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# **Climate Change - a global issue**

## **Is a renewable energy target an effective response for the New Zealand electricity sector?**

A thesis presented in partial fulfilment of the requirements for the degree of  
Master of Applied Science  
at Massey University, Palmerston North  
New Zealand

**Tracy Jennifer Dyson**

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# Abstract

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The main objective of this thesis is to investigate the effectiveness of a mandatory renewable energy target (MRET) in reducing greenhouse gas (GHG) emissions from the electricity sector. New Zealand's electricity sector emissions have grown at a rapid rate over the last decade (+19%) due to an increasing reliance on thermal generation plant.

Since the mid 1980's there has been increasing scientific evidence and acceptance that GHG emissions caused by human activity are reducing the amount of solar heat that would otherwise be radiated back out into space leading to climate change.

The Intergovernmental Panel on Climate Change (IPCC) has found new and stronger evidence that most of the observed warming of the past 50 years is attributable to human activities. The IPCC findings show potential for significant changes in temperature (1.4-5.8°C by 2100), rainfall patterns and sea level (9-88cm by 2100) and adverse weather events. This will impact on the global economy, the natural environment and the quality of life for present and future generations.

The Kyoto Protocol is the international vehicle for fighting anthropogenic climate change by reducing GHG emissions. Despite the US withdrawal from the Protocol in 2001, it could still enter into force and countries that ratify it could have legally binding GHG emission responsibilities by late 2002. Domestic policy and legislation presently under development will guide New Zealand's efforts to reduce GHGs and meet its future Kyoto Protocol commitments.

To assess the impact of a possible MRET, a tool was developed which evaluates the effect of five different MRET scenarios on the electricity sector's GHG emissions, the wholesale price of electricity and the level of renewable energy supply. It was found that an MRET is an effective method of reducing GHGs and increasing the level of renewable energy supply, however this effectiveness depends on the level of the target. The higher the target the higher the electricity price, which will also increase if inappropriate investment decisions lead to plant redundancy or oversupply of the market. Implementing energy efficiency measures with an MRET further reduces GHG emissions. If existing renewable generation was prioritised over thermal generation then environmental outcomes are further improved.

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The research was carried out during a time of considerable change in the area of international and national climate change science and policy. This brought additional challenges to the writing of the thesis and required significant flexibility to ensure that the maximum value was gained for both the author and the main sponsor and focus of the work, Meridian Energy Ltd.

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# Table of Contents

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<i>Abstract</i>	i
<i>Acknowledgements</i>	ii
<i>Table of Contents</i>	iii
<i>List of Figure</i>	ix
<i>List of Tables</i>	x
<i>Abbreviations</i>	xi
<i>Chapter One - Introduction</i>	<b>1</b>
1.1 Background	<b>1</b>
1.2 Research objectives and processes	<b>5</b>
<i>SECTION ONE - GLOBAL CLIMATE CHANGE ISSUES</i>	<b>47</b>
<i>Chapter Two - The Science of Climate Change</i>	<b>11</b>
2.1 Climate Change	<b>11</b>
2.2 Greenhouse Gases (GHG)	<b>12</b>
2.3 The Greenhouse Effect	<b>13</b>
2.4 GHG units of measurement	<b>16</b>
2.4.1 GHG data quality	<b>17</b>
<i>Chapter Three - The Potential Global Implications of Climate Change</i>	<b>19</b>
3.1 The Possible Implications of Climate Change	<b>19</b>
<i>Chapter Four - The Kyoto Protocol</i>	<b>21</b>
4.1 Landmarks in the development of international climate change policy	<b>22</b>
4.2 Participants in international climate change policy development	<b>24</b>
4.2.1 Intergovernmental Panel on Climate Change (IPCC)	<b>24</b>
4.2.2 United Nations Framework Convention on Climate Change	<b>25</b>
4.2.3 Conference of Parties	<b>26</b>
4.2.4 Climate Change Negotiating Groups	<b>26</b>
4.3 The Kyoto Protocol	<b>26</b>
4.4 Methods of meeting Kyoto Protocol targets	<b>29</b>
4.4.1 Joint Implementation	<b>31</b>
4.4.2 Clean Development Mechanism	<b>32</b>
4.4.3 Sink/sequestration Credits	<b>32</b>
4.4.4 Emissions Trading	<b>33</b>
4.5 Present status of the Kyoto Protocol	<b>34</b>

4.5.1	COP 6	34
4.5.2	Kyoto Protocol “fatally flawed”	35
4.5.3	The Bonn Agreement from COP 6.5	36
4.5.4	Will the Kyoto Protocol enter into force?	37
<b>Chapter Five - Carbon Markets and the value of carbon</b>		<b>39</b>
<b>5.1</b>	<b>Carbon trading</b>	<b>39</b>
5.1.1	Internal company trading systems	40
5.1.2	National trading systems	41
5.1.3	International trading systems and carbon prices	42
<b>5.2</b>	<b>Potential size of carbon market</b>	<b>44</b>
<b>SECTION TWO - NEW ZEALAND AND THE ELECTRICITY SECTORS GHGs AND CLIMATE CHANGE ISSUES</b>		<b>47</b>
<b>Chapter Six - New Zealand’s GHG emissions and the effect of climate change</b>		<b>51</b>
<b>6.1</b>	<b>New Zealand’s GHG emissions in 1990</b>	<b>51</b>
<b>6.2</b>	<b>New Zealand’s forecast GHG emissions between 2008 - 2012</b>	<b>53</b>
<b>6.3</b>	<b>Has climate change affected New Zealand yet?</b>	<b>56</b>
<b>6.4</b>	<b>Potential future implications of climate change on New Zealand</b>	<b>56</b>
<b>Chapter Seven - Electricity sector climate change issues</b>		<b>59</b>
<b>7.1</b>	<b>New Zealand’s electricity sectors GHG emissions</b>	<b>59</b>
<b>7.2</b>	<b>Potential impact of climate change on the electricity industry</b>	<b>61</b>
<b>Chapter Eight - New Zealand’s Kyoto Protocol commitment and GHG reduction options</b>		<b>63</b>
<b>8.1</b>	<b>New Zealand’s Kyoto Protocol commitment</b>	<b>63</b>
<b>8.2</b>	<b>New Zealand’s options for reducing GHG emissions</b>	<b>64</b>
<b>8.3</b>	<b>New Zealand electricity sector’s main GHG reduction options</b>	<b>65</b>
<b>Chapter Nine - New Zealand’s climate change policy development</b>		<b>69</b>
<b>9.1</b>	<b>New Zealand climate change policy objectives</b>	<b>69</b>
<b>9.2</b>	<b>New Zealand energy and electricity policy</b>	<b>70</b>
<b>9.3</b>	<b>New Zealand’s climate change policy development</b>	<b>71</b>
9.3.1	Official climate change working groups	73
9.3.2	Climate change cabinet papers (February 2001)	74
9.3.3	Draft National Energy Efficiency and Conservation Strategy (NEECS)	76
<b>9.4</b>	<b>New Zealand’s potential future climate change policy</b>	<b>77</b>

9.4.1	Possible impact on the electricity sector of New Zealand’s potential climate change policy	78
SECTION THREE - A MANDATORY RENEWABLE ENERGY TARGET TO REDUCE GHG EMISSIONS IN THE ELECTRICITY SECTOR		85
<i>Chapter Ten - Renewable energy definition</i>		<b>87</b>
<b>10.1</b>	<b>Significance for electricity generation</b>	<b>87</b>
<b>10.2</b>	<b>Review of national and international definitions</b>	<b>88</b>
<b>10.3</b>	<b>Issues in developing a renewable energy definition</b>	<b>88</b>
<b>10.4</b>	<b>Selection of Renewable Energy Definition</b>	<b>89</b>
<i>Chapter Eleven - Possible mandatory renewable energy target mechanism</i>		<b>91</b>
<b>11.1</b>	<b>Possible mechanisms for increasing renewable energy supply</b>	<b>91</b>
11.1.1	Negotiated Agreements on sales or generation from renewable energy	92
11.1.2	Mandatory Renewables Quota (MRQ) for Generators	92
11.1.3	Mandatory Renewables Quota (MRQ) for Retailers	93
11.1.4	Guaranteed price for renewable energy	94
11.1.5	Tradeable Fossil Fuel Electricity Generation Permits	94
11.1.6	New Zealand issues	95
<i>Chapter Twelve - Development of the Mandatory Renewable Energy Target Impact Tool</i>		<b>97</b>
<b>12.1</b>	<b>Introduction to MRET Impact Tool development</b>	<b>97</b>
<b>12.2</b>	<b>MRET Impact Tool components</b>	<b>98</b>
<b>12.3</b>	<b>Scenario Module</b>	<b>99</b>
12.3.1	Scenario Module development notes	99
12.3.2	Stage 1 - Develop new generation plant profiles	100
12.3.3	Stage 2 - Develop MRET scenarios and annual renewable energy targets	103
12.3.4	Stage 3 - New generation plant required to meet annual targets	110
<b>12.4</b>	<b>Market Simulation Module</b>	<b>111</b>
12.4.1	Market Simulation Module development	111
12.4.2	Market Simulation Module input data	113
12.4.3	Market Simulation Module output data	114
12.4.4	Verification of results of the Market Simulation Module	115
<b>12.5</b>	<b>Impact Illustration Module</b>	<b>116</b>

<i>Chapter Thirteen - Analysis and potential impacts of five mandatory renewable energy target scenarios</i>	<b>117</b>
<b>13.1 The impact of an MRET on New Zealand’s GHG emissions</b>	<b>118</b>
13.1.1 The impact of an MRET on emission intensity	120
<b>13.2 The impact of an MRET on the wholesale price of electricity</b>	<b>120</b>
<b>13.3 Total capital investment required for each scenario</b>	<b>126</b>
<b>13.4 The impact of an MRET on renewable energy electricity supply</b>	<b>127</b>
13.4.1 Scenarios aiming to return to 1990 level of renewable electricity	128
13.4.2 Scenario aiming to return to 1999 levels of renewable energy supply	129
13.4.3 Best case scenario for increasing renewable energy generation	130
13.4.4 MRET Issues	128
<b>13.5 “Best” MRET Scenario</b>	<b>131</b>
 <b>SECTION FOUR - MERIDIAN ENERGY CLIMATE CHANGE CASE STUDY</b>	 <b>133</b>
 <i>Chapter Fourteen - Case Study on Meridian Energy Limited</i>	 <b>135</b>
<b>14.1 Brief background on Meridian Energy Ltd</b>	<b>135</b>
<b>14.2 Comparative assessment of generators climate change policy risk</b>	<b>137</b>
<b>14.3 The physical impacts of climate change on Meridian Energy</b>	<b>139</b>
<b>14.4 Recent Meridian Energy initiatives that impact on climate change</b>	<b>141</b>
14.4.1 Recent renewable energy initiatives	141
14.4.2 Recent demand and supply side energy efficiency initiatives	141
14.4.3 Meridian Energy’s Sustainability Report	143
14.4.4 Meridian Energy’s Voluntary Agreement reporting obligations	143
<b>14.5 SWOT analysis of Meridian Energy relating to climate change policy</b>	<b>144</b>
<b>14.6 Maximising opportunities and minimising threats</b>	<b>147</b>
14.6.1 Contribute to policy development	148
14.6.2 Assist with development of the renewable energy target and mechanisms	151
14.6.3 Measurement of emission reductions from renewable energy projects	153
14.6.4 Electricity Emission Factor	155
14.6.5 Explore emission reduction trading opportunities	156
14.6.6 Develop a NGA with government	157
<b>14.7 Approach to future climate change policy developments</b>	<b>157</b>
 <i>Chapter Fifteen - Summary, conclusions and recommendation for further work</i>	 <b>159</b>
<b>15.1 Summary</b>	<b>159</b>
15.1.1 The science and global implications of climate change	159
15.1.2 The Kyoto Protocol	160



15.1.3	Carbon Markets	162
15.1.4	New Zealand's GHGs, the effect of climate change and its Kyoto Protocol commitments	163
15.1.5	New Zealand's Kyoto Protocol commitment and GHG reduction options	164
15.1.6	The electricity sector's GHGs and the effect of climate change	165
15.1.7	New Zealand's climate change policy development	166
15.1.8	Renewable Energy Definition	168
15.1.9	Possible mandatory renewable energy target mechanisms	168
15.1.10	Development of the mandatory renewable energy target impact tool	169
15.1.11	The impacts of five mandatory renewable energy targets scenarios	170
15.1.12	Meridian Energy Ltd Case Study	171
<b>15.2</b>	<b>Recommendations for further work</b>	<b>173</b>
<b>15.3</b>	<b>Conclusions</b>	<b>174</b>
 <i>Chapter Sixteen - References</i>		<b>177</b>
 <i>Appendices</i>		<b>183</b>
Appendix 1	- International climate change agencies	183
Appendix 2	- Kyoto Protocol commitments of Annex I (industrialised) countries	186
Appendix 3	- Climate change negotiating groups	198
Appendix 4	- Summary of the Kyoto Protocol document	190
Appendix 5	- Important countries and groups COP6 negotiating positions at COP6	191
Appendix 6	- New Zealand Electricity Industry	193
Appendix 7	- New Zealand's Generic Policy Options	200
Appendix 8	- Resource Management Act (1991)	202
Appendix 9	- Voluntary Agreements (1995 - 1998)	204
Appendix 10	- Technical Design Issues For A Domestic Trading Regime	206
Appendix 11	- Low Level Carbon Charge	207
Appendix 12	- 1999 Domestic Policy Options	209
Appendix 13	- Sustainable Energy Supply Background Paper For NEECS	211
Appendix 14	- Review of Renewable Energy Definitions	213
Appendix 15	- Benefits and disadvantages of mechanisms to increase renewable energy	217
Appendix 16	- List of possible renewable energy supply generation stations	221
Appendix 17	- Comparison between macro and resource based assessment of renewable energy opportunities	223
Appendix 18	- Justification for thermal plant	224
Appendix 19	- Scenario 2 - 1990 RE Level Scenario Base Data	225
Appendix 20	- Scenario 2 - 1990 RE Level Scenario Annual Target Calculations	226
Appendix 21	- Scenario 3 - 1999 RE Level Scenario Base Data	227

Appendix 22 - Scenario 3 - 1999 RE Level Scenario Annual Target Calculations	228
Appendix 23 - Scenario 4 - Hybrid Scenario Base Data	229
Appendix 24 - Scenario 4 - Hybrid Scenario Target Calculations	230
Appendix 25 - Annual New Generation Build Lists and Calculations for Scenarios 2-4	231
Appendix 26 - GHG units of measurement/estimation and GHG conversion factors	239
Appendix 27 - Market Simulation Module Outputs for Scenarios 1-5	245
Appendix 28 - Scenario 1 - Base Case Scenario Impact Illustration Module Output	257
Appendix 29 - Scenario 2 - 1990 RE Level Scenario Impact Illustration Module Output	259
Appendix 30 - Scenario 3 - 1999 RE Level Scenario Impact Illustration Module Output	261
Appendix 31 - Scenario 4 - Hybrid Scenario Market Illustration Module Output	263
Appendix 32 - Scenario 5 - +1% Energy Efficiency Market Illustration Module Output	265
Appendix 33 - Australian Renewable Energy Policy	267
Appendix 34 - Resources for the quantification of GHG emissions	268

# List of Figures

---

Figure 1-1: Summary of research objectives and processes	7
Figure 2-1: The Greenhouse Effect	14
Figure 2-2: Global atmospheric concentrations of CO <sub>2</sub>	16
Figure 4-1: Relationship between international climate change agencies	24
Figure 4-2: Kyoto Protocol targets	27
Figure 4-3: Emission reduction options equation for industrialised countries	31
Figure 6-1: New Zealand's greenhouse gas emissions 1990 (CO <sub>2</sub> equivalent)	52
Figure 6-2: Contribution to total emissions by sector (1990)	52
Figure 6-3: New Zealand's forecast GHG emissions in 2010	54
Figure 6-4: New Zealand's likely first Kyoto period position	55
Figure 7-1: Breakdown of New Zealand energy CO <sub>2</sub> emissions (1990)	59
Figure 7-2: Electricity CO <sub>2</sub> emissions and Manapouri and Pukaki inflows 1990 – 2000	60
Figure 8-1: Options for meeting future Kyoto Protocol commitments	64
Figure 9-1: NEECS objectives, targets and means	77
Figure 9-2: Sources and proportion of renewable energy electricity supply (1990-1999)	79
Figure 11-1: United Kingdom's Mandatory Renewables Obligation for generators	93
Figure 11-2: Australian Mandatory Renewables Quota for retailers	93
Figure 11-3: Schematic of German Renewable Sources Act	94
Figure 11-4: Tradeable fossil fuel electricity generation permit scheme	95
Figure 12-1: Summary of the MRET Impact Tool inputs and outputs	99
Figure 12-2: New Zealand generation build	105
Figure 12-3: New Zealand generation and demand forecast	106
Figure 12-4: New Zealand capacity and peak demand forecast	106
Figure 13-1: New Zealand electricity sector's emission path under the MRET scenarios	118
Figure 13-2: Indirect relationship between % renewable energy and emission levels	119
Figure 13-3: Supply cost for new renewable generation capacity (ranked by cost)	122
Figure 13-4: Supply cost for new renewable electricity supply (ranked by cost)	123
Figure 13-5: Estimated supply cost versus expected market price	124
Figure 14-1: Climate change policy risk for New Zealand electricity companies	138
Figure 14-2: Contribution of renewable energy projects to New Zealand's emission profile	148
Figure 14-3: Whole of government approach	150

## List of Tables

---

Table 2-1: GHGs, their sources and GWPs	13
Table 2-2: Level of uncertainty of estimations of the three main GHGs	17
Table 4-1: International climate change policy development landmarks	22
Table 5-1: Company emissions, commitments and flexibility mechanisms	40
Table 5-2: National trading systems	41
Table 5-3: GHG prices per ton of CO <sub>2</sub> -e by commodity type and vintage	42
Table 5-4: Potential size of the carbon market	44
Table 6-1: New Zealand emissions in 1990 compared to 2008-2012 forecasts	54
Table 6-2: The potential effect of climate change on New Zealand	56
Table 7-1: Comparison of electricity sector emissions in 1990 and 1999	60
Table 8-1: New Zealand's GHG reduction options	64
Table 9-1: Summary of New Zealand climate change policy developments	71
Table 12-1: Options for additional electricity generation capacity	101
Table 12-2: Meridian Energy's view of future renewable energy electricity generation	102
Table 12-3: Data and summary of MRET Scenario data	112
Table 12-4: Comparison of Market Simulation Module and MED GHG emission data	115
Table 13-1: Capital investment for the five MRET scenarios	126
Table 13-2: Comparison of renewable energy targets and actual modelled outcomes	127
Table 13-3: Comparison of the "best" (Hybrid) scenario against the BAU	132
Table 14-1: Meridian Energy's generation portfolio	136

# Abbreviations

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2MTT	Manapouri Second Tailrace Tunnel Project
AA	Assigned Amounts
AAUs	Assigned Amount Units
Annex A	Annex A to the UNFCCC.
Annex B	Annex B to the UNFCCC.
Annex I	Annex I to the Kyoto Protocol to the UNFCCC
Annex II	Annex II to the Kyoto Protocol to the UNFCCC
ARC	Automation and Remote Control (Manapouri)
BAU	Business as usual
CD	Corporate Delivery, Meridian Energy Ltd
CDM	Clean Development Mechanism
CEL	Contact Energy Limited
CERs	Certified Emission Reductions
CH <sub>4</sub>	Methane
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CO <sub>2</sub> -e	Carbon dioxide equivalent
COP	Conference of Parties
EC	Economic Community
ECNZ	Electricity Corporation of New Zealand
EECA	Energy Efficiency and Conservation Authority
EIA	Enhanced Industry Agreements
EIT	Economies in Transition
ERUs	Emission Reduction Units
EU	European Union
FCCC	Framework Convention on Climate Change
GEF	Global Environment Facility
GEL	Genesis Energy Limited
GEM	Green Electricity Market
GHG	Greenhouse gas
GHGs	Greenhouse gases
GWh	Gigawatt hours (10 <sup>9</sup> watt hours)
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons

IET	International Emissions Trading
INC	Intergovernmental Negotiating Committee for FCCC
IPCC	Intergovernmental Panel on Climate Change
IPCC WG I	IPCC Working Group One
IPCC WG II	IPCC Working Group Two
IPCC WG III	IPCC Working Group Three
JI	Joint Implementation
kWh	Kilowatt hours ( $10^3$ watt hours)
LGNZ	Local Government New Zealand
LNI	Lower North Island
LULUCF	Land Use, Land Use Change and Forestry
MAF	Ministry of Agriculture and Fisheries
MED	Ministry of Economic Development, New Zealand
MEL	Meridian Energy Limited
MEPS	Minimum Energy Performance Standards
MFAT	Ministry of Foreign Affairs and Trade, NZ
MfE	Ministry for the Environment, New Zealand
MOC	Ministry of Commerce, New Zealand
MOT	Ministry of Transport
MRPL	Mighty River Power Limited
MRQ	Mandatory renewables quota
MS	Meridian Solutions, Meridian Energy Ltd
MW	Megawatt ( $10^6$ watts)
N <sub>2</sub> O	Nitrous Oxide
NA	Negotiated Agreement
NEC	National Environmental Standard
NEECS	National Energy Efficiency and Conservation Strategy
NI	North Island
NZ	New Zealand
NGA	Negotiated Greenhouse Agreements
NMVOCS	Non-methane volatile organic compounds
NO <sub>x</sub>	Oxides of nitrogen
NPS	National Policy Statement
NSSCCC	National Science Strategy Committee for Climate Change
NZEM	New Zealand Electricity Market
OECD	Organisation for Economic Co-operation and Development
PFCs	Perfluorocarbons
PJ	Petajoule ( $10^9$ joules)

R&D	Research and Development
REC	Renewable energy certificate
RE	Renewable Energy
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SF <sub>6</sub>	Sulphur Hexafluoride
SG	Strategic Growth, Meridian Energy Ltd
SI	South Island
SOE	State Owned Enterprise
tC	Tonnes of carbon (to convert to tCO <sub>2</sub> multiply by 12/44)
tCO <sub>2</sub>	Tonnes of carbon dioxide (to convert to tC multiply by 44/12)
tCO <sub>2</sub> -e	Tonnes of carbon dioxide equivalent (multiply tGHG by GWP)
TAL	TranAlta Limited (renamed NGC in 2001)
TPK	Te Puni Kokere, Department of Maori Affairs
TRP	Trust Power Ltd
UK	United Kingdom of Great Britain
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention for Climate Change
UNI	Upper North Island
USA	United States of America
VA	Voluntary Agreement
VI	Vertical Integration Model
WEM	Wholesale Energy Market
WMO	World Meteorological Organisation
WOGOCOP	Working Group on CO <sub>2</sub> Policy

### **Units**

k = 10<sup>3</sup>                      e.g. 1,000kg = 1t = 1,000,000 g = 1Mg

M = 10<sup>6</sup>                      e.g. 1 Mt = 1,000 kt

G = 10<sup>9</sup>                      e.g. 1 Gg = 1 kT

T = 10<sup>12</sup>

P = 10<sup>15</sup>

1 billion = 1,000 million = 10<sup>9</sup>

See Appendix 26 for GHG units of measure.