300	6,416	6,535	6,657	6,782	6,911	7,042	7,177
Railway transport	**18,559**	1,669	1,712	1,756	1,801	1,847	1,895	1,929	1,964	1,999	2,035	2,072	2,111	2,150	2,190	2,231	2,273
Water transport	**14,048**	1,264	1,296	1,329	1,363	1,398	1,434	1,460	1,486	1,513	1,540	1,569	1,597	1,627	1,657	1,688	1,720
Air transport	**52,011**	4,672	4,793	4,916	5,044	5,175	5,309	5,406	5,504	5,605	5,707	5,813	5,921	6,032	6,145	6,262	6,381
Other transport, services and storage	**135,797**	12,207	12,521	12,843	13,174	13,514	13,864	14,114	14,369	14,630	14,896	15,169	15,449	15,736	16,030	16,331	16,640
Commercial services	3,580,632	316,521	325,650	335,048	344,723	354,684	364,940	372,585	380,396	388,380	396,539	404,883	413,414	422,137	431,057	440,177	449,502
Total	4,841,708	**431,608**	**443,042**	**454,978**	**467,372**	**480,200**	**493,453**	**503,193**	**513,166**	**523,381**	**533,838**	**544,551**	**555,523**	**566,758**	**578,260**	**590,034**	**602,084**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**984**	352	181	96	53	30	17	10	6	4	3	2	1	1	1	0	0
Petroleum sector	**24,435**	3,137	2,965	2,812	2,673	2,549	2,436	2,318	2,213	2,119	2,035	1,961	1,896	1,839	1,790	1,747	1,709
Gas sector	**2,428**	916	430	210	106	55	30	16	9	6	3	2	1	1	1	0	0
Renewable Electricity	**6,415**	437	458	479	501	523	546	548	550	553	697	844	992	1,142	1,295	1,451	1,609
Coal-fired Electricity	**40,682**	4,362	4,388	4,416	4,447	4,478	4,390	4,267	4,144	4,022	3,900	3,779	3,658	3,537	3,415	3,293	3,170
Internal-combustion Electricity	**130**	13	13	13	13	13	13	13	13	14	14	14	14	14	14	14	14
Gas-turbine Electricity	**893**	87	88	89	90	91	92	92	92	93	93	94	94	95	96	96	97
Combined-cycle Electricity	**4,079**	185	187	189	191	193	317	458	601	745	748	752	757	762	767	772	778
Agriculture, forestry and fishing	**53,804**	5,139	5,208	5,280	5,354	5,431	5,512	5,553	5,596	5,642	5,690	5,741	5,795	5,853	5,913	5,977	6,043
Mining	**1,151**	110	111	113	115	116	118	119	120	121	122	123	124	125	127	128	129
Food, beverages and tobacco	**279,317**	26,681	27,037	27,408	27,795	28,197	28,615	28,827	29,051	29,289	29,538	29,804	30,087	30,385	30,699	31,029	31,374
Textile, clothing, footwear and leather	**86,311**	8,245	8,355	8,469	8,589	8,713	8,842	8,908	8,977	9,050	9,128	9,210	9,297	9,389	9,486	9,588	9,695
Wood, paper and printing products	**72,455**	6,921	7,013	7,110	7,210	7,314	7,423	7,478	7,536	7,598	7,662	7,731	7,805	7,882	7,963	8,049	8,139
Basic chemicals	**84,138**	8,037	8,144	8,256	8,373	8,494	8,620	8,683	8,751	8,823	8,898	8,978	9,063	9,153	9,248	9,347	9,451
Non-metallic mineral products	**1,681**	161	163	165	167	170	172	173	175	176	178	179	181	183	185	187	189
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**205**	20	20	20	20	21	21	21	21	21	22	22	22	22	23	23	23
Fabricated metal products	**5,288**	505	512	519	526	534	542	546	550	555	559	564	570	575	581	587	594
Machinery and equipment	**175,164**	16,732	16,955	17,188	17,431	17,683	17,945	18,078	18,218	18,367	18,524	18,691	18,868	19,055	19,252	19,459	19,675
Miscellenous manufacturing	**18,836**	1,799	1,823	1,848	1,874	1,902	1,930	1,944	1,959	1,975	1,992	2,010	2,029	2,049	2,070	2,093	2,116
Water, sewerage and drainage	**36,115**	3,450	3,496	3,544	3,594	3,646	3,700	3,727	3,756	3,787	3,819	3,854	3,890	3,929	3,969	4,012	4,057
Construction	**28,675**	2,739	2,776	2,814	2,853	2,895	2,938	2,959	2,982	3,007	3,032	3,060	3,089	3,119	3,152	3,185	3,221
Road transport	**55,121**	5,247	5,321	5,397	5,477	5,560	5,645	5,691	5,739	5,789	5,842	5,898	5,957	6,020	6,085	6,154	6,226
Railway transport	**17,499**	1,669	1,692	1,716	1,740	1,766	1,793	1,806	1,821	1,836	1,852	1,869	1,888	1,907	1,927	1,948	1,970
Water transport	**13,238**	1,264	1,281	1,298	1,317	1,336	1,356	1,366	1,377	1,389	1,401	1,413	1,427	1,441	1,456	1,472	1,489
Air transport	**49,037**	4,672	4,737	4,804	4,874	4,947	5,023	5,062	5,104	5,148	5,194	5,243	5,295	5,350	5,407	5,468	5,531
Other transport, services and storage	**128,207**	12,207	12,378	12,556	12,741	12,933	13,133	13,237	13,348	13,464	13,586	13,715	13,851	13,995	14,146	14,304	14,469
Commercial services	**3,538,242**	316,521	324,899	333,525	342,407	351,551	360,964	367,788	374,771	381,916	389,225	396,713	404,383	412,238	420,282	428,518	436,948
Total	4,724,530	**431,608**	**440,631**	**450,335**	**460,531**	**471,140**	**482,131**	**489,689**	**497,483**	**505,506**	**513,756**	**522,265**	**531,033**	**540,061**	**549,350**	**558,901**	**568,716**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: PPP for Early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,091**	352	211	128	79	49	31	20	13	8	6	4	3	2	2	1	1
Petroleum sector	**25,756**	3,137	3,014	2,901	2,797	2,700	2,610	2,507	2,412	2,326	2,249	2,180	2,120	2,066	2,019	1,978	1,941
Gas sector	**2,702**	916	516	296	172	102	61	37	23	14	9	6	4	3	2	2	1
Renewable Electricity	**7,336**	437	463	489	516	544	573	580	587	747	910	1,078	1,250	1,427	1,609	1,796	1,988
Coal-fired Electricity	**43,232**	4,362	4,433	4,505	4,579	4,655	4,733	4,645	4,554	4,461	4,366	4,268	4,167	4,063	3,957	3,847	3,734
Internal-combustion Electricity	**137**	13	13	13	13	14	14	14	14	15	15	15	15	15	16	16	16
Gas-turbine Electricity	**939**	87	89	91	92	94	96	97	99	100	101	103	104	105	107	108	110
Combined-cycle Electricity	**3,229**	185	189	193	197	201	205	355	510	516	523	530	537	544	552	559	567
Agriculture, forestry and fishing	**56,705**	5,139	5,263	5,390	5,521	5,655	5,793	5,889	5,987	6,087	6,191	6,297	6,405	6,517	6,631	6,749	6,869
Mining	**1,214**	110	113	115	118	121	124	126	128	130	132	135	137	139	142	144	147
Food, beverages and tobacco	**294,383**	26,681	27,322	27,982	28,660	29,357	30,074	30,572	31,081	31,603	32,138	32,688	33,252	33,831	34,425	35,035	35,660
Textile, clothing, footwear and leather	**90,966**	8,245	8,443	8,647	8,856	9,072	9,293	9,447	9,604	9,765	9,931	10,101	10,275	10,454	10,638	10,826	11,019
Wood, paper and printing products	**76,363**	6,921	7,088	7,259	7,434	7,615	7,801	7,930	8,063	8,198	8,337	8,479	8,626	8,776	8,930	9,088	9,250
Basic chemicals	**88,677**	8,037	8,230	8,429	8,633	8,843	9,059	9,209	9,363	9,520	9,681	9,847	10,017	10,191	10,370	10,554	10,742
Non-metallic mineral products	**1,771**	161	164	168	172	177	181	184	187	190	193	197	200	204	207	211	215
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**216**	20	20	21	21	22	22	22	23	23	24	24	24	25	25	26	26
Fabricated metal products	**5,573**	505	517	530	543	556	569	579	588	598	608	619	630	641	652	663	675
Machinery and equipment	**184,611**	16,732	17,134	17,548	17,973	18,410	18,860	19,172	19,492	19,819	20,154	20,499	20,853	21,216	21,589	21,971	22,363
Miscellenous manufacturing	**19,852**	1,799	1,843	1,887	1,933	1,980	2,028	2,062	2,096	2,131	2,167	2,204	2,242	2,281	2,322	2,363	2,405
Water, sewerage and drainage	**38,063**	3,450	3,533	3,618	3,706	3,796	3,888	3,953	4,019	4,086	4,155	4,226	4,299	4,374	4,451	4,530	4,611
Construction	**30,221**	2,739	2,805	2,873	2,942	3,014	3,087	3,138	3,191	3,244	3,299	3,356	3,414	3,473	3,534	3,597	3,661
Road transport	**58,064**	5,247	5,376	5,509	5,645	5,785	5,930	6,031	6,135	6,241	6,350	6,461	6,576	6,694	6,815	6,939	7,066
Railway transport	**18,429**	1,669	1,709	1,751	1,794	1,838	1,883	1,914	1,946	1,979	2,013	2,047	2,083	2,120	2,157	2,195	2,235
Water transport	**13,950**	1,264	1,294	1,326	1,358	1,391	1,425	1,449	1,473	1,498	1,523	1,550	1,576	1,604	1,632	1,661	1,691
Air transport	**51,662**	4,672	4,786	4,904	5,025	5,149	5,276	5,366	5,457	5,551	5,647	5,746	5,847	5,951	6,058	6,167	6,279
Other transport, services and storage	**134,861**	12,207	12,504	12,809	13,122	13,445	13,776	14,007	14,244	14,486	14,734	14,989	15,251	15,519	15,794	16,077	16,366
Commercial services	**3,570,188**	316,521	325,476	334,692	344,178	353,941	363,990	371,428	379,030	386,798	394,741	402,862	411,166	419,657	428,338	437,214	446,289
Total	**4,820,193**	**431,608**	**442,547**	**454,071**	**466,079**	**478,524**	**491,383**	**500,733**	**510,318**	**520,134**	**530,198**	**540,510**	**551,074**	**561,894**	**572,973**	**584,315**	**595,926**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: SRP for early action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**1,187**	352	228	150	100	68	46	32	23	16	12	9	6	5	4	3	2
Petroleum sector	**26,598**	3,137	3,034	2,940	2,854	2,775	2,702	2,614	2,535	2,464	2,399	2,340	2,287	2,240	2,199	2,164	2,134
Gas sector	**2,919**	916	562	351	223	144	94	62	42	29	20	14	10	8	6	4	3
Renewable Electricity	**5,914**	437	460	484	509	534	560	565	570	575	580	586	742	902	1,065	1,232	1,403
Coal-fired Electricity	**42,302**	4,362	4,412	4,463	4,517	4,572	4,628	4,523	4,418	4,311	4,203	4,093	3,982	3,870	3,756	3,640	3,523
Internal-combustion Electricity	**133**	13	13	13	13	13	14	14	14	14	14	14	14	15	15	15	15
Gas-turbine Electricity	**917**	87	88	90	91	93	94	95	96	97	97	98	99	100	101	102	104
Combined-cycle Electricity	**4,325**	185	188	191	194	197	200	346	494	645	800	957	966	976	986	996	1,007
Agriculture, forestry and fishing	**54,969**	5,139	5,231	5,326	5,424	5,524	5,628	5,691	5,756	5,823	5,892	5,963	6,037	6,114	6,194	6,276	6,362
Mining	**1,176**	110	112	114	116	118	120	122	123	125	126	128	129	131	133	134	136
Food, beverages and tobacco	**285,366**	26,681	27,158	27,649	28,157	28,680	29,219	29,543	29,879	30,227	30,587	30,959	31,342	31,740	32,153	32,582	33,025
Textile, clothing, footwear and leather	**88,180**	8,245	8,392	8,544	8,701	8,862	9,029	9,129	9,233	9,341	9,452	9,566	9,685	9,808	9,936	10,068	10,205
Wood, paper and printing products	**74,024**	6,921	7,045	7,172	7,304	7,440	7,579	7,664	7,751	7,841	7,934	8,031	8,130	8,233	8,341	8,452	8,567
Basic chemicals	**85,960**	8,037	8,181	8,329	8,482	8,639	8,802	8,899	9,001	9,105	9,214	9,326	9,441	9,561	9,685	9,815	9,948
Non-metallic mineral products	**1,717**	161	163	166	169	173	176	178	180	182	184	186	189	191	193	196	199
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**209**	20	20	20	21	21	21	22	22	22	22	23	23	23	24	24	24
Fabricated metal products	**5,403**	505	514	523	533	543	553	559	566	572	579	586	593	601	609	617	625
Machinery and equipment	**178,957**	16,732	17,031	17,339	17,657	17,985	18,323	18,527	18,738	18,956	19,182	19,415	19,655	19,905	20,164	20,432	20,711
Miscellenous manufacturing	**19,244**	1,799	1,831	1,865	1,899	1,934	1,970	1,992	2,015	2,038	2,063	2,088	2,114	2,140	2,168	2,197	2,227
Water, sewerage and drainage	**36,897**	3,450	3,511	3,575	3,641	3,708	3,778	3,820	3,863	3,908	3,955	4,003	4,052	4,104	4,157	4,213	4,270
Construction	**29,296**	2,739	2,788	2,838	2,891	2,944	3,000	3,033	3,067	3,103	3,140	3,178	3,218	3,258	3,301	3,345	3,390
Road transport	**56,267**	5,247	5,343	5,443	5,545	5,651	5,760	5,826	5,895	5,967	6,041	6,117	6,195	6,276	6,361	6,448	6,539
Railway transport	**17,872**	1,669	1,699	1,730	1,763	1,796	1,830	1,850	1,872	1,894	1,917	1,941	1,965	1,990	2,016	2,044	2,072
Water transport	**13,523**	1,264	1,286	1,310	1,334	1,359	1,385	1,400	1,416	1,433	1,450	1,468	1,486	1,505	1,525	1,545	1,566
Air transport	**50,068**	4,672	4,757	4,845	4,936	5,029	5,126	5,184	5,245	5,308	5,373	5,440	5,509	5,581	5,655	5,732	5,812
Other transport, services and storage	**130,885**	12,207	12,431	12,663	12,901	13,146	13,399	13,554	13,714	13,879	14,050	14,226	14,408	14,596	14,791	14,993	15,202
Commercial services	**3,558,893**	316,521	325,267	334,271	343,540	353,084	362,909	370,129	377,515	385,070	392,796	400,697	408,776	417,046	425,511	434,175	443,041
Total	**4,773,201**	**431,608**	**441,747**	**452,405**	**463,512**	**475,031**	**486,945**	**495,373**	**504,041**	**512,945**	**522,081**	**531,451**	**541,054**	**550,919**	**561,048**	**571,445**	**582,113**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: PPP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**2,147**	352	363	375	386	398	411	77	16	4	1	0	0	0	0	0	0
Petroleum sector	**28,202**	3,137	3,234	3,334	3,437	3,544	3,654	3,245	2,894	2,593	2,332	2,109	1,921	1,763	1,629	1,515	1,417
Gas sector	**5,523**	916	945	974	1,004	1,035	1,067	129	19	3	1	0	0	0	0	0	0
Renewable Electricity	**6,453**	437	467	499	532	567	603	604	605	607	608	765	924	1,084	1,245	1,408	1,573
Coal-fired Electricity	**45,523**	4,362	4,480	4,602	4,727	4,855	4,987	4,995	5,004	5,015	4,872	4,729	4,588	4,447	4,306	4,166	4,027
Internal-combustion Electricity	**138**	13	13	13	14	14	15	15	15	15	15	15	15	15	15	15	15
Gas-turbine Electricity	**950**	87	90	92	95	98	101	102	102	102	102	102	103	103	103	104	104
Combined-cycle Electricity	**2,429**	185	191	197	203	209	216	216	216	217	373	374	375	376	377	379	381
Agriculture, forestry and fishing	**57,102**	5,139	5,299	5,463	5,632	5,807	5,987	6,044	6,102	6,163	6,226	6,291	6,359	6,431	6,506	6,584	6,665
Mining	**1,222**	110	113	117	121	124	128	129	131	132	133	135	136	138	139	141	143
Food, beverages and tobacco	**296,440**	26,681	27,508	28,361	29,240	30,146	31,081	31,375	31,680	31,995	32,320	32,659	33,014	33,385	33,774	34,178	34,599
Textile, clothing, footwear and leather	**91,602**	8,245	8,500	8,764	9,035	9,315	9,604	9,695	9,789	9,887	9,987	10,092	10,201	10,316	10,436	10,561	10,691
Wood, paper and printing products	**76,897**	6,921	7,136	7,357	7,585	7,820	8,062	8,139	8,218	8,300	8,384	8,472	8,564	8,660	8,761	8,866	8,975
Basic chemicals	**89,296**	8,037	8,286	8,543	8,808	9,081	9,363	9,451	9,543	9,638	9,736	9,838	9,945	10,057	10,174	10,295	10,422
Non-metallic mineral products	**1,784**	161	166	171	176	181	187	189	191	193	194	197	199	201	203	206	208
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**218**	20	20	21	21	22	23	23	23	23	24	24	24	24	25	25	25
Fabricated metal products	**5,612**	505	521	537	554	571	588	594	600	606	612	618	625	632	639	647	655
Machinery and equipment	**185,902**	16,732	17,251	17,785	18,337	18,905	19,491	19,676	19,867	20,064	20,268	20,481	20,703	20,937	21,180	21,434	21,697
Miscellenous manufacturing	**19,991**	1,799	1,855	1,913	1,972	2,033	2,096	2,116	2,136	2,158	2,180	2,202	2,226	2,251	2,278	2,305	2,333
Water, sewerage and drainage	**38,329**	3,450	3,557	3,667	3,781	3,898	4,019	4,057	4,096	4,137	4,179	4,223	4,269	4,317	4,367	4,419	4,474
Construction	**30,433**	2,739	2,824	2,912	3,002	3,095	3,191	3,221	3,252	3,285	3,318	3,353	3,389	3,427	3,467	3,509	3,552
Road transport	**58,437**	5,247	5,410	5,577	5,750	5,929	6,112	6,177	6,243	6,312	6,383	6,456	6,533	6,613	6,696	6,783	6,873
Railway transport	**18,555**	1,669	1,721	1,774	1,829	1,886	1,944	1,963	1,983	2,003	2,024	2,046	2,068	2,092	2,117	2,143	2,170
Water transport	**14,046**	1,264	1,303	1,343	1,385	1,428	1,472	1,486	1,501	1,516	1,532	1,548	1,565	1,583	1,602	1,621	1,641
Air transport	**52,002**	4,672	4,817	4,966	5,120	5,279	5,443	5,498	5,556	5,616	5,677	5,741	5,808	5,877	5,950	6,026	6,104
Other transport, services and storage	**135,769**	12,207	12,586	12,976	13,378	13,793	14,221	14,362	14,508	14,659	14,815	14,976	15,145	15,322	15,506	15,697	15,896
Commercial services	**3,579,637**	316,521	326,333	336,450	346,880	357,633	368,720	375,246	381,911	388,718	395,670	402,775	410,046	417,486	425,098	432,884	440,847
Total	**4,844,637**	**431,608**	**444,988**	**458,783**	**473,005**	**487,668**	**502,786**	**508,823**	**516,203**	**523,958**	**531,963**	**540,218**	**548,745**	**557,538**	**566,594**	**575,910**	**585,486**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-1 Sectoral outputs for final consumption: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**2,243**	352	363	375	386	398	411	159	65	28	13	6	3	2	1	1	0
Petroleum sector	**29,534**	3,137	3,234	3,334	3,437	3,544	3,654	3,353	3,089	2,856	2,650	2,471	2,316	2,179	2,062	1,960	1,872
Gas sector	**5,749**	916	945	974	1,004	1,035	1,067	354	126	47	19	8	4	2	1	1	0
Renewable Electricity	**5,776**	437	467	499	532	567	603	601	600	598	597	596	596	747	900	1,053	1,207
Coal-fired Electricity	**45,122**	4,362	4,480	4,602	4,727	4,855	4,987	4,970	4,956	4,944	4,782	4,623	4,468	4,314	4,164	4,016	3,870
Internal-combustion Electricity	**137**	13	13	13	14	14	15	15	15	15	15	15	15	15	15	15	15
Gas-turbine Electricity	**941**	87	90	92	95	98	101	101	101	100	100	100	100	100	100	100	100
Combined-cycle Electricity	**2,984**	185	191	197	203	209	216	215	214	214	366	517	669	669	669	670	671
Agriculture, forestry and fishing	**56,119**	5,139	5,299	5,463	5,632	5,807	5,987	5,993	6,003	6,015	6,031	6,050	6,072	6,098	6,129	6,163	6,202
Mining	**1,201**	110	113	117	121	124	128	128	128	129	129	129	130	131	131	132	133
Food, beverages and tobacco	**291,338**	26,681	27,508	28,361	29,240	30,146	31,081	31,114	31,164	31,228	31,308	31,407	31,525	31,659	31,817	31,996	32,196
Textile, clothing, footwear and leather	**90,026**	8,245	8,500	8,764	9,035	9,315	9,604	9,615	9,630	9,650	9,674	9,705	9,741	9,783	9,832	9,887	9,949
Wood, paper and printing products	**75,574**	6,921	7,136	7,357	7,585	7,820	8,062	8,071	8,084	8,101	8,121	8,147	8,178	8,212	8,253	8,300	8,352
Basic chemicals	**87,760**	8,037	8,286	8,543	8,808	9,081	9,363	9,373	9,387	9,407	9,431	9,461	9,496	9,537	9,584	9,638	9,698
Non-metallic mineral products	**1,753**	161	166	171	176	181	187	187	188	188	188	189	190	191	191	193	194
Basic iron and steel	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basic non-ferrous metals	**214**	20	20	21	21	22	23	23	23	23	23	23	23	23	23	23	24
Fabricated metal products	**5,516**	505	521	537	554	571	588	589	590	591	593	595	597	599	602	606	610
Machinery and equipment	**182,702**	16,732	17,251	17,785	18,337	18,905	19,491	19,512	19,543	19,584	19,634	19,696	19,769	19,854	19,953	20,065	20,191
Miscellenous manufacturing	**19,647**	1,799	1,855	1,913	1,972	2,033	2,096	2,098	2,102	2,106	2,111	2,118	2,126	2,135	2,146	2,158	2,171
Water, sewerage and drainage	**37,669**	3,450	3,557	3,667	3,781	3,898	4,019	4,023	4,029	4,038	4,048	4,061	4,076	4,093	4,114	4,137	4,163
Construction	**29,909**	2,739	2,824	2,912	3,002	3,095	3,191	3,194	3,199	3,206	3,214	3,224	3,236	3,250	3,266	3,285	3,305
Road transport	**57,398**	5,247	5,410	5,577	5,750	5,929	6,112	6,124	6,139	6,157	6,177	6,202	6,230	6,261	6,297	6,337	6,381
Railway transport	**18,239**	1,669	1,721	1,774	1,829	1,886	1,944	1,947	1,951	1,956	1,961	1,968	1,976	1,985	1,996	2,008	2,021
Water transport	**13,804**	1,264	1,303	1,343	1,385	1,428	1,472	1,474	1,476	1,480	1,484	1,489	1,495	1,501	1,509	1,518	1,527
Air transport	**51,085**	4,672	4,817	4,966	5,120	5,279	5,443	5,452	5,464	5,478	5,496	5,516	5,540	5,567	5,598	5,632	5,671
Other transport, services and storage	**133,520**	12,207	12,586	12,976	13,378	13,793	14,221	14,247	14,281	14,322	14,369	14,425	14,489	14,561	14,643	14,734	14,835
Commercial services	**3,577,714**	316,521	326,333	336,450	346,880	357,633	368,720	375,119	381,669	388,373	395,232	402,264	409,468	416,846	424,417	432,182	440,144
Total	**4,823,672**	**431,608**	**444,988**	**458,783**	**473,005**	**487,668**	**502,786**	**508,051**	**514,215**	**520,833**	**527,765**	**535,005**	**542,526**	**550,315**	**558,411**	**566,808**	**575,501**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total final consumption is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110;
- The share of electricity-mix in final consumption reflect changes due to MRET scheme as well as inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: BC scenario ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**81,301**	7,104	7,324	7,551	7,784	8,025	8,274	8,464	8,659	8,857	9,061	9,269	9,482	9,700	9,923	10,151	10,384
Petroleum sector	**-8,997**	-804	-825	-847	-869	-892	-915	-933	-952	-971	-990	-1,010	-1,030	-1,050	-1,072	-1,093	-1,115
Gas sector	**-2,183**	-191	-197	-203	-209	-215	-222	-227	-232	-238	-243	-249	-255	-260	-266	-273	-279
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**55,815**	4,864	5,017	5,176	5,339	5,507	5,681	5,813	5,949	6,088	6,230	6,375	6,524	6,676	6,832	6,991	7,154
Mining	**102,358**	8,944	9,221	9,506	9,801	10,104	10,417	10,656	10,901	11,152	11,408	11,670	11,938	12,213	12,493	12,780	13,074
Food, beverages and tobacco	**6,331**	524	547	570	594	619	645	664	684	705	726	748	770	792	815	839	863
Textile, clothing, footwear and leather	**-42,777**	-3,757	-3,869	-3,985	-4,104	-4,227	-4,353	-4,450	-4,549	-4,650	-4,754	-4,860	-4,968	-5,079	-5,193	-5,309	-5,427
Wood, paper and printing products	**-17,516**	-1,558	-1,600	-1,643	-1,688	-1,734	-1,782	-1,819	-1,856	-1,894	-1,933	-1,973	-2,014	-2,056	-2,098	-2,142	-2,187
Basic chemicals	**-35,065**	-3,096	-3,185	-3,276	-3,370	-3,468	-3,568	-3,645	-3,723	-3,803	-3,886	-3,970	-4,055	-4,143	-4,233	-4,325	-4,419
Non-metallic mineral products	**310**	11	15	19	23	27	32	35	39	42	46	50	54	58	62	66	70
Basic iron and steel	**10,147**	876	905	936	967	1,000	1,033	1,058	1,085	1,111	1,139	1,166	1,195	1,224	1,254	1,285	1,316
Basic non-ferrous metals	**63,634**	5,560	5,732	5,910	6,093	6,281	6,476	6,625	6,777	6,933	7,092	7,255	7,422	7,592	7,767	7,945	8,128
Fabricated metal products	**892**	73	76	80	83	87	91	94	97	100	103	106	110	113	117	120	124
Machinery and equipment	**-106,423**	-9,301	-9,589	-9,885	-10,191	-10,506	-10,831	-11,079	-11,333	-11,593	-11,859	-12,131	-12,410	-12,694	-12,986	-13,284	-13,589
Miscellenous manufacturing	**-11,371**	-987	-1,019	-1,052	-1,086	-1,121	-1,157	-1,185	-1,213	-1,242	-1,272	-1,302	-1,333	-1,365	-1,398	-1,431	-1,465
Water, sewerage and drainage	**-7,049**	-616	-635	-655	-675	-696	-717	-734	-751	-768	-786	-804	-822	-841	-861	-880	-901
Construction	**-4,714**	-412	-425	-438	-451	-465	-480	-491	-502	-513	-525	-537	-549	-562	-575	-588	-601
Road transport	**11,160**	975	1,005	1,036	1,068	1,102	1,136	1,162	1,189	1,216	1,244	1,273	1,302	1,332	1,363	1,394	1,426
Railway transport	**10,788**	942	971	1,001	1,033	1,065	1,098	1,123	1,149	1,176	1,203	1,231	1,259	1,288	1,318	1,348	1,379
Water transport	**2,836**	248	255	263	271	280	289	295	302	309	316	323	331	338	346	354	362
Air transport	**9,650**	843	869	896	924	953	982	1,005	1,028	1,051	1,076	1,100	1,126	1,151	1,178	1,205	1,233
Other transport, services and storage	**-4,450**	-389	-401	-413	-426	-439	-453	-463	-474	-485	-496	-507	-519	-531	-543	-556	-569
Commercial services	**-396,199**	-34,616	-35,689	-36,795	-37,935	-39,110	-40,322	-41,249	-42,197	-43,166	-44,158	-45,173	-46,212	-47,274	-48,360	-49,472	-50,609
Total	**-281,524**	**-24,765**	**-25,495**	**-26,248**	**-27,024**	**-27,824**	**-28,649**	**-29,279**	**-29,924**	**-30,584**	**-31,259**	**-31,949**	**-32,655**	**-33,378**	**-34,117**	**-34,873**	**-35,647**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed constant, according to fixed Leontief coefficients presented in quadrant B of Figure B-1, p. 217.

Table F-2 Sectoral outputs for (net) exports: PPP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**76,555**	7,104	7,253	7,403	7,554	7,707	7,861	7,956	8,051	8,147	8,243	8,341	8,440	8,541	8,644	8,748	8,855
Petroleum sector	**-7,460**	-804	-797	-790	-783	-776	-770	-758	-747	-736	-726	-715	-704	-694	-683	-674	-664
Gas sector	**-992**	-191	-161	-136	-116	-98	-84	-71	-61	-52	-44	-38	-32	-28	-24	-20	-18
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**55,005**	4,864	5,004	5,149	5,298	5,451	5,609	5,725	5,845	5,966	6,091	6,218	6,348	6,481	6,617	6,756	6,899
Mining	**100,891**	8,944	9,197	9,458	9,726	10,002	10,287	10,497	10,712	10,931	11,156	11,385	11,618	11,859	12,105	12,356	12,613
Food, beverages and tobacco	**6,298**	524	546	569	593	617	641	660	679	698	718	739	759	784	809	835	861
Textile, clothing, footwear and leather	**-42,143**	-3,757	-3,859	-3,964	-4,072	-4,183	-4,297	-4,381	-4,467	-4,555	-4,645	-4,737	-4,831	-4,926	-5,024	-5,123	-5,225
Wood, paper and printing products	**-17,267**	-1,558	-1,596	-1,635	-1,676	-1,717	-1,760	-1,792	-1,824	-1,857	-1,891	-1,925	-1,960	-1,996	-2,032	-2,069	-2,106
Basic chemicals	**-34,554**	-3,096	-3,176	-3,259	-3,345	-3,432	-3,523	-3,589	-3,658	-3,727	-3,799	-3,871	-3,945	-4,021	-4,097	-4,176	-4,256
Non-metallic mineral products	**290**	11	14	18	22	26	30	33	36	39	43	46	49	53	57	60	64
Basic iron and steel	**9,993**	876	903	931	959	989	1,019	1,042	1,065	1,088	1,112	1,136	1,161	1,187	1,214	1,241	1,268
Basic non-ferrous metals	**62,741**	5,560	5,718	5,880	6,047	6,219	6,396	6,527	6,661	6,798	6,938	7,080	7,226	7,377	7,532	7,690	7,851
Fabricated metal products	**875**	73	76	79	82	86	89	92	95	97	100	103	106	109	112	116	119
Machinery and equipment	**-104,803**	-9,301	-9,563	-9,832	-10,109	-10,393	-10,687	-10,904	-11,125	-11,351	-11,582	-11,818	-12,059	-12,304	-12,555	-12,811	-13,073
Miscellenous manufacturing	**-11,191**	-987	-1,016	-1,046	-1,077	-1,109	-1,141	-1,166	-1,190	-1,215	-1,241	-1,268	-1,294	-1,322	-1,350	-1,378	-1,408
Water, sewerage and drainage	**-6,935**	-616	-633	-651	-669	-688	-707	-722	-736	-751	-767	-782	-798	-814	-830	-846	-863
Construction	**-4,641**	-412	-424	-436	-448	-460	-473	-483	-493	-503	-513	-523	-534	-544	-555	-566	-578
Road transport	**11,033**	975	1,003	1,032	1,062	1,093	1,124	1,148	1,172	1,197	1,222	1,248	1,274	1,301	1,329	1,358	1,387
Railway transport	**10,661**	942	969	997	1,026	1,056	1,087	1,109	1,133	1,156	1,181	1,206	1,231	1,257	1,285	1,312	1,341
Water transport	**2,821**	248	255	263	271	279	287	294	300	307	313	320	328	335	342	350	358
Air transport	**9,609**	843	869	895	922	950	978	1,000	1,022	1,045	1,068	1,092	1,116	1,141	1,167	1,193	1,220
Other transport, services and storage	**-4,352**	-389	-399	-410	-421	-433	-445	-453	-462	-471	-480	-490	-499	-508	-516	-525	-533
Commercial services	**-394,733**	-34,616	-35,666	-36,749	-37,864	-39,013	-40,198	-41,098	-42,017	-42,958	-43,920	-44,904	-45,909	-46,916	-47,945	-48,997	-50,073
Total	**-282,299**	**-24,765**	**-25,483**	**-26,233**	**-27,015**	**-27,829**	**-28,676**	**-29,333**	**-30,010**	**-30,706**	**-31,422**	**-32,157**	**-32,911**	**-33,645**	**-34,398**	**-35,170**	**-35,960**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: SRP_1 (\$ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**69,952**	7,104	7,132	7,157	7,179	7,201	7,223	7,189	7,156	7,125	7,096	7,071	7,048	7,028	7,011	6,997	6,984
Petroleum sector	**-7,096**	-804	-787	-770	-755	-740	-726	-709	-692	-676	-661	-648	-635	-624	-613	-604	-596
Gas sector	**-779**	-191	-143	-108	-82	-63	-48	-37	-29	-22	-17	-14	-11	-9	-7	-6	-5
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**54,276**	4,864	4,992	5,124	5,259	5,398	5,542	5,644	5,749	5,856	5,965	6,078	6,192	6,309	6,429	6,551	6,674
Mining	**99,250**	8,944	9,169	9,401	9,639	9,884	10,135	10,313	10,495	10,682	10,873	11,069	11,269	11,473	11,682	11,895	12,111
Food, beverages and tobacco	**7,383**	524	565	607	651	695	741	780	820	863	907	952	997	1,043	1,089	1,136	1,180
Textile, clothing, footwear and leather	**-40,709**	-3,757	-3,834	-3,913	-3,995	-4,079	-4,165	-4,221	-4,279	-4,338	-4,398	-4,460	-4,523	-4,588	-4,655	-4,723	-4,794
Wood, paper and printing products	**-16,620**	-1,558	-1,585	-1,612	-1,641	-1,670	-1,701	-1,720	-1,739	-1,759	-1,779	-1,800	-1,821	-1,843	-1,865	-1,888	-1,913
Basic chemicals	**-33,301**	-3,096	-3,155	-3,215	-3,277	-3,341	-3,407	-3,450	-3,493	-3,537	-3,582	-3,628	-3,676	-3,725	-3,775	-3,826	-3,880
Non-metallic mineral products	**275**	11	14	17	21	25	29	31	34	37	40	43	46	50	53	56	60
Basic iron and steel	**9,820**	876	900	925	950	976	1,003	1,022	1,042	1,062	1,082	1,103	1,125	1,147	1,169	1,192	1,215
Basic non-ferrous metals	**61,741**	5,560	5,701	5,845	5,994	6,146	6,303	6,415	6,528	6,646	6,766	6,889	7,015	7,144	7,275	7,409	7,544
Fabricated metal products	**883**	73	76	79	83	86	90	93	96	99	102	105	108	111	114	118	121
Machinery and equipment	**-101,192**	-9,301	-9,500	-9,705	-9,915	-10,131	-10,354	-10,500	-10,650	-10,802	-10,959	-11,119	-11,284	-11,453	-11,626	-11,804	-11,987
Miscellenous manufacturing	**-10,782**	-987	-1,009	-1,032	-1,055	-1,079	-1,104	-1,120	-1,136	-1,153	-1,171	-1,189	-1,207	-1,226	-1,245	-1,265	-1,285
Water, sewerage and drainage	**-6,709**	-616	-629	-643	-657	-672	-687	-697	-707	-717	-727	-738	-749	-760	-771	-783	-796
Construction	**-4,487**	-412	-421	-430	-440	-449	-459	-466	-472	-479	-486	-493	-501	-508	-516	-524	-532
Road transport	**11,007**	975	1,003	1,031	1,061	1,091	1,122	1,145	1,169	1,193	1,218	1,243	1,269	1,295	1,322	1,350	1,377
Railway transport	**10,607**	942	968	995	1,023	1,052	1,081	1,103	1,125	1,148	1,172	1,196	1,220	1,245	1,271	1,297	1,323
Water transport	**2,861**	248	256	264	273	282	291	298	305	313	321	328	336	344	353	361	370
Air transport	**9,834**	843	873	903	934	966	999	1,025	1,052	1,079	1,107	1,136	1,165	1,194	1,224	1,255	1,286
Other transport, services and storage	**-3,896**	-389	-391	-394	-397	-400	-403	-403	-403	-402	-401	-400	-399	-398	-398	-397	-399
Commercial services	**-392,825**	-34,616	-35,636	-36,688	-37,771	-38,887	-40,038	-40,903	-41,787	-42,674	-43,582	-44,510	-45,460	-46,432	-47,425	-48,442	-49,506
Total	**-280,507**	**-24,765**	**-25,443**	**-26,162**	**-26,918**	**-27,709**	**-28,532**	**-29,166**	**-29,818**	**-30,456**	**-31,112**	**-31,785**	**-32,474**	**-33,181**	**-33,904**	**-34,645**	**-35,447**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**71,959**	7,104	7,183	7,251	7,314	7,373	7,431	7,430	7,431	7,432	7,434	7,439	7,447	7,459	7,473	7,491	7,511
Petroleum sector	**-6,331**	-804	-769	-735	-703	-673	-644	-612	-582	-554	-527	-504	-482	-463	-445	-429	-415
Gas sector	**-645**	-191	-125	-83	-56	-38	-25	-17	-12	-8	-6	-4	-3	-2	-1	-1	-1
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**54,220**	4,864	4,991	5,122	5,257	5,396	5,538	5,639	5,743	5,849	5,957	6,067	6,179	6,293	6,410	6,529	6,651
Mining	**99,475**	8,944	9,174	9,410	9,653	9,902	10,158	10,341	10,528	10,720	10,914	11,112	11,314	11,521	11,732	11,948	12,169
Food, beverages and tobacco	**6,229**	524	546	568	591	614	637	654	675	696	713	730	747	763	780	796	812
Textile, clothing, footwear and leather	**-41,551**	-3,757	-3,849	-3,943	-4,040	-4,139	-4,242	-4,315	-4,388	-4,464	-4,541	-4,621	-4,703	-4,787	-4,874	-4,962	-5,053
Wood, paper and printing products	**-17,038**	-1,558	-1,592	-1,627	-1,663	-1,700	-1,739	-1,766	-1,793	-1,821	-1,850	-1,880	-1,911	-1,942	-1,975	-2,008	-2,043
Basic chemicals	**-34,081**	-3,096	-3,168	-3,242	-3,319	-3,398	-3,479	-3,536	-3,594	-3,653	-3,715	-3,778	-3,843	-3,910	-3,978	-4,048	-4,121
Non-metallic mineral products	**270**	11	14	17	21	25	28	31	34	37	40	42	45	48	51	55	58
Basic iron and steel	**9,844**	876	900	926	952	978	1,006	1,025	1,045	1,066	1,087	1,108	1,129	1,151	1,174	1,197	1,221
Basic non-ferrous metals	**61,873**	5,560	5,704	5,851	6,002	6,158	6,318	6,432	6,550	6,671	6,792	6,915	7,041	7,170	7,302	7,436	7,573
Fabricated metal products	**859**	73	75	78	82	85	88	90	93	95	98	100	103	105	108	110	113
Machinery and equipment	**-103,285**	-9,301	-9,537	-9,778	-10,027	-10,283	-10,546	-10,733	-10,923	-11,117	-11,316	-11,522	-11,732	-11,948	-12,169	-12,396	-12,629
Miscellenous manufacturing	**-11,022**	-987	-1,013	-1,040	-1,068	-1,096	-1,126	-1,147	-1,168	-1,189	-1,212	-1,235	-1,258	-1,282	-1,307	-1,332	-1,358
Water, sewerage and drainage	**-6,830**	-616	-631	-647	-664	-680	-698	-710	-722	-734	-747	-761	-775	-789	-804	-819	-834
Construction	**-4,573**	-412	-423	-433	-444	-455	-467	-475	-483	-492	-501	-510	-519	-528	-538	-548	-558
Road transport	**10,906**	975	1,001	1,028	1,056	1,084	1,113	1,134	1,156	1,179	1,201	1,224	1,247	1,271	1,295	1,320	1,345
Railway transport	**10,535**	942	967	993	1,020	1,047	1,075	1,096	1,117	1,139	1,160	1,182	1,204	1,227	1,250	1,274	1,298
Water transport	**2,804**	248	255	262	270	278	286	292	298	305	311	317	324	331	338	345	352
Air transport	**9,561**	843	868	894	920	947	975	995	1,017	1,039	1,061	1,083	1,106	1,129	1,153	1,176	1,201
Other transport, services and storage	**-4,272**	-389	-398	-407	-416	-426	-437	-444	-449	-455	-464	-472	-481	-490	-499	-509	-520
Commercial services	**-393,385**	-34,616	-35,644	-36,703	-37,794	-38,919	-40,077	-40,950	-41,823	-42,715	-43,653	-44,613	-45,595	-46,600	-47,629	-48,682	-49,759
Total	**-284,477**	**-24,765**	**-25,470**	**-26,239**	**-27,059**	**-27,923**	**-28,826**	**-29,545**	**-30,249**	**-30,974**	**-31,765**	**-32,579**	**-33,415**	**-34,273**	**-35,154**	**-36,059**	**-36,986**

Notes: - This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**60,933**	7,104	6,940	6,763	6,585	6,413	6,250	6,051	5,865	5,691	5,527	5,376	5,237	5,109	4,990	4,880	4,779
Petroleum sector	**-5,913**	-804	-749	-699	-654	-614	-578	-543	-512	-485	-462	-441	-424	-409	-396	-385	-376
Gas sector	**-502**	-191	-89	-43	-22	-11	-6	-3	-2	-1	0	0	0	0	0	0	0
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**52,843**	4,864	4,966	5,072	5,181	5,293	5,408	5,483	5,560	5,639	5,719	5,802	5,886	5,973	6,062	6,153	6,247
Mining	**96,400**	8,944	9,117	9,296	9,480	9,670	9,866	9,990	10,118	10,250	10,383	10,521	10,663	10,809	10,960	11,114	11,274
Food, beverages and tobacco	**8,147**	524	584	643	704	764	828	884	939	994	1,045	1,096	1,145	1,195	1,243	1,292	1,340
Textile, clothing, footwear and leather	**-38,927**	-3,757	-3,799	-3,843	-3,890	-3,938	-3,988	-4,010	-4,034	-4,060	-4,088	-4,119	-4,152	-4,187	-4,225	-4,265	-4,307
Wood, paper and printing products	**-15,862**	-1,558	-1,569	-1,582	-1,596	-1,610	-1,624	-1,629	-1,634	-1,639	-1,647	-1,655	-1,664	-1,674	-1,685	-1,697	-1,710
Basic chemicals	**-31,792**	-3,096	-3,125	-3,155	-3,188	-3,221	-3,256	-3,270	-3,285	-3,301	-3,320	-3,340	-3,363	-3,387	-3,413	-3,441	-3,471
Non-metallic mineral products	**242**	11	13	16	19	22	26	28	30	32	35	37	39	42	44	46	49
Basic iron and steel	**9,518**	876	894	914	933	954	975	988	1,002	1,016	1,031	1,045	1,060	1,076	1,092	1,109	1,126
Basic non-ferrous metals	**59,986**	5,560	5,669	5,781	5,897	6,015	6,139	6,218	6,299	6,383	6,466	6,552	6,641	6,732	6,826	6,922	7,021
Fabricated metal products	**870**	73	76	79	82	86	89	92	94	97	100	102	105	108	110	113	116
Machinery and equipment	**-96,674**	-9,301	-9,412	-9,527	-9,649	-9,775	-9,906	-9,966	-10,031	-10,100	-10,175	-10,256	-10,343	-10,435	-10,534	-10,638	-10,748
Miscellenous manufacturing	**-10,274**	-987	-999	-1,012	-1,025	-1,039	-1,053	-1,060	-1,067	-1,074	-1,083	-1,091	-1,101	-1,111	-1,122	-1,133	-1,145
Water, sewerage and drainage	**-6,421**	-616	-624	-632	-640	-649	-658	-662	-666	-671	-677	-683	-689	-696	-703	-710	-718
Construction	**-4,292**	-412	-417	-423	-428	-434	-440	-443	-446	-449	-452	-456	-460	-464	-469	-474	-479
Road transport	**10,847**	975	1,000	1,026	1,053	1,080	1,108	1,129	1,149	1,170	1,191	1,212	1,234	1,255	1,278	1,301	1,324
Railway transport	**10,421**	942	965	989	1,014	1,039	1,065	1,084	1,103	1,122	1,140	1,160	1,179	1,199	1,220	1,240	1,261
Water transport	**2,874**	248	256	265	274	283	293	300	308	316	323	331	338	346	354	362	370
Air transport	**9,956**	843	876	910	944	979	1,014	1,043	1,072	1,101	1,129	1,158	1,188	1,217	1,247	1,277	1,308
Other transport, services and storage	**-3,458**	-389	-382	-375	-369	-363	-356	-347	-338	-330	-323	-317	-311	-305	-301	-296	-292
Commercial services	**-389,987**	-34,616	-35,584	-36,582	-37,612	-38,672	-39,751	-40,545	-41,357	-42,189	-43,063	-43,958	-44,876	-45,817	-46,780	-47,767	-48,777
Total	**-281,065**	**-24,765**	**-25,390**	**-26,118**	**-26,904**	**-27,728**	**-28,555**	**-29,187**	**-29,832**	**-30,489**	**-31,199**	**-31,925**	**-32,667**	**-33,425**	**-34,202**	**-34,996**	**-35,809**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: PPP for Early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**69,773**	7,104	7,147	7,172	7,189	7,201	7,212	7,168	7,126	7,085	7,049	7,017	6,989	6,965	6,945	6,928	6,915
Petroleum sector	**-5,868**	-804	-755	-708	-665	-624	-586	-547	-511	-478	-449	-422	-399	-378	-359	-342	-327
Gas sector	**-558**	-191	-107	-61	-35	-21	-12	-7	-4	-2	-1	-1	0	0	0	0	0
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**53,829**	4,864	4,985	5,109	5,237	5,367	5,502	5,596	5,693	5,790	5,889	5,991	6,094	6,200	6,308	6,419	6,532
Mining	**98,772**	8,944	9,162	9,385	9,615	9,851	10,093	10,264	10,438	10,613	10,792	10,976	11,163	11,355	11,550	11,751	11,955
Food, beverages and tobacco	**6,185**	524	546	567	589	612	635	654	674	690	705	720	735	749	763	777	790
Textile, clothing, footwear and leather	**-41,262**	-3,757	-3,844	-3,932	-4,024	-4,118	-4,214	-4,281	-4,349	-4,419	-4,492	-4,566	-4,642	-4,721	-4,802	-4,885	-4,970
Wood, paper and printing products	**-16,927**	-1,558	-1,590	-1,623	-1,657	-1,692	-1,728	-1,752	-1,777	-1,804	-1,831	-1,859	-1,888	-1,917	-1,948	-1,979	-2,012
Basic chemicals	**-33,851**	-3,096	-3,164	-3,234	-3,306	-3,380	-3,456	-3,509	-3,562	-3,618	-3,675	-3,734	-3,795	-3,857	-3,921	-3,987	-4,055
Non-metallic mineral products	**261**	11	14	17	20	24	27	30	33	35	38	40	43	46	49	52	55
Basic iron and steel	**9,770**	876	899	923	948	973	999	1,017	1,036	1,055	1,074	1,093	1,113	1,134	1,155	1,176	1,198
Basic non-ferrous metals	**61,442**	5,560	5,696	5,836	5,979	6,127	6,278	6,386	6,496	6,605	6,717	6,831	6,948	7,067	7,189	7,314	7,441
Fabricated metal products	**851**	73	75	78	81	84	87	89	92	94	96	98	101	103	105	108	110
Machinery and equipment	**-102,546**	-9,301	-9,523	-9,751	-9,986	-10,227	-10,476	-10,647	-10,822	-11,003	-11,189	-11,380	-11,576	-11,778	-11,985	-12,197	-12,416
Miscellenous manufacturing	**-10,940**	-987	-1,012	-1,037	-1,063	-1,090	-1,118	-1,137	-1,157	-1,177	-1,198	-1,219	-1,241	-1,263	-1,286	-1,310	-1,334
Water, sewerage and drainage	**-6,779**	-616	-630	-645	-661	-677	-693	-704	-715	-726	-739	-751	-764	-777	-791	-805	-819
Construction	**-4,540**	-412	-422	-432	-442	-453	-464	-471	-479	-487	-495	-503	-512	-521	-530	-539	-549
Road transport	**10,842**	975	1,000	1,026	1,052	1,080	1,107	1,128	1,148	1,169	1,190	1,211	1,233	1,255	1,278	1,301	1,324
Railway transport	**10,471**	942	966	991	1,017	1,043	1,070	1,089	1,109	1,129	1,149	1,169	1,190	1,211	1,233	1,255	1,277
Water transport	**2,796**	248	255	262	270	277	285	291	297	303	309	316	322	329	335	342	349
Air transport	**9,535**	843	868	893	919	945	973	993	1,014	1,035	1,057	1,078	1,100	1,122	1,145	1,168	1,191
Other transport, services and storage	**-4,235**	-389	-397	-405	-414	-423	-433	-438	-443	-450	-457	-465	-474	-483	-492	-501	-511
Commercial services	**-392,722**	-34,616	-35,632	-36,680	-37,759	-38,871	-40,016	-40,857	-41,716	-42,619	-43,544	-44,491	-45,460	-46,452	-47,467	-48,505	-49,567
Total	**-285,704**	**-24,765**	**-25,464**	**-26,249**	**-27,097**	**-27,992**	**-28,929**	**-29,643**	**-30,378**	**-31,180**	**-32,004**	**-32,851**	**-33,719**	**-34,610**	**-35,524**	**-36,462**	**-37,422**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: SRP for early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**65,291**	7,104	7,039	6,965	6,888	6,811	6,736	6,613	6,497	6,388	6,284	6,187	6,094	6,009	5,931	5,859	5,794
Petroleum sector	**-6,458**	-804	-768	-735	-704	-676	-650	-621	-596	-573	-552	-533	-517	-502	-490	-479	-470
Gas sector	**-604**	-191	-117	-73	-46	-29	-19	-12	-8	-6	-4	-3	-2	-1	-1	-1	0
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**53,571**	4,864	4,980	5,099	5,221	5,347	5,476	5,565	5,656	5,750	5,845	5,943	6,042	6,143	6,246	6,353	6,461
Mining	**97,843**	8,944	9,144	9,350	9,561	9,779	10,002	10,154	10,310	10,470	10,633	10,801	10,970	11,143	11,322	11,504	11,691
Food, beverages and tobacco	**7,802**	524	574	625	677	730	784	834	884	935	986	1,037	1,084	1,131	1,177	1,224	1,271
Textile, clothing, footwear and leather	**-39,809**	-3,757	-3,817	-3,879	-3,943	-4,009	-4,077	-4,116	-4,156	-4,198	-4,241	-4,286	-4,334	-4,383	-4,435	-4,488	-4,544
Wood, paper and printing products	**-16,233**	-1,558	-1,577	-1,598	-1,619	-1,640	-1,663	-1,674	-1,686	-1,698	-1,711	-1,724	-1,739	-1,755	-1,772	-1,789	-1,808
Basic chemicals	**-32,536**	-3,096	-3,140	-3,186	-3,233	-3,282	-3,333	-3,360	-3,388	-3,418	-3,449	-3,481	-3,515	-3,551	-3,589	-3,628	-3,669
Non-metallic mineral products	**259**	11	14	17	20	24	27	30	32	35	38	40	43	46	49	52	54
Basic iron and steel	**9,672**	876	897	919	942	965	989	1,006	1,022	1,040	1,057	1,075	1,093	1,112	1,131	1,150	1,170
Basic non-ferrous metals	**60,883**	5,560	5,685	5,814	5,946	6,082	6,222	6,319	6,417	6,518	6,622	6,728	6,834	6,942	7,053	7,167	7,284
Fabricated metal products	**878**	73	76	79	83	86	90	92	95	98	101	104	107	110	113	116	119
Machinery and equipment	**-98,913**	-9,301	-9,457	-9,618	-9,784	-9,955	-10,132	-10,234	-10,339	-10,449	-10,563	-10,681	-10,804	-10,933	-11,067	-11,207	-11,352
Miscellenous manufacturing	**-10,526**	-987	-1,004	-1,022	-1,040	-1,059	-1,079	-1,090	-1,102	-1,114	-1,126	-1,139	-1,153	-1,167	-1,182	-1,197	-1,213
Water, sewerage and drainage	**-6,561**	-616	-626	-637	-649	-660	-673	-679	-686	-693	-701	-709	-717	-726	-736	-745	-755
Construction	**-4,388**	-412	-419	-426	-434	-442	-450	-454	-459	-464	-469	-474	-480	-486	-492	-498	-505
Road transport	**10,931**	975	1,001	1,029	1,057	1,086	1,115	1,137	1,160	1,182	1,205	1,229	1,253	1,277	1,301	1,326	1,352
Railway transport	**10,520**	942	967	993	1,019	1,046	1,074	1,094	1,115	1,136	1,158	1,180	1,201	1,224	1,246	1,269	1,293
Water transport	**2,870**	248	256	265	274	283	292	299	307	315	322	330	338	346	354	362	371
Air transport	**9,902**	843	874	906	939	973	1,007	1,035	1,063	1,091	1,120	1,149	1,178	1,208	1,238	1,268	1,299
Other transport, services and storage	**-3,663**	-389	-387	-385	-383	-381	-380	-374	-369	-363	-358	-353	-350	-347	-345	-343	-342
Commercial services	**-391,277**	-34,616	-35,610	-36,635	-37,690	-38,778	-39,899	-40,717	-41,553	-42,408	-43,282	-44,176	-45,118	-46,083	-47,071	-48,083	-49,119
Total	**-280,549**	**-24,765**	**-25,415**	**-26,132**	**-26,898**	**-27,702**	**-28,539**	**-29,153**	**-29,782**	**-30,426**	**-31,085**	**-31,757**	**-32,492**	**-33,245**	**-34,017**	**-34,808**	**-35,618**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: PPP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**72,010**	7,104	7,324	7,551	7,784	8,025	8,274	8,060	7,773	7,489	7,219	6,966	6,732	6,516	6,315	6,129	5,956
Petroleum sector	**-6,654**	-804	-825	-847	-869	-892	-915	-775	-656	-556	-470	-398	-339	-290	-250	-216	-189
Gas sector	**-1,147**	-191	-197	-203	-209	-215	-222	-26	-3	0	0	0	0	0	0	0	0
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**54,186**	4,864	5,017	5,176	5,339	5,507	5,681	5,739	5,799	5,860	5,923	5,987	6,052	6,120	6,188	6,259	6,332
Mining	**99,419**	8,944	9,221	9,506	9,801	10,104	10,417	10,522	10,629	10,739	10,853	10,968	11,086	11,208	11,334	11,463	11,596
Food, beverages and tobacco	**6,185**	524	547	570	594	619	645	661	676	691	708	721	731	741	748	755	761
Textile, clothing, footwear and leather	**-41,549**	-3,757	-3,869	-3,985	-4,104	-4,227	-4,353	-4,392	-4,432	-4,474	-4,517	-4,562	-4,610	-4,660	-4,713	-4,768	-4,826
Wood, paper and printing products	**-17,042**	-1,558	-1,600	-1,643	-1,688	-1,734	-1,782	-1,796	-1,810	-1,825	-1,840	-1,857	-1,875	-1,894	-1,914	-1,935	-1,957
Basic chemicals	**-34,083**	-3,096	-3,185	-3,276	-3,370	-3,468	-3,568	-3,598	-3,629	-3,662	-3,695	-3,731	-3,769	-3,809	-3,851	-3,895	-3,941
Non-metallic mineral products	**269**	11	15	19	23	27	32	33	35	37	39	40	42	44	46	48	49
Basic iron and steel	**9,837**	876	905	936	967	1,000	1,033	1,044	1,056	1,068	1,080	1,092	1,105	1,118	1,132	1,146	1,160
Basic non-ferrous metals	**61,833**	5,560	5,732	5,910	6,093	6,281	6,476	6,543	6,611	6,680	6,754	6,826	6,900	6,977	7,056	7,137	7,220
Fabricated metal products	**857**	73	76	80	83	87	91	92	94	95	97	98	100	101	103	104	106
Machinery and equipment	**-103,278**	-9,301	-9,589	-9,885	-10,191	-10,506	-10,831	-10,931	-11,034	-11,142	-11,253	-11,369	-11,492	-11,622	-11,757	-11,899	-12,047
Miscellenous manufacturing	**-11,021**	-987	-1,019	-1,052	-1,086	-1,121	-1,157	-1,169	-1,180	-1,192	-1,205	-1,218	-1,231	-1,246	-1,261	-1,277	-1,293
Water, sewerage and drainage	**-6,831**	-616	-635	-655	-675	-696	-717	-724	-730	-737	-743	-751	-759	-767	-776	-785	-794
Construction	**-4,573**	-412	-425	-438	-451	-465	-480	-484	-489	-493	-498	-503	-508	-514	-520	-526	-532
Road transport	**10,897**	975	1,005	1,036	1,068	1,102	1,136	1,150	1,165	1,180	1,195	1,211	1,226	1,242	1,258	1,274	1,291
Railway transport	**10,525**	942	971	1,001	1,033	1,065	1,098	1,112	1,125	1,139	1,154	1,169	1,183	1,198	1,213	1,228	1,244
Water transport	**2,802**	248	255	263	271	280	289	294	299	305	310	316	321	327	332	338	344
Air transport	**9,550**	843	869	896	924	953	982	1,001	1,020	1,039	1,059	1,078	1,098	1,117	1,137	1,156	1,176
Other transport, services and storage	**-4,285**	-389	-401	-413	-426	-439	-453	-455	-457	-460	-461	-465	-470	-475	-481	-488	-496
Commercial services	**-393,417**	-34,616	-35,689	-36,795	-37,935	-39,110	-40,322	-41,121	-41,940	-42,778	-43,613	-44,495	-45,399	-46,324	-47,272	-48,242	-49,236
Total	**-285,509**	**-24,765**	**-25,495**	**-26,248**	**-27,024**	**-27,824**	**-28,649**	**-29,217**	**-30,078**	**-30,997**	**-31,902**	**-32,876**	**-33,873**	**-34,892**	**-35,932**	**-36,994**	**-38,077**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-2 Sectoral outputs for (net) exports: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**70,153**	7,104	7,324	7,551	7,784	8,025	8,274	7,907	7,524	7,154	6,808	6,489	6,195	5,923	5,676	5,451	5,244
Petroleum sector	**-7,272**	-804	-825	-847	-869	-892	-915	-824	-744	-676	-616	-565	-521	-484	-453	-428	-406
Gas sector	**-1,195**	-191	-197	-203	-209	-215	-222	-73	-26	-9	-3	-1	0	0	0	0	0
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**54,226**	4,864	5,017	5,176	5,339	5,507	5,681	5,740	5,800	5,863	5,928	5,995	6,064	6,134	6,207	6,282	6,360
Mining	**99,166**	8,944	9,221	9,506	9,801	10,104	10,417	10,507	10,600	10,696	10,797	10,903	11,013	11,125	11,242	11,364	11,490
Food, beverages and tobacco	**7,334**	524	547	570	594	619	645	717	788	858	930	1,001	1,070	1,133	1,195	1,255	1,314
Textile, clothing, footwear and leather	**-40,698**	-3,757	-3,869	-3,985	-4,104	-4,227	-4,353	-4,349	-4,346	-4,347	-4,349	-4,353	-4,361	-4,372	-4,386	-4,403	-4,424
Wood, paper and printing products	**-16,620**	-1,558	-1,600	-1,643	-1,688	-1,734	-1,782	-1,775	-1,768	-1,763	-1,758	-1,754	-1,751	-1,751	-1,752	-1,754	-1,757
Basic chemicals	**-33,296**	-3,096	-3,185	-3,276	-3,370	-3,468	-3,568	-3,558	-3,550	-3,545	-3,540	-3,538	-3,538	-3,542	-3,548	-3,557	-3,568
Non-metallic mineral products	**274**	11	15	19	23	27	32	34	35	37	39	41	44	46	48	50	52
Basic iron and steel	**9,811**	876	905	936	967	1,000	1,033	1,043	1,053	1,063	1,074	1,086	1,098	1,110	1,122	1,135	1,149
Basic non-ferrous metals	**61,683**	5,560	5,732	5,910	6,093	6,281	6,476	6,533	6,593	6,654	6,719	6,788	6,858	6,929	7,002	7,078	7,158
Fabricated metal products	**881**	73	76	80	83	87	91	93	96	99	101	104	107	109	112	115	117
Machinery and equipment	**-101,160**	-9,301	-9,589	-9,885	-10,191	-10,506	-10,831	-10,823	-10,821	-10,825	-10,834	-10,850	-10,873	-10,904	-10,943	-10,991	-11,046
Miscellenous manufacturing	**-10,779**	-987	-1,019	-1,052	-1,086	-1,121	-1,157	-1,156	-1,156	-1,156	-1,157	-1,158	-1,161	-1,164	-1,168	-1,173	-1,179
Water, sewerage and drainage	**-6,709**	-616	-635	-655	-675	-696	-717	-717	-718	-719	-719	-721	-722	-725	-728	-732	-737
Construction	**-4,486**	-412	-425	-438	-451	-465	-480	-480	-480	-480	-481	-482	-483	-484	-486	-489	-491
Road transport	**10,995**	975	1,005	1,036	1,068	1,102	1,136	1,155	1,174	1,194	1,214	1,234	1,255	1,276	1,297	1,318	1,339
Railway transport	**10,594**	942	971	1,001	1,033	1,065	1,098	1,115	1,132	1,149	1,167	1,185	1,204	1,222	1,241	1,260	1,279
Water transport	**2,858**	248	255	263	271	280	289	297	305	313	321	329	338	346	354	363	371
Air transport	**9,821**	843	869	896	924	953	982	1,014	1,047	1,079	1,112	1,144	1,177	1,209	1,241	1,274	1,306
Other transport, services and storage	**-3,907**	-389	-401	-413	-426	-439	-453	-436	-420	-405	-389	-373	-358	-346	-335	-324	-315
Commercial services	**-392,819**	-34,616	-35,689	-36,795	-37,935	-39,110	-40,322	-41,096	-41,890	-42,703	-43,516	-44,348	-45,201	-46,102	-47,028	-47,977	-48,952
Total	**-281,144**	**-24,765**	**-25,495**	**-26,248**	**-27,024**	**-27,824**	**-28,649**	**-29,131**	**-29,773**	**-30,469**	**-31,150**	**-31,844**	**-32,548**	**-33,311**	**-34,090**	**-34,885**	**-35,696**

Notes:
- This Table shows the results calculated using the assumption of economic growth given in Section 6.2, pp. 138-139;
- The share of each sector in total (net) exports is assumed to vary according to inputs substitution, calculated from Equation 5-20, p. 110.

Table F-3 Sectoral supply of investment goods: BC scenario ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,423**	562	579	597	615	634	654	669	684	700	716	732	749	766	783	801	820
Mining	**10,850**	949	978	1,008	1,039	1,071	1,104	1,129	1,155	1,182	1,209	1,236	1,265	1,294	1,323	1,354	1,385
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,282**	374	386	398	410	423	436	446	456	466	477	488	499	511	522	534	547
Wood, paper and printing products	**28,443**	2,487	2,563	2,642	2,724	2,808	2,895	2,961	3,029	3,098	3,169	3,242	3,316	3,392	3,469	3,549	3,630
Basic chemicals	**2,669**	233	241	248	256	263	272	278	284	291	297	304	311	318	325	333	341
Non-metallic mineral products	**983**	86	89	91	94	97	100	102	105	107	110	112	115	117	120	123	125
Basic iron and steel	**394**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,762**	2,952	3,043	3,137	3,233	3,333	3,436	3,515	3,595	3,677	3,762	3,848	3,936	4,026	4,118	4,212	4,309
Machinery and equipment	**420,660**	36,769	37,905	39,077	40,286	41,532	42,817	43,796	44,799	45,824	46,873	47,946	49,044	50,167	51,316	52,492	53,694
Miscellenous manufacturing	**1,096**	96	99	102	105	108	112	114	117	119	122	125	128	131	134	137	140
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**943,745**	82,466	85,023	87,659	90,377	93,180	96,070	98,269	100,519	102,820	105,175	107,583	110,047	112,568	115,146	117,784	120,482
Road transport	**8,603**	752	775	799	824	849	876	896	916	937	959	981	1,003	1,026	1,049	1,073	1,098
Railway transport	**1,675**	146	151	156	160	165	170	174	178	182	187	191	195	200	204	209	214
Water transport	**848**	74	76	79	81	84	86	88	90	92	95	97	99	101	103	106	108
Air transport	**1,342**	117	121	125	129	133	137	140	143	146	150	153	156	160	164	168	171
Other transport, services and storage	**2,776**	243	250	258	266	274	282	289	296	302	309	316	324	331	339	346	354
Commercial services	**197,323**	17,252	17,784	18,332	18,898	19,481	20,082	20,542	21,012	21,493	21,985	22,488	23,003	23,529	24,068	24,620	25,183
Total	**1,666,260**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,489**	**177,461**	**181,523**	**185,679**	**189,931**	**194,280**	**198,729**	**203,281**	**207,938**	**212,701**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: PPP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,420**	562	579	597	615	634	653	668	684	699	715	731	748	765	783	800	819
Mining	**10,844**	949	978	1,008	1,039	1,071	1,104	1,129	1,155	1,181	1,208	1,235	1,264	1,292	1,321	1,351	1,382
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,280**	374	386	398	410	423	436	446	456	466	477	488	499	510	522	533	545
Wood, paper and printing products	**28,428**	2,487	2,563	2,642	2,723	2,807	2,893	2,959	3,027	3,096	3,167	3,239	3,313	3,388	3,465	3,544	3,624
Basic chemicals	**2,667**	233	241	248	256	263	271	278	284	290	297	304	311	318	325	332	340
Non-metallic mineral products	**983**	86	89	91	94	97	100	102	105	107	109	112	115	117	120	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,740**	2,952	3,043	3,136	3,233	3,332	3,435	3,513	3,593	3,675	3,759	3,844	3,932	4,020	4,111	4,203	4,297
Machinery and equipment	**420,356**	36,769	37,902	39,070	40,275	41,517	42,797	43,773	44,771	45,792	46,837	47,906	48,999	50,089	51,204	52,344	53,511
Miscellenous manufacturing	**1,095**	96	99	102	105	108	111	114	117	119	122	125	128	130	133	136	140
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**942,933**	82,466	85,015	87,642	90,352	93,146	96,027	98,217	100,457	102,749	105,093	107,491	109,945	112,352	114,814	117,332	119,906
Road transport	**8,598**	752	775	799	824	849	875	895	916	937	958	980	1,002	1,024	1,047	1,071	1,095
Railway transport	**1,674**	146	151	156	160	165	170	174	178	182	186	191	195	199	204	208	213
Water transport	**847**	74	76	79	81	84	86	88	90	92	94	97	99	101	103	105	108
Air transport	**1,341**	117	121	125	129	132	137	140	143	146	149	153	156	160	163	167	171
Other transport, services and storage	**2,774**	243	250	258	266	274	282	289	295	302	309	316	323	331	338	346	353
Commercial services	**197,206**	17,252	17,782	18,329	18,893	19,474	20,073	20,531	20,999	21,478	21,968	22,470	22,982	23,500	24,030	24,572	25,126
Total	**1,664,965**	**145,626**	**150,119**	**154,751**	**159,527**	**164,453**	**169,531**	**173,397**	**177,352**	**181,397**	**185,536**	**189,770**	**194,101**	**198,391**	**202,778**	**207,265**	**211,853**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: SRP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,416**	562	579	597	615	634	653	668	683	699	714	731	747	764	782	799	817
Mining	**10,835**	949	978	1,008	1,039	1,070	1,103	1,128	1,154	1,180	1,206	1,233	1,261	1,290	1,319	1,349	1,379
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,276**	374	386	398	410	422	435	445	455	466	476	487	498	509	520	532	545
Wood, paper and printing products	**28,408**	2,487	2,563	2,641	2,722	2,806	2,892	2,958	3,025	3,093	3,163	3,235	3,308	3,383	3,459	3,538	3,619
Basic chemicals	**2,665**	233	240	248	255	263	271	277	284	290	297	303	310	317	324	332	339
Non-metallic mineral products	**982**	86	89	91	94	97	100	102	105	107	109	112	114	117	119	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,707**	2,952	3,042	3,135	3,231	3,331	3,433	3,511	3,590	3,670	3,752	3,836	3,922	4,010	4,100	4,192	4,288
Machinery and equipment	**419,872**	36,769	37,897	39,061	40,261	41,498	42,774	43,745	44,738	45,729	46,743	47,779	48,839	49,924	51,033	52,167	53,396
Miscellenous manufacturing	**1,094**	96	99	102	105	108	111	114	117	119	122	125	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**941,505**	82,466	85,004	87,621	90,320	93,104	95,974	98,154	100,383	102,571	104,807	107,095	109,433	111,825	114,270	116,771	119,593
Road transport	**8,589**	752	775	799	823	849	875	895	915	935	956	977	999	1,021	1,044	1,068	1,092
Railway transport	**1,671**	146	151	156	160	165	170	174	178	182	186	190	194	199	203	207	212
Water transport	**846**	74	76	79	81	84	86	88	90	92	94	96	98	101	103	105	108
Air transport	**1,340**	117	121	125	128	132	136	140	143	146	149	152	156	159	163	166	170
Other transport, services and storage	**2,772**	243	250	258	266	274	282	289	295	302	309	315	323	330	337	345	353
Commercial services	**197,039**	17,252	17,780	18,325	18,887	19,466	20,063	20,519	20,985	21,455	21,937	22,430	22,934	23,449	23,977	24,517	25,081
Total	**1,662,798**	**145,626**	**150,100**	**154,715**	**159,473**	**164,380**	**169,440**	**173,287**	**177,223**	**181,121**	**185,108**	**189,185**	**193,355**	**197,620**	**201,982**	**206,442**	**211,356**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,417**	562	579	597	615	634	653	668	683	699	715	731	747	764	782	800	818
Mining	**10,836**	949	978	1,008	1,039	1,070	1,103	1,128	1,154	1,180	1,206	1,234	1,261	1,290	1,319	1,349	1,380
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,280**	374	386	398	410	422	435	445	455	466	476	488	499	511	523	535	547
Wood, paper and printing products	**28,420**	2,487	2,563	2,641	2,723	2,806	2,892	2,958	3,025	3,093	3,164	3,237	3,311	3,387	3,465	3,545	3,626
Basic chemicals	**2,665**	233	240	248	255	263	271	278	284	290	297	303	310	317	325	332	339
Non-metallic mineral products	**982**	86	89	91	94	97	100	102	105	107	109	112	114	117	120	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,730**	2,952	3,042	3,136	3,232	3,331	3,433	3,511	3,590	3,670	3,754	3,841	3,929	4,019	4,112	4,207	4,304
Machinery and equipment	**420,452**	36,769	37,898	39,063	40,264	41,502	42,779	43,752	44,721	45,713	46,788	47,890	49,017	50,172	51,354	52,564	53,803
Miscellenous manufacturing	**1,094**	96	99	102	105	108	111	114	117	119	122	125	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**943,680**	82,466	85,006	87,626	90,327	93,113	95,987	98,169	100,310	102,499	104,975	107,511	110,109	112,769	115,494	118,284	121,142
Road transport	**8,597**	752	775	799	824	849	875	895	915	935	957	979	1,002	1,025	1,049	1,074	1,099
Railway transport	**1,674**	146	151	156	160	165	170	174	178	182	186	191	195	200	204	209	214
Water transport	**848**	74	76	79	81	84	86	88	90	92	94	97	99	101	104	106	108
Air transport	**1,342**	117	121	125	128	132	137	140	143	146	149	153	156	160	164	168	172
Other transport, services and storage	**2,772**	243	250	258	266	274	282	289	295	302	309	316	323	330	337	345	353
Commercial services	**197,151**	17,252	17,780	18,326	18,888	19,468	20,065	20,522	20,982	21,453	21,946	22,450	22,967	23,495	24,036	24,589	25,155
Total	**1,665,722**	**145,626**	**150,104**	**154,722**	**159,485**	**164,396**	**169,461**	**173,313**	**177,128**	**181,030**	**185,335**	**189,744**	**194,258**	**198,881**	**203,615**	**208,461**	**213,424**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,411**	562	579	596	614	633	653	667	682	698	713	730	746	763	780	798	816
Mining	**10,824**	949	978	1,007	1,038	1,070	1,102	1,127	1,152	1,178	1,204	1,231	1,259	1,287	1,316	1,346	1,377
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,275**	374	386	397	410	422	435	445	455	465	476	487	498	510	521	534	546
Wood, paper and printing products	**28,391**	2,487	2,562	2,640	2,721	2,804	2,889	2,954	3,021	3,088	3,159	3,231	3,305	3,381	3,459	3,538	3,619
Basic chemicals	**2,662**	233	240	248	255	263	271	277	283	290	296	303	310	317	324	331	339
Non-metallic mineral products	**981**	86	89	91	94	97	100	102	104	107	109	112	114	117	119	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**386**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,686**	2,952	3,041	3,134	3,230	3,328	3,429	3,505	3,582	3,662	3,746	3,832	3,920	4,010	4,102	4,197	4,293
Machinery and equipment	**419,815**	36,769	37,889	39,045	40,237	41,467	42,715	43,654	44,616	45,599	46,667	47,762	48,883	50,031	51,207	52,411	53,644
Miscellenous manufacturing	**1,093**	96	99	102	105	108	111	114	116	119	122	124	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**941,904**	82,466	84,986	87,585	90,268	93,035	95,812	97,885	100,005	102,173	104,630	107,147	109,726	112,368	115,076	117,850	120,691
Road transport	**8,585**	752	775	799	823	848	874	893	913	933	955	977	999	1,023	1,046	1,071	1,096
Railway transport	**1,671**	146	151	155	160	165	170	174	178	181	186	190	194	199	204	208	213
Water transport	**846**	74	76	79	81	84	86	88	90	92	94	96	98	101	103	106	108
Air transport	**1,340**	117	121	125	128	132	136	139	142	145	149	152	156	160	163	167	171
Other transport, services and storage	**2,769**	243	250	258	266	274	282	288	295	301	308	315	322	329	337	344	352
Commercial services	**196,916**	17,252	17,776	18,318	18,876	19,452	20,041	20,488	20,945	21,413	21,903	22,405	22,918	23,444	23,983	24,534	25,099
Total	**1,662,949**	**145,626**	**150,068**	**154,651**	**159,380**	**164,259**	**169,184**	**172,880**	**176,661**	**180,529**	**184,803**	**189,181**	**193,667**	**198,262**	**202,969**	**207,790**	**212,728**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: PPP for Early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,415**	562	579	596	615	634	653	668	683	698	714	730	747	764	781	799	817
Mining	**10,833**	949	978	1,008	1,038	1,070	1,103	1,128	1,153	1,179	1,206	1,233	1,261	1,289	1,318	1,348	1,379
Food, beverages and tobacco	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,280**	374	386	398	410	422	435	445	455	466	477	488	499	511	523	535	547
Wood, paper and printing products	**28,417**	2,487	2,563	2,641	2,722	2,806	2,892	2,957	3,024	3,093	3,164	3,237	3,311	3,387	3,465	3,544	3,626
Basic chemicals	**2,665**	233	240	248	255	263	271	277	284	290	297	303	310	317	324	332	339
Non-metallic mineral products	**982**	86	89	91	94	97	100	102	104	107	109	112	114	117	120	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,725**	2,952	3,042	3,135	3,231	3,330	3,432	3,509	3,587	3,670	3,754	3,840	3,929	4,019	4,112	4,206	4,303
Machinery and equipment	**420,457**	36,769	37,896	39,059	40,258	41,495	42,771	43,717	44,684	45,734	46,809	47,910	49,037	50,192	51,373	52,583	53,822
Miscellenous manufacturing	**1,094**	96	99	102	105	108	111	114	116	119	122	125	127	130	133	136	139
Water, sewerage and drainage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**943,852**	82,466	85,002	87,618	90,315	93,098	95,967	98,056	100,192	102,609	105,085	107,621	110,219	112,879	115,605	118,396	121,254
Road transport	**8,597**	752	775	799	823	849	875	894	914	935	957	979	1,002	1,025	1,049	1,074	1,099
Railway transport	**1,674**	146	151	156	160	165	170	174	178	182	186	191	195	200	204	209	214
Water transport	**848**	74	76	79	81	84	86	88	90	92	94	97	99	101	104	106	109
Air transport	**1,342**	117	121	125	128	132	136	139	143	146	149	153	157	160	164	168	172
Other transport, services and storage	**2,771**	243	250	258	266	274	282	289	295	302	308	315	323	330	337	345	353
Commercial services	**197,123**	17,252	17,780	18,324	18,886	19,465	20,062	20,511	20,971	21,452	21,944	22,448	22,964	23,492	24,032	24,586	25,152
Total	**1,665,854**	**145,626**	**150,097**	**154,708**	**159,464**	**164,369**	**169,427**	**173,150**	**176,956**	**181,159**	**185,463**	**189,871**	**194,385**	**199,007**	**203,740**	**208,587**	**213,550**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: SRP for early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,413**	562	579	596	615	633	653	668	683	698	714	730	747	764	781	799	817
Mining	**10,829**	949	978	1,008	1,038	1,070	1,103	1,127	1,153	1,178	1,205	1,232	1,260	1,288	1,317	1,347	1,378
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,275**	374	386	398	410	422	435	445	455	465	476	486	498	509	521	533	546
Wood, paper and printing products	**28,399**	2,487	2,563	2,641	2,722	2,805	2,891	2,956	3,022	3,091	3,160	3,232	3,306	3,381	3,459	3,538	3,620
Basic chemicals	**2,663**	233	240	248	255	263	271	277	283	290	296	303	310	317	324	331	339
Non-metallic mineral products	**981**	86	89	91	94	97	100	102	104	107	109	112	114	117	119	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,694**	2,952	3,042	3,135	3,231	3,329	3,431	3,507	3,586	3,665	3,747	3,831	3,919	4,009	4,101	4,196	4,292
Machinery and equipment	**419,788**	36,769	37,893	39,053	40,249	41,483	42,755	43,698	44,663	45,650	46,659	47,692	48,812	49,959	51,134	52,338	53,570
Miscellenous manufacturing	**1,094**	96	99	102	105	108	111	114	116	119	122	124	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**941,510**	82,466	84,995	87,604	90,294	93,070	95,932	98,014	100,142	102,319	104,546	106,822	109,397	112,035	114,737	117,505	120,341
Road transport	**8,586**	752	775	799	823	848	874	894	914	934	955	976	999	1,022	1,046	1,070	1,095
Railway transport	**1,671**	146	151	156	160	165	170	174	178	182	186	190	194	199	203	208	213
Water transport	**846**	74	76	79	81	84	86	88	90	92	94	96	98	101	103	105	108
Air transport	**1,339**	117	121	125	128	132	136	139	142	146	149	152	156	159	163	167	171
Other transport, services and storage	**2,770**	243	250	258	266	274	282	288	295	301	308	315	322	330	337	345	352
Commercial services	**196,963**	17,252	17,778	18,321	18,881	19,459	20,054	20,503	20,961	21,430	21,911	22,402	22,916	23,442	23,981	24,532	25,097
Total	**1,662,601**	**145,626**	**150,085**	**154,683**	**159,427**	**164,319**	**169,365**	**173,075**	**176,870**	**180,752**	**184,723**	**188,783**	**193,265**	**197,854**	**202,555**	**207,370**	**212,301**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: PPP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,417**	562	579	597	615	634	654	668	683	699	715	731	747	764	781	799	817
Mining	**10,838**	949	978	1,008	1,039	1,071	1,104	1,129	1,154	1,180	1,207	1,234	1,261	1,289	1,318	1,348	1,379
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,280**	374	386	398	410	423	436	446	456	466	476	487	499	510	522	534	547
Wood, paper and printing products	**28,422**	2,487	2,563	2,642	2,724	2,808	2,895	2,960	3,026	3,094	3,164	3,236	3,310	3,385	3,462	3,542	3,623
Basic chemicals	**2,666**	233	241	248	256	263	272	278	284	290	297	303	310	317	324	332	339
Non-metallic mineral products	**982**	86	89	91	94	97	100	102	105	107	109	112	114	117	120	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,735**	2,952	3,043	3,137	3,233	3,333	3,436	3,513	3,592	3,673	3,754	3,840	3,927	4,017	4,109	4,204	4,300
Machinery and equipment	**420,484**	36,769	37,905	39,077	40,286	41,532	42,817	43,776	44,759	45,766	46,770	47,862	48,981	50,127	51,301	52,504	53,736
Miscellenous manufacturing	**1,095**	96	99	102	105	108	112	114	117	119	122	125	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**943,736**	82,466	85,023	87,659	90,377	93,180	96,070	98,223	100,430	102,690	104,907	107,422	110,000	112,642	115,349	118,124	120,967
Road transport	**8,598**	752	775	799	824	849	876	895	915	936	957	979	1,001	1,025	1,048	1,073	1,097
Railway transport	**1,674**	146	151	156	160	165	170	174	178	182	186	191	195	200	204	209	214
Water transport	**848**	74	76	79	81	84	86	88	90	92	94	96	99	101	103	106	108
Air transport	**1,342**	117	121	125	129	133	137	140	143	146	149	153	156	160	164	168	172
Other transport, services and storage	**2,773**	243	250	258	266	274	282	289	295	302	309	316	323	330	337	345	353
Commercial services	**197,173**	17,252	17,784	18,332	18,898	19,481	20,082	20,532	20,994	21,467	21,944	22,444	22,956	23,481	24,018	24,568	25,132
Total	**1,665,845**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,408**	**177,304**	**181,294**	**185,247**	**189,618**	**194,098**	**198,688**	**203,391**	**208,210**	**213,146**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-3 Sectoral supply of investment goods: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas sector	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Internal-combustion Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas-turbine Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined-cycle Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture, forestry and fishing	**6,416**	562	579	597	615	634	654	668	683	699	714	730	747	764	781	799	817
Mining	**10,837**	949	978	1,008	1,039	1,071	1,104	1,129	1,154	1,180	1,206	1,233	1,261	1,289	1,318	1,347	1,378
Food, beverages and tobacco	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile, clothing, footwear and leather	**4,278**	374	386	398	410	423	436	446	456	466	476	487	498	509	521	533	545
Wood, paper and printing products	**28,414**	2,487	2,563	2,642	2,724	2,808	2,895	2,959	3,026	3,094	3,163	3,234	3,306	3,382	3,459	3,538	3,619
Basic chemicals	**2,665**	233	241	248	256	263	272	278	284	290	297	303	310	317	324	331	339
Non-metallic mineral products	**982**	86	89	91	94	97	100	102	105	107	109	112	114	117	119	122	125
Basic iron and steel	**393**	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Basic non-ferrous metals	**387**	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Fabricated metal products	**33,720**	2,952	3,043	3,137	3,233	3,333	3,436	3,513	3,591	3,672	3,753	3,836	3,921	4,010	4,102	4,196	4,292
Machinery and equipment	**420,160**	36,769	37,905	39,077	40,286	41,532	42,817	43,773	44,753	45,756	46,757	47,782	48,831	49,972	51,140	52,338	53,565
Miscellenous manufacturing	**1,094**	96	99	102	105	108	112	114	117	119	122	125	127	130	133	136	139
Water, sewerage and drainage	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	**942,581**	82,466	85,023	87,659	90,377	93,180	96,070	98,216	100,415	102,667	104,877	107,138	109,451	112,075	114,764	117,521	120,346
Road transport	**8,593**	752	775	799	824	849	876	895	915	936	956	977	999	1,022	1,046	1,070	1,095
Railway transport	**1,673**	146	151	156	160	165	170	174	178	182	186	190	194	199	203	208	213
Water transport	**847**	74	76	79	81	84	86	88	90	92	94	96	98	101	103	105	108
Air transport	**1,341**	117	121	125	129	133	137	140	143	146	149	152	156	159	163	167	171
Other transport, services and storage	**2,772**	243	250	258	266	274	282	289	295	302	309	315	322	330	337	345	352
Commercial services	**197,098**	17,252	17,784	18,332	18,898	19,481	20,082	20,531	20,991	21,462	21,938	22,426	22,925	23,448	23,983	24,532	25,094
Total	**1,664,252**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,396**	**177,279**	**181,255**	**185,195**	**189,227**	**193,352**	**197,915**	**202,592**	**207,385**	**212,297**

Note: This Table shows the results obtained by the application of Equation 5-34, p. 124.

Table F-4 Sectoral demand for investment: BC scenario ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**70,708**	6,200	6,386	6,578	6,775	6,979	7,189	7,353	7,520	7,691	7,866	8,046	8,229	8,417	8,608	8,805	9,006
Petroleum sector	**2,738**	241	248	255	263	270	279	285	291	298	304	311	318	325	332	340	347
Gas sector	**9,148**	801	826	851	876	903	930	951	973	995	1,018	1,041	1,065	1,089	1,114	1,140	1,166
Renewable Electricity	**17,565**	1,369	1,463	1,561	1,663	1,771	1,883	1,926	1,970	2,015	2,062	2,109	2,157	2,207	2,257	2,309	2,362
Coal-fired Electricity	**79,151**	7,018	7,204	7,395	7,591	7,793	7,999	8,182	8,370	8,561	8,757	8,958	9,163	9,373	9,587	9,807	10,032
Internal-combustion Electricity	**275**	24	25	26	26	27	28	29	29	30	31	31	32	33	34	34	35
Gas-turbine Electricity	**2,051**	180	185	191	196	202	209	213	218	223	228	234	239	244	250	256	262
Combined-cycle Electricity	**2,340**	205	211	218	224	231	238	243	249	255	260	266	273	279	285	292	298
Agriculture, forestry and fishing	**84,426**	7,398	7,622	7,854	8,092	8,338	8,592	8,786	8,984	9,187	9,395	9,607	9,824	10,046	10,274	10,506	10,744
Mining	**54,394**	4,754	4,901	5,052	5,209	5,370	5,536	5,663	5,793	5,925	6,061	6,201	6,343	6,489	6,637	6,790	6,946
Food, beverages and tobacco	**24,381**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,654	2,714	2,776	2,839	2,903	2,969	3,036	3,105
Textile, clothing, footwear and leather	**3,376**	296	305	314	324	333	344	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,177**	1,593	1,641	1,691	1,742	1,795	1,850	1,892	1,934	1,978	2,023	2,069	2,115	2,163	2,212	2,262	2,313
Basic chemicals	**17,849**	1,564	1,611	1,660	1,711	1,763	1,816	1,857	1,899	1,942	1,986	2,031	2,077	2,124	2,172	2,222	2,272
Non-metallic mineral products	**8,085**	710	731	753	776	799	823	841	860	879	898	918	939	960	981	1,003	1,025
Basic iron and steel	**6,292**	552	568	586	603	622	640	655	669	685	700	716	732	748	765	782	800
Basic non-ferrous metals	**14,164**	1,238	1,276	1,316	1,356	1,398	1,442	1,475	1,509	1,543	1,579	1,615	1,652	1,690	1,729	1,768	1,809
Fabricated metal products	**8,448**	739	762	785	809	834	860	879	899	920	941	962	984	1,006	1,029	1,053	1,077
Machinery and equipment	**27,999**	2,447	2,523	2,601	2,681	2,764	2,850	2,915	2,982	3,050	3,120	3,191	3,265	3,339	3,416	3,494	3,574
Miscellenous manufacturing	**1,636**	143	147	152	156	161	166	170	174	178	183	187	191	196	200	205	209
Water, sewerage and drainage	**16,967**	1,483	1,529	1,576	1,625	1,675	1,727	1,766	1,807	1,848	1,891	1,934	1,978	2,024	2,070	2,118	2,166
Construction	**39,272**	3,432	3,538	3,648	3,761	3,877	3,998	4,089	4,183	4,279	4,376	4,477	4,579	4,684	4,791	4,901	5,013
Road transport	**19,740**	1,726	1,780	1,834	1,891	1,949	2,009	2,055	2,102	2,150	2,199	2,249	2,301	2,353	2,407	2,462	2,518
Railway transport	**36,596**	3,202	3,300	3,401	3,505	3,613	3,723	3,809	3,896	3,985	4,076	4,169	4,264	4,362	4,461	4,563	4,668
Water transport	**3,836**	335	346	356	367	379	390	399	408	418	427	437	447	457	468	479	490
Air transport	**37,997**	3,320	3,423	3,529	3,638	3,751	3,867	3,956	4,047	4,139	4,235	4,332	4,431	4,533	4,637	4,744	4,853
Other transport, services and storage	**101,799**	8,900	9,174	9,457	9,749	10,050	10,360	10,597	10,840	11,088	11,342	11,602	11,868	12,140	12,418	12,703	12,994
Commercial services	**956,851**	83,622	86,208	88,875	91,624	94,458	97,380	99,614	101,900	104,239	106,631	109,079	111,582	114,144	116,764	119,444	122,186
Total	**1,666,260**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,489**	**177,461**	**181,523**	**185,679**	**189,931**	**194,280**	**198,729**	**203,281**	**207,938**	**212,701**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: PPP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**70,326**	6,200	6,381	6,568	6,761	6,960	7,165	7,323	7,485	7,651	7,820	7,993	8,170	8,317	8,467	8,621	8,778
Petroleum sector	**2,735**	241	248	255	263	270	278	285	291	297	304	311	318	324	332	339	346
Gas sector	**9,278**	801	824	848	872	897	923	942	963	983	1,004	1,026	1,047	1,135	1,225	1,318	1,413
Renewable Electricity	**17,507**	1,369	1,463	1,561	1,663	1,770	1,882	1,925	1,969	2,014	2,060	2,107	2,155	2,189	2,224	2,260	2,296
Coal-fired Electricity	**77,968**	7,018	7,203	7,394	7,589	7,790	7,996	8,178	8,365	8,555	8,751	8,950	9,155	9,013	8,864	8,709	8,547
Internal-combustion Electricity	**275**	24	25	26	26	27	28	29	29	30	31	31	32	33	33	34	34
Gas-turbine Electricity	**2,044**	180	185	191	196	202	208	213	218	223	228	233	239	242	246	250	254
Combined-cycle Electricity	**2,976**	205	211	217	224	231	238	243	249	254	260	266	272	474	682	897	1,118
Agriculture, forestry and fishing	**84,420**	7,398	7,622	7,854	8,092	8,338	8,591	8,785	8,983	9,186	9,394	9,606	9,823	10,045	10,272	10,505	10,743
Mining	**54,374**	4,754	4,901	5,052	5,208	5,369	5,534	5,661	5,791	5,923	6,059	6,198	6,340	6,483	6,630	6,780	6,934
Food, beverages and tobacco	**24,380**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,654	2,714	2,775	2,838	2,903	2,969	3,036	3,105
Textile, clothing, footwear and leather	**3,376**	296	305	314	324	333	344	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,172**	1,593	1,641	1,691	1,742	1,795	1,849	1,891	1,934	1,977	2,022	2,068	2,114	2,162	2,210	2,260	2,311
Basic chemicals	**17,841**	1,564	1,611	1,660	1,710	1,762	1,816	1,857	1,899	1,941	1,985	2,030	2,076	2,123	2,170	2,219	2,269
Non-metallic mineral products	**8,076**	710	731	753	775	799	822	840	859	878	897	917	938	957	978	999	1,020
Basic iron and steel	**6,288**	552	568	585	603	621	640	654	669	684	699	715	731	747	764	781	798
Basic non-ferrous metals	**14,162**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,508	1,543	1,578	1,615	1,652	1,689	1,728	1,767	1,808
Fabricated metal products	**8,441**	739	762	785	809	834	859	879	899	919	940	961	983	1,005	1,027	1,050	1,074
Machinery and equipment	**27,981**	2,447	2,523	2,600	2,681	2,763	2,848	2,913	2,980	3,048	3,118	3,189	3,262	3,335	3,410	3,487	3,565
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,958**	1,483	1,529	1,576	1,624	1,674	1,726	1,765	1,805	1,847	1,889	1,932	1,976	2,022	2,068	2,116	2,165
Construction	**39,239**	3,432	3,538	3,647	3,760	3,876	3,996	4,087	4,180	4,276	4,373	4,473	4,575	4,675	4,778	4,883	4,991
Road transport	**19,734**	1,726	1,779	1,834	1,890	1,949	2,008	2,054	2,101	2,149	2,198	2,248	2,299	2,352	2,405	2,460	2,515
Railway transport	**36,547**	3,202	3,299	3,400	3,503	3,610	3,720	3,804	3,890	3,978	4,068	4,160	4,255	4,350	4,447	4,546	4,647
Water transport	**3,835**	335	346	356	367	379	390	399	408	418	427	437	447	457	468	478	489
Air transport	**37,990**	3,320	3,423	3,529	3,638	3,750	3,866	3,955	4,046	4,138	4,233	4,330	4,430	4,531	4,636	4,742	4,851
Other transport, services and storage	**101,769**	8,900	9,173	9,455	9,745	10,045	10,354	10,590	10,832	11,079	11,332	11,590	11,855	12,135	12,422	12,716	13,016
Commercial services	**956,638**	83,622	86,204	88,867	91,612	94,442	97,360	99,590	101,872	104,206	106,594	109,037	111,536	114,094	116,711	119,387	122,126
Total	**1,664,965**	**145,626**	**150,119**	**154,751**	**159,527**	**164,453**	**169,531**	**173,397**	**177,352**	**181,397**	**185,536**	**189,770**	**194,101**	**198,391**	**202,778**	**207,265**	**211,853**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: SRP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**69,697**	6,200	6,375	6,556	6,742	6,935	7,133	7,284	7,439	7,568	7,700	7,835	7,974	8,116	8,263	8,412	8,563
Petroleum sector	**2,732**	241	248	255	262	270	278	284	291	297	303	310	317	324	331	338	345
Gas sector	**9,785**	801	823	845	868	892	916	935	953	1,032	1,113	1,197	1,282	1,370	1,460	1,553	1,581
Renewable Electricity	**17,518**	1,369	1,462	1,560	1,662	1,769	1,881	1,924	1,968	1,998	2,029	2,061	2,093	2,126	2,159	2,193	2,804
Coal-fired Electricity	**74,673**	7,018	7,202	7,392	7,586	7,786	7,991	8,172	8,358	8,226	8,088	7,944	7,793	7,636	7,472	7,300	7,146
Internal-combustion Electricity	**272**	24	25	26	26	27	28	29	29	30	30	31	31	32	32	33	33
Gas-turbine Electricity	**2,027**	180	185	191	196	202	208	213	218	221	225	228	232	235	239	243	247
Combined-cycle Electricity	**4,710**	205	211	217	224	231	238	243	249	433	623	818	1,020	1,227	1,441	1,662	1,693
Agriculture, forestry and fishing	**84,414**	7,398	7,622	7,853	8,092	8,337	8,591	8,784	8,983	9,185	9,392	9,605	9,822	10,044	10,271	10,503	10,741
Mining	**54,341**	4,754	4,900	5,051	5,207	5,367	5,532	5,659	5,788	5,919	6,053	6,189	6,329	6,473	6,619	6,769	6,924
Food, beverages and tobacco	**24,379**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,653	2,714	2,775	2,838	2,902	2,968	3,036	3,105
Textile, clothing, footwear and leather	**3,375**	296	305	314	324	333	343	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,164**	1,593	1,641	1,690	1,742	1,794	1,849	1,890	1,933	1,976	2,021	2,066	2,112	2,160	2,208	2,258	2,309
Basic chemicals	**17,832**	1,564	1,611	1,660	1,710	1,762	1,815	1,856	1,897	1,940	1,984	2,028	2,074	2,120	2,168	2,217	2,267
Non-metallic mineral products	**8,062**	710	731	753	775	798	822	840	858	876	895	913	933	953	973	994	1,017
Basic iron and steel	**6,282**	552	568	585	603	621	640	654	669	683	698	714	729	745	762	778	796
Basic non-ferrous metals	**14,158**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,508	1,542	1,578	1,614	1,650	1,688	1,727	1,766	1,807
Fabricated metal products	**8,432**	739	762	785	809	833	859	878	898	918	938	959	980	1,002	1,024	1,047	1,071
Machinery and equipment	**27,954**	2,447	2,522	2,600	2,680	2,762	2,847	2,911	2,978	3,044	3,112	3,182	3,253	3,326	3,401	3,477	3,558
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,949**	1,483	1,528	1,575	1,623	1,673	1,724	1,763	1,803	1,845	1,887	1,931	1,975	2,021	2,067	2,115	2,162
Construction	**39,182**	3,432	3,537	3,646	3,758	3,874	3,994	4,084	4,177	4,268	4,362	4,457	4,555	4,655	4,757	4,861	4,978
Road transport	**19,724**	1,726	1,779	1,834	1,890	1,948	2,008	2,053	2,100	2,148	2,196	2,246	2,297	2,349	2,402	2,457	2,513
Railway transport	**36,475**	3,202	3,298	3,397	3,500	3,605	3,714	3,797	3,882	3,968	4,055	4,145	4,237	4,331	4,427	4,525	4,623
Water transport	**3,834**	335	346	356	367	379	390	399	408	418	427	437	447	457	467	478	489
Air transport	**37,982**	3,320	3,423	3,528	3,637	3,750	3,865	3,954	4,044	4,137	4,232	4,329	4,428	4,530	4,634	4,740	4,849
Other transport, services and storage	**101,785**	8,900	9,172	9,452	9,742	10,040	10,348	10,583	10,823	11,078	11,338	11,605	11,877	12,156	12,441	12,732	13,021
Commercial services	**956,421**	83,622	86,200	88,858	91,598	94,424	97,337	99,563	101,841	104,172	106,557	108,997	111,493	114,046	116,659	119,331	122,074
Total	**1,662,798**	**145,626**	**150,100**	**154,715**	**159,473**	**164,380**	**169,440**	**173,287**	**177,223**	**181,121**	**185,108**	**189,185**	**193,355**	**197,620**	**201,982**	**206,442**	**211,356**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**69,635**	6,200	6,377	6,559	6,748	6,942	7,141	7,295	7,421	7,551	7,681	7,814	7,950	8,090	8,232	8,378	8,528
Petroleum sector	**2,732**	241	248	255	262	270	278	284	291	297	303	310	317	324	331	338	345
Gas sector	**9,385**	801	823	845	868	892	916	934	1,011	1,089	1,108	1,128	1,148	1,169	1,190	1,212	1,235
Renewable Electricity	**22,710**	1,369	1,463	1,560	1,663	1,770	1,882	1,924	1,955	1,985	2,540	3,114	3,710	4,327	4,967	5,630	6,316
Coal-fired Electricity	**73,738**	7,018	7,203	7,392	7,587	7,787	7,992	8,174	8,047	7,913	7,798	7,676	7,547	7,411	7,266	7,113	6,953
Internal-combustion Electricity	**273**	24	25	26	26	27	28	29	29	30	30	31	31	32	32	33	34
Gas-turbine Electricity	**2,029**	180	185	191	196	202	208	213	216	220	224	228	233	237	242	246	251
Combined-cycle Electricity	**3,591**	205	211	217	224	231	238	243	423	609	621	633	645	657	669	682	695
Agriculture, forestry and fishing	**84,418**	7,398	7,622	7,853	8,092	8,337	8,591	8,785	8,983	9,185	9,393	9,605	9,823	10,045	10,272	10,505	10,743
Mining	**54,351**	4,754	4,900	5,051	5,207	5,368	5,533	5,659	5,787	5,918	6,053	6,191	6,332	6,477	6,625	6,776	6,931
Food, beverages and tobacco	**24,379**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,653	2,714	2,775	2,838	2,903	2,969	3,036	3,105
Textile, clothing, footwear and leather	**3,376**	296	305	314	324	333	344	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,171**	1,593	1,641	1,691	1,742	1,795	1,849	1,891	1,933	1,976	2,021	2,067	2,114	2,162	2,211	2,262	2,313
Basic chemicals	**17,837**	1,564	1,611	1,660	1,710	1,762	1,815	1,856	1,898	1,940	1,984	2,029	2,075	2,122	2,170	2,219	2,270
Non-metallic mineral products	**8,078**	710	731	753	775	798	822	840	858	876	896	917	938	959	981	1,004	1,027
Basic iron and steel	**6,287**	552	568	585	603	621	640	654	668	683	699	715	731	748	765	782	800
Basic non-ferrous metals	**14,162**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,508	1,542	1,578	1,614	1,651	1,690	1,728	1,768	1,809
Fabricated metal products	**8,441**	739	762	785	809	834	859	878	898	918	939	961	983	1,005	1,029	1,053	1,077
Machinery and equipment	**27,978**	2,447	2,522	2,600	2,680	2,762	2,847	2,912	2,977	3,044	3,114	3,187	3,261	3,336	3,414	3,493	3,574
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,948**	1,483	1,529	1,575	1,624	1,673	1,725	1,764	1,805	1,846	1,888	1,931	1,974	2,019	2,065	2,111	2,159
Construction	**39,265**	3,432	3,537	3,646	3,759	3,875	3,994	4,085	4,174	4,266	4,368	4,473	4,581	4,691	4,803	4,919	5,037
Road transport	**19,730**	1,726	1,779	1,834	1,890	1,948	2,008	2,054	2,100	2,148	2,197	2,247	2,298	2,351	2,405	2,460	2,516
Railway transport	**36,462**	3,202	3,299	3,398	3,501	3,607	3,716	3,799	3,883	3,969	4,054	4,142	4,231	4,322	4,416	4,512	4,610
Water transport	**3,834**	335	346	356	367	379	390	399	408	418	427	437	447	457	467	478	489
Air transport	**37,984**	3,320	3,423	3,529	3,637	3,750	3,866	3,954	4,045	4,138	4,232	4,329	4,429	4,530	4,634	4,740	4,849
Other transport, services and storage	**101,745**	8,900	9,172	9,453	9,742	10,041	10,349	10,584	10,834	11,089	11,341	11,598	11,861	12,131	12,407	12,689	12,978
Commercial services	**956,549**	83,622	86,200	88,859	91,601	94,427	97,342	99,569	101,849	104,181	106,574	109,022	111,527	114,090	116,713	119,396	122,141
Total	**1,665,722**	**145,626**	**150,104**	**154,722**	**159,485**	**164,396**	**169,461**	**173,313**	**177,128**	**181,030**	**185,335**	**189,744**	**194,258**	**198,881**	**203,615**	**208,461**	**213,424**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**68,863**	6,200	6,364	6,535	6,711	6,893	7,056	7,170	7,289	7,411	7,534	7,662	7,793	7,928	8,068	8,211	8,359
Petroleum sector	**2,728**	241	248	255	262	270	278	284	290	296	303	309	316	323	330	337	344
Gas sector	**9,775**	801	820	840	860	882	953	1,026	1,101	1,178	1,197	1,218	1,239	1,261	1,284	1,307	1,332
Renewable Electricity	**22,470**	1,369	1,462	1,559	1,661	1,768	1,868	1,896	1,925	1,954	2,499	3,064	3,649	4,255	4,884	5,534	6,208
Coal-fired Electricity	**70,922**	7,018	7,201	7,389	7,582	7,780	7,719	7,588	7,451	7,308	7,184	7,053	6,915	6,769	6,616	6,455	6,285
Internal-combustion Electricity	**270**	24	25	26	26	27	28	28	29	29	30	30	31	31	32	33	33
Gas-turbine Electricity	**2,013**	180	185	190	196	202	207	210	213	216	220	225	229	233	238	242	247
Combined-cycle Electricity	**5,098**	205	211	217	224	231	384	561	743	931	948	966	984	1,003	1,022	1,041	1,061
Agriculture, forestry and fishing	**84,407**	7,398	7,622	7,853	8,091	8,337	8,590	8,783	8,981	9,184	9,391	9,603	9,820	10,043	10,270	10,503	10,740
Mining	**54,309**	4,754	4,900	5,050	5,205	5,365	5,528	5,653	5,780	5,911	6,045	6,183	6,324	6,468	6,616	6,767	6,921
Food, beverages and tobacco	**24,377**	2,135	2,200	2,267	2,336	2,407	2,481	2,537	2,594	2,653	2,713	2,775	2,838	2,902	2,968	3,035	3,104
Textile, clothing, footwear and leather	**3,375**	296	305	314	323	333	343	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,159**	1,593	1,641	1,690	1,741	1,794	1,848	1,889	1,931	1,974	2,019	2,065	2,112	2,160	2,209	2,259	2,310
Basic chemicals	**17,823**	1,564	1,611	1,659	1,709	1,761	1,814	1,854	1,896	1,938	1,982	2,026	2,072	2,119	2,167	2,216	2,266
Non-metallic mineral products	**8,058**	710	731	752	774	797	820	837	854	872	892	913	933	955	977	999	1,022
Basic iron and steel	**6,279**	552	568	585	603	621	639	653	667	682	697	713	729	746	763	780	798
Basic non-ferrous metals	**14,157**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,507	1,541	1,577	1,613	1,650	1,688	1,727	1,767	1,808
Fabricated metal products	**8,428**	739	762	785	808	833	858	876	896	915	936	958	980	1,003	1,026	1,049	1,074
Machinery and equipment	**27,940**	2,447	2,522	2,599	2,678	2,760	2,843	2,907	2,971	3,037	3,108	3,179	3,253	3,328	3,405	3,484	3,564
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,928**	1,483	1,528	1,574	1,622	1,671	1,723	1,762	1,802	1,843	1,885	1,927	1,970	2,015	2,060	2,107	2,154
Construction	**39,194**	3,432	3,537	3,645	3,756	3,871	3,987	4,074	4,162	4,253	4,354	4,459	4,565	4,675	4,787	4,901	5,019
Road transport	**19,716**	1,726	1,779	1,833	1,889	1,947	2,007	2,052	2,098	2,145	2,194	2,244	2,295	2,348	2,401	2,456	2,513
Railway transport	**36,357**	3,202	3,296	3,394	3,495	3,598	3,704	3,785	3,867	3,951	4,035	4,122	4,210	4,300	4,393	4,488	4,586
Water transport	**3,832**	335	346	356	367	378	390	399	408	417	427	437	446	457	467	478	489
Air transport	**37,969**	3,320	3,423	3,528	3,636	3,748	3,864	3,952	4,043	4,135	4,230	4,327	4,426	4,527	4,631	4,737	4,845
Other transport, services and storage	**101,701**	8,900	9,169	9,448	9,735	10,032	10,345	10,586	10,833	11,085	11,335	11,591	11,854	12,122	12,396	12,678	12,965
Commercial services	**956,165**	83,622	86,191	88,842	91,575	94,394	97,302	99,523	101,796	104,121	106,508	108,950	111,450	114,007	116,624	119,302	122,041
Total	**1,662,949**	**145,626**	**150,068**	**154,651**	**159,380**	**164,259**	**169,184**	**172,880**	**176,661**	**180,529**	**184,803**	**189,181**	**193,667**	**198,262**	**202,969**	**207,790**	**212,728**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: PPP for Early action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**69,391**	6,200	6,375	6,555	6,741	6,932	7,130	7,251	7,376	7,501	7,629	7,761	7,895	8,034	8,175	8,320	8,469
Petroleum sector	**2,731**	241	248	255	262	270	278	284	290	297	303	310	316	323	330	338	345
Gas sector	**9,406**	801	822	844	866	889	912	987	1,063	1,081	1,099	1,118	1,138	1,159	1,180	1,201	1,224
Renewable Electricity	**24,308**	1,369	1,462	1,560	1,662	1,769	1,881	1,911	1,941	2,482	3,044	3,626	4,229	4,854	5,501	6,172	6,866
Coal-fired Electricity	**72,437**	7,018	7,202	7,392	7,586	7,786	7,991	7,866	7,735	7,622	7,503	7,376	7,242	7,101	6,951	6,794	6,628
Internal-combustion Electricity	**272**	24	25	26	26	27	28	28	29	29	30	31	31	32	32	33	34
Gas-turbine Electricity	**2,025**	180	185	191	196	202	208	212	215	219	223	227	232	236	241	245	250
Combined-cycle Electricity	**3,775**	205	211	217	224	231	238	414	595	607	618	630	642	654	667	679	692
Agriculture, forestry and fishing	**84,416**	7,398	7,622	7,853	8,092	8,337	8,591	8,784	8,982	9,185	9,393	9,605	9,822	10,045	10,272	10,505	10,743
Mining	**54,343**	4,754	4,900	5,051	5,207	5,367	5,532	5,657	5,785	5,917	6,052	6,190	6,331	6,475	6,623	6,775	6,929
Food, beverages and tobacco	**24,379**	2,135	2,200	2,267	2,336	2,407	2,481	2,537	2,595	2,653	2,714	2,775	2,838	2,903	2,968	3,036	3,105
Textile, clothing, footwear and leather	**3,375**	296	305	314	324	333	343	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,170**	1,593	1,641	1,690	1,742	1,794	1,849	1,890	1,932	1,976	2,021	2,067	2,114	2,162	2,211	2,262	2,313
Basic chemicals	**17,835**	1,564	1,611	1,660	1,710	1,762	1,815	1,856	1,897	1,940	1,984	2,029	2,075	2,122	2,170	2,219	2,269
Non-metallic mineral products	**8,077**	710	731	753	775	798	822	839	857	876	896	917	938	960	982	1,005	1,028
Basic iron and steel	**6,287**	552	568	585	603	621	640	654	668	683	699	715	731	748	765	782	800
Basic non-ferrous metals	**14,161**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,508	1,542	1,578	1,614	1,651	1,690	1,728	1,768	1,809
Fabricated metal products	**8,440**	739	762	785	809	833	859	878	897	918	939	961	983	1,006	1,029	1,053	1,077
Machinery and equipment	**27,975**	2,447	2,522	2,600	2,679	2,762	2,847	2,910	2,975	3,044	3,115	3,187	3,261	3,336	3,414	3,493	3,574
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,943**	1,483	1,528	1,575	1,623	1,673	1,724	1,764	1,805	1,845	1,887	1,930	1,973	2,018	2,063	2,110	2,158
Construction	**39,271**	3,432	3,537	3,646	3,758	3,874	3,993	4,081	4,170	4,270	4,372	4,477	4,585	4,695	4,807	4,923	5,041
Road transport	**19,728**	1,726	1,779	1,834	1,890	1,948	2,008	2,053	2,100	2,148	2,197	2,247	2,298	2,351	2,404	2,459	2,516
Railway transport	**36,431**	3,202	3,298	3,397	3,500	3,605	3,714	3,796	3,879	3,962	4,047	4,134	4,224	4,315	4,408	4,504	4,601
Water transport	**3,834**	335	346	356	367	379	390	399	408	418	427	437	447	457	467	478	489
Air transport	**37,981**	3,320	3,423	3,528	3,637	3,750	3,865	3,954	4,045	4,137	4,232	4,329	4,428	4,529	4,633	4,740	4,848
Other transport, services and storage	**101,730**	8,900	9,171	9,452	9,741	10,039	10,347	10,590	10,839	11,085	11,336	11,593	11,856	12,126	12,402	12,684	12,972
Commercial services	**956,496**	83,622	86,198	88,855	91,595	94,420	97,334	99,560	101,838	104,176	106,568	109,016	111,520	114,082	116,703	119,386	122,130
Total	**1,665,854**	**145,626**	**150,097**	**154,708**	**159,464**	**164,369**	**169,427**	**173,150**	**176,956**	**181,159**	**185,463**	**189,871**	**194,385**	**199,007**	**203,740**	**208,587**	**213,550**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: SRP for early action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**69,218**	6,200	6,370	6,546	6,727	6,914	7,107	7,225	7,346	7,471	7,600	7,733	7,866	8,003	8,144	8,288	8,437
Petroleum sector	**2,730**	241	248	255	262	270	278	284	290	296	303	309	316	323	330	337	345
Gas sector	**9,888**	801	822	843	864	887	910	984	1,060	1,138	1,219	1,301	1,324	1,347	1,372	1,397	1,422
Renewable Electricity	**19,959**	1,369	1,462	1,560	1,662	1,769	1,880	1,909	1,939	1,969	1,999	2,030	2,596	3,183	3,791	4,421	5,074
Coal-fired Electricity	**72,197**	7,018	7,201	7,390	7,584	7,783	7,987	7,860	7,727	7,588	7,443	7,291	7,157	7,016	6,867	6,711	6,546
Internal-combustion Electricity	**271**	24	25	26	26	27	28	28	29	29	30	30	31	31	32	33	33
Gas-turbine Electricity	**2,017**	180	185	191	196	202	208	211	215	218	221	225	229	233	238	242	247
Combined-cycle Electricity	**5,238**	205	211	217	224	231	238	414	595	782	974	1,172	1,194	1,217	1,240	1,263	1,287
Agriculture, forestry and fishing	**84,410**	7,398	7,622	7,853	8,091	8,337	8,590	8,784	8,982	9,184	9,392	9,604	9,821	10,043	10,270	10,503	10,741
Mining	**54,322**	4,754	4,900	5,051	5,206	5,366	5,531	5,656	5,783	5,914	6,047	6,184	6,325	6,469	6,617	6,768	6,923
Food, beverages and tobacco	**24,378**	2,135	2,200	2,267	2,336	2,407	2,481	2,537	2,594	2,653	2,713	2,775	2,838	2,902	2,968	3,036	3,105
Textile, clothing, footwear and leather	**3,375**	296	305	314	324	333	343	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,161**	1,593	1,641	1,690	1,741	1,794	1,848	1,890	1,932	1,975	2,019	2,065	2,111	2,159	2,209	2,259	2,310
Basic chemicals	**17,827**	1,564	1,611	1,659	1,709	1,761	1,814	1,855	1,896	1,939	1,982	2,027	2,073	2,119	2,167	2,217	2,267
Non-metallic mineral products	**8,058**	710	731	752	775	797	821	838	856	874	892	911	932	953	975	998	1,021
Basic iron and steel	**6,280**	552	568	585	603	621	639	653	668	682	697	712	729	745	762	780	797
Basic non-ferrous metals	**14,157**	1,238	1,276	1,315	1,356	1,398	1,441	1,474	1,507	1,542	1,577	1,613	1,650	1,688	1,727	1,767	1,808
Fabricated metal products	**8,429**	739	762	785	809	833	858	877	897	916	937	957	979	1,002	1,025	1,049	1,073
Machinery and equipment	**27,945**	2,447	2,522	2,599	2,679	2,761	2,846	2,909	2,974	3,040	3,108	3,178	3,251	3,326	3,403	3,482	3,563
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,939**	1,483	1,528	1,575	1,623	1,672	1,723	1,763	1,803	1,844	1,887	1,930	1,973	2,018	2,063	2,110	2,158
Construction	**39,181**	3,432	3,537	3,645	3,757	3,873	3,992	4,079	4,168	4,259	4,352	4,447	4,553	4,662	4,774	4,889	5,006
Road transport	**19,719**	1,726	1,779	1,834	1,890	1,948	2,007	2,053	2,099	2,146	2,195	2,245	2,296	2,348	2,402	2,457	2,513
Railway transport	**36,412**	3,202	3,297	3,396	3,497	3,602	3,710	3,791	3,874	3,959	4,046	4,135	4,223	4,314	4,407	4,503	4,600
Water transport	**3,833**	335	346	356	367	379	390	399	408	417	427	437	447	457	467	478	489
Air transport	**37,976**	3,320	3,423	3,528	3,637	3,749	3,865	3,953	4,044	4,136	4,231	4,328	4,427	4,528	4,632	4,738	4,847
Other transport, services and storage	**101,756**	8,900	9,171	9,450	9,738	10,036	10,343	10,585	10,833	11,087	11,346	11,611	11,873	12,142	12,417	12,699	12,987
Commercial services	**956,290**	83,622	86,196	88,850	91,587	94,409	97,319	99,543	101,819	104,147	106,529	108,966	111,467	114,025	116,644	119,323	122,064
Total	**1,662,601**	**145,626**	**150,085**	**154,683**	**159,427**	**164,319**	**169,365**	**173,075**	**176,870**	**180,752**	**184,723**	**188,783**	**193,265**	**197,854**	**202,555**	**207,370**	**212,301**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: PPP for Delay action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**69,871**	6,200	6,386	6,578	6,775	6,979	7,189	7,328	7,470	7,616	7,734	7,855	7,979	8,108	8,241	8,378	8,520
Petroleum sector	**2,733**	241	248	255	263	270	279	285	291	297	303	310	317	323	331	338	345
Gas sector	**9,147**	801	826	851	876	903	930	944	958	973	1,049	1,063	1,079	1,095	1,113	1,131	1,151
Renewable Electricity	**21,409**	1,369	1,463	1,561	1,663	1,771	1,883	1,925	1,969	2,013	2,044	2,614	3,205	3,817	4,451	5,108	5,789
Coal-fired Electricity	**75,901**	7,018	7,204	7,395	7,591	7,793	7,999	8,179	8,362	8,551	8,415	8,300	8,178	8,048	7,912	7,767	7,615
Internal-combustion Electricity	**274**	24	25	26	26	27	28	29	29	30	30	31	32	32	33	33	34
Gas-turbine Electricity	**2,038**	180	185	191	196	202	209	213	218	223	226	231	235	239	244	249	253
Combined-cycle Electricity	**2,831**	205	211	218	224	231	238	243	249	254	443	451	459	468	477	486	495
Agriculture, forestry and fishing	**84,418**	7,398	7,622	7,854	8,092	8,338	8,592	8,785	8,983	9,186	9,393	9,605	9,822	10,044	10,271	10,504	10,742
Mining	**54,360**	4,754	4,901	5,052	5,209	5,370	5,536	5,661	5,790	5,921	6,054	6,192	6,333	6,477	6,624	6,775	6,929
Food, beverages and tobacco	**24,379**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,653	2,714	2,775	2,838	2,902	2,968	3,036	3,105
Textile, clothing, footwear and leather	**3,376**	296	305	314	324	333	344	351	359	367	376	384	393	402	411	420	430
Wood, paper and printing products	**18,171**	1,593	1,641	1,691	1,742	1,795	1,850	1,891	1,933	1,977	2,021	2,067	2,113	2,161	2,210	2,261	2,312
Basic chemicals	**17,838**	1,564	1,611	1,660	1,711	1,763	1,816	1,857	1,898	1,940	1,984	2,028	2,074	2,121	2,169	2,218	2,268
Non-metallic mineral products	**8,079**	710	731	753	776	799	823	841	859	877	895	916	937	958	980	1,003	1,026
Basic iron and steel	**6,288**	552	568	586	603	622	640	654	669	684	699	714	730	747	764	781	799
Basic non-ferrous metals	**14,162**	1,238	1,276	1,316	1,356	1,398	1,442	1,474	1,508	1,543	1,578	1,614	1,651	1,689	1,728	1,768	1,809
Fabricated metal products	**8,442**	739	762	785	809	834	860	879	898	918	939	960	982	1,005	1,028	1,051	1,076
Machinery and equipment	**27,981**	2,447	2,523	2,601	2,681	2,764	2,850	2,914	2,979	3,046	3,114	3,185	3,259	3,334	3,411	3,490	3,570
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,947**	1,483	1,529	1,576	1,625	1,675	1,727	1,765	1,805	1,845	1,887	1,930	1,973	2,017	2,062	2,109	2,156
Construction	**39,268**	3,432	3,538	3,648	3,761	3,877	3,998	4,087	4,179	4,273	4,366	4,470	4,576	4,686	4,798	4,913	5,030
Road transport	**19,731**	1,726	1,780	1,834	1,891	1,949	2,009	2,054	2,101	2,148	2,197	2,247	2,298	2,350	2,404	2,459	2,515
Railway transport	**36,482**	3,202	3,300	3,401	3,505	3,613	3,723	3,804	3,887	3,973	4,058	4,144	4,231	4,321	4,413	4,507	4,603
Water transport	**3,834**	335	346	356	367	379	390	399	408	418	427	437	447	457	467	478	489
Air transport	**37,984**	3,320	3,423	3,529	3,638	3,751	3,867	3,955	4,045	4,137	4,232	4,329	4,428	4,529	4,632	4,738	4,847
Other transport, services and storage	**101,719**	8,900	9,174	9,457	9,749	10,050	10,360	10,590	10,828	11,072	11,330	11,586	11,847	12,114	12,388	12,669	12,956
Commercial services	**956,546**	83,622	86,208	88,875	91,624	94,458	97,380	99,592	101,860	104,181	106,557	108,996	111,493	114,048	116,662	119,338	122,075
Total	**1,665,845**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,408**	**177,304**	**181,294**	**185,247**	**189,618**	**194,098**	**198,688**	**203,391**	**208,210**	**213,146**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-4 Sectoral demand for investment: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**69,801**	6,200	6,386	6,578	6,775	6,979	7,189	7,322	7,459	7,601	7,716	7,835	7,960	8,087	8,218	8,354	8,495
Petroleum sector	**2,733**	241	248	255	263	270	279	285	291	297	303	310	316	323	330	338	345
Gas sector	**9,405**	801	826	851	876	903	930	944	958	973	1,049	1,128	1,209	1,228	1,247	1,268	1,290
Renewable Electricity	**19,210**	1,369	1,463	1,561	1,663	1,771	1,883	1,925	1,968	2,012	2,043	2,074	2,105	2,692	3,300	3,929	4,582
Coal-fired Electricity	**75,771**	7,018	7,204	7,395	7,591	7,793	7,999	8,178	8,361	8,548	8,410	8,266	8,114	7,984	7,847	7,702	7,550
Internal-combustion Electricity	**273**	24	25	26	26	27	28	29	29	30	30	31	31	32	32	33	34
Gas-turbine Electricity	**2,034**	180	185	191	196	202	209	213	218	223	226	230	233	237	242	246	251
Combined-cycle Electricity	**3,577**	205	211	218	224	231	238	243	249	254	442	636	836	851	867	884	900
Agriculture, forestry and fishing	**84,415**	7,398	7,622	7,854	8,092	8,338	8,592	8,785	8,983	9,185	9,392	9,604	9,821	10,043	10,270	10,502	10,740
Mining	**54,350**	4,754	4,901	5,052	5,209	5,370	5,536	5,661	5,789	5,921	6,053	6,189	6,329	6,472	6,620	6,770	6,924
Food, beverages and tobacco	**24,379**	2,135	2,200	2,267	2,336	2,408	2,481	2,537	2,595	2,653	2,713	2,775	2,838	2,902	2,968	3,035	3,104
Textile, clothing, footwear and leather	**3,375**	296	305	314	324	333	344	351	359	367	376	384	393	402	411	420	429
Wood, paper and printing products	**18,167**	1,593	1,641	1,691	1,742	1,795	1,850	1,891	1,933	1,976	2,020	2,066	2,112	2,159	2,208	2,258	2,310
Basic chemicals	**17,834**	1,564	1,611	1,660	1,711	1,763	1,816	1,857	1,898	1,940	1,983	2,027	2,073	2,119	2,167	2,216	2,266
Non-metallic mineral products	**8,070**	710	731	753	776	799	823	840	858	877	895	914	933	954	975	998	1,021
Basic iron and steel	**6,285**	552	568	586	603	622	640	654	669	683	698	713	729	745	762	780	797
Basic non-ferrous metals	**14,160**	1,238	1,276	1,316	1,356	1,398	1,442	1,474	1,508	1,543	1,578	1,614	1,650	1,688	1,727	1,767	1,808
Fabricated metal products	**8,436**	739	762	785	809	834	860	879	898	918	938	959	980	1,002	1,025	1,049	1,073
Machinery and equipment	**27,966**	2,447	2,523	2,601	2,681	2,764	2,850	2,913	2,979	3,045	3,113	3,182	3,252	3,327	3,404	3,482	3,563
Miscellenous manufacturing	**1,635**	143	147	152	156	161	166	170	174	178	182	187	191	195	200	205	209
Water, sewerage and drainage	**16,945**	1,483	1,529	1,576	1,625	1,675	1,727	1,765	1,804	1,844	1,886	1,929	1,973	2,017	2,062	2,108	2,156
Construction	**39,223**	3,432	3,538	3,648	3,761	3,877	3,998	4,087	4,178	4,272	4,364	4,459	4,555	4,664	4,775	4,889	5,006
Road transport	**19,727**	1,726	1,780	1,834	1,891	1,949	2,009	2,054	2,101	2,148	2,196	2,246	2,296	2,348	2,402	2,457	2,513
Railway transport	**36,474**	3,202	3,300	3,401	3,505	3,613	3,723	3,803	3,885	3,970	4,054	4,141	4,231	4,320	4,411	4,505	4,601
Water transport	**3,834**	335	346	356	367	379	390	399	408	418	427	437	447	457	467	478	489
Air transport	**37,982**	3,320	3,423	3,529	3,638	3,751	3,867	3,955	4,045	4,137	4,231	4,328	4,427	4,528	4,631	4,737	4,846
Other transport, services and storage	**101,735**	8,900	9,174	9,457	9,749	10,050	10,360	10,590	10,827	11,069	11,327	11,590	11,859	12,126	12,399	12,678	12,965
Commercial services	**956,456**	83,622	86,208	88,875	91,624	94,458	97,380	99,590	101,854	104,172	106,545	108,974	111,460	114,011	116,623	119,295	122,030
Total	**1,664,252**	**145,626**	**150,133**	**154,780**	**159,572**	**164,513**	**169,608**	**173,396**	**177,279**	**181,255**	**185,195**	**189,227**	**193,352**	**197,915**	**202,592**	**207,385**	**212,297**

Note: This Table shows the results obtained by the application of Equation 5-33, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: BC scenario ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**138,252**	12,166	12,519	12,884	13,259	13,645	14,043	14,359	14,682	15,013	15,352	15,698	16,052	16,414	16,784	17,163	17,551
Petroleum sector	**70,407**	6,161	6,350	6,544	6,745	6,951	7,164	7,328	7,495	7,666	7,841	8,020	8,203	8,390	8,581	8,777	8,978
Gas sector	**28,078**	2,462	2,536	2,612	2,691	2,771	2,855	2,920	2,986	3,054	3,123	3,194	3,267	3,341	3,417	3,495	3,575
Renewable Electricity	**23,513**	1,833	1,958	2,089	2,227	2,370	2,521	2,579	2,638	2,698	2,760	2,823	2,888	2,954	3,021	3,090	3,161
Coal-fired Electricity	**206,181**	18,280	18,765	19,264	19,775	20,299	20,838	21,314	21,802	22,301	22,812	23,334	23,869	24,415	24,974	25,546	26,132
Internal-combustion Electricity	**606**	53	55	56	58	60	62	63	64	66	67	69	71	72	74	76	77
Gas-turbine Electricity	**4,164**	365	376	387	399	411	423	433	443	453	464	474	485	496	508	519	531
Combined-cycle Electricity	**8,860**	776	799	824	849	874	901	922	943	964	986	1,009	1,032	1,056	1,080	1,105	1,130
Agriculture, forestry and fishing	**239,326**	20,956	21,595	22,254	22,933	23,634	24,356	24,908	25,473	26,050	26,642	27,246	27,865	28,498	29,145	29,808	30,485
Mining	**129,970**	11,369	11,718	12,078	12,449	12,832	13,226	13,528	13,837	14,154	14,477	14,808	15,146	15,492	15,846	16,209	16,579
Food, beverages and tobacco	**204,536**	17,894	18,444	19,010	19,593	20,195	20,815	21,290	21,775	22,272	22,780	23,300	23,831	24,375	24,931	25,501	26,083
Textile, clothing, footwear and leather	**75,387**	6,600	6,801	7,009	7,223	7,444	7,672	7,846	8,024	8,207	8,393	8,584	8,779	8,979	9,183	9,392	9,606
Wood, paper and printing products	**320,225**	28,008	28,870	29,758	30,673	31,617	32,590	33,334	34,095	34,873	35,670	36,484	37,318	38,170	39,042	39,934	40,847
Basic chemicals	**321,048**	28,100	28,960	29,846	30,760	31,702	32,673	33,416	34,175	34,952	35,747	36,560	37,392	38,243	39,114	40,005	40,916
Non-metallic mineral products	**135,846**	11,882	12,248	12,625	13,014	13,414	13,828	14,143	14,465	14,794	15,131	15,476	15,829	16,189	16,558	16,936	17,322
Basic iron and steel	**135,090**	11,821	12,184	12,557	12,942	13,340	13,749	14,062	14,381	14,709	15,043	15,386	15,736	16,094	16,461	16,836	17,220
Basic non-ferrous metals	**58,777**	5,140	5,298	5,461	5,630	5,803	5,982	6,119	6,258	6,402	6,548	6,698	6,851	7,007	7,168	7,332	7,499
Fabricated metal products	**181,641**	15,883	16,373	16,877	17,398	17,934	18,487	18,910	19,341	19,783	20,235	20,698	21,171	21,655	22,150	22,656	23,174
Machinery and equipment	**464,159**	40,575	41,828	43,119	44,451	45,824	47,239	48,321	49,428	50,560	51,718	52,903	54,115	55,355	56,623	57,921	59,248
Miscellenous manufacturing	**13,716**	1,199	1,236	1,274	1,314	1,354	1,396	1,428	1,461	1,494	1,528	1,563	1,599	1,636	1,673	1,712	1,751
Water, sewerage and drainage	**31,950**	2,795	2,881	2,969	3,060	3,154	3,251	3,325	3,401	3,479	3,559	3,640	3,723	3,808	3,895	3,985	4,076
Construction	**63,823**	5,580	5,752	5,929	6,112	6,301	6,495	6,644	6,796	6,952	7,111	7,274	7,441	7,611	7,786	7,964	8,147
Road transport	**133,066**	11,645	12,001	12,369	12,748	13,139	13,542	13,850	14,165	14,488	14,818	15,155	15,501	15,854	16,215	16,585	16,963
Railway transport	**38,024**	3,331	3,432	3,536	3,643	3,754	3,868	3,956	4,046	4,138	4,232	4,328	4,427	4,528	4,631	4,737	4,845
Water transport	**18,860**	1,650	1,701	1,753	1,807	1,862	1,919	1,963	2,008	2,054	2,101	2,149	2,198	2,248	2,299	2,352	2,405
Air transport	**74,944**	6,552	6,754	6,962	7,177	7,399	7,627	7,802	7,980	8,163	8,350	8,541	8,737	8,937	9,142	9,352	9,566
Other transport, services and storage	**475,272**	41,561	42,841	44,160	45,519	46,921	48,367	49,473	50,604	51,762	52,946	54,158	55,397	56,665	57,962	59,289	60,646
Commercial services	**2,671,564**	233,556	240,762	248,192	255,852	263,749	271,892	278,116	284,484	290,998	297,662	304,479	311,453	318,587	325,886	333,352	340,990
Total	**6,267,285**	**548,194**	**565,036**	**582,399**	**600,299**	**618,754**	**637,781**	**652,349**	**667,252**	**682,498**	**698,095**	**714,051**	**730,373**	**747,071**	**764,153**	**781,627**	**799,504**

Note: This Table shows the results obtained by multiplying fixed technical coefficient matrix (Table C-3, Appendix C) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: PPP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**130,990**	12,166	12,392	12,628	12,875	13,131	13,397	13,584	13,777	13,975	14,180	14,390	14,605	14,697	14,793	14,893	14,996
Petroleum sector	**69,054**	6,161	6,326	6,497	6,673	6,854	7,041	7,179	7,320	7,465	7,612	7,763	7,918	8,070	8,225	8,384	8,547
Gas sector	**27,380**	2,462	2,507	2,554	2,605	2,658	2,715	2,754	2,795	2,838	2,882	2,927	2,974	3,250	3,528	3,808	4,090
Renewable Electricity	**23,006**	1,833	1,951	2,075	2,205	2,340	2,480	2,529	2,579	2,631	2,683	2,737	2,791	2,828	2,865	2,903	2,941
Coal-fired Electricity	**199,616**	18,280	18,702	19,135	19,579	20,035	20,502	20,908	21,322	21,746	22,179	22,621	23,074	22,653	22,219	21,772	21,309
Internal-combustion Electricity	**594**	53	54	56	57	59	61	62	63	64	66	67	68	69	70	71	72
Gas-turbine Electricity	**4,079**	365	374	385	395	406	417	425	433	442	451	460	469	475	481	488	494
Combined-cycle Electricity	**11,018**	776	797	818	840	863	887	904	922	940	959	978	998	1,732	2,486	3,260	4,054
Agriculture, forestry and fishing	**236,195**	20,956	21,544	22,149	22,773	23,415	24,076	24,567	25,069	25,582	26,106	26,641	27,188	27,747	28,318	28,901	29,497
Mining	**127,474**	11,369	11,675	11,991	12,317	12,653	13,000	13,255	13,515	13,782	14,055	14,333	14,618	14,900	15,189	15,484	15,785
Food, beverages and tobacco	**202,229**	17,894	18,405	18,931	19,474	20,032	20,608	21,038	21,477	21,926	22,385	22,854	23,334	23,824	24,324	24,836	25,359
Textile, clothing, footwear and leather	**74,401**	6,600	6,784	6,975	7,172	7,374	7,583	7,738	7,897	8,059	8,225	8,394	8,567	8,744	8,925	9,110	9,299
Wood, paper and printing products	**316,520**	28,008	28,805	29,628	30,476	31,351	32,253	32,926	33,615	34,319	35,040	35,776	36,529	37,293	38,073	38,871	39,686
Basic chemicals	**316,163**	28,100	28,873	29,672	30,496	31,347	32,224	32,873	33,538	34,219	34,915	35,626	36,354	37,093	37,850	38,623	39,413
Non-metallic mineral products	**133,798**	11,882	12,212	12,553	12,904	13,267	13,642	13,919	14,203	14,493	14,789	15,093	15,404	15,706	16,015	16,331	16,654
Basic iron and steel	**133,034**	11,821	12,148	12,485	12,833	13,191	13,562	13,836	14,116	14,403	14,696	14,996	15,303	15,609	15,921	16,241	16,568
Basic non-ferrous metals	**57,915**	5,140	5,283	5,432	5,584	5,742	5,904	6,024	6,147	6,273	6,402	6,533	6,667	6,802	6,941	7,082	7,227
Fabricated metal products	**178,889**	15,883	16,324	16,779	17,249	17,735	18,235	18,606	18,986	19,374	19,771	20,178	20,593	21,007	21,430	21,862	22,305
Machinery and equipment	**457,360**	40,575	41,709	42,880	44,088	45,335	46,620	47,574	48,550	49,548	50,569	51,613	52,680	53,748	54,839	55,955	57,096
Miscellenous manufacturing	**13,568**	1,199	1,233	1,269	1,306	1,343	1,382	1,412	1,441	1,472	1,503	1,535	1,568	1,601	1,635	1,669	1,705
Water, sewerage and drainage	**31,483**	2,795	2,872	2,951	3,034	3,119	3,207	3,272	3,339	3,408	3,478	3,550	3,624	3,700	3,779	3,860	3,942
Construction	**62,865**	5,580	5,735	5,895	6,061	6,231	6,408	6,538	6,672	6,809	6,949	7,092	7,238	7,385	7,535	7,689	7,846
Road transport	**131,235**	11,645	11,970	12,305	12,651	13,008	13,376	13,649	13,929	14,214	14,507	14,805	15,111	15,420	15,736	16,058	16,389
Railway transport	**36,721**	3,331	3,407	3,486	3,569	3,655	3,744	3,808	3,874	3,942	4,012	4,084	4,157	4,228	4,300	4,374	4,450
Water transport	**18,477**	1,650	1,694	1,739	1,786	1,834	1,884	1,921	1,958	1,996	2,035	2,075	2,116	2,157	2,200	2,243	2,287
Air transport	**74,078**	6,552	6,739	6,931	7,130	7,336	7,547	7,705	7,867	8,032	8,202	8,375	8,552	8,733	8,919	9,109	9,303
Other transport, services and storage	**469,078**	41,561	42,725	43,927	45,169	46,451	47,774	48,760	49,769	50,801	51,858	52,939	54,044	55,230	56,442	57,681	58,947
Commercial services	**2,639,283**	233,556	240,178	247,020	254,085	261,376	268,897	274,511	280,258	286,138	292,154	298,307	304,601	311,027	317,598	324,316	331,183
Total	6,176,503	**548,194**	**563,419**	**579,148**	**595,386**	**612,143**	**629,427**	**642,278**	**655,432**	**668,891**	**682,660**	**696,744**	**711,146**	**725,730**	**740,637**	**755,873**	**771,443**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: SRP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**124,886**	12,166	12,282	12,414	12,559	12,716	12,883	12,976	13,075	13,073	13,079	13,093	13,114	13,143	13,178	13,220	13,255
Petroleum sector	**67,602**	6,161	6,299	6,443	6,593	6,747	6,907	7,018	7,132	7,244	7,360	7,479	7,601	7,727	7,856	7,989	8,127
Gas sector	**29,216**	2,462	2,492	2,527	2,568	2,612	2,660	2,692	2,725	2,999	3,277	3,561	3,851	4,147	4,448	4,756	4,813
Renewable Electricity	**22,491**	1,833	1,943	2,057	2,176	2,300	2,429	2,467	2,507	2,530	2,553	2,577	2,601	2,626	2,652	2,678	3,406
Coal-fired Electricity	**187,423**	18,280	18,618	18,967	19,327	19,697	20,078	20,396	20,723	20,265	19,800	19,327	18,846	18,356	17,857	17,349	16,888
Internal-combustion Electricity	**576**	53	54	55	57	58	59	60	61	62	62	63	64	64	65	65	66
Gas-turbine Electricity	**3,957**	365	373	381	390	399	408	415	421	425	429	433	437	441	445	450	456
Combined-cycle Electricity	**16,785**	776	793	811	829	849	868	882	896	1,550	2,216	2,894	3,585	4,290	5,008	5,740	5,817
Agriculture, forestry and fishing	**231,216**	20,956	21,457	21,974	22,505	23,052	23,616	24,010	24,414	24,825	25,247	25,679	26,122	26,575	27,038	27,513	28,000
Mining	**124,709**	11,369	11,624	11,890	12,165	12,450	12,744	12,948	13,156	13,363	13,575	13,794	14,018	14,248	14,484	14,725	14,979
Food, beverages and tobacco	**198,965**	17,894	18,348	18,815	19,297	19,794	20,306	20,672	21,047	21,430	21,823	22,224	22,636	23,057	23,488	23,928	24,380
Textile, clothing, footwear and leather	**72,942**	6,600	6,758	6,923	7,092	7,267	7,447	7,574	7,704	7,837	7,973	8,113	8,256	8,403	8,553	8,706	8,864
Wood, paper and printing products	**312,056**	28,008	28,724	29,465	30,231	31,022	31,838	32,427	33,030	33,642	34,269	34,912	35,570	36,244	36,933	37,639	38,375
Basic chemicals	**310,200**	28,100	28,762	29,450	30,163	30,900	31,662	32,198	32,748	33,310	33,887	34,479	35,086	35,708	36,345	36,998	37,674
Non-metallic mineral products	**131,410**	11,882	12,169	12,466	12,775	13,095	13,426	13,660	13,900	14,133	14,373	14,619	14,871	15,130	15,395	15,666	15,973
Basic iron and steel	**130,552**	11,821	12,102	12,394	12,696	13,009	13,332	13,560	13,794	14,027	14,266	14,512	14,764	15,022	15,286	15,557	15,848
Basic non-ferrous metals	**56,879**	5,140	5,265	5,394	5,528	5,666	5,809	5,909	6,012	6,116	6,222	6,332	6,443	6,558	6,675	6,795	6,921
Fabricated metal products	**175,655**	15,883	16,264	16,660	17,071	17,496	17,936	18,247	18,566	18,884	19,211	19,546	19,890	20,243	20,604	20,974	21,373
Machinery and equipment	**449,117**	40,575	41,558	42,579	43,636	44,728	45,857	46,657	47,477	48,298	49,141	50,006	50,893	51,802	52,733	53,687	54,697
Miscellenous manufacturing	**13,399**	1,199	1,230	1,263	1,296	1,331	1,367	1,393	1,419	1,446	1,474	1,502	1,531	1,561	1,591	1,623	1,655
Water, sewerage and drainage	**30,961**	2,795	2,861	2,931	3,003	3,078	3,155	3,211	3,267	3,328	3,389	3,453	3,517	3,584	3,652	3,722	3,790
Construction	**61,821**	5,580	5,716	5,857	6,003	6,154	6,310	6,421	6,535	6,650	6,768	6,889	7,013	7,141	7,271	7,405	7,543
Road transport	**128,862**	11,645	11,927	12,219	12,521	12,833	13,155	13,384	13,617	13,854	14,097	14,346	14,601	14,862	15,130	15,404	15,688
Railway transport	**35,490**	3,331	3,381	3,436	3,495	3,558	3,625	3,667	3,711	3,754	3,800	3,847	3,897	3,948	4,001	4,056	4,107
Water transport	**18,058**	1,650	1,686	1,724	1,763	1,803	1,845	1,873	1,902	1,932	1,963	1,994	2,027	2,060	2,094	2,130	2,165
Air transport	**73,103**	6,552	6,720	6,895	7,075	7,262	7,454	7,594	7,737	7,884	8,034	8,189	8,347	8,509	8,674	8,844	9,016
Other transport, services and storage	**462,267**	41,561	42,586	43,653	44,759	45,903	47,086	47,934	48,804	49,747	50,713	51,702	52,715	53,751	54,810	55,894	56,948
Commercial services	**2,604,152**	233,556	239,508	245,690	252,095	258,718	265,559	270,507	275,577	280,782	286,118	291,586	297,186	302,920	308,790	314,797	320,985
Total	**6,074,750**	**548,194**	**561,502**	**575,333**	**589,669**	**604,499**	**619,820**	**630,752**	**641,958**	**653,389**	**665,120**	**677,150**	**689,482**	**702,117**	**715,058**	**728,308**	**741,809**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**124,102**	12,166	12,264	12,386	12,525	12,679	12,845	12,938	12,925	12,919	12,914	12,918	12,929	12,948	12,974	13,006	13,045
Petroleum sector	**67,867**	6,161	6,303	6,451	6,605	6,765	6,931	7,047	7,162	7,280	7,403	7,529	7,660	7,794	7,931	8,073	8,218
Gas sector	**26,861**	2,462	2,477	2,501	2,533	2,569	2,610	2,634	2,857	3,075	3,091	3,109	3,130	3,154	3,180	3,208	3,239
Renewable Electricity	**29,097**	1,833	1,945	2,062	2,183	2,310	2,442	2,484	2,509	2,534	3,224	3,933	4,661	5,410	6,179	6,970	7,783
Coal-fired Electricity	**186,147**	18,280	18,638	19,009	19,391	19,785	20,189	20,532	20,098	19,656	19,267	18,867	18,454	18,029	17,591	17,140	16,673
Internal-combustion Electricity	**580**	53	54	56	57	58	60	61	61	62	63	64	65	65	66	67	68
Gas-turbine Electricity	**3,985**	365	373	382	391	401	410	417	421	426	432	437	444	450	456	463	469
Combined-cycle Electricity	**13,017**	776	794	813	832	852	873	888	1,537	2,199	2,229	2,260	2,291	2,323	2,356	2,390	2,424
Agriculture, forestry and fishing	**233,281**	20,956	21,493	22,046	22,616	23,202	23,806	24,240	24,683	25,136	25,601	26,076	26,564	27,063	27,573	28,096	28,631
Mining	**125,282**	11,369	11,632	11,907	12,193	12,489	12,795	13,009	13,221	13,439	13,668	13,904	14,146	14,394	14,648	14,909	15,176
Food, beverages and tobacco	**200,111**	17,894	18,367	18,855	19,358	19,877	20,411	20,800	21,197	21,603	22,019	22,445	22,882	23,328	23,786	24,254	24,732
Textile, clothing, footwear and leather	**73,515**	6,600	6,768	6,942	7,122	7,308	7,499	7,637	7,779	7,923	8,071	8,223	8,379	8,539	8,702	8,870	9,041
Wood, paper and printing products	**313,340**	28,008	28,741	29,503	30,291	31,106	31,946	32,559	33,180	33,815	34,480	35,161	35,859	36,573	37,304	38,053	38,819
Basic chemicals	**312,016**	28,100	28,787	29,505	30,251	31,023	31,822	32,395	32,977	33,574	34,195	34,832	35,485	36,155	36,842	37,546	38,267
Non-metallic mineral products	**132,213**	11,882	12,176	12,483	12,804	13,136	13,479	13,725	13,964	14,209	14,488	14,775	15,069	15,371	15,680	15,996	16,321
Basic iron and steel	**131,328**	11,821	12,112	12,415	12,730	13,057	13,394	13,636	13,877	14,123	14,389	14,662	14,942	15,229	15,523	15,825	16,133
Basic non-ferrous metals	**57,159**	5,140	5,269	5,403	5,541	5,685	5,832	5,938	6,044	6,153	6,268	6,386	6,506	6,629	6,756	6,885	7,017
Fabricated metal products	**176,655**	15,883	16,275	16,685	17,113	17,555	18,013	18,342	18,669	19,004	19,368	19,741	20,124	20,516	20,918	21,330	21,752
Machinery and equipment	**451,614**	40,575	41,590	42,650	43,750	44,888	46,064	46,911	47,756	48,622	49,544	50,490	51,459	52,453	53,471	54,514	55,583
Miscellenous manufacturing	**13,439**	1,199	1,231	1,264	1,298	1,334	1,370	1,397	1,424	1,452	1,481	1,510	1,540	1,571	1,603	1,635	1,669
Water, sewerage and drainage	**31,088**	2,795	2,863	2,935	3,010	3,088	3,169	3,228	3,289	3,352	3,414	3,478	3,543	3,609	3,678	3,748	3,819
Construction	**62,031**	5,580	5,718	5,863	6,013	6,168	6,329	6,445	6,561	6,680	6,803	6,930	7,060	7,193	7,329	7,469	7,612
Road transport	**129,627**	11,645	11,938	12,244	12,560	12,886	13,223	13,466	13,712	13,964	14,225	14,493	14,768	15,050	15,338	15,634	15,937
Railway transport	**35,641**	3,331	3,382	3,440	3,504	3,572	3,644	3,692	3,738	3,785	3,830	3,877	3,925	3,976	4,028	4,083	4,139
Water transport	**18,145**	1,650	1,687	1,726	1,767	1,809	1,852	1,882	1,913	1,945	1,978	2,011	2,046	2,081	2,118	2,156	2,194
Air transport	**73,325**	6,552	6,723	6,902	7,087	7,278	7,475	7,620	7,768	7,919	8,074	8,232	8,394	8,560	8,730	8,904	9,082
Other transport, services and storage	**463,818**	41,561	42,609	43,707	44,849	46,032	47,256	48,145	49,104	50,084	51,036	52,011	53,012	54,036	55,086	56,161	57,263
Commercial services	**2,612,347**	233,556	239,595	245,905	252,463	259,253	266,268	271,389	276,622	281,976	287,519	293,198	299,016	304,974	311,074	317,319	323,712
Total	6,097,630	**548,194**	**561,803**	**576,037**	**590,836**	**606,165**	**622,009**	**633,458**	**645,049**	**656,909**	**669,072**	**681,553**	**694,352**	**707,474**	**720,923**	**734,703**	**748,819**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**115,347**	12,166	12,045	11,978	11,945	11,935	11,858	11,715	11,591	11,484	11,383	11,298	11,229	11,173	11,130	11,099	11,078
Petroleum sector	**65,373**	6,161	6,249	6,347	6,453	6,564	6,678	6,745	6,817	6,893	6,974	7,059	7,149	7,243	7,341	7,443	7,549
Gas sector	**28,238**	2,462	2,447	2,455	2,473	2,498	2,719	2,951	3,186	3,424	3,441	3,461	3,484	3,509	3,538	3,569	3,602
Renewable Electricity	**27,335**	1,833	1,927	2,026	2,129	2,235	2,331	2,337	2,344	2,352	2,973	3,604	4,246	4,900	5,567	6,248	6,942
Coal-fired Electricity	**172,734**	18,280	18,471	18,681	18,906	19,142	18,747	18,200	17,654	17,111	16,627	16,143	15,658	15,169	14,677	14,180	13,677
Internal-combustion Electricity	**553**	53	54	55	56	56	57	57	57	57	58	58	59	59	60	60	61
Gas-turbine Electricity	**3,796**	365	370	375	381	388	392	393	394	395	398	401	404	407	411	415	419
Combined-cycle Electricity	**17,395**	776	787	799	811	825	1,356	1,956	2,560	3,168	3,190	3,214	3,240	3,267	3,295	3,325	3,356
Agriculture, forestry and fishing	**224,130**	20,956	21,319	21,699	22,093	22,501	22,924	23,183	23,453	23,732	24,022	24,325	24,639	24,965	25,303	25,652	26,014
Mining	**120,456**	11,369	11,530	11,710	11,903	12,106	12,313	12,433	12,560	12,693	12,838	12,990	13,149	13,316	13,489	13,669	13,856
Food, beverages and tobacco	**194,114**	17,894	18,252	18,626	19,015	19,417	19,833	20,108	20,391	20,684	20,986	21,298	21,621	21,954	22,297	22,651	23,015
Textile, clothing, footwear and leather	**70,850**	6,600	6,716	6,839	6,968	7,102	7,241	7,329	7,420	7,515	7,613	7,715	7,821	7,931	8,044	8,162	8,283
Wood, paper and printing products	**305,280**	28,008	28,579	29,186	29,822	30,482	31,162	31,620	32,093	32,581	33,096	33,627	34,176	34,741	35,323	35,922	36,538
Basic chemicals	**301,328**	28,100	28,565	29,074	29,615	30,182	30,771	31,144	31,533	31,937	32,363	32,806	33,267	33,744	34,239	34,751	35,280
Non-metallic mineral products	**128,052**	11,882	12,089	12,317	12,559	12,813	13,068	13,228	13,395	13,568	13,774	13,986	14,207	14,435	14,670	14,913	15,164
Basic iron and steel	**126,936**	11,821	12,021	12,239	12,471	12,714	12,962	13,117	13,279	13,448	13,635	13,829	14,031	14,240	14,456	14,680	14,910
Basic non-ferrous metals	**55,289**	5,140	5,232	5,330	5,433	5,540	5,650	5,720	5,792	5,866	5,946	6,029	6,115	6,204	6,296	6,390	6,488
Fabricated metal products	**170,952**	15,883	16,155	16,455	16,774	17,109	17,450	17,667	17,893	18,128	18,389	18,661	18,942	19,233	19,535	19,846	20,167
Machinery and equipment	**437,029**	40,575	41,288	42,064	42,886	43,746	44,626	45,187	45,772	46,379	47,038	47,723	48,433	49,169	49,930	50,716	51,527
Miscellenous manufacturing	**13,133**	1,199	1,225	1,252	1,280	1,310	1,340	1,361	1,383	1,405	1,428	1,452	1,476	1,501	1,527	1,554	1,581
Water, sewerage and drainage	**30,141**	2,795	2,842	2,895	2,952	3,012	3,076	3,118	3,163	3,208	3,253	3,299	3,347	3,397	3,448	3,501	3,556
Construction	**60,202**	5,580	5,679	5,788	5,903	6,023	6,147	6,227	6,311	6,398	6,489	6,584	6,682	6,784	6,889	6,998	7,110
Road transport	**125,362**	11,645	11,853	12,075	12,310	12,554	12,806	12,967	13,135	13,308	13,491	13,682	13,879	14,083	14,295	14,513	14,739
Railway transport	**33,635**	3,331	3,330	3,345	3,369	3,399	3,432	3,442	3,456	3,473	3,488	3,506	3,527	3,551	3,577	3,606	3,637
Water transport	**17,406**	1,650	1,672	1,696	1,722	1,749	1,778	1,795	1,812	1,831	1,851	1,872	1,894	1,917	1,941	1,966	1,993
Air transport	**71,557**	6,552	6,687	6,831	6,982	7,139	7,303	7,415	7,530	7,649	7,771	7,897	8,026	8,160	8,297	8,439	8,584
Other transport, services and storage	**451,135**	41,561	42,332	43,176	44,071	45,006	46,020	46,713	47,429	48,165	48,878	49,616	50,380	51,170	51,985	52,825	53,692
Commercial services	**2,548,992**	233,556	238,254	243,337	248,693	254,276	260,077	264,033	268,117	272,326	276,694	281,204	285,854	290,645	295,578	300,652	305,869
Total	**5,916,750**	**548,194**	**557,970**	**568,651**	**579,973**	**591,824**	**604,115**	**612,162**	**620,521**	**629,180**	**638,086**	**647,339**	**656,934**	**666,868**	**677,138**	**687,744**	**698,685**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: PPP for Early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**121,331**	12,166	12,200	12,268	12,359	12,468	12,591	12,533	12,485	12,441	12,409	12,387	12,374	12,370	12,374	12,386	12,405
Petroleum sector	**67,324**	6,161	6,291	6,428	6,572	6,722	6,878	6,980	7,085	7,195	7,309	7,427	7,549	7,674	7,803	7,936	8,073
Gas sector	**26,531**	2,462	2,462	2,477	2,501	2,530	2,564	2,771	2,970	2,976	2,986	2,999	3,014	3,033	3,054	3,077	3,103
Renewable Electricity	**30,780**	1,833	1,941	2,055	2,173	2,296	2,424	2,445	2,466	3,133	3,816	4,517	5,236	5,973	6,729	7,505	8,302
Coal-fired Electricity	**181,626**	18,280	18,605	18,946	19,299	19,662	20,036	19,584	19,125	18,720	18,307	17,883	17,449	17,004	16,547	16,078	15,595
Internal-combustion Electricity	**574**	53	54	55	57	58	59	60	60	61	62	63	63	64	65	66	67
Gas-turbine Electricity	**3,944**	365	373	381	389	398	407	411	414	419	424	430	435	441	447	452	459
Combined-cycle Electricity	**13,551**	776	793	810	828	847	866	1,498	2,140	2,166	2,193	2,220	2,249	2,277	2,307	2,338	2,369
Agriculture, forestry and fishing	**231,854**	20,956	21,467	21,994	22,537	23,096	23,672	24,077	24,492	24,918	25,355	25,803	26,261	26,731	27,213	27,706	28,211
Mining	**124,250**	11,369	11,610	11,865	12,132	12,409	12,695	12,883	13,077	13,282	13,493	13,710	13,933	14,162	14,398	14,640	14,888
Food, beverages and tobacco	**199,076**	17,894	18,347	18,816	19,300	19,799	20,313	20,682	21,058	21,445	21,841	22,247	22,663	23,088	23,524	23,970	24,427
Textile, clothing, footwear and leather	**73,085**	6,600	6,759	6,925	7,097	7,275	7,458	7,588	7,721	7,858	7,998	8,142	8,289	8,440	8,595	8,753	8,916
Wood, paper and printing products	**311,797**	28,008	28,708	29,441	30,201	30,987	31,798	32,375	32,966	33,586	34,222	34,873	35,540	36,224	36,924	37,641	38,374
Basic chemicals	**310,041**	28,100	28,743	29,422	30,132	30,868	31,629	32,161	32,707	33,276	33,861	34,463	35,080	35,713	36,362	37,028	37,710
Non-metallic mineral products	**131,443**	11,882	12,158	12,450	12,755	13,073	13,401	13,620	13,844	14,102	14,367	14,640	14,919	15,205	15,499	15,800	16,109
Basic iron and steel	**130,509**	11,821	12,093	12,381	12,681	12,992	13,314	13,533	13,759	14,003	14,254	14,512	14,777	15,048	15,326	15,611	15,904
Basic non-ferrous metals	**56,791**	5,140	5,261	5,388	5,520	5,657	5,797	5,894	5,993	6,098	6,206	6,317	6,430	6,546	6,664	6,786	6,911
Fabricated metal products	**175,584**	15,883	16,250	16,639	17,047	17,470	17,907	18,206	18,513	18,848	19,192	19,546	19,909	20,280	20,662	21,053	21,454
Machinery and equipment	**448,870**	40,575	41,530	42,536	43,585	44,673	45,797	46,571	47,366	48,215	49,087	49,982	50,900	51,842	52,807	53,797	54,812
Miscellenous manufacturing	**13,377**	1,199	1,230	1,261	1,295	1,329	1,364	1,389	1,415	1,442	1,470	1,498	1,527	1,557	1,587	1,619	1,650
Water, sewerage and drainage	**30,902**	2,795	2,859	2,927	2,999	3,074	3,151	3,208	3,266	3,323	3,382	3,442	3,504	3,567	3,632	3,699	3,767
Construction	**61,639**	5,580	5,710	5,847	5,990	6,138	6,291	6,397	6,506	6,620	6,736	6,856	6,979	7,105	7,234	7,366	7,502
Road transport	**128,855**	11,645	11,922	12,213	12,515	12,827	13,149	13,375	13,606	13,847	14,094	14,348	14,608	14,875	15,149	15,429	15,716
Railway transport	**35,173**	3,331	3,369	3,418	3,473	3,534	3,599	3,635	3,673	3,710	3,748	3,788	3,831	3,875	3,921	3,969	4,019
Water transport	**17,991**	1,650	1,684	1,720	1,757	1,796	1,837	1,864	1,892	1,921	1,951	1,982	2,014	2,047	2,082	2,117	2,153
Air transport	**72,964**	6,552	6,716	6,887	7,066	7,250	7,441	7,579	7,720	7,864	8,012	8,164	8,319	8,478	8,641	8,808	8,978
Other transport, services and storage	**461,299**	41,561	42,550	43,599	44,695	45,832	47,010	47,899	48,809	49,691	50,596	51,525	52,478	53,455	54,456	55,482	56,533
Commercial services	**2,599,423**	233,556	239,298	245,359	251,683	258,240	265,017	269,889	274,877	280,048	285,351	290,787	296,357	302,063	307,906	313,890	320,017
Total	6,060,582	**548,194**	**560,981**	**574,507**	**588,636**	**603,300**	**618,466**	**629,107**	**640,007**	**651,210**	**662,724**	**674,549**	**686,686**	**699,138**	**711,909**	**725,002**	**738,422**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: SRP for early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**119,585**	12,166	12,165	12,195	12,246	12,315	12,398	12,307	12,230	12,165	12,110	12,066	12,026	11,998	11,980	11,971	11,972
Petroleum sector	**66,449**	6,161	6,275	6,396	6,523	6,656	6,794	6,879	6,969	7,062	7,158	7,258	7,363	7,472	7,584	7,701	7,822
Gas sector	**27,690**	2,462	2,458	2,467	2,484	2,507	2,535	2,737	2,934	3,127	3,316	3,501	3,505	3,513	3,525	3,541	3,560
Renewable Electricity	**24,946**	1,833	1,935	2,042	2,152	2,267	2,387	2,400	2,414	2,429	2,444	2,460	3,119	3,793	4,482	5,186	5,908
Coal-fired Electricity	**178,470**	18,280	18,545	18,824	19,115	19,417	19,730	19,228	18,725	18,219	17,709	17,196	16,737	16,272	15,800	15,320	14,831
Internal-combustion Electricity	**563**	53	54	55	56	57	58	59	59	59	60	60	61	61	62	63	63
Gas-turbine Electricity	**3,869**	365	371	378	386	393	401	403	406	408	411	413	417	422	426	431	436
Combined-cycle Electricity	**18,228**	776	790	805	820	836	853	1,471	2,095	2,728	3,369	4,019	4,060	4,102	4,146	4,192	4,240
Agriculture, forestry and fishing	**227,651**	20,956	21,390	21,839	22,302	22,780	23,273	23,598	23,933	24,277	24,631	24,995	25,369	25,756	26,154	26,565	26,987
Mining	**122,520**	11,369	11,578	11,801	12,034	12,278	12,530	12,686	12,849	13,017	13,191	13,370	13,562	13,761	13,966	14,178	14,397
Food, beverages and tobacco	**196,517**	17,894	18,301	18,722	19,158	19,607	20,071	20,390	20,718	21,055	21,400	21,754	22,119	22,494	22,880	23,276	23,682
Textile, clothing, footwear and leather	**71,880**	6,600	6,737	6,881	7,030	7,185	7,344	7,451	7,561	7,674	7,790	7,909	8,033	8,160	8,291	8,426	8,565
Wood, paper and printing products	**308,577**	28,008	28,653	29,326	30,027	30,751	31,501	32,019	32,551	33,098	33,658	34,233	34,839	35,461	36,100	36,756	37,430
Basic chemicals	**305,620**	28,100	28,665	29,263	29,888	30,539	31,213	31,661	32,125	32,603	33,095	33,601	34,131	34,678	35,242	35,823	36,422
Non-metallic mineral products	**129,644**	11,882	12,129	12,392	12,666	12,953	13,249	13,438	13,633	13,834	14,041	14,254	14,501	14,755	15,018	15,287	15,565
Basic iron and steel	**128,677**	11,821	12,062	12,317	12,583	12,860	13,148	13,334	13,527	13,726	13,931	14,141	14,371	14,609	14,854	15,106	15,365
Basic non-ferrous metals	**56,067**	5,140	5,249	5,363	5,481	5,603	5,730	5,814	5,900	5,988	6,080	6,173	6,272	6,375	6,480	6,588	6,700
Fabricated metal products	**173,201**	15,883	16,210	16,558	16,921	17,300	17,693	17,950	18,215	18,489	18,770	19,059	19,377	19,705	20,044	20,392	20,750
Machinery and equipment	**442,870**	40,575	41,426	42,323	43,260	44,235	45,244	45,909	46,596	47,304	48,033	48,782	49,588	50,418	51,274	52,154	53,060
Miscellenous manufacturing	**13,262**	1,199	1,228	1,257	1,288	1,320	1,354	1,377	1,401	1,425	1,450	1,476	1,503	1,530	1,558	1,587	1,617
Water, sewerage and drainage	**30,532**	2,795	2,852	2,913	2,977	3,044	3,114	3,163	3,214	3,266	3,319	3,374	3,428	3,484	3,542	3,601	3,662
Construction	**60,986**	5,580	5,698	5,822	5,953	6,088	6,228	6,322	6,420	6,520	6,623	6,729	6,840	6,954	7,071	7,192	7,317
Road transport	**127,070**	11,645	11,890	12,148	12,416	12,694	12,981	13,173	13,371	13,575	13,784	14,000	14,225	14,458	14,697	14,944	15,198
Railway transport	**34,484**	3,331	3,356	3,390	3,430	3,476	3,525	3,548	3,574	3,601	3,631	3,663	3,693	3,726	3,761	3,798	3,838
Water transport	**17,723**	1,650	1,679	1,710	1,742	1,776	1,811	1,833	1,856	1,880	1,905	1,931	1,958	1,985	2,014	2,044	2,075
Air transport	**72,308**	6,552	6,704	6,863	7,029	7,200	7,378	7,503	7,632	7,764	7,899	8,038	8,180	8,326	8,477	8,631	8,789
Other transport, services and storage	**456,565**	41,561	42,461	43,414	44,411	45,449	46,524	47,314	48,124	48,956	49,808	50,681	51,533	52,410	53,313	54,242	55,196
Commercial services	**2,575,497**	233,556	238,889	244,510	250,377	256,468	262,773	267,193	271,737	276,403	281,188	286,095	291,195	296,438	301,824	307,356	313,034
Total	**5,991,451**	**548,194**	**559,751**	**571,972**	**584,758**	**598,056**	**611,841**	**621,162**	**630,767**	**640,650**	**650,805**	**661,231**	**672,005**	**683,116**	**694,564**	**706,352**	**718,480**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: PPP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**125,962**	12,166	12,519	12,884	13,259	13,645	14,043	13,640	13,389	13,190	12,911	12,663	12,452	12,272	12,119	11,988	11,879
Petroleum sector	**67,998**	6,161	6,350	6,544	6,745	6,951	7,164	7,194	7,245	7,304	7,363	7,429	7,502	7,581	7,665	7,754	7,848
Gas sector	**26,329**	2,462	2,536	2,612	2,691	2,771	2,855	2,753	2,718	2,697	2,865	2,834	2,811	2,795	2,785	2,780	2,780
Renewable Electricity	**27,290**	1,833	1,958	2,089	2,227	2,370	2,521	2,535	2,554	2,575	2,579	3,254	3,937	4,630	5,334	6,049	6,776
Coal-fired Electricity	**191,806**	18,280	18,765	19,264	19,775	20,299	20,838	20,957	21,115	21,285	20,658	20,103	19,551	19,000	18,450	17,898	17,344
Internal-combustion Electricity	**583**	53	55	56	58	60	62	62	62	63	63	63	64	64	65	65	65
Gas-turbine Electricity	**4,004**	365	376	387	399	411	423	426	429	433	433	435	438	441	443	446	450
Combined-cycle Electricity	**10,260**	776	799	824	849	874	901	906	913	920	1,580	1,588	1,597	1,607	1,617	1,628	1,640
Agriculture, forestry and fishing	**233,257**	20,956	21,595	22,254	22,933	23,634	24,356	24,615	24,894	25,181	25,477	25,784	26,103	26,433	26,775	27,128	27,493
Mining	**125,442**	11,369	11,718	12,078	12,449	12,832	13,226	13,283	13,377	13,482	13,587	13,706	13,833	13,969	14,112	14,262	14,420
Food, beverages and tobacco	**200,109**	17,894	18,444	19,010	19,593	20,195	20,815	21,071	21,348	21,635	21,929	22,234	22,548	22,873	23,207	23,552	23,906
Textile, clothing, footwear and leather	**73,528**	6,600	6,801	7,009	7,223	7,444	7,672	7,751	7,842	7,936	8,033	8,135	8,241	8,350	8,463	8,581	8,702
Wood, paper and printing products	**313,459**	28,008	28,870	29,758	30,673	31,617	32,590	32,968	33,410	33,872	34,342	34,843	35,361	35,896	36,448	37,016	37,601
Basic chemicals	**312,280**	28,100	28,960	29,846	30,760	31,702	32,673	32,924	33,267	33,636	34,018	34,428	34,858	35,307	35,774	36,260	36,762
Non-metallic mineral products	**132,351**	11,882	12,248	12,625	13,014	13,414	13,828	13,937	14,091	14,257	14,416	14,612	14,816	15,029	15,249	15,476	15,712
Basic iron and steel	**131,444**	11,821	12,184	12,557	12,942	13,340	13,749	13,857	14,003	14,160	14,317	14,495	14,681	14,875	15,077	15,286	15,502
Basic non-ferrous metals	**57,179**	5,140	5,298	5,461	5,630	5,803	5,982	6,035	6,100	6,167	6,236	6,310	6,388	6,468	6,552	6,638	6,727
Fabricated metal products	**176,830**	15,883	16,373	16,877	17,398	17,934	18,487	18,632	18,835	19,053	19,271	19,520	19,780	20,051	20,332	20,624	20,925
Machinery and equipment	**452,003**	40,575	41,828	43,119	44,451	45,824	47,239	47,646	48,175	48,741	49,309	49,939	50,596	51,281	51,992	52,730	53,492
Miscellenous manufacturing	**13,443**	1,199	1,236	1,274	1,314	1,354	1,396	1,413	1,433	1,454	1,475	1,497	1,520	1,544	1,568	1,593	1,619
Water, sewerage and drainage	**31,121**	2,795	2,881	2,969	3,060	3,154	3,251	3,276	3,313	3,354	3,398	3,441	3,485	3,532	3,580	3,630	3,682
Construction	**62,095**	5,580	5,752	5,929	6,112	6,301	6,495	6,548	6,619	6,695	6,772	6,854	6,941	7,031	7,125	7,223	7,324
Road transport	**129,697**	11,645	12,001	12,369	12,748	13,139	13,542	13,671	13,827	13,992	14,159	14,338	14,525	14,719	14,920	15,129	15,344
Railway transport	**35,862**	3,331	3,432	3,536	3,643	3,754	3,868	3,814	3,803	3,802	3,802	3,801	3,805	3,813	3,825	3,841	3,859
Water transport	**18,174**	1,650	1,701	1,753	1,807	1,862	1,919	1,925	1,936	1,949	1,964	1,980	1,998	2,018	2,039	2,061	2,085
Air transport	**73,360**	6,552	6,754	6,962	7,177	7,399	7,627	7,714	7,819	7,929	8,042	8,159	8,280	8,405	8,534	8,667	8,804
Other transport, services and storage	**464,014**	41,561	42,841	44,160	45,519	46,921	48,367	48,816	49,416	50,057	50,769	51,454	52,167	52,907	53,673	54,465	55,282
Commercial services	**2,614,003**	233,556	240,762	248,192	255,852	263,749	271,892	274,798	278,474	282,356	286,350	290,542	294,882	299,365	303,988	308,752	313,655
Total	6,103,883	**548,194**	**565,036**	**582,399**	**600,299**	**618,754**	**637,781**	**643,170**	**650,407**	**658,176**	**666,118**	**674,443**	**683,161**	**692,255**	**701,713**	**711,523**	**721,680**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-5 Sectoral outputs for intermediate consumption: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**125,886**	12,166	12,519	12,884	13,259	13,645	14,043	13,676	13,409	13,193	12,902	12,649	12,426	12,227	12,057	11,912	11,789
Petroleum sector	**67,676**	6,161	6,350	6,544	6,745	6,951	7,164	7,183	7,216	7,257	7,300	7,350	7,405	7,468	7,537	7,612	7,693
Gas sector	**27,064**	2,462	2,536	2,612	2,691	2,771	2,855	2,769	2,726	2,699	2,878	3,044	3,200	3,169	3,146	3,130	3,119
Renewable Electricity	**24,441**	1,833	1,958	2,089	2,227	2,370	2,521	2,528	2,538	2,550	2,546	2,544	2,542	3,202	3,869	4,544	5,228
Coal-fired Electricity	**190,393**	18,280	18,765	19,264	19,775	20,299	20,838	20,893	20,978	21,080	20,398	19,727	19,066	18,482	17,904	17,332	16,764
Internal-combustion Electricity	**578**	53	55	56	58	60	62	62	62	62	62	62	62	62	63	63	63
Gas-turbine Electricity	**3,971**	365	376	387	399	411	423	425	426	428	428	427	427	429	430	432	435
Combined-cycle Electricity	**12,666**	776	799	824	849	874	901	903	907	912	1,560	2,207	2,855	2,865	2,877	2,890	2,906
Agriculture, forestry and fishing	**231,131**	20,956	21,595	22,254	22,933	23,634	24,356	24,508	24,678	24,860	25,053	25,260	25,479	25,712	25,961	26,224	26,502
Mining	**124,809**	11,369	11,718	12,078	12,449	12,832	13,226	13,257	13,314	13,386	13,460	13,545	13,639	13,749	13,868	13,997	14,135
Food, beverages and tobacco	**198,910**	17,894	18,444	19,010	19,593	20,195	20,815	21,012	21,226	21,453	21,689	21,936	22,195	22,465	22,748	23,043	23,350
Textile, clothing, footwear and leather	**72,931**	6,600	6,801	7,009	7,223	7,444	7,672	7,722	7,781	7,846	7,914	7,987	8,065	8,147	8,234	8,326	8,422
Wood, paper and printing products	**312,106**	28,008	28,870	29,758	30,673	31,617	32,590	32,912	33,280	33,673	34,079	34,505	34,948	35,424	35,920	36,437	36,973
Basic chemicals	**310,304**	28,100	28,960	29,846	30,760	31,702	32,673	32,843	33,076	33,343	33,629	33,937	34,266	34,624	35,005	35,408	35,832
Non-metallic mineral products	**131,582**	11,882	12,248	12,625	13,014	13,414	13,828	13,912	14,026	14,156	14,283	14,419	14,564	14,746	14,937	15,138	15,349
Basic iron and steel	**130,647**	11,821	12,184	12,557	12,942	13,340	13,749	13,825	13,928	14,046	14,166	14,295	14,433	14,593	14,763	14,942	15,130
Basic non-ferrous metals	**56,887**	5,140	5,298	5,461	5,630	5,803	5,982	6,022	6,071	6,124	6,179	6,237	6,299	6,367	6,439	6,514	6,593
Fabricated metal products	**175,803**	15,883	16,373	16,877	17,398	17,934	18,487	18,594	18,741	18,908	19,079	19,262	19,457	19,685	19,925	20,178	20,444
Machinery and equipment	**449,399**	40,575	41,828	43,119	44,451	45,824	47,239	47,539	47,926	48,361	48,807	49,286	49,795	50,369	50,975	51,614	52,283
Miscellenous manufacturing	**13,399**	1,199	1,236	1,274	1,314	1,354	1,396	1,412	1,429	1,447	1,466	1,486	1,507	1,529	1,551	1,575	1,599
Water, sewerage and drainage	**30,958**	2,795	2,881	2,969	3,060	3,154	3,251	3,269	3,297	3,328	3,363	3,400	3,439	3,478	3,519	3,562	3,607
Construction	**61,856**	5,580	5,752	5,929	6,112	6,301	6,495	6,539	6,595	6,658	6,723	6,793	6,868	6,948	7,033	7,122	7,216
Road transport	**128,888**	11,645	12,001	12,369	12,748	13,139	13,542	13,635	13,747	13,870	13,999	14,137	14,283	14,440	14,607	14,783	14,968
Railway transport	**35,608**	3,331	3,432	3,536	3,643	3,754	3,868	3,808	3,777	3,759	3,744	3,735	3,731	3,727	3,729	3,735	3,746
Water transport	**18,069**	1,650	1,701	1,753	1,807	1,862	1,919	1,921	1,927	1,935	1,944	1,955	1,967	1,981	1,997	2,014	2,033
Air transport	**73,102**	6,552	6,754	6,962	7,177	7,399	7,627	7,704	7,793	7,888	7,989	8,094	8,204	8,317	8,435	8,558	8,685
Other transport, services and storage	**462,052**	41,561	42,841	44,160	45,519	46,921	48,367	48,736	49,208	49,731	50,334	50,966	51,623	52,263	52,935	53,639	54,373
Commercial services	**2,604,622**	233,556	240,762	248,192	255,852	263,749	271,892	274,474	277,580	280,948	284,483	288,180	292,025	296,090	300,326	304,729	309,295
Total	6,075,737	**548,194**	**565,036**	**582,399**	**600,299**	**618,754**	**637,781**	**642,082**	**647,661**	**653,901**	**660,457**	**667,427**	**674,769**	**682,557**	**690,792**	**699,455**	**708,531**

Note: This Table shows the results obtained by multiplying an updated technical coefficient matrix (calculated from Equation 5-20, p. 110) with Equation 5-32, p. 124.

Table F-6 Change in sectoral prices (percentage change from BC scenario)

	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
Coal sector	12.1	23.9	23.5	45.1	29.3	34.4	40.2	40.7
Petroleum sector	21.9	44.3	43.1	85.1	53.8	64.4	74.0	76.2
Gas sector	8.0	21.7	15.6	41.0	19.4	31.3	26.7	37.0
Electricity	184.6	254.7	336.9	450.9	409.0	353.9	556.1	416.8
Agriculture, forestry and fishing	6.3	18.1	12.2	34.2	15.2	26.1	20.9	30.8
Mining	10.6	27.2	20.2	50.6	24.9	38.9	34.1	45.9
Food, beverages and tobacco	7.6	23.9	14.4	44.7	17.8	34.3	24.4	40.5
Textile, clothing, footwear and leather	3.9	12.3	7.4	22.9	9.1	17.6	12.5	20.7
Wood, paper and printing products	6.0	18.0	11.4	33.7	14.1	25.8	19.3	30.5
Basic chemicals	9.1	19.3	17.7	36.7	22.0	27.9	30.2	33.0
Non-metallic mineral products	16.7	36.7	32.3	69.3	40.1	52.9	55.1	62.4
Basic iron and steel	34.1	65.6	66.6	125.1	82.9	95.0	113.9	112.3
Basic non-ferrous metals	37.6	75.4	73.1	142.3	90.7	108.6	124.6	128.2
Fabricated metal products	11.2	34.5	21.6	65.3	26.7	49.7	36.7	58.7
Machinery and equipment	4.0	12.9	7.7	24.2	9.6	18.5	13.1	21.9
Miscellenous manufacturing	2.0	7.0	3.9	13.1	4.8	10.0	6.6	11.9
Water, sewerage and drainage	7.6	22.7	14.1	41.6	17.2	32.2	23.5	37.9
Construction	5.4	18.1	10.4	34.3	12.9	26.1	17.6	30.9
Road transport	21.1	31.7	41.8	61.7	52.3	46.5	72.1	55.0
Railway transport	11.3	28.5	21.6	52.9	26.7	40.7	36.6	48.0
Water transport	25.0	44.8	49.6	87.4	62.0	65.7	85.5	77.8
Air transport	17.6	26.6	35.1	51.9	43.9	39.0	60.5	46.2
Other transport, services and storage	5.5	17.5	10.3	32.0	12.6	24.7	17.2	29.1
Commercial services	3.4	12.5	6.3	23.2	7.8	17.8	10.6	21.0

Note: This Table shows the results obtained by the application of Equations 5-14 and 5-15 as detailed in Section 5.4, pp. 106-107.

Table F-6 Changes in inflation (Index)

	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
2005	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2006	1.006	1.016	1.013	1.031	1.016	1.023	1.000	1.000
2007	1.013	1.031	1.025	1.061	1.032	1.046	1.000	1.000
2008	1.019	1.046	1.038	1.090	1.047	1.068	1.000	1.000
2009	1.025	1.060	1.050	1.119	1.062	1.089	1.000	1.000
2010	1.031	1.075	1.062	1.147	1.077	1.110	1.000	1.000
2011	1.037	1.089	1.073	1.173	1.092	1.131	1.031	1.039
2012	1.043	1.103	1.085	1.199	1.106	1.151	1.062	1.076
2013	1.049	1.117	1.096	1.224	1.119	1.170	1.091	1.113
2014	1.055	1.130	1.107	1.248	1.132	1.189	1.120	1.148
2015	1.061	1.143	1.118	1.271	1.145	1.207	1.148	1.182
2016	1.066	1.156	1.128	1.294	1.157	1.224	1.174	1.215
2017	1.072	1.168	1.137	1.315	1.169	1.241	1.199	1.246
2018	1.077	1.180	1.147	1.336	1.180	1.258	1.223	1.276
2019	1.083	1.192	1.156	1.356	1.191	1.274	1.246	1.305
2020	1.088	1.203	1.165	1.375	1.202	1.289	1.268	1.332

Note: This Table shows the results obtained by calculate weighted mean of change in prices from all sectors shown in previous Table with the total output [that is, ∑(final consumption + (net) exports + investment demand + intermediate demand)] of each sector.

Table F-7 Carbon tax revenue: PPP_1 (\$ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**900**	0	108	109	110	112	113	114	115	115	116	117	118	118	119	119	120
Petroleum sector	**644**	0	76	77	79	80	81	81	82	83	83	84	85	85	86	87	87
Gas sector	**56**	0	7	7	7	7	7	7	7	7	7	7	7	7	8	8	9
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**15,241**	0	1,831	1,854	1,878	1,903	1,928	1,947	1,966	1,985	2,005	2,025	2,045	1,988	1,931	1,874	1,817
Internal-combustion Electricity	**45**	0	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6
Gas-turbine Electricity	**302**	0	35	35	36	37	38	38	39	39	40	40	41	41	42	42	42
Combined-cycle Electricity	**640**	0	55	57	58	59	61	61	62	63	64	65	66	114	163	213	263
Agriculture, forestry and fishing	**422**	0	48	49	50	51	52	53	54	55	55	56	57	58	59	60	61
Mining	**417**	0	47	48	49	50	52	52	53	54	55	56	56	57	58	59	60
Food, beverages and tobacco	**279**	0	31	32	33	34	34	35	36	36	37	37	38	38	39	40	40
Textile, clothing, footwear and leather	**45**	0	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6
Wood, paper and printing products	**187**	0	21	22	22	23	23	23	24	24	25	25	25	26	26	27	27
Basic chemicals	**1,029**	0	117	119	122	125	127	129	131	133	135	137	139	141	144	146	148
Non-metallic mineral products	**497**	0	56	58	59	60	62	62	63	64	65	66	67	68	69	70	71
Basic iron and steel	**1,381**	0	157	160	164	167	171	174	176	179	181	184	187	190	193	195	198
Basic non-ferrous metals	**1,419**	0	160	164	168	172	176	178	181	184	187	190	193	195	198	202	205
Fabricated metal products	**38**	0	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5
Machinery and equipment	**56**	0	6	6	7	7	7	7	7	7	7	7	8	8	8	8	8
Miscellenous manufacturing	**2**	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Water, sewerage and drainage	**7**	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Construction	**334**	0	38	39	40	40	41	42	43	43	44	45	45	46	47	47	48
Road transport	**1,985**	0	224	229	235	240	246	249	253	257	261	265	269	273	278	282	286
Railway transport	**169**	0	19	20	20	20	21	21	21	22	22	22	23	23	23	24	24
Water transport	**382**	0	43	44	45	46	47	48	49	49	50	51	52	53	53	54	55
Air transport	**1,414**	0	159	163	167	171	175	178	180	183	186	189	192	195	198	201	205
Other transport, services and storage	**78**	0	9	9	9	9	10	10	10	10	10	10	11	11	11	11	11
Commercial services	**388**	0	44	45	46	47	48	49	50	50	51	52	53	54	55	56	56
Total	**28,356**	**0**	**3,307**	**3,362**	**3,418**	**3,476**	**3,535**	**3,576**	**3,618**	**3,661**	**3,705**	**3,749**	**3,795**	**3,810**	**3,826**	**3,843**	**3,861**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-11, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: SRP_1 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,671**	0	220	219	218	217	216	214	212	210	207	204	201	199	197	195	193
Petroleum sector	**1,312**	0	164	165	165	166	167	166	166	166	166	165	165	165	165	165	165
Gas sector	**172**	0	22	21	20	20	19	19	19	20	21	23	24	26	27	29	29
Renewable Electricity	**523**	0	60	62	65	67	69	69	69	69	68	66	65	64	63	62	78
Coal-fired Electricity	**19,699**	0	2,644	2,645	2,647	2,650	2,654	2,649	2,648	2,548	2,441	2,337	2,236	2,138	2,042	1,948	1,863
Internal-combustion Electricity	**53**	0	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7
Gas-turbine Electricity	**326**	0	39	40	40	41	41	42	42	42	42	42	42	42	42	42	42
Combined-cycle Electricity	**1,275**	0	72	73	74	75	76	76	77	131	186	240	295	349	404	458	460
Agriculture, forestry and fishing	**1,630**	0	195	198	200	203	205	207	208	210	210	211	212	213	214	215	216
Mining	**1,778**	0	215	218	220	222	225	226	227	229	229	229	229	229	229	230	231
Food, beverages and tobacco	**2,773**	0	337	340	344	347	351	352	354	356	356	356	356	356	357	358	359
Textile, clothing, footwear and leather	**443**	0	54	55	55	56	56	56	57	57	57	57	57	57	57	57	57
Wood, paper and printing products	**1,526**	0	184	186	188	191	193	194	195	196	196	197	197	197	198	198	199
Basic chemicals	**2,222**	0	265	268	272	276	279	281	284	286	287	288	290	292	293	295	297
Non-metallic mineral products	**1,294**	0	155	156	159	161	163	164	165	166	167	168	168	169	170	171	172
Basic iron and steel	**2,724**	0	322	327	332	337	342	345	348	351	353	355	357	360	362	365	368
Basic non-ferrous metals	**3,005**	0	357	362	367	372	378	380	384	387	389	391	393	395	398	400	403
Fabricated metal products	**1,365**	0	163	165	167	170	172	173	174	176	176	177	177	178	179	180	181
Machinery and equipment	**2,568**	0	310	314	317	321	325	326	328	330	330	331	331	332	333	334	335
Miscellenous manufacturing	**57**	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Water, sewerage and drainage	**333**	0	41	42	42	42	42	42	43	43	42	42	42	42	42	42	42
Construction	**3,204**	0	383	387	393	398	404	406	410	413	414	415	417	418	420	422	426
Road transport	**2,533**	0	295	300	305	311	316	320	323	326	330	333	336	340	343	347	351
Railway transport	**585**	0	72	72	73	74	74	74	75	75	75	75	74	74	74	75	75
Water transport	**599**	0	70	71	72	74	75	76	76	77	78	79	79	80	81	82	82
Air transport	**1,841**	0	213	217	221	225	230	232	235	237	240	243	245	248	251	254	257
Other transport, services and storage	**2,236**	0	275	277	279	281	284	284	286	287	286	285	285	284	284	284	284
Commercial services	**16,089**	0	1,933	1,956	1,981	2,006	2,032	2,043	2,059	2,076	2,077	2,079	2,082	2,086	2,091	2,098	2,105
Total	73,834	**0**	**9,074**	**9,149**	**9,229**	**9,313**	**9,402**	**9,430**	**9,477**	**9,479**	**9,436**	**9,399**	**9,369**	**9,346**	**9,329**	**9,317**	**9,281**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-12, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: PPP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**1,671**	0	212	212	212	213	214	213	212	211	210	209	208	207	206	206	205
Petroleum sector	**1,215**	0	151	152	152	153	154	154	153	153	153	154	154	155	155	156	157
Gas sector	**103**	0	14	13	12	12	12	12	13	13	13	13	13	13	13	14	14
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**27,375**	0	3,649	3,665	3,683	3,701	3,721	3,728	3,596	3,466	3,348	3,231	3,116	3,002	2,888	2,775	2,663
Internal-combustion Electricity	**87**	0	10	10	10	11	11	11	11	11	11	11	11	12	12	12	12
Gas-turbine Electricity	**586**	0	69	70	71	73	74	75	75	75	76	76	77	78	78	79	79
Combined-cycle Electricity	**1,550**	0	111	113	115	117	119	121	208	296	298	301	304	306	309	312	315
Agriculture, forestry and fishing	**830**	0	95	97	99	101	103	104	106	107	109	110	111	113	115	116	118
Mining	**819**	0	94	96	98	100	102	103	104	106	107	108	110	111	113	114	116
Food, beverages and tobacco	**549**	0	63	64	65	67	68	69	70	71	72	73	74	75	76	77	78
Textile, clothing, footwear and leather	**88**	0	10	10	11	11	11	11	11	11	12	12	12	12	12	12	12
Wood, paper and printing products	**368**	0	42	43	44	45	46	46	47	48	48	49	50	50	51	52	53
Basic chemicals	**2,026**	0	232	237	242	247	252	255	258	261	265	268	272	276	279	283	287
Non-metallic mineral products	**979**	0	112	115	117	119	122	123	125	126	128	130	132	133	135	137	139
Basic iron and steel	**2,720**	0	312	318	325	331	338	342	346	351	355	360	365	370	375	381	386
Basic non-ferrous metals	**2,792**	0	320	326	333	340	347	351	356	361	365	370	375	380	385	391	396
Fabricated metal products	**75**	0	9	9	9	9	9	9	10	10	10	10	10	10	10	11	11
Machinery and equipment	**110**	0	13	13	13	13	14	14	14	14	14	15	15	15	15	15	16
Miscellenous manufacturing	**3**	0	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Water, sewerage and drainage	**14**	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Construction	**660**	0	75	77	78	80	82	83	84	85	86	88	89	90	92	93	94
Road transport	**3,911**	0	447	456	466	476	486	492	499	505	512	519	526	533	541	549	556
Railway transport	**329**	0	38	39	40	40	41	41	42	42	43	43	44	44	45	45	46
Water transport	**750**	0	86	88	90	91	93	94	96	97	98	99	101	102	103	105	106
Air transport	**2,790**	0	318	325	332	339	346	351	356	361	366	371	376	381	387	393	398
Other transport, services and storage	**153**	0	17	18	18	19	19	19	20	20	20	20	21	21	21	22	22
Commercial services	**769**	0	87	89	91	93	95	97	98	100	101	103	104	106	107	109	111
Total	53,320	**0**	**6,589**	**6,656**	**6,728**	**6,802**	**6,879**	**6,922**	**6,910**	**6,902**	**6,823**	**6,746**	**6,671**	**6,598**	**6,527**	**6,458**	**6,391**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-11, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: SRP_2 ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**2,856**	0	428	413	401	390	379	364	352	340	330	318	308	298	289	281	274
Petroleum sector	**2,358**	0	323	317	312	308	304	299	294	290	286	282	278	275	273	271	269
Gas sector	**306**	0	40	36	35	34	36	38	40	43	42	42	41	41	40	40	39
Renewable Electricity	**1,147**	0	119	121	124	126	128	123	119	115	141	163	182	199	215	229	242
Coal-fired Electricity	**33,715**	0	5,246	5,147	5,056	4,971	4,731	4,450	4,188	3,942	3,723	3,494	3,278	3,073	2,879	2,695	2,519
Internal-combustion Electricity	**98**	0	13	13	13	13	13	13	12	12	12	12	12	12	12	12	12
Gas-turbine Electricity	**608**	0	78	78	78	78	78	77	77	76	76	75	75	75	75	74	74
Combined-cycle Electricity	**2,603**	0	143	143	143	143	233	331	427	522	520	516	513	510	508	506	504
Agriculture, forestry and fishing	**3,045**	0	388	388	389	390	392	389	387	385	384	380	377	374	371	369	367
Mining	**3,282**	0	428	427	426	426	426	421	417	413	410	404	397	392	386	381	377
Food, beverages and tobacco	**5,109**	0	669	667	665	665	664	655	649	643	637	626	616	607	598	590	583
Textile, clothing, footwear and leather	**812**	0	108	107	107	106	106	104	103	102	101	99	97	95	94	92	91
Wood, paper and printing products	**2,834**	0	367	366	366	367	367	363	360	358	356	350	345	341	336	333	329
Basic chemicals	**4,175**	0	526	527	529	532	534	532	530	529	528	525	522	520	518	516	515
Non-metallic mineral products	**2,438**	0	307	308	309	311	312	310	309	308	308	306	305	303	302	301	300
Basic iron and steel	**5,158**	0	641	644	648	652	657	656	655	655	656	654	652	652	651	651	651
Basic non-ferrous metals	**5,647**	0	709	712	715	719	724	720	718	717	716	711	707	703	700	697	695
Fabricated metal products	**2,558**	0	324	325	326	327	329	326	325	324	323	320	318	315	314	312	310
Machinery and equipment	**4,761**	0	616	615	615	616	617	610	604	600	597	588	581	573	567	561	555
Miscellenous manufacturing	**105**	0	14	14	14	14	14	13	13	13	13	13	13	13	12	12	12
Water, sewerage and drainage	**601**	0	82	81	80	80	79	78	76	75	74	72	70	68	66	65	63
Construction	**6,014**	0	760	762	765	768	772	767	763	760	760	754	749	745	741	738	735
Road transport	**4,841**	0	586	592	598	604	611	613	615	617	620	622	625	628	631	634	638
Railway transport	**1,067**	0	142	141	140	140	139	137	135	133	132	129	127	125	123	121	119
Water transport	**1,139**	0	139	140	141	143	144	144	145	145	145	146	146	147	147	148	149
Air transport	**3,532**	0	424	429	434	439	445	447	449	452	454	456	459	461	464	467	470
Other transport, services and storage	**4,076**	0	546	542	539	537	535	526	519	512	506	493	481	470	459	449	439
Commercial services	**29,971**	0	3,851	3,857	3,866	3,878	3,892	3,852	3,824	3,800	3,782	3,721	3,663	3,610	3,559	3,511	3,466
Total	134,857	**0**	**18,014**	**17,913**	**17,835**	**17,777**	**17,660**	**17,359**	**17,106**	**16,882**	**16,632**	**16,273**	**15,937**	**15,624**	**15,330**	**15,055**	**14,797**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-12, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: PPP for Early action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**2,027**	0	264	263	262	261	261	258	256	253	251	249	247	245	244	242	241
Petroleum sector	**1,483**	0	188	188	188	188	188	187	186	186	186	186	186	186	186	187	188
Gas sector	**125**	0	17	16	15	15	14	15	16	16	16	16	16	16	16	16	16
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**32,942**	0	4,570	4,571	4,574	4,579	4,585	4,405	4,228	4,069	3,912	3,759	3,608	3,459	3,312	3,167	3,024
Internal-combustion Electricity	**107**	0	13	13	13	13	14	14	14	14	14	14	14	14	14	14	15
Gas-turbine Electricity	**725**	0	86	88	89	90	92	92	92	93	93	94	94	95	96	96	97
Combined-cycle Electricity	**2,036**	0	139	141	143	146	148	255	363	365	368	371	374	377	380	383	386
Agriculture, forestry and fishing	**1,034**	0	119	121	124	126	129	130	132	133	135	137	138	140	142	143	145
Mining	**1,018**	0	118	120	122	124	127	128	130	131	133	134	136	137	139	141	142
Food, beverages and tobacco	**683**	0	79	80	82	83	85	86	87	88	89	90	91	93	94	95	96
Textile, clothing, footwear and leather	**110**	0	13	13	13	13	14	14	14	14	14	14	15	15	15	15	15
Wood, paper and printing products	**459**	0	53	54	55	56	57	58	58	59	60	61	62	62	63	64	65
Basic chemicals	**2,521**	0	291	297	302	308	314	317	321	325	329	333	337	341	346	350	355
Non-metallic mineral products	**1,220**	0	141	143	146	149	152	153	155	157	159	161	163	166	168	170	173
Basic iron and steel	**3,387**	0	391	398	406	413	421	426	431	436	442	447	453	459	465	471	477
Basic non-ferrous metals	**3,474**	0	401	408	416	424	432	437	443	448	453	459	465	470	476	482	488
Fabricated metal products	**94**	0	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13
Machinery and equipment	**137**	0	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19
Miscellenous manufacturing	**4**	0	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Water, sewerage and drainage	**17**	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Construction	**822**	0	94	96	98	100	102	103	104	106	107	109	110	112	114	115	117
Road transport	**4,871**	0	560	571	582	594	606	613	620	628	636	644	653	661	670	679	688
Railway transport	**408**	0	48	49	49	50	51	51	52	52	53	53	54	54	55	56	56
Water transport	**933**	0	108	110	112	114	116	117	119	120	122	123	125	126	128	129	131
Air transport	**3,476**	0	398	406	415	423	432	437	443	449	455	461	467	473	480	486	493
Other transport, services and storage	**191**	0	22	22	23	23	24	24	24	25	25	25	26	26	26	27	27
Commercial services	**960**	0	109	111	114	116	119	121	122	124	126	128	130	132	134	136	138
Total	65,263	**0**	**8,250**	**8,308**	**8,373**	**8,441**	**8,514**	**8,476**	**8,443**	**8,325**	**8,211**	**8,101**	**7,996**	**7,894**	**7,796**	**7,701**	**7,609**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-11, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: SRP for Early action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**2,289**	0	557	530	507	487	469	448	429	412	397	383	370	358	347	334	323
Petroleum sector	**1,847**	0	362	350	339	330	321	310	300	291	283	275	268	261	255	249	243
Gas sector	**230**	0	31	29	27	26	26	27	28	30	31	32	32	31	31	30	30
Renewable Electricity	**819**	0	77	78	79	81	82	80	78	76	74	73	72	70	87	101	114
Coal-fired Electricity	**26,838**	0	3,386	3,306	3,239	3,180	3,129	2,957	2,807	2,666	2,533	2,406	2,285	2,170	2,066	1,947	1,833
Internal-combustion Electricity	**75**	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Gas-turbine Electricity	**462**	0	50	50	50	50	50	49	49	49	49	49	49	49	49	49	49
Combined-cycle Electricity	**2,042**	0	92	92	92	92	92	156	219	282	345	408	471	535	536	535	534
Agriculture, forestry and fishing	**2,341**	0	289	291	294	296	298	299	298	298	298	298	298	297	295	294	293
Mining	**2,537**	0	319	321	322	324	326	325	323	322	321	319	319	315	312	309	306
Food, beverages and tobacco	**3,953**	0	499	501	503	505	508	507	504	501	499	497	496	490	484	479	474
Textile, clothing, footwear and leather	**630**	0	80	80	81	81	81	81	80	80	79	79	78	77	76	75	74
Wood, paper and printing products	**2,184**	0	273	275	276	278	280	280	278	277	277	276	276	273	270	267	265
Basic chemicals	**3,200**	0	392	395	399	403	407	407	407	408	408	409	410	409	409	408	408
Non-metallic mineral products	**1,865**	0	229	231	233	235	237	238	237	237	237	238	238	238	237	237	237
Basic iron and steel	**3,938**	0	478	483	488	493	499	501	501	503	504	506	508	509	509	510	511
Basic non-ferrous metals	**4,329**	0	529	534	539	544	550	552	552	552	553	554	556	554	553	552	551
Fabricated metal products	**1,962**	0	242	244	246	248	250	250	250	250	250	250	250	249	248	247	246
Machinery and equipment	**3,671**	0	460	462	465	468	471	470	468	466	465	463	463	459	454	451	447
Miscellenous manufacturing	**81**	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Water, sewerage and drainage	**470**	0	61	61	61	61	61	61	60	59	59	58	58	56	55	54	53
Construction	**4,608**	0	567	572	576	582	587	588	587	586	586	587	589	586	585	583	582
Road transport	**3,682**	0	438	443	450	456	463	466	469	472	475	479	482	485	489	492	496
Railway transport	**829**	0	106	106	106	107	107	106	105	105	104	103	103	101	100	99	97
Water transport	**869**	0	104	105	106	108	109	110	111	111	112	113	113	114	115	115	116
Air transport	**2,681**	0	316	321	326	331	336	339	342	344	347	350	353	356	358	361	364
Other transport, services and storage	**3,169**	0	407	408	408	409	410	408	404	401	398	395	393	385	377	370	363
Commercial services	**23,056**	0	2,870	2,889	2,911	2,934	2,958	2,961	2,948	2,938	2,931	2,926	2,924	2,888	2,854	2,822	2,791
Total	**104,656**	**0**	**13,235**	**13,176**	**13,140**	**13,125**	**13,125**	**12,994**	**12,855**	**12,735**	**12,631**	**12,544**	**12,472**	**12,333**	**12,169**	**11,988**	**11,817**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-12, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: PPP for Delay action ($ million)

	Present value	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal sector	**2,188**	0	0	0	0	0	0	582	562	545	527	510	495	482	469	458	448
Petroleum sector	**1,613**	0	0	0	0	0	0	418	404	393	383	375	368	363	359	355	353
Gas sector	**129**	0	0	0	0	0	0	32	30	30	31	31	31	30	30	30	30
Renewable Electricity	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal-fired Electricity	**36,869**	0	0	0	0	0	0	10,203	9,970	9,752	9,187	8,681	8,201	7,747	7,315	6,904	6,511
Internal-combustion Electricity	**122**	0	0	0	0	0	0	29	29	29	29	29	29	29	29	29	29
Gas-turbine Electricity	**820**	0	0	0	0	0	0	195	195	195	194	194	193	193	193	192	192
Combined-cycle Electricity	**1,918**	0	0	0	0	0	0	314	315	316	539	539	539	540	541	542	543
Agriculture, forestry and fishing	**1,173**	0	0	0	0	0	0	271	272	274	276	277	279	281	283	285	287
Mining	**1,153**	0	0	0	0	0	0	268	269	270	271	272	274	275	277	279	280
Food, beverages and tobacco	**775**	0	0	0	0	0	0	179	180	181	182	183	185	186	187	189	190
Textile, clothing, footwear and leather	**124**	0	0	0	0	0	0	29	29	29	29	29	30	30	30	30	30
Wood, paper and printing products	**522**	0	0	0	0	0	0	120	121	121	122	123	125	126	127	128	129
Basic chemicals	**2,861**	0	0	0	0	0	0	661	664	668	672	676	681	686	691	696	702
Non-metallic mineral products	**1,385**	0	0	0	0	0	0	319	321	323	324	327	330	333	336	339	342
Basic iron and steel	**3,844**	0	0	0	0	0	0	886	891	896	902	908	915	922	929	937	945
Basic non-ferrous metals	**3,943**	0	0	0	0	0	0	911	916	921	926	932	938	944	950	957	964
Fabricated metal products	**106**	0	0	0	0	0	0	24	25	25	25	25	25	26	26	26	26
Machinery and equipment	**156**	0	0	0	0	0	0	36	36	36	37	37	37	37	38	38	38
Miscellenous manufacturing	**4**	0	0	0	0	0	0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
Water, sewerage and drainage	**20**	0	0	0	0	0	0	5	5	5	5	5	5	5	5	5	5
Construction	**935**	0	0	0	0	0	0	215	216	217	219	221	223	225	227	229	232
Road transport	**5,537**	0	0	0	0	0	0	1,274	1,282	1,290	1,299	1,309	1,319	1,329	1,340	1,351	1,363
Railway transport	**460**	0	0	0	0	0	0	108	108	108	108	109	109	109	109	110	110
Water transport	**1,058**	0	0	0	0	0	0	245	246	247	249	250	251	253	255	256	258
Air transport	**3,959**	0	0	0	0	0	0	907	914	921	928	936	944	952	961	969	979
Other transport, services and storage	**217**	0	0	0	0	0	0	50	50	51	51	51	52	52	53	53	54
Commercial services	**1,098**	0	0	0	0	0	0	249	251	254	257	260	263	266	269	272	275
Total	72,990	**0**	**0**	**0**	**0**	**0**	**0**	**18,531**	**18,302**	**18,098**	**17,772**	**17,289**	**16,839**	**16,419**	**16,027**	**15,661**	**15,318**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-11, p. 105) with Equation 5-32, p. 124.

Table F-7 Carbon tax revenue: SRP for Delay action ($ million)

	Present value	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal sector	**2,155**	0	0	0	0	0	0	612	579	552	525	499	476	455	434	415	398
Petroleum sector	**1,762**	0	0	0	0	0	0	464	448	434	422	411	401	393	384	377	370
Gas sector	**209**	0	0	0	0	0	0	54	49	46	48	50	51	50	49	47	46
Renewable Electricity	**835**	0	0	0	0	0	0	195	189	184	178	170	163	198	225	250	272
Coal-fired Electricity	**26,132**	0	0	0	0	0	0	7,480	7,248	7,035	6,579	6,131	5,716	5,351	4,981	4,637	4,316
Internal-combustion Electricity	**74**	0	0	0	0	0	0	18	18	18	18	17	17	17	17	17	16
Gas-turbine Electricity	**450**	0	0	0	0	0	0	113	111	109	107	105	104	103	101	101	100
Combined-cycle Electricity	**1,703**	0	0	0	0	0	0	207	204	202	340	473	603	596	588	581	576
Agriculture, forestry and fishing	**2,279**	0	0	0	0	0	0	560	555	550	545	539	533	529	521	514	508
Mining	**2,468**	0	0	0	0	0	0	618	609	601	594	584	575	567	555	543	533
Food, beverages and tobacco	**3,839**	0	0	0	0	0	0	964	950	937	925	908	893	880	860	841	824
Textile, clothing, footwear and leather	**611**	0	0	0	0	0	0	155	152	150	147	144	142	139	136	132	129
Wood, paper and printing products	**2,127**	0	0	0	0	0	0	528	522	516	511	503	497	491	481	472	463
Basic chemicals	**3,119**	0	0	0	0	0	0	761	754	749	744	737	731	727	719	712	706
Non-metallic mineral products	**1,819**	0	0	0	0	0	0	443	439	437	434	430	426	424	419	415	412
Basic iron and steel	**3,846**	0	0	0	0	0	0	927	922	918	914	909	904	901	895	890	886
Basic non-ferrous metals	**4,228**	0	0	0	0	0	0	1,028	1,021	1,015	1,009	1,000	993	986	975	965	956
Fabricated metal products	**1,915**	0	0	0	0	0	0	469	465	461	458	453	448	445	439	434	429
Machinery and equipment	**3,577**	0	0	0	0	0	0	890	879	869	859	846	834	824	808	793	780
Miscellenous manufacturing	**79**	0	0	0	0	0	0	20	19	19	19	19	18	18	18	17	17
Water, sewerage and drainage	**455**	0	0	0	0	0	0	118	115	113	111	108	105	102	99	95	92
Construction	**4,503**	0	0	0	0	0	0	1,101	1,091	1,083	1,076	1,064	1,054	1,048	1,035	1,024	1,014
Road transport	**3,603**	0	0	0	0	0	0	854	852	852	852	851	851	852	852	852	854
Railway transport	**802**	0	0	0	0	0	0	205	201	197	194	189	186	182	177	173	169
Water transport	**849**	0	0	0	0	0	0	203	202	201	201	200	200	200	199	199	199
Air transport	**2,629**	0	0	0	0	0	0	618	619	619	620	621	622	624	625	626	628
Other transport, services and storage	**3,077**	0	0	0	0	0	0	785	771	758	746	729	714	700	678	657	638
Commercial services	**22,552**	0	0	0	0	0	0	5,562	5,511	5,467	5,427	5,351	5,286	5,231	5,121	5,019	4,924
Total	**101,693**	**0**	**0**	**0**	**0**	**0**	**0**	**25,951**	**25,495**	**25,091**	**24,603**	**24,041**	**23,542**	**23,031**	**22,391**	**21,801**	**21,256**

Note: This Table shows the results obtained by multiplying ad-valorem tax rate, t_n (calculated from Equation 5-12, p. 105) with Equation 5-32, p. 124.

Table F-8 Share of electricity generation (per cent)

	BC					PPP_1					SRP_1					PPP_2					SRP_2				
	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE
2005	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6
2006	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9
2007	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2
2008	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6
2009	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9
2010	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	81.9	0.2	1.7	5.9	10.2
2011	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	79.3	0.2	1.7	8.5	10.2
2012	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	81.6	0.2	1.7	6.2	10.2	76.7	0.2	1.7	11.1	10.2
2013	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	81.6	0.2	1.7	6.2	10.2	79.0	0.2	1.7	8.8	10.2	74.1	0.2	1.7	13.7	10.2
2014	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	79.0	0.2	1.7	8.8	10.2	76.4	0.2	1.7	8.8	12.8	71.5	0.2	1.7	13.7	12.8
2015	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	76.4	0.2	1.7	11.4	10.2	73.8	0.2	1.7	8.8	15.4	68.9	0.2	1.7	13.7	15.4
2016	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	73.8	0.2	1.7	14.0	10.2	71.2	0.2	1.7	8.8	18.0	66.3	0.2	1.7	13.7	18.0
2017	84.2	0.2	1.7	3.6	10.2	81.6	0.2	1.7	6.2	10.2	71.2	0.2	1.7	16.6	10.2	68.6	0.2	1.7	8.8	20.6	63.7	0.2	1.7	13.7	20.6
2018	84.2	0.2	1.7	3.6	10.2	79.0	0.2	1.7	8.8	10.2	68.6	0.2	1.7	19.2	10.2	66.0	0.2	1.7	8.8	23.2	61.1	0.2	1.7	13.7	23.2
2019	84.2	0.2	1.7	3.6	10.2	76.4	0.2	1.7	11.4	10.2	66.0	0.2	1.7	21.8	10.2	63.4	0.2	1.7	8.8	25.8	58.5	0.2	1.7	13.7	25.8
2020	84.2	0.2	1.7	3.6	10.2	73.8	0.2	1.7	14.0	10.2	63.4	0.2	1.7	21.8	12.8	60.8	0.2	1.7	8.8	28.4	55.9	0.2	1.7	13.7	28.4

Note: This Table shows the results obtained by dividing total output of electricity production from each technology *i* to total electricity production (that is, $x_i / x_{electricity}$).

Table F-8 Share of electricity generation (per cent), continued

	BC					PPP_{Early}					SRP_{Early}					PPP_{Delay}					SRP_{Delay}				
	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE	CF	IC	GT	CC	RE
2005	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6	85.8	0.2	1.7	3.6	8.6
2006	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9	85.5	0.2	1.7	3.6	8.9
2007	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2	85.2	0.2	1.7	3.6	9.2
2008	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6	84.8	0.2	1.7	3.6	9.6
2009	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9	84.5	0.2	1.7	3.6	9.9
2010	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2
2011	84.2	0.2	1.7	3.6	10.2	81.6	0.2	1.7	6.2	10.2	81.6	0.2	1.7	6.2	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2
2012	84.2	0.2	1.7	3.6	10.2	79.0	0.2	1.7	8.8	10.2	79.0	0.2	1.7	8.8	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2
2013	84.2	0.2	1.7	3.6	10.2	76.4	0.2	1.7	8.8	12.8	76.4	0.2	1.7	11.4	10.2	84.2	0.2	1.7	3.6	10.2	84.2	0.2	1.7	3.6	10.2
2014	84.2	0.2	1.7	3.6	10.2	73.8	0.2	1.7	8.8	15.4	73.8	0.2	1.7	14.0	10.2	81.6	0.2	1.7	6.2	10.2	81.6	0.2	1.7	6.2	10.2
2015	84.2	0.2	1.7	3.6	10.2	71.2	0.2	1.7	8.8	18.0	71.2	0.2	1.7	16.6	10.2	79.0	0.2	1.7	6.2	12.8	79.0	0.2	1.7	8.8	10.2
2016	84.2	0.2	1.7	3.6	10.2	68.6	0.2	1.7	8.8	20.6	68.6	0.2	1.7	16.6	12.8	76.4	0.2	1.7	6.2	15.4	76.4	0.2	1.7	11.4	10.2
2017	84.2	0.2	1.7	3.6	10.2	66.0	0.2	1.7	8.8	23.2	66.0	0.2	1.7	16.6	15.4	73.8	0.2	1.7	6.2	18.0	73.8	0.2	1.7	11.4	12.8
2018	84.2	0.2	1.7	3.6	10.2	63.4	0.2	1.7	8.8	25.8	63.4	0.2	1.7	16.6	18.0	71.2	0.2	1.7	6.2	20.6	71.2	0.2	1.7	11.4	15.4
2019	84.2	0.2	1.7	3.6	10.2	60.8	0.2	1.7	8.8	28.4	60.8	0.2	1.7	16.6	20.6	68.6	0.2	1.7	6.2	23.2	68.6	0.2	1.7	11.4	18.0
2020	84.2	0.2	1.7	3.6	10.2	58.2	0.2	1.7	8.8	31.0	58.2	0.2	1.7	16.6	23.2	66.0	0.2	1.7	6.2	25.8	66.0	0.2	1.7	11.4	20.6

Note: This Table shows the results obtained by dividing total output of electricity production from each technology *i* to total electricity production (that is, $x_i / x_{electricity}$).

Table F-9 Cost of electricity (¢/kWh)

	BC		PPP_1		SRP_1		PPP_2		SRP_2		PPP_{Early}		SRP_{Early}		PPP_{Delay}		SRP_{Delay}	
2004	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70	CF	4.70
2005	CF	4.74	CF	5.30	CF	5.59	CF	5.89	CF	6.48	CF	6.20	CF	6.02	CF	4.70	CF	4.70
2006	CF	4.77	CF	5.89	CF	6.46	CF	7.07	CF	8.20	CF	7.67	CF	7.31	CF	4.70	CF	4.70
2007	CF	4.81	CF	6.47	CF	7.32	CF	8.22	CF	9.87	CF	9.10	CF	8.57	CF	4.70	CF	4.70
2008	CF	4.84	CF	7.04	CF	8.15	CF	9.35	CF	11.48	CF	10.51	CF	9.79	CF	4.70	CF	4.70
2009	CF	4.88	CF	7.60	CF	8.97	CF	10.45	CF	13.04	CF	11.88	CF	10.98	CF	4.70	CF	4.70
2010	CF	4.92	CF	8.16	CF	9.77	CF	11.54	CC	14.53	CF	13.23	CF	12.14	CF	7.61	CF	6.91
2011	CF	4.92	CF	8.71	CF	10.56	CF	12.61	CC	15.96	CC	14.54	CC	13.25	CF	10.44	CF	9.04
2012	CF	4.92	CF	9.26	CF	11.34	CC	13.65	CC	17.32	CC	15.80	CC	14.32	CF	13.18	CF	11.10
2013	CF	4.92	CF	9.80	CC	12.08	CC	14.67	CC	18.63	RE	17.01	CC	15.34	CF	15.85	CF	13.09
2014	CF	4.92	CF	10.34	CC	12.81	RE	15.64	RE	19.86	RE	18.16	CC	16.33	CC	18.40	CC	14.97
2015	CF	4.92	CF	10.87	CC	13.51	RE	16.56	RE	21.02	RE	19.25	CC	17.29	RE	20.81	CC	16.77
2016	CF	4.92	CF	11.39	CC	14.18	RE	17.43	RE	22.12	RE	20.29	RE	18.19	RE	23.07	CC	18.48
2017	CF	4.92	CC	11.91	CC	14.84	RE	18.27	RE	23.15	RE	21.27	RE	19.04	RE	25.20	RE	20.08
2018	CF	4.92	CC	12.41	CC	15.47	RE	19.06	RE	24.12	RE	22.20	RE	19.85	RE	27.20	RE	21.57
2019	CF	4.92	CC	12.90	CC	16.09	RE	19.82	RE	25.03	RE	23.09	RE	20.61	RE	29.08	RE	22.98
2020	CF	4.92	CC	13.38	RE	16.67	RE	20.53	RE	25.90	RE	23.92	RE	21.34	RE	30.84	RE	24.29

Note: This Table shows the results obtained by the application of Equations 5-14 and 5-15 as detailed in Section 5.4, pp. 106-107.

Table F-10 Primary energy consumption: BC scenario (PJ)

	Economy-wide						Electricity sector					
	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**
1980	846	321	917	318	177	**2,578**	545	288	76	51	177	**1,138**
1981	887	312	869	367	189	**2,624**	571	283	107	50	189	**1,199**
1982	876	358	833	407	191	**2,665**	578	331	131	54	191	**1,285**
1983	869	329	762	409	164	**2,534**	619	309	118	48	164	**1,257**
1984	914	317	788	429	158	**2,605**	659	296	124	46	158	**1,283**
1985	944	343	780	455	159	**2,680**	682	321	126	38	159	**1,326**
1986	974	371	772	482	160	**2,759**	705	349	127	32	160	**1,374**
1987	1,008	405	764	514	163	**2,854**	731	384	129	28	163	**1,434**
1988	1,047	419	788	540	164	**2,959**	764	399	139	31	164	**1,497**
1989	1,087	434	813	568	165	**3,068**	798	416	149	35	165	**1,563**
1990	1,132	451	840	600	167	**3,190**	836	434	161	40	167	**1,639**
1991	1,152	456	851	603	173	**3,236**	858	441	152	36	173	**1,660**
1992	1,174	461	862	606	180	**3,283**	881	448	144	32	180	**1,684**
1993	1,196	467	874	609	187	**3,332**	906	455	136	29	187	**1,712**
1994	1,213	474	897	640	181	**3,405**	917	461	146	29	181	**1,734**
1995	1,243	492	954	688	179	**3,555**	947	479	167	33	179	**1,804**
1996	1,275	523	959	696	185	**3,639**	981	510	157	30	185	**1,863**
1997	1,309	559	964	705	192	**3,729**	1,018	545	148	27	192	**1,931**
1998	1,335	609	974	737	188	**3,843**	1,049	597	169	25	188	**2,029**
1999	1,362	669	984	771	187	**3,973**	1,081	660	196	24	187	**2,149**
2000	1,352	674	996	829	188	**4,040**	1,085	666	218	23	188	**2,180**
2001	1,342	679	1,009	891	189	**4,111**	1,089	671	242	22	189	**2,213**
2002	1,333	685	1,023	957	190	**4,187**	1,094	676	269	22	190	**2,250**
2003	1,323	690	1,036	1,028	192	**4,269**	1,098	681	299	21	192	**2,290**
2004	1,313	696	1,050	1,120	194	**4,373**	1,102	687	341	20	194	**2,344**
2005	1,342	710	1,077	1,147	207	**4,484**	1,126	701	349	21	207	**2,404**
2006	1,372	726	1,104	1,176	220	**4,597**	1,150	716	357	21	220	**2,464**
2007	1,402	741	1,132	1,205	233	**4,714**	1,174	732	365	22	233	**2,527**
2008	1,433	757	1,161	1,234	247	**4,833**	1,199	747	374	22	247	**2,591**
2009	1,465	773	1,191	1,265	262	**4,956**	1,225	763	383	23	262	**2,656**
2010	1,497	790	1,221	1,296	277	**5,081**	1,251	780	391	23	277	**2,723**
2011	1,523	804	1,243	1,319	282	**5,171**	1,274	794	398	24	282	**2,772**
2012	1,550	818	1,265	1,342	287	**5,263**	1,296	808	405	24	287	**2,821**
2013	1,578	833	1,287	1,366	292	**5,356**	1,319	822	413	25	292	**2,871**
2014	1,606	848	1,310	1,390	298	**5,451**	1,343	837	420	25	298	**2,922**
2015	1,634	863	1,333	1,415	303	**5,548**	1,367	852	427	26	303	**2,974**
2016	1,663	878	1,356	1,440	308	**5,646**	1,391	867	435	26	308	**3,027**
2017	1,693	894	1,380	1,465	314	**5,746**	1,416	882	443	27	314	**3,081**
2018	1,723	910	1,405	1,491	319	**5,848**	1,441	898	451	27	319	**3,136**
2019	1,753	926	1,430	1,518	325	**5,952**	1,466	914	459	27	325	**3,191**
2020	1,784	942	1,455	1,544	331	**6,057**	1,492	930	467	28	331	**3,248**

Note: This Table shows the results obtained by the application of Equation 5-35, p. 125.

Table F-10 Total primary energy consumption: PPP_1, SRP_1, PPP_2 and SRP_1 (PJ)

	PPP_1						SRP_1						PPP_2						SRP_2					
	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**
2005	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	207	**4,484**
2006	1,362	720	1,100	1,167	218	**4,567**	1,349	712	1,095	1,158	216	**4,529**	1,352	714	1,096	1,158	216	**4,537**	1,326	698	1,086	1,140	211	**4,461**
2007	1,382	730	1,124	1,187	229	**4,653**	1,356	714	1,114	1,169	224	**4,577**	1,363	718	1,116	1,171	226	**4,593**	1,311	687	1,096	1,136	216	**4,447**
2008	1,403	739	1,148	1,209	241	**4,741**	1,363	716	1,133	1,182	234	**4,628**	1,374	722	1,137	1,185	235	**4,653**	1,298	677	1,107	1,135	221	**4,439**
2009	1,424	749	1,174	1,230	254	**4,831**	1,371	718	1,153	1,195	243	**4,681**	1,385	727	1,158	1,200	246	**4,715**	1,286	668	1,120	1,136	226	**4,435**
2010	1,446	760	1,200	1,253	266	**4,924**	1,380	721	1,174	1,209	252	**4,736**	1,397	731	1,180	1,215	256	**4,780**	1,241	638	1,132	1,202	231	**4,444**
2011	1,461	767	1,217	1,267	269	**4,982**	1,383	721	1,186	1,216	252	**4,758**	1,404	733	1,194	1,223	256	**4,811**	1,188	604	1,137	1,270	229	**4,427**
2012	1,477	775	1,234	1,282	272	**5,041**	1,386	721	1,199	1,223	252	**4,781**	1,367	708	1,207	1,308	258	**4,847**	1,138	571	1,142	1,340	227	**4,417**
2013	1,494	783	1,252	1,297	274	**5,101**	1,346	695	1,211	1,307	253	**4,813**	1,330	684	1,220	1,394	259	**4,887**	1,090	541	1,147	1,410	225	**4,414**
2014	1,511	791	1,271	1,313	277	**5,162**	1,308	669	1,224	1,393	254	**4,848**	1,297	661	1,235	1,399	326	**4,917**	1,048	513	1,154	1,406	280	**4,400**
2015	1,528	800	1,289	1,328	280	**5,224**	1,270	644	1,237	1,481	256	**4,887**	1,265	639	1,249	1,403	393	**4,950**	1,008	486	1,161	1,402	333	**4,391**
2016	1,545	808	1,308	1,345	283	**5,288**	1,233	619	1,250	1,570	257	**4,929**	1,233	617	1,264	1,409	460	**4,984**	969	461	1,169	1,401	386	**4,386**
2017	1,514	786	1,326	1,445	286	**5,357**	1,197	594	1,264	1,660	259	**4,974**	1,202	595	1,280	1,415	528	**5,020**	933	437	1,177	1,400	438	**4,385**
2018	1,482	764	1,345	1,547	290	**5,429**	1,161	570	1,278	1,752	261	**5,022**	1,170	574	1,296	1,422	597	**5,059**	898	414	1,186	1,401	491	**4,388**
2019	1,451	743	1,364	1,651	293	**5,503**	1,126	546	1,293	1,845	264	**5,074**	1,139	552	1,312	1,430	666	**5,100**	864	391	1,195	1,402	543	**4,396**
2020	1,420	721	1,384	1,757	297	**5,579**	1,095	524	1,308	1,856	333	**5,115**	1,109	531	1,329	1,438	737	**5,143**	832	369	1,205	1,405	596	**4,407**

Note: This Table shows the results obtained by the application of Equation 5-35, p. 125.

Table F-10 Primary energy consumption for electricity production: PPP_1, SRP_1, PPP_2 and SRP_1 (PJ)

	PPP_1						SRP_1						PPP_2						SRP_2					
	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**
2005	1,126	701	349	21	207	**2,404**	1,126	701	349	21	207	**2,404**	1,126	701	349	21	207	**2,404**	1,126	701	349	21	207	**2,404**
2006	1,141	711	353	21	218	**2,444**	1,128	703	349	21	216	**2,416**	1,131	705	349	21	216	**2,423**	1,107	690	341	21	211	**2,369**
2007	1,156	720	358	22	229	**2,485**	1,131	705	349	21	224	**2,430**	1,138	709	350	21	226	**2,443**	1,089	679	333	20	216	**2,338**
2008	1,171	730	362	22	241	**2,527**	1,134	707	349	21	234	**2,445**	1,144	713	351	21	235	**2,465**	1,073	669	327	20	221	**2,310**
2009	1,187	740	367	22	254	**2,570**	1,138	709	350	21	243	**2,461**	1,151	717	352	21	246	**2,488**	1,059	660	321	20	226	**2,285**
2010	1,204	750	371	23	266	**2,614**	1,142	712	351	21	252	**2,478**	1,159	722	353	22	256	**2,511**	1,010	630	380	19	231	**2,270**
2011	1,216	758	374	23	269	**2,639**	1,142	712	350	21	252	**2,477**	1,162	724	353	22	256	**2,517**	956	596	446	19	229	**2,245**
2012	1,228	765	377	23	272	**2,665**	1,143	712	349	21	252	**2,477**	1,122	699	429	21	258	**2,529**	904	564	513	18	227	**2,226**
2013	1,241	773	380	23	274	**2,692**	1,100	686	425	21	253	**2,485**	1,082	674	506	21	259	**2,543**	855	533	581	17	225	**2,212**
2014	1,254	781	383	23	277	**2,719**	1,059	660	503	20	254	**2,496**	1,047	652	502	20	326	**2,546**	811	505	574	17	280	**2,186**
2015	1,267	790	386	24	280	**2,746**	1,018	635	581	20	256	**2,510**	1,011	630	498	20	393	**2,551**	769	479	567	16	333	**2,164**
2016	1,280	798	390	24	283	**2,774**	978	610	661	20	257	**2,526**	976	608	494	20	460	**2,557**	728	454	561	16	386	**2,145**
2017	1,245	776	477	24	286	**2,808**	939	585	742	19	259	**2,544**	941	586	490	19	528	**2,565**	690	430	556	15	438	**2,129**
2018	1,210	754	566	23	290	**2,843**	900	561	824	19	261	**2,565**	906	565	487	19	597	**2,574**	652	406	552	15	491	**2,116**
2019	1,175	732	656	23	293	**2,880**	862	537	907	18	264	**2,589**	871	543	484	19	666	**2,584**	616	384	548	14	543	**2,107**
2020	1,140	710	748	23	297	**2,918**	827	516	908	18	333	**2,601**	837	521	482	18	737	**2,595**	582	362	545	14	596	**2,100**

Note: This Table shows the results obtained by the application of Equation 5-35, p. 125.

Table F-10 Total primary energy consumption: PPP/SRP for Early and Delay action (PJ)

	PPP_{Early}						SRP_{Early}						PPP_{Delay}						SRP_{Delay}					
	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**
2005	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	207	**4,484**	1,342	710	1,077	1,147	188	**4,465**
2006	1,347	711	1,094	1,154	215	**4,521**	1,337	705	1,090	1,149	213	**4,495**	1,372	726	1,104	1,176	220	**4,597**	1,372	726	1,104	1,176	192	**4,570**
2007	1,353	712	1,112	1,163	224	**4,564**	1,334	701	1,105	1,153	220	**4,512**	1,402	741	1,132	1,205	233	**4,714**	1,402	741	1,132	1,205	196	**4,677**
2008	1,359	714	1,131	1,173	233	**4,610**	1,331	697	1,120	1,158	227	**4,533**	1,433	757	1,161	1,234	247	**4,833**	1,433	757	1,161	1,234	201	**4,786**
2009	1,366	715	1,150	1,185	242	**4,659**	1,329	693	1,137	1,165	234	**4,557**	1,465	773	1,191	1,265	262	**4,956**	1,465	773	1,191	1,265	205	**4,899**
2010	1,374	717	1,171	1,198	251	**4,710**	1,327	690	1,153	1,173	241	**4,584**	1,497	790	1,221	1,296	277	**5,081**	1,497	790	1,221	1,296	209	**5,013**
2011	1,333	690	1,182	1,278	251	**4,734**	1,280	659	1,161	1,247	240	**4,587**	1,470	772	1,220	1,272	271	**5,004**	1,459	766	1,217	1,269	203	**4,913**
2012	1,293	664	1,193	1,359	252	**4,761**	1,234	629	1,170	1,323	239	**4,595**	1,446	757	1,221	1,256	265	**4,946**	1,425	744	1,214	1,248	197	**4,829**
2013	1,258	640	1,206	1,360	315	**4,778**	1,190	600	1,178	1,400	239	**4,608**	1,424	742	1,224	1,244	259	**4,894**	1,394	724	1,214	1,232	192	**4,755**
2014	1,223	616	1,218	1,362	379	**4,798**	1,148	572	1,188	1,478	239	**4,625**	1,360	701	1,227	1,312	255	**4,856**	1,323	679	1,213	1,295	184	**4,693**
2015	1,189	593	1,232	1,365	442	**4,820**	1,107	545	1,197	1,558	239	**4,647**	1,303	664	1,232	1,298	313	**4,810**	1,256	637	1,213	1,360	177	**4,644**
2016	1,155	570	1,245	1,369	506	**4,845**	1,071	521	1,208	1,560	299	**4,658**	1,249	630	1,237	1,286	370	**4,771**	1,194	597	1,215	1,427	171	**4,604**
2017	1,122	547	1,259	1,374	570	**4,872**	1,035	497	1,218	1,562	359	**4,673**	1,198	596	1,243	1,276	424	**4,737**	1,139	562	1,217	1,414	162	**4,495**
2018	1,089	525	1,274	1,379	635	**4,901**	1,001	474	1,230	1,566	420	**4,691**	1,149	565	1,250	1,268	477	**4,709**	1,087	529	1,221	1,404	154	**4,395**
2019	1,057	503	1,289	1,385	700	**4,933**	968	452	1,242	1,571	480	**4,713**	1,102	534	1,257	1,262	529	**4,685**	1,039	498	1,225	1,396	146	**4,304**
2020	1,026	481	1,304	1,391	766	**4,968**	936	430	1,254	1,576	541	**4,738**	1,058	505	1,265	1,257	580	**4,666**	994	468	1,231	1,390	138	**4,221**

Note: This Table shows the results obtained by the application of Equation 5-35, p. 125.

Table F-10 Primary energy consumption for electricity production: PPP/SRP for Early and Delay action (PJ)

	PPP_{Early}						SRP_{Early}						PPP_{Delay}						SRP_{Delay}					
	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**	Black coal	Brown coal	Petroleum	Natural gas	Renewable	**Total**
2005	1,126	701	349	21	207	**2,404**	1,126	701	349	21	207	**2,404**	1,126	701	349	21	207	**2,404**	1,126	701	349	21	188	**2,385**
2006	1,127	702	347	21	215	**2,412**	1,117	696	345	21	213	**2,393**	1,150	716	357	21	220	**2,464**	1,150	716	357	21	192	**2,437**
2007	1,129	703	346	21	224	**2,423**	1,110	692	341	21	220	**2,384**	1,174	732	365	22	233	**2,527**	1,174	732	365	22	196	**2,490**
2008	1,131	705	345	21	233	**2,435**	1,104	688	338	21	227	**2,378**	1,199	747	374	22	247	**2,591**	1,199	747	374	22	201	**2,544**
2009	1,134	706	345	21	242	**2,447**	1,098	684	335	21	234	**2,373**	1,225	763	383	23	262	**2,656**	1,225	763	383	23	205	**2,599**
2010	1,137	708	344	21	251	**2,461**	1,093	681	333	21	241	**2,369**	1,251	780	391	23	277	**2,723**	1,251	780	391	23	209	**2,655**
2011	1,093	681	417	21	251	**2,464**	1,044	650	403	20	240	**2,357**	1,224	763	377	23	271	**2,657**	1,214	756	376	23	203	**2,571**
2012	1,051	655	492	20	252	**2,469**	996	621	474	19	239	**2,349**	1,199	747	365	22	265	**2,599**	1,179	735	362	22	197	**2,495**
2013	1,012	631	486	20	315	**2,464**	950	592	546	19	239	**2,346**	1,176	733	354	22	259	**2,544**	1,147	715	349	22	192	**2,425**
2014	975	607	480	19	379	**2,460**	905	564	619	18	239	**2,346**	1,111	692	422	21	255	**2,501**	1,076	670	415	21	184	**2,366**
2015	937	584	475	19	442	**2,458**	862	537	693	18	239	**2,349**	1,052	656	408	20	313	**2,450**	1,008	628	483	20	177	**2,317**
2016	901	561	471	19	506	**2,457**	823	513	688	17	299	**2,341**	997	621	396	19	370	**2,402**	945	589	551	19	171	**2,275**
2017	864	539	467	18	570	**2,458**	785	489	685	17	359	**2,336**	943	588	384	19	424	**2,359**	889	554	539	18	162	**2,162**
2018	829	516	463	18	635	**2,461**	748	466	682	17	420	**2,333**	893	556	374	18	477	**2,319**	836	521	528	18	154	**2,057**
2019	793	494	460	17	700	**2,465**	713	444	680	16	480	**2,333**	844	526	365	18	529	**2,283**	787	490	519	17	146	**1,959**
2020	758	472	457	17	766	**2,471**	678	422	678	16	541	**2,335**	798	497	358	17	580	**2,250**	740	461	511	16	138	**1,867**

Note: This Table shows the results obtained by the application of Equation 5-35, p. 125.

Table F-11 Economy-wide CO_2 emissions from fossil fuel combustion (ktonnes)

	BC	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
1980	186,974								
1981	189,070								
1982	192,046								
1983	183,903								
1984	189,534								
1985	195,750								
1986	202,171								
1987	209,132								
1988	217,095								
1989	225,360								
1990	234,437								
1991	237,735								
1992	241,080								
1993	244,544								
1994	250,054								
1995	260,820								
1996	267,637								
1997	274,817								
1998	284,517								
1999	294,918								
2000	298,898								
2001	302,931								
2002	307,018								
2003	311,161								
2004	315,502								
2005	322,815	322,815	322,815	322,815	322,815	322,815	322,815	322,815	322,815
2006	330,299	328,119	325,324	325,946	320,386	324,843	322,897	330,299	330,299
2007	337,958	333,571	328,023	329,309	318,554	327,186	323,321	337,958	337,958
2008	345,796	339,167	330,892	332,859	317,145	329,758	324,017	345,796	345,796
2009	353,817	344,907	333,919	336,573	316,073	332,511	324,943	353,817	353,817
2010	362,026	350,790	337,093	340,433	313,314	335,421	326,072	362,026	362,026
2011	368,436	354,890	338,558	342,561	309,100	334,008	323,191	356,537	354,599
2012	374,962	359,071	340,116	342,063	305,398	332,835	320,683	352,266	348,244
2013	381,604	363,333	339,205	341,750	302,167	328,234	318,522	348,466	342,577
2014	388,365	367,675	338,526	337,870	295,894	323,816	316,686	342,440	335,021
2015	395,248	372,097	338,069	334,111	290,052	319,565	315,157	333,320	328,354
2016	402,254	376,600	337,826	330,462	284,602	315,473	310,330	324,837	322,478
2017	409,386	378,130	337,788	326,917	279,511	311,527	305,774	316,928	313,666
2018	416,645	379,764	337,950	323,467	274,752	307,720	301,468	309,543	305,571
2019	424,035	381,504	338,304	320,108	270,298	304,043	297,394	302,636	298,120
2020	431,557	383,347	334,957	316,833	266,125	300,489	293,536	296,169	291,247

Note: This Table shows the results obtained by the application of Equation 5-36, p. 125.

Table F-11 CO_2 emissions from electricity sector (ktonnes)

	BC	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
1980	84,284								
1981	87,555								
1982	94,403								
1983	94,842								
1984	97,459								
1985	101,776								
1986	106,284								
1987	111,309								
1988	116,536								
1989	122,007								
1990	128,146								
1991	130,183								
1992	132,253								
1993	134,405								
1994	136,536								
1995	142,254								
1996	147,758								
1997	153,699								
1998	162,643								
1999	172,669								
2000	174,909								
2001	177,178								
2002	179,477								
2003	181,805								
2004	184,240								
2005	188,222	188,222	188,222	188,222	188,222	188,222	188,222	188,222	188,222
2006	192,289	190,703	188,588	189,123	184,922	188,322	186,786	192,289	192,289
2007	196,442	193,241	189,034	190,110	181,943	188,542	185,519	196,442	196,442
2008	200,683	195,835	189,553	191,166	179,210	188,852	184,391	200,683	200,683
2009	205,015	198,485	190,138	192,281	176,685	189,232	183,384	205,015	205,015
2010	209,438	201,190	190,785	193,449	172,382	189,672	182,485	209,438	209,438
2011	213,160	203,191	190,776	193,941	167,603	186,875	178,634	204,546	202,919
2012	216,949	205,229	190,815	191,797	163,254	184,265	175,091	200,203	197,016
2013	220,806	207,304	188,363	189,793	159,301	178,171	171,835	196,143	191,569
2014	224,732	209,415	186,090	184,170	152,249	172,199	168,848	189,785	184,116
2015	228,728	211,563	183,988	178,612	145,545	166,339	166,115	180,214	177,413
2016	232,795	213,748	182,051	173,111	139,156	160,581	160,023	171,160	171,382
2017	236,936	212,956	180,272	167,661	133,054	154,915	154,135	162,574	162,294
2018	241,151	212,225	178,645	162,254	127,214	149,335	148,434	154,416	153,801
2019	245,441	211,552	177,164	156,885	121,611	143,832	142,903	146,647	145,838
2020	249,808	210,938	171,948	151,550	116,227	138,400	137,529	139,236	138,350

Note: This Table shows the results obtained by the application of Equation 5-36, p. 125.

Table F-12 Total employment (persons)

	BC	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
2005	8,409,215	8,409,215	8,409,215	8,409,215	8,409,215	8,409,215	8,409,215	8,409,215	8,409,215
2006	8,521,232	8,503,037	8,503,037	8,484,846	8,484,846	8,475,589	8,460,953	8,521,232	8,521,232
2007	8,634,785	8,598,671	8,596,451	8,563,828	8,561,526	8,546,575	8,517,038	8,634,785	8,634,785
2008	8,749,893	8,696,038	8,691,538	8,645,403	8,640,739	8,620,667	8,576,332	8,749,893	8,749,893
2009	8,866,577	8,795,079	8,788,239	8,729,109	8,722,020	8,697,070	8,638,186	8,866,577	8,866,577
2010	8,984,858	8,895,750	8,886,509	8,814,657	8,805,078	8,775,355	8,702,214	8,984,858	8,984,858
2011	9,029,692	8,923,834	8,912,224	8,828,475	8,816,442	8,781,165	8,694,867	8,934,717	8,922,107
2012	9,074,770	8,952,357	8,938,356	8,841,846	8,827,335	8,787,742	8,688,977	8,900,074	8,870,671
2013	9,120,096	8,981,285	8,964,868	8,855,815	8,838,800	8,797,482	8,684,390	8,869,193	8,824,889
2014	9,165,668	9,010,589	8,991,734	8,872,763	8,853,221	8,808,187	8,680,988	8,839,216	8,781,776
2015	9,211,489	9,040,249	9,018,930	8,890,495	8,868,400	8,819,789	8,678,681	8,813,806	8,742,145
2016	9,257,560	9,070,243	9,046,438	8,908,960	8,884,287	8,832,236	8,679,878	8,790,783	8,705,504
2017	9,303,880	9,099,514	9,073,197	8,928,119	8,900,843	8,845,488	8,682,495	8,769,929	8,674,117
2018	9,350,452	9,129,117	9,100,264	8,947,942	8,918,038	8,859,507	8,686,450	8,751,066	8,645,936
2019	9,397,277	9,159,042	9,127,628	8,968,404	8,935,845	8,874,264	8,691,671	8,734,042	8,620,676
2020	9,444,354	9,189,278	9,155,306	8,989,481	8,954,242	8,889,729	8,698,092	8,718,723	8,598,094

Note: This Table shows the results obtained by the application of Equation 5-38, p. 126.

Table F-12 Sectoral employment for 2005 and 2020 (persons)

	2005	2020								
	BC	BC	PPP_1	SRP_1	PPP_2	SRP_2	PPP_{Early}	SRP_{Early}	PPP_{Delay}	SRP_{Delay}
Coal sector	27,756	31,017	25,912	25,988	22,227	23,557	20,817	18,869	19,010	17,942
Petroleum sector	5,224	5,803	5,023	5,157	4,508	4,829	4,302	4,236	3,976	4,064
Gas sector	6,081	6,804	5,784	6,747	4,491	5,860	4,297	4,932	3,849	4,318
Renewable Electricity	3,712	4,925	4,582	5,131	12,126	7,984	12,934	9,204	10,556	8,146
Coal-fired Electricity	37,021	40,713	33,200	32,940	25,977	30,635	24,298	23,106	27,022	26,118
Internal-combustion Electricity	107	120	112	111	106	107	104	99	102	99
Gas-turbine Electricity	738	827	770	764	731	736	714	679	701	677
Combined-cycle Electricity	1,571	1,760	6,316	5,702	3,777	3,562	3,690	6,606	2,555	4,527
Agriculture, forestry and fishing	318,760	356,147	344,121	340,111	333,425	328,273	328,237	314,246	319,418	308,415
Mining	79,733	89,617	85,893	85,505	82,765	82,617	81,261	79,003	78,782	77,619
Food, beverages and tobacco	179,983	201,373	194,592	191,835	188,559	184,832	185,641	176,480	180,666	173,019
Textile, clothing, footwear and leather	58,839	65,764	63,482	62,528	61,494	60,183	60,533	57,340	58,887	56,175
Wood, paper and printing products	241,375	269,717	261,542	259,589	255,127	252,580	251,909	243,647	246,344	240,126
Basic chemicals	89,508	100,043	96,390	95,485	93,462	92,325	92,044	88,274	89,628	86,699
Non-metallic mineral products	38,922	43,230	41,602	41,445	40,766	40,466	40,242	38,906	39,267	38,370
Basic iron and steel	30,778	34,334	33,053	32,882	32,164	31,958	31,699	30,676	30,891	30,207
Basic non-ferrous metals	18,851	21,197	20,425	20,324	19,757	19,679	19,426	18,919	18,866	18,603
Fabricated metal products	95,027	106,479	102,529	102,036	99,940	99,300	98,565	95,358	96,148	93,951
Machinery and equipment	230,292	258,753	249,235	247,460	242,582	240,223	239,118	230,248	233,073	226,563
Miscellenous manufacturing	14,918	16,860	16,283	16,085	15,782	15,520	15,538	14,841	15,121	14,562
Water, sewerage and drainage	25,307	28,434	27,432	27,024	26,531	25,994	26,118	24,730	25,426	24,224
Construction	735,793	826,921	795,095	792,827	780,271	774,879	770,379	745,070	751,361	734,832
Road transport	207,095	232,401	224,534	222,070	218,075	214,836	214,931	205,729	209,582	202,150
Railway transport	44,225	49,597	46,813	46,497	44,514	44,503	43,546	41,647	42,101	40,764
Water transport	14,175	15,923	15,288	15,126	14,757	14,568	14,509	13,864	14,093	13,588
Air transport	39,839	44,789	43,443	43,011	42,262	41,703	41,695	40,138	40,732	39,494
Other transport, services and storage	326,865	367,128	356,100	353,030	345,496	342,019	340,756	329,272	332,638	323,717
Commercial services	5,536,720	6,223,674	6,089,728	6,077,898	5,977,807	5,970,514	5,922,425	5,841,972	5,827,927	5,789,125
Total	**8,409,215**	**9,444,354**	**9,189,278**	**9,155,306**	**8,989,481**	**8,954,242**	**8,889,729**	**8,698,092**	**8,718,723**	**8,598,094**

Note: This Table shows the results obtained by the application of Equation 5-38, p. 126.

Table F-13 Economic impacts in present- and future-values ($ million)

	BC	PPP_{Early}			SRP_{Early}			PPP_{Delay}			SRP_{Delay}		
	GDP=Net	GDP	Tax Revenue	Net	GDP	Tax Revenue	Net	GDP	Tax Revenue	Net	GDP	Tax Revenue	Net
$PV_{2005-2020}$	**6,325.1**	6,200.3	65.3	**6,265.6**	6,155.3	135.1	**6,290.4**	6,225.0	73.0	**6,298.0**	6,206.8	101.7	**6,308.5**
$PV_{2005-2040}$	**9,123.3**	8,724.7	95.3	**8,820.0**	8,616.9	173.1	**8,790.0**	8,692.9	103.1	**8,796.0**	8,630.1	141.7	**8,771.8**
2005	552.5	552.5	0.0	552.5	552.5	0.0	552.5	552.5	0.0	552.5	552.5	0.0	552.5
2006	569.6	567.2	8.2	575.4	566.4	17.6	584.1	569.6	0.0	569.6	569.6	0.0	569.6
2007	587.3	582.5	8.3	590.8	581.0	17.5	598.5	587.3	0.0	587.3	587.3	0.0	587.3
2008	605.6	598.4	8.4	606.8	596.0	17.5	613.5	605.6	0.0	605.6	605.6	0.0	605.6
2009	624.4	614.9	8.4	623.3	611.6	17.4	629.1	624.4	0.0	624.4	624.4	0.0	624.4
2010	643.7	631.9	8.5	640.4	627.8	17.4	645.2	643.7	0.0	643.7	643.7	0.0	643.7
2011	658.6	644.2	8.5	652.7	639.3	17.2	656.5	653.0	18.5	671.5	652.3	26.0	678.3
2012	673.7	656.9	8.4	665.3	651.1	17.0	668.2	663.4	18.3	681.7	661.7	25.5	687.2
2013	689.2	670.1	8.3	678.4	663.3	16.9	680.1	674.3	18.1	692.4	671.6	25.1	696.7
2014	705.1	683.7	8.2	691.9	675.7	16.7	692.4	685.3	17.8	703.1	681.8	24.6	706.4
2015	721.3	697.5	8.1	705.6	688.5	16.6	705.1	697.0	17.3	714.2	692.4	24.0	716.4
2016	737.9	711.7	8.0	719.7	701.8	16.5	718.3	709.0	16.8	725.8	703.3	23.5	726.9
2017	754.9	726.3	7.9	734.2	715.5	16.4	731.9	721.3	16.4	737.8	714.9	23.0	738.0
2018	772.3	741.2	7.8	749.0	729.6	16.3	745.9	734.1	16.0	750.1	726.9	22.4	749.3
2019	790.0	756.4	7.7	764.1	744.0	16.1	760.1	747.1	15.7	762.8	739.3	21.8	761.1
2020	808.2	772.1	7.6	779.7	758.8	15.8	774.6	760.6	15.3	775.9	752.1	21.3	773.4
2021	826.6	771.1	7.7	778.8	752.0	12.0	764.1	752.3	15.3	767.5	740.1	20.9	761.0
2022	845.5	785.0	10.3	795.4	765.6	12.8	778.4	766.1	9.6	775.7	753.5	12.7	766.2
2023	864.8	799.3	10.4	809.7	779.4	12.9	792.3	780.2	9.7	789.9	767.1	12.8	779.9
2024	884.5	813.8	10.4	824.3	793.6	13.0	806.5	794.7	9.7	804.4	781.1	12.8	793.9
2025	904.7	828.7	10.5	839.2	808.0	13.0	821.1	809.4	9.8	819.1	795.3	12.9	808.2
2026	925.3	843.8	10.6	854.4	822.8	13.1	835.9	824.4	9.8	834.3	809.9	13.0	822.9
2027	946.5	859.3	10.6	869.9	837.9	13.2	851.1	839.8	9.9	849.7	824.8	13.1	837.8
2028	968.1	875.1	10.7	885.8	853.3	13.3	866.6	855.5	9.9	865.4	840.0	13.1	853.1
2029	990.2	891.3	10.7	902.1	869.1	13.4	882.4	871.5	10.0	881.5	855.5	13.2	868.8
2030	1,012.8	907.8	10.8	918.6	885.2	13.5	898.6	887.9	10.1	898.0	871.4	13.3	884.7
2031	1,035.9	924.7	10.9	935.6	901.6	13.6	915.2	904.6	10.1	914.8	887.7	13.4	901.0
2032	1,059.6	941.9	10.9	952.8	918.4	13.7	932.1	921.7	10.2	931.9	904.2	13.5	917.7
2033	1,083.8	959.5	11.0	970.5	935.6	13.7	949.3	939.1	10.3	949.4	921.2	13.6	934.7
2034	1,107.5	977.4	11.1	988.5	953.1	13.9	967.0	956.9	10.4	967.3	938.5	13.7	952.1
2035	1,133.9	995.8	11.2	1,006.9	971.0	14.0	985.0	975.1	10.4	985.6	956.1	13.8	969.9
2036	1,159.8	1,014.5	11.2	1,025.7	989.3	14.1	1,003.4	993.7	10.5	1,004.2	974.2	13.9	988.1
2037	1,186.3	1,033.6	11.3	1,044.9	1,008.0	14.2	1,022.2	1,012.7	10.6	1,023.2	992.6	14.0	1,006.6
2038	1,213.4	1,053.1	11.4	1,064.5	1,027.1	14.3	1,041.4	1,032.0	10.7	1,042.7	1,011.5	14.1	1,025.5
2039	1,241.2	1,073.1	11.5	1,084.6	1,046.6	14.4	1,061.0	1,051.8	10.7	1,062.5	1,030.7	14.2	1,044.9
2040	1,269.6	1,093.4	11.6	1,105.0	1,066.5	14.5	1,081.0	1,072.0	10.8	1,082.8	1,050.4	14.3	1,064.7
$FV_{2005-2020}$	**23,711.5**	22,999.3	255.8	**23,255.1**	22,737.6	528.6	**23,266.2**	22,977.8	416.8	**23,394.6**	22,843.6	580.7	**23,424.3**
$FV_{2005-2040}$	**208,424.3**	186,265.7	2,116.8	**188,382.5**	181,952.1	2,860.6	**184,812.7**	182,793.2	2,182.9	**184,976.2**	179,609.9	2,914.4	**182,524.3**

Notes:
- Net economic impacts shown in this Table refer to net of GDP and tax revenue;
- GDP shown in this Table is calculated from ∑ (final consumption + (net) exports + investment) for all sectors. Final consumption, (net) exports, and investment are taken from Tables F-1, F-2, and F-4, respectively;
- Tax revenues shown in this Table are taken from Table F-7.

BIBLIOGRAPHY

AATSE 1988, *Technology in Australia 1788-1988: A condensed history of Australian technology innovation and adaptation during the first two hundred years*, compiled by Fellows of the Australian Academy of Technological Science and Engineering, Melbourne.

ABARE 1997, 'International Climate Change Policy - Economic implications for Australia', *Australian Bureau of Agricultural and Resource Economics (ABARE) Current Issues*, no. 2, April.

ABARE 2006a, *Australian Energy: consumption and production, 1974-75 to 2004-05*, Australian Bureau of Agricultural and Resource Economics, Commonwealth of Australia, viewed September 2006 <http://www.abareconomics.com/interactive/energy/index.html>.

ABARE 2006b, *Drought update: Australian crop and livestock report*, Australian Bureau of Agricultural and Resource Economics, Canberra.

ABARE various, *Australian Commodity Statistics: ...year*, Australian Bureau of Agricultural and Resource Economics (ABARE), Canberra.

ABC 2004a, *The 7.30 Report: Howard unveils big spending energy package*, Australian Broadcasting Corporation, Sydney, <http://www.abc.net.au/7.30/content/2004/s1132541.htm>.

ABC 2004b, *The 7.30 Report: Kemp defends Government's green initiatives*, Australian Broadcasting Corporation, Sydney, <http://www.abc.net.au/7.30/content/2004/s1132546.htm>.

ABS 2003, *Consumer Price Index, Australia (Catalogue No: 6401.0)*, Australian Bureau of Statistics (ABS), viewed December.

ABS 2004a, *Australian Mining Industry: various years (Catalogue No: 8414.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2004b, *Australian National Accounts: Input-Output Table, 1990*, Australian Bureau of Statistics (ABS), viewed May.

ABS 2004c, *Australian National Accounts: Input-Output Tables, 1999 (Catalogue No: 5209.0.55.001)*, Australian Bureau of Statistics (ABS), viewed July <http://www.abs.gov.au/ausstats/abs@.nsf/lookupresponses/2dc4adb6157d1ba2ca256ec1007e4323?opendocument>.

ABS 2004d, *Australian System of National Accounts: Table 8. Implicit Price Deflator for Capital Formation (Catalogue No: 5204.0)*, Australian Bureau of Statistics (ABS), viewed September.

ABS 2004e, *Australian System of National Accounts: Table 62. Gross Fixed Capital Formation (Catalogue No: 5204.0)*, Australian Bureau of Statistics (ABS), viewed June.

ABS 2004f, *Australian System of National Accounts: Table 69. Capital Stock (Catalogue No: 5204.0)*, Australian Bureau of Statistics (ABS), viewed June.

ABS 2004g, *Electricity, Gas, Water and Sewerage Industries, Australia: various years (Catalogue No: 8208.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2004h, *Electricity, Gas, Water and Sewerage Operations, Australia: various years (Catalogue No: 8226.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2004i, *Labour Force, Australia: various years (Catalogue No: 6203.0) Table 38. Employed Persons by Industry*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2004j, *Manufacturing Industry, Australia: various years (Catalogue No: 8221.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2004k, *Producer Price Indexes, Australia (Catalogue No:6427.0)*, Australian Bureau of Statistics (ABS), viewed September.

ABS 2004l, *Survey of Motor Vehicle Use, Australia: various years (Catalogue No: 9208.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS 2006a, *Australian System of National Accounts: Table 2 Expenditure on GDP (Catalogue No: 5204.0)*, Australian Bureau of Statistics (ABS), viewed January 2007.

ABS 2006b, *Electricity, Gas, Water and Sewerage Operations, Australia: various years (Catalogue No: 8226.0)*, Australian Bureau of Statistics (ABS), Canberra.

ABS various, *Australian National Accounts: Input-Output Tables (Catalogue No: 5209.0.55.001)*, Australian Bureau of Statistics (ABS).

ACA 2005, *The Australian Coal Industry*, Australian Coal Association, viewed October 2005 <http://www/australiancoal.com.au>.

ACARP 2002, *ACARP - Coal in a Sustainable Society (ACARP Project II)*, Australian Coal Association Research Program, viewed December 2003 <http://ciss.com.au/ref/static/reports/public/acarp/acarp2.html>.

ACG & MMA 1999, *Energy Market Reform and Greenhouse Gas Emission Reductions*, Report by The Allen Consulting Group and McLennan Magasanik Associates for the Department of Industry, Science and Resources, Canberra.

Adriaanse, A., Bringezu, S., Hammond, A., Moriguchi, Y., Rodenburg, E., Rogich, D. & Schütz, H. 1997, *Resource Flows: The material basis of industrial economies*, World Resources Institute, Washington DC.

AGO 2005, *National Greenhouse Gas Inventory: Analysis of recent trends and greenhouse indicators 1990 to 2003*, Department of the Environment and Heritage, Commonwealth of Australia, Canberra.

AGO 2006, *National Greenhouse Gas Inventory 2004*, Australian Greenhouse Office, Department of the Environment and Heritage, Canberra.

AGO 2007, *Low Emissions Technology Demonstration Fund*, Australian Greenhouse Office, <http://www.greenhouse.gov.au/demonstrationfund/index.html>.

AGPS 1994, *Climate Change: Australia's national report under the United Nations Framework Convention on Climate Change*, Australian Government Publishing Service, Commonwealth of Australia, Canberra.

Ahammad, H., Matysek, A., Fisher, B.S., Curtotti, R., Gurney, A., Jakeman, G., Heyhoe, E. & Gunasekera, D. 2006, *Economic Impact of Climate Change Policy: The Role of Technology and Economic Instruments* ABARE Research Report 06.7, Canberra.

Akmal, M., Thorpe, S., Dickson, A., Burg, G. & Klijn, N. 2004, *Australian Energy: National and state projections to 2019-20*, ABARE Report no: 04.11, Prepared for the Department of Industry, Tourism and Resources, Commonwealth of Australia, Canberra.

Al-Ali, H.M. 1979, 'Input-Output Analysis of Energy Requirement: An application to the Scottish economy in 1973', *Energy Economics*, vol. 1, pp. 211-218.

Apelbaum Consulting Group 1997, *The Australian Transport Task - Energy Consumed and Greenhouse Gas Emissions*, Australian Government Publishing Service, Canberra.

Armstrong, G. 1997, *Greenhouse issues, policies and positions. Kyoto 1997*, NIEIR.

Arrow, K., Chenery, H., Minhas, B.S. & Solow, R. 1961, 'Capital-Labour Substitution and Economic Efficiency', *Review of Economics and Statistics*, vol. 43, no. 3, pp. 225-250.

Atkinson, G., Dubourg, R., Hamilton, K., Munasinghe, M., Pearce, D. & Young, C. 1997, *Measuring Sustainable Development: Macroeconomics and the Environment*, Edward Elgar, Cheltenham, UK.

Ayers, R.U. 1978, *Resources, Environment and Economics: Applications of the Materials/Energy Balance Principle*, John Wiley and Sons, New York.

Ayers, R.U. 1999, 'Materials, Economics and the Environment', in J.C.J.M. van den Bergh (ed.), *Handbook of Environmental and Resource Economics*, Edward Elgar Publication, Cheltenham, pp. 867-894.

Ayers, R.U. & Kneese, A.V. 1969, 'Production, Consumption, and Externalities', *American Economic Review*, vol. 59, no. 3, pp. 282-297.

Baer, P. 2003, 'An Issue of Scenarios: Carbon Sequestration as Investment and the Distribution of Risk', *Climatic Change*, vol. 59, no. 3, pp. 283 - 291.

Bartelmus, P. & Vesper, A. 2000, *Green Accounting and Material Flow Analysis: Alternatives or Complements?*, Wuppertal Papers No. 106, Division for Material Flows and Structural Change, Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany.

Barten, A.P. 1969, 'Maximum Likelyhood Estimation of a Complete System of Demand Equations', *European Economic Review*, vol. 1, no. 3, pp. 7-73.

BCSE 2004, *PM delivers a black energy future*, Australian Business Council for Sustainable Energy, Carlton, Victoria.

Beder, S. 2003, *Power play : the fight to control the world's electricity*, Scribe, Melbourne.

Bergerson, J. & Lave, L. 2002, *A Life Cycle Analysis of Electricity Generation Technologies: Health and Environmental Implications of Alternative Fuels and Technologies*, Carnegie Mellon Electricity Industry Centre, Carnegie Mellon University, Pittsburgh.

Berndt, E.R. & Christensen, L.R. 1973, 'The Internal Structure of Functional Relationships: Separability, Substitution and Aggregation', *Review of Economic Studies*, vol. 40, pp. 403-410.

Berndt, E.R. & Wood, D.O. 1975, 'Technology, Prices and the Derived Demand for Energy', *The Review of Economics and Statistics*, vol. 57, pp. 376-384.

Binswanger, H.P. 1974, 'A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution', *American Journal of Agricultural Economics*, vol. 56, no. 2, pp. 377-386.

Blakers, A. & Diesendorf, M. 1996, 'A Scenario for the Expansion of Solar and Wind Generated Electricity in Australia', *Australian Journal of Environmental Management*, vol. 3, no. 1, pp. 11-25.

Boehm, E.A. 1955, 'The Impact of Electricity', *The Economic Record*, vol. 31, pp. 61-76.

Booth, R.R. 2003, *Warring tribes: the story of power development in Australia*, Bardak Group, Doonan, QLD.

Boulding, K. 1966, 'The Economics of the Coming Spaceship Earth', in H. Jarrett (ed.), *Environmental Quality in a Growing Economy*, Resources for the Future/Johns Hopkins University Press, Baltimore, pp. 3-14.

Bouman, M., Heijungs, R., van der Voet, E., van den Bergh, J. & Huppes, G. 2000, 'Material flows and economic models: an analytical comparison of SFA, LCA and partial equilibrium models', *Ecological Economics*, vol. 32, pp. 195-216.

Boustead, I. & Hancock, G.F. 1979, *Handbook of Industrial Energy Analysis*, Ellis Horwood Limited, Chichester.

Bringezu, S. & Schütz, H. 2001, *Total Material Requirement of the European Union*, European Environment Agency Technical Report No. 55, Copenhagen.

Bulkeley, H. 2001, 'No regrets? Economy and environment in Australia's domestic climate change policy process', *Global Environmental Change*, vol. 11, no. 2, pp. 155-169.

Bullard, C.W. & Herendeen, R.A. 1975, 'The Energy Cost of Goods and Services', *Energy Policy*, vol. 3, no. 4, pp. 268-278.

Bullard, C.W., Penner, P.S. & Pilati, D.A. 1978, 'Net Energy Analysis: Handbook for Combining Process and Input-Output Analysis', *Resources and Energy*, vol. 1, pp. 267-313.

Bulmer-Thomas, V. 1982, *Input-Output Analysis in Developing Countries: Sources, Methods and Applications*, John Wiley & Sons, New York.

Burbridge, D., Mills, D. & Morrison, G. 2000, 'Stanwell Solar Thermal Power Project', *Proceedings of the 10th Solar PACES International Symposium on Solar Thermal Concentrating Technologies, March 8-10*, IEA SolarPACES Australia, Sydney.

Burney, N.A. & Al-Matrouk, F.T. 1996, 'Energy Conservation in Electricity Generation: A Case Study of the Electricity and Water Industry in Kuwait', *Energy Economics*, vol. 18, pp. 69-79.

Carter, A.J., Peet, N.J. & Baines, J.T. 1981, *Direct and Indirect Energy Requirements of the New Zealand Economy: An energy analysis of the 1971-72 inter-industry survey*, Report Number P55, New Zealand Energy Research and Development Committee, Auckland.

Chapman, P.F. 1975, 'The Energy Costs of Materials', *Energy Policy*, vol. 3, no. 2, pp. 47-57.

Chapman, P.F., Leach, G. & Slesser, M. 1974, 'The Energy Cost of Fuels', *Energy Policy*, vol. 2, no. 3, pp. 231-243.

Christensen, L.R., Jorgenson, D.W. & Lau, E.J. 1971, 'Conjugate Duality and the Transcendental Logarithmic Production Function', *Econometrica*, vol. 39, no. 4, pp. 225-256.

Christensen, L.R., Jorgenson, D.W. & Lau, E.J. 1973, 'Transcendental Logarithmic Production Frontiers', *Review of Economics and Statistics*, vol. 55, no. 1, pp. 28-45.

Christoff, P. 2005, 'Some Like It Hot: Making sense of the Howard Government's climate policy', *Arena Magazine*, no. 75 (Feb-Mar), pp. 39-42.

Coase, R. 1960, 'The Problem of Social Cost', *Journal of Law and Economics*, vol. 3, pp. 1-44.

Cobb, C.W. & Douglas, P.H. 1928, 'A Theory of Production', *American Economic Review*, vol. 18, no. 1, pp. 139-165.

Common, M.S. & Hamilton, C. 1996, 'The Economic Consequences of Carbon Taxation in Australia', in W.J. Bouma, G.I. Pearson & M.R. Manning (eds), *Greenhouse: Coping with climate change*, CSIRO, Collingwood, Victoria.

Common, M.S. & Salma, U. 1992, 'Accounting for Changes in Australian Carbon Dioxide Emissions', *Energy Economics*, vol. 14, no. 3, pp. 217-225.

Commonwealth of Australia 1992, *National Greenhouse Response Strategy*, Australian Government Publishing Service, Canberra.

Commonwealth of Australia 1998, *The National Greenhouse Strategy: Strategic Framework for Advancing Australia's Greenhouse Response*, Australian Greenhouse Office, Canberra.

Commonwealth of Australia 2000, *National Greenhouse Strategy 2000 Progress Report: Implementing the Strategic Framework for Advancing Australia's Greenhouse Response*, Australian Greenhouse Office, Canberra.

Commonwealth of Australia 2004, *Securing Australia's Energy Future*, Department of the Prime Minister and Cabinet, Canberra.

Commonwealth of Australia 2006, *Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia?*, Report to the Prime Minister by the Uranium Mining, Processing and Nuclear Energy Review Taskforce, Department of the Prime Minister and Cabinet, Canberra.

Cordato, R. 2004, 'Towards an Austrian Theory of Environmental Economics', *The Quarterly Journal of Austrian Economics*, vol. 7, no. 1, pp. 3-16.

Cornwell, A. & Creedy, J. 1995, 'A Carbon Tax for Australia', *Economic Papers*, vol. 14, no. 4, pp. 16-28.

Cornwell, A. & Creedy, J. 1996, 'Carbon Taxation, Prices and Inequality in Australia', *Fiscal Studies*, vol. 17, no. 3, pp. 21-38.

Cornwell, A. & Creedy, J. 1997, *Environmental Taxes and Economic Welfare*, Edward Elgar, Aldershot.

Costello, P. 2002, *Intergenerational Report: 2002-03*, Budget Paper no: 5, Commonwealth of Australia, Canberra.

Creedy, J. 1997, 'Taxation in General Equilibrium: An Introduction', *Bulletin of Economic Research*, vol. 49, no. 3, pp. 177-203.

Creedy, J. & Martin, C. 2000, 'Carbon Taxation, Fuel Substitution and Welfare in Australia', *The Australian Economic Review*, vol. 33, no. 1, pp. 32-48.

Cruz, L.M.G. 2002, 'A Portugese energy-economy-environment input-output model: Policy applications', PhD thesis, Keele University, UK.

CSIRO 1998, *The OzECCO Embodied Energy Model of Australia's Physical Function: Model Description and Calibration*, CSIRO Wildlife & Ecology, Resource Futures Program, Lyneham, ACT.

CSIRO 2001, *Climate Change Impacts for Australia*, Climate Impact Group, Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atmospheric Research, Melbourne.

Cuevas-Cubria, C. & Riwoe, D. 2006, *Australian Energy: National and State Projections to 2029-30*, ABARE research report 06.26 Prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra.

Daly, H.E. 2002, *Sustainable Development: Definitions, Principles, Policies*, Invited Address, April 30, World Bank, Washington DC.

Dalziell, I., Noble, K. & Ofei-Mensah, A. 1993, *The Economics Of Interconnection : Electricity Grids & Pipelines In Australia*, ABARE Research Report 93.12, Commonwealth of Australia, Canberra.

Dickson, A. & Warr, S. 2000, *Profile of the Australian Electricity Industry*, Report Number 2000.7, Australian Bureau of Agricultural and Resource Economics, Canberra.

Diesendorf, M. 1996, 'How can a competitive market for electricity be made compatible with the reduction of greenhouse gas emissions?' *Ecological Economics*, vol. 17, pp. 33-48.

Diesendorf, M. 2003, *Australia's Polluting Power: Coal-fired electricity and its impact on global warming*, WWF Australia, Sydney.

Diesendorf, M. 2007, *The Base Load Fallacy*, *Energy Science Briefing Paper No.16, Issue 1*, <www.energyscience.org.au/BP16%20BaseLoad.pdf>.

Dietzenbacher, E. & Stage, J. 2006, 'Mixing Oil and Water? Using hybrid Input-output tables in a structural decomposition analysis', *Economic Systems Research*, vol. 18, no. 1, pp. 85-95.

Diewert, W.E. 1974, 'Applications of Duality Theory', in M.D. Intriligator & D.A. Kendrick (eds), *Frontiers of Quantitative Economics*, vol. 2, North-Holland, Amsterdam, pp. 106-171.

DITR 2004, *Consultation Regulation Impact Statement: Draft guiding regulatory framework for carbon dioxide geosequestration*, Prepared by Department of Industry, Tourism and Resources (DITR) for Council of Australian Governments (COAG), Canberra.

Dixon, P.B., Parmenter, B.R., Powell, A.A. & Wilcoxen, P.J. 1992, *Notes and Problems in Applied General Equilibrium Economics*, North-Holland Publishing Company, Amsterdam.

Dixon, P.B. & Rimmer, M.T. 2000, 'The Government/Democrats' Package of Changes in Indirect Taxes', *Australian Journal of Agricultural & Resource Economics*, vol. 44, no. 1, pp. 147-157.

Duchin, F. 1998, *Structural Economics: Measuring change in technology, lifestyles, and the environment*, Island Press, Washington DC.

Duchin, F. & Steenge, A. 1999, 'Input-Output Analysis, Technology and the Environment', in J. van den Bergh (ed.), *Handbook of Environmental and Resource Economics*, Edward Elgar, Cheltenham, UK, pp. 1037-1059.

Eatwell, J., Milgate, M. & Newman, P. 1998, *The New Palgrave: a dictionary of economics*, Macmillan, London.

ERAA 2004, *Climate Change*, Policy Position Paper version 1.2, Energy Retailers Association of Australia.

ESAA 1973, *The Electricity Supply Industry in Australia, 1971-72*, Electricity Supply Association of Australia, Melbourne.

ESAA 1996, *Submission to Industry Commission: The Microeconomic Reform Agenda*, Electricity Supply Association of Australia, Sydney.

ESAA 2006, *Electricity Gas Australia*, Electricity Supply Association of Australia, Melbourne.

ESAA various, *Electricity Australia ... : the electricity supply industry in Australia*, Electricity Supply Association of Australia, Melbourne.

Fathollazadeh, R. 2006, 'Electricity Industry Reform in Australia: Reasons, Impacts and Challenges', unpublished PhD thesis, University of Technology, Sydney.

Fiksel, J. 1996, *Design for Environment: Eco-efficient Products and Processes*, McGraw-Hill, New York.

Fiore, K. 2005, 'Nuclear energy and sustainability: Understanding ITER', *Energy Policy (In Press, Corrected Proof)*.

Foran, B. & Crane, D. 2000, 'Modelling the Transition to a Biofuel Economy in Australia', *Advances in Energy Studies: Exploring Supplies Constraints and Strategies*, 24-27 May, Porto Venere, Italy, pp. 423-439.

Foran, B. & Poldy, F. 2002, *Future Dilemmas: Options to 2050 for Australia's population, technology, resources and environment*, Working paper series 02/02, CSIRO Sustainable Ecosystems, Report to the Department of Immigration and Multicultural and Indigenous Affairs, Canberra.

Fritsch, B., Schmidheiny, S. & Seifritz, W. 1994, *Towards an Ecologically Sustainable Growth Society: Physical Foundations, Economic Transitions and Political Constraints*, Springer-Verlag, Berlin, Heidelberg.

Fuss, M.A. 1977, 'The Demand for Energy in Canadian Manufacturing: An Example of the Estimation of Production Structures with Many Inputs', *Journal of Econometrics*, vol. 5, no. 1, pp. 89-116.

Gagnon, L., Bélanger, C. & Uchiyama, Y. 2002, 'Life Cycle Assessment of Electricity Generation Options: The status of research in year 2001', *Energy Policy*, vol. 30, pp. 1267-1278.

Gault, F.D., Hamilton, K.E., Hoffman, R.B. & McInnis, B.C. 1987, 'The Design Approach to Socio-Economic Modelling', *Futures*, vol. 19, no. 1, pp. 3-25.

Gay, P.W. & Proops, J.L.R. 1993, 'Carbon dioxide Production by the UK Economy: An input-output assessment', *Applied Energy*, vol. 44, no. 2, pp. 113-130.

Georgescu-Roegen, N. 1971, *The Entropy Law and the Economic Process*, Harvard University Press, Cambridge, Massachusette.

Gerlagh, R. & van der Zwaan, B. 2006, 'Options and Instruments for a Deep Cut in CO_2 Emissions: Carbon Dioxide Capture or Renewables, Taxes or Subsidies?' *The Energy Journal*, vol. 27, no. 3, pp. 25-48.

Gielen, D.J. 1995, 'Towards Integrated Energy and Materials Policies? A case study on CO_2 reduction in the Netherlands', *Energy Policy*, vol. 23, no. 12, pp. 1049-1062.

Gielen, D.J. 1999a, 'CO_2 emission mitigation for the West European iron and steel industry', in, *Materiallising Dematerialisation: Integrated energy and materials systems emgineering for greenhouse gas emisssion mitigation*, Design for Sustainability Program, Delft University of Technology, the Netehrlands.

Gielen, D.J. 1999b, 'Materials strategies for greenhouse gas emission mitigation in the West European building and construction industry', in, *Materiallising Dematerialisation: Integrated energy and materials systems emgineering for greenhouse gas emisssion mitigation*, Design for Sustainability Program, Delft University of Technology, the Netherlands.

Gielen, D.J., Bos, A.J.M. & Gerlagh, T. 1998, *MATTER 1.0: A MARKAL Energy and Materials System Characterisation*, Report Number ECN-C-98-065, Netherlands Energy Research Foundation ECN, Petten, The Netherlands.

Gielen, D.J. & Kram, T. 1998, 'Integral Energy and Materials Policy for Cheaper Greenhouse Gas Reduction', *paper prepared for the NOP-Symposium, 29-30 October*, Garderen, The Netherlands.

Góralczyk, M. 2003, 'Life Cycle Assessment in the Renewable Energy Sector', *Applied Energy*, vol. 75, pp. 205-211.

Gross, L.S. & Veendorp, E.C.H. 1990, 'Growth with Exhaustible Resources and a Materials-balance Production Function', *Natural Resource Modelling*, vol. 4, pp. 77-94.

Grubb, M., Carraro, C. & Schellnhuber, J. 2006, 'Technological Change for Atmospheric Stabilization: Introductory Overview to the Innovation Modeling Comparison Project', *The Energy Journal, Special Issue - Endogenous Technological Change and the Economics of Atmospheric Stabilisation*, pp. 1-16.

Guinée, J.B., van den Bergh, J., Boelens, J., Fraanje, P.J., Huppes, G., Kandelaars, P.P., Lexmond, T.M., Moolenaar, S.W., Olsthoorn, A.A., Udo de Haes, H.A., Verkuijlen, E. & bvan der Voet, E. 1999, 'Evaluation of risks of metal flows and accumulation in economy and environment', *Ecological Economics*, vol. 30, pp. 47-65.

GWA & ES 2002, *Australia's National Greenhouse Gas Inventory 1990, 1995 and 1999: End Use Allocation of Emissions*, Report by George Wilkenfeld & Associates Pty Ltd and Energy Strategies to the Australian Greenhouse Office, Canberra.

Hamilton, C. 2001, *Running from the Storm: The development of climate change policy in Australia*, University of New South Wales Press, Sydney.

Hamilton, C. & Quiggin, J. 1997, *Economic Analysis of Greenhouse Policy: A layperson's guide to the perils of economic modelling*, Discussion Paper Number 15, The Australia Institute, Australia.

Hargraves, A.J. (ed.) 1993, *History of Coal Mining in Australia - Monograph 21*, The Australasian Institute of Mining and Metallurgy, Melbourne.

Hendrikson, C., Horvarth, A., Klausner, S., Lave, M. & McMichael, F. 1998, *Comparing Two Life Cycle Assessment Approaches: A Process Model vs Economic Input-Output based Assessment*, Green Design Initiative, Engineering Design Research Centre and Environmental Institute, Carnegie Mellon University, Pittsburgh.

Herendeen, R.A. & Plant, R.L. 1981, 'Energy Analysis for four geothermal technologies', *Energy*, vol. 6, pp. 73-82.

Hilmer, F., Raynor, M. & Taperell, G. 1993, *National Competition Policy*, Australian Government Publishing Service, Canberra.

Hoeller, P., Dean, A. & Nicolaisen, J. 1991, 'Macroeconomic Implications of Reducing Greenhouse Gas Emissions: A survey of empirical studies', *OECD Economic Studies*, no. 16, pp. 45-78.

Hoerner, J.A. & Muller, F. 1996, *Carbon Taxes for Climate Protection in a Competitive World*, A paper prepared for the Swiss Federal Office for Foreign Economic Affair by the Center for Global Change, University of Maryland.

Hoffman, K. 1980, 'Analysis of the Materials System: The role of Optimisation', *Technical Forecasting and Social Change*, vol. 18, pp. 189-204.

Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. & Johnson, C.A. (eds) 2001, *Climate Change 2001: The Scientific Basis*, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK.

Hudson, E.A. & Jorgenson, D.W. 1974, 'US Energy Policy and Economic Growth, 1979-2000', *Bell Journal of Economics*, vol. 5, pp. 461-514.

Hunt, C. 2004, 'Australia's Greenhouse Policy', *Australasian Journal of Environmental Management*, vol. 11, no. 2, pp. 156-163.

IAEA 1994, *Net Energy Analysis of Different Electricity Generation Systems*, Technical Document No 753, International Atomic Energy Agency, Austria.

IEA 2005, *Energy Balances of non-OECD Countries 2002-2003*, International Energy Agency/Organisation for Economic Co-operation and Development, Paris.

IEA 2006, *Electricity Information*, International Energy Agency/Organisation for Economic Co-operation and Development, Paris.

IFIAS 1978, 'International Federation of Institutes for Advanced Studies Workshop Report: Energy Analysis and Economics', *Resources and Energy*, vol. 1, pp. 151-204.

IHA 2003, *The Role of Hydropower in Sustainable Development*, IHA White Paper, International Hydro Association, <http://hydropower.org/DownLoads/IHA%20White%20Paper_260203_LowRes.pdf>.

Industry Commission 1991a, *Costs and Benefits of Reducing Greenhouse Gas Emissions*, Report Number 15, Australian Government Publishing Service, Canberra.

Industry Commission 1991b, *Energy Generation and Distribution*, Report Number 11, Australian Government Publishing Service, Canberra.

Industry Commission 1992, *Measuring the Total Factor Productivity of Government Trading Enterprises*, Performance Monitoring Report, Steering Committee on National Performance Monitoring of Government Trading Enterprises, Australian Government Publishing Service, Canberra.

Industry Commission 1995, *The growth and revenue implications of Hilmer and related reforms*, Report for the Council of Australian Governments, Australian Government Publishing Service, Canberra.

ISO 1997, *ISO 14040: Environmental management - Life cycle assessment - Principles and framework*, International Organization for Standardization, Geneva.

Johnson, M. & Rix, S. 1991, *Powering the Future: The Electricity Industry and Australia's Energy Future*, Pluto Press, NSW.

Jones, B.P., Peng, Z.-Y. & Naughten, B. 1994, 'Reducing Australian energy sector greenhouse gas emissions', *Energy Policy*, vol. 22, no. 4, pp. 270-286.

Jorgenson, D.W. 2000, *Econometrics: Econometric Modelling of Producer Behaviour*, vol. 1, The MIT Press, Cambridge, Massachusette, London.

Kandelaars, P.P. 1999, *Economic Models of Material-Product Chains for Environmental Policy Analysis*, Kluwer Academic Publishers, Boston.

Karoly, D., Risbey, J. & Reynolds, A. 2003, *Global Warming Contributes to Australia's Worst Drought*, WWF Australia, Sydney.

Kay, P. 1997, *Australia and Greenhouse Policy - A Chronology*, Background Paper 4, Parliamentary Library, Canberra.

Kellow, A. 1996, *Transforming Power: The Politics of Electricity Planning*, Cambridge University Press, Cambridge.

Kelly, P. 1992, *The end of certainty : the story of the 1980s*, Allen & Unwin, St. Leonards, NSW.

Kline, D. 2001, 'Positive feedback, lock-in, and environmental policy', *Policy Sciences*, vol. 34, no. 1, pp. 95-107.

Kneese, A.V., Ayers, R.U. & d'Arge, R.C. 1970, *Economics and the Environment: A Materials Balance Approach*, Resources for the Future Inc., The Johns Hopkins Press, Baltimore.

Konijn, P., de Boer, S. & van Dalen, J. 1997, 'Input-Output analysis of material flows with application to iron, steel and zinc', *Structural Change and Economic Dynamics*, vol. 8, no. 1, pp. 129-153.

Kula, M. 1998, 'Analysis of Price Increases by the Input-Output Costing Model in the Turkish Economy, 1996', *Twelfth International Conference on Input-Output Techniques, 18-22 May 1998*, New York.

Lave, L., Cobas-Flores, E., Hendrikson, C. & McMichael, F. 1995, 'Life Cycle Assessment: Using Input-Output Analysis to Estimate Economy-Wide Discharges', *Environmental Science and Technology*, vol. 29, no. 9, pp. 420-426.

Lenzen, M. 1998, 'Primary Energy and Greenhouse Gases Embodied in Australian Final Consumption: An Input-Output Analysis', *Energy Policy*, vol. 26, no. 6, pp. 495-506.

Leontief, W. 1936, 'Quantitative Input-Output Relations in the Economic System of the United States', *Review of Economics and Statistics*, vol. 18, no. 3, pp. 105-125.

Lilien, D., Sueyoshi, G., Wilkins, C., Liang, G., Fuquay, P., Wong, J., Startz, R., Hall, R., Kawakatsu, H., Engle, R., Ellsworth, S. & Noh, J. 2005, *EVIEWS version 5.1*, Quantitative Micro Software, LLC, California.

Lomborg, B. 2001, *The Skeptical Environmentalist: Measuring the real state of the World*, Cambridge University Press, Cambridge.

Macdonald, D., Donner, J. & Nikifork, A. 1997, 'Full Fuel Cycle Emission Analysis for Electric Power Generation Options and its Application in a Market-Based Economy', *Energy Conversion Management*, vol. 38, pp. S601-S606.

Mann, M.K. & Spath, P.L. 2000, *Life Cycle Assessment Comparisons of Electricity from Biomass, Coal and Natural Gas*, National Renewable Energy Laboratory, Colorado.

McColl, G.D. 1976, *The Economics of Electricity Supply in Australia*, Melbourne University Press, Carlton, Victoria.

McDougall, R.A. 1993, *Short-Run Effects of a Carbon Tax*, Report Number G-100, Centre of Policy Studies and the Impact Project, Monash University, Clayton, Victoria.

McKibbin, W. & Pearce, D. 1996, 'Global Carbon Taxes: An Australian Perspective', in W.J. Bouma, G.I. Pearson & M.R. Manning (eds), *Greenhouse: Coping with climate change*, CSIRO, Collingwood, Victoria.

McKibbin, W. & Wilcoxen, P.J. 2006, *A Credible Foundation for Long Term International Cooperation in Climate Change*, Working Papers in International Economics No. 1.06, Lowy Institute for International Policy, Sydney.

Meier, P.J. 2002, 'Life Cycle Assessment of Electricity Generation System and Applications for Climate Change Policy Analysis', PhD thesis, University of Wisconsin-Madison, Wisconsin.

Melvin, J.R. 1979, 'Short-Run Price Effects of the Corporate Income Tax and Implications for International Trade', *American Economic Review*, vol. 69, no. 5, pp. 765-774.

Miernyk, W.H. 1965, *The Elements of Input-Output Analysis*, Random House, New York.

Miller, R. & Blair, P. 1985, *Input-Output Analysis: Foundations and Extensions*, Prentice Hall, New Jersey.

Missfeldt, F. & Hauff, J. 2004, 'The Role of Economic Instruments', in A.D. Owen & N. Hanley (eds), *The Economics of Climate Change*, Routledge, London and New York.

MMA 2002, *Incremental Electricity Supply Costs from Additional Renewable and Gas-fired Generation in Australia*, McLennan Magasanik Associates, Melbourne.

MMA 2006a, *Impacts of a National Emissions Trading Scheme on Australia's Electricity Markets*, Report to National Emissions Trading Taskforce, McLennan Magasanik Associates, Melbourne.

MMA 2006b, *Renewable Energy – A contribution to Australia's environmental and economic sustainability*, Report to Renewable Energy Generators Australia, McLennan Magasanik Associates, Melbourne.

MRET Review Panel 2003, *Renewable Opportunities: A Review of the Operation of the Renewable Energy (Electricity) Act 2000*, Australian Greenhouse Office, Commonwealth of Australia, Canberra.

Murphy, K. 2005, 'Climate pact cold on carbon tax', *The Australian*, August 1, p. 13.

Nakicenovic, N. & Swart, R. (eds) 2000, *Emissions Scenarios: Special Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge-UK.

National Greenhouse Steering Committee 1992, *National Greenhouse Response Strategy*, Australian Government Publishing Service, Canberra.

Naughten, B. 2003, 'Economic assessment of combined cycle gas turbines in Australia: Some effects of microeconomic reform and technological change', *Energy Policy*, vol. 31, no. 3, pp. 225-245.

Neff, T.L. 1997, *Improving Energy Security in Pacific Asia: Diversification and Risk Reduction for Fossil and Nuclear Fuels*, Pacific Asia Regional Energy Security (PARES) Project, The Nautilus Institute, <http://www.nautilus.org/archives/papers/energy/NeffPARES.pdf>.

Nemry, F., Theunis, J., Bréchet, T. & Lopez, P. 2001, *Greenhouse Gas Emissions Reduction and Material Flows*, Global Change and Sustainable Development Programe, Federal Office for Scientific, Technical and Cultural Affairs, Belgium.

NGGIC 1996, *Workbook for Fuel Combustion Activities (Stationary Sources), Workbook 1.1*, National Greenhouse Gas Inventory Committee, Commonwealth of Australia, Canberra.

NIEIR 1995, *Measuring the Economic Impact of Reducing Greenhouse Gas Emissions*, Report prepared by the National Institute of Economic and Industry Research for the Electricity Supply Association of Australia, Sydney.

NIEIR 1996, *Subsidies to the Use of Natural Resources*, Report prepared by the National Institute of Economic and Industry Research for the Department of the Environment, Sport and Territories, Canberra.

Nishimura, K., Hondo, H. & Uchiyama, Y. 1996, 'Derivation of Energy-Embodiment Functions to Estimate the Embodied Energy from the Material Content', *Energy*, vol. 21, no. 12, pp. 1247-1256.

OECD 1994, *Managing the Environment : The role of economic instruments*, Organisation for Economic Co-operation and Development, Paris.

OECD 1997, *Reforming Coal and Electricity Subsidies*, Annex I Expert Group on the United Nations Framework Convention on Climate Change, Working Paper No. 2, Organisation for Economic Co-operation and Development, Paris.

OECD 2001, *Instruments and Technologies for Climate Change Policy: An integrated energy and materials system modelling approach*, Environment Policy Committe, Organisation for Economic Co-operation and Development, Paris.

OECD/IEA 2001, *Energy Policies of IEA Countries: Australia 2001 Review*, International Energy Agency, Organisation for Economic Co-operation and Development, Paris.

OECD/IEA 2003, *World Energy Investment Outlook*, Organisation for Economic Co-operation and Development (OECD), Paris.

OECD/IEA 2005, *Energy Policies of IEA Countries: Australia 2005 Review*, International Energy Agency, Organisation for Economic Co-operation and Development, Paris.

Owen, A.D. 1992, *The Use of a Carbon Tax for Controlling Carbon Dioxide Emissions: A Review*, Report prepared for the Department of the Arts, Sports, the Environment and Territories, Canberra.

Owen, A.D. 2004, 'The transition to renewable energy', in A.D. Owen & N. Hanley (eds), *The Economics of Climate Change*, Routledge, London and New York.

Pearce, D.W. 1991, 'The role of carbon taxes in adjusting to global warming', *The Economic Journal*, no. 101, pp. 938-948.

Pearce, D.W. & Turner, R.K. 1990, *Economics of Natural Resources and the Environmental*, Harvester Wheatsheaf, Hertfordshire.

Pearse, G.D. 2005, 'The Business Response to Climate Change: Case studies of Australian interests groups', PhD thesis, The Australian National University, Canberra.

Peet, J. 1993, 'Input-Output Methods for Energy Analysis', *International Journal of Global Energy Issues*, vol. 5, no. 1, pp. 10-18.

Perrings, C. 1987, *Economy and Environment : a theoretical essay on the interdependence of economic and environmental systems*, Cambridge University Press, Cambridge.

Pethig, R. 2003, 'The 'materials balance approach' to pollution: its origin, implications and acceptance' (Economic Discussion Paper 105-03), Institute of Public Economics and Environmental Economics, University of Siegen, Germany.

Pigou, A.C. 1978, *The Economics of Welfare*, AMS Press, New York (Reprint of the 4th ed. published in 1932 by Macmillan, London).

Pittock, B. (ed.) 2003, *Climate Change: An Australian Guide to the Science and Potential Impacts*, Australian Greenhouse Office, Canberra.

Poldy, F. 1998, 'The Rationale for Physical Analysis', in, *The OzECCO Embodied Energy Model of Australia's Physical Function: Model Description and Calibration*, CSIRO Wildlife & Ecology, Resource Futures Program, Lyneham, ACT.

Price Waterhouse 1991, *Carbon Tax as a Greenhouse Response Measure - A Series of Greenhouse Studies Number 4*, Consultancy report to Department of the Arts, Sport, the Environment, Tourism and Territories, Commonwealth of Australia, Canberra.

Productivity Commission 1998, *The Australian Black Coal Industry - Inquiry Report*, AusInfo, Canberra.

Proops, J.L.R. 1977, 'Input-Output Analysis and Energy Intensities: A comparison of some methodologies', *Applications of Mathematical Modelling*, vol. 1, pp. 181-186.

Proops, J.L.R., Faber, M. & Wagenhals, G. 1993, *Reducing CO_2 Emissions: A Comparative Input-Output Study for Germany and the UK*, Springer-Verlag, Berlin, Heidelberg.

Proops, J.L.R., Gay, P.W., Speck, S. & Schröder, T. 1996, 'The lifetime pollution implications of various types of electricity generation: An input-output analysis', *Energy Policy*, vol. 24, no. 3, pp. 229-237.

Quesnay, F. 1758, 'Tableau Économique'.

RBA 2004, *Interest Rates*, Reserve Bank of Australia (RBA), viewed September <http://www.rba.gov.au/Statistics/Bulletin/index.html>.

Riedy, C. 2005, 'The Eye of the Storm: An Integral Perspective on Sustainable Development and Climate Change Response', PhD thesis, University of Technology, Sydney.

Roarty, M. 2001, *Renewable Energy Used for Electricity Generation in Australia*, Department of the Parliamentary Library, Commonwealth of Australia, Canberra.

Rose, A. 1984, 'Technological Change and Input-Output Analysis: An Appraisal', *Socio-Economic Planning Sciences*, vol. 18, no. 5, pp. 305-318.

Rosenthal, S. & Russ, P. 1988, *The politics of power: inside Australia's electric utilities*, Melbourne University Press, Melbourne.

RRI 1983, *Renewable Energy and Electricity Generation Technologies*, Resource Research Institute, Science and Technology Agency, Japan.

Ruth, M. 1993, *Integrating Economics, Ecology and Thermodynamics*, Kluwer Academic Publishers, Dordrecht, Netherlands.

Saddler, H. 1981, *Energy in Australia: Politics and Economics*.

Saddler, H. 1996, 'Greenhouse policies and the Australian energy supply industries', in W.J. Bouma, G.I. Pearman & M.R. Manning (eds), *Greenhouse: Coping with climate change*, CSIRO, Melbourne.

Saddler, H., Diesendorf, M. & Denniss, R. 2004, *A Clean Energy Future for Australia*, A Study by Energy Strategies for the Clean Energy Future Group, WWF Australia, Sydney.

Saddler, H., Riedy, C. & Passey, R. 2004, *Geosequestration: What is it and how much can it contribute to a sustainable energy policy in Australia?*, Discussion Paper Number 72, The Australia Institute, Australia.

San Martin, R.L. 1989, *Environmental Emissions from Energy Technology System: The Total Fuel Cycle*, US Department of Energy, Washington DC.

Shariful Islam, A.R. & Morison, J.B. 1992, 'Sectoral Changes in Energy Use in Australia: An input-output analysis', *Economic Analysis and Policy*, vol. 22, no. 2, pp. 161-175.

Sharma, D. 2003, 'The Multidimensionality of Electricity Reform - An Australian perspective', *Energy Policy*, vol. 31, no. 11, pp. 1093-1102.

Sharma, D. & Bartels, R. 1998, 'Distributed Electricity Generation in Competitive Energy Markets: A case study in Australia', *The Energy Journal (Special Issue: Distributed Resources)*, pp. 17-40.

Sharma, D. & Sproule, A. 1998, 'The Nexus Between Competitive Markets and the Environment', *21st Annual International Conference - Experimenting with Freer Markets: Lessons from the Last 20 Years and Prospects for the Future*, vol. I, International Association for Energy Economics, Ohio, pp. 391-398.

Shaw, A.G.L. & Bruns, G.R. 1947, *The Australian Coal Industry*, Melbourne University Press, Carlton, VIC.

Shephard, R.W. 1953, *Cost and Production Functions*, Princeton University Press, Princeton, New Jersey.

Slesser, M. 1992, *ECCO User Manual Part 1*, Third edn, The Reosurce Institute, Edinburgh, Scotland.

Sonneborn, C.L. 2004, 'Renewable energy and market-based approaches to greenhouse gas reduction - opportunity or obstacle?' *Energy Policy*, vol. 32, no. 16, pp. 1799-1805.

Spangenberg, J.H., Femia, A., Hinterberger, F. & Schütz, H. 1998, *Material Flow-based Indicators in Environmental Reporting*, Environmental Issues Series No. 14, European Environment Agency, Wuppertal, Germany.

Spreng, D.T. 1988, *Net-Energy Analysis and the Energy Requirements of Energy Systems*, Praeger, New York.

Steenge, A.E. 1999, 'Input-Output Theory and Institutional Aspects of Environmental Policy', *Structural Change and Economic Dynamics*, vol. 10, no. 1, pp. 161-176.

Stern, N.H. 2006, *Stern Review: The Economics of Climate Change*, report prepared for the HM Treasury, London.

Stiegel, G. 2002, 'Life Cycle Analysis of Advanced Power Generation System', *Technology: A Journal of Science Serving Legislative, Regulatory and Judicial System*, vol. 8, pp. 217-228.

Strubegger, M. 2003, *Personal Communication via email June 9th, 2003*.

Sundberg, J. & Wene, C.-O. 1994, 'Integrated Modelling of Material Flows and Energy Systems (MIMES)', *International Journal of Energy Research*, vol. 18, pp. 359-381.

Symons, E., Proops, J.L.R. & Gay, P. 1994, 'Carbon Taxes, Consumer Demand and Carbon Dioxide Emissions: A simulation analysis for the UK', *Fiscal Studies*, vol. 15, no. 2, pp. 19-43.

Taplin, R. 1994, 'Greenhouse: An Overview of Australian Policy and Practice', *Australian Journal Of Environmental Management*, vol. 1, no. 3, pp. 142-155.

Tarlo, K. 1996, *Why MEGABARE is wrong*, Summary briefing, Greenpeace Australia, Sydney.

TEC 1984, *Australia and the nuclear choice: the report of the Independent Committee of Inquiry into Nuclear Weapons and Other Consequences of Australian Uranium Mining*, Total Environment Centre, Sydney.

Tedesco, L., Dickson, A., Johnston, T. & Short, C. 2004, *Energy in Australia 2004*, Australian Bureau of Agricultural and Resource Economics (ABARE), Report prepared for Department of Industry, Tourism and Resources, Canberra.

Thorpe, S., Peng, Z.-Y., Dickson, A., Stuart, R. & Fisher, B.S. 1994, 'The least-cost principle and the distribution of greenhouse control costs', *ABARE's National Agricultural and Resources Outlook Conference*, Australian Bureau of Agricultural and Resource Economics, Canberra, pp. 3-24.

Timilsina, G.R. 2001, 'A General Equilibrium Analysis of Greenhouse Gases Mitigation Policy Options in Thailand', PhD thesis, Asian Institute of Technology, Bangkok, Thailand.

Tisdale, M. 2002, *Modelling Inter-Industry Material Flows: a review of methodologies*, Energy and Materials Research Group, Simon Fraser University, Burnaby, B.C.

Topham, F. & Hennessy, W. 1996, 'Coal: The Industry, Trade and The Future', in W.J. Bouma, G.I. Pearman & M.R. Manning (eds), *Greenhouse: Coping with Climate Change*, CSIRO, Collingwood, Victoria.

Treloar, G.J. 1998, 'A Comprehensive Embodied Energy Analysis Framework', PhD thesis, Deakin University, Geelong.

Treloar, G.J., Love, P.E.D. & Holt, G.D. 2001, 'Using national input-output data for embodied energy analysis of individual residential buildings', *Construction Management and Economics*, vol. 19, pp. 49-61.

Truong, T.P. 1985, 'Inter-Fuel and Inter-Factor Substitution in NSW Manufacturing Industry', *The Economic Record*, vol. 61, no. 174, pp. 644-653.

Turnovsky, M., Folie, M. & Ulph, A. 1982, 'Factor Substitutability in Australian Manufacturing with Emphasis on Energy Inputs', *The Economic Record*, vol. 58, pp. 61-67.

Uchiyama, Y. 1992, 'Total System Analysis of Greenhouse Effect from Power Generation Plants', *Energy Forum*.

UIC 2005, *Nuclear Energy Prospects in Australia*, Nuclear Issues Briefing Paper 44, Uranium Information Centre, Melbourne.

UN 1992, *United Nations Framework Convention on Climate Change*, United Nations.

Unruh, G.C. 2000, 'Understanding carbon lock-in', *Energy Policy*, vol. 28, no. 12, pp. 817-830.

Unruh, G.C. 2002, 'Escaping carbon lock-in', *Energy Policy*, vol. 30, no. 4, pp. 317-325.

Uzawa, H. 1962, 'Production Functions with Constant Elasticities of Substitution', *Review of Economic Studies*, vol. 29, no. 80, pp. 291-299.

Valadkhani, A. & Mitchell, W.F. 2002, 'Assessing the Impact of Changes in Petroleum Prices on Inflation and Household Expenditures in Australia', *The Australian Economic Review*, vol. 35, no. 2, pp. 122-132.

Varian, H.R. 1987, *Intermediate Microeconomics: A Modern Approach*, W.W. Norton, New York.

Walras, L. 1874, *Elements of Pure Economics*, Translated by William Jaffé 1954: Richard Irwin Inc., Homewood, Illinois.

Weir, M. 2000, 'An Environmental Macro-Economic Model for the Construction Sector', *Environmental Resource Economics*, vol. 15, no. 4, pp. 323-341.

Westoby, R. & McGuire, A. 1984, 'Factor Substitution and Complementarity in Energy: A Case Study of the UK Electricity Industry', *Applied Economics*, vol. 16, no. 2, pp. 111-118.

Whalley, J. & Wigle, R. 1991, 'The International Incidence of Carbon Taxes', in R. Dornbusch & J.M. Poterba (eds), *Global Warming: Economic Policy Responses*, MIT Press, Cambridge Massachusette.

Wilkenfeld, G., Hamilton, C. & Saddler, H. 1995, *Australia's Greenhouse Strategy: Can the future be rescued?*, Discussion Paper No. 3, The Australia Institute, Canberra.

Wright, D.J. 1974, 'Goods and Services: An input-output analysis', *Energy Policy*, vol. 2, no. 4, pp. 307-315.

Wright, D.J. 1975, 'The Natural Resource Requirements of Commodities', *Applied Economics*, vol. 7, pp. 31-39.

Wu, R.-H. & Chen, C.-Y. 1990, 'On the Application of Input-Output Analysis to Energy Issues', *Energy Economics*, vol. 12, no. 1, pp. 71-76.

Zellner, A. 1962, 'An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias', *Journal of the American Statistical Association*, vol. 57, pp. 348-368.