

Policy Framework for New Zealand to Transition to a Low-Carbon Economy

The Paris Agreement of 12 December 2015 was an important political step forward for the planet. It is a statement of commitment by 185 nations to limit global warming to below 2°C above pre-industrial levels. Most nations also signed up to ‘the intent to pursue a 1.5°C target’. On its own this does not deliver the target. The challenge now for New Zealand is to dramatically lift the pace from the slow progress of the past 25 years. To do our ‘fair share’ we need a comprehensive policy framework and agreed actions for transitioning to a low-carbon economy.

The main provisions of the Paris Agreement have been discussed in a previous issue of *Policy Quarterly* (Macey, 2016). This article examines what policies are now required in New Zealand. It recommends

a target of net zero carbon dioxide (CO₂) emissions by 2050, which will require much stronger action than New Zealand’s current 2030 target and gazetted 50% by 2050 target. It discusses an officials’ think

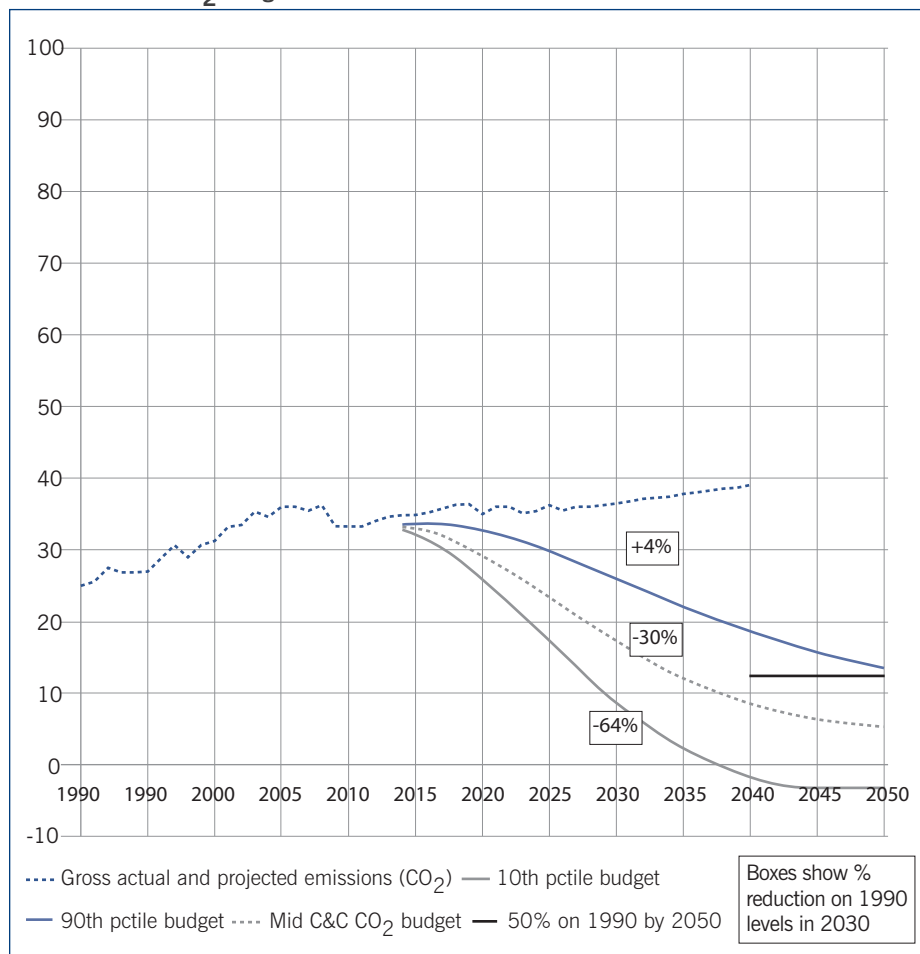
piece on potential long-term pathways to a low-carbon economy. It proposes that the review of the emissions trading scheme (ETS) include a \$25 per tonne of carbon floor price and an interim \$100 per tonne price cap for 2 years, and bring nitrous oxide immediately into the ETS. It recommends complementary policies including moving towards a target of 100% renewable electricity generation, a target of 100% renewable transport fuels by 2040 (through uptake of electric vehicles and biofuels), and other policies in energy, the economy, cities, agriculture, forestry and adaptation. Finally, it calls for political leadership and a collaborative process to achieve a broad agreement within two years on a 20- to 30- year transition path to a low-carbon economy.

Emission reduction targets

Conforming to the Paris Agreement brings major challenges for New Zealand. Our Intended Nationally Determined Contribution (INDC) of a 30% reduction on 2005 levels by 2030 (New Zealand Government, 2015a), or about 11% reduction on 1990 levels, has received local and international criticism for its lack of ambition. European analysts said that if most countries were to

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Figure 1: New Zealand's gross actual and projected CO₂ emissions compared to some CO₂ budgets



Source: Ministry for the Environment, 2014

follow New Zealand's approach, global warming would exceed 3-4°C (Climate Action Tracker, 2015). The assessment of the Climate Action Tracker, however, has been challenged on three 'debatable judgements': first, the Climate Action Tracker is critical of using forest sinks to offset rising carbon dioxide emissions in other sectors, though the international community has broadly accepted forest carbon sequestration as a legitimate contribution to global mitigation; second, the Climate Action Tracker does not evaluate New Zealand's cost of mitigation relative to that of other countries, but this is a legitimate consideration in target setting; and third, in its focus on projected growth in domestic emissions it assumes the carry-over of surplus mitigation credits from earlier periods, but this is not substantiated (Leining, Fallows and Renwick, 2016).

As part of its wider analysis of New Zealand's INDC, the Ministry for the Environment examined how potential

targets compared with those of other countries (Ministry for the Environment, 2015a). This analysis informed the government's final decisions on the INDC (Office of the Minister for Climate Change Issues, 2015). The ministry's paper considers 'fair share' relative to that of other countries and to the 2°C warming cap. Four indicators show the targets that may be expected of New Zealand: equal cost between countries; equal per capita emissions in 2050; equal effort based on historical responsibility; and equal reduction from business as usual. The paper noted that:

It is likely that some stakeholders will judge New Zealand based on the headline number of its target. For example, New Zealand taking a headline target of '-5 per cent' may be seen as less ambitious than the European Union taking a headline target of '-40 per cent' or Russia taking a headline target of '-25

-30 per cent'. Comparisons based on headline number do not provide a fair reflection of effort.

The paper concluded that:

All indicators support the need for a headline number set below 1990 levels. However, only the historical responsibility indicator supports a target in the range of 40 per cent below 1990 levels, as previously recommended by a large number of stakeholders during consultation on New Zealand's 2020 target.

The climate models suggest that if the global community were to continue on a business-as-usual pathway the world would warm by more than 4°C over the next 100 years. This would have catastrophic effects (Global Commission on the Economy and Climate, 2015). The global warming 'guardrail' of 2°C, set at the Copenhagen Conference of the Parties in 2009, was the maximum tolerable warming; beyond that, risks from extreme climatic change are judged to be too high. Even warming of 2°C will result in major impacts, including significant sea level rise, more extreme temperatures, and more severe storms, droughts and wildfires.

The parties to the Paris Agreement have a double challenge. First, the sum of the INDCs (pledges) lodged at Paris falls well short of what is required to deliver a 2°C limit (let alone 1.5°C); and second, even if the pledges are strengthened and global greenhouse gas emissions peak soon, they are unlikely to fall fast enough to avoid warming of more than 2°C (and certainly not 1.5°C). Many authorities point to the policy target for New Zealand (and the world) being a transition to net zero carbon emissions by early in the second half of this century (Global Commission on the Economy and Climate, 2015; Royal Society of New Zealand, 2015; Chapman, 2015). Rogelj et al (2015) said "The move from a 2°C- to a 1.5°C-consistent world will be achieved mainly through additional reductions of CO₂. This implies an earlier transition to net zero carbon emissions worldwide, to be achieved between 2045 and 2060".

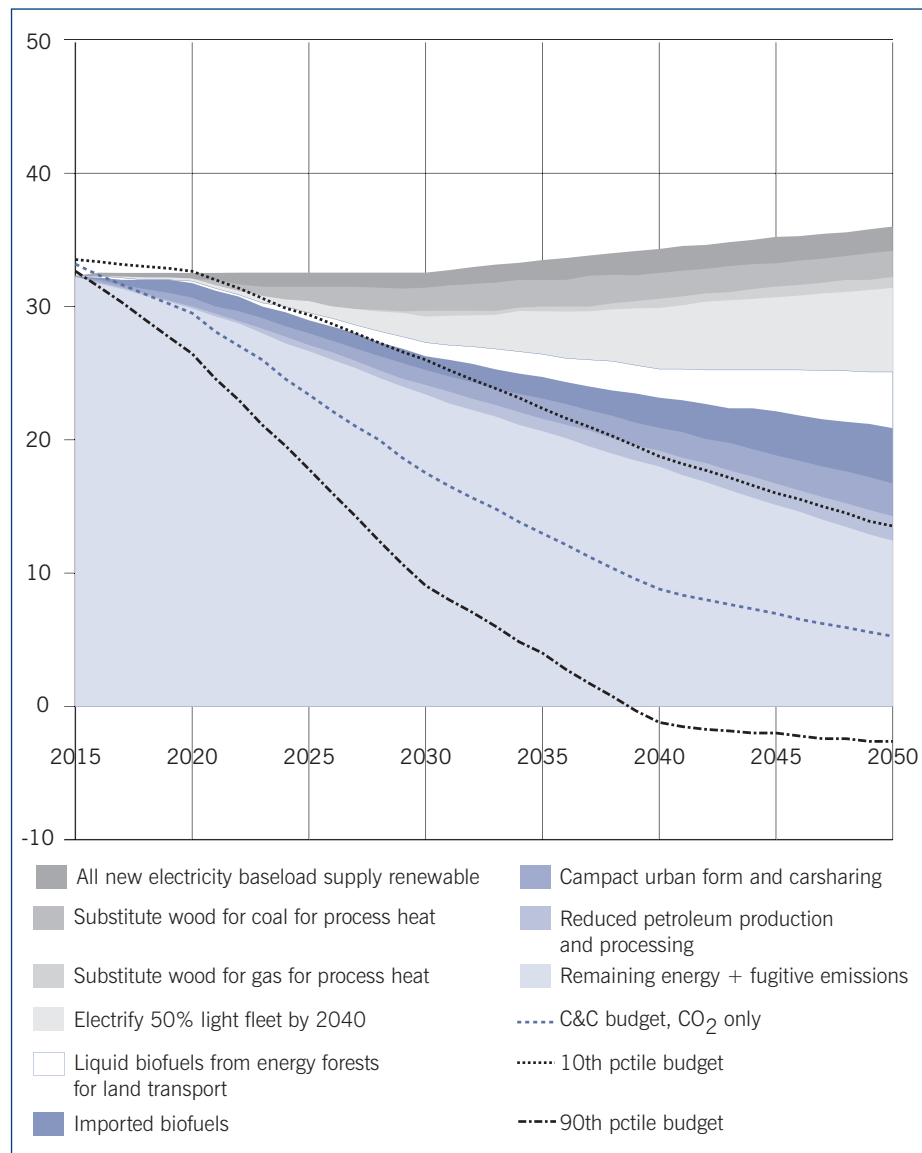
Before and after the Paris Agreement to limit global warming to below 2°C (and the intent to hold warming to 1.5°C), there has been debate about ‘negative emissions’ technology, such as mass deployment of carbon capture and storage, contributing to achieving this target in the second half of this century. Anderson (2015) has warned against “the pervasive inclusion of speculative negative emission technologies to deliver politically palatable 2°C mitigation”. Given the uncertainty about any reliance on such technologies, it would be prudent to set the target for New Zealand to net zero carbon dioxide emissions by 2050.

Potential long-term pathways to a low-carbon economy for New Zealand

In 2014 the Ministry for the Environment prepared a paper on ‘Potential long-term pathways to a low-carbon economy for New Zealand’ (Ministry for the Environment, 2014). This has been officially released with the caveat that the paper is a ‘think piece’ and not government or ministry policy. It takes a scenarios approach to possible pathways, using a working hypothesis that we are aiming to limit global warming to less than 2°C and that a ‘contract and converge’ (C&C) approach to achieve equal per capita emissions globally by 2050 is plausible for New Zealand’s ‘fair share’. The paper presents some possible carbon budgets for New Zealand, based on convergence to equal per capita global carbon dioxide (CO₂) emissions in 2050, while keeping within a ‘global 2°C’ budget. The paper assesses whether the domestic economy could change rapidly enough so that emissions remain within these 2°C budgets, and the country meets the 50% reduction by 2050 target.

The CO₂ emissions budgets (10th percentile, median and 90th percentile) for New Zealand prepared using this method are shown in Figure 1. The spread of budgets arises from the spread of results in the Intergovernmental Panel on Climate Change modelling, which assembles modelling results from many research teams around the world using different assumptions. Also shown in Figure 1 is the business-as-usual (BAU) projection for gross emissions. Forestry emissions and removals are not shown, as

Figure 2. Low-carbon pathway 2 and CO₂ budgets (CO₂ only; ‘energy forest’ abatement not shown)



Source: Ministry for the Environment, 2014

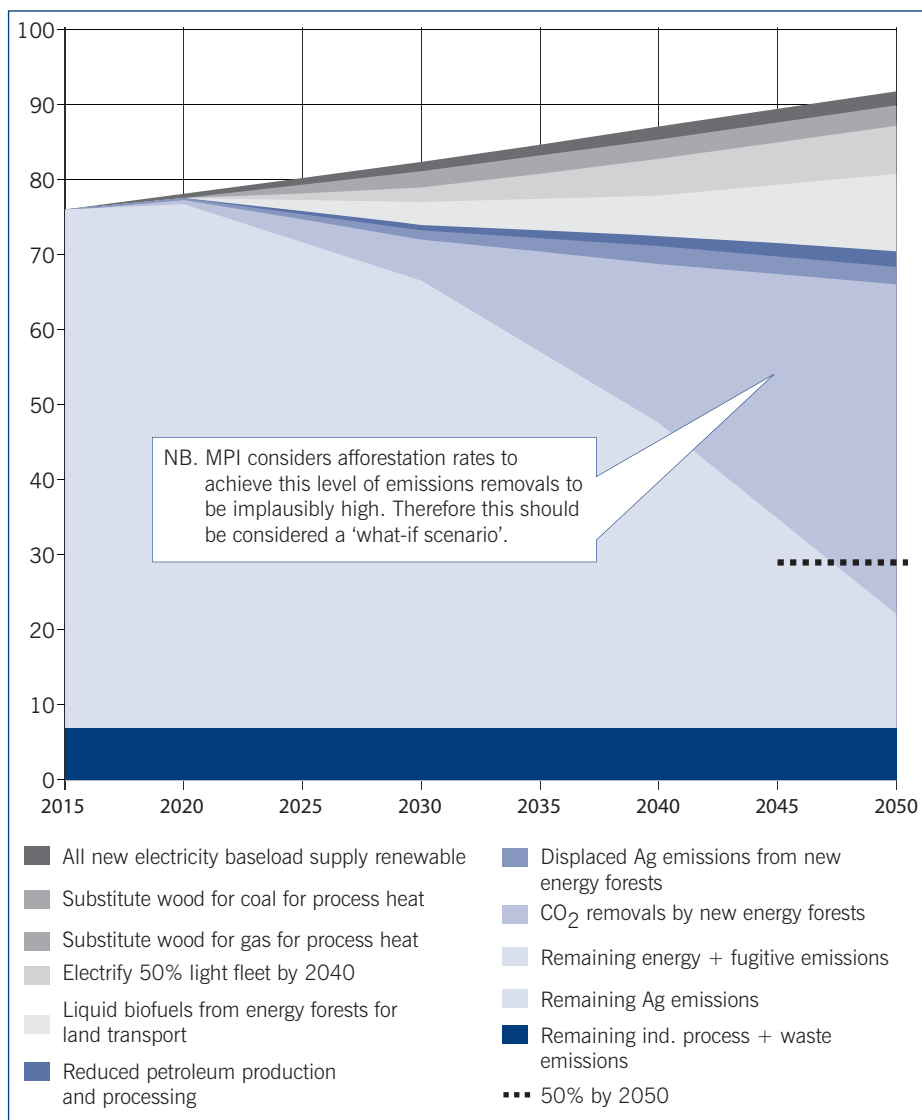
their impact depends on the accounting rules applied. The 90th percentile contract and converge budget is consistent with reducing emissions by 50% by 2050. The think piece concludes that:

The budgets shown in Figure 1 imply that domestic carbon emissions would have to change at rates of up to 7% per annum to comply with the median budget (or up to 3-4% to comply with the 90th percentile budget). The domestic economy is likely to be able to change to reduce carbon dioxide emissions at rates of around 3-4% based on standard asset lifetimes and turnover rates for most sectors. This suggests that the New Zealand economy could

change quickly enough to meet the 90th percentile budget, but not the median budget, without replacing assets before the end of their life. The median budget would deliver greater emission reductions, which is closer to a goal of net zero carbon emissions by 2050.

To illustrate possible changes in the New Zealand economy that would be entailed by these rates of change, two plausible ‘low-carbon pathways’ out to 2050 were constructed. These assume renewable energy technology is rolled out at standard asset turnover rates. Figure 2 shows low-carbon pathway 2. The shaded wedges show abatement achieved from different sources. The

Figure 3. Multi-gas pathway 1 (showing energy, agriculture and other emissions and abatement from energy forests)



Source: Ministry for the Environment, 2014

mechanisms to reduce emissions are: 1) further switching to renewable energy for electricity supply; 2) reduction in travel demand (e.g. from a shift to compact urban form and to electric- or biofuel-powered vehicles); 3) CO₂ removals by new 'energy forests', grown to provide feedstock for biofuels (e.g. for industrial process heat); 4) new energy forests displacing 2% agricultural emissions by changing land use.

Figure 3 shows the multi-gas pathway 1. This is a pathway for all greenhouse gases, including forest removals, shown against the 50% reduction by 2050 target (all gases). The projected business-as-usual emissions (all gases) assume some improvement in agricultural emissions efficiency. Figure 3 shows that this pathway could achieve the 50% by 2050 target. The think piece notes that the

Ministry for Primary Industries considers pathway 1's afforestation rates to be 'implausible'. International recognition of this forest sink would depend on the accounting rules applied. After 2050 the forest offset would no longer be available, assuming new planting rates drop to zero once sufficient energy forests have been established.

The Ministry's think piece concludes:

The analysis approach taken in this paper suggests it is only just possible to reduce New Zealand's gross domestic CO₂-only emissions rapidly enough to meet a 'contract and converge budget' for New Zealand consistent with a 2°C global climate goal. Domestic pathways which achieve this reduce CO₂-only emissions by around 50% on

1990 levels by 2050. Higher rates of change are theoretically possible, but would incur higher costs. Different allocation methods (than 'contraction and convergence') to determine New Zealand's 'fair share' of a global budget would produce substantially higher or lower values for New Zealand's 'budget' and could therefore change this conclusion.

The Ministry for the Environment's long-term pathways work is very welcome. Further scenarios could include more ambitious domestic policies that would accelerate mitigation of carbon dioxide, to realise a net zero carbon dioxide emissions target by 2050.

Calls for a plan for New Zealand to move to a low-carbon economy

There have been many strong calls for a comprehensive plan for New Zealand to move to a low-carbon economy. For example, feedback from consultation on New Zealand's climate change target in 2015 included a core theme expressed by stakeholders of 'ensuring the target is based on a domestic plan', and a need for a consensus to be built around climate change (Ministry for the Environment, 2015b). Ralph Chapman has stressed that:

NZ's low-carbon energy transition will need a mix of mutually reinforcing policies. Recognising that a high carbon price is a long political stretch in the short term, complementary policies have a critical role in preparing the way for a rising carbon price. (Chapman, 2015)

The Ministry for the Environment reported:

To improve productivity and transition NZ to a low-emissions economy we are likely to need further action in addition to NZ ETS, particularly where there are barriers to reducing emissions or where there are significant opportunities that aren't being realised. (Ministry for the Environment, 2015c)

The remainder of this article focuses on policy measures which could form part of a comprehensive framework to move New Zealand to a low-carbon economy.

Review of the emissions trading scheme

The New Zealand emissions trading scheme (ETS) has been New Zealand's primary tool for addressing domestic greenhouse gas emissions and removals and international commitments on climate change since it came into effect in 2009. However, it has had remarkably little effect. Chapman has commented:

Taken together, the neoclassical economic literature, for all its limitations, points to a need for a carbon price of at least around \$100 per tonne, markedly higher than the price under \$7 at which carbon units have recently been trading in New Zealand. (Chapman, 2015)

A range of exclusions, concessions, and rule adjustments has been allowed in the ETS, with the effect of lowering the price of carbon to the point where it has been described by the parliamentary commissioner for the environment as 'almost toothless' (Wright, 2012).

The ETS is currently under review (Ministry for the Environment, 2016), and the removal of the '2 for 1' concession has been flagged by climate change issues minister Paula Bennett. An initial question for this review was: is an ETS still a 'better' solution than a carbon charge? Chapman, Renwick and Dodge (2016) recommended in their submission on the review:

We consider that a phase-in or price path is not necessary, given the low ETS price currently, but, to limit uncertainty, a \$25 price floor and an interim \$100 price cap could be provided for 2 years or so. Other than this, prices need to reflect supply and demand. The price floor needs to take into account that the social cost of carbon is in reality likely to be more than \$100 per tonne, and could be as high as several hundred dollars per tonne (Moore and Diaz, 2015).

While achieving a well-functioning carbon market is important in New Zealand and internationally, this needs to be supported by other policy measures. Such policies could help remove barriers to reducing emissions or realising significant opportunities. Actions in the areas of energy, transport, agriculture and forestry will be very important.

Energy policies

An officials' paper in 2014 provided a preliminary analysis of options to reduce greenhouse gas emissions in New Zealand's domestic electricity and industrial heat sectors. It was designed to contribute to advice to ministers later that year on the level of New Zealand's international contribution (Ministry of Business,

photovoltaic technology could shift businesses from reliance on traditional large-scale generation, distribution and retail, and thus increase diversity and therefore reduce risk. More micro-generation, smart two-way grids and local trading, battery storage, deep energy efficiency and integrated energy services are likely developments in the electricity sector. A recent upturn in patents for photovoltaic technology has foreshadowed a relatively short gap (five to seven years) between research and widespread development.

Meanwhile, there is a lot that energy users can do to improve their energy efficiency. The Energy Efficiency and Conservation Authority estimates that the 200 largest companies in New

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Innovation and Employment, 2014).

New Zealand's electricity system is currently about 80% renewable, and there is a target of 90% by 2025. This is frequently cited as a reason for limited opportunity to significantly reduce our emissions from electricity. However, there is further capacity available in wind power and geothermal energy. Gas-fired electricity generation plants will be needed to cope with peak load demand in the short term. A target of moving towards 100% renewable electricity generation, complemented by a carbon price that better reflects the social cost of carbon, could incentivise this shift. We would need to recognise that, with our overall energy consumption being less than 40% renewable, major investments in renewable heat and transport over the next two decades are also likely to be cost-effective for reducing emissions.

Transformational technologies which focus on an energy services logic promise cheaper, cleaner power. For example,

Zealand are failing to realise \$1.2 billion of energy efficiencies. Its chief executive, Mike Underhill, points out that there is a major opportunity with industrial heat:

A major source of that heat is carbon-emitting coal. However, many heat demands can easily and cheaply be reduced with some basic efficiency measures, and many could be at least partially replaced with clean, renewable resources, such as changing a coal-fired boiler to one using wood energy. (Underhill, 2015)

New Zealand has taken a leadership role internationally on energy subsidies, recognising that they are responsible for a great deal of waste and unnecessary carbon emissions. However, we do have energy subsidies in New Zealand. There is no case for the New Zealand taxpayer to support the oil and gas industry by enabling a tax deduction for petroleum-mining expenditures. New Zealand

has one of the cheapest oil and gas exploration regimes in the Asia-Pacific. Another current energy subsidy is that given by the New Zealand government to the aluminium smelter at Tiwai Point, which uses about 12% of the country's total electricity at an undisclosed but low price. This is hard to justify when it is using 600 megawatts of renewable electricity capacity to support an energy-intensive commodity in falling demand.

Transport policies

An officials' paper in 2014 set out policies and measures to reduce greenhouse gas emissions from the transport sector. It was designed to contribute to advice to

year goes into our private vehicles. Global interest in electric vehicles is surging ahead, making local options for a greener transport system more practical and viable. Figures from the Ministry of Transport indicate that up to 95 per cent of daily travel needs could be covered by electric vehicles, including virtually all daily commutes. Running costs have definite appeal – EECA estimates the average electric vehicle would cost [the equivalent of] just 30c a litre to charge. There is also security in having a reliable source of domestic fuel – we have enough consented renewable generation to run our

of 100% renewable transport fuels by 2040 would be part of a credible policy package.

Economic policies

The government's Business Growth Agenda signals that New Zealand should improve energy efficiency and increase the use of renewable energy in order to raise productivity, reduce greenhouse gas emissions, promote consumer choice and increase international competitiveness.

The Treasury's advice to government on New Zealand's post-2020 climate change target focused on 'least cost' in the narrow sense of cost to the economy of policy measures, rather than recognising the wider costs to the economy of climate change, even if bold mitigation action is taken globally (Treasury, 2015). Treasury has not adequately recognised the co-benefits of carbon mitigation actions such as those listed above. In contrast, the New Climate Economy report cites research which shows that:

not only are there many abatement options that create net benefits in narrow economic terms, but there are many more – and the economic welfare gain becomes significantly larger – once co-benefits are included. (Global Commission on the Economy and Climate, 2015)

The Treasury could have advised on the long-term structural changes to the economy that will be required to transition to a low-carbon economy, and the risks and opportunities for New Zealand. That would have provided the government with a fuller picture for its positioning on climate change policy.

During the INDC consultation the government commissioned modelling from Infometrics and Landcare Research, the results of which showed almost negligible differences in domestic GDP growth across global warming targets ranging from 5% to 40% below 1990 levels (Infometrics, 2015; Daigneault, 2015). This was a conservative assessment, which excluded the effects of future innovation, forestry and mitigation benefits. This suggests that a more stringent target could be adopted in future without

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ministers later that year on the level of New Zealand's international contribution. The transport sector accounts for nearly 20% of domestic greenhouse gas emissions in New Zealand, and is the single highest emitting sector after agriculture (Ministry of Transport, 2014).

More sustainable transport options have emerged in the last decade, which has seen the development of electric vehicles (cars, trucks, buses and bicycles); the resurgence of active modes of travel (walking and cycling); digital connectivity giving rise to car-sharing initiatives such as Uber, bike sharing, and the preference of the millennial generation to use their smart phones on public transport; and the prospect of autonomous vehicles by 2030.

Transport (along with industrial heat) offers New Zealand's greatest opportunities for greenhouse gas emission reductions. Underhill said:

More than half the \$9b-worth of oil imported into New Zealand each

entire fleet of cars on electricity. (Underhill, 2015)

There is a leadership opportunity for the government to convert its ministerial limousines to electric vehicles. This has been rejected for now on the grounds that ministers need to have access to a vehicle at all times for trips anywhere in New Zealand. However, the current capacity of electric vehicles and the growing coverage for recharging will change that.

Central government and local government investments in public transport and cycling infrastructure, for example through the Urban Cycleways Fund, the National Land Transport Fund and the long-term plans of councils, open the way for a significant shift in modes of transport. Biofuels will enable cars and trucks to substitute New Zealand-based renewable fuel for imported carbon-heavy oil. Given the major shifts to more sustainable transport options, and the opportunity for biofuels to substitute for oil, investigating a New Zealand target

significant incremental loss of GDP. The Royal Society said:

One of the most important things for New Zealand is to create competitive advantages with the global transition to a low-carbon economy. If we fall behind such a major shift in the way the world does business, we are bound to suffer economically. There is a need for New Zealand policy to be nimble and flexible, so that we can adapt as new information emerges, without stranding assets or seeing under-investment in key areas. (Royal Society, 2015)

The alternative risk is that if New Zealand does not make the transition to a low-carbon economy there will be falling competitiveness, incomes and social well-being.

Cities' policies

Cities have become the engines of growth of nations, a global trend arising from globalisation, the knowledge economy and rapid urbanisation. Worldwide, cities account for 70% or so of greenhouse gas emissions.

The Auckland Plan and Auckland Low Carbon Action Plan have put in place measures to achieve a target of 40% reduction in greenhouse gas emissions from 1990 levels by 2040 – for one third of the nation's population and economy. Wellington, Christchurch and other cities have similar targets. Quality compact city strategies of Auckland and other cities will result in lower greenhouse gas emissions. Intensification in the city centre, inner suburbs and around transport nodes (and investments in public transport, such as Auckland's City Rail Link) will contribute to making public transport, cycling and walking modes more viable and reduce private vehicle trips. Other benefits also accrue, such as greater choice of different types, sizes and cost of housing. These contributions to a low-carbon economy could be leveraged by an amendment to the Resource Management Act 1991, to remove provisions from the 2004 amendments to the Act. These provisions prohibit local authorities from considering the effects of greenhouse gas emissions

on climate change when making rules to control discharges into the air, and when considering an application for discharge permits.

The 2015 report of the Global Commission on the Economy and Climate includes cities as one of three critical economic systems (the other two being land use and energy). Given the tendency for urban form to become locked in, policies regarding cities should have a prominent place in New Zealand's domestic climate change policy framework, to drive longer-term climate change mitigation.

Agriculture policies

An officials' paper in 2014 provided a preliminary analysis of emissions abatement measures for the agriculture sector. It was designed to contribute to advice to ministers later that year on the level of New Zealand's international contribution (Ministry for Primary Industries, 2014a)

New Zealand is unusual for a developed country in that nearly half our greenhouse gas emissions come from agriculture. Addressing these will be important for long-term transition to a low-emissions economy. It needs to be recognised that methane is not as long-lasting as carbon dioxide, but nitrous oxide is. Some progress is being made in reducing ruminant emissions, and New Zealand has the potential to further diversify agricultural production and better manage nitrogen in agriculture.

The Ministry for the Environment comments: 'The efficiency of agricultural production has been improving steadily for the past 25 years, but to reduce agricultural emissions faster without reducing productivity will require new technologies and practices' (Ministry for the Environment, 2015c).

Alison Dewes, Tipuna Whenua, in a presentation to a post-COP21 seminar

at Victoria University in February 2016 said:

The New Zealand dairy farm in 2025 will be different from today in the following ways: 25-30% reduction in nitrous oxide, 60-100% more profit through fewer stock optimized, highly productive, well fed and 25% fewer cows and replacements, with 25% less support land required (Dewes, 2015).

Agriculture should be brought into the ETS, initially at a much reduced

International agreement is needed on how carbon stored in forests can help countries meet future targets.

carbon price; this would help fund the science, spur solutions, and incentivise commercialisation on the farm. Nitrous oxide should be brought in immediately, but methane's entry (while ultimately necessary) could be delayed, recognizing that it is a shorter-lived gas in the atmosphere than carbon dioxide and nitrous oxide.

Forestry policies

An officials' paper in 2014 provided a preliminary analysis of an achievable level of abatement from the forestry sector. It was designed to contribute to advice to ministers later that year on the level of New Zealand's international contribution (Ministry for Primary Industries, 2014b).

International agreement is needed on how carbon stored in forests can help countries meet future targets. Biofuels from the temporary sequestration of carbon as wood can contribute to other sectors' emissions reduction efforts (e.g. the dairy sector's). A more meaningful price of carbon in the ETS – a floor price of \$25 per tonne, for example – would improve the mitigation potential of our forestry sector through investment in afforestation and biofuels development.

Adaptation policies

Climate change will affect the whole economy, particularly at exposed locations. Because of policy gaps, adaptation policies will need to be fast-tracked to get effective action (Lawrence et al., 2013).

The Ministry for the Environment notes:

New Zealand has a framework for adapting to climate change. Under this framework, local government hold the responsibility to plan for and respond to local climate change impacts, while central government supports this work by providing guidance and information. (Ministry for the Environment, 2015c)

infrastructural, economic, environmental and social resilience.

Political leadership

One of the striking features of COP21 was the level of political leadership shown by the 150 prime ministers and heads of state who were present and those who spoke at the opening session (including New Zealand's prime minister). It was perhaps the strongest demonstration yet of global political leadership in response to the seriousness of the threat of climate change.

Chapman (2015) analysed a wide range of surveys on public attitudes to climate change:

create competitive advantage for New Zealand in a world that is dramatically changing the way it does business. The political leadership of Parliament will be crucial, and a multi-party process for climate change could well be appropriate given the long-term implications for New Zealand.

Next steps

The review of the emissions trading scheme needs to be completed within the next two years to ensure that it is an effective and durable policy instrument that delivers on the government's climate change objectives. Concurrent with this review of the ETS, a domestic plan should be developed, including a package of actions by central government, local government, the private sector and civil society, for New Zealand to transition to a low-carbon economy. Such a plan will require wide buy-in across sectors and interests. A forum including business, iwi, civil society (including NGOs) and academia, working with government and local government, would help achieve broad agreement on the 20- to 30-year transition path to a low-carbon economy.

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However, the parliamentary commissioner for the environment highlighted policy gaps in her report on sea level rise from climate change (Wright, 2015). She directed eight recommendations to central government, which need to be included in an overall policy package.

While local authorities are making provision for adaptation, such as for sea level rise, this is happening in a fragmented and incremental way (Lawrence, 2015). The Society of Local Government Managers is promoting 'building community resilience'. This is a concept supported by the Rockefeller Foundation, New York, as a way for communities to deal with chronic stresses (such as climate change) and shocks (such as the 2010 and 2011 Canterbury earthquakes and 2012's Hurricane Sandy). 'Community resilience' is what enables people to survive, adapt and thrive in the face of shocks and chronic stresses. This is a holistic approach, which includes

What I conclude provisionally from this patchwork of evidence is that New Zealanders on the whole do want to be active on climate change, and they are likely to favour policies that have co-benefits in terms of other goals such as health, quality of life, energy security and – very likely – long-term economic gain, arising, for example, from enhancing New Zealand's clean, green reputation.

Even so, awareness remains relatively low. Climate change has not had a profile in high-level political discourse in New Zealand in recent years. However, the new minister for climate change issues has called for New Zealand to 'be a global leader in transitioning to a low-carbon economy that still supports that vital growth' (Bennett, 2016).

This article has shown that transformation to a low-carbon economy need not be at the expense of economic growth; indeed, such a transition will

Conclusion

These reflections and analyses lead to ten conclusions. First, New Zealand and the world need to aim for a target of net zero carbon emissions by 2050 in order to meet the COP21 objective of limiting global warming to 2°C and the intent to hold global warming to 1.5°C. This is significantly more challenging than New Zealand's 2030 INDC target and the 50% by 2050 gazetted target. Second, this will require emissions of carbon dioxide to be reduced rapidly over the next two decades.

Third, preliminary analyses by officials on long-term pathways to a low-carbon economy suggest that it is only just possible to reduce New Zealand's gross domestic CO₂-only emissions rapidly enough to meet a 'contract and converge' budget for New Zealand consistent with a 2°C global climate goal (based on standard asset lifetimes and turnover rates for most sectors). Other scenarios need to be developed.

Fourth, there have been strong calls for a comprehensive plan for moving New Zealand to a low-carbon economy, in which the ETS is complemented by a mix of mutually reinforcing policies.

Fifth, the review of the ETS should include a \$25 per tonne price floor and an interim \$100 per tonne price cap for two years to limit uncertainty; thereafter prices need to reflect supply and demand, and will be expected to approach the social cost of carbon over time, and nitrous oxide should be brought immediately into the ETS.

Sixth, the largest incremental gains in emissions reduction are likely to be in the areas of energy and transport; for example, from the shift to electric vehicles, and with biofuels replacing carbon-emitting coal as the source of industrial heat. There will be strong technology-led and market-led drivers for change, but

policies will be required where there are market barriers.

Seventh, it is recommended that New Zealand set a target of moving towards 100% renewable electricity, and adopt a target of 100% renewable transport fuels by 2040.

Eighth, cities have become the engines of growth of nations because of globalisation, the knowledge economy and rapid urbanisation, and city policies such as compact city strategies support a shift towards public transport, cycling and walking and will significantly add to the achievement of New Zealand's emission reduction targets.

Ninth, science and productivity solutions to reduce ruminant emissions in agriculture, and a more meaningful price of carbon in the ETS to improve the mitigation potential in the forestry sector (through investment in afforestation and

biofuels development), will be essential parts of the policy package.

Finally, it is proposed that a forum including business, iwi, civil society and academia work with central and local government to help achieve broad agreement within two years on the 20-30- year transition path to a low-carbon economy.

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Date	Presenter	Speaker	Title
Monday 23 May 5:30 – 6:30pm Rutherford House Lecture Theatre 2*	Institute for Governance & Policy Studies and International Law Association	Professor Lavanya Rajamani, <i>Sir Frank Holmes Fellow</i>	The Paris Agreement: Interplay of Hard, Soft and Non-Obligations
Tuesday 31st May 12:30 – 1:30pm Old Government Buildings Lecture Theatre 3 (ground floor)*	Institute for Governance & Policy Studies	Dr Russell Wills, <i>Children's Commissioner</i>	"Are We There Yet?" Five years on the Road to Addressing Child Poverty
Thursday 2nd June 12:30 – 1:30pm Old Government Buildings Lecture Theatre 3 (ground floor) RSVP: e-government@vuw.ac.nz	Chair in Digital Government	Rochelle Stewart-Allen, <i>Senior Policy Advisor, Open Government Data & Information Programme, LINZ</i>	Open Data – the New Oil of the Digital Economy
Tuesday 14th June 12:30 – 1:30pm Old Government Buildings Lecture Theatre 3 (ground floor)	Health Services Research Centre	Dr Charlotte Chambers, <i>Principal Analyst, Association of Salaried Medical Specialists</i>	'Superheroes don't take sick leave': Presenteeism in the NZ Senior Medical Workforce
*RSVP's can be sent to igps@vuw.ac.nz			
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