Chapter 13: Households and communities

Our modelling suggests that most households would not see an increase in electricity bills and petrol costs over the course of the first three emissions budgets. Energy efficient electric appliances, improvements in fuel efficiency, a shift to electric vehicles and more public transport, walking and cycling, will play an important role in meeting our proposed emissions budgets.

This chapter looks at what impacts the climate transition may have on household bills, on access to transport and how land use changes could impact the communities of Aotearoa.

Contents

Our modelling suggests that most households would not see an increase in electricity bills and petrol costs over the course of the first three emissions budgets. Energy efficient electric appliances, improvements in fuel efficiency, a shift to electric vehicles and more public transport, walking and cycling, will play an important role in meeting our proposed emissions budgets.

This chapter looks at what impacts the climate transition may have on household bills, on access to transport and how land use changes could impact the communities of Aotearoa.

13.1 Introduction

This chapter looks more closely at what impacts the climate transition may have on household bills due to changing electricity and petrol prices, on access to transport and the particular impact land use change to forestry could have on Aotearoa communities.

Energy and petrol costs are key expenses for households. We analysed the potential impact of our proposed emissions budgets on household bills, access to transport and health. We found that our proposed emissions budgets would not increase bills for most households. Most households could see a reduction in electricity bills and transport costs, particularly if they switched to lower emissions heating and transport.

However, not all households would benefit equally. For example, low income households could struggle to access these technologies, even though they would benefit the most from the cost savings and health co-benefits. Targeted assistance would be needed to ensure that low income households can access new low emissions technologies and are not disproportionately affected by the climate transition.

13.2 Electricity

Our analysis suggests that overall household electricity bills for heating, cooking and lighting are unlikely to increase as a result of our proposed emissions budgets. However, exactly how they could change is highly uncertain. Household electricity bills depend on both electricity prices and household electricity demand.

We modelled wholesale electricity prices, which is only one component of household bills. The results of our modelling, shown in Figure 13.1, suggest that wholesale electricity prices across the country would remain stable or fall over the course of the first three emissions budgets. One of the reasons for this is that we assume the Tiwai Point Aluminium Smelter closes, deferring the need for investment in new generation. However, we note there are uncertainties around the timing of the closure of the smelter and gas supply for electricity generation. These factors could cause different price outcomes from what has been modelled.

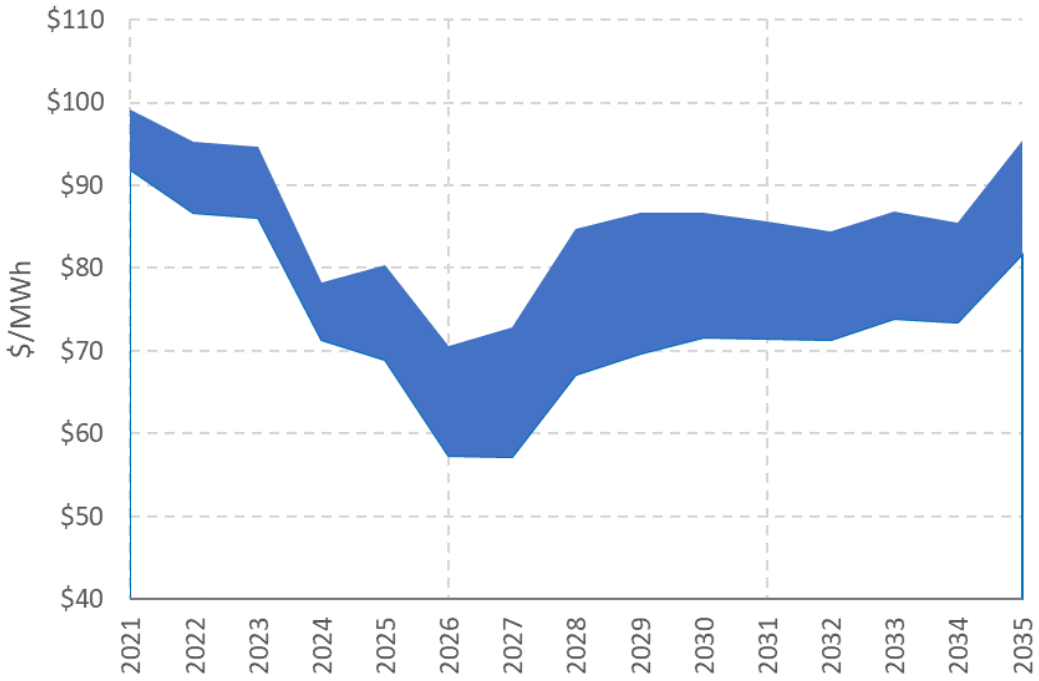


Figure 13.1: In our modelling path, wholesale electricity prices in Aotearoa decrease and then return to close to 2021 levels by 2035. The shaded area shows the range between the maximum and minimum price for different regions.

Source: Commission Analysis.

Household electricity prices are influenced by wholesale prices but also depend on several other factors. Based purely on taking actions to meet our proposed emissions budgets, household electricity prices may follow the same trends as wholesale prices. However, projecting future electricity prices is very uncertain. There are a number of reforms currently being made by the Government for other purposes. The Government is currently making changes to electricity pricing structures, such as transmission and distribution pricing, which may change how costs are allocated to consumers.

13.2.1 Regional electricity prices

Our emissions budgets are unlikely to change regional electricity prices beyond the level of regional variation that already exists. However, there are numerous factors outside of the factors included in our emissions budgets that make future electricity prices highly uncertain.

Households electricity bills vary from region to region and even within regions. Different areas already face varying electricity prices. This reflects the cost of not only generating electricity, but also of distributing it. Communities further away from where electricity is generated often pay higher electricity prices. For example, electricity pricing surveys show that households in Kerikeri and the West Coast pay more for electricity than the national average. There can be as much as a 50% variation between regions.

Average household electricity demand varies across Aotearoa and depends on climatic conditions, personal choice and whether the household uses gas, electricity or wood to heat their homes. For example, the average household electricity consumption is twice as much in Queenstown as in Westport.

13.2.2 Electricity bills

Households that are able to make energy efficiency improvements, for example by switching to heat pumps, installing insulation or LED lightbulbs, should be able to reduce their household electricity bills.

Households bills not only depend on residential electricity prices, but also on demand. Making energy efficiency improvements may be able to reduce household demand. There are a range of energy efficiency improvements that could reduce household demand and household bills. For example, replacing incandescent or halogen light bulbs with more efficient LED light bulbs, upgrading appliances with more energy efficient ones, or installing insulation, more efficient heating, curtains with thermal lining or double glazing would all help to improve a home's energy efficiency and therefore reduce how much energy that home uses.[1]

Making energy efficiency improvements can also reduce energy use at peak times – in the mornings, evenings and in winter. Reducing demand at peak times helps the entire energy system as there is less need to upgrade electricity lines, avoiding potential additional costs for all households.[2] This would require both the adoption of technologies for demand response and innovative business and pricing models. Electricity pricing incentives, such as low-cost night rates, combined with smart charging technology could be an effective way to address this issue.

Household electricity bills could also increase if a household purchases an EV. However, if that EV is replacing a petrol car, then overall household energy bills could decrease.

13.2.3 Assisting lower income households

Lower income households, some Māori and Pasifika households, elderly and people with disabilities will benefit more from making energy efficiency improvements. Some groups are more likely to live in older, poorly insulated homes[3] and would therefore benefit more from energy initiatives and savings, or improved health from being able to use savings for additional heating, or healthy homes.

An evaluation of the 'Warm Up New Zealand' programme found that the health benefits from insulating lower income households were substantial, resulting in savings of more than $800 a year on average. However, there were small benefits in terms of cost savings as households continued to heat their homes.[4]

[1] (Gen Less, 2017)
[2] (Transpower, 2020)
[3] (Environmental Health Indicators New Zealand, 2020)
[4] (Grimes et al., 2012; Telfar Barnard et al., 2011)

13.2.4 How this can be managed?

Assistance will be needed to help those on lower incomes with the upfront cost for energy efficiency improvements.

The Government's 'Warmer Kiwi Homes' programme continues to provide funding to those on low incomes who own their own home to install insulation or more efficient heating. The Government has also introduced healthy home standards for rental homes that include standards for insulation and heating.

Continued intervention would be needed to ensure that lower income households can access these benefits. The Government would need to assess whether the existing programmes are delivering at an appropriate pace and scale and consider whether these programmes have any impact more broadly on rental prices and affordability.

13.3 Natural gas

Households that use natural gas for heating and cooking are likely to see an increase in their natural gas bills as a result of our proposed emissions budgets. In 2035, the impact of our emissions budgets could increase the average household gas bill by up to $150 a year. This would affect homes with reticulated natural gas and liquified petroleum gas.

However, natural gas prices are hard to predict as the gas industry is at the beginning of a transition partly because of climate policy. This introduces considerable uncertainty into future gas prices.

The transition away from natural gas may mean that, over time, many households would benefit from replacing gas appliances. This could happen as households naturally need to replace appliances and heating systems, reducing the cost to households.

13.3.1 How this can be managed?

As part of the transition, the Government would need to pay particular attention to low income households who use natural gas, who may not have the money for the upfront conversion cost, or who may rent homes with natural gas appliances or heating. Landlords that own properties with natural gas may not have any incentive to replace them with lower emissions options and therefore low-cost options, as they would not benefit from the savings in running cost. There may be some efficiencies and cost savings from replacing old gas heating systems with modern electric systems.

Portable gas heaters are still used by some households in Aotearoa. They are used proportionately more in the North Island, particularly in Gisborne and Northland.[5] These heaters tend to be used by lower income households due to the low upfront cost and the ease of budgeting for heating bills. However, they contribute to mouldy homes and cause health problems.[6] Although the number of these heaters is decreasing, replacing them with more efficient low emissions options would take continued government support.

[5] (Stats NZ, 2018)
[6] (Canterbury District Health Board, 2015)

13.4 Petrol bills and access to transport

Transport is crucial to New Zealanders' livelihoods, wellbeing and economy. It is important for people to connect to families, for allowing people to participate in wider society and for ensuring access to work or education, healthcare, supermarkets, banks and local activities.

Our current system tends to prioritise travel by car, disadvantaging those who do not have easy access to vehicles. This particularly impacts young, elderly, disabled and economically disadvantaged communities. The design of cities, underinvestment in public transport and walking and cycling and incentives encouraging travel by car all contribute to this challenge.[7] The New Zealand Health Survey 2018/19 found that 2.8% of the adult population had an unmet need for general practitioner (GP) services and 1% had an unmet need for after-hours healthcare due to lack of transport in the past 12 months.[8] Additionally, low income households may also not be able to afford fast broadband, which limits virtual access to services.

Improving fuel efficiency, a shift to electric vehicles and more public transport, walking and cycling would all be important parts of meeting our proposed emissions budgets.

Our modelling indicates impacts from our budgets would increase petrol and diesel prices by up to 30 cents per litre over the course of our budgets. Some households may experience an increase in petrol bills if they are not able to replace their vehicle with a more fuel-efficient vehicle in the next 5, 10 or 15 years. To keep costs down, these individuals would need to reduce travel by car. This would be more likely to impact those on lower incomes or those with less access to public or shared transport. Intervention would be needed to support these households.

For households that are able to upgrade to newer petrol vehicles, the higher petrol and diesel prices may be offset by fuel efficiency improvements. Our path shows that, by 2035, 40% of light passenger vehicles would need to be electric. Households that replace an internal combustion engine vehicle with an electric one could be $1,000 a year better off. This is because electric vehicles will be cheaper to buy and to operate. Although electricity bills would increase, the total household energy bill would decrease for these households. However, wealthier and urban households would benefit from electric vehicles earlier than lower income and rural households. The total energy costs for households with and without an electric vehicle are shown in Figure 13.2.

[7] (Waka Kotahi (NZ Transport Agency), 2019)
[8] (Ministry of Health, 2019)

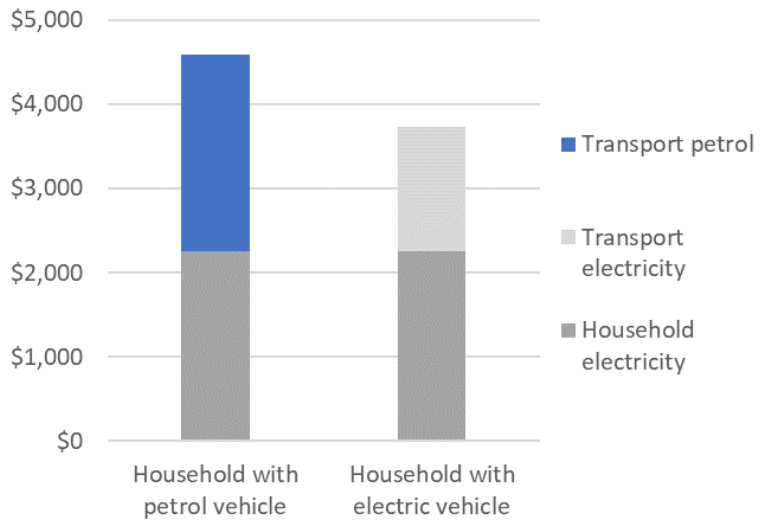


Figure 13.2: Total household energy cost in 2035 for a single car household.

Source: Commission Analysis.

Access to transport is a particular issue for some Māori. Transport is hugely important for Māori to connect to their whānau, haukāinga and tūrangawaewae. About a quarter of Māori in Aotearoa live in Auckland, however, many have whakapapa connections outside of Auckland and may need to travel long distances to participate in iwi, hapū and whānau activities and events. Some Māori households are large or intergenerational and require larger vehicles. Transport, particularly utes, is also a key enabler for the haukāinga to collect resources and provide services to the marae.[9]

Some people and businesses have specific transport needs that the transition would need to address. Farmers, contractors and others in rural communities need vehicles that can carry heavy loads or access rugged or remote locations, such as a single or double-cab ute. Farm bikes and quad bikes are also an essential part of farming and rural landscapes. For these needs, there are cost-effective solutions available now, or would be in the next few years.

Public transport might not be feasible in smaller towns and rural areas, or for people with disabilities. In some smaller towns, mobility as a service may be a better option. For example, Timaru is trialling a new system called MyWay by Metro in place of the usual bus service. Through this system, people can request a vehicle directly through a smartphone app or call-centre. The technology identifies a 'virtual bus stop' within a short walking distance, allowing for shared trips without fixed routes or schedules. This system was developed because the previous bus service was not well used. Rather than reducing services or removing public transport altogether, on demand services were developed as an alternative. A low floor vehicle can be requested when booking for passengers with mobility aids, service animals and for parents with pushchairs. MyWay also offers enhanced mobility services at a fixed fee that is driveway to driveway in off-peak hours, enhancing accessibility.[10]

[9] (Raerino et al., 2013)
[10] (MyWay by Metro, 2020)

13.4.1 How this can be managed?

Targeted assistance will be needed to ensure an equitable transition. More public transport, walking and cycling will have a positive impact, particularly on those who live in cities and larger urban areas. Central and local government would need to provide more and better transport options to increase access to transport to people with disabilities or on low incomes. Currently public transport is not always a realistic option for people with disabilities and many therefore rely on cars. Good policy and planning would be needed to ensure that transport systems are integrated and accessible.

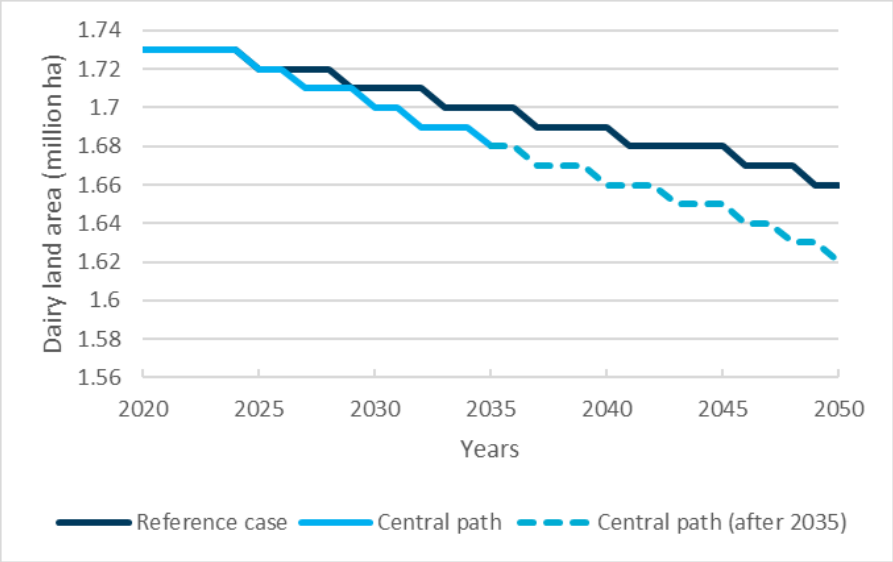
The Government would also need to provide proactive and targeted support to ensure that lower income and rural households and people with disabilities could also reap the benefits of electric vehicles and bring down costs. Policies that help to generate a second-hand electric vehicle market, encourage car sharing and that assist with purchasing an electric vehicle or electric bike could help. For example, California's 'Enhanced Fleet Modernization Program Plus-Up' provides support to scrap old internal combustion engine vehicles and provides vouchers to purchase a replacement vehicle or for public transport and car-sharing services. The value of the vouchers varies depending on income.[11]

13.5 Potential impacts from land use change

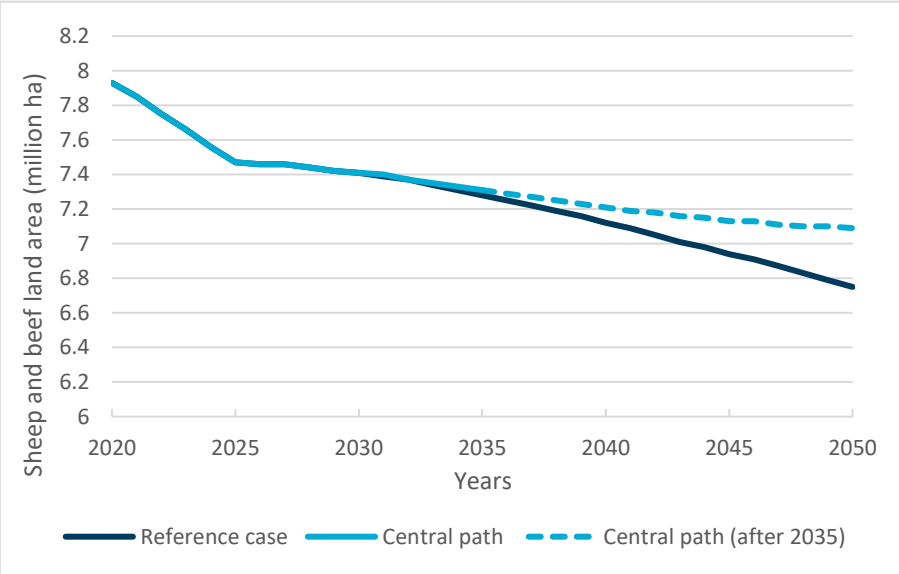
Our economic modelling suggests that in our current policy reference case, the land area in dairy and sheep and beef would decrease and the land area in exotic and native forestry would increase over the course of the first three emissions budgets and out to 2050 (See Figure 13.3).

Our central path would see a reduction in dairy land area, but less reduction in the area in sheep and beef farming out to 2050 relative to the current policy reference case. Our path would also see comparatively less exotic forestry and more native forestry compared to the current policy reference case out to 2050. This is because our central path places less reliance on forestry removals and more reliance on gross emissions reductions. It is also because these our central path assumes a greater proportion of native forestry, reflecting the greater co-benefits of native forests.

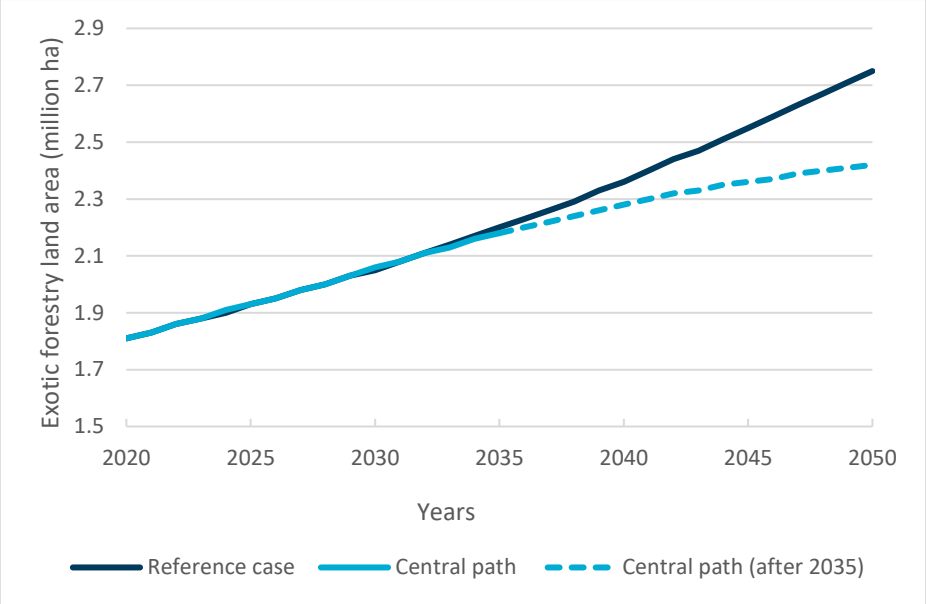
[11] (The Greenlining Institute, 2016)



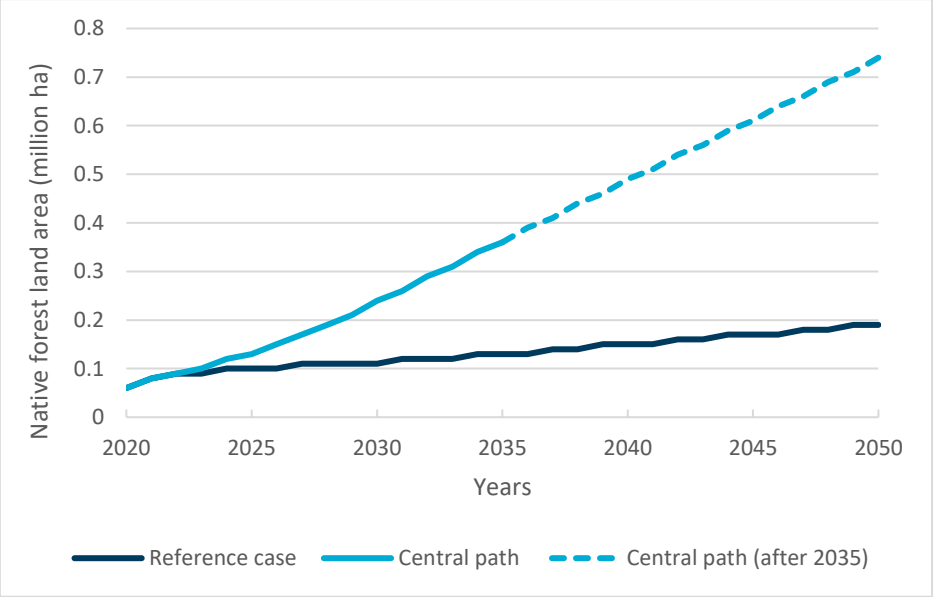
Dairy land area (million ha)



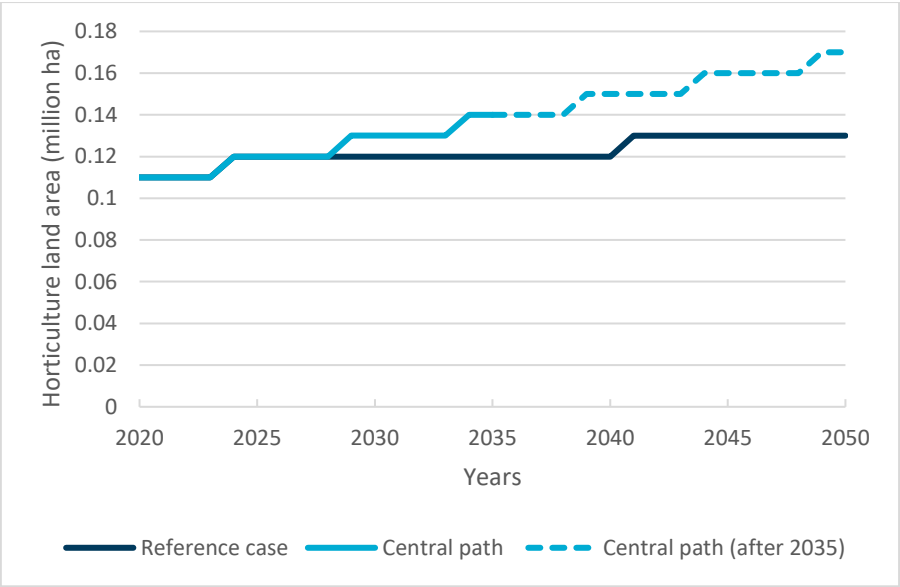
Sheep and beef land area (million ha)



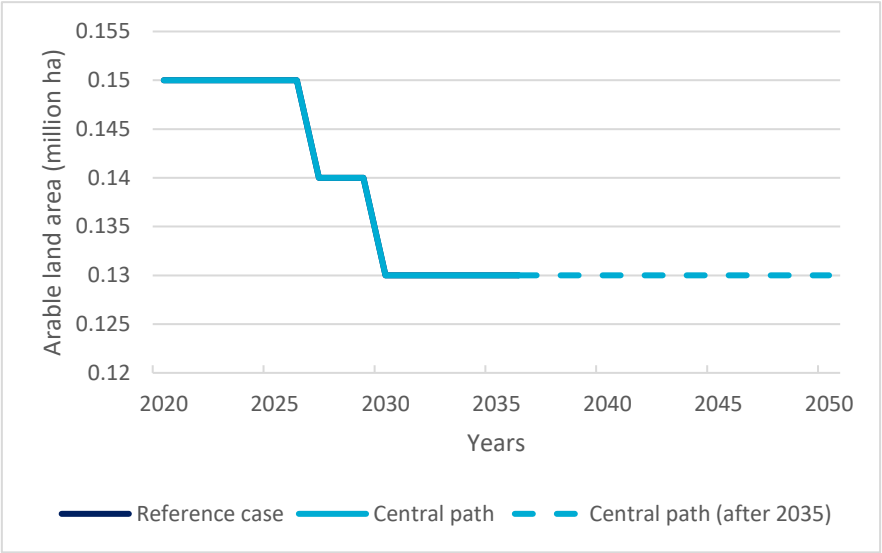
Exotic forestry land area (million ha)



Native forest land area (million ha)



Horticulture land area (million ha)



Arable land area (million ha)

Figure 13.3: The land area of the dairy, sheep and beef, exotic forestry, native forestry, horticulture, arable sectors under the reference case and our central path.

Source: Commission Analysis.

13.5.1 Afforestation

Afforestation could play a role in helping achieve our emissions budgets and emissions reduction targets. However, there some concerns that the speed and potential extent of afforestation could have significant impacts on communities. This could impact both rural communities and provincial centres that are reliant on the food and fibre industry for work.

Rural communities are particularly reliant on the primary sector for employment. The food and fibre produced in rural communities also supports the wider communities and the broader food system, including many of our towns, providing work for transporting and processing primary products. Impacts on rural communities can therefore have flow on effects to urban and provincial centres.

Rural communities and the workers living there also face other pressures, for example from automation. Automation of jobs is expected to impact rural communities more than urban centres.[12]

These concerns reflect the experience of rural communities in the late 1980s when economic restructuring, including the reduction of state services and removal of agricultural subsidies, led to wholesale and rapid land use change. This negatively impacted some rural communities through reduced employment and population. The closure and consolidation of food and timber processing plants had dramatic effects on small towns previously dependent on them. These shifts drove demographic changes and affected key social institutions such as schools, libraries and sports clubs.[13]

Some rural communities are concerned that significant afforestation could occur on sheep and beef land, with associated employment impacts and flow-on effects. The impacts of any afforestation would depend on the scale, pace and species of trees that are grown, the purpose for which the trees are grown, the type of land that is afforested and how much other sectors are able to reduce gross emissions.

Our modelling in ENZ does not determine the location of this afforestation, but recent research suggests the north-eastern North Island is where the largest afforestation would likely occur.[14] This could also significantly intersect with collectively owned Māori land.

Many sheep and beef farms have areas of land that are considered unproductive, due to steepness and susceptibility to erosion and which could be afforested without a significant impact on farming productivity or employment. There are a range of estimates as to how much land falls into this category. Recent studies put the potential area at 1,150,000 to 1,400,000 hectares,[15] while the Biological Emissions Reference Group estimated that approximately 6% of hill country sheep and beef farms could be afforested without negatively affecting production, equating to approximately 250,000 hectares.[16] However, the characteristics of some of this land also make it uneconomical or

[12] (Infometrics, 2018)
[13] (Taylor, 2019)
[14] (West et al., 2020)
[15] (Manley, 2019; Mason & Morgenroth, 2017; Ministry for Primary Industries, 2018)
[16] (Reisinger et al., 2018)

highly environmentally risky to harvest forests on it, meaning permanent forest may be the more suitable land use.[17]

The bigger concern for many is that entire farms could be converted into forestry, thereby entirely displacing sheep and beef operations, with resulting economic and employment impacts. There are a number of studies that have looked at these potential impacts.

Significant land-use change from pastoral agriculture to forestry would lower export earnings until the forests were first harvested – typically after 25-30 years for *Pinus radiata*. We have commissioned Infometrics to analyse the implications of land use change on the balance of payments. The provisional analysis of this study suggests that under some circumstances the income from the resulting timber exports would likely be greater than the lost earnings from pastoral agriculture.[18]

Jobs offered by forestry and sheep and beef farming varies by time and location and depends on the type of forestry. PwC carried out the most recent analysis of the number of jobs at the national level across the value chain for both production forestry and sheep and beef. Their analysis suggests that production forestry generates, on average, 38 full time equivalent jobs (FTEs) per 1,000 hectares across the whole value chain, from site to export, while the figure for the sheep and beef value chain is 17 FTEs. Plantation forestry integrated into sheep and beef farming and permanent carbon forestry were associated with 20 and 1 to 2 value chain FTEs per 1,000 hectares, respectively.[19] These FTE numbers include direct jobs such as shepherding and logging as well as those in food and wood processing and indirect and induced jobs in areas such as transport, consulting, retail and hospitality.[20]

At a more local level, consultants looked at the direct jobs in Wairoa from sheep and beef farming compared to forestry, where direct jobs were considered to mean working 48 weeks a year for 40 hours per week at at least $25/hour.[21] This study found that sheep and beef farming created 7.4 direct jobs per 1,000 hectares compared to 5.1 for forestry and 0.6 for carbon farming. They also found that there were fewer direct local forestry jobs for most of the rotation period before growing rapidly for a temporary period during harvest.[22] However, the seasonal nature of forestry jobs could be managed by managing harvesting patterns and ensuring that the forest estate is a mixed age class.

These numbers suggest that, on average, forestry could provide more jobs across the value chain but that wholesale or large conversions of sheep and beef farmland to forestry might reduce employment in the immediate area. This aligns with earlier work assessing the impact of increased forestry in the 1980s and 1990s, which found forestry provided slightly more jobs than pastoral

[17] For example, some land may be physically difficult to access for cutting, or far from processing facilities, making it too costly to harvest. Other land may be too steep or close to sensitive waterways, meaning the risks of erosion and sedimentation are unacceptably high.
[18] (Infometrics, Forthcoming)
[19] The PwC analysis for permanent carbon forestry included radiata pine, exotic forests and indigenous forests using MPI look up tables. The value of 2 FTEs per 1,000 ha corresponds to radiata pine. The other two types of forest result in 1 FTE per 1,000 ha each (PwC, 2020).
[20] (PwC, 2020)
[21] This definition of 'jobs' is therefore weightier than FTEs used in the PwC report, which partly accounts for the lower number.
[22] (Bruce & Harrison, 2019)

agriculture overall, but these were more concentrated in larger rural towns, particularly those involved in processing.[23]

Forestry and pastoral farming vary not just in terms of the number and location of jobs, but also in terms of wages and skills required.

In the past, the development of forestry boom towns was associated with higher Māori populations and comparative ethnic diversity.[24] Māori workers made up 22% of the forestry workforce in 2017,[25] while the average share of Māori in agriculture, forestry and fishing employment in 2013 was 11%.[26]

Initial analysis being carried out for the Commission by Motu, based on census and other Stats NZ data, has found the forestry and logging sectors have a higher percentage of male workers, full-time workers, permanent workers and Māori workers relative to pastoral farming. Workers in these sectors also tend to be paid more and are more likely than those in pastoral farming to only have one job, especially if they work full-time. However, forestry and logging workers are also much more likely to be based in locations outside of rural areas and are working in higher risk occupations.

A shift in where workers live would have wider implications for the social structure of rural communities, potentially leading to declines in school rolls and spending in local businesses. This could affect all rural communities but potentially have particularly important ramifications for Māori who have already suffered displacement and disconnection from their whenua.

Relying on forestry removals to reduce the effects of climate change would also create risks associated with the physical impacts of climate change and could also divert action away from reducing gross emissions in other sectors. Fires, high winds and other physical impacts that are exacerbated as a result of climate change would increasingly pose a risk to forests.

The scale of afforestation that is expected to occur would in large part be driven by the emissions price in the New Zealand Emissions Trading Scheme (NZ ETS) and other financial incentives such as the One Billion Trees programme, in addition to export prices. Current policy settings and sector infrastructure heavily favour the planting of exotic *Pinus radiata* over other species. Increasing emissions prices would also incentivise greater shares of permanent exotic carbon forestry.

Constraining this price incentive for afforestation through the NZ ETS could help limit its overall scale. However, it would not necessarily address the issue of wholesale farm conversions, which is what likely has the greatest effect on rural communities. Limiting this would likely require a regulatory approach, through the Resource Management Act or alternative intervention, that places restrictions on land use change.

Capacity building and extension services for landowners focused on integrating trees or forestry onto farms as diversification rather than wholescale farm change could limit the impacts of afforestation. Developing carbon monitoring systems that allow for tracking and rewarding sequestration from smaller or dispersed areas of trees could also facilitate this.

[23] (Fairweather et al., 2000)
[24] (Taylor, 2019)
[25] (Te Uru Rākau et al., 2020)
[26] (BERL & FOMA, 2019)

Changing the balance of incentives in exotic versus native afforestation would also alter the impact on rural communities. Native afforestation might generate less value chain jobs than exotic forestry if it is not all planted and harvested. However, it could be suitable for areas of less productive land. It would, therefore, not come at the expense of other economic activity. Mechanisms to incentivise native afforestation could come by extending grant schemes such as One Billion Trees or by developing ecosystem services payment schemes that could reward the other environmental benefits of native forests.

Efforts could also be made to promote a native forestry industry. This could be particularly relevant for iwi/Māori. Efforts to increase domestic timber demand by changing building policies could also stimulate the wood processing industry and increase the value chain employment of forestry.

13.5.2 Land use change to horticulture and other uses

Diversifying land and switching some land currently in pastoral agriculture to horticulture, arable crops and other livestock such as pigs and poultry produce considerably lower biological greenhouse gas emissions per hectare.[27] However, horticulture and arable systems often involve higher fossil fuel consumption.[28]

The combined area of land in horticulture and arable crops in Aotearoa is currently about 1% of total land use. More than 1.5 million hectares of land currently in livestock farming would be suitable for horticulture or arable cropping.[29]

However, there has not been significant diversification to horticulture despite it being more profitable per hectare than dairy or livestock farming. This indicates that there are barriers to shifting land use in this way. Barriers include:

- Labour shortages for seasonal workers,
- High capital investment of converting and lack of access to capital,[30]
- Lack of infrastructure and supply chains,[31]
- Challenges with market access and non-tariff barriers,[32]
- Tightly managed markets to maintain premium prices.[33]

Workers require adequate housing, transportation and access to recreational facilities. Hence, labour shortages in horticulture and agriculture in general are a more complex issue than merely lack of capacity or skills. COVID-19 and the close of our borders has exacerbated existing labour shortages of the industry.

Aotearoa citizens and permanent residents make up about 65%-75% of the horticultural labour force, with the remaining being workers on temporary visas.[34] About 33% of the seasonal labour in

[27] (Interim Climate Change Committee, 2019)
[28] (Reisinger et al., 2017, p. 61)
[29] (Reisinger et al., 2017, p. 8). For example, apples, kiwifruit, grapes, vegetables and pulses.
[30] Productive orchards sell for about NZ$350,000/ha for Green and NZ$500,000/ha for Zespri Gold, severely limiting new entrants to the industry. (Cradock-Henry, 2017)
[31] (Clothier et al., 2017)
[32] (Horticulture New Zealand, 2019; Journeaux et al., 2017; Westpac, 2016)
[33] (ANZ, 2018)
[34] Includes viticulture, seasonal and off-season (NZIER, 2019)

2019 were part of the Recognised Seasonal Employer scheme and most workers for apple and pears sub-sector come from the Pacific.[35]

Globally, automation in horticulture would accelerate in the packhouse and the fields within the next 5 years. The use of machines may reduce contamination of plant diseases and transmission of human viruses. Opportunities may open in data science, technology and information and communications technology (ICT) related to the industry.[36]

Hence, in the long term, the industry will need to attract people who can work with machines, through apprenticeships and science, technology and mathematics education for the whole food and agriculture sector. This will require collaboration across agricultural sectors as well.[37]

Some Aotearoa companies are testing and using robotics for fruit picking and sorting.[38] Automation would be constrained by access to capital.

13.6 Benefits of improved health to communities

Many of the actions Aotearoa could take to address climate change would have broader health co-benefits and reduce the burden on the public health system, from better air quality to less noise and from more active local travel.

There is growing evidence both within Aotearoa and internationally of the health benefits of reducing emissions. At an international scale, new modelling suggests that climate policy can deliver immediate global benefits, that outweigh costs, when health co-benefits and co-harms are considered. These health benefits would be observed most particularly in countries with high air pollution.[39]

Evidence from Aotearoa suggests that New Zealanders could benefit from improved health from warmer, drier homes,[40] moving to more active forms of transport,[41] and from reduced air pollution from a move away from fossil fuels.[42]

In addition, global action to reduce emissions would also reduce the costs that would occur as a result of the changing climate, including costs on the health system from increased heat stress from warmer temperatures and temperature extremes and changing patterns of infectious disease. The health impacts of climate change would be unlikely to be spread evenly across the population, with more vulnerable groups being more exposed.[43]

[35] (New Zealand Kiwifruit Growers Incorporated (NZKGI), 2020)
[36] (Higgins et al., 2020)
[37] (Higgins et al., 2020)
[38] (Good Fruit & Vegetables, 2019; Jee, 2019; Robotic Plus, 2019)
[39] (Scovronick et al., 2019)
[40] (Grimes et al., 2012)
[41] (Macmillan et al., 2014)
[42] (Kuschel et al., 2012)
[43] (Royal Society Te Apārangi, 2017)

13.7 References

ANZ. (2018). *Insights into the Kiwifruit industry investment opportunities and challenges*.

BERL & FOMA. (2019). *Education, training, and extension services for Māori land owners*. BERL, FOMA. https://www.iccc.mfe.govt.nz/assets/PDF_Library/f12a9f85fb/FINAL-BERL_FOMA-Education-training-and-extension-services-for-Maori-land-owners-BERL_FOMA.pdf

Bruce, H., & Harrison, E. (2019). *Case study: Socio-economic impacts of large-scale afforestation on rural communities in the Wairoa District* [Commissioned for Beef + Lamb NZ]. BakerAg. https://beeflambnz.com/sites/default/files/Wairoa%20Afforestation_FINAL.pdf

Canterbury District Health Board. (2015). *Unflued Gas Heaters: Position statement and background paper for the Canterbury District Health Board* [Prepared by the Information Team Community and Public Health. Adopted by the Canterbury District Health Board July 2015]. Canterbury District Health Board. https://www.cdhb.health.nz/About-CDHB/corporate-publications/Documents/CDHB%20Unflued%20Gas%20Heaters%20PositionStatement.pdf

Clothier, B., Muller, K., Hall, A., Thomas, S., van den Dijssel, C., Beare, M., Mason, K., Green, S., & George, S. (2017). *Futures for New Zealand's arable and horticultural industries in relation to their land area, productivity, profitability, greenhouse gas emissions and mitigations* [Report for NZAGRC]. Plant & Food Research Rangahau Ahumāra Kai.

Cradock-Henry, N. A. (2017). New Zealand kiwifruit growers' vulnerability to climate and other stressors. *Regional Environmental Change*, *17*(1), 245–259. https://doi.org/10.1007/s10113-016-1000-9

Environmental Health Indicators New Zealand. (2020). *Socioeconomic deprivation profile*. https://ehinz.ac.nz/indicators/population-vulnerability/socioeconomic-deprivation-profile/

Fairweather, J. R., Mayell, P. J., & Swaffield, S. R. (2000). *Forestry and agriculture on the New Zealand East Coast: Socio-economic characteristics associated with land use change*. Lincoln University. Agribusiness and Economics Research Unit. https://hdl.handle.net/10182/591

Gen Less. (2017). *Heating Your Home—Home Heating Options*. Gen Less. https://genless.govt.nz/living/lower-energy-homes/heating-your-home/

Good Fruit & Vegetables. (2019). *NZ apple orchard uses world's first commercial robot picker*. Good Fruit & Vegetables. http://www.goodfruitandvegetables.com.au/story/5978042/nz-orchard-says-domo-arigato-mr-roboto/

Grimes, A., Denne, T., Howden-Chapman, P., Arnold, R., Telfar-Barnard, L., & Young, C. (2012). *Cost Benefit Analysis of the Warm Up New Zealand: Heat Smart Programme* (p. 30) [Prepared for the Ministry for Economic Development]. https://motu.nz/assets/Documents/our-work/urban-and-regional/housing/Cost-Benefit-Analysis-of-the-Warm-Up-New-Zealand-Heat-Smart-Programme.pdf

Higgins, H., van Rijswick, C., & Fumasi, R. (2020). *Covid-19 Changes the Horticulture Labour & Workplace Landscape*. RaboResearch Food & Agribusiness. https://research.rabobank.com/far/en/sectors/fresh-produce/Podcast-covid-19-changes-the-horticulture-labour-and-workplace-landscape.html

Horticulture New Zealand. (2019). *Submission on action on agriculture*. MfE. https://www.mfe.govt.nz/sites/default/files/media/Consultations/Attachments%20for%2003028%20Horticulture%20NZ.pdf

Infometrics. (Forthcoming). *Land Use, Balance of Payments and Emissions* [Commissioned by Climate Change Commission]. Infometrics.

Infometrics. (2018). *From education to employment: Megatrends affecting NZ's working environment*. Infometrics. https://static.infometrics.co.nz/Content/Infometrics_Megatrends_2018.pdf

Interim Climate Change Committee. (2019). *Action on agricultural emissions: Evidence, analysis and recommendations*. https://www.iccc.mfe.govt.nz/what-we-do/agriculture/agriculture-inquiry-final-report/action-agricultural-emissions/

Jee, C. (2019). *A robot apple-picker is now harvesting fruit in New Zealand orchards*. MIT Technology Review. https://www.technologyreview.com/2019/03/28/239350/a-robot-apple-picker-is-using-machine-vision-to-harvest-fruit-in-new-zealand/

Journeaux, P., van Reenen, E., Manjala, T., Pike, S., & Hanmore, I. (2017). *Analysis of drivers and barriers to land use change* [Report prepared for the Ministry of Primary Industries]. Agfirst. https://www.mpi.govt.nz/dmsdocument/23056-analysis-of-drivers-and-barriers-to-land-use-change

Kuschel, G., Metcalfe, J., Wilton, E., Hales, S., Rolfe, K., & Woodward, A. (2012). *Updated Health and Air Pollution in New Zealand Study, Volume 1: Summary Report* (p. 89) [Prepared for Health Research Council of New Zealand, Ministry of Transport, Ministry for the Environment and New Zealand Transport Agency]. https://www.mfe.govt.nz/sites/default/files/media/Air/updated-health-and-air-pollution-new-zealand-study-summary-report.pdf

Macmillan, A., Connor, J., Witten, K., Kearns, R., Rees, D., & Woodward, A. (2014). The societal costs and benefits of commuter bicycling: Simulating the effects of specific policies using system dynamics modeling. *Environmental Health Perspectives*, *122*(4), 335–344. https://doi.org/10.1289/ehp.1307250

Manley, B. (2019). *Potential impacts of NZ ETS accounting rule changes for forestry – averaging and harvested wood products* (MPI Technical Paper No: 2019/14). Ministry of Primary Industries. https://www.mpi.govt.nz/dmsdocument/37116/direct

Mason, E., & Morgenroth, J. (2017). Potential for forestry on highly erodible land in New Zealand. *New Zealand Journal of Forestry*, *62*(1), 8–15.

Ministry for Primary Industries. (2018). *One Billion Trees programme: Actions and decisions for implementation*. Ministry for Primary Industries. https://www.mpi.govt.nz/dmsdocument/30942/direct

Ministry of Health. (2019). *NZ Health Survey 2018/19 Annual Data Explorer*. Adults Topic: Barriers to Accessing Health Care. https://minhealthnz.shinyapps.io/nz-health-survey-2018-19-annual-data-explorer/_w_c7bd97e4/_w_54929b7f/#!/explore-topics

MyWay by Metro. (2020). *MyWay by Metro: Public transport designed around you*. http://www.mywaybymetro.co.nz

New Zealand Kiwifruit Growers Incorporated (NZKGI). (2020). *RSE Survey 2020*. https://www.hortnz.co.nz/news-events-and-media/media-releases/rse-survey-2020/

NZIER. (2019). *Horticulture labour supply and demand 2019 update.* [NZIER report to Horticulture NZ, Summerfruit NZ, NZ Kiwifruit Growers, NZ Apples and Pears and NZ Wine, June 2019]. NZIER.

PwC. (2020). *Economic impact of forestry in New Zealand* [Report prepared for Te Uru Rakau]. https://www.nzfoa.org.nz/resources/file-libraries-resources/discussion-papers/848-economic-impacts-of-forestry-pwc-report/file

Raerino, K., MacMillan, A., & Jones, R. (2013). *Indigenous Māori perspectives on urban transport patterns linked to health and wellbeing*. https://doi.org/10.1016/j.healthplace.2013.04.007

Reisinger, A., Clark, H., Abercrombie, R., Aspin, M., Harris, M., Ettema, P., Hoggard, A., Newman, M., & Sneath, G. (2018). *Future options to reduce biological GHG emissions on-farm: Critical assumptions and national-scale impact* [Report to the Biological Emissions Reference Group]. https://www.mpi.govt.nz/dmsdocument/32158-berg-current-mitigaiton-potential-final

Reisinger, A., Clark, H., Journeaux, P., Clark, D., & Lambert, G. (2017). *On-farm options to reduce agricultural GHG emissions in New Zealand* [Report to the Biological Emissions Reference Group]. New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC). https://www.mpi.govt.nz/dmsdocument/32158-berg-current-mitigaiton-potential-final

Robotic Plus. (2019). *Kiwifruit-Picker*. Robotics Plus. https://www.roboticsplus.co.nz/kiwifruit-picker

Royal Society Te Apārangi. (2017). *Human Health Impacts of Climate Change for New Zealand: Evidence Summary* (p. 18). Royal Society Te Apārangi. https://www.royalsociety.org.nz/assets/documents/Report-Human-Health-Impacts-of-Climate-Change-for-New-Zealand-Oct-2017.pdf

Scovronick, N., Budolfson, M., Dennig, F., Errickson, F., Fleurbaey, M., Peng, W., Socolow, R. H., Spears, D., & Wagner, F. (2019). The impact of human health co-benefits on evaluations of global climate policy. *Nature Communications*, *10*(1), 2095. https://doi.org/10.1038/s41467-019-09499-x

Stats NZ. (2018). *Main types of heating used (total responses) by occupied dwelling type, for occupied private dwellings, 2018 Census*. Stats NZ. http://nzdotstat.stats.govt.nz/WBOS/Index.aspx?DataSetCode=TABLECODE8390

Taylor, N. (2019). *Potential impacts of price-based climate policies in rural people and communities: A review and scoping of issues for social impact assessment* (p. 24). Nick Taylor and Associates. https://www.iccc.mfe.govt.nz/assets/PDF_Library/6b2fe1b5b8/FINAL-Taylor-

Potential-impacts-of-price-based-climate-policies-on-rural-people-and-communities-a-review-and-scoping-of-issu.pdf

Te Uru Rākau, NZIF, Future Foresters, Forest Owners Association, Toi-Ohomai, Rayonier Matariki Forests, Competenz, FICA, & NZTIF. (2020). *Forestry and Wood Processing Workforce Action Plan 2020-2024*. https://www.teururakau.govt.nz/dmsdocument/40366-Forestry-Wood-Processing-Workforce-Action-Plan-20202024

Telfar Barnard, L., Preval, N., Howden-Chapman, P., Arnold, R., Young, C., Grimes, A., & Denne, T. (2011). *The impact of retrofitted insulation and new heaters on health services utilisation and costs, pharmaceutical costs and mortality. Evaluation of Warm Up New Zealand: Heat Smart* (p. 64). University of Otago, Victoria University of Wellington, Motu, Covec. http://www.healthyhousing.org.nz/wp-content/uploads/2012/03/NZIF_Health_report-Final.pdf

The Greenlining Institute. (2016). *Electric vehicles for all: An equity toolkit*. The Greenlining Institute. https://greenlining.org/resources/electric-vehicles-for-all/

Transpower. (2020). *Whakamana i Te Mauri Hiko: Empowering our Energy Future.* https://www.transpower.co.nz/sites/default/files/publications/resources/TP%20Whakamana%20i%20Te%20Mauri%20Hiko.pdf

Waka Kotahi (NZ Transport Agency). (2019). *Keeping cities moving: Increasing the wellbeing of New Zealand's cities by growing the share of travel by public transport, walking and cycling*. https://www.nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf

West, T. A. P., Monge, J. J., Dowling, L. J., Wakelin, S. J., Yao, R. T., Dunningham, A. G., & Payn, T. (2020). Comparison of spatial modelling frameworks for the identification of future afforestation in New Zealand. *Landscape and Urban Planning*, *198*, 103780. https://doi.org/10.1016/j.landurbplan.2020.103780

Westpac. (2016). *Industry insights: Horticulture*. Westpac Institutional Bank.