# Incidence of Emissions Charges and Other Climate Change Policies: Implications for Māori Cost of Living

Research Report for

Ministry for the Environment &
Climate Change Iwi Leaders Group

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economic insight

# Important Notice

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# Abbreviations

| | |
|---|---|
| CCILG | Climate Change Iwi Leaders Group |
| $CO_2$ | Carbon dioxide |
| EECA | Energy Efficiency and Conservation Authority |
| GHG | Greenhouse Gas |
| MFE | Ministry for the Environment |
| NDC | Nationally Determined Commitment |
| NZ ETS | New Zealand Emissions Trading Scheme |
| NZU | New Zealand Unit |
| PV | Photovoltaic |
| $tCO_2e$ | Tonne of $CO_2$ equivalent |
| UNFCCC | United Nations Framework Convention on Climate Change |

# 1. Introduction and Summary

## 1.1 Purpose of the Report

This report is one of a number being prepared to help the Ministry for the Environment (MFE) and Climate Change Iwi Leaders Group (CCILG) better understand how climate change and climate change policies will affect Māori. The specific purpose of this report is to review relevant economic literatures on the incidence of emissions pricing and other climate change policies, with a focus on the implications of such pricing and policies on Māori cost of living. In doing so, it also addresses the ability of Māori to:

1. Mitigate (i.e. reduce) their greenhouse gas (GHG) emissions; and

2. Manage the impacts of emissions pricing, and adapt to climate change itself.

## 1.2 Defining Incidence and Cost of Living

In this report "incidence" is taken to mean the ultimate bearing of either emissions pricing (i.e. liability for emitting GHGs) or other climate change policies. In other words, irrespective of to whom a liability for GHG emissions (which we refer to as "emissions" for convenience) has been attributed, which party of parties ultimately pays the cost of that liability? In the discussion that follows it will be clear that the ultimate incidence of emissions pricing will largely be shared among the consumers of liable emitters' products, and suppliers of inputs (i.e. capital, labour, intermediate products) to those emitters.

The question of who bears the costs of emissions pricing naturally leads in to the question of how such pricing affects the cost of living. Here, "cost of living" is taken to mean the cost of buying goods and services at a household level. As a consequence, the particular bundle of goods and services consumed by different household types will expose those households to differing levels of emissions charges. These charges are from the direct consumption of products on which emissions liability has been imposed (e.g. motor fuels) and some part of that charge has been impounded in prices. They are also from the change in prices of other consumed goods for which those products are intermediate goods (e.g. motor fuel prices affect freight charges, which then affect food prices).

To assess the implications of emissions pricing incidence for Māori, it is therefore necessary to examine how Māori household consumption patterns – e.g. for fuel, electricity and food – differ from those of non-Māori households. This then enables a sense of the *relative* incidence of emissions pricing for Māori and non-Māori, and hence identifies whether, and in what ways, Māori households might bear more or less emissions pricing incidence than non-Māori households. To the extent that such analysis identifies disproportionate emissions pricing incidence for Māori households, this could assist in better targeting assistance via other aspects of climate change policy, or other policies, to address such incidence.

## 1.3 Context

### 1.3.1 Climate Change

While there is a range of scenarios for possible climate change in New Zealand over the next century, common themes include:

1. A widespread increase in average temperatures, with increased frequency of hot days in hot areas, and reduced frequency of frost/snow days in colder areas;

2. Changes in rainfall patterns, as well as in the frequency and severity of storm events (e.g. flooding) and droughts; and

3. Increased risk to low-lying coastal areas from sea-level rise and storm surges.

Further details are provided in Section 2.1.

### 1.3.2 Climate Change Policy

New Zealand is party to the international Paris Agreement negotiated in December 2015, under the United Nations Framework Convention on Climate Change (UNFCCC). Ahead of the Paris negotiations, all countries were asked to propose national targets for reducing GHG emissions. New Zealand ratified the agreement in October 2016, with a nationally determined contribution (NDC) obliging the country to reduce its GHG emissions 30% below 2005 levels by 2030 (equivalent to 11% below 1990 levels by 2030).

A key part of New Zealand's approach to meeting its NDC is to reduce domestic emissions. To this end, it has had an "all gases" emissions trading scheme (NZ ETS) in operation since 1 January 2008. Liable emitters of GHGs are required annually to account for their GHG emissions, and to surrender to the government a specified number of emission units (including New Zealand Units, NZUs), for each tonne of carbon dioxide equivalent ($tCO_2e$) emitted.[1] Until 1 June 2015 certain emission units from international schemes could be purchased for surrender to meet NZ ETS obligations. Since then, the scheme has become domestic only, so liable emitters must surrender admissible emission units they have either been allocated as part of free allocations by the government, or purchased at the prevailing domestic price from other holders of such rights.

Various sectors have been made subject to the scheme, starting with forestry. Since then liquid fossil fuels, electricity production and other sectors have been added, although the entry of agriculture (accounting for almost half of New Zealand's GHG emissions) remains to be decided. While emissions pricing in forestry affects a relatively narrow range of products entering into household expenditures, emissions pricing for motor fuels (e.g. petrol, diesel) and electricity affect the prices faced directly by households for their consumption of those goods. They are also important inputs into most other production processes, and hence they indirectly affect the prices of other household goods and services.

Other relevant features of New Zealand's climate change policy include:[2]

1. An exemption until 2020 from paying road user charges for purchasers of electric vehicles (which also do not pay fuel excise duties, since they do not require fuel, meaning electric vehicle purchasers will not contribute to the cost of roading and traffic enforcement until the exemption expires); and

2. Other support measures designed to aid households or other parties in reducing their GHG emissions and hence exposure to emissions pricing.

[1] For a timeline of NZ ETS developments, see Leining (2016), and MFE (2016a).
[2] See MFE (2015) for tables summarising key New Zealand climate change policies.

The latter include:[3]

1. Information provision such as through efficiency labelling programmes run by the Energy Efficiency and Conservation Authority (EECA);

2. Targeted government subsidies for the retrofitting of home insulation and energy-efficient heating systems; and

3. Government funding of research into climate change mitigation and adaptation, particularly in agriculture (for which there are currently no significant and cost-effective mitigation options).

### 1.3.3 Māori Circumstances

How emissions pricing, other climate change policies, and climate change itself, affect Māori will reflect their particular circumstances. These include locational features such as where Māori live and work, and how climate change is likely to affect those places. It will also reflect Māori demographics, such as age profile and life expectancy, as well as education, employment and investments (together affecting income). It will also reflect housing tenure (i.e. renting versus owning homes), and access to motor vehicles. It will also reflect cultural dimensions affecting resource use (e.g. inter-generational focus).

In turn, differences between the circumstances of Māori and non-Māori will affect how emissions pricing, other climate change policies, and climate change itself will affect their *relative* impacts on Māori and non-Māori.

## 1.4 Factors Affecting Incidence and Cost of Living

### 1.4.1 Short-Term – Consumption Choices

Superficially, the incidence of emissions pricing and other climate change policies on Māori can be gauged by examining the major components of household expenditures (discretionary and essential) affected by emissions pricing. Adjustments can then be made for how those components might vary for Māori vis-à-vis others, and then assessment made of how emissions pricing affects Māori cost of living.

However, this report stresses that such short-term cost of living impacts of emissions pricing are driven by factors arising over longer time-frames. In particular, a large part of household-level emissions pricing incidence arises from the impact of emissions pricing on motor fuels and electricity. Households do not consume fuels and electricity as final goods. Rather, these constitute key inputs in processes for the household production of services such as transport and heating.

The extent to which a household consumes inputs like fuel and electricity depends on their demand for household services like travel and heating. For example, do household members drive to work or take public transport, and how much do they need to heat their home? In turn, the production of those services – and the efficiency at which fuels and electricity are converted into services – depends crucially on investments made by households (or their housing

[3] We note that certain climate change policy measures, such as those implemented via EECA, are funded by levies (e.g. on all electricity consumers' power bills). The relative burden or advantage created for different sectors or groups from such levies are beyond the scope of this study, as they do not represent emissions pricing per se.

providers). These include the type of motor vehicle they own, and the type and efficiency of home heating systems, house type and level of insulation, etc.

Household investments are fixed in the short-term, so short-term household-level consumption of fuels and electricity is relatively price-insensitive. Households are therefore unable to change their consumption patterns in response to emissions pricing in the short-term. As a consequence, they face greater emissions pricing incidence, and increased cost of living, over this time-frame.

### 1.4.2 Medium-Term – "Conditioning Investments" affecting Consumption Choices

Over the medium-term, however, households can change the mix of their household investments in things like vehicles, electrical appliances and home insulation. This creates two effects:

1. The cost of providing household services changes, which in turn affects household demand for the inputs (like fuel and electricity) needed to provide those services; and

2. The household's purchasing power also changes, as a consequence of the change in the cost of providing household services.

In particular, investing in more efficient vehicles or home heating systems lowers the unit cost of travel and heating respectively. This inclines households to produce more travel and heating services, all other things being equal. It also means a household with a given income has more free income to spend, which it can apply to the purchase of other goods (e.g. food), but also to increased consumption of travel and heating services (since their unit costs are now lower). The household's production of such household services is therefore subject to – or conditional on – the types of investments made in vehicles and appliances. Hence we refer to those investments as "conditioning investments".

There is ample literature from New Zealand and overseas showing that such efficiency investments can result in "rebound" effects, meaning that total expenditure on inputs like fuel and electricity falls by less than expected, and might even rise ("backfire" effects).[4] While the household might save little on fuel and electricity expenditures, it is able to enjoy a higher level of travel or heating services with the same level of income as before. Alternatively, for an increased level of expenditure on fuels and electricity (e.g. due to emissions pricing), a household with more efficient vehicles or appliances is able to maintain its production of household services for a given income.

These considerations highlight how emissions pricing incidence and cost of living are affected by factors such as housing tenure (renting versus owning) and having the income to make investments in efficient vehicles and heating technologies. Thus, to the extent there are differences between Māori and non-Māori in terms of such factors, it can be predicted that Māori will be able to mitigate their emissions differently to non-Māori in response to emissions pricing. It can also be predicted that Māori will be differently able to adapt to climate change policies, and also climate change itself.

They also highlight how focusing just on the emissions pricing incidence by comparing household expenditures may result in a misleading impression. Two households may have the same level of expenditure on (e.g.) electricity, but one might enjoy much greater benefits from electricity

[4] For New Zealand evidence of rebound effects, see Grimes et al. (2011). International evidence is provided in Revelt and Train (1998), Davis et al. (2012), and Davis (2008). Rapson (2012) and Brännlund et al. (2007) report energy efficiency investments not resulting in increased energy consumption, while Borenstein (2014) suggests backfire should be rare, and rebound should be modest.

consumption due to being able to invest in energy-efficient appliances. Recognising that important household expenditures such as those on motor fuels and electricity are simply inputs into household production processes (for services like travel and heating), further research remains to identify emissions pricing incidence at the level of units of household services produced (rather than just per dollar of household expenditure).

### 1.4.3 Long-Term – "Contextualising Investments" affecting both Conditioning Investments and Consumption Choices

Finally, over even longer time-frames it can be predicted that there will be differences between Māori and non-Māori in terms of their ability to make the types of household investments referred to above. These stem from household choices, and choices made by other parties, affecting things like location choice, and investments in house type, education and business/profession. These in turn affect long-term housing tenure and income, which affect the need for, and ability to afford, the types of investments that affect a household's ability to mitigate and adapt. Because the need for, and ability to, make conditioning investments depends on these longer-term investments, we refer to them as "contextualising investments." They set the context in which conditioning investments might arise.

Hence, to look beyond short- and even medium-term drivers of emissions pricing and climate change incidence on Māori, it is necessary to look also at these other, longer-term drivers. In other words, contextualising investments affect a household's ability to make conditioning investments, and both types of investment ultimately affect that household's short-term consumption choices that affect the incidence of emissions pricing and climate change, and hence the impacts of each on the cost of living.

## 1.5 Key Findings

Our key findings are as follows:

1. The incidence of any emissions charge – like that of a consumption tax – does not simply rest with the party formally liable to pay the charge (i.e. points of obligation, like fuel companies, under the NZ ETS).

2. The ultimate incidence of the charge will be shared between consumers of a liable emitter's products or services, and parties that supply that emitter with capital (owners/lenders – via lower returns), labour (employees – via lower income) or other inputs (e.g. other businesses – via lower revenues).

3. The relative responsiveness of each of these parties to changes in their relevant prices determines their ultimate incidence. All other things being equal, a decrease in a consumer's price responsiveness will result in them bearing a higher incidence, while an increase in responsiveness results in a lower incidence.

4. How emissions pricing incidence is shared between different parties can also result in income effects for consumers (in addition to price effects), altering their consumption patterns (i.e. if those consumers also own, supply and/or work at liable emitters).

5. The two most important components of a household's emissions is from their consumption of motor fuels for producing transport services, and electricity for producing other household services (e.g. heating, refrigeration, lighting, etc).

6. Based on short-term consumption patterns, there is evidence that Māori households (on average) have more emissions-intensive expenditures than non-Māori households. In part this can be explained in terms of factors such as larger average household sizes, lower home ownership rates (associated with higher travel-related emissions), and higher rates of social housing.

7. This suggests Māori households may also therefore bear a higher emissions pricing incidence than non-Māori households, all other things being equal. Further primary research is required to be more definitive.[5]

8. In the medium-term, Māori households have less ability than non-Māori households to make conditioning investments, such as purchases of more fuel-efficient vehicles, or investments in energy-efficient appliances (heat pumps, etc) and home insulation. This is particularly due to lower average incomes and higher rates of renting.

9. Consequences of these lower investments are less ability to modify short-term consumption patterns (e.g. motor fuels, electricity) in response to emissions charges, meaning Māori households continue to remain relatively unresponsive to emissions charges even as other households become more price-responsive.

10. This is particularly the case regarding solar photovoltaic systems (PV) for small-scale electricity generation. Wealthier households investing in such technologies both reduce their exposure to emissions charges, and shift consumption-based network fixed charges to poorer households.

11. Current electricity pricing models incentivise such investments, to the disadvantage of poorer households, and households in rented accommodation, both of which are more likely to be Māori households.

12. Relatedly, subsidies offered under climate change policy to buyers of electric vehicles are likely to favour wealthier, multi-car households that own their own homes. This places Māori households at a relative disadvantage in reducing their exposure to fuel-related emissions pricing, although current electricity pricing structures mean households with electric vehicles may be paying more than cost-reflective prices, to the benefit of other electricity users.

13. The overall impact of this lesser ability of Māori households to make conditioning investments is unclear. While households making such investments increase their responsiveness to emissions charges and hence can reduce their incidence related to fuel or electricity consumption, more efficient technologies can induce an overall increase in fuel or electricity demand due to “rebound/backfire” effects.

14. A consequence of rebound effects for wealthier households that make conditioning investments is that those households’ total fuel or electricity consumption might rise. While they bear a greater emissions pricing incidence due to increased consumption, their incidence per unit of household services supplied (travel, heating, etc) is reduced.

[5] Data are increasingly available enabling Māori households to be statistically distinguished from non-Māori, including at geographical and finer levels. However, as of writing, little primary research has been undertaken to provide more definitive analysis in relation to Māori household expenditures and emissions pricing incidence, let alone at regional or more disaggregated levels. This represents an important gap in research.

15. Hence, because of Māori households being relatively less able to make conditioning investments, their medium-term emissions pricing incidence may appear to be relatively low due to lower overall fuel and electricity consumption. However, their emissions pricing incidence may be relatively high per unit of household services produced, due to producing lower levels of travel, heating (etc). Further primary research is required to be more definitive. This point stresses that more refined metrics are required to properly assess emissions pricing incidence.

16. A consequence of Māori households having lower average incomes, higher rental rates, and lower conditioning investments is that they are likely to suffer ongoing higher rates of illness related to poor housing conditions. This affects educational and work opportunities, lowering relative income. It also raises the need for (if not the ability) for higher medical expenditures.

17. Short- and medium-term incidence of emissions pricing for Māori households is reduced to the extent that social transfers received by those households are indexed to movements in emissions prices, and/or they enjoy support for energy efficiency measures (e.g. subsidies for heat pumps and house insulation).

18. Long-term emissions pricing incidence for Māori households will reflect, among other things, choices about location and housing type. Māori commitment to traditional areas of interest might limit long-term contextualising investments in education and profession choice that (e.g.) maintain lower average incomes. It might also mean Māori households will face higher cost of living if they live in remote or rural areas vulnerable to climate change – and where infrastructure providers (and insurers) might reduce service levels in response to climate change – through having to invest in self-sufficiency or backup technologies (e.g. electricity and water supply).

19. Furthermore, complexities surrounding governance and use of traditional land and other resources might limit adaptability in response to climate change.

20. However, a long-term commitment of Māori to specific locales could actually assist with government and other parties prioritising adaptation investments (e.g. in infrastructure) which might otherwise be deferred due to uncertain long-term prospects for those locales.

21. Likewise, Māori community's stewardship and inter-generational focuses mean they are more likely to seek solutions to adapt to climate change in their traditional areas of interest, rather than abandon those areas.

# 2. Background

## 2.1 Climate Change

A summary of projected climate changes in New Zealand is provided in MFE (2016b), with detailed projections in MFE (2016c). In short, the projections are for:

1. Higher average temperatures (0.7-1.0 degrees Celsius by 2040), with greatest warming in the northeast of the country;

2. Changes in rainfall:

    2.1 North and east of North Island – increased summer rainfall, but decreased spring rainfall;

    2.2 South Island – increased winter rainfall in many parts, but decreased spring rainfall in south and east;

3. More frequent dry days – for most of the North Island, and parts of the South Island;

4. More frequent heavy rain events in the South Island, and parts of the North Island;

5. More frequent and intense droughts – especially in the northern and eastern North Island, and east of the Southern Alps in the South Island;

6. Some increase in storm intensity – with low-lying coastal areas at risk of storm surges;[6]

7. More frequent hot days – with largest changes in hot areas; and

8. Less frequent frost and snow days – with largest changes in high altitude regions, and in the south of the South Island.

Figure 2.1 (overleaf) illustrates the projected changes in temperature and average rainfall throughout the country, by 2090, under optimistic and pessimistic scenarios. Of particular note for Māori is the likely decline in rainfall in eastern and northern parts of the North Island, where the Māori population is proportionately greater.

Notably, the projected impact of climate change on agriculture is not uniformly negative, and overall could be positive for much of the country. Stroombergen (2011) models changes in net primary production due to climate change, finding that even without adaptation in agricultural and forestry production, primary production rises on average across the country. The West Coast, Southland, Otago and Central North Island are predicted to enjoy strong gains, with small or no losses for Canterbury, and the eastern and northern North Island.

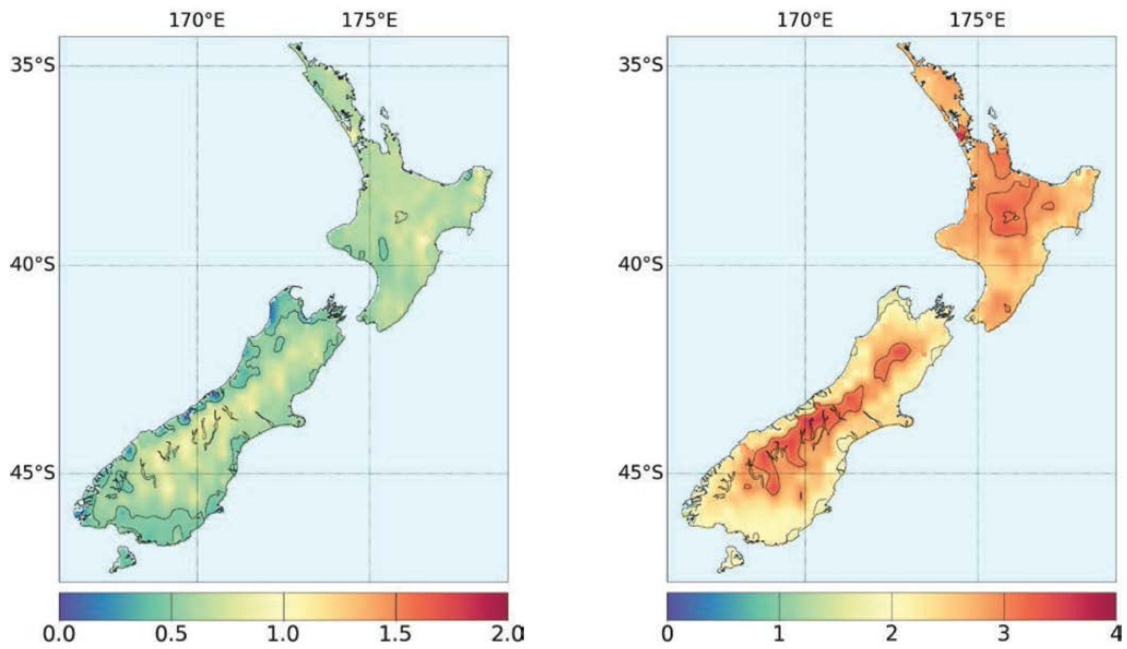
These positive impacts are likely to be even more pronounced based on research into the global impacts of climate change on agriculture.[7] In many parts of the world climate change will harm

[6] In addition, sea level rises are expected, though at time of writing further research is being undertaken to develop projections (MFE (2016c)).
[7] NZAGRC (undated) makes similar arguments. MFE (2013) provides sectoral projections, including of benefits for some regions. See also Mendelsohn et al. (2006) and Tol (2014) for international evidence.

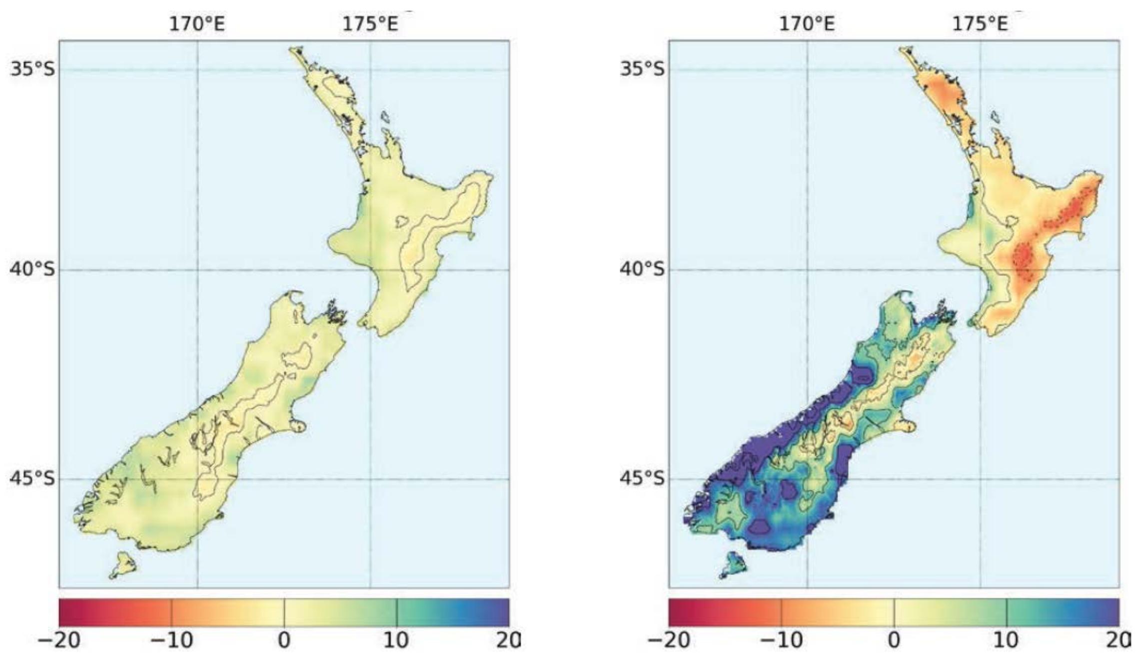
production, placing upward pressure on commodity prices. These would benefit local producers, but likely make food more expensive for domestic consumers.

## Figure 2.1 – Projected Changes in Temperature and Rainfall by 2090

**Average change in temperature (°C) by 2090 under RCP2.6 (left) and RCP8.5 (right)**




**Annual average change in rainfall (%) by 2090 under RCP2.6 (left) and RCP8.5 (right)**




Source: MFE (2016b).

## 2.2 Māori Household Characteristics

In this report, reliance has been placed on third-party data for, and analyses of, Māori household characteristics. In the main these sources provide snapshots of Māori society at a more aggregated level than the household, and so at best the descriptions that follow should be treated as stylised facts with some evidentiary basis. There is currently a gap in research regarding detailed features of Māori households (including at regional and more disaggregated levels), and how those features compare with, or differ to, those of non-Māori households. We leave filling that gap to future research.

Table 2.1 sets out stylised facts for Māori society at large, in comparison with non-Māori, compiled by the Ministry of Health.

### Table 2.1 – Socioeconomic Indicators for Māori and Non-Māori, 2013 (%)

| | Māori | | | Non-Māori | | |
|---|---|---|---|---|---|---|
| **Indicator** | **Males** | **Females** | **Total** | **Males** | **Females** | **Total** |
| School completion (Level 2 Certificate or higher), 15+ years, percent, 2013 | 42.1 | 47.8 | 45.1 | 65.2 | 63.4 | 64.3 |
| Unemployed, 15+ years, percent, 2013 | 9.8 | 10.9 | 10.4 | 3.9 | 4.1 | 4.0 |
| Total personal income less than $10,000, 15+ years, percent, 2013 | 23.0 | 25.0 | 24.1 | 14.8 | 21.7 | 18.4 |
| Receiving income support, 15+ years, percent, 2013 | 23.1 | 36.7 | 30.4 | 10.9 | 16.4 | 13.8 |
| Living in household without any telecommunications, all age groups, percent, 2013 | 3.1 | 2.9 | 3.0 | 1.0 | 0.8 | 0.9 |
| Living in household with internet access, all age groups, percent, 2013 | 69.4 | 68.6 | 69.0 | 84.3 | 83.2 | 83.8 |
| Living in household without motor vehicle access, all age groups, percent, 2013 | 8.1 | 9.3 | 8.7 | 3.7 | 5.0 | 4.4 |
| Living in rented accommodation, all age groups, percent, 2013 | 48.3 | 50.5 | 49.5 | 27.7 | 27.3 | 27.5 |
| Household crowding, all age groups, percent, 2013 | 18.3 | 18.8 | 18.6 | 7.8 | 7.6 | 7.7 |

Source: www.health.govt.nz.

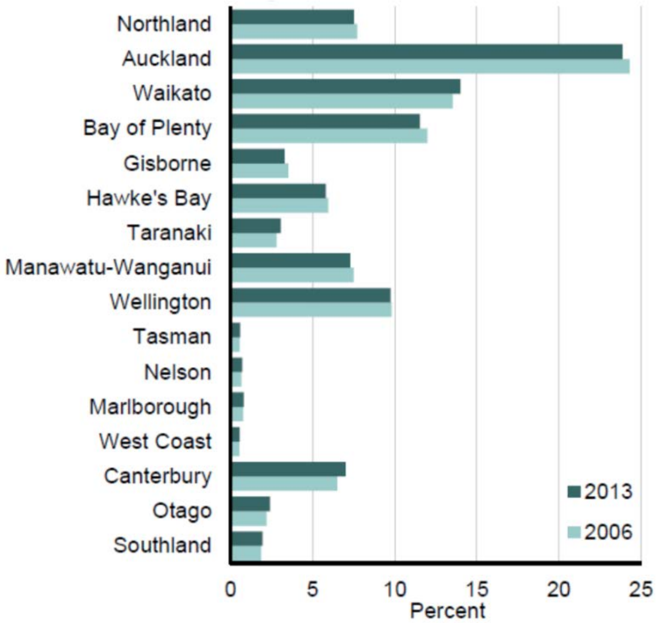
As can be seen, at the average population level, Māori are – relative to non-Māori:

1. Much less likely to have completed secondary school;
2. Much more likely to be unemployed;
3. More likely to be on a low income;
4. Much more likely to be receiving income support;
5. More likely to be in a household with no telecommunications or internet;
6. More likely to not have access to a motor vehicle; and
7. Much more likely to be renting, and living in a crowded house.

Māori are also younger on average than non-Māori (Statistics New Zealand, (2013a)).

Based on 2013 Census data, around 85% of New Zealand's 561,333 Māori live in the North Island, with 15% living in the South Island. Figure 2.2 shows that nearly a quarter of all Māori live in Auckland, with the next most significant Māori populations being in the Waikato, Bay of Plenty and Wellington. Most South Island Māori live in Canterbury. The largest iwi, Ngāpuhi, alone constitutes more than 20% of the total Māori population, with the next largest iwi being Ngāti Porou, followed by Ngāi Tahu and Waikato-Tainui.

## Figure 2.2 – 2013 Māori Population by Regional Council Area




Source: Statistics New Zealand (2013a).

Census data for 2013 (Statistics New Zealand (2013a, 2014)) also reveal that:

1. The three most common occupational groups for Māori were labourers (19.4%), professionals (16.4%) and managers (13.1%);

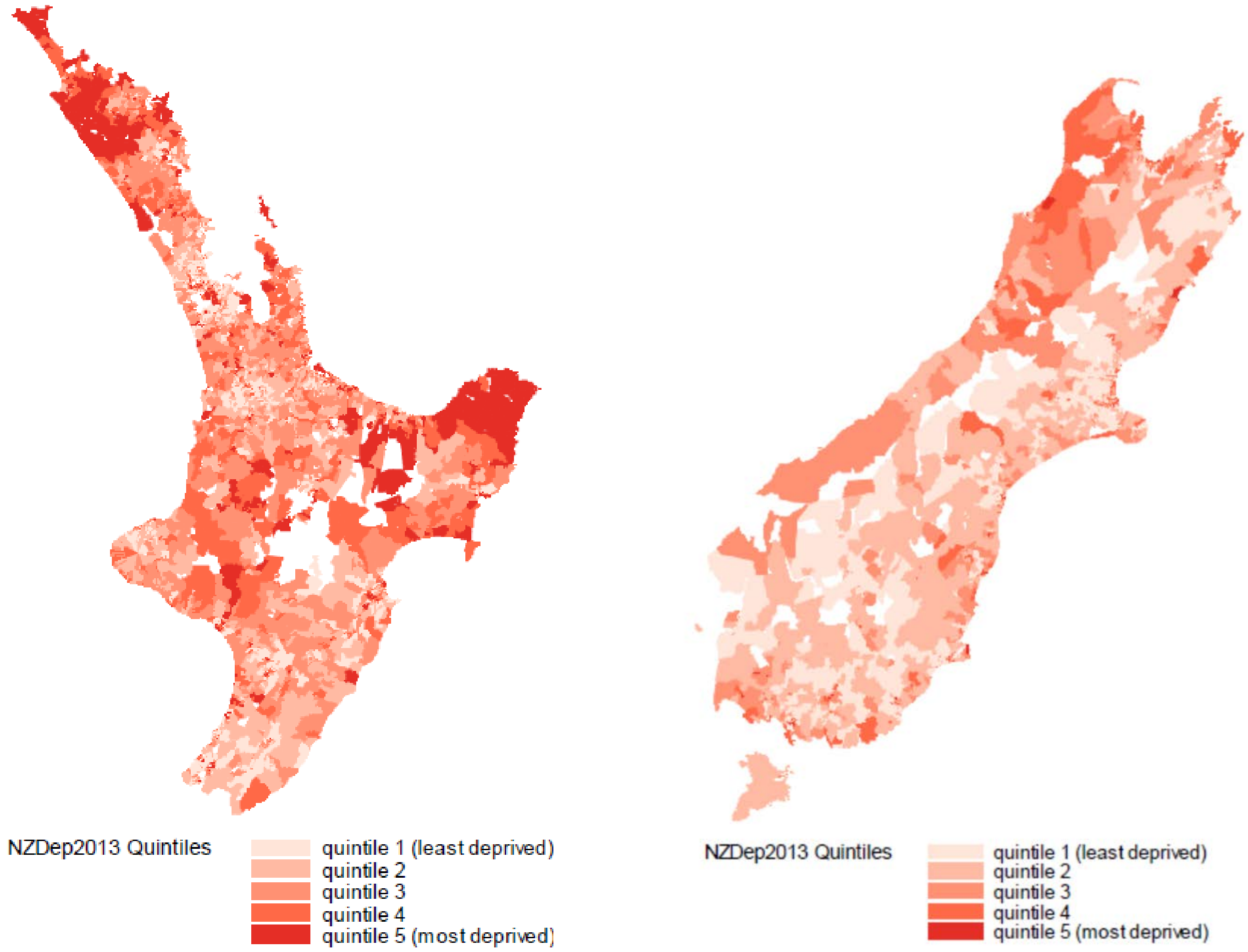
2. The most common industries for Māori to be employed in were manufacturing (12.2%), health care and social assistance (10%), and education and training (9.4%);

3. The three Regional Council areas with the lowest gross median income were Northland, Gisborne and Manawatu-Wanganui, while those with the highest were Wellington, Canterbury and Auckland.

Combining measures such as those in Table 2.1 enables measurement of overall social deprivation, as mapped for all New Zealanders in Figure 2.3. This mapping indicates concentrations of deprivation in Northland, Gisborne and Bay of Plenty in particular. Based on 1996 deprivation data, Maré et al. (2001) show that the regions with the most deprived people were Auckland (by far), Northland and Waikato. Conversely, they show that the regions with the highest *proportion* of deprived people were Gisborne and Northland, followed by Auckland and Waikato. In all these areas Māori were more likely to be in the most deprived category than non-Māori.[8]

[8] An update of this research would be highly beneficial. While it is highly dated, it provides the best available disaggregated view of relative Māori socio-economic status.

Figure 2.3 – Mapping of Social Deprivation Index, NZDep2013




Source: Atkinson et al. (2014).

## 2.3 Other Relevant Māori Features

Other features of Māori society of relevance to potentially distinguishing Māori from non-Māori households are:

1. A particular affinity with traditional (e.g. tribal) areas;

2. A distinctive concern to preserve natural resources for future generations, with associated perception of being stewards (kaitiaki) of those resources (as opposed to owners); and

3. Distinctive arrangements for owning and managing collective lands.

Regarding the latter, draft legislation is expected to be passed and implemented by October 2017, reforming ownership and control arrangements for Māori land.[9] Existing arrangements have proved cumbersome, but even the reforms require special governance arrangements for Māori land, and continue to impose (in some cases strengthen) restrictions on the alienation of that land.[10] While the reforms should help to alleviate some of the complexities of managing Māori land, it is likely that a significant proportion of that land will continue to be under-utilised and possibly un-governed.

Table 2.2 presents some summary statistics regarding Māori land, while Figure 2.4 (overleaf) maps the location of that land.

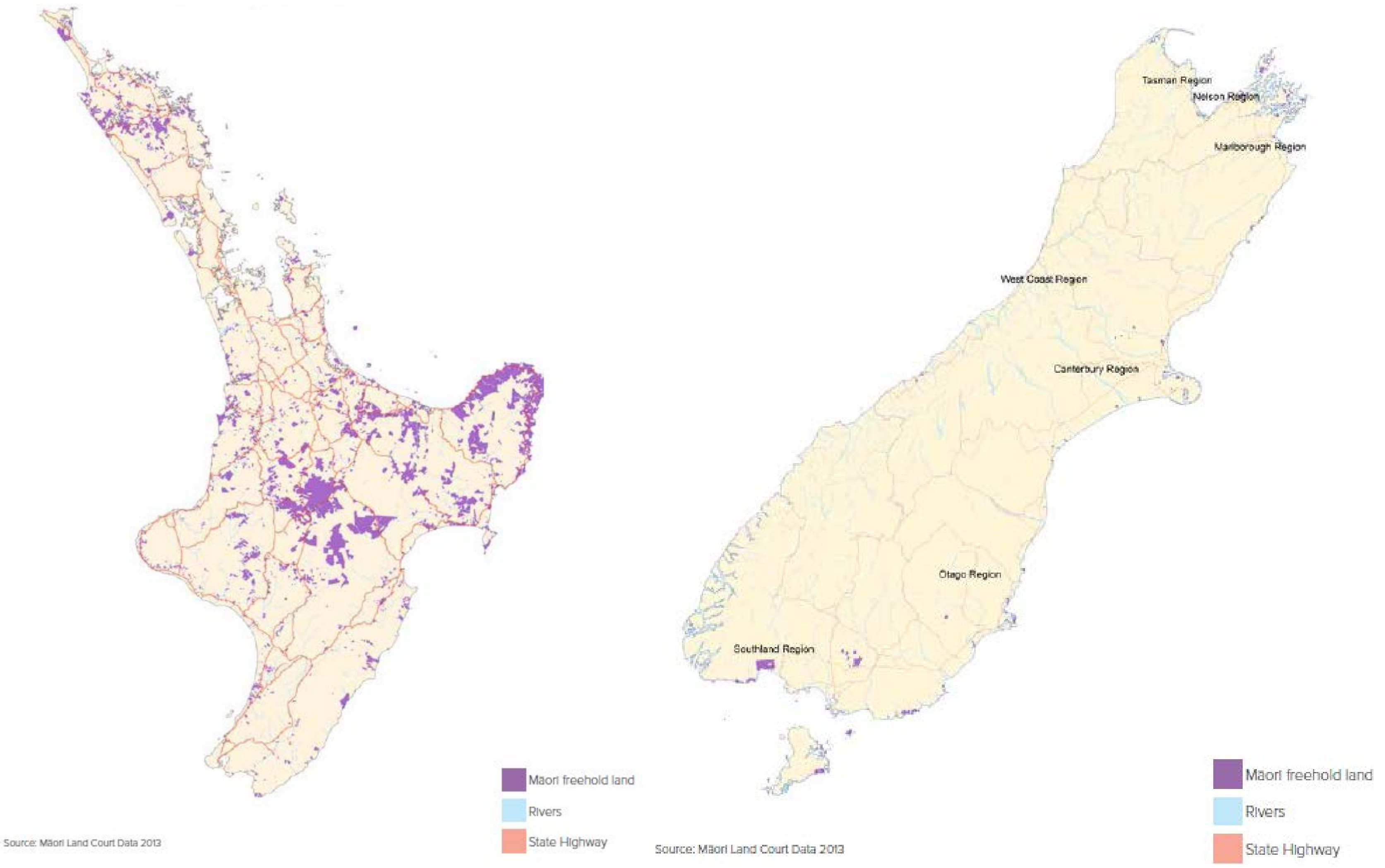
### Table 2.2 – Summary Statistics about Māori Land

| |
|---|
| 1.45 million ha (5.5% of NZ land area) |
| Most Māori land is in the north, centre, and east of the North Island |
| Around a third of Māori land is unused or unoccupied |
| 27,500 Māori land blocks |
| Average of 106 owners per block (average block size is 54 ha) |
| 2.8 million interests in Māori land |

Source: Te Puni Kokiri (2016).

[9] See Te Puni Kokiri (2016) for a background on, and summary of, the reforms.
[10] Day and Emmanuel (2010) estimate that restrictions on the tradability of fish quota received by Māori in Treaty settlement allocations potentially reduces the value of those assets by up to 30%. Restrictions on the alienability of Māori land potentially impose value reductions of the same order of magnitude.

Figure 2.4 – Mapping of Māori Freehold Land (Māori Land Court Data)




Source: Te Puni Kokiri (2016).

# 3. Framework for Assessing Incidence

## 3.1 Factors Affecting Incidence and Cost of Living

### 3.1.1 Legal vs Effective Incidence

The NZ ETS makes certain GHG emitters liable for their GHG emissions – e.g. fuel companies for motor fuels, and electricity generators for emissions arising from electricity generation (e.g. from steam turbines using heating from natural gas). This means those emitters – or points of obligation – face the prevailing price of emissions when meeting their obligations under the scheme. However, being legally liable to meet the costs of emissions does not mean these parties bear the ultimate cost.[11]

Figure 3.1 (overleaf) sets out the relevant considerations. Depending on the precise industry make-up, liable emitters will have some ability to pass *forward* emissions costs to customers.[12] This is particularly so if they enjoy some degree of market power. To the extent that liable emitters can pass through emissions charges, this *directly* raises prices for consumers who consume the liable emitters' products. It also *indirectly* raises prices to those consumers to the extent that the emitters' products are inputs in the production of other goods or services, since the prices of those goods or services are also likely to rise. Finally, price changes in one sector of the economy can have flow-on effects for other parts of the economy, so in general even goods or services not directly affected by emissions pricing might change, also affecting the consumers of liable emitters' products.

However, customers of liable emitters are unlikely to be the only party ultimately bearing the cost of emissions pricing. As shown in Figure 3.1, suppliers of liable emitters are also likely to bear some cost. These include the suppliers of capital to the liable emitters (i.e. their owners, or lenders). If other parties cannot be made to bear emissions costs, the emitters' owners – as residual claimants on the emitters' cash flows – face a fall in profits and investment value. Lenders could face a fall in the debt servicing capacity of the emitters, and hence a fall in loan value.

Additionally, a liable emitter might pass through some of the emissions charges to its employees in the form of reduced wages or wage growth. Alternatively, emitters might shrink production and reduce their overall employment. In some circumstances liable emitters might also impose costs on employees in the form of reduced safety (reflecting an alternative form of economising, in the face of having to bear additional costs).

Finally, other input suppliers to liable emitters might face downward pressure on their prices, if the emitter must shrink output in response to becoming more costly due to emissions pricing. The overall balance of this incidence between emitters' customers, capital and input suppliers, and employees, depends on the relative price/wage-responsiveness of each party.

In general:

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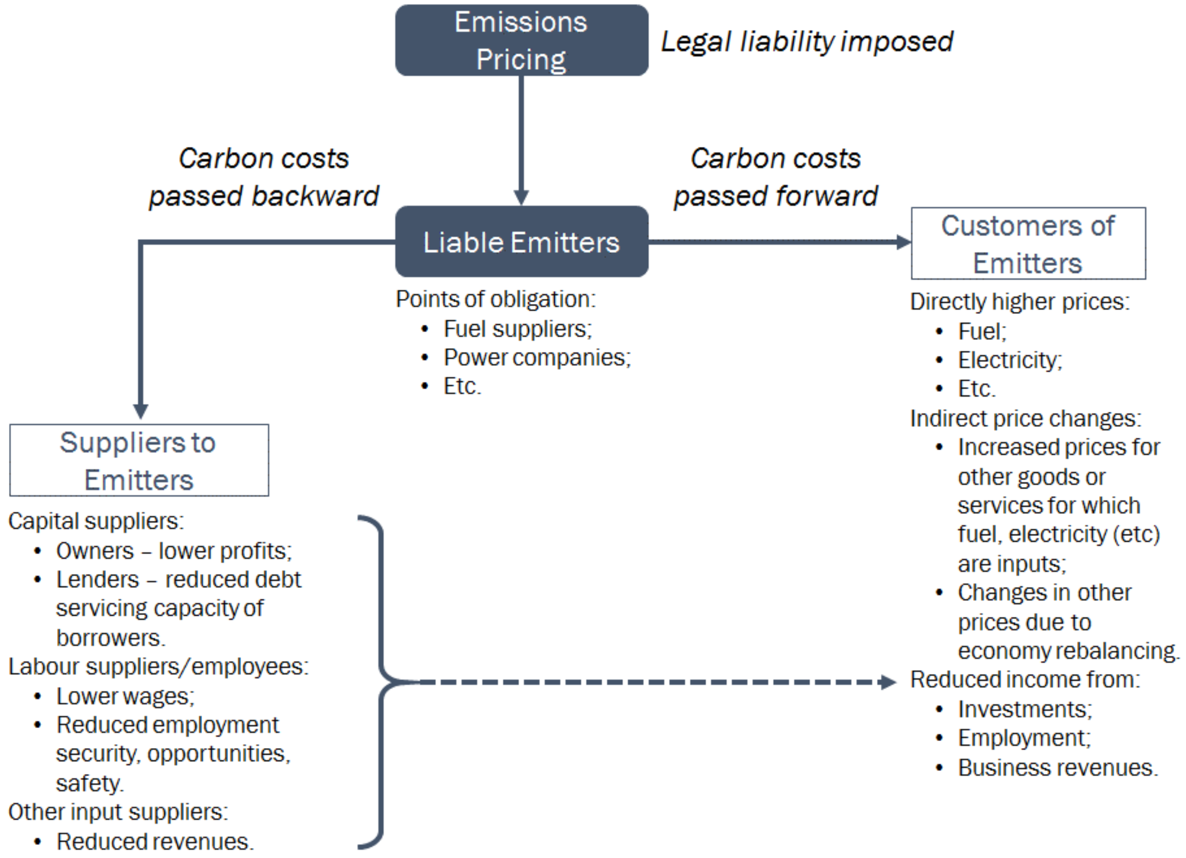
[11] For discussions of tax incidence, see Parry et al. (2005), Kerr (2001), and Sin et al. (2005).

[12] Weyl and Fabinger (2013) provide a general framework for assessing tax incidence in imperfectly competitive industries. Bushnell and Jacob Humber (2015) provide evidence of imperfect pass-through of environmental charges in the US fertiliser industry.

Figure 3.1 – Tracing Incidence from Liable Emitters to their Customers and Suppliers




1. It should be expected that not all of the emissions charge incidence will fall on just one of these parties;[13] and

2. The ability of Māori households to lower their incidence of emissions pricing depends on their ability to change their expenditures in response to price changes. The relatively more price-responsive they are, the less they bear the incidence of emissions charges relative to other household types, and relative to other parties that might also bear emissions charge incidence (i.e. the employees and suppliers of other inputs to liable emitters).

Figure 3.1 also indicates alternative pathways through which emissions pricing incidence might affect liable emitters' customers. Specifically, to the extent that emissions pricing incidence falls on emitters' employees, this could also affect customers' incomes (particularly if those customers are also employees). To the extent that customers are also capital providers of the emitters, their incomes might be reduced through lower investment returns. Finally, if customers are also involved in supplying inputs to liable emitters, they might face decreased income from those activities bear some of the liable emitters' emissions pricing liability. Thus customers of emitters will bear some of the emissions pricing incidence via prices, but might also via incomes.

[13] This is consistent with New Zealand's experience with the introduction of goods and services tax (GST). Statistics New Zealand (2010) reports that the GST rate was not fully reflected in price increases.

Either way, their overall purchasing power is affected, which in turn will affect their household expenditure bundles and hence cost of living.

### 3.1.2 Ability to Mitigate

Under the NZ ETS, households are not the point of obligation for GHG emission liabilities, and hence face no direct legal liability for emissions. Instead, they bear a price of emissions via their consumption of goods and services that have been produced using products or services embedding an emissions charge (e.g. freight costs from transport fuels in food). Alternatively, to the extent households release emissions directly (e.g. by consuming motor fuels in vehicles), they bear a cost for the emissions released vie the liability borne by fuel companies, which is passed through to some degree in fuel prices.

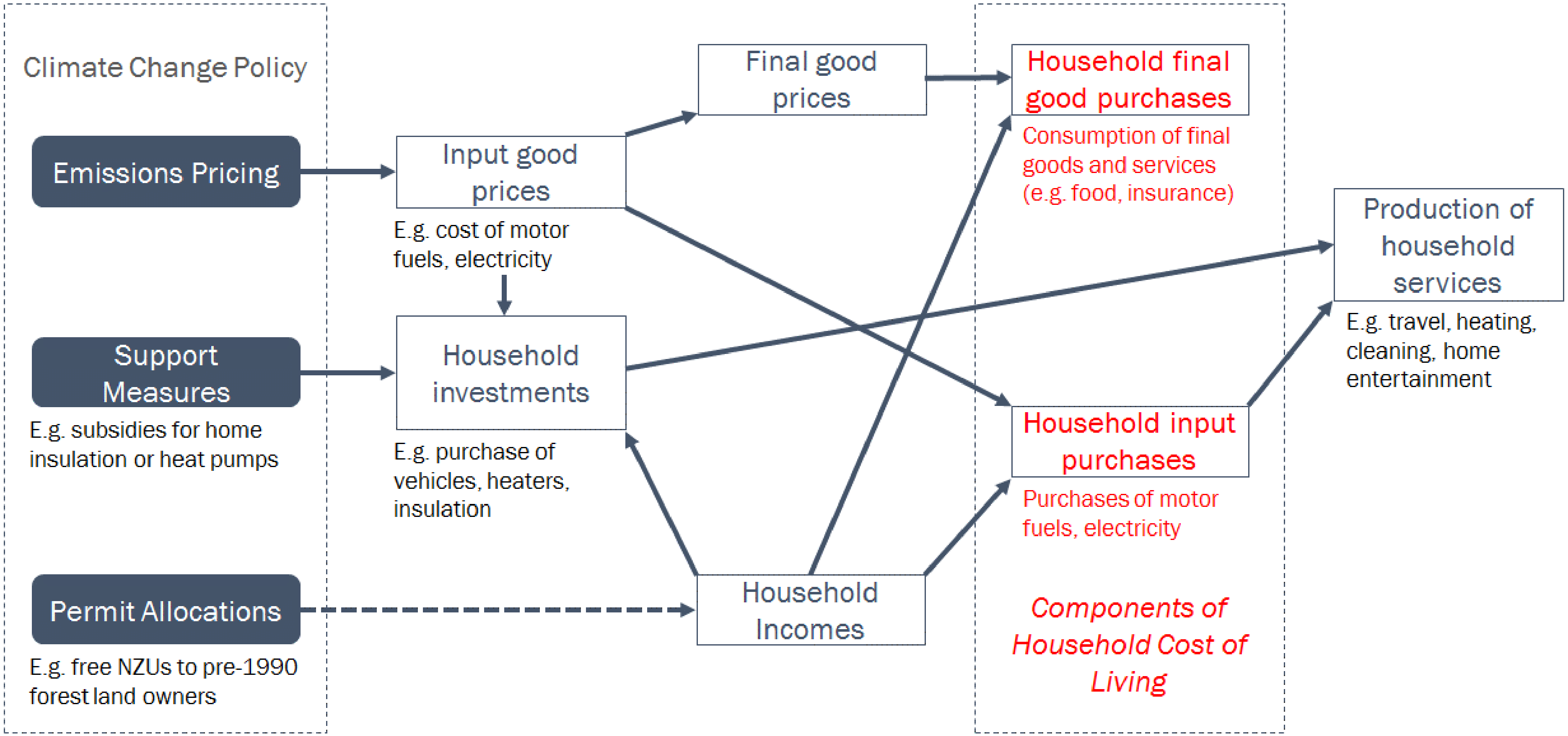
The ability of households to mitigate their emissions costs rests in some part by changing their consumption bundle to less emissions-intensive goods and services (e.g. food with less embedded emissions). In the main, however, it stems from their choices regarding the use of motor fuels and electricity. As discussed in Section 1, those choices reflect the combination of choices regarding desired levels of travel, heating, etc, and investments in the household assets producing those services (e.g. motor vehicles, heaters, other electrical appliances). It also depends on household investments affecting the efficiency of those investments – e.g. home insulation, affecting heating efficiency.

Therefore the main ability for households to mitigate their GHG emissions, and hence exposure to emissions pricing, stems from choices such as where to live (affecting heating requirements, as well as proximity to work and other destinations). It also stems from decisions regarding whether to own a vehicle and drive to work, or take public transport (at lower emissions per voyage). Choices over what heating and insulation technologies to use, and how much heating to produce, are also key. Finally, even dietary choices can have a material impact on household emissions, given the differing levels of GHG emissions embedded in different types of food (e.g. methane emissions embedded in meat, although these are not currently priced under the NZ ETS due to the scheme’s exemption of agriculture).

Figure 3.2 (overleaf) elaborates on how climate change policy affects different aspects of household expenditure, which in turn affects emissions pricing incidence and cost of living. As discussed, emissions pricing affects input costs such as the costs of motor fuels and electricity. These inputs affect the prices of certain final goods such as food. The prices of final goods, and households’ incomes, affects how much they spend on such final goods (and hence how much emissions price they bear, and their cost of living).

Fuel and electricity costs combine with household incomes to affect household investments in vehicles, electrical appliances (e.g. heaters), and home insulation. For example, as electricity prices rise, households might consider improving the efficiency of their heating system. These investments are also affected by climate change policy support measures, such as subsidies to eligible households to retrofit insulation or efficient heating. Prices of inputs like motor fuels and electricity combine with investments in vehicles and electrical appliances to then affect household choices over how much travel and heating (etc) services to produce.

Figure 3.2 – Decomposing Household Expenditures affecting Cost of Living



Free permit allocations under climate change policy may also be reflected in household incomes, if those households were eligible to receive an allocation (e.g. pre-1990 forest land owners). Hence they might affect final good consumption, household investments, and how many household services are produced.[14]

As indicated in the figure, household expenditure is constituted by the combination of:

1. Final good purchases – for household final consumption; and

2. Household purchases of inputs such as fuel and electricity – for the production of other services consumed by the household.

### 3.1.3 Ability to Manage Emissions Pricing Impact, and Adapt to Climate Change

A household's ability to adapt to emissions pricing is analogous to its ability to mitigate. While mitigation refers to reducing emissions, adaptation to emissions pricing refers to rearranging household affairs so as to reduce the impact of emissions pricing. In either case the key factors are:

1. Short-term – a household's ability to change consumption patterns so as to consume less emissions-intensive goods and services (e.g. taking a bus instead of driving);

2. Medium term – the ability to make conditioning investments (as defined in Section 1.4.2) such as more fuel-efficient vehicles, or replacing inefficient electrical appliances with efficient ones, each of which affect how cheaply households can produce services such as travel or heating (etc);

3. Long-term – the ability to make contextualising investments (as defined in Section 1.4.3) such as in house type, education and profession/business, which affect households' ability to make conditioning investments, and thereby affecting their short-term consumption choices.

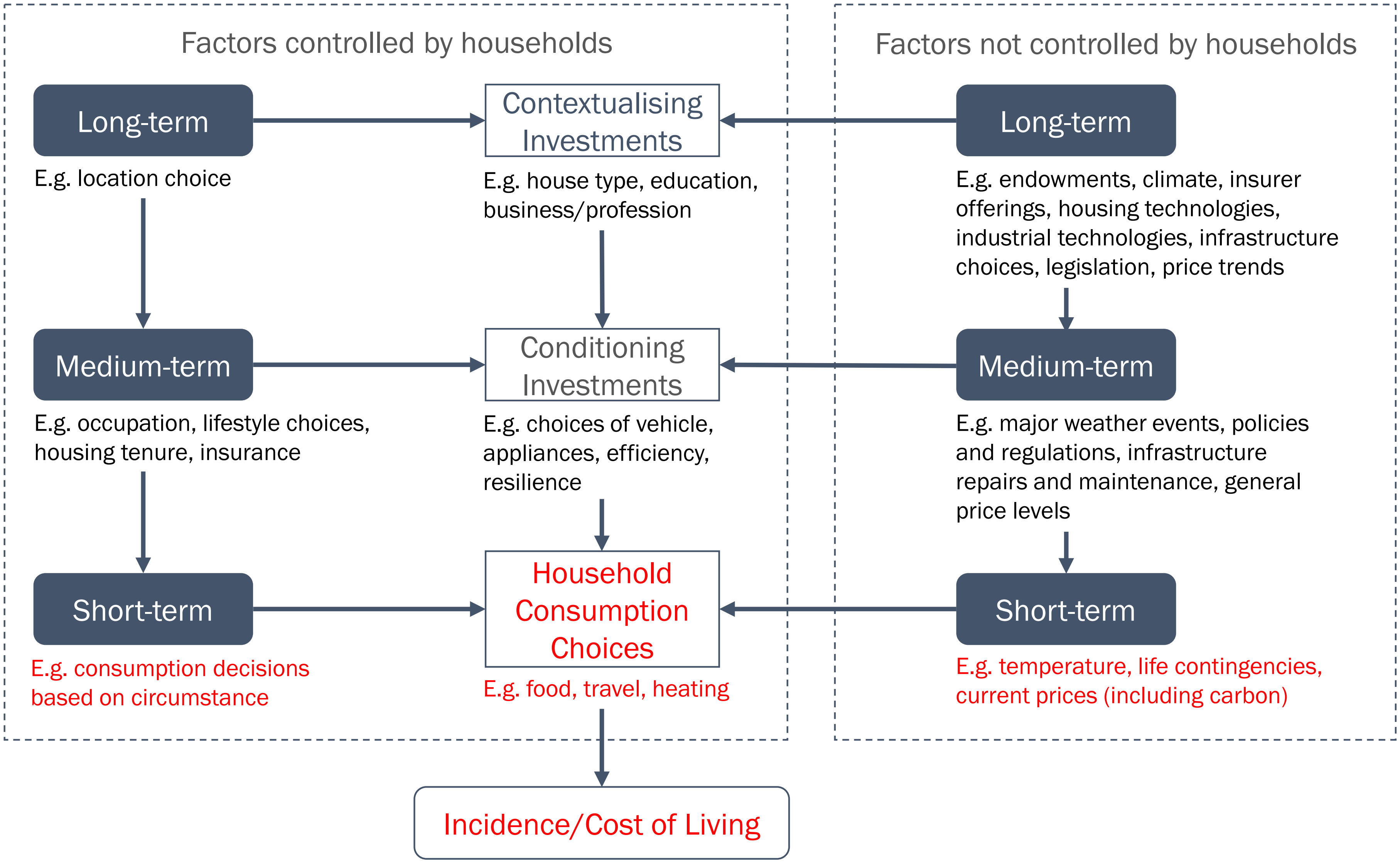
Both contextualising and conditioning investments can include investments in resilience, and otherwise help households to adapt to climate change. This can include investments in things like heat pumps, which provide cooling as well as efficient heating services. Such investments provide an ability to withstand climate change itself (e.g. rising average temperatures). It can also involve investments in technologies like self-generation through solar panels, providing backup in the event that more severe weather events (such as more frequent or intense storms) affect electricity distribution infrastructure. It might also include investments in water storage capacity, in case local water supply security is at risk from adverse weather events due to climate change.

## 3.2 Analytical Scheme

Figure 3.3 (overleaf) draws together the above discussion into a unified analytical scheme. In Sections 4 through 6 this scheme will be elaborated on in detail, and applied to explain emissions pricing incidence and cost of living implications in the short-, medium- and long-term respectively.

[14] The extent of this effect hinges on whether households that enjoyed allocations of free NZUs also incurred associated liabilities (i.e. for any deforestation of pre-1990 forest land). Since those liabilities exceeded the level of free allocations, in general any wealth effect from including pre-1990 forestry in the NZ ETS is likely to be negative.

Figure 3.3 – Analytical Scheme for Determining Climate Change Policy Incidence and Impact on Cost of Living



The figure distinguishes factors controlled by households from those not under household control. It further distinguishes those two sets of factors by whether they affect households' long-term contextualising investments, medium-term conditioning investments, and short-term consumption decisions. The multiplicity of arrows indicates that long-term factors and investments in turn affect medium-term factors and investments, which in turn affect short-term consumption choices.

As per the preceding discussion, emissions pricing incidence and cost of living impacts are superficially just a reflection of households' short-term consumption choices, given prevailing prices and short-term consumption drivers. However, behind such short-term considerations are complex sets of medium- and long-term drivers affecting households' need to consume final goods and inputs like fuels and electricity, and the efficiency at which they can produce household services. For example, is the household:

1. A small, educated, high-income household, with a modern insulated house and energy-efficient appliances, living in an inner suburb in a warm major city, with resilient infrastructure, and within easy walking distance or public transport ride from shops, schools and work; or

2. A large, low-income household, renting an old and poorly-insulated house, unable to and lacking the resources to install efficient appliances, and living in the suburbs of a cold rural town without public transport or resilient infrastructure, needing to drive to get to shops, schools and work?

To look beyond short-term incidence of emissions pricing, and its effects on cost of living, it is necessary to look at these wider factors, and their impacts on conditioning and contextualising investments.

# 4. Short-Term Incidence

## 4.1 Drivers of Short-Term Incidence

Building on the Analytical Scheme in Section 3.2, Table 4.1 summarises factors affecting short-term household consumption choices. Here we refer to consumption choices made over the space of days, weeks or months.

Table 4.1 – Factors affecting Short-Term Household Consumption Decisions

| Factors controlled by households | Factors not controlled by households |
|---|---|
| Consumption preferences. | Income. |
| Spending commitments – e.g. insurances, subscriptions. | Prices – emissions, final goods, household production inputs (motor fuels, electricity, etc). |
| Spur of the moment purchases. | Temperature and other weather – demand for heating/cooling, clothes drying, lighting, driving vs walking or using public transport. |
| Fixed consumption – e.g. refrigeration. | Incidentals and contingencies – travel to a family event, hosting visitors, etc. |

In the short-term many household expenditures will be committed, and household income, while possibly variable, will not be easily changed. Prices of final consumption goods (e.g. food), and of inputs required for the production of household services like travel and heating (e.g. motor fuel and electricity), will be given, and beyond household control. These prices include emissions pricing to the extent the relevant goods and services have embedded emissions that are priced.

While many consumption decisions will be fixed (e.g. spending on essentials or subscriptions), others will be discretionary. These include spur of the moment purchases, but to a greater extent will be driven by uncontrollable factors such as the weather (affecting heating/cooling requirements, use of clothes dryers, etc). Some consumption occurs without conscious choice – e.g. of electricity, for refrigeration.

## 4.2 Short-Term Ability to Mitigate or Adapt

In the short-term households have little ability to materially change their consumption plans. This means their demand for things like electricity and motor fuels, as well as for food, are relatively price-insensitive. While food purchases could be changed in the short-term (e.g. substituting cheaper foods for more expensive, depending on prices and income), transport mode choice and electricity usage are largely determined by longer-term choices such as location of home relative to work, vehicle investments, and appliance choices.

Hence households' ability to reduce emissions in the short-term, or to adapt to changes in emissions prices, are limited. This means emissions pricing incidence will be relatively high over this time horizon.[15]

## 4.3 Short-Term Incidence of Emissions Pricing

Allan and Kerr (2016), updating Allan et al. (2015), provide detailed evidence on the incidence of emissions pricing for New Zealand households, using data from the Household Expenditure Survey. They relate consumption to emissions, and explain variation in emissions across households. This requires them to calculate the emissions embodied in consumption bundles of a sample of households, using input-output tables to compute emissions embodied in final products.

Table 4.2 reproduces Allan and Kerr (2016)'s Table 1, comparing emissions intensities for a selection of household expenditure items.[16]

### Table 4.2 – Comparing Emissions Intensities for Selected Expenditure Categories

| | kg-$CO_2$e/$ 2006 | kg-$CO_2$e/$ 2012 | Percentage change between 2006 and 2012 |
|---|---|---|---|
| Milk, cheese, and eggs | 1.944 | 1.835 | -5.61% |
| Meat and poultry | 3.149 | 2.843 | -9.72% |
| Fruit | 0.348 | 0.346 | -0.57% |
| Petrol | 1.005 | 1.101 | 9.55% |
| Air travel | 0.509 | 0.229 | -55.01% |
| Electricity | 0.98 | 0.723 | -26.22% |
| Average | | | -2.67% |

Source: Allan and Kerr (2016).

Figure 4.1 reproduces Allan and Kerr (2016)'s Figure 2, showing how different expenditure categories vary with level of expenditure (which the authors take to proxy lifetime income).[17] Notable from the figure are:

1. Expenditure on utilities (e.g. electricity) is higher for lower incomes (i.e. expenditure);

2. Expenditure on travel – especially air travel, increases as incomes rise.[18]

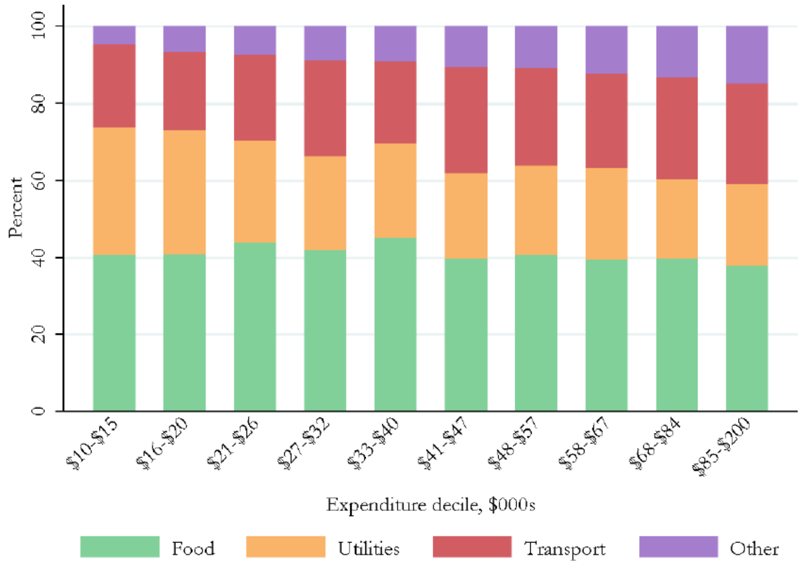
The authors find the following factors to explain variations across households in terms of emissions embedded in household expenditures:

1. Expenditure (i.e. income level) explains the vast majority of variation in emissions across households, although emissions rise less than proportionately with expenditure (similar to

[15] Reiss and White (2005) provide evidence for this in terms of electricity consumption patterns in California. See Section 5.3 for further discussion.
[16] Note that the change in petrol intensity was due to a change in the petrol emissions factor. See Allan and Kerr (2016) for further details.
[17] Parry et al. (2005) discuss limitations of using expenditure to proxy for lifetime earnings.
[18] See these authors' Figure 6 for further details.

overseas studies, the authors find that a 10% rise in household expenditure results in a 6.5% rise in emissions);

Figure 4.1 – Expenditure Components by Level of Household Expenditure




Source: Allan and Kerr (2016).

2. Emissions from household energy are unresponsive to expenditure changes,[19] but emissions from air travel are highly sensitive to expenditure increases – houses that spend more – i.e. are "wealthier" – might not spend more on energy than less wealthy households, but do spend more on air travel, with their emissions rising that way;

3. Wealthier households spend a larger fraction of income on less emissions-intensive items;

4. Household size is positively related with emissions;

5. Age of the household head also increases emissions (perhaps due to increased heating demand);

6. Householder education level is negatively related to emissions, driven by a less-emissions intensive diet, though partially offset by higher air travel; and

7. Homeowners are less emissions-intensive than renters, but due to lower transport emissions.

Finally, these authors find that the greatest contributor to declining household-level emissions between 2006 and 2012 was falling product emission intensities (particularly falling emissions from electricity production) rather than due to household behavioural changes. This is consistent

[19] Electricity Authority (2016) states that a typical household's electricity consumption comprises refrigeration (28%), water heating (26%), space heating (24%), electronics and other appliances (17%), and lighting and cooking (5%). This implies that at least half a household's electricity consumption – refrigeration and water heating – is essentially non-discretionary.

with the conclusion stated above that households have limited ability to affect their emissions pricing incidence by changing short-term consumption choices.[20]

Other New Zealand evidence relevant to determining the short-term incidence of emissions pricing includes:

1. Creedy and Sleeman (2006) – find that households with relatively low total expenditure spent a proportionately greater part of their income on emissions-intensive items such as motor fuel and electricity, but for most households the relative tax burden does not vary systematically with expenditure (implying that emissions pricing is regressive over some ranges, but progressive for others);[21]

2. Kerr (2001) – examines the incidence of a petrol tax using New Zealand data, finding that petrol expenditures comprise a larger share of total expenditures for lower income levels (indicating the tax is regressive); and

3. Kennedy and Wallis (2007) – estimate the sensitivity of petrol demand to price using New Zealand data, finding short-term petrol demand to be less sensitive than longer-term demand (consistent with the conclusion stated above that households have limited ability to affect their emissions pricing incidence by changing short-term consumption choices).

## 4.4 Implications for Māori

Based on the available New Zealand evidence (particularly Allan and Kerr (2016)), factors suggesting Māori household short-term consumption might be *less* emissions-intensive than for non-Māori households include:

1. Lower household incomes, implying lower household expenditures overall – the evidence presented by Allan and Kerr is that lower expenditure strongly suggests lower emissions;

2. Lower household incomes, implying lower air travel – Allan and Kerr find that electricity expenditures do not vary significantly with income, but air travel expenditures do, and this implies fuel-related energy emissions should fall with lower incomes; and

3. Lower age of household head – the Māori age distribution is strongly biased towards younger age ranges relative to non-Māori, with a notably smaller share of the elderly (Statistics New Zealand (2013a)). Combining lower average ages with evidence that lower-income households are more likely to have no heating at all (Concept Consulting (2017), Figure 36), it is likely that Māori households use less energy for heating than non-Māori.

Conversely, the following factors suggest Māori household short-term consumption might be *more* emissions-intensive than for non-Māori households:

1. Likely greater average household size – the relatively younger Māori age distribution, plus evidence of Māori suffering greater housing overcrowding than non-Māori (Statistics New Zealand (2013b, Figure 3)), weakly suggests Māori households are larger than for non-

[20] It is also consistent with US evidence cited by Allan and Kerr showing that most of household emissions savings comes from reductions in pollution per unit of output, rather than from behaviour changes.
[21] Three groups were identified in this research as having relatively high carbon tax burden – households with one child, single adults, and couples where the head of the household is aged over 65 and weekly household expenditure was relatively high.

Māori. While suggesting there are possibly economies of scale in some household expenditures (such as energy for heating), Allan and Kerr find larger household size to be significantly associated with higher total emissions;

2. Lower education – the evidence of Allan and Kerr suggests that the lower educational attainment of Māori households is likely to be associated with increased diet-related emissions, mitigated somewhat by lower air-travel related emissions.

3. Lower home ownership rate – Allan and Kerr suggest the lower relative home ownership rate of Māori should be associated with higher transport-related emissions. Furthermore, they find that living in social housing is also positively associated with total emissions (though negatively associated with emissions from air-travel).

Overall, the evidence of Allan and Kerr is that total household expenditure-related emissions, and transport fuels emissions, are increased for Māori households, all other things being equal (Table 4). Taken together this evidence suggests that Māori households are likely to face a greater emissions pricing incidence than non-Māori households, reflected in a higher cost of living impact from emissions pricing for Māori households than for comparable non-Māori households. This indicates that that emissions pricing is likely to be regressive for Māori in the short-term, taking as given their conditioning and contextualising investments (addressed further in Sections 5 and 6 respectively).

This conclusion must be tempered to the extent that:

1. Māori households receive social assistance, given the indexing of such assistance to movements in general price levels (which reflect the impacts of emissions pricing).[22] With the Māori unemployment rate being higher than for non-Māori, this suggests a greater proportion of Māori households receive such inflation-adjusted social payments; and

2. Higher food-related emissions for Māori households (see discussion above regarding lower education) are in the main not subject to emissions pricing, due to agriculture not currently being liable for emissions under the NZ ETS. Food-related emissions from embedded emissions from fuel and electricity are priced, but the larger part of food emissions are currently exempt.

Further detailed research would be required to determine the extent to which these latter considerations reduce or offset the likely short-term regressivity of emissions pricing for Māori households.

[22] See the explanatory note in the *Social Security (Rates of Benefits and Allowances) Order 2017*, available at www.legislation.govt.nz, for details of which social payments are automatically inflation-adjusted.

# 5. Medium-Term Incidence

## 5.1 Drivers of Medium-Term Incidence

In Section 4 we discussed factors affecting households' short-term consumption decisions, taking as given those households contextualising investments (to be discussed in Section 6) and conditioning investments. Those conditioning investments – i.e. investments in vehicles, electrical appliances, efficiency (e.g. home insulation) and resilience – are discussed here. Such investments are important for determining households' ability to maintain household service levels (i.e. travel, heating, etc) for a given level of expenditure (including emissions pricing costs). Alternatively, they enable households to lower the cost of producing household services, e.g. in response to increases in emissions pricing.

Building on the Analytical Scheme in Section 3.2, Table 5.1 summarises factors affecting household conditioning investments relevant in the medium-term. We treat such investments as being those with lives measured in years (vs up to months for short-term consumption choices, and decades for long-term contextualising investments).

Table 5.1 – Factors affecting Medium-Term Household Conditioning Investments

| Factors controlled by households | Factors not controlled by households |
|---|---|
| Income potential – e.g. occupation choice, work/life balance choice, lifestyle choices. | Climate change-related policies and regulations – e.g. support (information, financial) for retrofitting home insulation and heat pumps, improved home insulation requirements (for new builds, renovations, landlords). |
| Housing tenure (rent vs own) – ability to make and enjoy house-specific investments (e.g. heat pump installation). | Average price levels – emissions, vehicles, electrical appliances, home insulation, final goods, and household production inputs (motor fuels, electricity, etc). |
| Proximity of house to work, schools, shops and family. | Climate, severe weather episodes – demand for (resilient) heating/cooling, clothes drying, lighting, driving vs walking or using public transport. |
| | Repair, maintenance and reinforcement of infrastructure by local and central government (e.g. roading, water supply), and utility owners (e.g. electricity distribution networks). |
| | Choices by businesses affecting employment opportunities. |
| | Choices by government affecting income support. |

In the medium-term, households face price signals in the form of average/sustained price levels for emissions, as well as final goods and services. These price signals also include the average/ sustained prices of inputs (i.e. motor fuel, electricity) required for the production of household services such as travel and heating/refrigeration. Importantly, they also include price signals in the shape of the costs of buying (and installing) conditioning investments such as motor vehicles, heating/cooling/refrigeration and other electrical appliances, and home insulation (affecting the efficiency of home heating/cooling).

These price level signals combine with medium-term choices (by households, businesses and government) affecting income levels, and household choices such as where to live relative to work, schools, shops and family, and choices over housing tenure (renting vs owning). They also combine with policies and regulation requiring, or providing assistance for, conditioning investments (e.g. insulation standards for landlords and in building requirements, subsidies, etc). Finally, they combine with climate drivers affecting household requirements for heating/cooling.

Together, these factors affect both household demand for conditioning investments, and their capacity to make them. In turn this affects households' short-term consumption choices – particularly of emissions-intensive items such as motor fuels and electricity – and hence the incidence of emissions pricing and its impact on cost of living.

Additionally, in the medium-term the occurrence of severe weather events raises the importance of resilience in the production of household services such as travel and heating. To a large extent this resilience depends on decisions about infrastructure repair, maintenance and reinforcement taken by central and local government, as well as utility businesses. In main urban centres, with relatively dense infrastructure networks enjoying large scale economies in operation, repairs and maintenance, and reinforcement, resilience is commonly not a concern at the household level.

In smaller and more remote communities, however, households often need – and make – additional conditioning investments to provide backup when alternative sources of services are unreliable or non-existent. For example, rural households might invest in backup generators or solar panels, or alternative heating and cooking sources (e.g. wood/gas), to provide resilience against power cuts caused by storms. In the medium-term, household decisions over such investments can be influenced by the frequency and severity of severe weather events.

Hence climate itself, and weather events possibly reflecting climate change, will also play a role in household choices regarding conditioning investments. In drier parts of the country – particularly if they face increased drought risk, investments in water storage might become an important new area for conditioning investments affecting household resilience.

## 5.2 Medium-Term Ability to Mitigate or Adapt

Internationally, evidence exists of a so-called "energy paradox", in which consumers and firms are slow to make energy efficiency investments despite apparently high returns (in the form of energy savings).[23] This can be explained in terms of:

1. Households being unaware of potential savings;

2. Households undervaluing the benefits of greater efficiencies;[24]

[23] For example, see Allcott and Wozny (2011).
[24] Allcott and Wozny (2011) find US car buyers undervalue efficiency benefits, and hence they inefficiently purchase new vehicles with low fuel economy.

3. Households being risk-averse, and reluctant to invest in new technologies because their benefits are uncertain;[25]

4. Credit constraints – poorer or already-indebted households' inability to fund efficiency-enhancing investments;

5. Households renting rather than owning their home – hence potentially undervaluing landlord investments in insulation (etc) where the benefits are hard to verify (meaning landlords cannot then recover their efficiency investments);[26] and

6. Potential efficiency gains being less than predicted due to "rebound effects" or "backfire effects" – i.e. efficiency gains lower the unit cost of producing household services such as travel or heating, and increase household purchasing power, both of which can result in increased consumption of inputs like motor fuel or electricity (as well as higher production of household services).[27]

The latter point is important. Medium-term energy-efficiency investments can increase price-responsiveness, suggesting they decrease the incidence of emissions pricing for the party making the investment. However, they can also cause an increase in energy demand at all prices due to rebound/backfire effects. The combined effect is that energy efficiency investments might reduce overall emissions incidence, but if rebound/backfire effects are sufficiently large, then such investments can result in higher emissions pricing incidence overall.

Grimes et al. (2011) provide New Zealand evidence of rebound/backfire effects. They examine impacts on household electricity and reticulated gas use of retrofitting houses with insulation or clean heat sources under the New Zealand Insulation Fund's "Warm Up New Zealand: Heat Smart" programme. They found that:

1. While houses in areas with average temperatures below 16 degrees Celsius saved on electricity use from retrofitted insulation, those with higher average temperatures used *more* electricity (with an average saving of just under 1%);

2. Houses that installed heat pumps *increased* their electricity use by almost 2% on average, though this was for houses in areas with average temperatures of less than 8

[25] This is explored by Farsi (2010). To this could be added that many energy-enhancing investments are a least partially irreversible, meaning households have an incentive to "wait and see" if the benefits of such investments prove to be as much as predicted. This incentive is only accentuated further when the costs of new technologies are rapidly falling, and quality levels rapidly rising.
[26] Allcott et al. (2015), Gillingham et al. (2012). Using data for Pacific Island families in New Zealand, Gibson et al. (2017) find evidence that households are willing to pay enough to cover landlords' costs of efficiency-enhancing investments such as heat recovery ventilation and dehumidifiers (which improve the efficacy of heating to relieve respiratory disease). However, those households did not sufficiently value heat pumps or enclosed wood burners to recover landlords' investment outlays.
[27] International evidence is provided in Revelt and Train (1998), Davis et al. (2012), and Davis (2008). Rapson (2012) and Brännlund et al. (2007) report energy efficiency investments not resulting in increased energy consumption. Davis et al. (2012) find evidence that genuine efficiency savings can be made for services such as refrigeration, since household refrigeration usage is less likely to change with the installation of more efficient refrigeration. Air conditioning, by contrast, involves user discretion (e.g. thermostat setting), which is affected by the unit cost reductions caused by improved efficiency, giving rise to increased consumption and "rebound/backfire". Brännlund et al. (2007) show that rebound/backfire effects also arise due to the impact of efficiency savings in one consumption area on consumption patterns more generally.

degrees, with electricity savings enjoyed by households in areas with temperatures between 9 and 13 degrees;

3. Income was not found to have strongly affected electricity use from retrofitting insulation or heat pumps; and
4. Energy savings were realised by homes with reticulated gas that installed heat pumps.[28]

Allcott et al. (2015) observe that subsidies for things like energy efficiency investments are preferentially adopted by consumers who are less in need of them (i.e. wealthy environmentalist homeowners). Hence the efficiency of support measures to make such investments is improved by being "tagged" to low-income households, rental properties, or consumers who have not yet participated in efficiency programmes (i.e. who are likely to be less-informed about potential savings).

The considerations set out above indicate that the drivers of medium-term incidence of emissions pricing – mediated via its impacts on conditioning investments – will be highly context-dependent (and hence affected by contextualising investments, discussed in Section 6). In the following section we further explore the drivers of emissions pricing incidence for motor vehicles and fuel expenditure, and for electrical appliances and electricity expenditure. This is because of the importance of motor fuels and electricity expenditures for household emissions, as discussed in Section 4.3.

As mentioned in Section 1, research remains to quantify emissions pricing incidence beyond just that based on household expenditure levels. Hence, for example, a low income household with inefficient space heating might consume a similar amount of energy as a wealthier household with efficient heating, but the emissions pricing incidence per unit of heating services consumed will be much higher for the former simply because it enjoys much lower heating services. Likewise, two household types might bear the same apparent emissions pricing incidence due to having similar expenditures on motor fuels. However, if one of those households can afford to invest in more fuel-efficient vehicles, then their incidence per unit of transport services provided (e.g. passenger-kilometre travelled) will be lower. Hence, while household-level expenditures shed light on the relative emissions pricing incidence of different household types, it will become clear from the discussion in this section that more refined metrics of incidence are warranted.

## 5.3 Medium-Term Incidence of Emissions Pricing

### 5.3.1 Transport

West (2004) examines US motor fuel consumption patterns, taking into account vehicle purchase decisions. She discusses how pollution-control policies have unclear impacts on poorer households due to uncertainties about their responsiveness to fuel prices:

1. Poorer households might be more price-responsive due to having smaller budgets to spend on fuel, and might be more inclined to take public transport. Alternatively, if they have fewer transport options, poorer households might be less price-responsive than

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[28] We note that research remains to be done on the extent to which Māori households have participated in programmes supporting the installation of insulation and efficient home heating, recognising the higher renting rate of Māori households, and hence reliance on landlords (whether government, council or private) participating in or providing such programmes.

wealthier households. Hence it is unclear which households spend more of their income on motor fuels in response to an emissions charge.

2. Likewise, wealthier households might buy newer cars than poorer households, but it is not clear whether they buy larger or smaller ones. Hence it is unclear whether wealthier households might increase or reduce their exposure to emissions pricing when buying new vehicles.

Examining data on US car purchase decisions and resulting fuel demands, West found:

1. Greater responsiveness to motor fuel price increases among poorer households, reducing the regressivity of emissions pricing; and
2. Subsidies to new vehicles were significantly more regressive than emissions pricing.[29]

With regards the former, Allan and Kerr (2016) provide evidence that fuel expenditures form a relatively greater share of household budgets for lower-income households, while Kerr (2001) and Creedy and Sleeman (2006) find evidence of fuel taxes in New Zealand being regressive. Also, there is a gap in New Zealand research examining differences in fuel price responsiveness across households and regions. Hence it remains possible that emissions pricing in motor fuels is regressive for certain households – e.g. those with greater travel needs and/or fewer public transport options, possibly divided along urban, suburban and rural lines. West (2004)'s evidence of greater fuel price responsiveness among poorer US households must therefore be interpreted with these cautions in mind.

With regards West's latter finding, New Zealand's policy (see Section 1.3) to subsidise purchases of electric vehicles is also likely to favour wealthier households, which are more likely to purchase new cars. This is particularly so since "range anxiety" about the distance electric cars can travel between charges makes them more suitable as households' second car, which option is less available to poorer households (some of which have no access to a car, let alone a second one). Moreover, renting households may struggle for reasons of lack of income or authority to install required vehicle charging infrastructure, placing them at further disadvantage. However, mitigating this effect is the likelihood that electric vehicle users effectively cross-subsidise other electricity consumers if they charge overnight at anytime electricity prices.[30]

### 5.3.2 Electricity

Reiss and White (2005) undertake a similar study to West (2004), but this time for US (specifically, California) household electrical appliance choices and resulting electricity demand. They model the impacts of longer-term household choices over appliance ownership and dwelling characteristics to examine distributional impact of changes in electricity tariffs.

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[29] Studies from France and Finland also find policies to encourage new car buyers to purchase more efficient vehicles are regressive, either disproportionately favouring wealthier buyers, or imposing disproportionate costs on poorer households (Durrmeyer (2015) and Stitzing (2016)). Bento et al. (2008) find that the relative incidence of US petrol taxes depends on how those taxes are recycled to different demographic groups. This is a common theme for carbon taxes, or regimes based on auctioned carbon permits, both of which raise revenue for the government that can be redistributed. The possible use of revenue recycling to dampen distributional impacts of emissions pricing does not arise in systems like the NZ ETS, which is based on permits that are not auctioned (e.g. gifted instead) to emitters. See Parry et al. (2005) for further discussion.

[30] See Concept Consulting (2017), e.g. Figure 4 and associated discussion.

Like Allan and Kerr (2016), they find little relationship between rises in income and increases in electricity consumption. As Reiss and White put it (p. 868), "to the extent that income affects electricity consumption, it is evidently manifest through households' choice of appliances rather than through utilization behaviour." However, they find that households' uses of different appliances – given their conditioning investments in those appliances – reveal different levels of electricity price-responsiveness. Use of appliances like space heating and air conditioning are especially price-responsive. Also, households differ markedly in terms of their overall responsiveness to electricity prices, with 44% of households having no responsiveness at all (effectively they operated just a refrigerator, with little other discretionary electricity use).

Consistent with the analysis in Section 4.2, most California households in Reiss and White's study alter their consumption very little in response to a price change, given their appliance choices. Roughly 1 in 8 are responsive, meaning much of the welfare impact from a price increase is borne by a small proportion of households. However, as for the evidence for fuel price responsiveness in West (2004), lower income households are found to be the most responsive to electricity prices. Indeed, households substitute less price-responsive electricity uses as income rises.[31]

An important innovation in electricity sectors worldwide is the growing use of small-scale solar photovoltaic panels (PV) to produce electricity. This has often been accompanied by the purchase of electric vehicles,[32] and/or batteries to store generated electricity for later use. Concept Consulting (2017) assess the social implications of this innovation using data on New Zealand household electricity consumption and demographics. They show that current electricity pricing structures are ill-suited to ensuring that electricity users that impose costs on the electricity system, or relieve electricity costs, face appropriate price signals. Consequences of this include:

1. Poorer households are likely to face increasing power bills as more wealthy households install PV technologies and reduce their payment of energy-related network charges (shifting the burden of those charges onto customers who do not, or cannot, install PV systems); and

2. The existing electricity tariff structures potentially induce wealthier households to invest in PV systems sooner than they might with a more cost-reflective tariff structure.

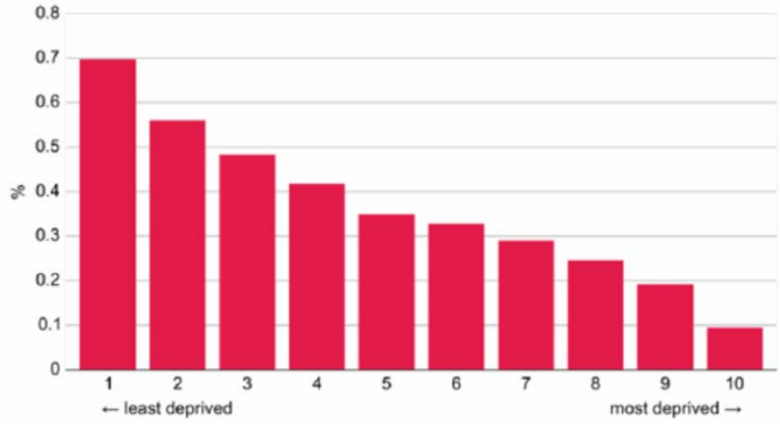
Indeed, Figure 5.1 reproduces Concept Consulting's Figure 12, showing the likelihood of installing PV systems according to social deprivation status (based on Electricity Authority analysis). The very clear lower likelihood of poorer households installing PV systems can be attributed to two well-known factors:

1. Poorer households are less able to afford the upfront cost of such systems; and

2. Many poorer households rent their home,[33] meaning they are unable to install long-term PV systems, or their insecurity of tenure means they are not assured of securing a return on any installation even if they could.

[31] In the New Zealand context this would be consistent with higher-income households being more likely to install and use heat pumps in lieu of (e.g.) using cheaper but less efficient electric fan or oil column heaters.
[32] Delmas et al. (2017).
[33] Concept Consulting (2017) Figure 13 clearly shows the correlation between renting and social deprivation in the case of Wellington.

Figure 5.1 – Uptake of Solar Panels by Social Deprivation Score




Source: Concept Consulting (2017).

An additional consequence of poorer households being unable to invest in technologies like PV systems is that they are less able to self-provide resilience in areas where local electricity infrastructure might become more unreliable due to climate change effects. Wealthier households will enjoy improved resilience by investing in their own electricity supplies. In turn this shifts a greater share of variable network costs onto the remaining, poorer households. If those households are unable to bear those increased costs, local electricity infrastructure providers may reduce their maintenance and/or reliability levels to reduce costs. This would serve to further increase the incentives for wealthier households to make PV system investments, while reducing supply reliability for poorer households.

Davis (2010) discusses a more general tenure-related problem, namely that landlords face private incentives to buy lower-cost and less-efficient appliances for rental properties. This is because they cannot fully recover the higher costs of more efficient appliances (e.g. due to renters being unaware of, or undervaluing, those benefits). Additionally, they face the risk that tenants will not take care of appliances, so installing cheaper ones reduces their exposure to this risk. A consequence of such private incentives is that extra emissions costs are borne by renters who might, if they could, have opted for more efficient appliances.[34]

## 5.4 Implications for Māori

As discussed in Section 3.1.1, the ability of Māori households to lower their incidence of emissions pricing depends on their ability to change their expenditures in response to price changes. The relatively more price-responsive they are, the less they bear the incidence of emissions charges relative to other household types, and relative to other parties that might also bear emissions charge incidence (i.e. the employees and suppliers of other inputs to liable emitters).

Section 4.3 showed that motor fuel and electricity expenditure are significant and direct ways in which Māori households face emissions charges. The discussion in this section shows that the ability of Māori households to respond to changes in the prices of motor fuels and electricity is conditioned by their investments in motor vehicles and electrical appliances:

[34] As mentioned earlier, Gibson et al. (2017) find evidence that Pacific Island households do not sufficiently value heat pumps or enclosed wood burners to recover landlords' investment outlays.

1. If Māori households purchase fuel-efficient vehicles, this means they can travel further for a given expenditure on motor fuels. Alternatively, it means they do not face as severe a decline in their ability to travel in the face of an increased emissions charge, than if they had a less fuel-efficient vehicle; and
2. Likewise, if they invest in more energy-efficient appliances (perhaps coupled with investments in home insulation), they are better able to produce household services such as heating, or maintain those services in the face of increased emissions charges.

Making such medium-term investments should enhance the price-responsiveness of Māori households relative the short-term. However, the evidence referred to above shows that household expenditures on fuel and electricity might fall only little, or even increase, in response to such investments. This is because of "rebound" or "backfire" effects, in which households with more efficient technologies for travel and heating (etc) often produce more of those household services due to being able to produce them at lower unit cost, and due to resulting increases in overall purchasing power. The affected household potentially bears an even greater exposure to emissions pricing as a consequence of those investments, but the cost of emissions per unit of household service provided (i.e. travel, heating, etc) is reduced, and overall household welfare can be improved (through more travel, heating, etc).

In the case of Māori households, however, there are reasons to predict these effects are less likely to arise, since those households, irrespective of whether or not they are aware of efficiency options:

1. Are relatively low-income, and hence face constraints in being able to afford conditioning technologies (e.g. are less likely to buy a new car, let alone take advantage of subsidies to buy an electric vehicle); and
2. Are much more likely to be renting, so are unable to invest in many house-specific efficiency measures (e.g. heat pumps, insulation), and are disadvantaged by landlords' private incentives to install low-cost and energy-inefficient appliances.

This means Māori households are more likely than non-Māori households to persist with using inefficient vehicles and electrical appliances, even in the medium-term. In the case of motor fuels, Māori households are likely to be relatively price-*insensitive*, and hence even in the medium term, bear a disproportionate share of emissions pricing. This is because travel demands for work activities in particular are non-discretionary, particularly in areas not well served by public transport.

In the case of electricity, Māori households are also likely to be relatively price-*insensitive*, even in the medium term. This is not because they must persist with maintaining a certain level of household services even with increased emissions pricing (e.g. as they do for work-related travel). Instead it is because they are less likely, even absent emissions pricing, to make large discretionary expenditures on the production of household services like heating. For example, Concept Consulting (2017, Figure 36) present evidence that poorer households are:

1. Far less likely than wealthier households to have either electric or (reticulated) gas heating; and
2. Far more likely to have no heating at all.

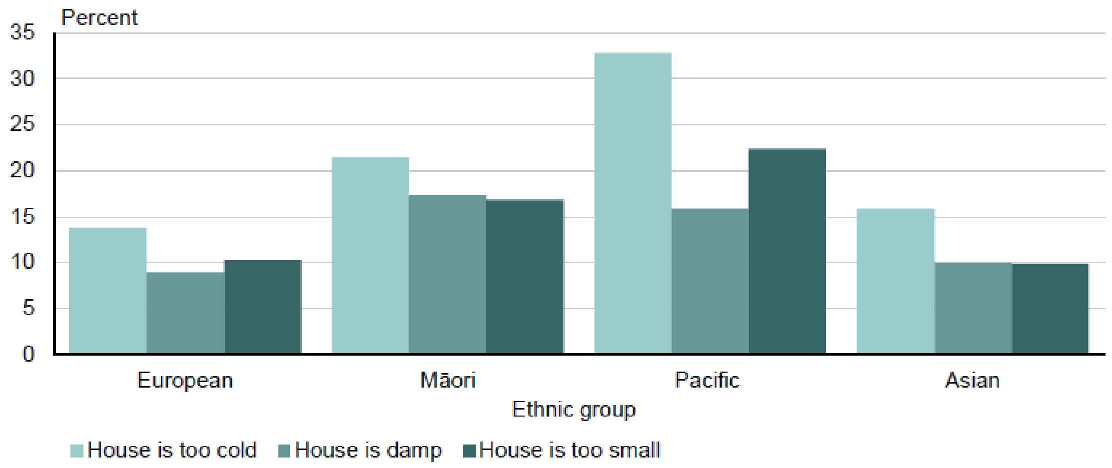
In the case of both motor fuels and electricity there is currently a research gap regarding the price-sensitivity or price-insensitivity of Māori households relative to non-Māori. So these inprinciple conclusions, suggesting that Māori households in particular might bear a disproportionate share of emissions pricing incidence – at least relative to consumers producing comparable levels of household services (i.e. not allowing for rebound/backfire effects for wealthier households) – must be treated as tentative.

However, existing evidence for New Zealand on the incidence of emissions charges (e.g. Allan and Kerr (2016), Creedy and Sleeman (2006), and Kerr (2001)) lends weight to the conclusion that poorer households in general will face disproportionate burden. This raises the importance of ensuring that any support to assist households in making energy efficiency investments is properly targeted, in particular to low-income households, rental properties, and less-informed consumers.[35] This avoids assistance being taken up by more wealthy and informed households, who need such assistance the least, which uptake only serves to worsen the relative incidence of emissions pricing on poorer households.

As a footnote to this discussion, Statistics New Zealand (2013b) provides evidence that Māori households are relatively more likely to report their accommodation as being too cold or damp, as in Figure 5.2.[36] Gibson et al. (2017) observe the connection between poor housing conditions and higher disease burden in New Zealand, such as respiratory diseases. Likewise, Tomkins et al. (2012) estimate that the primary drivers in New Zealand of selected infectious diseases are humidity, average temperature, and (in some cases) rainfall. Secondary factors include age, location, ethnicity, gender and/or social deprivation status.[37]

Hence, in addition to the emissions pricing incidence conclusions drawn above, mention should be made of how emissions pricing might contribute to increased disease burden in Māori households, and cost of living. With Māori households being more likely to live in rented accommodation, and less likely to make discretionary expenditures on electricity for heating (and relatively less able to afford efficient heating investments), they are relatively more likely to carry disease burden from cold and damp accommodation.

Figure 5.2 – Self-Reported Housing Problems by Ethnic Group




Source: Statistics New Zealand (2013b).

[35] Allcott et al. (2015).

[36] The document cites BRANZ research indicating that rental properties in general are of poorer quality than owner-occupied homes.

[37] It should be noted that MFE (2013) suggests climate change could reduce overall disease burden, for example by increasing average temperatures.

To the extent that Māori households are relatively price-insensitive regarding expenditures on motor fuels and electricity, increases in emissions pricing are likely to increase Māori households' (relatively non-discretionary) expenditures on these items. This leaves less income available for discretionary items such as medical bills, while potentially requiring greater such expenditures, relative to non-Māori households, due to higher relative disease burden. This higher burden and associated costs – as well as lost education and work opportunities due to poor health – can be considered consequential sources of emissions pricing incidence that are disproportionately borne by Māori households.

# 6. Long-Term Incidence

## 6.1 Drivers of Long-Term Incidence

Building on the Analytical Scheme in Section 3.2, Table 6.1 summarises factors affecting household contextualising investments relevant in the long-term. We treat such investments as being those with lives measured in decades (vs up to months for short-term consumption choices, and years for medium-term conditioning investments). Conditioning investments such as vehicle and heater choices directly affect short-term consumption choices by affecting the efficiency at which inputs like motor fuels and electricity produce household services like travel and heating. By contrast, contextualising investments are those made over much longer time-frames which set the context for conditioning investments. They also affect the long-term ability of households, and need, to make those investments, as well as their preferences for those investments.

Table 6.1 – Factors affecting Long-Term Household Contextualising Investments

| Factors controlled by households | Factors not controlled by households |
|---|---|
| Location choice – affecting access to educational and work/business opportunities, access to public transport, exposure to climate change, access to natural resources (e.g. water), local community resilience (including rate base). | Institutional endowments – e.g. cultural norms (stewardship, commitment to place, etc), land tenure and governance, statutory frameworks for responding to climate change issues and long-term land use planning. |
| Housing technology choice. | Resource endowments – e.g. climate, land and other natural resources, financial, human and social capital, comparative advantage. |
| | Long-term price levels/trends – emissions, vehicles, electrical appliances, home insulation, final goods, household production inputs (motor fuels, electricity, etc). |
| | Long-term climate change and climate variability. |
| | Choice of level and resilience of infrastructure by local and central government (e.g. roading, water supply, public transport), and utility owners (e.g. electricity distribution networks). |
| | Choices by businesses regarding emissions-intensity of production technologies, and by insurers regarding whether and how much coverage to offer households and local governments. |

In the long-term, the principal choices a household has to make is where to locate, and what sort of house technology to use (whether renting or owning). Location choice sets that household's access to resources (e.g. land) and opportunities for contextualising investments (e.g. in education and profession) that importantly determine long-term income-earning potential. Meanwhile, housing technology choice (e.g. old, uninsulated homes, versus modern, insulated homes with energy-efficient technologies) affects long-term exposure to climate change. Together these set the platform for the need for, and ability to make, conditioning investments such as vehicle and appliance choices that affect ultimate consumption patterns.

In the long-term a number of other factors, beyond direct household control, affect households' contextualising investments. The type and level of infrastructure investments made by central/local government and utility firms provide strong signals for households' locational and housing technology choices. In wealthy urban centres households can have greater surety of long-term supply continuity and resilience, including in the face of climate change challenges. In smaller or rural centres, climate change challenges to infrastructure could cause reductions in long-term service levels. Likewise, climate challenges to private properties (e.g. property damage from coastal erosion or storm surges) could affect the long-term prospects for insurance coverage at an affordable price.[38] Both risks to infrastructure service levels and insurance availability could cause businesses to consider their long-term location choices, aside from any existing locational comparative advantage.

Other long-term factors beyond household control are the statutory frameworks for climate change response and long-term land use and management. Other institutional endowments of relevance are cultural norms – in the case of Māori, including the traditional commitment to place, intergenerational focus, and principles of stewardship and collective governance.

Below we discuss how these factors combine to affect different parties ability to respond to climate change itself, as well as to modify their exposure to emissions pricing (and hence the impact of emissions pricing on cost of living).

## 6.2 Long-Term Ability to Mitigate or Adapt

Hennessey and Fitzharris (2007) discuss the impacts of climate change on Māori, as well as the ability of Māori to adapt to climate change. They observe that the majority of Māori live in urban environments, but also occupy remote and rural areas where the local economy and social/cultural systems rely on the natural environment (e.g. traditional resource use, tourism). Moreover, infrastructure and services in remote and rural areas are vulnerable to extreme weather events.[39]

These authors observe that the capacity of Māori to respond to climate threats varies greatly. Relevant factors include access to funds, information and human capital. Northland and the East Coast are highlighted as areas where there are both large Māori populations, and increased risks of extreme weather. They also observe that traditional land ownership and governance models involve complex decision-making processes, affecting the ability of Māori to adapt to climate change. Finally, Māori retain traditional commitment to particular locales and associated natural resources, making it more costly for them to relocate in response to climate challenges.[40]

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[38] See Storey et al. (2017) for a discussion of how climate change issues may affect insurance.
[39] Likewise, King et al. (2012) observe that Māori coastal communities and associated infrastructure are highly vulnerable to sea level rise and extreme events like storms and high waves. They also observe that these communities already face challenges in terms of erosion, floods, and catchment runoff.
[40] Mendelsohn et al. (2006) observe that the greatest driver of vulnerability to climate change – including at the national level – is location. Countries (or regions) already above their optimal temperature will only become worse. However, countries or regions currently below their optimum temperature stand to gain

## 6.3 Long-Term Incidence of Emissions Pricing

In terms of emissions pricing incidence, location is indeed an important driver of “household carbon footprint”. Baiocchi et al. (2015) examine the emissions of different types of human settlements in England. They find that there are unique, place-specific combinations of emissions drivers, although population density (settlements accounting for a small overall area, but having a disproportionate share of population), and income, are dominant local drivers. The geographical distribution of lifestyles also explains emissions – e.g. high-income households with large houses in outer suburbs have highest average household emissions, while high-density, low-income settlements have lowest average household emissions.

Evidence form the US sheds additional light on how location and density affect emissions and emissions pricing incidence. Gudipudi et al. (2016) find that a doubling of population density reduces total $CO_2$ emissions from the buildings and on-road sectors by at least 42% (with density affecting on-road emissions more than buildings emissions). Jones and Kammen (2014) cite conclusions from other studies suggesting that population-dense municipalities have a beneficial impact on emissions due to employment, housing and services being located more closely (reducing travel distances, and enabling public transport). They also have less space for larger homes, which tend to have higher emissions (e.g. for heating).

Using precise spatial data to examine US households’ emissions footprint, Jones and Kammen find that household emissions exhibit distinct rings of emissions surrounding urban cores. In particular, suburbs located 15-45 miles from urban centres displayed noticeably higher household emissions. They attribute this to higher transport-related emissions, noting that suburbs of a given urban centre face the same weather, energy prices and emissions-intensity of electricity production, but still exhibit noticeably higher energy-related emissions.

## 6.4 Implications for Māori

Long-term location choices by Māori households are likely to be key drivers of their ability to adapt to climate change, and to make the contextualising and conditioning investments that affect their ultimate consumption patterns and hence emissions pricing incidence (and cost of living). This is clear for Māori living in remote and rural areas, where the need for conditioning investments to reduce exposure to climate change vulnerability are likely to be more pronounced. These include investments in backup supplies of electricity and water, particularly if local infrastructure is at risk from climate change, and if local rate bases or customer bases needed to support the development and maintenance of those infrastructures are low.

Either Māori households in these regions face increasing rates burdens or utility prices to sustain local shared infrastructures, or they face higher costs through self-provision. Climate change itself will contribute to an increased cost of living in the long-term, even if emissions pricing is not. This is likely to fall most heavily on regions such as Northland and the East Coast of the North Island, where there are both large Māori populations and elevated risks (e.g. drought, coastal erosion) from climate change.

Conversely, urban Māori – constituting the larger part of the Māori population – potentially face a relatively high emissions pricing burden due to their locational choices within urban environments. The issue here is not the increased cost of maintaining infrastructure in the face of climate risks. Rather it is the likelihood that lower-income Māori households are more likely to

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from temperature rise. Evidence that New Zealand agriculture will likely gain from climate change was discussed in Section 2.1.

locate relatively far away from urban centres, and face greater travel-related emissions than non-Māori households (as found by Allan and Kerr (2016), discussed in Section 4.3, and consistent with the US evidence discussed above). While such Māori households have greater access to public transport and potentially shorter trips than their rural counterparts, relative to other urban households they are likely to travel further, and hence face higher travel-related emissions costs. Additionally, Jones and Kammen (2014) note that the emissions benefits of urban density can also come at the cost of greater over-crowding and higher rents. These extra costs are likely to weigh relatively more heavily on Māori households, given their greater likelihood of renting.

Whether Māori households locate in urban or rural locations, either way these location choices interact with household choices about house type to affect long-term opportunities for making the conditioning investments that modify household exposure to emissions pricing. In particular, for Māori households the problems limiting medium-term conditioning investments such as energy-efficiency heating and home insulation repeat in longer-term choices. Relatively high rates of social deprivation limit educational and professional investments for Māori households, limiting lifetime income opportunities. They also limit long-term house type choices.

Both of these in turn limit medium term housing tenure and conditioning investment opportunities, raising the prospect that Māori households are slower to adapt new technologies (e.g. PV systems, electric vehicles and energy-efficient heating). Relative to non-Māori households, because of these long-term issues, Māori households are therefore more likely to face constraints in becoming more responsive to emissions pricing. Over time, this suggests they might bear an increasing share of emissions pricing burden, as non-Māori households make conditioning investments at a greater rate. That is unless non-Māori households simply bear higher emissions pricing burden because their conditioning investments allow them to enjoy much greater levels of household service provision (i.e. travel, heating, etc). In that case Māori households might not bear a higher incidence of emissions pricing in absolute terms, but they would do so in terms of emissions pricing incidence per unit of household service produced.

Finally, Māori cultural norms are likely to play a role in affecting both contextualising and conditioning investments. Complexities in managing multiply-owned resources such as Māori land could create complications in reaching decisions about how best to respond to long-term climate change challenges, particularly given uncertainties in those challenges. However, a long-term commitment to specific locales could actually assist with prioritising adaptation investments (e.g. in infrastructure) which might otherwise be deferred due to uncertain long-term situation.

Likewise, Māori community's stewardship and inter-generational focuses mean they are more likely to seek solutions to adapt to climate change in their traditional areas of interest. Hence, for example, they might seek to find community-based solutions to problems of maintaining viability of remote or rural areas in the face of climate change, rather than abandon vulnerable areas that become too expensive to insure, or for which infrastructure becomes uneconomic to support.

In their review of international literatures on the climate change vulnerability and adaptation capacity of indigenous peoples, King et al. (2012) note that overstating the risks of climate change can do indigenous peoples a disservice by deterring investment or support, and unduly favouring relocation over adaptation. They further note that indigenous peoples have often proved extremely adaptable and resilient when dealing with climate challenges, and that the greatest threat to indigenous adaptation can be external constraints on traditional solutions.[41]

[41] These findings echo those in Ostrom (2000) regarding the usefulness of social norms in resolving collective choice problems more generally.

# 7. Conclusions

This study uses published research and publicly-available data to provide a high-level assessment of the incidence of emissions pricing on Māori households, and hence of the implications of emissions pricing for Māori cost of living. While very useful New Zealand and international research is available to assist with this assessment, important gaps remain for future primary research.

The study highlights that the incidence of emissions pricing needs to be considered over different time-frames. In the short-term, households have relatively little ability to change consumption patterns in response to changes in emissions prices, and so face a relatively high short-term incidence. We show that there are reasons why that short-term incidence is likely to be relatively high for Māori households, due to the composition of those households, and home tenure.

Importantly, however, we show that short-term emissions pricing incidence is affected by longer-term conditioning and contextualising investments. These affect households' ability to adjust their consumption patterns in response to emissions price signals, e.g. through investments in energy efficient appliances or vehicles. Again, on the available evidence we can say that Māori households generally suffer disadvantages relative to non-Māori households in making these types of medium- and long-term investments. These reflect lower income levels, and greater rates of home renting, in particular. As a consequence, Māori households are likely to bear a greater emissions pricing incidence over the medium- and longer-term than non-Māori households.

A subtlety arises in respect of how conditioning investments (e.g. in fuel efficient vehicles, or energy efficient appliances) affect the relative incidence of emissions pricing for different household types. Specifically, both local and international evidence exists for rebound/backfire effects under which energy consumption does not decline when households make conditioning investments. Rather, energy consumption either falls little, is maintained, or even increases, but the household making the investment enjoys much higher levels of household production (i.e. of travel and heating services).

This complicates assessments of relative emissions pricing incidence if only household expenditures are considered. More refined metrics, such as emissions pricing incidence per unit of household services produced, would provide better insight into relative incidence in the presence of rebound/backfire effects. This is one of the gaps that future primary research would usefully address.

Finally, while Māori households are likely to bear a relatively high incidence of emissions pricing relative to non-Māori households, there are other features of Māori communities which are likely to improve resilience in the face of climate change challenges. This is likely to be particularly important in smaller, rural and more remote areas, particularly those that are relatively exposed to climate risks. Such advantages should serve to mitigate, if not remove, any disproportionate emissions pricing burden of Māori households, in those areas at least.

We leave it to future research to more definitively explore the issues and conclusions explored here, especially at regional and more disaggregated levels, but also using more refined metrics of emissions pricing incidence.

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