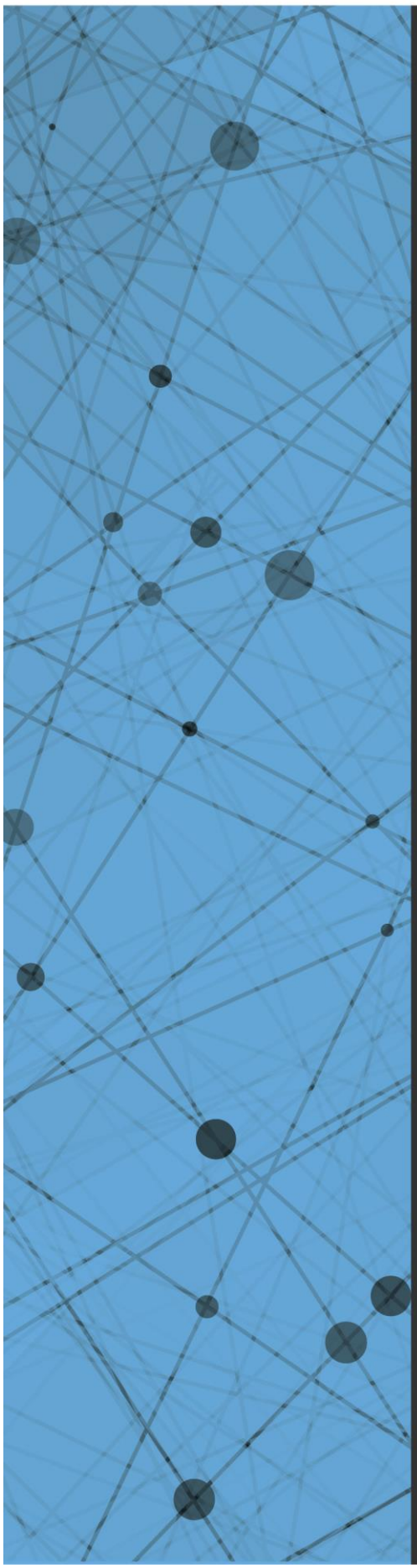

A Community of Practice for Economic Modelling of Climate Change Mitigation in New Zealand

Niven Winchester, Dominic White, and Catherine Leining

Motu Working Paper 19-12

Motu Economic and Public Policy Research

June 2019

Document information

Author contact details

Niven Winchester
Motu Economic and Public Policy Research
niven.winchester@motu.org.nz

Dominic White
Motu Economic and Public Policy Research
dominic.white@motu.org.nz

Catherine Leining
Motu Economic and Public Policy Research
catherine.leining@motu.org.nz

Acknowledgements

The authors are grateful for financial support from Climate Change Adaptation, Reporting and Evidence at the Ministry for Primary Industries, and the Aotearoa Foundation. The authors also acknowledge assistance from the Ministry for the Environment in organising the workshop 'A Community of Practice for New Zealand's Economic Modelling of Climate Change Mitigation' and are thankful for the contributions of participants at the workshop, including Utkur Djanibekov, Joel Gibbs, Laëtitia Leroy, Tamara Linnhoff, Andy Reisinger, Adolf Stroombergen, Hazelle Tomlin, Tony van der Weerden, Jeff Vickers, and Anita Wreford.

Disclaimer

The inclusion of the ideas in this document does not imply any recommendation, consensus, or endorsement by modelling workshop participants or presenters, their affiliated organisations, or the programme funder. All opinions, errors, and omissions in this document are the responsibility of the authors.

Motu Economic and Public Policy Research

PO Box 24390 info@motu.org.nz +64 4 9394250
Wellington www.motu.org.nz
New Zealand

 ISSN 1176-2667 (Print), ISSN 1177-9047 (Online).

Abstract

The public and private sectors face important strategic decisions about low-emissions transitional pathways. Such decisions require sound evidence, with input from experts and stakeholders across the board. Models can be used for evidence-based decision-making, but New Zealand has shortcomings in its capacity for climate policy analysis, particularly in comparison with other jurisdictions. These deficiencies pose a serious risk to New Zealand's future economic development. Climate policy analysis requires assessing a wide range of factors. A multi-model approach supported by multiple providers improves consistency, coordination, and collaboration across members of the modelling community, users of modelling results, and funders of modelling. This document summarises the compelling case for developing a New Zealand 'Climate Policy Modelling Initiative' (CPMI). This initiative would coordinate and enhance delivery of modelling across multiple providers. This work is informed by several workshops that brought together economic modellers from a range of organisations. If supported by government leadership and commitment, the CPMI would have a transformational effect on New Zealand's capacity to plan for a successful low-emissions future.

JEL codes

Q54; Q58

Keywords

Greenhouse gas emissions, emissions abatement, policy analysis

Summary haiku

In community
modelling our future can
take us to new heights

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1 Introduction

At the 2015 Paris Climate Conference – the 21st Conference of the Parties (COP21) under the United Nations Framework Convention on Climate Change (UNFCCC) – representatives from 195 countries agreed to mitigate greenhouse gas (GHG) emissions as part of a strategy to address climate change. Nations that are Parties to the agreement are required to submit Nationally Determined Contributions (NDCs) that outline future reductions in GHG emissions, most commonly for 2030. Under the agreement, Parties are required to pursue domestic measures to achieve emission targets,[1] report regularly on their implementation efforts, and provide information necessary for clarity and transparency (United Nations 2015). New Zealand's NDC is to reduce GHG emissions by 30% below 2005 levels by 2030, and more ambitious emission reductions are planned for 2050 (Ministry for the Environment 2019).

Both the public and private sectors are facing important strategic decisions about New Zealand's low-emissions transitional pathways. The country's transition must be built on sound evidence, with input from experts and stakeholders across the board. In this regard, models are useful for evidence-based decision-making and can be applied to compare policy options in a rigorous manner and highlight the trade-offs (European Commission 2016). New Zealand needs accessible and consistent modelling tools for assessing the impacts of climate change mitigation targets and policies, and evaluating associated risks and opportunities as they arise.

New Zealand currently has a suite of models available to help inform the transition to a low-emissions economy. These have been developed over time 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, as noted by Hendy et al. (2018) and White et al. (2018), when it comes to applying these tools to assess issues and options for climate change mitigation, New Zealand has a history of using many of them in a sporadic and ad hoc way. This has been problematic because it has led to:

- inconsistency in input parameters and key assumptions, leading to differences in results that are not meaningful and serve only to muddy public debate;
- results that highlight only part of the impact, and can omit key pieces of information;
- slow and inefficient processes that are more expensive than necessary;
- lack of ongoing model and data improvements between policy decision-making cycles;
- lack of validation and peer review of models and datasets;

[1] Under Article 6, Parties may apply internationally transferred mitigation outcomes toward achieving their NDCs.

- lack of transparency, understanding and trust regarding modelling assumptions and outcomes;
- inability to assess the integrated impacts of policies across environmental, economic, and social domains, as well as distributional effects across sectors, regions, and socio-economic groups;
- misalignment of outcomes from different types of sectoral, regional, and national models across government, research, and private-sector entities; and
- poor understanding of the relative strengths and limitations of different models by decision makers and the general public.

These outcomes constitute serious barriers to evidence-based decision-making in both the public and private sectors.

The current shortcomings of New Zealand's mitigation modelling capacity pose a serious risk to the country's future economic development in the context of delivering on its international commitments under the Paris Agreement, as well as the emissions-reduction targets and budgets to be established under the Climate Change Response (Zero Carbon) Amendment Bill 2019. They also have the potential to undermine political and public confidence in climate change policy design and support for climate change policy continuity.

To design an effective and enduring economy-wide climate change policy portfolio, the government must be able to assess interactions between a wide range of factors, such as population growth, energy demand and production, the uptake of new technologies, changes in land use and agricultural practices, and the evolution of overseas commodity markets as well as climate change and trade policies. Rising to this challenge requires a multi-model approach supported by a 'community of practice' to improve consistency, coordination, and collaboration across members of the modelling community (both from different institutions and different modelling perspectives), users of modelling results, and funders of modelling.

In 2018–19, with funding from the Ministry for Primary Industries and the Aotearoa Foundation, Motu Economic and Public Policy Research held three workshops with the goal of assessing and improving New Zealand's climate change mitigation modelling capacity. The final workshop, held in March 2019, was titled 'A Community of Practice for New Zealand's Economic Modelling of Climate Change Mitigation'.[2] The goals of the workshop were to: (1) refine the agenda for future economic modelling of climate change mitigation in New Zealand; (2) explore innovative options for designing, governing, and resourcing a community of practice for economic modelling of climate change mitigation that meets the needs of decision makers and

[2] Previous workshops, held in 2018, focused on land-use modelling (Hendy et al. 2018), and energy and multisector modelling (White et al. 2018). The 2018 workshops provided a 'stocktake' of models and explored options for a more strategic approach to climate change mitigation modelling.

the modelling community; and (3) provide a road map for establishing a New Zealand community of practice for climate change mitigation modelling. The workshop was attended by 41 participants from 21 organisations, including government ministries, universities and other research institutes, and private consultancies. The workshop agenda is provided Appendix A. As the workshop was held under the Chatham House Rule and discussion items have been augmented by the authors, the views expressed in this document should not be attributed to individuals or organisations represented at the workshop. The recommendations and conclusions in this paper are the views of the authors and do not necessarily reflect the opinions of workshop attendees.

Building from the discussions at all three workshops, this document presents a compelling case for developing a New Zealand 'Climate Policy Modelling Initiative' to coordinate and enhance delivery of modelling across multiple providers. Supported by government leadership and commitment, the Climate Policy Modelling Initiative would have a transformational effect on New Zealand's capacity to plan for a successful low-emissions future. It could also offer a prototype for boosting New Zealand's modelling capacity in other areas.

This document has six further sections. Section 2 profiles the climate change mitigation modelling programmes of three leading jurisdictions overseas. Section 3 outlines the future needs of New Zealand decision makers for climate change mitigation modelling. Perspectives on New Zealand's current modelling practices are presented in Section 4. Section 5 outlines central elements and implementation options for a new community of practice. Recommendations for establishing a Climate Policy Modelling Initiative are set out in Section 6. The final section concludes the paper.

2 Overseas case studies of climate change mitigation modelling

New Zealand lags behind other leading jurisdictions in its capacity to model climate change mitigation policies. This sections summarises climate change mitigation modelling 'ecosystems' used by the European Union (EU), the United Kingdom (UK), and California. It draws insights relevant for a New Zealand community of practice for climate change mitigation modelling.

2.1 The European Union

In the EU, the European Commission, the institute responsible for proposing legislation and implementing decisions, is supported by the Joint Research Centre (JRC). The JRC is a science and knowledge service that provides independent scientific advice to support EU policies across a range of areas, include climate change. All European Commission legislative proposals include

impact assessments, which examine the need for the EU to take action and analyse the possible impacts of possible solutions. The assessments consider environmental, social, and economic impacts, and provide evidence to inform and support the decision-making process in the preparation phase of the legislative proposals. The quality of each impact assessment report is checked by an independent body, the Regulatory Scrutiny Board (European Commission 2016).

The JRC uses a suite of models for climate policy analysis, as summarised in Table 1. Models used by the JRC include: (1) the CAPRI model, a partial-equilibrium model of the agricultural sector that supports decision-making related to the Common Agricultural Policy and environmental policies related to agriculture; (2) GEM-E3, a global applied general equilibrium model that focuses on the interactions between the economy, the energy system, and the environment; (3) GLOBIOM-G4M, a global recursive-dynamic, partial-equilibrium model that provides policy analysis on land use across the agricultural, bioenergy, and forestry sectors; (4) the GAINS model, an integrated assessment model that projects air pollutants and GHG emissions at the sub-sectoral level, along with their impacts on human health, vegetation, and acidification of ecosystems; (5) PRIMES Biomass Supply, an economic supply model that determines the optimal use of biomass or waste resources and conversion technologies to produce a certain amount of biomass energy; (6) PRIMES, an energy system model that simulates energy supply and demand and emission-abatement technologies; (7) PRIMES-TREMOVE, a transport model that projects the changing demand for passenger and freight transport by transport mode; and (8) PROMETHEUS, a stochastic world energy model that considers the uncertainties associated with economic growth, resource endowments, and the impact of policy actions. Some models are maintained by the JRC (e.g. CAPRI), while others are housed in private consultancies, universities, and other research institutes (European Commission 2016). Documentation for each model is publicly available, but the data and code for the models are, in general, not open source.

Table 1: Core models used for climate change mitigation modelling in the European Union.

Model	**Model type**	**Model documentation**
Common Agricultural Policy Regionalised Impact (CAPRI) model	Partial-equilibrium model of the agriculture sector	Britz & Witzke (2011)
General Equilibrium Model for Economy-Energy-Environment (GEM-E3)	Global applied general equilibrium model	Energy-Economy-Environment Laboratory (2011)
Global Biosphere Management Model-Global Forest Model (GLOBIOM-G4M)	Land use model	International Institute for Applied Systems Analysis. (n.d.a) International Institute for Applied Systems Analysis. (n.d.b)

Model	Model type	Model documentation
Greenhouse gas and Air Pollution Information and Simulation (GAINS) model	Integrated assessment model of air pollutants and GHG emissions	International Institute for Applied Systems Analysis. (n.d.c)
PRIMES Biomass Supply	Optimal biomass supply model	Capros (2012)
Price-Induced Market Equilibrium System (PRIMES)	Energy system model	National Technical University of Athens (2014)
PRIMES-TREMOVE	Transport model	Capros & Siskos (2011)
PROMETHEUS	Stochastic world energy model	National Technical University of Athens (2017)

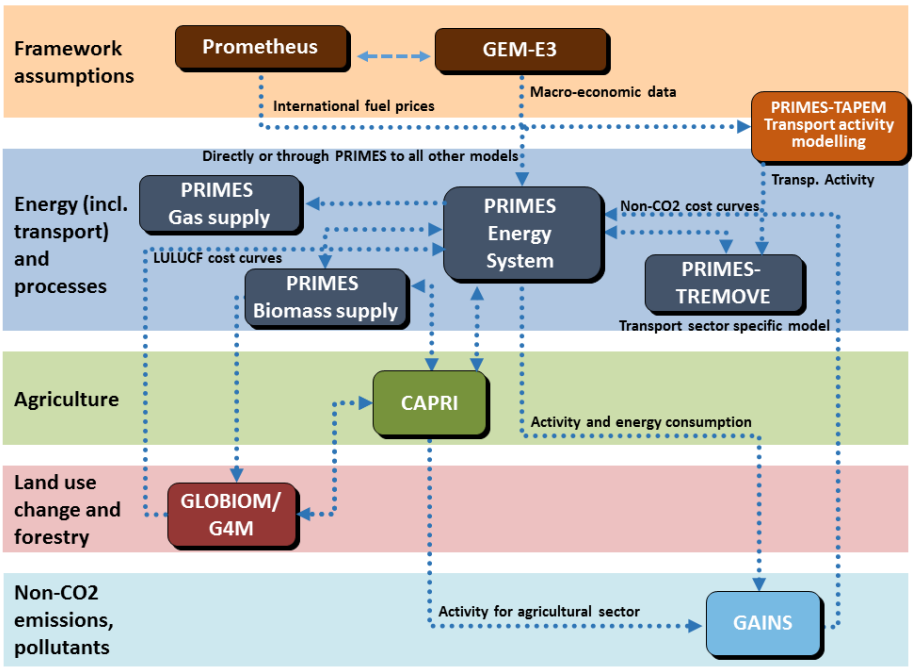
The models used by the JRC cover all GHG emissions and removals. They can produce country-level results for all EU member states, EU candidate countries, and, where relevant, Norway, Switzerland, and Bosnia and Herzegovina. The models are available to evaluate policy impacts on the economy (both at the sectoral and macro levels), employment, energy, transport, industry, agriculture, forestry, land use, atmospheric dispersion, health, ecosystems (acidification, eutrophication), and social welfare (European Commission 2016). Although all models contribute to the modelling 'ecosystem', they are not necessarily used for each policy assessment.

Key elements of the JRC modelling tool suite include harmonisation of models to common future baseline assumptions, and links between some models. Baseline assumptions specify the future values of key variables (e.g. Gross Domestic Product (GDP), population, and GHG emissions) under 'business as usual' (e.g. current trends and policies) conditions. In this connection, a core component of the JRC's modelling 'ecosystem' is the regular update of business as usual GHG emissions for each state (European Commission 2016).

In the JRC modelling framework, output from one model is used to inform the operation of another model using 'soft' rather than 'hard' links.[3] The links between JRC models are illustrated in Figure 1. An example is the link between the GEM-E3 model and the PRIMES Energy System model. In this linkage, GEM-E3 determines the values of macro variables for each scenario, such as GDP and aggregate electricity demand. These are then used as inputs to the PRIMES Energy System model, which determines granular energy results, such as electricity production by technology (National Technical University of Athens 2014). See Vandyck et al. (2016) for more detail on linkages among models used by the JRC.

[3] In a soft link, the processing and transfer of information is controlled by the user, who evaluates results from the models and decides if and how the inputs of each model should be modified. In a hard link, one model is given control over certain results and the other model is set up to reproduce the same results (Helgesen 2013).

Figure 1: The linking of models within the European Commission



Source: European Commission (2016)

The EU has devoted significant resources over several decades to developing models for climate policy analysis. For example, the GEM-E3 model, which is used to estimate economy-wide impacts, has been developed since the 1980s with funding from the European Commission, Directorate-General for Research and Innovation (DG RTD), EU Framework Programmes, and national authorities. This funding has facilitated the development of the model as a collaborative effort by a consortium of research institutions, including the National Technical University of Athens, Katholieke Universiteit of Leuven, University of Manheim, the Centre for European Economic Research, and École Centrale de Paris (Capros et al. 2013).

The European Commission supports capacity building in modelling through: (1) both long-term and ad hoc contracts; (2) multi-lateral research projects; (3) modelling and data networks; and (4) strategic partnerships (European Commission 2016). In commissioning research, the JRC allows freedom for researchers to advance modelling practices and publish in academic journals, in addition to evaluating specific policy proposals.

2.2 The United Kingdom

In the UK, the Committee on Climate Change (UK-CCC) – an independent, non-departmental public body – provides advice to government on building a low-carbon economy and preparing for climate change. In fulfilling this role, among other activities, the UK-CCC conducts and commissions independent analysis into climate change economics and policy.

The UK-CCC relies on models developed by government departments (e.g. the Dynamic Dispatch Model developed by the Department of Energy and Climate Change), research

organisations (e.g. the National Household Model developed by the Centre for Sustainable Energy), and consulting firms and universities (e.g. marginal abatement cost curves for the UK were developed by Scotland's Rural College and Ricardo-AEA). The sharing of analyses, modelling, and research is governed by a Memorandum of Understanding (MoU) among the UK-CCC; Department for Business Energy and Industrial Strategy; Department for the Environment, Food and Rural Affairs; Department for Transport; HM Treasury; and Department for Communities and Local Government. Although the MoU is not legally binding, it sets expectations for the climate mitigation modelling in the community.

The aims of the MoU are to: (1) foster a collaborative approach to analysis, modelling, and sharing of information relating to GHG emissions and energy use; (2) assist UK government departments (and devolved administrations) in developing policies while avoiding unnecessary duplication of effort; and (3) maintain the analytical independence of the UK-CCC (Committee on Climate Change et al. 2016: Appendix B). The MoU outlines those data and analyses relating to carbon budgets, and the work of the UK-CCC is shared publicly. The MoU also states that those involved in analyses relating to carbon budgets and the work of the UK-CCC should keep other parties to the MoU informed about the status of their analytical projects, and that relevant parties will be on steering groups for analytical projects (Committee on Climate Change et al. 2016).

A goal of the MoU is for relevant parties to be able to access, utilise, and commission runs from models owned or otherwise held by other parties, and to access other analyses and datasets. The MoU also states that entities seeking to use a particular model will be required to give advance notice when commissioning that model, or requesting access to datasets, including follow-up requests for information. Under the MoU, direct criticism of models or results should not be published without discussion with the model holder first, who should be shown the criticism and allowed sufficient time and information to respond (Committee on Climate Change et al. 2016). Enabled by the MoU, climate change mitigation modelling in the UK is based on an understanding between modellers and those who commission analytical analyses that modelling results will be shared in a transparent way.

In the UK modelling community, the UK-CCC commissions modelling analyses in partnership with other government departments (Committee on Climate Change et al. 2016). The UK-CCC also produces carbon budgets and other publicly available documents alongside policy advice, including climate mitigation modelling outputs and modelling outputs that are required for future analyses (Committee on Climate Change n.d.). While the specific funding allocation in the UK is unclear, short-term funding for modelling efforts is determined by the policies being considered. In the long term, the UK government strives to have high-quality, fit-for-purpose models across all subject areas, not just climate change mitigation, and it recognises that supporting the long-term upkeep and updates of models is needed as part of this process

(HM Treasury 2015). Information regarding budgeting and modelling is commonly made publicly available by all parties, with the aim of being as transparent as possible.

The main models used for climate change mitigation analyses in the UK are summarised in Table 2. These include: (1) ADPCF, a model used to help determine a sustainable long-term strategy for the development of air travel to 2030; (2) the UK-CCC Aviation Demand and Emissions model, a user-friendly (reduced form) aviation demand and emissions model; (3) the Carbon Price Model, a tool used to set the valuation of carbon at a level that is in line with the UK's domestic and international targets; (4) DDM, a fully integrated power market model looking at the UK over the medium to long term; (5) DICE, a forward-looking integrated assessment model; (6) EPPA a recursive-dynamic multi-regional computable general equilibrium model that can be used to project economic activity, energy use, and GHG emissions around the world; (7) the UK Energy Pathway Models, which lets users create their own UK emissions-reduction pathway and runs to 2050; (8) the Fuel Poverty Model, which determines whether certain households would be pushed below the poverty line due to rising fuel prices; (9) the GLOCAF model, designed to analyse potential global climate mitigation targets and determine how much mitigation must be done domestically and how much can be funded internationally through carbon trading; (10) the Industry Pathways model, a bottom-up, dynamic, linear programming optimisation model that analyses all aspects of the UK energy system in the industrial sector; (11) the LCF model, a tool to estimate the consumer cost required for low-carbon electricity technologies; (12) the UK Marginal Abatement Cost Curves, tools designed to minimise the cost of meeting national GHG emissions-reduction targets, with a focus on land use and land-use change; (13) MiniCAM, a long-term partial-equilibrium model for large-scale changes in global and regional energy and agricultural systems; (14) MERGE, a partial-equilibrium, integrated assessment model for estimating regional and global climate change; (15) NHM, a domestic energy tool that provides a representation of the physical characteristics of the housing stock and occupant types; (16) NTM, a transport model that determines aggregate demand for various transport options; (17) the Non-domestic Buildings Model and Buildings Energy Efficiency Survey, which gather data on energy use in non-domestic premises in England and Wales to understand how energy consumption can be reduced; (18) PAGE, an integrated assessment model that determines the economic cost of damages caused by climate change; (19) the UK-CCC UK Shipping Emissions model, used to forecast shipping emissions to 2050 for different ship types and routes; (20) TMfS, a multi-model transport demand and assignment model with an interactive land-use model for Scotland; and (21) UKTM, a bottom-up, technology-rich cost-optimisation model that focuses on decarbonisation pathways and technology assessment for the UK energy system.

As shown in Table 2, the MERGE, DICE, UK TIMES, NHM, Industry Pathways, and UK Energy Pathway models are open-source models. As for climate change mitigation modelling in

the EU, there are several other models that feed into the models outlined in Table 2, and not all models are used for each policy assessment.

Table 2: Core models used for climate change mitigation modelling in the United Kingdom

Model	**Model type**	**Model documentation**
UK Air Passenger Demand and CO_2 Forecasting Framework (APDCF)	Air travel model	Department for Transport (2009)
UK-CCC Aviation Demand and Emissions model	Aviation demand and emissions model	MVA Consultancy (2009)
Carbon Price Model	Carbon valuation model	AEA Technology (2005); additional information is available at: https://www.gov.uk/government/collections/carbon-valuation--2#guidance-on-estimating-carbon-values-beyond-2050
Dynamic Dispatch Model (DDM)	Electricity dispatch model	Department of Energy and Climate Change (2012); additional information is available at: https://www.gov.uk/government/publications/dynamic-dispatch-model-ddm
Dynamic Integrated Climate Change Model (DICE)*	Integrated assessment model of consumption, investment and greenhouse gas reduction	Open-source documentation: https://sites.google.com/site/williamdnordhaus/dice-rice
MIT Emissions Prediction and Policy Analysis Model (EPPA)	Computable general equilibrium model of global greenhouse gas emissions	Paltsev et al. (2005); additional information is available at: https://globalchange.mit.edu/publication/14578
UK Energy Pathway Models*	UK emissions-reduction pathway to 2050 model	Department for Business, Energy and Industrial Strategy (2013) Open-source documentation: https://github.com/decc/twenty-fifty

Model	Model type	Model documentation
Fuel Poverty Model	Household fuel cost model	Department for Business, Energy and Industrial Strategy and Building Research Establishment (2018); additional information is available at: https://www.gov.uk/government/collections/fuel-poverty-statistics
Global Carbon Finance Model (GLOCAF)	Global carbon market model	Global CCS Institute (n.d.); additional information is available at: https://www.thepmr.org/content/department-energy-and-climate-change-united-kingdom-global-carbon-finance-glocaf-model
Industry Pathways model*	Industrial sector energy optimisation model	Agricultural Engineers Association (2011) Open source documentation: https://github.com/decc/twenty-fifty
Levy Control Framework Forecast Model (LCF)	Electricity energy bill model	Department for Business, Energy and Industrial Strategy (2016b); additional information is available at: https://www.gov.uk/government/collections/levy-control-framework-lcf
UK Marginal Abatement Cost Curves	Agriculture, land use and land-use change cost models	Eory et al. (2015); additional information is available at: https://www.theccc.org.uk/publication/scotlands-rural-collage-sruc-ricardo-energy-and-environment-2015-review-and-update-of-the-uk-agriculture-macc-to-assess-abatement-potential-for-the-fifth-carbon-budget-period-and-to-2050
MiniCAM	Partial-equilibrium model of regional energy and agriculture systems	Brenkert et al. (2003); additional information is available at: https://www.energyplan.eu/othertools/global/minicam
Model for Estimating the Regional and Global Effects of greenhouse gas reductions (MERGE)	Integrated assessment model for climate change costs, damages, valuation, and discounting	Manne & Richels (2005)

Model	Model type	Model documentation
National Household Model (NHM)*	Domestic energy policy model for the UK housing market	Centre for Sustainable Energy (2016) Open-source documentation: https://www.deccnhm.org.uk
National Transport Model (NTM)	Transport model	Atkins (2018); additional information is available at: https://www.gov.uk/government/publications/national-transport-model-implementation-report
Non-domestic Buildings Model and Buildings Energy Efficiency Survey	Non-domestic energy use model	Department for Business, Energy and Industrial Strategy (2016); additional information is available at: https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees
Policy Analysis of the Greenhouse Effect (PAGE)	Integrated assessment model of climate change costs	Hope et al. (1993); additional information is available at: https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=OAP&dirEntryId=240711
UK-CCC UK Shipping Emissions model	Shipping emissions model	Committee on Climate Change (2011)
Transport Model for Scotland (TMfS)	Transport and interactive land use model	Lumsden (2005)
UK TIMES model (UKTM)*	Energy system cost optimisation model	Daly & Fais (2014); additional information is available at: https://www.ucl.ac.uk/energy-models/models/uk-times Open source documentation: https://github.com/decc?page=1

Note: * denotes that the model is open source.

2.3 California

California is a global leader in climate mitigation, with policy decisions informed by a wide range of models (Morrison et al. 2014). Models used to evaluate climate change mitigation options in the state are owned by private organisations (e.g. the PATHWAYS model is held by E3 Energy and Environmental Economics); government agencies (e.g. the Scenario Modelling System is owned by the California Air Resources Board); and universities (e.g. the Berkeley Energy and Resources Model is owned by the University of California, Berkeley). The funding for modelling

depends on the needs of stakeholders and policy makers, who contract the models they need based on policies under consideration (Morrison et al. 2014).

The core models used for climate change mitigation modelling in California are listed in Table 3. These include: (1) BEAR, an applied general equilibrium model of California for energy and environmental policy analysis; (2) the California Greenhouse Gas Inventory Spreadsheet, a tool for establishing historical emission trends and tracking California's progress in reducing GHG emissions; (3) LEAP, an integrated scenario-based modelling tool developed by the Stockholm Environment Institute to estimate energy consumption, production, and resource extraction; (4) California-TIMES, a technologically rich, 'bottom-up', optimisation and partial-equilibrium model of the energy system in California; (5) the PATHWAYS model, a long-horizon energy model developed by Energy and Environment Economics that can be used to assess the costs and GHG emissions impacts of California's energy demand and supply choices; (6) the Scenario Modelling System, a system-wide transport model that tracks multiple pollutants; (7) Switch, a power systems planning model that explores the feasibility and costs of generation, transmission, and storage options for future electricity systems; and (8) the WWS Roadmap, a blueprint for converting California's all-purpose energy infrastructure to one derived entirely from the generation of electricity and electrolytic hydrogen from wind, water, and sunlight.

Table 3: Core models used for climate change mitigation modelling in California

Model	**Model description**	**Model documentation**
Berkeley Energy and Resources Model (BEAR)	Applied general equilibrium model	Roland-Holst (2008); additional information is available at: https://policyinstitute.ucdavis.edu/uc-berkeley-energy-resources-bear-model
California Greenhouse Gas Inventory Spreadsheet*	GHG emissions tracking tool	Open-source documentation: https://www.arb.ca.gov/cc/inventory/data/data.htm
California Long-range Energy Alternatives Planning System (LEAP)	Scenario-based tool for energy and GHG emissions	Wei et al. (2013); additional information is available at: https://www.energycommunity.org/default.asp?action=introduction
Integrated MARKAL-EFOM System (California-TIMES) model for California	Energy system model	Yang et al. (2014); additional information is available at: https://steps.ucdavis.edu/research/mavric-modeling-analysis-verification-regulatory-and-international-comparisons/ca-times

Model	Model description	Model documentation
PATHWAYS model	Long-horizon energy model	Energy and Environmental Economics (2017); additional information is available at: https://www.ethree.com/tools/pathways-model
Scenario Modelling System*	Transport model	Open-source documentation: https://www.arb.ca.gov/planning/vision/downloads.htm#2016vision21lr
Switch	Power systems planning model	Nelson (2013)
Wind, Water, and Sunlight (WWS) Roadmap	Road map to repower California's all-purpose energy with wind, water, sunlight	Jacobson et al. (2014)

Note: * denotes that the model is open source.

Most models included in California's modelling tool suite are open source, with detailed information about the models available online. Information provided includes descriptions of the models, model updates and version history, and data used by the models.

Climate change mitigation modelling in California is aided by the California Climate Policy Modelling (CCPM) Dialogue. The CCPM Dialogue is a joint project of the Policy Institute for Energy, Environment, and the Economy and the Sustainable Transportation Energy Pathways Program, both at the University of California, Davis. The goal of the CCPM Dialogue is to bring together policy makers, modelling groups, and key stakeholders, in order to: (1) improve the knowledge of plausible scenarios for future technology adoption, energy use, air quality, and GHG emissions; (2) identify plausible mid-point goals and targets for GHG emissions; (3) discuss policy options needed for meeting the state's climate and air-quality goals; and (4) improve the state of modelling (Morrison et al. 2014).

The CCPM Dialogue periodically organises workshops to promote discussion, collaboration, and progress on its priorities. Workshops funders include Pacific Gas and Electric, the Energy Foundation, and the Environmental Defense Fund (Morrison et al. 2014). The workshops provide a platform for communication between modellers and users of modelling results, and improve the transparency of modelling efforts. The CCPM Dialogue is guided by a steering committee that includes representatives from universities, consultancies, and California government agencies.

2.4 Insights for New Zealand

This brief survey of climate change mitigation modelling programmes brings to light several design elements than would be beneficial for a community of practice for New Zealand modelling. First, and importantly, as analyses to support climate change policy decisions need

multiple models, it is not possible for one organisation to operate all the required models, even in a jurisdiction as large as the EU. Instead, a community practice must bring together models from different organisations – inside and outside of government – on an ongoing basis. In such a setting, coordination among modelling groups can be enhanced by: (1) providing a common future baseline for all groups; (2) holding regular meetings/workshops for members of the modelling community; and (3) agreements among modelling stakeholders such as the MoU in the UK, supported by constant, active networking.

A second notable aspect of modelling efforts elsewhere is that dedicated, long-term government funding for climate change mitigation modelling, sometimes extending over a period of several decades, is an important ingredient for a successful community of practice. Such funding can either be included in budgets for an organisation that coordinates (and possibly implements some) modelling efforts, such as the JRC in the EU, or included in budgets for government agencies, with an appropriate agreement among the agencies and an organisation to coordinate the research. Third, detailed documentation is provided for most models and some, especially in California, are open source, which enhances the transparency and credibility of modelling analyses. Fourth, providing scope for academic endeavours, in addition to prescribed scenarios, is important for attracting and retaining suitable personnel.

3 The future needs of decision makers

In May 2019, the New Zealand government proposed the Climate Change Response (Zero Carbon) Amendment Bill 2019, an amendment to the Climate Change Response Act 2002, that will that set targets to: (1) reduce all GHGs (except biogenic methane) to net zero by 2050; and (2) reduce emissions of biogenic methane within the range of 24–47% below 2017 levels by 2050, including to 10% below 2017 levels by 2030 (Ministry for the Environment 2019). The Zero Carbon Bill will also set five-year emissions budgets that are stepping stones to the 2050 target, and establish an independent New Zealand Climate Change Commission (CCC). The CCC will advise the government on setting emissions budgets, including realistic means (e.g. carbon pricing and regulations) of meeting those budgets. To enable technical work to begin before the establishment of the CCC, the Interim Climate Change Committee (iCCC) was established in April 2018. In setting climate change policies, the government aims to achieve a 'just and effective transition' to a low-carbon economy by 'taking a transparent and participative approach to climate change policy' and 'creating enduring institutional arrangements for climate change and environmental governance, with decisions underpinned by strong data and evidence' (Office of the Minister for Climate Change 2018).

Designing effective policies that align New Zealand's economy with a global temperature goal of 1.5°C will require a step-change improvement in economic modelling capacity at both

sector and economy-wide levels. Whereas past modelling exercises have been commissioned to respond to short-term policy demands, like setting international targets in negotiations, New Zealand needs an enduring approach that produces consistent outputs over time for cyclical decision-making on emissions-reduction targets, budgets, emissions trading scheme (ETS) caps, and policies. Transitioning to net-zero emissions of long-lived gases within a few decades will require transformational change at unprecedented scale and speed. This creates new analytical challenges. New Zealand needs to strengthen our ability to model:

- low-emission innovations extending beyond historical norms;
- transitional pathways over time, not just equilibrium states;
- distributional impacts and co-benefits of policy options;
- integrated effects of policy options across multiple economic, environmental, and social domains;
- realistic (irrational) behaviour by producers and consumers;
- complex interactions between sectors (especially the energy and land sectors), and between emission pricing and other mitigation policies; and
- the implications for New Zealand of changes to overseas markets and policies.

In addition to improving the use of existing and new models, New Zealand needs to address critical data deficiencies and strengthen underlying knowledge through primary research.

Decision makers also need modelling processes that will bring stakeholders along with them on the journey to decarbonisation. They need to be able to leverage detailed sectoral knowledge and build trust among stakeholders. For example, policy processes should make it possible for stakeholders to become familiar with models and review key assumptions and outputs. The experience gained to date by the iCCC in engaging stakeholders in modelling exercises could help with rgw development of guidelines for a more effective modelling community.

Priority sectors for improving New Zealand's modelling capacity include agriculture, transport, tourism, industrial production, and construction. New Zealand also needs better tools for assessing crossovers between sectors (e.g. the clusters of electricity, transport, and industrial heat; or forestry, biomass energy, and carbon capture and storage). New approaches to modelling will be needed to address key strategic questions on these topics, like trade-offs between high-value versus high-volume outputs for agriculture and tourism.

4 Perspectives on current practices

New Zealand has a suite of models for climate policy analysis, but they have been used in a sporadic and ad hoc way to inform decision-making. Modelling practitioners have reported that the timelines typically allocated for model development and policy analysis tend to be unrealistically short, and it can be difficult to secure funding for systematic model development between policy cycles. Models tend to be used intermittently ,and when they are left unused, organisations can lose the human capital needed to run and extend them. Resources are also limited for primary research and data collection to address information deficiencies. Government bid processes discourage collaborative and comparative modelling by multiple providers. Few processes or forums exist for encouraging formal or informal interactions between modellers, modelling users, and funders.

As noted in Section 1, the limitations in New Zealand's current modelling practice pose serious barriers to evidence-based decision-making on climate change mitigation policy. In earlier work, Hendy et al. (2018) and White et al. (2018) provided the following suggestions for improvement:

- strengthen underlying knowledge through primary research;
- provide sustained funding for model development and underlying data collection and primary research;
- build sufficient time and funding for model development and analyses into decision-making processes;
- centralise and improve data collection – models should use common datasets, scenarios, and assumptions;
- enable greater collaboration among researchers, policy makers, and other end users;
- improve the communication of modelling results;
- increase international collaboration; and
- improve the transparency (e.g. open source), credibility (e.g. peer review), and comparability of models and their outputs.

Recent modelling work commissioned by the New Zealand Productivity Commission (2018) provides a good example of a successful collaborative approach. Three independent organisations – Concept Consulting, Motu Economic and Public Policy Research, and Vivid Economics – brought together their models and expertise to prepare an economy-wide evaluation of outcomes from a series of scenarios for technology development and GHG targets. The associated reports provided a clear explanation as to what models were used, their

limitations, and how they produced their outputs. This helped to underpin the policy recommendations advanced by the Productivity Commission during its inquiry.

5 Central elements and implementation options for a community of practice

As it is not possible for one organisation to operate all the models required for analyses to support climate policy decisions, there is a clear case for developing a New Zealand Climate Policy Modelling Initiative. A successful community of practice for mitigation modelling should be designed to: (1) improve the quality, transparency, credibility, and comparability of modelling to inform decision-making; (2) create institutions and networks to boost modelling development, coordination, collaboration, integration, and communication; and (3) secure increased, predictable, and sustained funding for modelling activities.

A key consideration will be the role of the CCC in administering, funding, or otherwise supporting this community of practice in relation to other government departments, research institutions and consultancies, and/or a new entity established for this purpose.

5.1 Modelling elements

5.1.1 Model development

The modelling community should aim to have a suite of models that have been thoroughly tested and refined, with quality control embedded through the process. To facilitate this goal, where possible, all models should be open source and peer reviewed. In particular, New Zealand needs a multi-sector, general equilibrium/whole economy model that is open source. Consideration should be given to maintaining and using existing modelling collateral, and developing new models to address limitations. There should be a mandate and funding for continuous model improvement, which could be aided by incentives to provide long-term training for future modellers (e.g. PhD students).

New Zealand also needs to develop the capacity to conduct modelling of distributional impacts of targets, budgets, ETS caps, and policy options across sectors, regions, and socio-economic dimensions. To aid this objective, sectoral models could be 'linked' with each other and/or an economy-wide model. Due to the complexity of linking models, they should be soft linked rather than hard linked, as in the JRC approach. Meeting these aims will help models to provide deep and accurate insight on climate policy questions.

Modelling projects should be co-designed by research providers and policy end users under reasonable time frames. Initiators of modelling projects should be sympathetic to the

need for model development and maintenance, and the complexity of multi-model projects analyses.

5.1.2 Primary research and data collection

Primary research and underlying data for models need to be improved. As the core inputs of models get better, the modelling outputs will become more reliable. The CCC or a similar organisation could play a pivotal role in coordinating research priorities and setting the modelling agenda, including commissioning primary research to assist models. The data used in modelling should be subject to quality-control processes and open source (where possible). There should also be standards for sharing data, with appropriate protocols for managing confidential or commercially sensitive data. To address data and primary research deficiencies, New Zealand stakeholders and modellers should develop a master plan over a specified period, for example three years, which identifies and prioritises current gaps and sets out a detailed plan to address them.

5.1.3 Information sharing

The modelling community needs a centralised repository for information sharing. To improve harmonisation across models this should include, at a minimum, key projection data for future baseline scenarios (e.g. GDP and sectoral GHG emissions), and descriptions of, and assumptions in, a series of core scenarios that also consider alternative developments overseas that influence New Zealand. More intricate databases (e.g. spatial data on land use) could also be hosted by, or linked to, the centralised repository. If some data (and software) are confidential, similar to the Integrated Data Infrastructure operated by Statistics New Zealand, a 'modelling lab' could be created to facilitate information sharing. The CCC seems like the logical organisation to host the central data repository.

Along with a central data repository, there should be strong links and open communications between model providers and users. This could be improved by incorporating resources to facilitate information sharing into project proposals and funding. To increase communication within the modelling community and facilitate information sharing, there should be regular workshops and/or conferences for New Zealand climate change mitigation researchers and stakeholders.

5.1.4 Integrating models and comparing results from different models

Climate change mitigation models in New Zealand have different assumptions, and it needs to be clear when and why those differences exist and, where necessary, how to harmonise assumptions. This could be achieved by better integrating models. As noted above, model integration should be in the form of soft rather than hard links among models.

Improving consistency among models and integrating models will support more meaningful comparisons of results from different models. However, full harmonisation is not essential as differences in model assumptions can provide useful insights. For example, comparing models with different assumptions facilitates an understanding of uncertainty in modelling outcomes. Both 'top-down' and 'bottom-up' modelling approaches should be used for comparative purposes, and New Zealand modelling groups should also participate in model comparison exercises, such as the Energy Modelling Forum led by Stanford University.

5.2 Governance elements

5.2.1 Administration

A designated governing body for climate mitigation modelling should engage in policy foresight planning and set the modelling agenda for the next three to five years. An example of a successful modelling governing body is the European Commission's JRC; however, an initiative like the JRC is unlikely to be a feasible in New Zealand. In fulfilling this function, the governing body should leverage existing modelling expertise in different organisations. It should also incentivise innovations in modelling (by providing scope for basic research and academic excellence), facilitate the sharing of confidential data, and be decentralised from departments to make it more palatable to industry and help with managing interdepartmental dynamics.

It seems logical for the CCC to play a key role in both the interface between policy foresight and delivery of modelling results, and the facilitation and coordination of modelling efforts across New Zealand, including setting agendas for model development, primary research, and data collection. If the CCC has a facilitative role, this needs to be provided for in the terms of reference and funding allocated to the organisation. If the CCC does not play a facilitative role, an independent body should operate alongside the CCC to facilitate and coordinate modelling development. The iCCC should be involved in the formation of the community of practice until the CCC is established.

The CCC (or other facilitative body) should be assisted by a steering group and a technical advisory board. The steering group should include representatives from government ministries, funding bodies, industry, and modelling practitioners. The steering group would lay out the overall direction of the community of practice and provide guidance on governance and funding initiatives. The advisory board should comprise modelling experts, both from New Zealand and abroad. The advisory board would help to ensure that models in the community of practice meet international best-practice standards, and assist with international collaboration among modellers. As the New Zealand modelling community is quite small, procedures should be established to avoid conflicts of interest in the establishment of the steering group and the advisory board.

The planning and implementation horizon for setting up the community of practice should start immediately. A good example of a local governance model is the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), which sits at the junction between policy foresight and science delivery.

5.2.2 Membership

A community of practice for mitigation modelling could encompass modelling practitioners as well as decision makers applying modelling results, researchers and data collectors, and other stakeholders with an interest in modelling outcomes. The community of practice needs to promote active membership and participation. In particular, it needs to be clear what the vision, mission, goals, and purpose of the community are to all involved. Organisations and individuals contributing models and results to the community will have to embrace the fact that models and results, and the modelling process, will be made more visible than under the status quo. An inclusive approach should be encouraged. A broader circle of affiliations could develop over time.

5.2.3 Communication

Communication is important not only when providing modelling results but also in the build-up to using models. It is beneficial to have transparent information regarding modelling capabilities, assumptions, and data quality. When multiple models are used for an analysis, the differences among models and explanations for why different models are needed should be clearly communicated. A 'dashboard' that synthesises results from different models would also help communicate results and allow decision makers to understand and apply the insights from the models more easily.

There should also be standardised peer review of model results, to explain or eliminate conflicting results. Model-based analyses should be accompanied by non-technical descriptions to allow non-modellers to understand how the models work. Models in the community of practice should also be appropriately documented. To incentivise this process, funding contracts should require that modelling results are appropriately communicated, and also that assumptions and their implications are transparent.

5.2.4 International linkages

New Zealand's community of practice should involve experts and models from overseas organisations. The modelling communities in the EU, the UK, and California are outlined in Section 2 of this report. To improve the suite of models available, New Zealand should, where suitable, leverage and adapt models from other countries. To increase transparency and international communication, documentation for New Zealand's models should be published in international journals, and be peer reviewed by overseas experts. It would also be useful for

New Zealand modelling practitioners to participate in international networks that focus on climate change mitigation modelling.

In addition, New Zealand should leverage existing international links to modelling initiatives through organisations such as the UNFCCC, the Organisation for Economic Co-operation and Development, and the Integrated Assessment Modeling Consortium. A New Zealand 'community of practice' platform could be used to bolster international linkages by increasing the visibility of climate change mitigation modelling here. Enhanced international linkages will not only improve the quality of models in New Zealand, but they could also improve trust in New Zealand's policy targets and measures.

5.3 Funding mechanisms

To align the incentives for both modellers and end users with the government's strategic objectives for sound evidence-based decision-making, the funding mechanisms for climate mitigation modelling in New Zealand need to be readjusted. Distinct funding streams should be designed to support: (1) maintenance of existing models; (2) commissioning of modelling to address specific policy issues; (3) addressing gaps in data and research; (4) independent use of models to address research questions beyond the government's short-term agenda; and (5) long-term model development and innovation, including adapting or developing models to look at new issues and developing intellectual capital (e.g. training PhD students). Such a readjustment to the allocation of funding would encourage modelling efforts that have a balance between delivering outputs and providing scope for basic research and academic excellence.

It would be useful to map current funding streams for modelling work and underlying research and data collection, and compare them with the requirements for sustaining an effective community of practice. New funding mechanisms may be needed to ensure that adequate levels of finance for modelling work are sustained consistently across budget cycles and government departments. It would be desirable if industry stakeholders contributed funding and data for the community of practice. This could be achieved by engaging with industry partners when models are developed and assumptions are made.

Funding priorities should be informed by a broad group of end users and funders. The CCC could have an advocacy role for funding modelling work and/or could assume responsibility as the core distributor of modelling funding. To ensure modelling capabilities are maintained and developed, funding for modelling analysis could be tied to the process that sets emission budgets. The community of practice could also be used as a 'springboard' for modelling groups to apply for contestable research grants, such as the Endeavour Fund.

6 A road map for the New Zealand Climate Policy Modelling Initiative

A road map for establishing and continuing a New Zealand Climate Policy Modelling Initiative is outlined in Figure 2. The road map distinguishes actions required to launch an effective community of practice (Horizon 1), and activities to refine and maintain the initiative (Horizon 2).

Horizon 1 priorities for the community of practice are to: (1) identify core models to support climate policy analysis (including new models that need to be developed); (2) harmonise model baselines and core scenarios (including new models that need to be developed); (3) boost data collection and primary research in key areas; (4) designate responsibility for coordination, facilitation, advocacy, delivery, and oversight to the CCC (or other organisation), and establish a steering committee and an advisory board; (5) invite stakeholders to join the initiative and create the infrastructure to support the network; and (6) take stock of current funding sources and channels, and secure and allocate funding for urgent tasks. Important Horizon 2 activities include: (1) improving integration across models, data collection, and primary research; (2) strengthening institutional elements and networks; and (3) establishing long-term funding for the initiative.

Figure 2: Road map for the New Zealand Climate Policy Modelling Initiative

Vision: A thriving cross-sector community of practice for economic modelling that develops and sustains New Zealand's capacity to design effective climate change mitigation policies.

Goals:
- Improve the quality, transparency, credibility, and comparability of modelling to inform decision-making.
- Create institutions and networks to boost modelling development, coordination, collaboration, integration, and communication.
- Secure increased, predictable, and sustained funding for modelling activities.

Component		Horizon 1	Horizon 2
Modelling	Models	• Identify core models for setting targets, budgets, caps, and policies • Identify other models for comparative exercises • Develop protocols for model documentation and peer review • Begin harmonisation of baselines, core scenarios, and assumptions	• Create a dashboard for presenting model outputs • Improve model linkages and integration • Develop modelling communication guidelines
	Data and primary research	• Conduct a data gap analysis • Commission data collection and primary research in priority areas • Create a central data platform (repository)	• Extend data collection and primary research • Implement data quality-control protocols
Governance	Institutions	• Delegate core functions to the CCC and/or other bodies: coordination, facilitation, advocacy, delivery, and oversight • Develop a memorandum of understanding for coordinating modelling across agencies • Designate a steering committee to advise the Climate Policy Modelling Initiative on strategic direction • Designate a technical advisory board to provide expert advice	• Evaluate and improve institutional coordination • Develop educational programmes to build modelling capacity
	Networks	• Invite membership/affiliation • Establish a website and distribution list • Organise periodic workshops	• Link to international modelling initiatives
Funding		• Map current funding sources and channels for modelling • Allocate priority funding for the core models, primary research, and data collection • Fund core and other modelling to address policy challenges • Delegate funding responsibilities across agencies	• Establish dedicated funding channels to sustain and develop New Zealand's modelling capacity • Provide funding for innovative academic research

As it will take time for governance and funding mechanisms to be established, assisted by seed funding from the government, the modelling community may want to take early action to establish the community of practice. A first step could be establishing a website that lists current research groups and their modelling capabilities, a register of interest to participate, and a wiki that allows members of the community to contribute ideas and information.

Once established, the Climate Policy Modelling Initiative will:

- operate as a hub to coordinate modelling groups from different organisations;
- act as a central repository of databases, assumptions, and scenarios;
- provide a centralised channel for international collaboration;
- provide a 'dashboard' for displaying results from a range of models;
- provide a means for communicating results to non-modellers; and
- enable greater collaboration among researchers, policy makers and other end users (e.g. through regular meetings and workshops).

7 Conclusions

New Zealand plans to reduce GHG emissions significantly to support the Paris Agreement and mitigate climate change. Quantitative analyses of policies and regulations to meet emissions-reduction targets will require multiple models focusing on diverse aspects of the economy.

In its capacity to model climate change mitigation policies, New Zealand currently lags behind other leading jurisdictions, which have dedicated significant resources to modelling efforts over an extended periods. This capacity gap poses a serious risk to New Zealand's future economic development in the context of delivering on its international commitments under the Paris Agreement.

Many of the shortcomings of New Zealand's mitigation modelling capacity stem from the sporadic and uncoordinated use of modelling in the past, and could be addressed by establishing a New Zealand Climate Policy Modelling Initiative. Creating the initiative will require significant leadership from the government to establish the required governance and dedicated, long-term funding mechanisms before other elements of the community of practice can be implemented. A logical facilitator of the community of practice is the CCC (or the iCCC until the CCC is established). A New Zealand Climate Policy Modelling Initiative will enhance the credibility and transparency of evidence-based decision-making, and assist New Zealand's transition to a low-emissions economy.

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Appendix A

A Community of Practice for New Zealand's Economic Modelling of Climate Change Mitigation

6 March 2019

Final agenda

Objectives

The objectives of this workshop are to:

- Refine the agenda for future economic modelling of climate change mitigation in New Zealand.
- Explore innovative options for designing, governing, and resourcing a community of practice for economic modelling of climate mitigation that meets the needs of decision makers and the modelling community.
- Provide a five-year road map to establish a community of practice for climate change mitigation modelling.

The outcomes from the workshop will be synthesised in a report submitted to the Ministry for Primary Industries and available to the general public from Motu's website.

Venue

Room 1A, Ministry for the Environment, 23 Kate Sheppard Place, Wellington.

Chatham House Rule

The Chatham House Rule applies to this workshop. Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed without the express permission of the speaker(s).

Acknowledgements

We would like to thank the Ministry for Primary Industries for financial support and the Ministry for the Environment for helping to organise this workshop. We also gratefully acknowledge funding from the Aotearoa Foundation.

Invited participant organisations

AgResearch; Covec; Energy Efficiency and Conservation Authority; EnergyLink; Eunomia, European Commission; Infometrics; Interim Climate Change Commission; Manaaki Whenua – Landcare Research; Lincoln University; Ministry for Primary Industries; Ministry for the Environment; Ministry of Business, Innovation and Employment; Ministry of Foreign Affairs and Trade; Ministry of Transport; Motu Economic and Public Policy Research; National Institute of Water and Atmospheric Research; New Zealand Agricultural Greenhouse Gas Research Centre; New Zealand Institute of Economic Research; New Zealand Productivity Commission; Office of the Parliamentary Commission for the Environment; OVERSEER; Plant and Food; Sapere Consulting; Scion; Sense Partners; ThinkStep; Transition Hub; Treasury; University of Auckland, University of Otago Centre for Sustainability; and University of Waikato.

AGENDA	
8:15–8:45	Arrival, sign in, tea and coffee
8:45–9:00	Introduction and goals for the workshop *Moderator: Niven Winchester, Motu*
9:00–9:15	Introduction of participants *Moderator: Niven Winchester, Motu*
Session 1: Climate mitigation modelling abroad and future needs for decision makers	
9:15– 10:00	Climate mitigation modelling in the European Union: approaches, governance mechanisms and cooperation across modellers and policy officials *Presenters: Bert Saveyn (JRC) and Miles Perry (DG-CLIMA), European Commission* *Moderator: Catherine Leining, Motu*
10:00–10:30	Emissions targets, budgets, and government planning to transition to a low-emissions economy: future needs by decision makers for climate change mitigation modelling in New Zealand *Presenters: Paul Alexander, Programme Director, MfE Transition Hub; Jo Hendy, ICCC* *Moderator: Niven Winchester, Motu*
10:30–10:45	Morning break
Session 2: Perspectives on current practices	
10:45–12:15	Perspectives on current practices • Creators of modelling: the modelling community • Users of modelling: policy officials • Funders of models • Discussion on gaps and opportunities *Presenters: Niven Winchester, Motu; Tamara Linnhoff, MfE; Andy Reisinger, NZAGRC* *Moderator: Catherine Leining, Motu*
12:15–13:15	Lunch break

Continued on the next page.

Session 3: A community of practice: key elements and implementation options	
13:15–13:30	A community of practice: objectives and key elements *Presenters: Niven Winchester and Catherine Leining, Motu*
13:30–15:00	A community of practice: implementation options Funding mechanisms Governance options Primary research and data collection Information sharing among modelling groups and integrating models Communicating model outputs to inform decision-making Facilitating international linkages *Moderator: Catherine Leining, Motu*
15:00–15:15	Afternoon break
Session 4: Synthesis	
15:15–16:00	A proposed five-year road map to develop a community of practice for climate change mitigation modelling *Moderator: Niven Winchester, Motu*
16:00–16:30	Workshop summary and next steps *Moderator: Catherine Leining, Motu*
16:30–18:00	Optional post-workshop social gathering (Thistle Inn Pub)

Recent Motu Working Papers

19-11 Fleming, David A., Suzi Kerr and Edmund Lou. 2019. "Cows, cash and climate: Low stocking rates, high-performing cows, emissions and profitability across New Zealand farms."

19-10 Cortés-Acosta, Sandra, David A. Fleming, Loïc Henry, Edmund Lou, Sally Owen and Bruce Small. 2019. "Identifying barriers to adoption of "no-cost" greenhouse gas mitigation practices in pastoral systems."

19-09 Kerr, Suzi, and Catherine Leining. 2019. 'Paying for Mitigation: How New Zealand Can Contribute to Others' Efforts."

19-08 Kerr, Suzi, and Catherine Leining. 2019. "Uncertainty, Risk and Investment and the NZ ETS."

19-07 Leining, Catherine and Suzi Kerr. 2019. 'Managing Scarcity and Ambition in the NZ ETS."

19-06 Grimes, Arthur, Kate Preston, David C Maré, Shaan Badenhorst and Stuart Donovan. 2019. "The Contrasting Importance of Quality of Life and Quality of Business for Domestic and International Migrants."

19-05 Maré, David C and Jacques Poot. 2019. "Valuing Cultural Diversity."

19-04 Kerr, Suzi, Steffen Lippert and Edmund Lou. 2019. "Financial Transfers and Climate Cooperation."

19-03 Fabling, Richard and David C Maré. 2019. "Improved productivity measurement in New Zealand's Longitudinal Business Database."

19-02 Sin, Isabelle and Judd Ormsby. 2019. "The settlement experience of Pacific migrants in New Zealand: Insights from LISNZ and the IDI"

19-01 Benjamin Davies and David C Maré. 2019. "Relatedness, Complexity and Local Growth."

18-16 Hendy, Jo, Anne-Gaelle Ausseil, Isaac Bain, Élodie Blanc, David Fleming, Joel Gibbs, Alistair Hall, Alexander Herzig, Patrick Kavanagh, Suzi Kerr, Catherine Leining, Laëtitia Leroy, Edmund Lou, Juan Monge, Andy Reisinger, Jim Risk, Tarek Soliman, Adolf Stroombergen, Levente Timar, Tony van der Weerdan, Dominic White and Christian Zammit. 2018. "Land-use modelling in New Zealand: current practice and future needs."

18-15 White, Dominic, 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. 2018. "Energy- and multi-sector modelling of climate change mitigation in New Zealand: current practice and future needs."

18-14 Preston, Kate, David C Maré, Arthur Grimes and Stuart Donovan. 2018. "Amenities and the attractiveness of New Zealand cities."

18-13 Alimi, Omoniyi, David C Maré and Jacques Poot. 2018. "Who partners up? Educational assortative matching and the distribution of income in New Zealand."

18-12 Fabling, Richard. 2018. "Entrepreneurial beginnings: Transitions to self-employment and the creation of jobs."

18-11 Fleming, David A and Kate Preston. 2018. "International agricultural mitigation research and the impacts and value of two SLMACC research projects." (also a Ministry for Primary Industries publication)

18-10 Hyslop, Dean and David Rea. 2018. "Do housing allowances increase rents? Evidence from a discrete policy change."

18-09 Fleming, David A., Ilan Noy, Jacob Pástor-Paz and Sally Owen. 2018. "Public insurance and climate change (part one): Past trends in weather-related insurance in New Zealand."

18-08 Sin, Isabelle, Kabir Dasgupta and Gail Pacheco. 2018. "Parenthood and labour market outcomes." (also a Ministry for Women Report)

18-07 Grimes, Arthur and Dennis Wesselbaum. 2018. "Moving towards happiness."

18-06 Qasim, Mubashir and Arthur Grimes. 2018. "Sustainable economic policy and well-being: The relationship between adjusted net savings and subjective well-being."


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