Assessment of Long-term Energy Scenarios for New South Wales (NSW)

PhD Thesis

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CERTIFICATE OF AUTHORSHIP

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.

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LIST OF RELEVANT PUBLICATIONS

Shrestha, S., 2004. *"Long-Term Energy Scenarios for NSW: Energy, Economic and Environmental Impacts"*, AIE NSW and ACT Postgraduate Student Energy Awards 2004, Australian Institute of Energy, Sydney, December.

Shrestha, S., 2005. *"Long Term Energy Scenarios for NSW: Energy, Economic, and Environmental Impacts"*, Research Showcase Proceedings, University of Technology, Sydney, May.

Shrestha, S., and Sharma, D., 2006. *"Alternative Energy Supply Scenarios for New South Wales, Australia"*, Proceedings of a Conference on "Energy for Sustainable Development: Prospects and Issues for Asia", Organised by Asian Institute of Technology, Phuket, Thailand, 1–3 March.

ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ADV	Advanced Scenario
AEEI	Autonomous Energy Efficiency Improvement
AEPSOM	Australian Energy Planning System Optimisation Model
AGO	Australian Greenhouse Office
BAS	Base Scenario
BF	Blast Furnace
BOF	Blast Oxygen Furnace
CC	Combined cycle
CCS	Carbon capture and sequestration
CEF	"Clean Energy Future" Study
CGE	Computable General Equilibrium
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
COAG	Council of Australian Governments
CRS	Constant returns to scale
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Coal Seam Methane
DRI	Direct Reduced Iron
EAF	Electric Arc Furnace
ESAA	Electricity Supply Association of Australia
FD	"Future Dilemmas" Study
GAMS	General Algebriac Modelling System
GDP	Gross Domestic Product
GEM	General Equilibrium Model
GHG	Greenhouse Gas
GRIT	Generation of Regional Input–output Tables
GTEM	Global Trade and Environment Model
GW	Gigawatt
GWh	Gigawatt hour
HVAC	Heating, Ventilating and Air-conditioning

IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
kWh	Kilowatt-hour
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LTW	"Living in Turbulent World" Study
MJ	Mega Joules
MOD	Moderate Scenario
MRET	Mandated Renewable Energy Technology
MW	Megawatt
NatHERS	Nationwide House Energy Rating Scheme
NEM	National Electricity Market
NGCC	Natural Gas Combined Cycle
NOx	Nitrogen Oxides
NSW	New South Wales
NT	Northern Territory
OECD	Organisation for Economic Co-operation and Development
OFD	Other final demand
OPEC	Organization of Petroleum Exporting Countries
OVA	Other Value Added
PJ	Petajoules
PM	Particulate Matter
PNG	Papua New Guinea
ppm	Parts per Million
PV	Photovoltaic
QLD	Queensland
R&D	Research and Development
RES	Reference Energy System
SA	South Australia
SEDA	Sustainable Energy Development Authority
SESSWG	Strategic Energy Supply and Security Working Group
SMHES	Snowy Mountains Hydro-electric Scheme
SO_2	Sulphur Dioxide

TAS	Tasmania
TJ	Terajoule
TWh	Terra Watt-hour
US	United States
UK	United Kingdom
VIC	Victoria
WA	Western Australia

ABSTRACT

This research analyses the economy-wide impacts of three energy scenarios (Base, Moderate and Advanced) for NSW for the period 2000–2040. These scenarios represent a suite of energy policy measures that the state could adopt in order to achieve its energy, environmental and economic goals. The Base scenario largely reflects the continuation of the current policy trends. In the Moderate and Advanced scenarios, CO_2 emissions, in the year 2040, are restricted to 8 percent above, and 25 percent below, the 1990 levels, respectively.

The scenario impacts are analysed in this research using a modelling framework that combines an optimisation-based energy sector model (MARKAL model) and an energy-oriented input–output economic model. The energy impacts are analysed in terms of how the state's primary and final energy requirements would evolve in response to alternative scenario-specific policies. And, the economic impact analysis focuses on how would such evolution affect sectoral outputs, wages and salaries, employment, and energy and CO_2 intensities.

The analysis suggests that a continuation of current policy trends (Base scenario) would result, by 2040, in a doubling of primary energy requirements, 80 percent increase in CO_2 emissions, and a markedly increased dependency on imported oil. The CO_2-restricting policies specific to the Moderate and Advanced scenarios could however result in significantly lower primary energy requirements – approximately 17 and 28 percent, respectively, below the Base level. Further, the economy wide impacts of these reduced energy requirements are likely to be minimal at the aggregate (State) level. For example, the Gross State Product, wages and salaries, and employment in 2040 would be lower by merely 0.28, 0.09 and 0.003 percent, respectively, in the Moderate scenario as compared with the Base scenario. These impacts at disaggregated (sectoral) levels would, however, be rather significant and mixed. The main beneficiaries, for example, in terms of wages and salaries and employment, would be the agriculture, other equipment, and construction sectors, and the main losers would be electricity, coal, and petroleum sectors. This shows the importance – in a policy context – of undertaking disaggregated analysis and the pitfalls of basing policy decisions on aggregate analyses

alone. Such disaggregate analysis also makes transparent the inter- and intra-sectoral linkages and provides more robust bases for developing trade-offs and compromises to achieve desirable policy outcomes.