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