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ENERGY- AND MULTI-SECTOR MODELLING OF CLIMATE CHANGE MITIGATION IN NZ: CURRENT PRACTICE AND FUTURE NEEDS

An executive summary of Motu Working Paper 18-15

Dominic White, Niven Winchester, Martin Atkins, John Ballingall, Simon Coates, Ferran de Miguel Mercader, Suzie Greenhalgh, Andrew Kerr, Suzi Kerr, Jonathan Leaver, Catherine Leining, Juan Monge, James Neale, Andrew Philpott, Vincent Smart, Adolf Stroombergen, and Kiti Suomalainen

Motu Economic and Public Policy Research
niven.winchester@motu.org.nz, dominic.white@motu.org.nz, and catherine.leining@motu.org.nz

SUMMARY HAIKU

NZ models need
collaboration, data,
and development.

INTRODUCTION

As New Zealand joins with other countries to achieve net zero greenhouse gas (GHG) emissions, it will come under increasing pressure from changing economic opportunities, potentially disruptive new technologies, natural resource constraints, and evolving social and political drivers. New Zealand faces the challenge of developing in ways resilient to those pressures while sustaining our natural environment and the well-being of all citizens.

High-quality modelling tools and data are essential for making robust decisions on New Zealand's transition to a low-emission economy under uncertainty.

Motu convened a workshop in Wellington in May 2018, bringing together some of New Zealand's expert energy-sector and economy-wide modelling practitioners from government, research institutions and the private sector. This report comes out of that workshop. A companion report profiles land-use models and datasets relevant to assessing a broad range of environmental issues.

MODELLING IN NEW ZEALAND

New Zealand has a suite of "stand-alone" energy-sector and multi-sector models, with infrequent coordination among models. These have been developed by government, research organisations and private sector entities in different contexts and to address a range of environmental and economic issues and regulatory/reporting needs. However, when it comes to the application of these tools, there is a history of using them in a sporadic and ad hoc way.

In addition, New Zealand has limited capacity to model:

- low-emission innovations extending beyond historical norms,
- complex interactions between sectors (especially the energy and land sectors), and
- the implications for New Zealand of changes to overseas markets and policies.

This paper was prepared under Motu's Shaping New Zealand's Low-Emission Future programme, with funding support from the Ministry for Primary Industries and the Aotearoa Foundation.

During the past decade, modelling undertaken to help inform major climate change policy decisions has often produced conflicting results. The differences and limitations of these results complicate assessment by policy-makers, stakeholders and the general public, and affect confidence in the decision-making process.

WHAT IS A MODEL?

People may think like a modeller when making a decision in a complex situation. They select certain key details, make assumptions about details they have ignored, and apply intuition and judgement to inform their decisions. Scientists make these models more explicit.

A scientific model is a simplified representation of reality that focuses on the key factors and (cause-and-effect) relationships of a phenomenon. Models describe how these factors are related, and the strengths of the different relationships. Constructing a model requires scientists to specify their assumptions explicitly, identify the phenomena they are concerned with, explain their methodology and use data to calibrate the model. By capturing the key agents, elements, processes and decisions, models enable complex systems and situations to be understood and complex problems to be solved.

Energy- and multi-sector models provide a structured way to think about energy use and GHG emissions and how they may be expected to change in relation to key drivers. In particular:

- Energy-sector models are focused on the impact of changes in policies, technologies or other factors on energy-related sectors such as electricity, industrial heat and transport.
- Multi-sector models address the impacts of change in policies, technologies or other factors within and between different sectors, and can offer insights into the outcomes of complex multi-sector interactions.

These models aim to deepen understanding of how people and systems react to policy change and other external forces. Some energy- and multi-sector models consider outcomes in aggregate. Other energy- and multi-sector models may include the specific configurations of different sectors, and how they change over time.

Through peer review processes, the quality of a model and the robustness of its conclusions can be tested within the scientific community before results are made available. This helps ensure that modelling upholds rigorous standards.

STOCKTAKE OF NEW ZEALAND'S ENERGY- AND MULTI-SECTOR MODELLING

Below is a list of the key energy- and multi-sector models used in New Zealand. The paper goes into further detail about these models, including collaborating organisations and strengths and weaknesses.

Table 1: A list of energy- and multi-sector models in New Zealand

Multi-sector models	
Name	**Organisation**
Climate Mitigation, Adaptation and Trade in Dynamic General Equilibrium (CliMAT-DGE)	Owned by Manaaki Whenua – Landcare Research
Energy and Emissions in New Zealand (ENZ)	Concept Consulting
Energy Substitution, Social Accounting Matrix (ESSAM)	Infometrics
Monash–New Zealand–Green (MNZG)	NZIER
TIMES-NZ	Owned by the BusinessNZ Energy Council
Vivid Economy Wide (ViEW)	Vivid Economics
Energy-sector models	
Name	**Organisation**
Biomass Supply Model*	Scion
Biomass Value Chain Model (BVCM)	Scion
Competitive Risk Averse Generation Expansion (CRAGE)	Electric Power Optimisation Centre (EPOC)
Concept Fuel Flexibility Models	Concept Consultng
Electricity Market Information Dynamic Outer Approximation Sampling Algorithm (EMI-DOASA)*	Electricity Authority (public version) Stochastic Optimization Limited (proprietary version)
Dynamic Outer Approximation Sampling Algorithm (DOASA)	Stochastic Optimization Limited (SOL)
Electricity Indicator Model*	Ministry of Business, Innovation and Employment (MBIE)
EMarket	Energy Link Limited
Generation Expansion Model in a STOchastic and Noisy Environment (GEMstone)	EPOC
Generation Expansion Model (GEM)	Electricity Authority, MBIE
Hydro-Sim	Concept Consulting
HydrovSPD	EPOC
Oil and Gas Simulation Model*	MBIE
OptGen*	Power System Modelling
Process Heat Emissions Reduction	University of Waikato Energy Research Group, MBIE and EECA
Project Rank Model (PRM)*	MBIE
Stochastic Dynamic Dual Programming (SDDP)*	Power System Modelling
Supply and Demand Energy Model (SADEM)	MBIE
UniSyd	Unitec, Stanford University, Asia Pacific Energy Research Centre (APERC), Iceland University, Reykjavik University, Massachusetts Institute of Technology, Kanagawa University and Aoyama University
UniTrac	Unitec and Kanagawa University
Vectorised Scheduling, Pricing and Dispatch (vSPD)	Electricity Authority
Vehicle Fleet Model (VFM)*	Ministry of Transport (MOT)
Woodscape*	Scion

* Models not profiled in this report

SETTING THE AGENDA

Under the Paris Agreement, New Zealand must transition toward a net-zero-emissions economy. Improved modelling would assist New Zealand to design an effective portfolio of policies and measures to reduce emissions and manage the distributional effects on regions, sectors, communities and households. More specifically, model are required to set emission-reduction goals, and in the shorter term, emission budgets, Emissions Trading Scheme (ETS) caps and price safeguards.

During the workshop, participants focused on two key development needs for modelling:
- improving datasets; and
- building New Zealand’s domestic modelling capability to address the types of policy questions identified above.

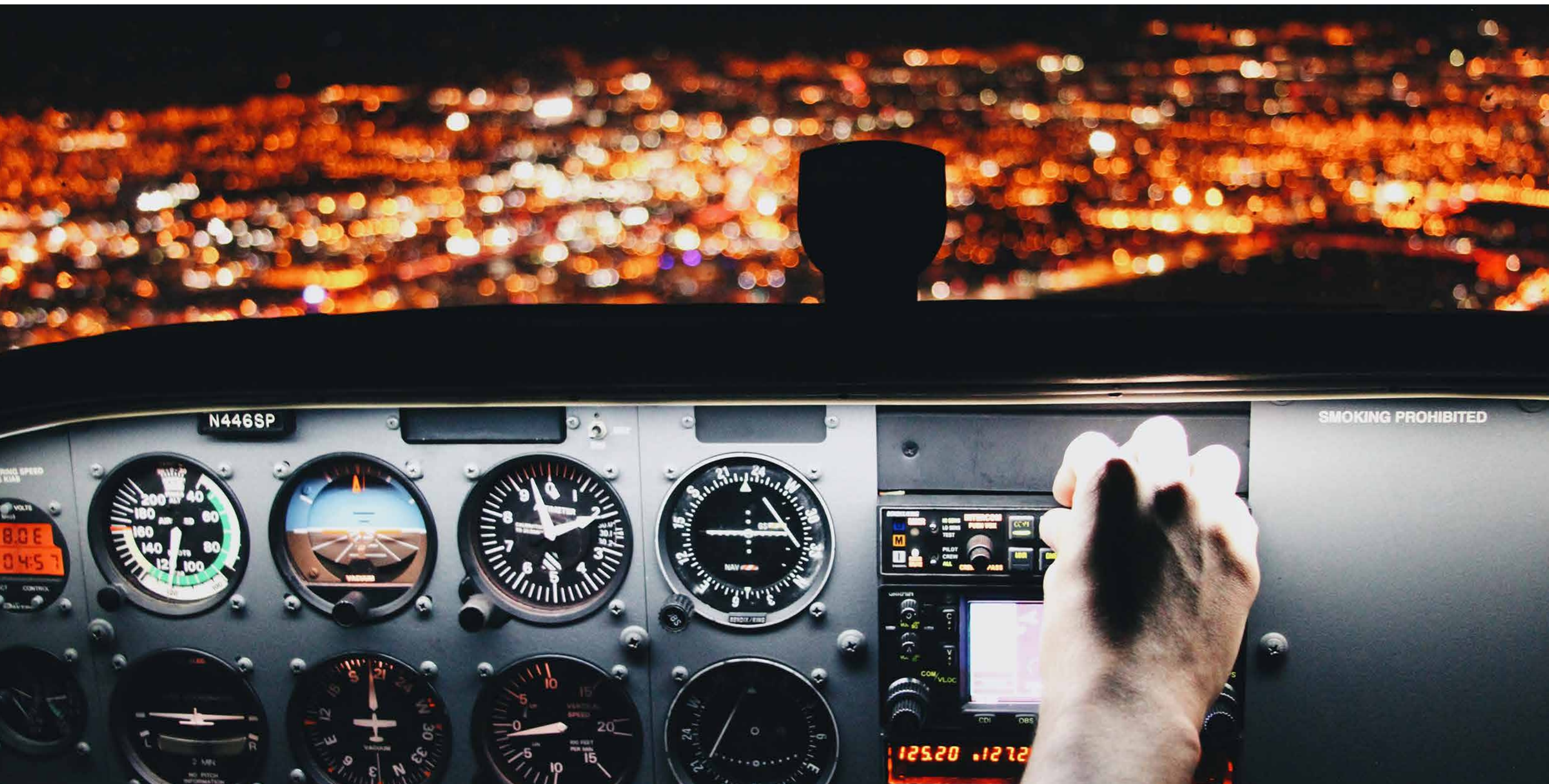
IMPROVING CLIMATE CHANGE MITIGATION MODELLING IN NEW ZEALAND

Workshop participants raised the following ideas for improving the process of climate change mitigation modelling in New Zealand, and developing a more strategic approach as a modelling community:
- Improve the transparency, credibility and comparability of models and their outputs,
- Buildunderlying knowledge,
- Improve model linkages,
- Increase international collaboration,
- Consider the impact of domestic policies in a global context,
- Build sufficient time and funding for model development and analyses into decision-making processes, and
- Communicate modelling results effectively.

AN INTEGRATED FRAMEWORK FOR CLIMATE CHANGE MITIGATION MODELLING

Many necessary improvements could be realised by creating an integrated framework for climate change mitigation modelling in New Zealand. This framework would regularly bring together a suite of models and a network of researchers to assess climate change mitigation policies.

Core elements of the framework would include:
- A central repository of data, common input assumptions and scenarios, and
- A “dashboard” that synthesises results from different models, allowing decision-makers to understand and apply the insights from the models more easily.



The framework would also have several other benefits:

- It could be used to improve linkages among models and ultimately allow each model to capitalise on the strength of other models in the framework.
- Enabling modellers to access high-quality datasets and apply consistent assumptions and scenarios would improve transparency and facilitate comparison of model outputs.
- The framework would provide a centralised, formal channel for international collaboration.

CONCLUSION

As New Zealand charts its course toward a low-emission economy, the quality of energy-sector and multi-sector modelling will be increasingly important. A companion to this report profiles similar issues for land-use models and datasets relevant to assessing a broad range of environmental issues.

This capability could be strengthened by collecting and sharing land-use data more effectively; building understanding of underlying relationships informed by primary research; creating more collaborative and transparent processes for applying common datasets, scenarios and assumptions, and conducting peer review; and conducting more integrated modelling across environmental issues. These improvements will require strategic policies and processes for refining model development, providing increased, predictable and sustained funding for modelling activity and underlying data collection and primary research, and strengthening networks across modellers inside and outside of government.

Sustained investment in a modelling framework would create an "ecosystem" for climate change mitigation modelling in New Zealand. It would also help ensure New Zealand's models are fit for purpose and ready to deploy when the policy demand becomes urgent.

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