Shifting gear

How New Zealand can accelerate the uptake of low emission vehicles

Report 1: Policies to incentivise EV uptake

27 January 2021

About this report

This report is the first in a three-volume study about policies to deliver the rapid transition away from combustion engine vehicles required to meet New Zealand's environmental and economic objectives.

Although it is an independent research piece by Concept in association with Retyna, it has been supported by the following organisations from the electricity and transport sectors who have variously provided funding and/or data:

> *AA New Zealand, ChargeNet, Contact Energy, Drive Electric, Fuso New Zealand, Genesis Energy, Imported Motor Vehicle Industry Association, Mercury Energy, Meridian Energy, Motor Industry Association of New Zealand, Orion, Powerco, Transpower, Trustpower, Unison Networks, Wellington Electricity*

We would like to thank the many individuals within these organisations, and others from other organisations, who have provided valuable input into this study. However, this report ultimately represents Concept's analysis and views (and any errors within it are our own), and the report should not be construed as representing the views of any of the supporting organisations.

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About Retyna (www.retyna.co.nz)

Retyna is a specialist consultancy focusing on electric vehicles and renewable energy for transport. Retyna's Managing Director, Elizabeth Yeaman, was previously the General Manager Transport at EECA and led the set up and delivery of EECA's EV programme. She has worked in the renewable energy and transport fields for over 25 years in both the private and public sectors.

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Executive Summary

Rapid EV uptake is both an emissions necessity, and a cost-saving opportunity

There is both an imperative and an opportunity associated with New Zealand transitioning away from internal combustion engine (ICE) vehicles to electric vehicles (EVs):

- The imperative is because without rapid uptake of EVs, it will be substantially harder for New Zealand to meet its carbon commitments – a fact that is increasingly being recognised by other countries, and which is spurring them to accelerate their transport electrification.
- The opportunity is because continued cost reductions for EVs means they will soon provide genuinely lower-cost transport solutions for many New Zealanders. Our modelling indicates that a more rapid uptake of EVs could deliver a 4.5% reduction in vehicle and fuel (petrol & electricity) costs out to 2050 – a $10bn reduction on a net present value basis – with a further $5bn reduction in carbon costs valued at a societal cost of NZ$200/t$CO_2$.[1]

To achieve rapid EV uptake will require overcoming a range of different barriers

There are many different barriers to the uptake of EVs:

- Consumer behavioural barriers are the most significant. Well-recognised cognitive biases lead many consumers to
  - place undue weight on upfront costs rather than evaluating full lifetime costs – a problem when the value proposition of EVs is higher up-front costs offset by lower running costs.
  - revert to technologies they are familiar with when faced with complexity in evaluating the relative benefits of different options.

  As result, they are less likely to choose EVs even if they have lower overall costs than ICEs.
- Several institutional barriers affect EV uptake:
  - Externalities which worsen the apparent relative price differential to consumers between EVs and ICEs, by not properly passing-on costs which fall on New Zealand as a whole:
    - Lack of pricing on the full emission costs from ICE vehicles (global warming, and human health)
    - Non-cost-reflective electricity pricing (too high in off-peak periods) making it more expensive to recharge EVs than it should be
  - Lack of public charging infrastructure
  - Unintended policy settings acting against EVs (e.g. Fringe Benefit Tax, road infrastructure funding approaches, WorkSafe regulations around charging a work vehicle at an employee's home)
  - Principal / agent dynamics in favour of suppliers selling larger models from existing technologies (i.e. ICE vehicles).

For drivers that travel a lot over the year, EVs are already lower overall cost options, and as EVs continue to fall in cost, by 2025 they will be lowest cost options for almost all driver requirements.

[1] We have used NZ$200/t$CO_2$ as representing a mid-point of various national and international studies of the price of carbon necessary to limit global warming to 1.5˚C. We suspect this is on the low side.

However, due to the above consumer and institutional barriers EV uptake will be a lot lower than a level that would be least-cost for New Zealand.

This study addresses which policies are likely to be best at overcoming EV-uptake barriers

The multi-faceted nature of these barriers will require a multi-faceted set of solutions. We will address two of these barriers (lack of public charging infrastructure, and non-cost-reflective electricity supply arrangements) in subsequent reports in this wider EV study.

To address the consumer behaviour, emissions externality, and principal/agent barriers will require policy instruments to alter the incentives and information for consumers. In this report we have evaluated the performance of a wide range of different policy instruments that have been implemented around the world.

Altering the purchase price of EVs and ICEs will be more cost-effective, and less regressive, than altering their running costs

We think the most effective policy instruments are those which alter the relative purchase price of high and low emissions vehicles – increasing the price of high emissions vehicles and reducing the price of low emissions vehicles. Given the cognitive biases of many consumers, changing the up-front cost of vehicles is much more effective at altering behaviour than measures which change the relative running costs of vehicles – e.g., carbon taxes, or road user charge adjustments. This need to address consumer 'short-termism' is increasingly being recognised in other policy areas such as the introduction of Kiwisaver default savings scheme.

Furthermore, mechanisms which increase the running cost of ICE vehicles relative to EVs will be more regressive than policies to alter the upfront cost of new vehicles, given that low-income consumers' uptake of EVs is likely to lag significantly behind that of other consumers.

Feebates and/or Emissions Standards?

The type of policy which has most commonly been used overseas to alter the relative purchase price of vehicles is a Feebate mechanism:

> This applies a sliding scale of fees for vehicles whose emissions are above a mid-point (known as a 'pivot-point'), with such fees being used to fund graduated rebates for vehicles that are below this pivot-point. Such a policy was proposed (but not passed into legislation) in New Zealand in 2019 under the title of a 'Clean Car Discount'.

Alongside the Clean Car Discount proposal, the 2019 government proposed (but also didn't pass into legislation) a 'Clean Car Standard' – a policy which belongs to the family of mechanisms we call Fleet Emissions Standards:

> Under such a mechanism, if the average emissions of all vehicles supplied by a vehicle supplier is above a pre-determined standard (expressed in gCO_2/km) it will pay a penalty on every vehicle supplied – being the difference between the average emissions across all the vehicles and the standard, multiplied by a penalty expressed in \$/gCO_2/km.
>
> The intention is to provide incentives on suppliers to alter their sales mix toward lower emission vehicles (e.g. EVs and smaller vehicles) and improve their technology over time.
>
> A Fleet Emissions Standard is also likely to affect the purchase price of vehicles. The effective cost to a supplier of supplying a high emissions vehicle will rise (by the extent to which supply of such a vehicle would push them above the standard), whereas the ability to offset this penalty by supplying a low emissions vehicle (or selling the effective 'credit' to a supplier of high emissions vehicles) will lower the effective cost of supplying a low emissions vehicle. This dynamic will tend to alter the price that suppliers charge consumers for high and low emissions

vehicles. Over time, the degree of price change should be just sufficient to alter consumers' vehicle purchasing for the standard to be met.

This similarity of effect has raised questions as to whether New Zealand needs both mechanisms, or just the 'best' one – whichever that is.

We think both mechanisms should be implemented

On the supplier side, we think Fleet Emissions Standards will create stronger incentives to secure scarce global EVs for New Zealand supply than a Feebate. This arises from the combined impact of commercial incentives arising from the penalty, plus many suppliers' reluctance to be perceived as not meeting a government requirement. The recent experience of the huge efforts made by European vehicle suppliers in 2020 to meet the much tougher European standard – backed by a tough financial penalty – bears testament to the ability of Fleet Emissions Standards to drive significant change.

As such, solely relying on a Fleet Emissions Standard – provided the penalty was high enough – could achieve desired emissions targets.

However, solely relying on a Fleet Emissions Standard would create significant risk for suppliers, as they would need to forecast the likely consumer response to altering high and low vehicle prices in order to meet the Standard – something which is inherently very hard to do. Such increased risk would be likely to flow through to consumer prices to a certain extent.

On the consumer side we think a Feebate will have a more certain impact on the relative prices of EVs and ICEs than a Fleet Emissions Standard with an equivalent penalty regime,[2] and is especially more likely to deliver EV price reductions. In large part this is because Feebates create a defined schedule with specified fees and rebates, whereas the price effects from a Fleet Emissions Standard will be affected by consumer and supplier behaviour making them harder to predict and accurately pass through to consumers.

However, because of the difficulty in forecasting likely consumer response to altered vehicle prices there will inevitably be some forecasting errors, resulting in the scheme not being fiscally neutral and not strictly guaranteeing that vehicles entering the fleet will achieve an average emission standard.

Because of their relative strengths and weaknesses, we see merit in using a Fleet Emissions Standard in conjunction with a Feebate:

- The Feebate can do much of the heavy lifting in terms of altering consumer prices, significantly reducing the risk for suppliers.
- The Fleet Emissions Standard will provide a backstop, and greater level of assurance that average emissions will meet a given standard over time.

Only relying on one or other of the mechanisms would likely result in less optimal uptake and outcomes for New Zealand. In this we note that, while the tougher European Fleet Emissions Standard has provided strong impetus for increased EV uptake, its efficacy has been complemented in many of the most significant European member states by Feebates or similar mechanisms.

We note that both Feebates and Fleet Emissions Standards have a similar potential for some of the rebate or penalty offsets to be captured as higher margins by suppliers – a point of some debate. This is due to the current dynamic of scarce global supply of EVs and thus the reduced effective competition between suppliers of EVs. However, as global EV supply, and the number of different

[2] The rate at which Fees and Rebates increase either side of the Feebate pivot-point is equivalent to the penalty that suppliers face (and penalty offsets that they would benefit from) for supplying vehicles increasingly above and below the standard in a Fleet Emissions Standard regime.

EV models, increases, the increased inter-EV competition will limit the ability of suppliers to capture such margin.

Lastly, we note that a Feebate arguably has some greater political acceptability challenges because of the higher level of visibility of impacts on vehicle purchase prices. While this is good for consumers buying vehicles whose price is reduced, it can cause resentment from consumers who buy vehicles whose price has increased. In contrast, while a Fleet Emissions Standard would also cause price increases (and decreases), these are much less transparent to consumers.

Offsetting this greater political challenge of a Feebate is the ability to apply more potential levers to address some perceived 'fairness' concerns. For example, it is possible to limit eligibility for receiving rebates to vehicles below a certain price. This can help manage the negative dynamic of fees charged on vehicles being purchased by middle and lower-income consumers being used to fund rebates on 'luxury' vehicles purchased by upper-income consumers. However, if such a mechanism is used to manage the politics, care needs to be taken that the purchase price cut-off point for 'luxury' EVs is not set too low.

How hard and fast should we go?

Irrespective of which mechanism is chosen, there are some core design features which will determine the extent of their success at achieving the required transition to low emissions vehicles.

The first key design choice is the setting of the gCO_2/km standard or Feebate pivot-point. Under either mechanism, the supply or purchase of vehicles whose emissions are at this level will face no increase or decrease in cost, with vehicles whose emissions are progressively above and below this point facing progressively increasing or decreasing costs. This gCO_2/km level represents the mid-point of a mix of vehicles which would deliver lower costs to New Zealand but without sacrificing utility to consumers.

We believe this 'mid-point' should be initially set at a level representing the emissions from the most efficient third of ICE vehicles (some 10% below current average ICE emissions levels) – but phased in over a two-year period to give the new vehicle import industry time to adjust.

However, as the cost of EVs continue to fall, there is the opportunity to significantly reduce this mid-point emissions level to deliver ever lower costs to New Zealand without sacrificing consumer utility. This steady movement in the mid-point emissions level to continue to incentivise ongoing improvement in vehicles has been a key feature of the successful European schemes.

Our assessment of the likely improvements in availability and cost of different types of vehicles with electric motors (petrol hybrids (HEVs) and EVs (PHEVs and BEVs)), is that within five to six years the emissions mid-point for *light passenger vehicles (LPVs)* in either mechanism should drop to be 65% of current average ICE emissions levels (roughly equivalent with HEV emissions), and by around the end of the decade should fall to approximately 20-30% of current average ICE emissions levels (roughly equivalent with PHEV emissions). The 65% level for LPVs is consistent with the 2019 proposed rate of reduction to 105 gCO_2/km for all Light vehicles (i.e. including light commercial vehicles (LCVs)). As we set out below, we believe a different trajectory is appropriate for LCVs.

Not only would the level of EV uptake implied by this emissions reduction be cost-effective for New Zealand (given the projected reduction in cost in EVs), but it is also necessary to be consistent with the rates of EV uptake required to meet our carbon commitments.

If both a Fleet Emissions Standard and a Feebate are implemented, this mid-point level should move together to ensure consistency of outcome. This is different to the 2019 proposals where the Fleet Standard mid-point dropped far more quickly over time than the Feebate pivot-point.

With regards to the level of price signal to send to vehicles of varying emissions, our modelling suggests the initial absolute magnitude of such a signal (if implemented from 2022) would need to be around \$70/gCO_2/km. This is at the low end of price signal from some of the most successful European feebate mechanisms in recent years, but reflects the projected fall in EV prices by 2022 and consequent reduced level of price change required to alter consumer purchases. It is higher than the approximately \$45/gCO_2/km that was in the 2019 Feebate proposal, but lower than the combined effect of the \$100/gCO_2/km Standard penalty plus the ≈ \$45/gCO_2/km Feebate.

However, over time as the cost of EVs continues to fall, it would be appropriate to progressively reduce this price signal accordingly.

This requirement to reduce the price signals is principally an issue for a Feebate which fixes a price schedule. In contrast, the price signal from a Fleet Emissions Standard should be 'self-correcting' in that it will only cause vehicle prices to move to the level required for consumer purchases to alter to meet the standard. Thus, if future falls in EV prices were to occur the extent to which relative prices would need to change to meet a Standard would also fall. As such, we believe the 2019 proposal for the Clean Car Standard of a \$100/gCO_2/km penalty is appropriate. We note it is lower than the €95/gCO_2/km (≈\$163/tCO2/km) penalty for the European standard, but should be still high enough to deliver a strong incentive to suppliers and deliver meaningful price signals if required (e.g. if there were no Feebate implemented). We would not recommend the penalty be substantially lower than this level as it will start to compromise the efficacy of the mechanism.

For both mechanisms, it is likely that adjustments to the settings will be necessary to finetune as new information emerges – e.g. changes in EV prices and availability, or consumer responsiveness to altered vehicle prices. As such, while publishing expected changes in mechanism settings over time will be important, it will be equally important for the government to set out the process by which these settings would change in response to changes in the state of the world.

ICE bans are an important complementary policy

A Fleet Emissions Standard and/or Feebate should be complemented with an ICE ban to come into effect at some point in the future. Such a ban would further signal to suppliers and consumers the long-term 'direction of travel', thereby increasing the confidence for suppliers to plan to transition from ICE supply, and increasing the confidence for consumers that purchasing an EV will be a sensible long-term choice. This increased confidence should improve the effectiveness of a Fleet Emissions Standard or Feebate, delivering greater consumer response for a given Feebate schedule, say. Announcing an ICE ban at the same as introducing the Fleet Emissions Standard and/or Feebate could also deliver greater public acceptance of the mechanisms.

An increasing number of international jurisdictions are implementing ICE bans for light passenger vehicles as complementary policies, with the date of bans coming into effect ranging from 2025 to 2040. We also note that an increasing number are bringing forward the date when bans will come into effect. This is due to a combination of increased confidence of when sufficient cost-effective EVs will be available, plus an increased realisation that not to make the transition to EVs by these earlier dates would result in such countries failing to meet their emissions reduction commitments.

To balance the risk of implementing a ban too early versus too late – both of which would deliver higher cost outcomes for New Zealand – we believe the timing of a ban should be linked to the timing of bans in significant right-hand-drive (RHD) overseas markets. Given that the UK has recently brough forward its light passenger vehicle ICE ban to 2030, and Japan has just introduced a ban from 2035, a New Zealand ban no later than 2035, and probably earlier subject to further analysis, would seem appropriate – noting that if technology improves at a faster rate than expected, or Japan brings forward the date of its ban, it would be appropriate to also bring forward New Zealand's date.

The same approach, but with different settings, will be required for heavier vehicles

The above analysis has focussed on light passenger vehicles (LPVs) – i.e. cars (including SUVs).

We think the need for Fleet Emissions Standards and/or Feebates is just as great for heavier vehicles – Light commercial vehicles (vans and utes), Trucks, and Buses – as they face many of the same barriers as for LPVs. Indeed, New Zealand is now in the minority of countries which don't have Emissions Standards for trucks. Likewise, ICE bans for heavier vehicles are similarly important, and increasingly being implemented overseas.

However, while the need for such mechanisms is the same as for LPVs, the specific settings in terms of where a standard / feebate pivot-point should be set, how quickly it should move down, and what level of feebate / penalty should apply, will need to be specific to these different classes of vehicle.

In part this need for specific settings is due to the heavier weight of such vehicles and inherent need for more energy (and associated emissions) to provide motive power, and the fact that different trailer types change efficiencies and emissions, as do differing duty cycles. However, a greater driver of the need for specific settings is the fact that the rate at which EV models will be produced for these different classes of vehicle is likely to be slower than for light passenger vehicles (LPVs). Thus, having a standard for 2030 which is based on the emissions of a PHEV may be appropriate for LPVs as by that time there will be a significant number of cost-effective plug-in light EVs to choose from, but there may be far fewer cost-effective EV choices for heavier vehicles.

It is for this reason that we believe that separate settings are required for Light commercial vehicles (LCVs), rather than grouping them within an approach which treated all 'light' (i.e. <3.5 tonnes) vehicles the same.

A range of additional complementary policies will be beneficial

A range of other policies are likely to be complementary to the 'core policies' outlined above. Two of them are equally 'core', and as such will be addressed in the next two reports in this study:

- Implementing measures to deliver adequate EV charging infrastructure
- Improving electricity supply arrangements to enable coordinated charging of EVs and access the potential from vehicle-to-grid.

However, there are also a range of other complementary policies to influence vehicle purchasing:

- The current exemption on EVs paying Road User Charges should be extended, at least until the time when equivalent policy support is implemented. While we do not believe RUC adjustments are an appropriate long-term means of supporting EV uptake, removing the RUC exemption before that time would send a negative signal to consumers about the government's commitment to EVs, frustrating EV uptake during this period, and thereby locking-in higher emissions from the ICEs that will be brought into the country as a result.
- Two Fringe Benefit Tax (FBT) distortions need to be addressed:
  - Because FBT is only applied on the capital purchase of a vehicle, not its fuel and maintenance costs, this creates a significant distortion in favour of (low-purchase-cost-high-running-cost) ICE vehicles relative to (high-purchase-cost-low-running-cost) EVs. This is a problem as the majority of new light passenger vehicles are purchased by companies. This distortion in favour of ICEs can be addressed by having different FBT rates applying to the capital purchase of EVs versus ICEs – a policy which countries such as the UK have already adopted.
  - FBT is currently exempt from vehicles which are "mainly designed to carry goods or goods and passengers equally" (such as vans and utes), are sign-written, and the employer informs employees in writing that the vehicle is not available for private use. As ute design has shifted since this policy was introduced from being 'uncomfortable farm vehicle' to saloon-equivalent comfort, this legacy policy and its perceived de-facto means of avoiding tax, has significantly contributed to New Zealanders hugely shifting to purchasing utes (a phenomenon not matched in areas such as Europe and Asia). As well as having negative tax

consequences, this is resulting in poor emissions outcomes because utes are generally less fuel efficient, and the development of EV ute models are going to be some years behind the development of other light vehicles such as SUVs and station wagons. Removing this de-facto exemption would put utes on an equivalent footing to other light vehicles and deliver positive tax and emissions outcomes.

- Public sector procurement approaches prohibiting purchase of ICEs by a certain date – except in situations where it can be demonstrated an EV can't meet requirements – will not only deliver lower costs for government, but will deliver wider public benefits including increasing public awareness of EVs and thereby increasing their speed of uptake. As such we welcome this proposed approach for central government, and the increasing uptake of such approaches by local governments.
- For some classes and technologies, which are at an earlier stage of their EV evolution (e.g. EV heavy trucks, and smart charging and V2G technologies), R&D funding will be an important additional facilitation mechanism.
- The high-purchase-cost-low-running-cost dynamic of EVs may prove particularly challenging for low-income consumers who struggle with accessing capital for major one-off purchases. Addressing this will require targeted financing mechanisms in the form of soft-loans, subsidy mechanisms, information and other support. While this will deliver some environmental benefits, we suspect the greatest benefit will be through reduced social costs, helping low-income consumers break out of the cycle of acquiring vehicles which are 'cheap' to purchase but whose reliability and subsequent repair costs mean they fall into the trap of problem debt.
- The human health costs from ICE vehicles mean that Low/Zero emissions zones in urban areas which prohibit or penalise ICE vehicles can deliver significant net public benefit, as well as delivering additional benefits from raising the attractiveness and awareness of EVs and thus increasing their speed of uptake.
- Information mechanisms will help consumers' understanding and awareness of EVs. In addition to continuing with existing programmes, we would recommend implementation of some form of number-plate identification (some countries have added a green flash) of EVs to distinguish them from ICEs. This recently-introduced measure in the UK, has the potential to be a low-cost means of increasing awareness and subsequent uptake, even when EVs are relatively well-established.

While each of these are unlikely to have the scale of effect of the core policies, they will collectively improve the effectiveness of these core policies.

For completeness, we note that moving to a low-emissions transport sector will also need changes to *how* we travel, with a shift towards greater use of public and active transport, and road freight shifting towards rail and coastal shipping. However, the policies to achieve this are themselves multi-faceted and complex, and out of scope for this study.

Further, we note that even with the most optimistic projections of what mode shifting can achieve, there will still be a huge residual demand for road vehicle travel – hence the focus of this study on policies to change the vehicles we travel in.

Some policies are likely to be less important for road transport

For the reasons identified earlier, we think emissions pricing is unlikely to be the most cost-effective mechanism to deliver the required transition for road vehicles, particularly light vehicles. Further, we note the potential for public concern around the likely regressive nature of emissions pricing for passenger vehicles (as occurred in France in 2018 with the mass 'Gilet Jaune' protests triggered by petrol price increases). Such concerns may frustrate the ability to implement emissions pricing in other parts of the economy where it is likely to be a much more important measure or, if the high level of emissions price necessary to effect change in these other sectors is also introduced at the petrol pump, cause a public backlash which results in a subsequent reversal of approach. As such, mechanisms which address this dynamic are likely to be important to implement the package of policy measures across the economy necessary to meet our emissions reduction commitments.

Scrappage mechanisms (paying incentives to encourage people to scrap old vehicles) are likely to be far less cost-effective means of improving EV uptake than the mechanisms described above.

Direct taxpayer-funded subsidies of EVs can be effective in encouraging EV uptake. However, we believe Feebates and Fleet Emissions Standards (which also alter purchase prices) are better at achieving 'causer-pays' outcomes. The exception is EV subsidies targeted at low-income households, where the desired outcomes are as much social as environmental, and thus more appropriately funded through general taxation.

Use incentives, such as priority access to certain road lanes and parking, may deliver some incremental benefit. However, these need to be carefully designed, can only be transitional mechanisms while EV uptake is low, and are unlikely to deliver huge benefit relative to other mechanisms.

Policies should be technology-neutral

Most of the analysis in this report has focussed on electric vehicles. In large part this is because our analysis to-date identifies these as being the most cost-effective ICE alternatives, even for trucks. That said, we recognise that there is some debate as to whether alternatives, particularly hydrogen vehicles (H2Vs) for the heaviest long-distance trucks, may be more cost-effective in the long run.

To that end, and consistent with general good policy principles, policy instruments should be framed around outcomes (in this case low emissions vehicles) and not specific to particular technologies (e.g. EVs versus H2Vs).

That said, the *settings* for policy instruments (e.g. the gCO_2/km level for a Fleet Emissions Standard) should be informed by expectations of their achievability by different technologies.

Different policy settings and/or different measures are likely to be required for the import of <u>used</u> light passenger vehicles

The recommendations around Feebates, Fleet Emissions Standards and ICE bans set out above apply to *new* vehicles. We think a different mechanism, or at the very least, different parameters within the above mechanisms will be required for *used* LPV imports.

In simple terms, this is because the average age of Used imports coming to New Zealand is 10 years' old. To safely apply a uniform approach across new and used imports which are moving to 100% EV uptake by 2031, there would need to have been extremely high levels of EV uptake in the fleets of the countries we source our used vehicles from for the last few years.

However, this has not happened, with the weighted average level of EV uptake across the countries we source our vehicles from (Japan – source of 83% of our Used vehicles – Australia and the UK) being less than 1% for 2019.

Our modelling of potential rates of uptake of EVs in these source countries indicates that, even if they were to rapidly move to EVs (as Japan and UK have indicated they will, by imposing 2030 ICE bans), it will be many years until there is sufficient supply of Used EVs to match the pace of transition we propose for New vehicles.

Thus, if common mechanisms were applied to New and Used vehicles, this would likely result in consumers of Used vehicles facing an increase in upfront prices but with little ability to choose alternative, lower emissions vehicles that would deliver a lower total cost of ownership. As well as such outcomes being 'unfair', they are also likely to be regressive as the lowest-income consumers are the section of society who rely almost entirely on purchasing the oldest vehicles to meet their transport needs. As with our concerns around using emissions pricing as the principal mechanism to incentivise EV uptake, mechanisms which are unfair or regressive are unlikely to be durable, and run the risk of subsequent reversal that may result in slower overall EV uptake in the long-run.

This problem is unique to New Zealand among Western economies, as no other developed country has such a high proportion of its light passenger vehicle imports being Used – 55% for New Zealand. We think this unique problem will require a tailored solution for Used imports:

- Setting the level of the Fleet Standard or Feebate pivot-point for Used vehicles so it moves down more slowly towards plug-in-EV-consistent levels
- Setting a lower $/g$CO_2$/km penalty under a Fleet Emissions Standard and/or lower rates for a Feebate schedule

We recognise that treating New and Used vehicles differently will create a potential for perverse incentives at the boundary. To minimise the extent of consumers switching from purchasing a New vehicle to a Used vehicle we suggest this boundary initially be set such that vehicles younger than 5 years' old be included within the New mechanism. Over time, this boundary age should be increased in line with projections of availability of Used vehicles of different ages from source markets sufficient to meet the settings in the New mechanisms.

We think it is only necessary to apply this New / Used policy setting distinction for light passenger vehicles, as this is the only category which is dominated by Used imports, and it is the only category where regressive outcomes will occur to a material extent.

Speed is of the essence

New Zealand's inability during the last coalition government to progress substantive EV policies means we are starting to fall behind many other countries. Our modelling indicates that an EV uptake profile which is one-year longer to complete will result in our cumulative whole-economy net emissions out to 2050 being 1% higher, and increased costs (in present value terms) of $0.8bn in non-emissions costs plus $0.5bn in carbon costs (valued at NZ$200/t$CO_2$).

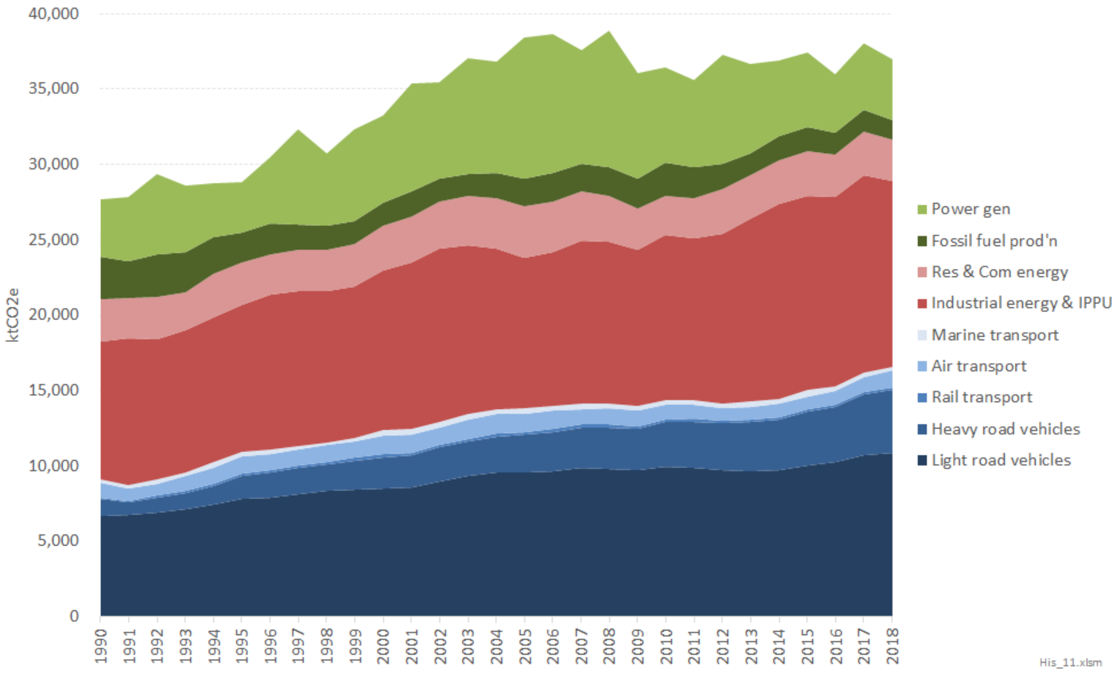
Our renewables-rich electricity system means the emissions and cost savings from EV uptake will be higher than almost any other country. We should waste no more time in implementing a Fleet Emissions Standard, Feebate, and ICE ban.

1 Introduction

1.1 Study background

As Figure 1 shows, New Zealand's transport emissions are now the single largest source of our non-agricultural emissions, and the fastest growing – with road transport dominating.

Figure 1: New Zealand's Energy and Industrial Processes & Product Use (IPPU) emissions[3]



If we are to meet our economy-wide target of net zero emissions by 2050, this will require a radical transformation of our transport sector.

Some of this will need to be through changing *how* we travel, with a shift towards greater use of public and active transport, and road freight shifting towards rail and coastal shipping.

However, even with the most optimistic projections of what mode shifting can achieve, there will still be a huge residual demand for road vehicle travel. To tackle this source of emissions we are going to need to change the vehicles we travel in.

The good news is that development in alternative-fuelled vehicles such as electric vehicles (EVs) and (potentially for heavy trucks) hydrogen fuel cell vehicles (FCVs) is making this transition feasible. As battery costs and performance continue to improve, it is likely that during the next decade EVs will become genuinely lower cost means of providing transport services than internal combustion engine (ICE) vehicles for all but the heaviest, long-distance trucking duties. Indeed, as we set out in this study, for many Light Passenger Vehicle requirements, that point of EVs transitioning to being cheaper than ICEs from a whole-of-life (a.k.a. total cost of ownership, 'TCO') perspective is happening around now.

Further, as we demonstrate in this study, with New Zealand's predominantly renewable electricity system, any growth in demand driven by EVs will be met almost 100% by renewables.

[3] 'Energy'-related emissions relate to the use of fossil fuels used for heating and providing motive power. 'Industrial Processes and Product Use' emissions cover non-energy-related production processes (e.g. from cement or steel-making) or the use of greenhouse gases (e.g. as refrigerants).

However, transitioning to a completely different energy source for fuelling our road transport fleet in a short space of time is going to be challenging. Some of these challenges relate to developing the charging infrastructure and electricity supply arrangements for fuelling these vehicles. These challenges are going to be addressed in the subsequent two reports in this study.

This report addresses the challenge of putting in place arrangements so that vehicle purchasers have the correct information and incentives so that they buy the 'right' vehicle that not only meets their requirements, but also meets New Zealand's collective need to transition to a net-zero economy.

As we set out in this report, there are significant barriers to consumers choosing an EV rather than an ICE vehicle, even when the EV is a lower cost option. This matters as, once-purchased, vehicles will spend a long time on New Zealand's roads. (The average age of light vehicles scrapped in New Zealand is nineteen years). Therefore, every time an ICE vehicle is purchased where an EV would have been a better option, we are locking-in almost twenty years of high emissions.

Various countries have started to address these barriers through implementing a range of policy measures to better align the incentives of individuals and vehicle suppliers with those of the nation as a whole. To date, New Zealand's policy measures for incentivising EV adoption are much less substantial – comprising of a soon-to-expire exemption on EVs paying road user charges plus some information and demonstration programmes. As a result, rates of EV uptake in New Zealand are significantly less than overseas jurisdictions with more comprehensive EV policy measures.

1.2 Purpose of this report

This report in our broader EV study assess the different policy options for improving the incentives on individuals and vehicle suppliers to enable New Zealand to cost-effectively transition to low-emissions vehicles.

This report addresses:

- What are the barriers to consumers purchasing low emissions vehicles?
- What is the likely cost-benefit to New Zealand of achieving a higher level of EV uptake?
- Which policy measures are likely to be most effective at achieving a higher level of EV uptake?
- How might the measures affect key consumer segments, particularly low-income and rural / commercial?

  To the extent that measures have adverse effects for some consumer segments, this study considers:

  – Are there particular settings for such measures which may mitigate the adverse effects without overly limiting overall effectiveness?
  – Are there other policy measures which may ameliorate the adverse effects?

In undertaking this study, we have drawn upon overseas experience but also undertaken quantitative analysis of the likely performance of the options given the specifics of New Zealand's context. In this respect, key specifics which are significant, include:

- Our exceptionally high number of vehicles that enter New Zealand second-hand from other countries. (Approximately 55% of light passenger vehicles enter the country as 'Used' – predominantly from Japan)
- The fact that we are a small, remote market, and require right-hand-drive vehicles.
- Our unusually high proportion of 'Utes' being purchased.

In considering the various policy measures to overcome barriers to EV uptake, this report's principal focus is on the measures that have been put forward by various parties as being the core elements needed to transition our vehicle fleet:

- Fleet Emissions Standards (a version of which, the 'Clean Car Standard' was proposed but not passed in 2019)
- Feebates (a version of which, the 'Clean Car Discount' was also proposed but not passed in 2019)
- ICE bans
- Emissions pricing

We have also considered some additional complementary policy measures which could improve the overall effectiveness of the core mechanisms. These are addressed in lesser detail than the core policy evaluations, and are set out in section 6. These include:

- Road funding charge adjustments
- Changes to Fringe Benefit Tax
- Public sector procurement
- Demonstration projects
- Financing mechanisms
- Low / Zero emissions zones
- Use incentives (priority access to roads and parking)
- Scrappage programmes
- Information programmes
- Direct subsidies

2 What are the barriers to consumers purchasing low-emissions vehicles?

In most cases, anyone purchasing a vehicle has a huge range of options to choose from. In addition to variations in functionality (principally carrying capacity), looks, performance, and in-car 'add-ons', there are variations in fuel efficiency. Until recently, this variation in fuel efficiency was between different internal combustion engine (ICE) vehicles. However, motorists can now also choose between ICE vehicles and different types of vehicle with an electric motor[4]:

- hybrid electric vehicles (HEVs),
- plug-in hybrid electric vehicles (PHEVs), and
- fully electric battery electric vehicles (BEVs)
- fuel-cell vehicles (FCVs)

The difference in emissions efficiency between these different types of vehicles is significant. Thus, compared to an 'average' ICE vehicle, the typical nominal gCO_2/km emissions for the different electric vehicles is 65% for HEVs, 30% for PHEVs and 0% for BEVs and FCVs.

In this report, when we refer to 'EVs' we are only referring to plug-in electric vehicles (BEVs and PHEVs), not hybrids or fuel-cell vehicles.

While EVs still cost more than ICEs to purchase (significantly more so for BEVs), the much lower fuel and maintenance costs mean that they will soon become genuinely lower cost options on a whole-of-life total-cost-of-ownership (TCO) basis. Indeed, for motorists who drive significantly more than average, our analysis suggests this point of achieving TCO parity has already been passed. And as the cost of EVs continue to fall, EVs will become the lowest TCO options for the majority of motorists considering purchasing a new vehicle within the next five or so years.

Unfortunately, while EVs are becoming lower cost options, there are significant barriers to their uptake. These can be grouped under two main categories:

- Consumer behaviour barriers
- Institutional barriers

[4] HEVs have a standard internal combustion engine powered by petrol, plus an electric motor powered by a battery which can also power the vehicle. The vehicle can switch between the two modes, or use both modes, depending on the power requirements and the extent of charge in the battery. The battery is charged from regenerative braking (effectively running the motor backwards to charge the battery and using the resistance to slow the vehicle down), and can also be charged from the petrol engine. It can only be refuelled with petrol so fundamentally HEVs are more fuel-efficient petrol vehicles.
PHEVs are fundamentally the same as HEVs, except the battery can also be charged by plugging-in to an external power source. PHEV batteries are typically much larger than HEVs', enabling typical daily journeys of 40-50km to be powered entirely from the battery – noting that the average daily journey distance of a car in New Zealand is approximately 33 km. Thus, whereas an HEV is entirely petrol-fuelled, a PHEV can be predominantly fuelled by electricity from the grid.
BEVs are solely powered by an electric motor and can only be refuelled from plugging-in to an external power source. As such, BEV batteries are significantly larger than PHEVs. Improvements in battery cost and performance mean that modern BEVS typically have ranges of 250-500km.
Fuel-cell vehicles are fuelled by hydrogen, which is then turned into electricity by an on-board fuel cell, which in turn charges a battery that drives an electric motor.

2.1 Consumer behaviour barriers

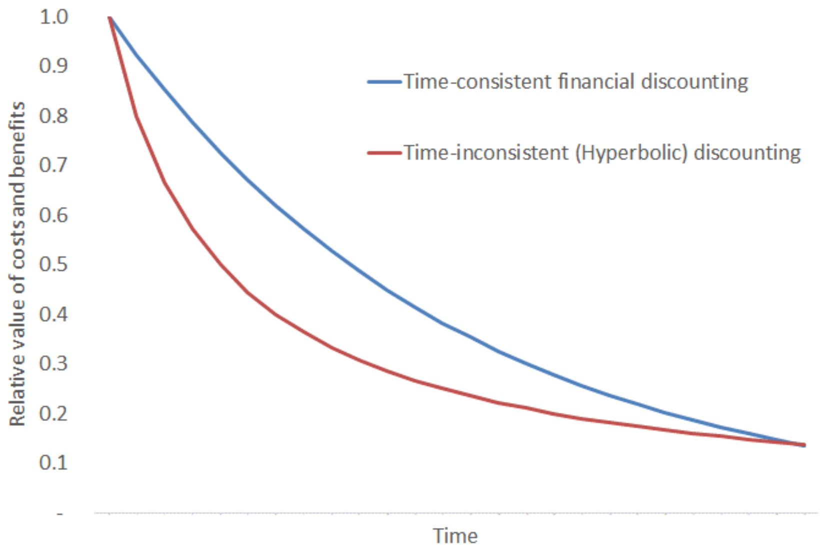
In theory, consumers should be able to evaluate the benefit of better fuel efficiency when making vehicle purchasing decisions, trading off any increase in purchase cost for a more fuel-efficient vehicle with the benefit of lower operating costs.

In practice, consumers have been shown to be poor at evaluating up-front costs vs long-term benefit. This 'time-inconsistency' as it is referred to in behavioural economics doesn't just apply to vehicle purchase decisions, but many other decisions, including saving for retirement, actions (or inactions!) to address diet or habits affecting health, and even managing groceries for budget-constrained households.

In simple terms, time-inconsistency results in individuals placing a huge amount of weight on near-term outcomes ('now'), and excessively discounting longer-term outcomes ('later'). Where such decisions have financial implications this behaviour (known as hyperbolic discounting in behavioural economics) contrasts with classical economic theory which suggests that individuals should consistently discount any costs and benefits that occur in the future using their cost of capital – the interest rate of borrowing for most individuals.

Figure 2 illustrates the effect of this time-inconsistency on how consumers value costs and benefits over time.

Figure 2: Illustration of time-consistent and time-inconsistent discounting of future values



Thus, time-inconsistent individuals rapidly discount outcomes that occur after 'now', even if they are not too-distant in the future. And beyond a certain point in the future, all future periods are effectively valued as 'later' with almost the same weight placed on outcomes that occur far in the future as those which are much closer to 'now'. Indeed, as this illustration shows, this can result in some very long-term periods having greater weight placed on them than a financial discounting approach which consistently discounts each subsequent period using a cost of capital.

This time-inconsistency is a significant problem for consumer choices which involve deciding between an option which has higher up-front costs but lower running costs, or an option which has lower up-front costs but higher running costs. Unfortunately, this exactly describes the choice faced by consumers considering an EV versus an ICE.[5]

[5] Indeed, this is a problem for many other areas involving a transitioning away from fossil technologies, as renewable options generally have higher capital costs but lower operating costs.

This problem for vehicle choice decisions is further exacerbated by significant inherent complexity for consumers to make an informed choice between an EV and ICE. Thus, they will need to:

- Have good knowledge of the likely number of kms they will travel in the vehicle, plus understand the extent to which they will be able to recharge the electric option at home versus using public charging (which is significantly more expensive)
- Be able to compare the running cost of a petrol option (with fuel efficiency expressed in l/100km and fuel priced in c/l) versus an electric option (with fuel efficiency expressed in kWh/100km and electricity priced in c/kWh)
- Project any likely changes in the cost of the two fuels (e.g. due to world oil price changes, or changes in NZ electricity supply cost drivers)
- Project any likely difference in the maintenance cost of the two vehicles, plus the likely relative depreciation and subsequent future price they could receive from selling the vehicles
- Have confidence that the electric option will meet their requirements, such as:
  - The battery size and extent of public charging station availability will meet their driving needs – i.e. addressing the 'range anxiety' faced by consumers switching to a vehicle whose range is lower than the ICE vehicles they are familiar with.
  - The driving performance (e.g. speed of acceleration, pulling power, etc) meets their needs.

  (It is worth pointing out that in the significant majority of use cases, EVs will definitely meet these requirements).

Faced with complexity, consumers will tend to default to what they know and are familiar with – known as 'status quo bias' in behavioural economics. In the case of vehicle choices this will mean choosing another ICE, rather than choosing an EV.

2.2 Institutional barriers

In addition to these significant behavioural barriers to consumers making choices that are best for them, EV uptake faces a number of other barriers:

- ICE owners not facing the externalities associated with their emissions:
  - The global warming costs associated with CO_2 emissions.

    Using a '1.5˚C-consistent'[6] carbon price of NZ\$200/tCO_2, New Zealand's 2019 road transport emissions cost \$3bn – just under half the cost of the petrol & diesel consumed.
  - The human health consequences associated with exhaust emissions.

    A 2012 study[7] for MoT, MFE and NZTA estimated these health costs to be approximately \$1bn per year. As we set out later in section 6.6, for vehicles travelling in urban areas, this is equivalent to approximately \$20/tCO_2 for petrol vehicles and \$200/tCO_2 for diesel vehicles.[8]
- Insufficient public charging station infrastructure to support a significant increase in EVs, and to address situations where consumers may not have the ability to charge their vehicle at their premises

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[6] We have used NZ\$200/tCO_2 as representing a mid-point of various national and international studies of the price of carbon necessary to limit global warming to 1.5˚C. We suspect this is on the low side.
[7] "*Updated Health & Air Pollution In New Zealand study*", March 2012
[8] Diesel engines emit more of the particulates that are most damaging to human health.

The issues relating to charging infrastructure will be addressed in the second report in this EV study.

- Non-cost-reflective electricity pricing arrangements resulting in EV owners generally paying more to charge their vehicle than the underlying cost of supply.

  Thus, the $/kWh price paid by consumers for charging their vehicle overnight – the time when the vast majority of EV charging occurs – is generally significantly greater than the actual generation and network costs of supplying electricity at such times. In contrast the price charged consumers for supplying electricity at times of peak demand is generally significantly lower than the actual generation and network costs of supplying electricity at such times.

  The issues relating to electricity supply arrangements will be addressed in the third report in this EV study.

- Principal / agent issues resulting in vehicle manufacturers and associated sales channels being incentivised to promote larger ICE vehicles.

  Some of this relates to manufacturers already having made the investments in ICE manufacturing capabilities such that incremental ICE sales have a high effective margin. Some also relates to the fact that EVs require much less ongoing maintenance than ICE vehicles. This lower maintenance requirement will significantly reduce after sales revenue for dealers.

- Transport and tax policies which unintentionally promote less-fuel efficient ICEs or dis-incentivise EV purchases, principally:
  - fringe-benefit tax, and WorkSafe regulations around charging a work-supplied vehicle in an employee’s home (addressed in section 6.2)
  - road infrastructure funding approaches (addressed in section 6.1)

3 What is the likely scale of benefit from improving EV uptake?

To examine this question, we have used our structural model of the NZ economy, 'ENZ'. This comprises a series of inter-linked models of different parts of the economy (energy, industry, transport, buildings, agriculture, forestry, etc.).

The transport model has a detailed representation of the drivers for transport services (passenger and freight), and the economics of the different options for meeting such services, including shifting between modes (e.g., from private vehicles to public transport) as well as different fuel options for each mode (e.g. ICE, EV, H_2).

The transport model is linked with the electricity model, so that any EV-related increase in electricity demand is captured along with effect on ,new generation, generation emissions and electricity prices. In turn, these electricity prices flow back to the transport model to feed into the economics of EV vs ICE vehicles.

We have used this model to consider the likely effect from altering the rate of EV uptake from a likely business-as-usual projection ('BAU') to one which would be more beneficial for New Zealand based on projected improvements in the cost and performance of EVs ('High EV Uptake').

The results are sensitive to some input assumptions. For the purposes of modelling road transport sector outcomes, the most significant are:

- The year when BEVs reach *purchase price* parity with ICEs: 2027 for LPV, 2029 for LCV, 2035 for medium trucks, 2047 for heavy trucks.[9] (Noting that all these vehicles reach total cost of ownership parity significantly earlier due to the major fuel and maintenance cost savings).
- The Carbon price in the ETS faced by non-agriculture parts of the NZ economy. We have used NZ$50/t$CO_2$ throughout.

  This is a low carbon price relative to estimates of what is required internationally to limit global warming to 1.5˚C, but consistent with current policy settings. Accordingly, while NZ$50/t$CO_2$ is used in the model for driving technology choice decisions, we have used a '1.5˚C-consistent' carbon price of NZ$200/t$CO_2$ for the purposes of valuing the carbon emissions avoided by increased EV uptake.
- Oil price = US$60/bbl throughout
- Electricity prices move to being cost-reflective (enabling substantially lower overnight charging rates for EVs) within 5 years
- Estimates of the effect of the Covid-19 pandemic on the demand for travel – both during 2020 and on a more sustained basis.
- Assumptions around mode-shifting from private vehicle to public and active transport for passenger travel, and from road to rail and coastal shipping for freight.

Although there is material uncertainty around all of these assumptions, they are held constant between both the BAU and Higher EV uptake scenarios, and thus have little impact on assessing the relative benefits of moving to a higher rate of EV uptake.

The figures on the following pages show the BAU and Higher EV Uptake results for a range of different metrics.[10]

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[9] LPV and LCV refer to light passenger vehicles (cars, SUVs and people movers) and light commercial vehicles (vans and utes), respectively.
[10] Note: EVs are defined as plug-in electric (i.e., either BEV or PHEV), but not HEV.

Figure 3: Proportion of vehicles entering the country which are EVs

BAU **High EV Uptake**

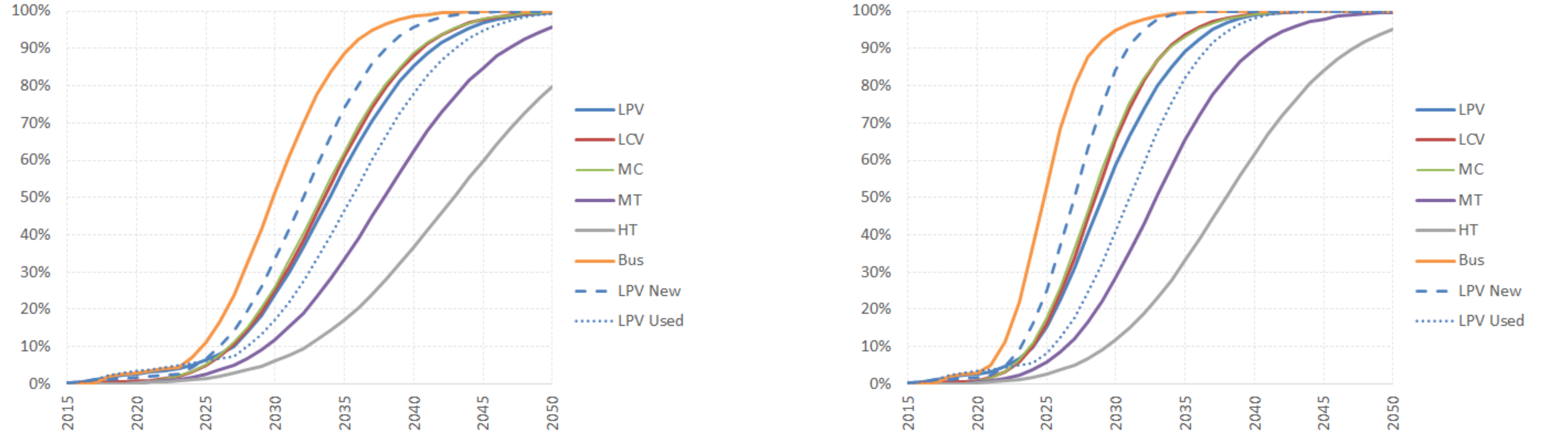


Figure 4: Proportion of vehicles in the fleet which are EVs

BAU **High EV Uptake**

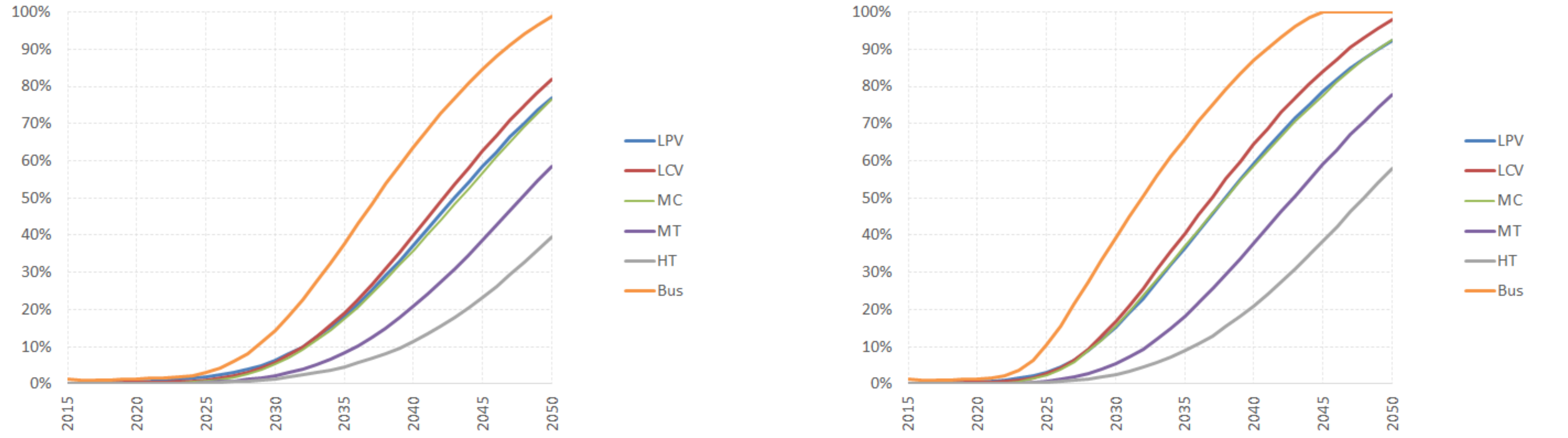
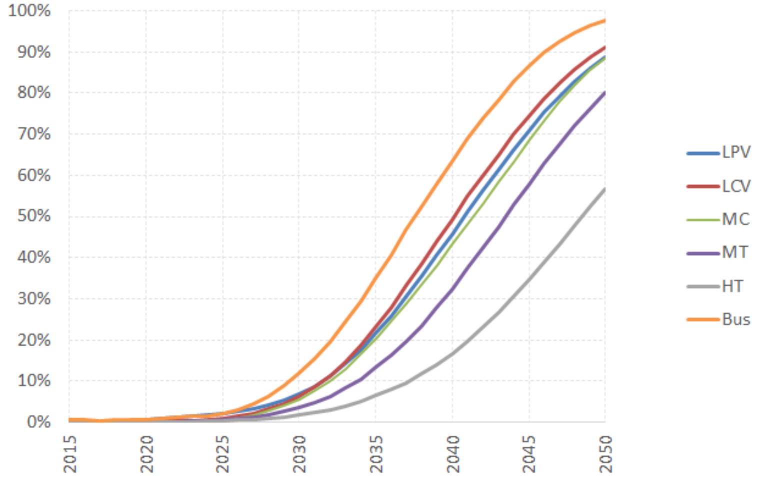


Figure 5: Proportion of vkt driven from EVs

BAU



High EV Uptake

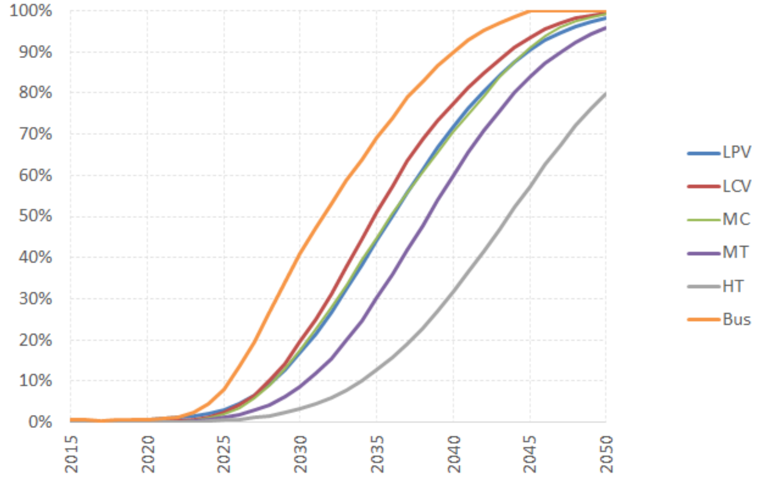
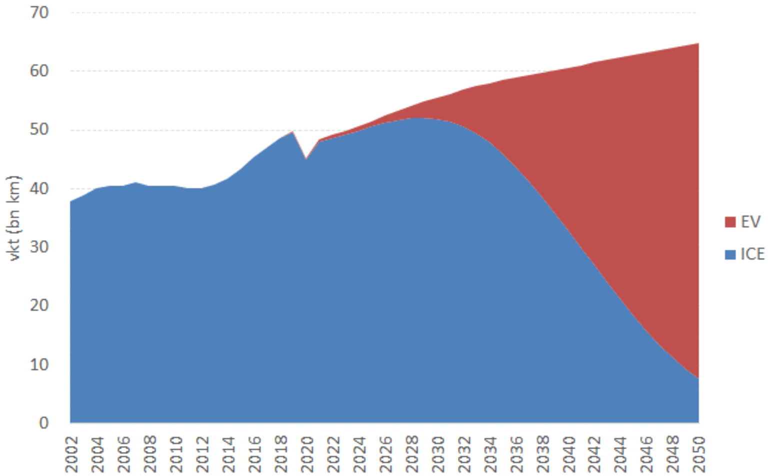


Figure 6: Total Road (light + heavy) vkt (bn km)

BAU



High EV Uptake

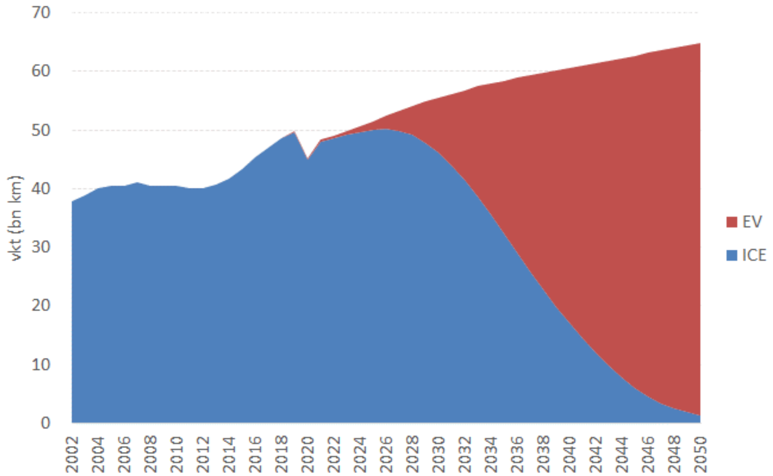


Figure 7: Emissions from road vehicles (ktCO$_2$)

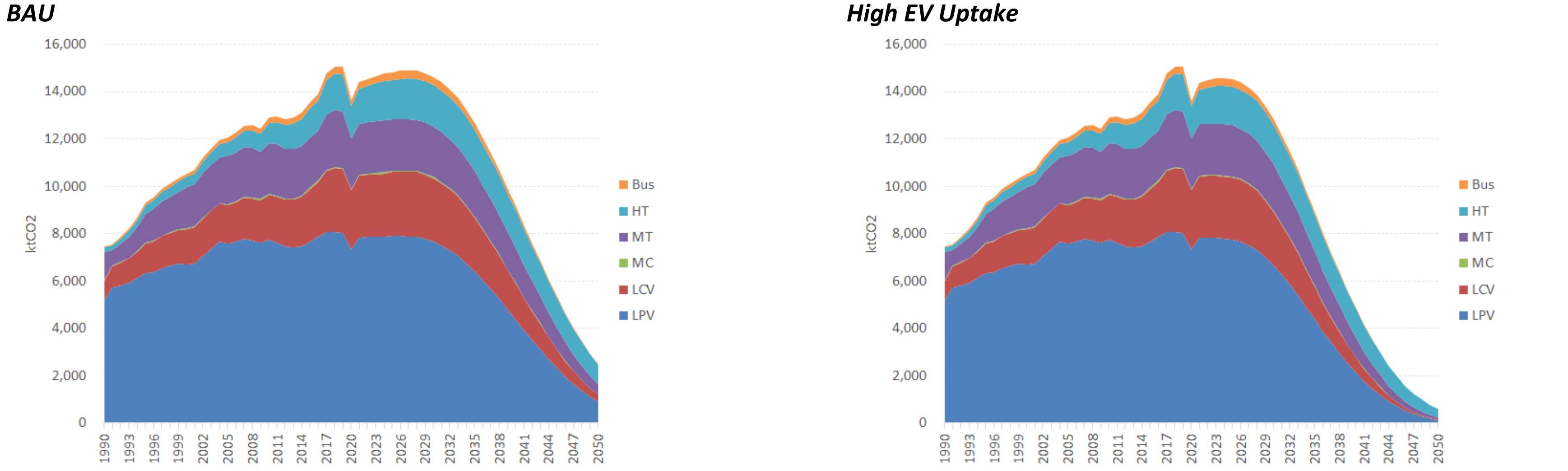


Figure 8: Total road transport sector costs (excludes road-building & road-maintenance and GST) (2019 $bn)

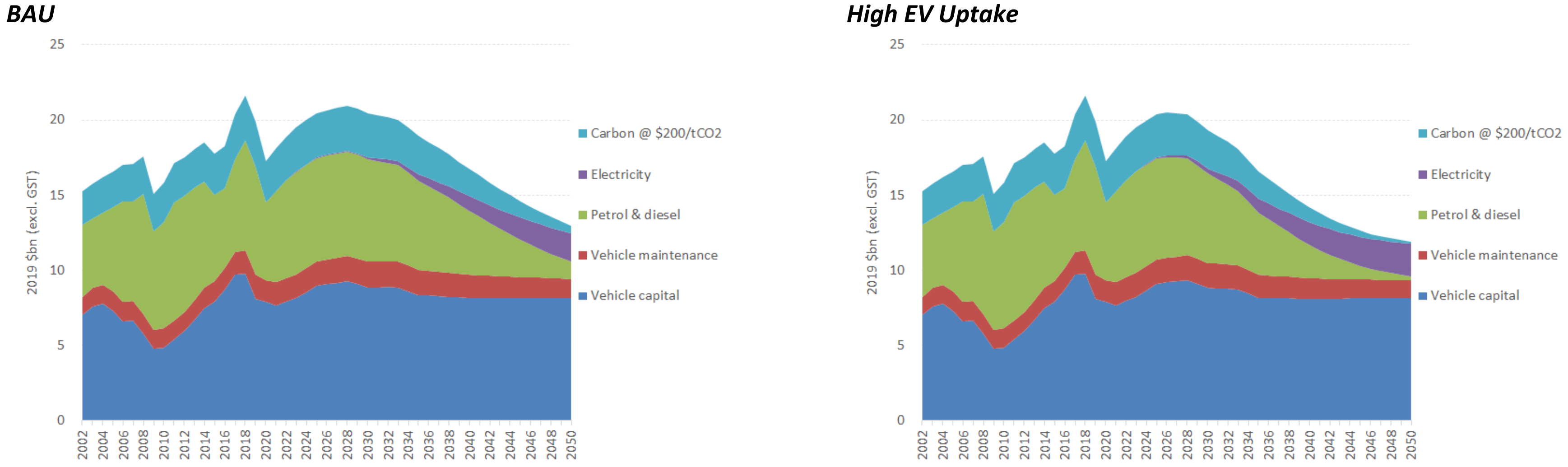
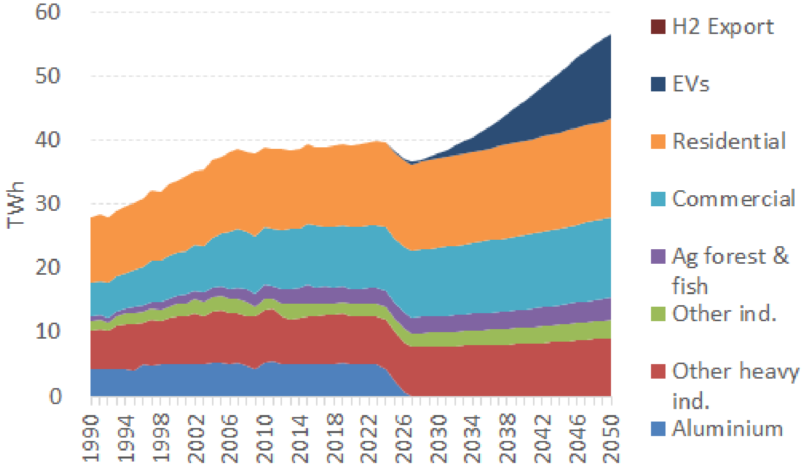


Figure 9: Electricity demand (TWh)

BAU



High EV Uptake

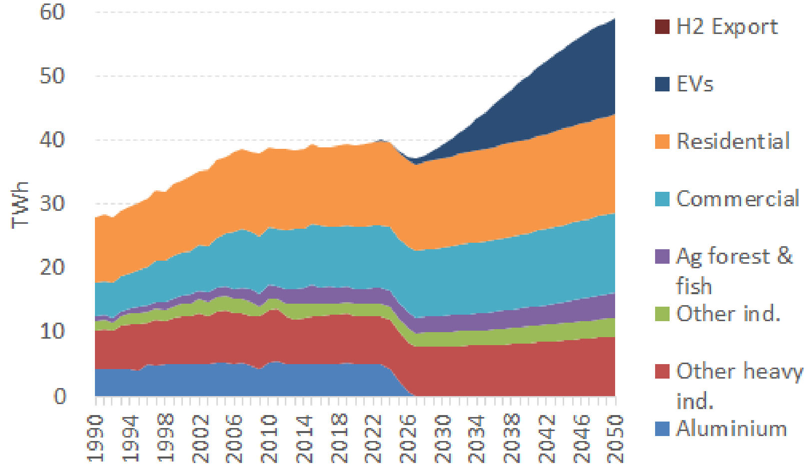
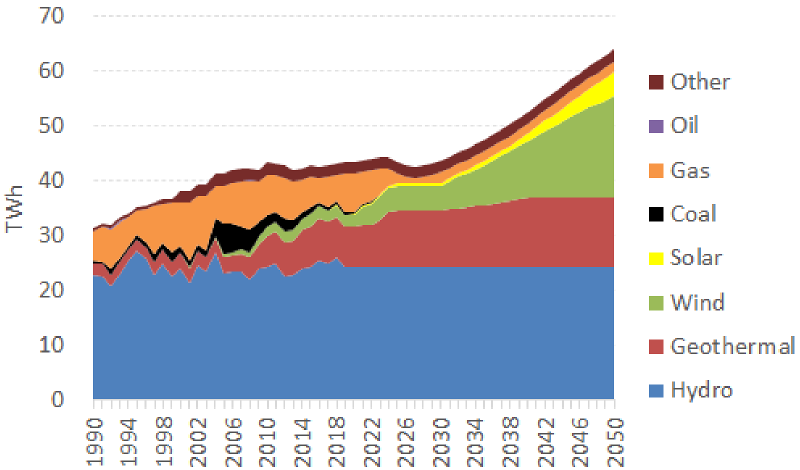
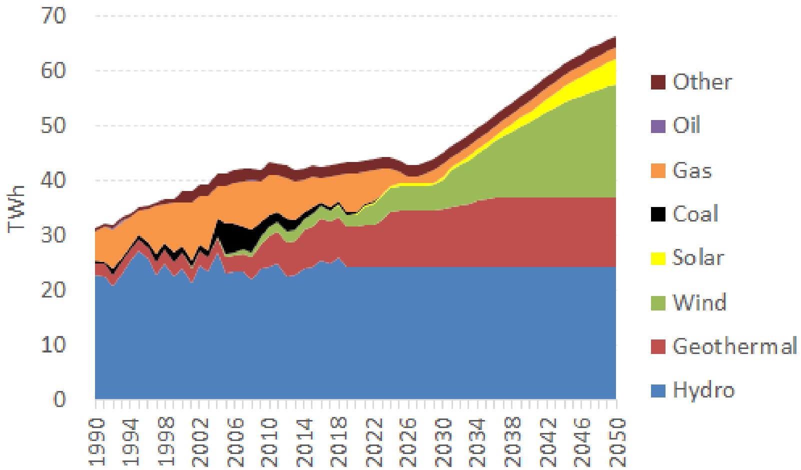


Figure 10: Electricity generation (TWh)

BAU



High EV Uptake



The key take-aways from the above results are:

- Higher uptake of EVs will lead to a substantial reduction in our emissions.
  - Our 2050 whole-economy[11] gross emissions will be approximately 3 $MtCO_2e$ less than in the BAU scenario. This is a significant amount in the context of trying to get to net-zero emissions by 2050.
  - Our cumulative whole-economy gross emissions from 2021-205 will be 84 $MtCO_2e$ less. This is slightly larger than our 2019 whole-economy gross emissions, including agriculture.
  - The increased electricity demand due to higher EV growth in the High EV uptake scenario is almost entirely met by building more renewable generation – 74% wind, 11% geothermal, 8% solar, and 7% gas. Note: If a higher carbon price was used to feed into the electricity module, even less would have been met by gas.
- This reduction in emissions is also accompanied by a reduction in costs:
  - The higher capital costs of EVs are offset by materially lower fuel[12] and maintenance costs.
  - Further, when EVs reach the point of being lower capital cost options than ICE vehicles, EVs even win on a capital cost basis.[13]
  - On a net present value[14] basis, and excluding carbon emissions, higher EV uptake will deliver savings of $10bn out to 2050 – a 4.5% reduction in road vehicle costs (purchase costs, maintenance, petroleum fuel, electricity supply, but excluding road building costs).
  - If avoided carbon emissions are included valued at a societal cost of NZ$200/$tCO_2$, the savings from higher EV uptake rise to $15bn – a 6.0% reduction.
  - Although the increased electricity demand from EVs drives a need for substantial electricity generation and network investment, this has relatively little effect on the $/kWh price. (Because the increased $ costs are spread over increased kWh)

Thus, not only is achieving this higher rate of EV uptake hugely significant in terms of New Zealand being able to meet its emissions reduction commitments, but doing so should deliver significant economic benefits.

The rest of this report analyses the merits of different policy mechanisms to overcome the barriers to EV uptake identified in section 2 in order to achieve this outcome.

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[11] Whole economy emissions includes electricity generation and other sectors of the economy.
[12] The inherently superior energy conversion efficiency of EVs compared to ICEs, means that the increased electricity costs are substantially less than the avoided petrol & diesel costs.
[13] This time of purchase price parity is estimated to be approximately 2029 for LPVs, 2032 for LCVs, 2036 for medium trucks, and 2048 for heavy trucks.
[14] Discounting future costs at a 6% discount rate.

4 Evaluation of potential 'core' policy mechanisms

This main section of the report addresses the policy measures that have been put forward by various parties as being the core elements needed to transition our vehicle fleet:

- Purchase price penalty / reward mechanisms:
  - Feebates
  - Fleet Emissions Standards
- ICE bans
- Emissions pricing

The evaluations of the relative merits of these mechanisms are detailed in sub-sections 4.1 to 4.3.

Sub-section 5 then addresses the extent to which different arrangements may be required for the import of second-hand cars from countries such as Japan.

4.1 Purchase price penalty / reward mechanisms: Feebates and Fleet Emissions Standards

Section 2.1 earlier identified that consumer behaviour barriers will tend to result in consumers favouring vehicles with lower up-front purchase costs, even if their higher running costs mean they have a worse total cost-of-ownership (TCO) than an alternative vehicle with lower running costs but higher up-front purchase costs. This is the dynamic currently faced by EVs, with their higher up-front costs being weighed more heavily by consumers than their lower running costs.

To address this, various overseas jurisdictions have introduced so-called 'Feebate' mechanisms which work to lower the purchase cost of low emissions vehicles and increase the purchase cost of high emissions vehicles, with the fees on high emissions vehicles being used to 'fund' the rebates on low emissions vehicles.

In 2019 the New Zealand government proposed a Feebate mechanism, which it called the 'Clean Car Discount'.

At the same time, it also proposed introducing a 'Clean Car Standard'. This mechanism falls under the category of mechanisms we call Fleet Emissions Standards, whereby suppliers of vehicles are penalised if the average emissions of the vehicles they supply are above a pre-specified standard.

While ostensibly these two mechanisms appear quite different, as we set out in this section, many of their core characteristics are fundamentally the same. In particular, with a Fleet Emissions Standard being based on the *average* emissions of a fleet of vehicles supplied, the penalties which would be incurred by supplying a vehicle whose emissions are above the standard can be offset by also supplying a vehicle whose emissions are below the standard. This has the potential to have the same effect as a Feebate: increasing the price of high emissions vehicles and decreasing the price of low emissions vehicles. We say there is this 'potential' effect because, as we set out in the body of this report, more conditions need to hold for such a pricing dynamic to eventuate.

In the event, neither the Clean Car Standard nor the Clean Car Discount proposals were passed by the then coalition government due to concerns expressed by one member of the coalition about possible negative effects. Further, in the wider policy debate, as well as questions being raised about the specific settings proposed for each mechanism, questions have been raised about the extent to which the mechanisms are complementary or overlapping, with some parties suggesting we may not need both.

In its manifesto, the now Labour government indicated that it intended to "*introduce a vehicle fuel efficiency standard for new and used light vehicles entering the fleet*" but made no comment as to whether it would also implement a Feebate mechanism.

Against this background of debate around whether New Zealand needs one or other of the mechanisms, and the potential similarity of outcome between the two mechanisms, we have analysed the two mechanisms alongside each other, seeking to address the following questions:

- Which mechanism is likely to perform better in the New Zealand context?
- Is there merit in implementing both mechanisms?
- What are the design specifics for each mechanism that are likely to maximise their effectiveness – either individually or in combination.

These are not straightforward questions, but they could have significant implications for the efficacy and the durability of the mechanisms:

- Settings which are too weak will result in the mechanisms under-performing relative to their potential, thereby resulting in higher combined transport and emission cost outcomes for New Zealand
- Conversely, setting which are too strong could result in some segments of society being unduly penalised due to their inability to purchase low-emissions vehicles which meet their requirements. If there are significant numbers of parties adversely affected this way, a mechanism is unlikely to be politically durable – particularly if these affected parties are vulnerable segments of society.

The structure of this section is as follows:

- Section 4.1.1 describes the basic operation of the two mechanisms
- Section 4.1.2 describes the experience from Europe which has used both mechanisms
- Section 4.1.3 assesses the relative merits of the two mechanisms, and whether there may be merit in implementing both
- Section 4.1.4 draws upon the analysis to set out some key parameters which are likely to maximise the effectiveness of the mechanisms

4.1.1 How do the two mechanisms work?

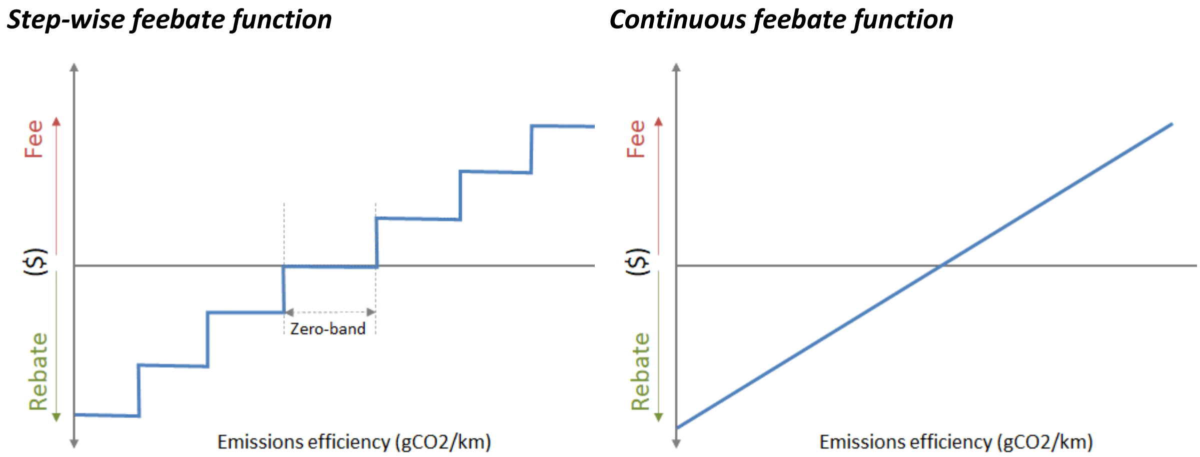
How does a Feebate work?

A feebate (also known as a Bonus-Malus mechanism in some countries[15]) mandates that a pre-determined fee or rebate be applied to vehicle sale prices based on the vehicle's emissions efficiency, expressed in gCO_2/km.

This is illustrated in Figure 11 below, which also illustrates that this can be implemented in a step-wise function with fees or rebates applying to 'bands' of emissions, or a continuous function (in this example a linear function).

[15] The French and Swedish schemes use the term Bonus-Malus, from the Latin for Good-Bad.

Figure 11: Operation of Feebate mechanisms



In general, most implementations of feebates have the settings of the mechanism (the emissions 'pivot-point' where a vehicle faces neither a fee or rebate, and the rate at which fees and rebates increase above and below this point) set against expectations of the pattern of sales of high and low emissions vehicles such that the sum of all fees collected will broadly equal the sum of all rebates given out – i.e. it is fiscally neutral.

However, as set out further below, it is inherently hard to accurately predict how consumers will respond to such altered prices, which will inevitably result in the scheme either giving out more rebates than fees (being a net draw on taxpayer funds), or vice versa. This requires the scheme to alter the feebate settings (setting of the pivot-point, and pattern of progressive fees and rebates above and below this point) to try and achieve future revenue neutrality, as well as 'wash-up' past over or under-payments.

How does a Fleet Emissions Standard work?

Most equipment 'standards' are absolute thresholds which a piece of equipment can either pass or fail. For example, the minimum energy performance standards (MEPS) for home appliances specify an absolute minimum level of performance for them to be sold in New Zealand.

A Fleet Emissions Standard is different in that it places an obligation on vehicle suppliers to meet an emissions standard (expressed in gCO_2/km) *on average* across all the vehicles they bring into the country during an evaluation period (typically a year).

If the average emissions of all the vehicles brought in by a supplier are above the target, the supplier must pay a penalty, expressed in $/$gCO_2$/km. If the average efficiency of the supplier's vehicles is below the target it does not pay a penalty.

For example, if a supplier brings in 100 vehicles, 60 of which were over the target by 20 gCO_2/km, and 40 of which were under the target by 10 gCO_2/km, the supplier's average performance relative to the target is 8 gCO_2/km over the target.[16] If the penalty were $50/$gCO_2$/km, the total amount it would have to pay would be 100 vehicles x 8 gCO_2/km x $50/$gCO_2$/km = $40,000.

In theory, this penalty can give rise to a price effect on vehicle purchase prices similar to that under a feebate mechanism. This is because the standard plus penalty increases the effective cost to a

[16] (60x20 + 40x-10)/100

supplier of selling a high emissions vehicle, and reduces the effective cost of selling a low emissions vehicle.[17]

These changes in the cost of supplying high and low emissions vehicles should flow through to changes in the price the supplier will charge consumers.

At the extreme, the scale of price effect should be the level of the $/g$CO_2$/km penalty multiplied by the extent to which a vehicle's gCO_2/km emissions is above or below the standard.

Thus, continuing with the above example, the price of the 60 higher emissions vehicles should increase by 20 gCO_2/km x $50/g$CO_2$/km = $100, and the price of the 40 lower emissions vehicles should reduce by 10 gCO_2/km x $50/g$CO_2$/km = $50. Overall, the relative price of the low emissions vehicles compared to the high emissions vehicles will have improved by $150.

The italicisation of "*at the extreme*" is because this outcome is unlikely to occur. Instead, the level of price change for high and low emissions vehicles should be just enough to result in sufficient consumers switching from high to low emissions vehicles to enable the standard to be met.

In this respect, it is entirely possible that a Fleet Emissions Standard will have *no* incremental price effect if the pattern of consumer purchasing will anyway deliver average emissions that are consistent with the standard. Such an outcome will either be due to the Standard being very weak or, more likely, due to other policy mechanisms (e.g. a Feebate or ICE ban) altering consumer purchasing to a level that would deliver outcomes consistent with the Standard.

It is only if these other policy mechanisms don't alter consumer purchasing sufficiently to meet the Standard that a Fleet Emissions Standard will start to incrementally alter vehicle purchase prices.

It should be noted that it is inherently hard for suppliers to predict the extent to which they will need to alter their price schedules to persuade sufficient numbers of consumers to switch from high to low emissions vehicles in order to meet the standard. This is directly analogous to the challenge (described on page 16 above) of governments trying to set Feebate settings such that the subsequent pattern of sales will result in the sum of Fees charged being equal to the sum of Rebates given out – i.e. to achieve fiscal neutrality. However, it is arguably even harder for individual suppliers to undertake such evaluations as they are not just concerned with the totality of high and low emission vehicle sales, but how their own models' competitiveness in the various high and low emissions segments will alter relative to their competitors.

As such, relying entirely on a Fleet Emissions Standard to deliver vehicle price changes creates greater risk for suppliers than mechanisms such as a Feebate. Thus, even though a Fleet Emissions Standard should, over time, be able to deliver the level of price change necessary to meet the standard, this greater risk on suppliers will likely flow through to higher consumer prices than would occur under a Feebate mechanism.

Most implementations of this policy allow for vehicle suppliers to pool their vehicles for evaluation against the standard. For example, if both supplier A and supplier B brought in 100 vehicles, but A's average was 20 gCO_2/km above the standard, but B's was 20 gCO_2/km below the standard, if they pooled their vehicles for evaluation the net would be exactly meeting the standard and no penalty would need to be paid.

This is an important design feature to enable suppliers of vehicles which are inherently very low emissions (e.g. BEVs) to benefit and thus allow them to lower their prices to consumers. If this pooling wasn't allowed, an EV-only company such as Tesla would never face a penalty and so would face no price-incentive which it could pass on in lower vehicle prices. With pooling, a supplier of

[17] The reduction in the effective cost of selling a low emissions vehicle arises through being able to offset the lower emissions against the penalty it would have incurred on supplying a higher emissions vehicle. In effect, a low emissions vehicle earns negative penalties.

lower emissions vehicles can trade their excess achievement against the standard with a supplier of higher emissions vehicles. This trading reduces the effective cost to the supplier of low emissions vehicles which they can then pass on in lower prices to consumers.

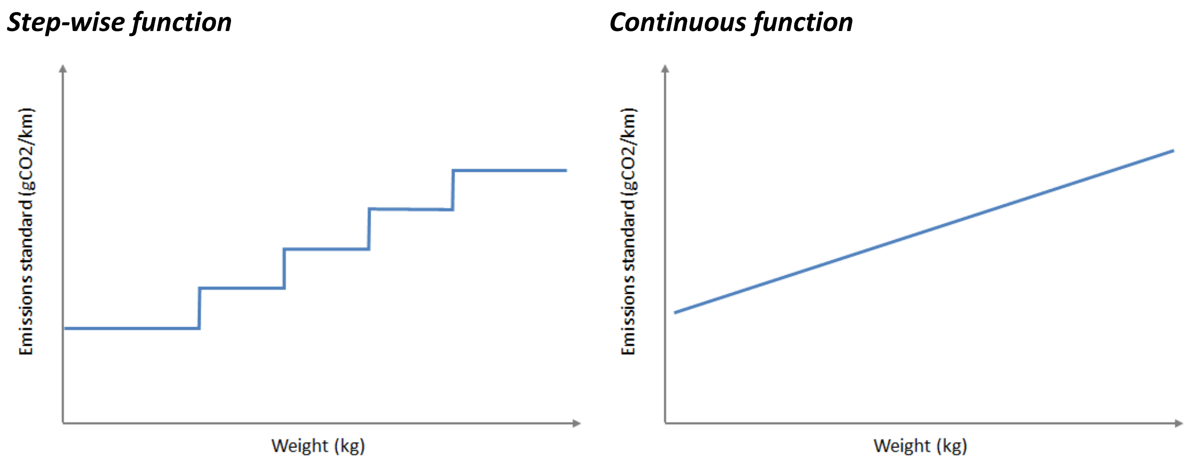
Further, such trading is also likely to be a useful mechanism to help suppliers manage their risk of exposure to penalties. On balance, improved risk management should result in lower consumer prices than would otherwise be the case. However, it is hard to reasonably estimate the scale of potential lower consumer prices.

Some implementations of this policy also allow for under-achievement in one period to be offset by over-achievement in subsequent periods – and vice versa. For example, the 2019 proposed Clean Car Standard allowed for over-achievement in a year to be 'banked' for use in any of the following three years, and under-achievement in a year could be met by 'borrowing' via over-achieving the following year.

This banking and borrowing is another mechanism intended to help vehicle suppliers manage their risk position – noting that the ability of vehicle suppliers (particularly suppliers of New vehicles) to change the product mix they bring into the country is more constrained in the short term than over the longer term. However, care must be given to manage the risk of parties with significant 'borrowings' from exiting the market and not honouring their debt.

Most implementations of this policy also vary the standard with some measure of the vehicle's size as illustrated in Figure 12, which shows the emissions standard rising with a vehicle's weight – either in a step-wise or continuous function. (Note, the emissions efficiency is on the y-axis for these graphs, whereas it was on the x-axis for Figure 11).

Figure 12: Varying Fleet Emissions Standard with size of vehicle



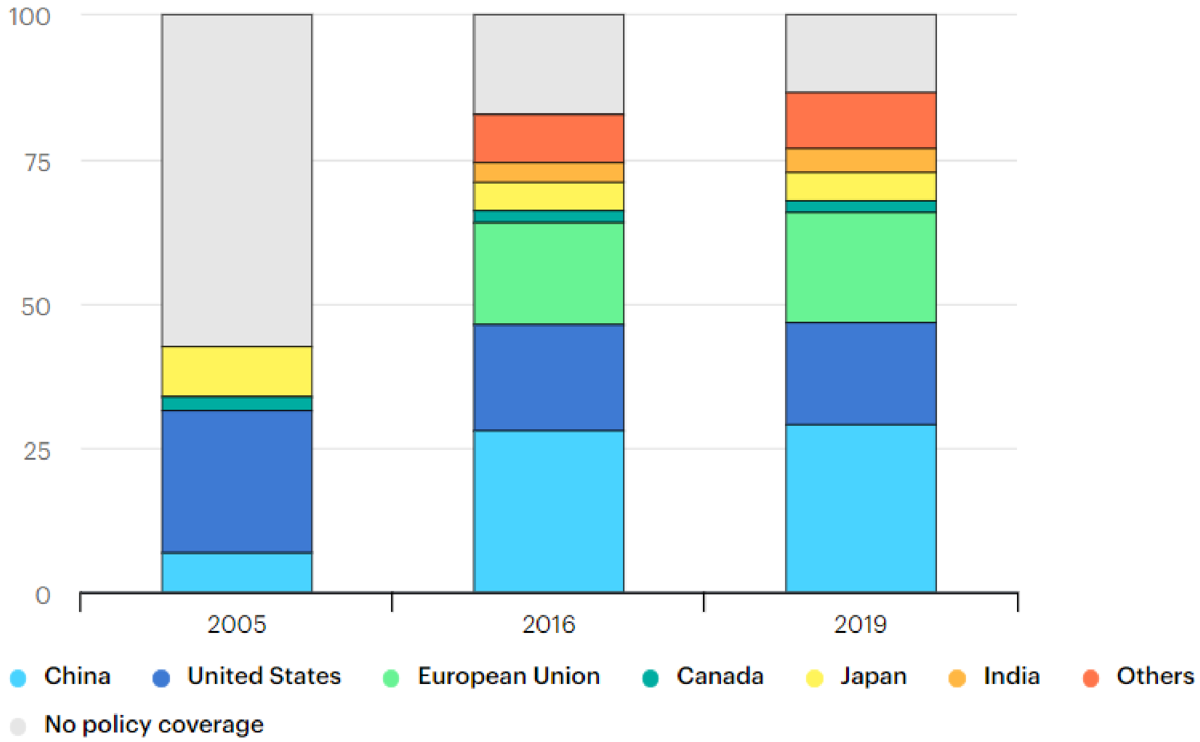
Varying the standard with the size of vehicle recognises that vehicles with a larger carrying capacity are inherently heavier and require more energy to move than vehicles with a smaller carrying capacity. Comparing larger vehicles against a higher gCO_2/km efficiency target than smaller vehicles thus doesn't unduly penalise vehicle owners who require the utility of vehicles with larger carrying capacity, but still preserves the incentive to purchase relatively more efficient large vehicles.

Given that carrying capacity is not a metric which is capable of being recorded on a standardised basis, Fleet Emissions Standard mechanisms use another metric as a proxy to vary the standard with size of vehicle – most typically vehicle weight (as in Figure 12), but sometimes vehicle footprint.[18]

[18] For the US Corporate Average Fuel Economy (CAFE) standards, vehicle footprint is the area defined by the four points where the tires touch the ground. It is calculated as the product of the wheelbase and the average track width of the vehicle.

Internationally, Fleet Emissions Standards are now a well-established policy mechanism. Indeed, as illustrated in Figure 13 below, New Zealand is now in the small minority of countries that haven't implemented a Fleet Emissions Standard for light vehicle sales.

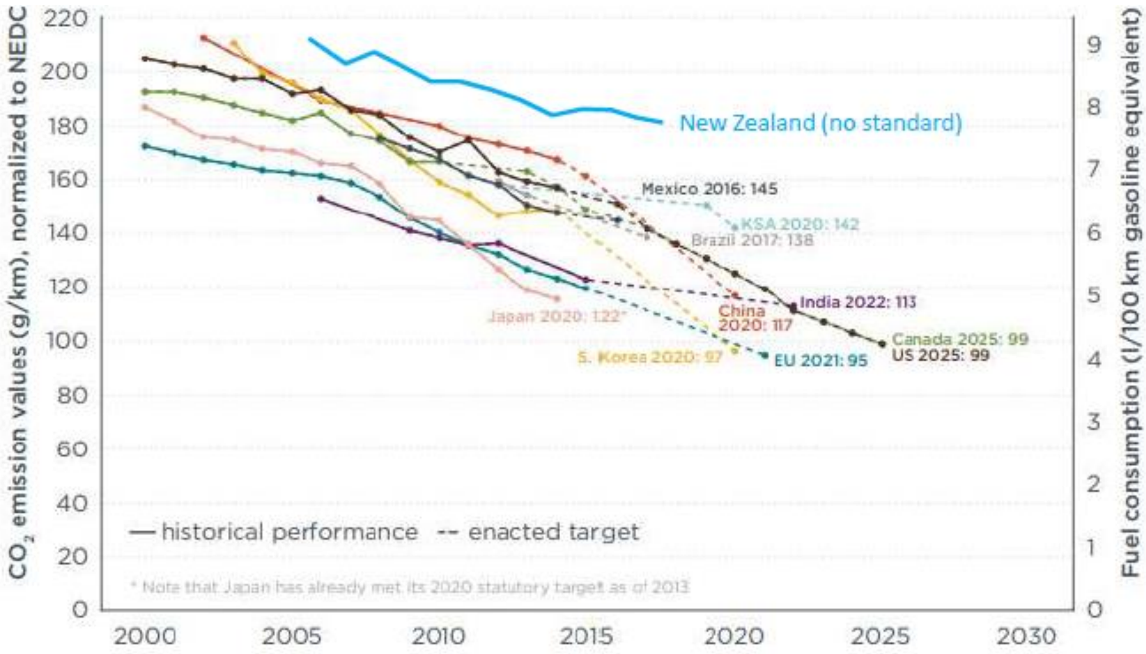
Figure 13: Percentage of global light vehicle sales covered by fleet emissions standards



Source: https://www.iea.org/reports/trucks-and-buses

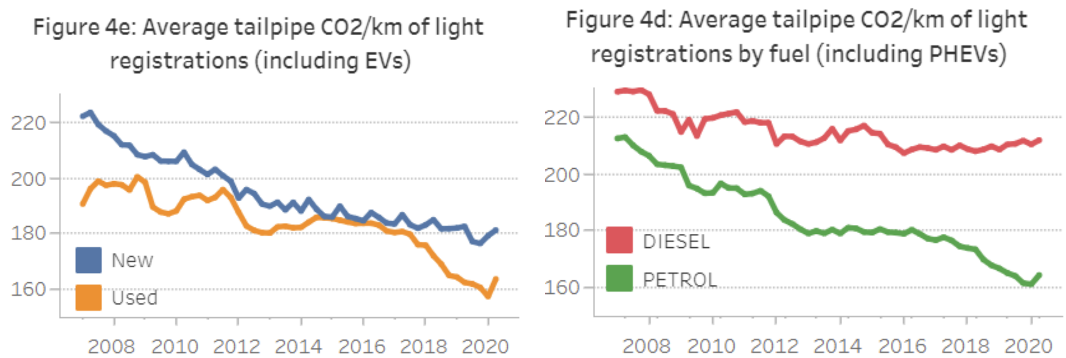
Despite these international standards driving the production of more efficient vehicles and EVs in the global market place, the average emissions of vehicles imported into New Zealand remain significantly higher than jurisdictions with Fleet Emissions Standards, as illustrated in Figure 14. This indicates that the international availability of EVs and efficient vehicles will not necessarily result in their uptake here to the same extent as countries with Fleet Emissions Standards in place

Figure 14: Comparison of historical light vehicle emissions in New Zealand and overseas



Further, New Zealand's high emissions is not as a result of New Zealand having a high proportion of used vehicles as entrants to the national fleet. Figure 15 below shows the relative efficiency of new and used import vehicles when they first enter the national fleet[19]. This shows that the average CO_2 emissions of used vehicles entering the fleet is lower than the average CO_2 emissions of new vehicles. The purchase of new diesel vehicles is the main factor contributing to the difference between the average emissions from new and used vehicles (used diesel vehicles are not generally available from Japan).

Figure 15: Historical change in emissions for vehicles entering New Zealand's light fleet



Source: MoT

4.1.2 Lessons from Europe

The experience of Europe is instructive in considering the relative performance of Fleet Emissions Standards and Feebates.

In 1995 the European vehicle industry introduced voluntary emissions standards which had a target of reducing emissions by approximately 2.1% per year to meet a 2008 target of 140 gCO_2/km.

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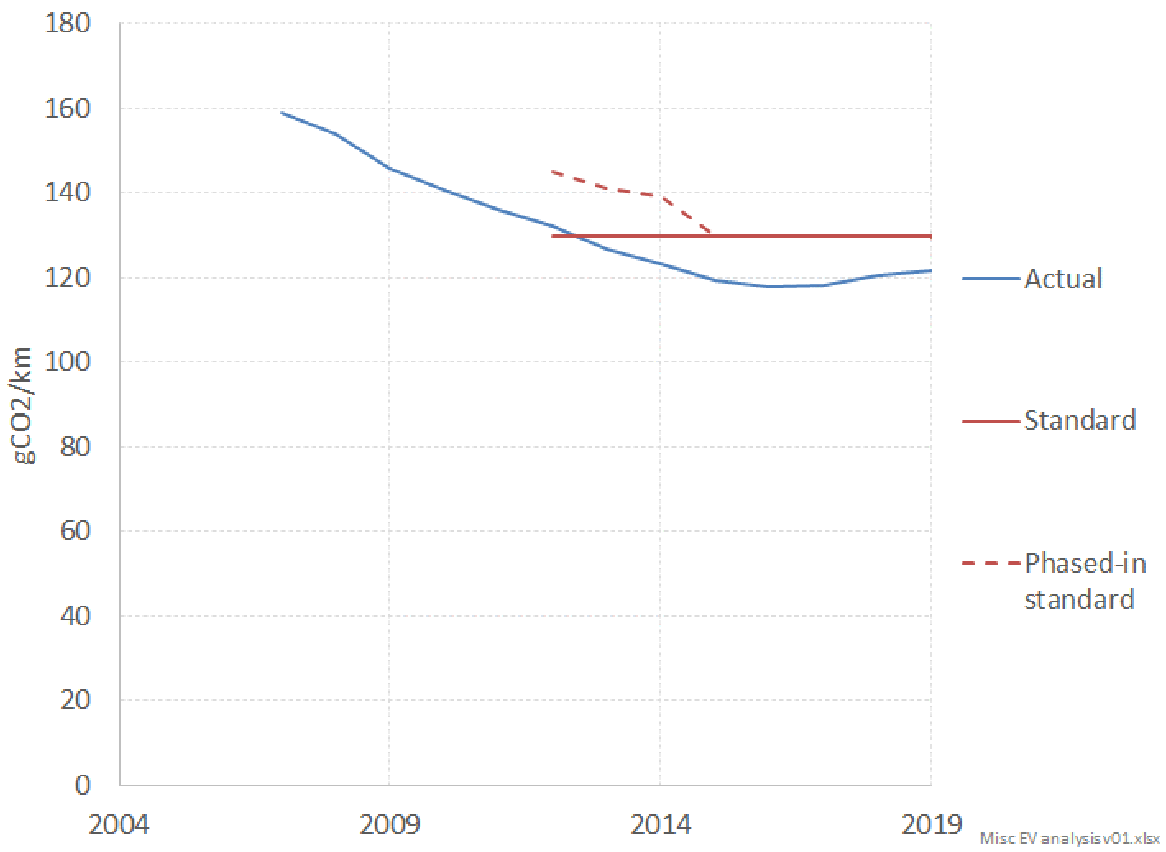
[19] https://www.transport.govt.nz/statistics-and-insights/fleet-statistics/quarterly-fleet-statistics/

However, with no teeth behind the mechanism, the emissions of new passenger cars entering Europe failed to fall below the required standard.

By 2005 it was clear that the voluntary approach was not working, causing the European Commission to develop a mandatory scheme. In 2007 it announced an emissions performance standard which was passed into legislation in 2009. This set emissions performance standards for new passenger cars starting from 2012. This specified a sales and mass-weighted standard of 130 gCO_2/km – albeit with effectively weaker standards for the first three years as it was phased-in.[20] Manufacturers who exceeded this target would face a penalty (called an 'excess emissions premium') of €95/gCO_2/km (approximately NZ$160/gCO2/km using today's NZ$/€ exchange rate).

As can be seen in Figure 16 below, since its introduction, the average emissions of new passenger cars entering the European fleet have been materially below the standard up to and including 2019.

Figure 16: Historical emissions and European standard up to 2019



Source: Concept analysis of Jato.com data and EU regulations, with phased-in standard based on Concept analysis of likely scale of effect of phasing-in approach using detailed vehicle fleet emissions data.

The fact that the emissions from new vehicles stopped falling after 2015 (and indeed have risen from that point[21]) may be seen as an indication that the level of the standard was too weak. Indeed, the fact that collective emissions were significantly below the standard meant that no penalties were paid in aggregate by manufacturers, and there was little observed effect on the purchase price of relatively high and low emissions vehicles.

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[20] The weaker standards due to phasing-in over the first three years were due to manufacturers being able to exclude the worst x% of their vehicles, with x being 35%, 25%, then 20% over the first three years.

[21] The increase in actual emissions since 2016 is largely due to 'dieselgate' and the significant shift away from consumers purchasing (more CO_2-efficient) diesel vehicles towards (less CO_2-efficient) petrol vehicles.

However, the above data does appear to indicate that the standard has had an effect in terms of setting a ceiling on new vehicle emissions. The scale of penalties from non-compliance are such that manufacturers collectively face strong incentives to not get close to the standard. Actual emissions appear to have 'tram-lined' the effective standard since its introduction. (i.e. taking account of phase-in allowances, and also considering the exceptional dynamic of 'dieselgate' causing a rise in emissions in later years).

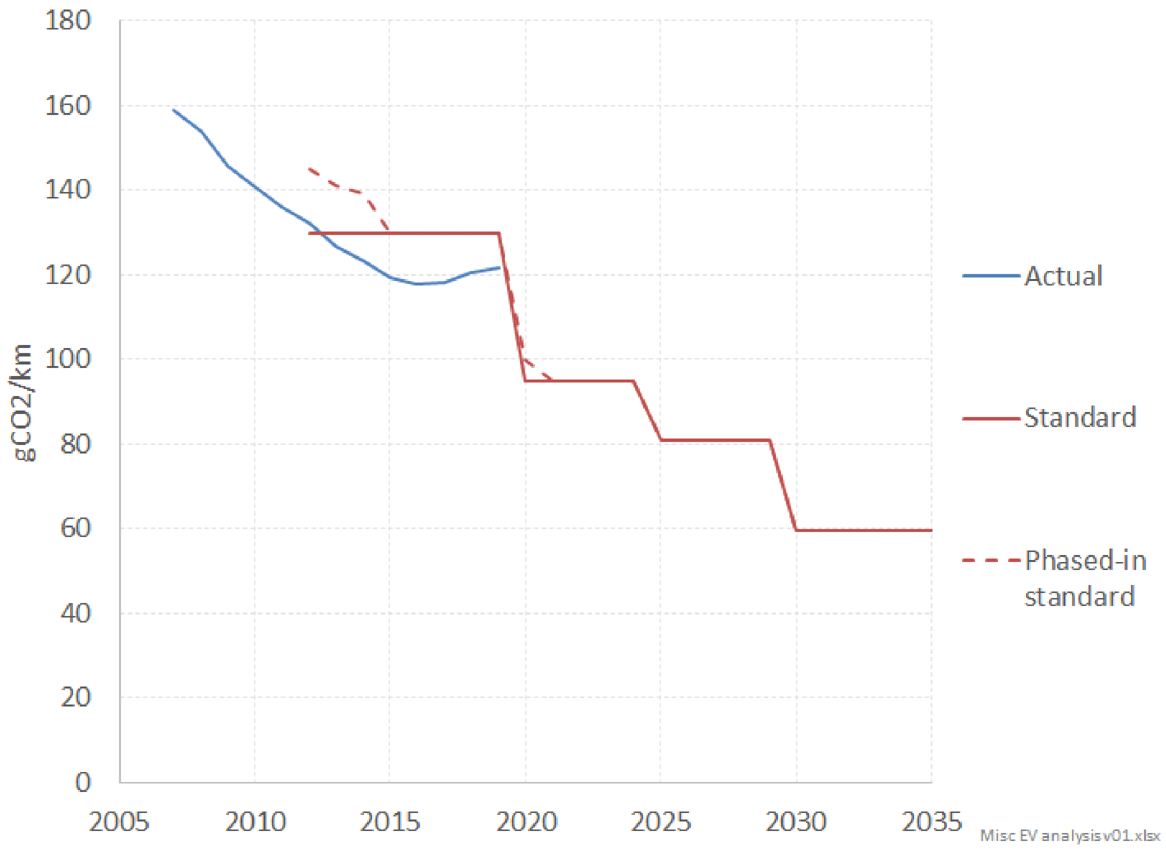
Further, it should be appreciated that the standard was never intended to be the sole mechanism to effect improvements in new vehicle emissions efficiencies. Europe had always intended that the standard be complemented by tax policies to provide additional incentives for individuals to purchase clean vehicles. However, such tax mechanisms were regarded by most European states as outside the jurisdiction of the European Commission and, as a consequence, no Europe-wide clean vehicle tax incentive was ever implemented.

Only a few countries introduced significant complementary tax incentive policies, some of the most successful of which were fundamentally Feebate-like systems (as in Norway, Sweden, France, and the Netherlands). As a consequence, the rate of uptake of EVs and average emissions from ICEs have all been substantially better in these countries than in other European states.

Then, in 2019, the European Union revised the emissions standard such that from 2020 the standard would move to 95 gCO_2/km (albeit phased-in in 2020 through manufacturers being allowed to exclude the worst 5% of their vehicles), then to just over 80 gCO_2/km from 2025 and 60 gCO_2/km from 2030.

As is illustrated in Figure 17 below, this tightening of the European emissions standard from 2020 is a considerable drop relative to 2019.

Figure 17: Actual versus standard emissions for passenger cars in Europe



Source: Concept analysis of Jato.com data and EU regulations, with phased-in standard based on Concept analysis of likely scale of effect of phasing-in approach

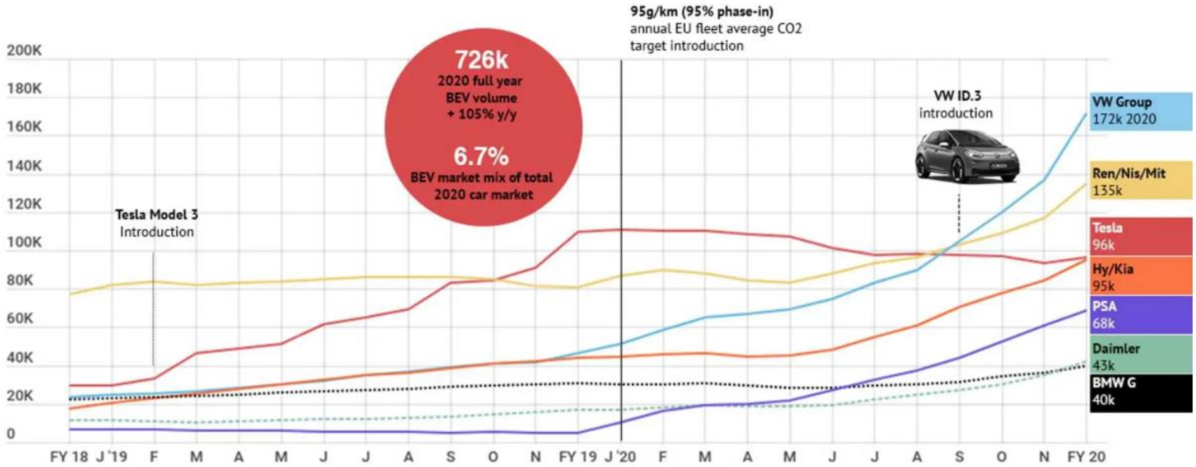
The much tighter standards are going to be hard for many manufacturers to meet and, as a consequence, some are facing having to pay significant penalties, particularly from 2021 – noting that the significantly reduced ICE sales during 2020 as a result of the Covid-19 pandemic, coupled with the more relaxed standard for 2020, should make achievement of the 2020 target much easier than the 2021 target.

To get a feel for the scale of potential fines, analysis undertaken at the start of 2020 indicated that, based on projections at the time, the 2021 fines could be €1.4 billion for the Volkswagen group, and fines equivalent to 10% of their 2017 global earnings for both Ford and Fiat-Chrysler.[22]

In response to these projected fines, manufacturers started to rapidly increase the supply and promotion of low-emissions vehicles during 2020 and for 2021. Manufacturers are also starting to do deals with each other for example, with Tesla selling credits to companies such as Fiat-Chrysler.

Figure 18 below (which is only for BEVs, not all plug-in EVs) illustrates the major increase in EV sales for 2020 compared to 2019.

Figure 18: Western Europe 18[23] New BEV passenger car 12-month rolling registrations



Source: https://insideevs.com/news/466564/was-tesla-disrupted-traditional-carmakers-europe/

For Volkswagen, the scale of effort was such that they managed to reduce a projected fine in the order of billions to approximately €275 million. And in the same December investor call where they made this assessment, Volkswagen said they expect to be compliant from 2021 onwards.

It appears that some of this effect is flowing through to the price of vehicles. In early December 2020, Concept compared the recommended retail prices of 40 different BEV and ICE models in the UK and New Zealand. Using this simple comparison, it appears that the average price of BEVs in the UK is 15% lower than in New Zealand, whereas the price of ICE vehicles is broadly the same.

That said, given this limited data sample, it is not possible to conclusively conclude that the pricing is due to the effect of the tighter European standard or not. However, comments from some vehicle manufacturers indicate they are planning to limit the supply of ICE vehicles (whether achieved through price rationing or some other constraint) to manage their liability. For example, in January 2020 Vauxhall's managing director said

> *"If the demand we're able to create for low-emission vehicles is below the [required] percentage of the predetermined mix, the consequence would be a limit to the number of vehicles we're able to sell. If the amount of pure combustion engines*

[22] https://www.carmagazine.co.uk/car-news/industry-news/co2-emissions-limits-europe/

[23] The 18 countries are the EU member states prior to the 2004 enlargement (including the UK), plus the EFTA markets of Norway, Switzerland and Iceland.

goes up and we go beyond [our CO_2 target], the financial penalty is so great the company cannot afford to take that risk."[24]

Looking beyond the effect the tightened emissions standard is having in the early 2020s, it is not clear that it will continue to have such a significant effect in later years.

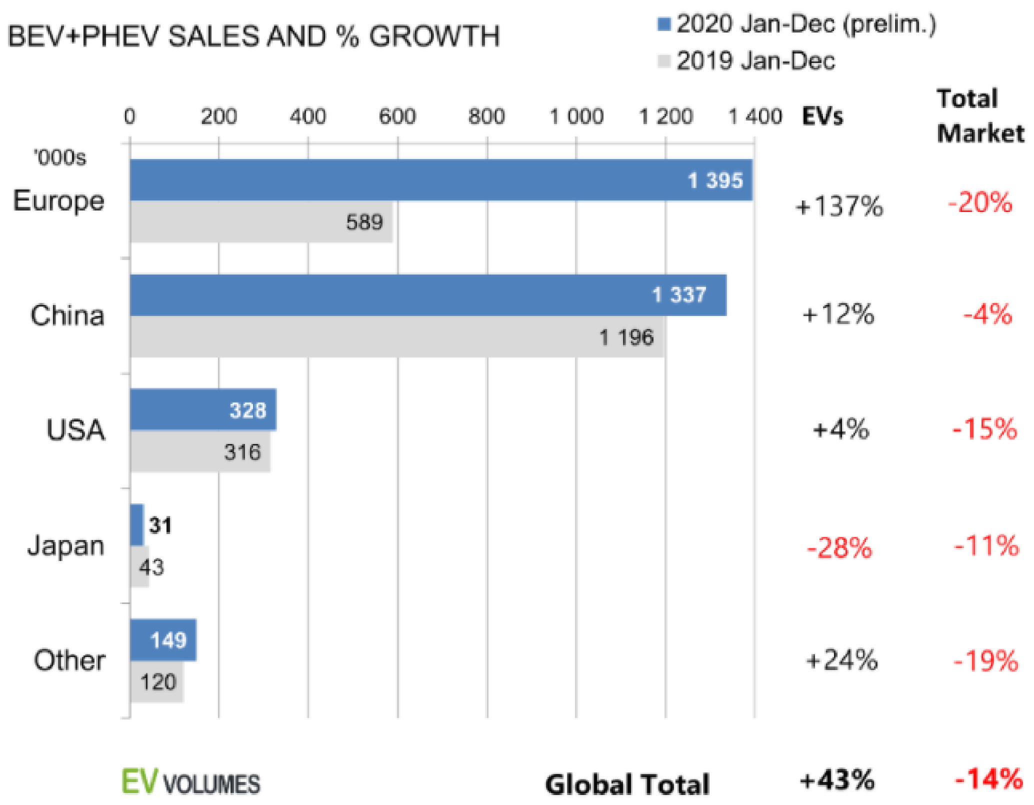
In part this is due to the every-five-year step-change nature of the proposed movement in the standard. Thus, the first year of the new five-year period will be the most challenging for manufacturers to meet, but the pace of clean-car development should make the final year of the five-year period much easier to meet. This effectively varying strength of the standard over time may reduce the extent to which manufacturers pass through the price effect to consumers.

Further, the projected pace of clean-car development is such that the 2025 and 2030 tightening of the standards are likely to be much easier to meet than the tightening that has occurred in 2020. Indeed, any manufacturer wishing to sell into those nine European countries who have already announced ICE bans from 2030 or earlier (see section 4.2 later) will massively over-achieve the 2030 standard. i.e. the effect of the standard will have been superseded by other policy mechanisms.

Europe vs the World

Figure 19 illustrates how the much tougher emissions standard for 2020 has driven rapid uptake of EVs in Europe compared to overseas jurisdiction where there hasn't been such a step-change in policies.

Figure 19: BEV + PHEV sales and % growth

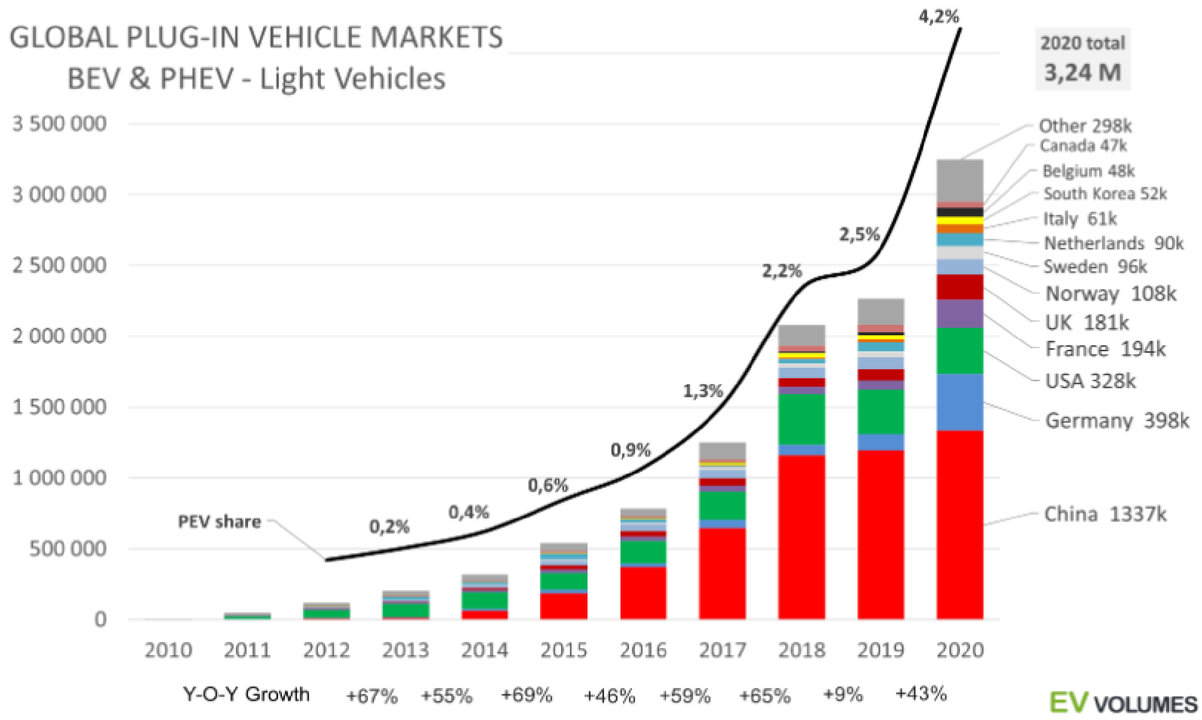


Source: http://www.ev-volumes.com/news/86364/

[24] https://www.carmagazine.co.uk/car-news/industry-news/co2-emissions-limits-europe/

Figure 20 below gives further detail of how EV uptake has changed for various jurisdictions over the years, but also illustrates that the high levels of EV uptake in Europe are more heavily concentrated in some European nations than in other.

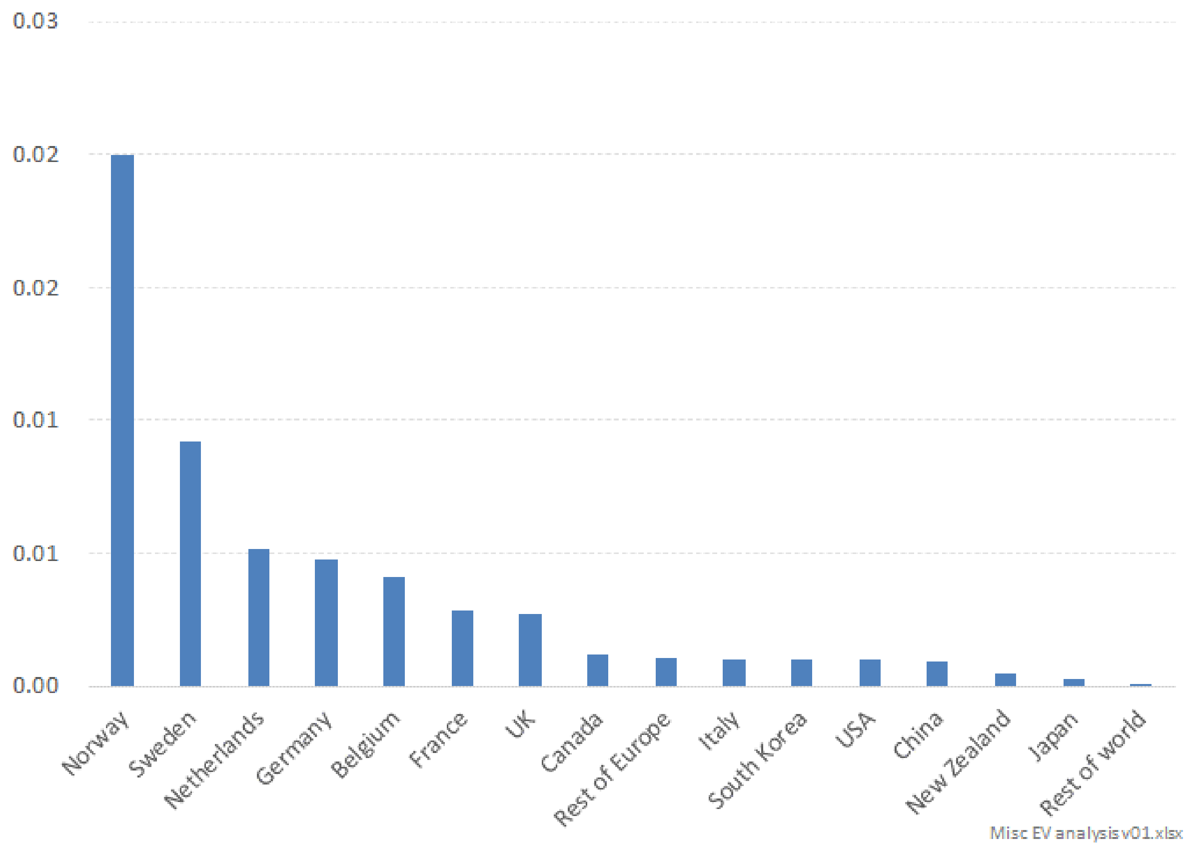
Figure 20: EVs sold each year



Source: http://www.ev-volumes.com/news/86364/. Note: 'PEV share' refers to plug-in EV share of total global new vehicle sales

This breakdown of differing rates of EV uptake in 2020 among differing jurisdictions is developed further in Figure 21, which shows the rates of uptake per head of population.

Figure 21: New vehicle sales per head of population in 2020[25]



Source: Concept analysis based on EV-Volumes plus MoT data

This shows that, although Europe has a common Fleet Emissions Standard, the rates of uptake have been significantly greater in those countries with the most comprehensive complementary policies in the form of feebates or other subsidies.

4.1.3 Feebate or Fleet Emissions Standard or both?

Given the similarity of potential effect of both mechanisms detailed in section 4.1.1, the question then becomes whether New Zealand needs both mechanisms or just the 'best' one – whichever that is.

We think *both* mechanisms should be implemented in New Zealand for the following reasons.

On the supplier side, we think Fleet Emissions Standards will create stronger incentives to secure scarce global EVs for New Zealand supply than a Feebate. This arises from the combined impact of commercial incentives arising from the penalty, plus many suppliers' reluctance to be perceived as not meeting a government requirement.

However, we note that solely relying on a Fleet Emissions Standard would create significant risk for suppliers, as they would need to forecast the likely consumer response to altering high- and low-emission vehicle prices in order to meet the Standard – something which is inherently very hard to do. On balance, increasing risk on suppliers is likely to flow through to increased consumer prices to

[25] The graph is based on New vehicle sales. If import of Used vehicles were also included for New Zealand (noting that this would be inconsistent with the rest of the data series), New Zealand's bar would be the same height as the Rest of Europe.
For reference, the average across the whole of Europe (value not shown) is almost exactly the same as the UK value.

some degree – likely through suppliers being more likely to pass through the penalty element for supply of high emissions vehicles but being less likely to pass through the penalty offset benefit for supply of low emissions vehicles.

In this respect, we think a Feebate will have a more certain impact on the relative prices of EVs and ICEs than a Fleet Emissions Standard with an equivalent penalty regime,[26] and is especially more likely to deliver EV price reductions. In large part this is because Feebates create a defined schedule with specified fees and rebates, whereas the price effects from a Fleet Emissions Standard will be affected by consumer and supplier behaviour making them harder to predict and accurately pass through to consumers.

However, we note that it is inherently hard for a government to forecast the likely consumer response to altered vehicle prices due to a Feebate. Not only will this likely result in the scheme either collecting more Fees than it gives out in Rebates (or vice versa), but it also means that a Feebate does not strictly guarantee that cars entering the fleet will achieve an average emission standard.

For all these above reasons (supplier incentives, supplier risks, certainty of outcome) we think that a combination of a Fleet Emissions Standard used in conjunction with a Feebate will deliver the best outcome over time:

- The Feebate would do much of the heavy lifting in terms of altering consumer prices, significantly reducing the risk for suppliers.
- The Fleet Emissions Standard will act as a 'backstop', providing a strong incentive on suppliers and a greater level of assurance that average emissions will meet a given standard over time.

This conclusion of the merits of implementing both mechanisms also draws upon the experience of Europe, where the tougher standard for 2020 has created significant impetus among vehicle suppliers, but by far the greatest success has been achieved in those countries which have comprehensive complementary policies in the form of Feebates or similar.

We note that if both mechanisms are implemented, the combined effect on vehicle prices is unlikely to be the sum of the price effect of each mechanism implemented separately. This is because a Feebate will alter consumers' purchases between high and low emission vehicles – potentially to the level sufficient to ensure the average emissions are at or below the standard, in which case the Fleet Emissions Standard will have no effect on prices.

It is only if the Feebate does not sufficiently alter behaviour to meet the Standard that a Fleet Emissions Standard will start to affect prices, but only to the extent necessary to incrementally alter consumer purchases beyond the level that would have been delivered by the Feebate alone.

Also, on pricing we note that each mechanism has a similar potential for some of the Feebate rebate, or Fleet Emissions Standard penalty offsets, to be captured as higher margins by suppliers – a point of some debate. This is due to the current dynamic of scarce global supply of EVs and thus the reduced effective competition between suppliers of EVs. As global EV supply, and the number of different EV models, increases, this effective inter-EV competition will increase and limit the ability of suppliers to capture such margin.

Lastly, we note that a Feebate arguably has some greater political acceptability challenges because of the higher level of visibility of impacts on vehicle purchase prices. While this is great for consumers buying vehicles whose price is reduced, it can cause resentment from consumers who

[26] The rate at which Fees and Rebates increase either side of the Feebate pivot-point is equivalent to the penalty that suppliers face (and penalty offsets that they would benefit from) for supplying vehicles increasingly above and below the standard in a Fleet Emissions Standard regime.

buy vehicles whose price has increased. In contrast, while a Fleet Emissions Standard would also cause price increases (and decreases), these are much less transparent to consumers.

Offsetting this greater political challenge of a Feebate is the ability to apply more potential levers to address some key concerns. In particular, with a Feebate it is possible to limit eligibility for receiving rebates to vehicles below a certain price. This will help manage the negative dynamic of fees charged on vehicles being purchased by middle and lower-income consumers being used to fund rebates on 'luxury' vehicles purchased by upper-income consumers.

That said, it should be noted that the high end of the vehicle market has been leading the way in terms of offering electric models. Further, the current high capital cost of batteries means that a model whose ICE equivalent may be considered 'upper-mid-range' has an EV version whose price is considered 'luxury' (but with much lower running costs to offset the capital cost premium). As such, if it should be deemed necessary to implement such a mechanism, care needs to be taken that the cut-off price for 'luxury' is not set at too low a level.

Summary on choice between mechanisms

In summary, we think that a desired switch from consumers purchasing high emissions vehicles to low emissions vehicles could be achieved with either mechanism working on its own.

On balance, if such a sole-mechanism approach were adopted, we think a Fleet Emissions Standard would give greater confidence of achieving the desired emissions outcomes than a Feebate – albeit with the potential effect of higher risks to suppliers from a 'Standard-only' approach being passed through in higher prices to consumers to some extent.

However, there is likely to be merit in implementing *both* mechanisms:

- The Feebate would deliver much of the price effect required and, in doing so, help manage the risk for suppliers. The use of a Feebate would also enable outcomes such as price reductions not being given to luxury vehicles.
- The Standard would ensure that suppliers faced strong enough incentives to bring low emissions vehicles to the country at a level sufficient to meet the desired outcome. It would also act as a 'backstop', delivering any additional price changes necessary to achieve desired outcomes to the extent that the Feebate price changes alone are insufficient.

4.1.4 How should a Fleet Emissions Standard or Feebate be designed?

Irrespective of whether either or both mechanisms are implemented, the most significant driver of outcomes will be the *settings* of the mechanisms. i.e.:

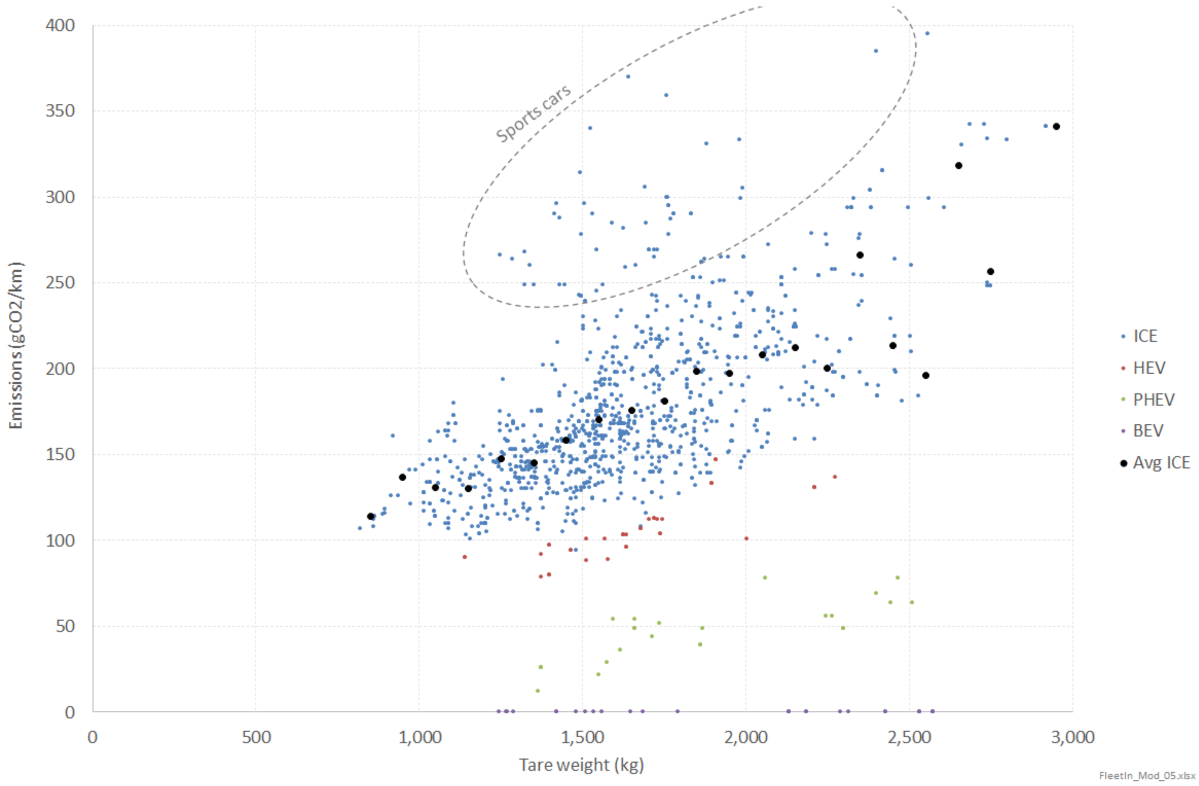
- The gCO_2/km level of the standard, or feebate pivot-point; and
- The \$/gCO_2/km level of the Fleet Emissions Standard penalty, or schedule of fees and rebates above and below the pivot-point.

With regards to what level should these settings be set at, we think an appropriate place to start is identifying the proportions of uptake of the different types of vehicles that would deliver the best outcome for New Zealand. This will help consideration of:

- where to set the gCO_2/km Fleet Emissions Standard or Feebate pivot-point, as we believe the 'mid-point' of the optimal mix of relatively high and low emissions vehicles should be where the standard or pivot-point should be set – depending on whichever of these instruments is to be the principal instrument to deliver the price effect to consumers.
- what level of price signal may be required to deliver changed consumer purchasing to deliver a vehicle uptake mix whose average emissions are at this mid-point.

To help consider where the emissions mid-point should be, Figure 22 plots the emissions versus weight for all the New Light Passenger Vehicle models entering New Zealand in 2019, distinguishing by engine type.

Figure 22: Emissions of New Light Passenger Vehicle models entering New Zealand in 2019



Source: Concept analysis of MIA data

The key immediate take-aways from this analysis are:

- The different types of vehicle with electric motors are significantly more emissions efficient than ICE vehicles. Compared to the average pure ICE vehicle, the nominal emissions from the average vehicle with an electric motor is: HEVs = 65%, PHEVs = 30%, BEVs = 0%.
- For a given size and type of engine, there is a spread of more or less emissions-efficient vehicles – except for BEVs which always have zero emissions. Our more detailed analysis of this data indicates that, for a given weight, the most emissions-efficient ICE is only 80% of the emissions of the average ICE. However, for ICE vehicles within similar price brackets, the emissions range is somewhat narrower, with emissions of the most efficient tercile only being 88% of the emissions of the middle tercile.
- Heavier vehicles generally have higher emissions than lighter vehicles. This is due to the inherent physics of heavier vehicles requiring more energy to move.

Each point on Figure 22 represents a particular model and sub-variant. E.g. There are 26 points representing the different variants of New Holden Commodore, with variants relating to engine size, model year (2017 to 2019 models in this data set), trim etc.

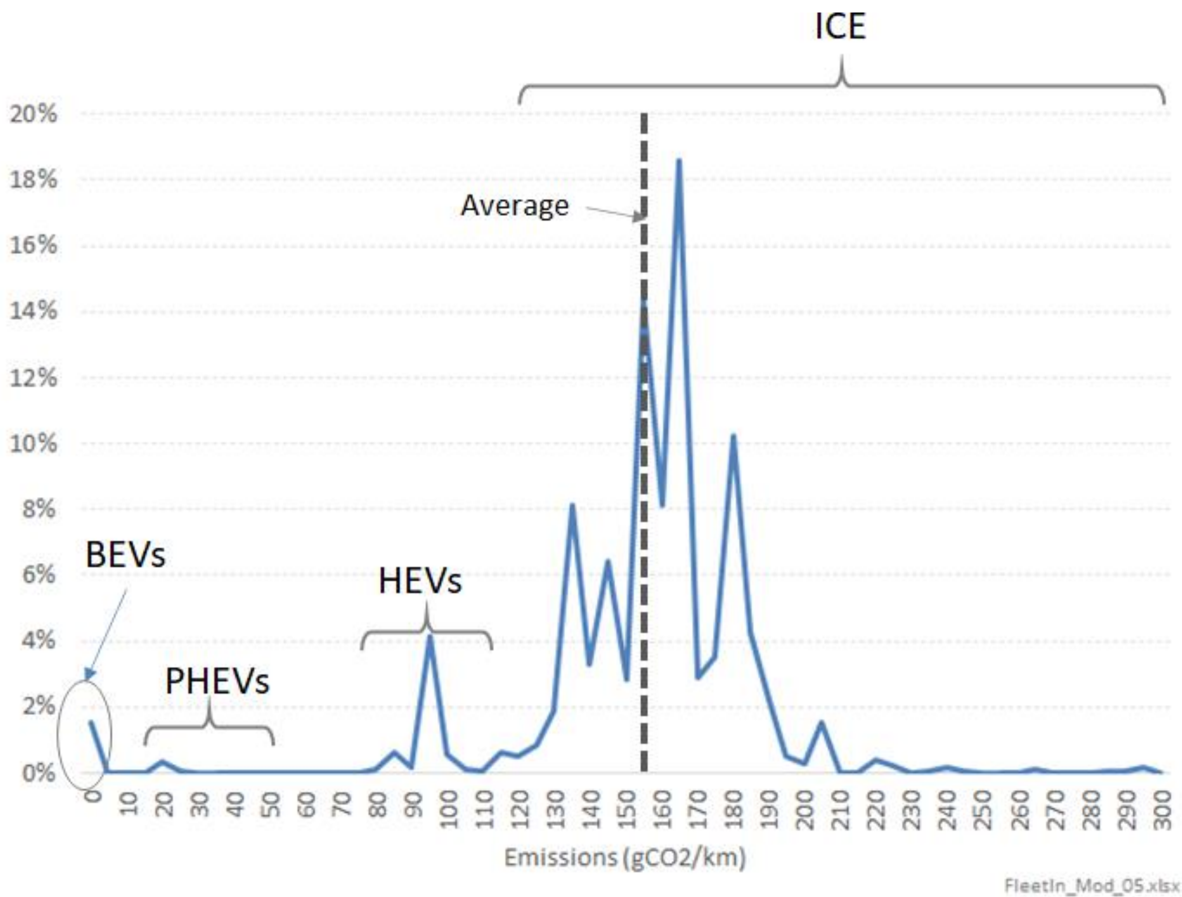
However, there were different numbers of vehicles sold for each model and sub-variant data point. Continuing with the Holden Commodore example, there were 1,710 individual New vehicles sold over these 26 different variants, with the most popular variant having 256 sales, and the least popular only having 6 sales.

The number of different types of model and variant and sold will determine the sales-weighted average emissions. The 'Avg ICE' points in Figure 22 show the sales-weighted average ICE emissions in 100 kg weight bands.

Considering the number of different vehicles sold at these different emissions levels is a useful way to think about the appropriateness of setting a standard / feebate pivot-point at a particular level.

Figure 23 shows the distribution of the number of vehicles sold with different emissions performances, for all vehicles between 1,400 and 1,600 kg. In effect it is taking a 'vertical slice' through Figure 22. Thus, in Figure 23 emissions are plotted on the x-axis, whereas in Figure 22 emissions were plotted on the y-axis. The 'Average' vertical line represents the sales-weighted average across all vehicles (ICEs and EVs).

Figure 23: Emissions distribution of sales of New Light passenger vehicles between 1,400 & 1,600 kg in 2019



Source: Concept analysis of MIA data

Although this plot is for a particular weight-band of LPVs, as Figure 22 indicates, this pattern is broadly representative of number of vehicles sold for different emissions levels for different weights:

- A broad range of emissions for ICE vehicles, with such vehicles representing the vast majority of current sales
- A relatively small number of HEVs sold, with emissions approximately 65% of the average ICE emissions
- Very few PHEVs sold, with emissions approximately 20-30% of the average ICE
- A few BEVs sold, with emissions 0% of ICE emissions

Given this pattern of current vehicle purchasing, the key question is where should the FES standard / Feebate pivot-point be set?

In considering this, a regulator needs to have regard to whether such a standard can feasibly and reasonably be met by consumers. i.e.

- The majority of consumers must be able to choose a low emissions option that is below the FES standard / Feebate pivot-point that meets their transport service requirements; and
- The cost of this lower emissions option (including the price effect of the Fleet Emissions Standard or Feebate) should not be greater than the cost of the vehicle which they would otherwise have purchased in the absence of the Fleet Emissions Standard or Feebate. In this, the key evaluation should not be the purchase cost but the *total cost of ownership*. i.e. it is entirely appropriate (a good thing, even) for consumers to pay more up front, provided that the future operating cost savings (valued using their cost of capital) outweigh the higher up-front purchase costs.

Using this evaluation criteria, setting a standard / feebate pivot for the next couple of years which requires purchase of an EV to be met would not be appropriate:

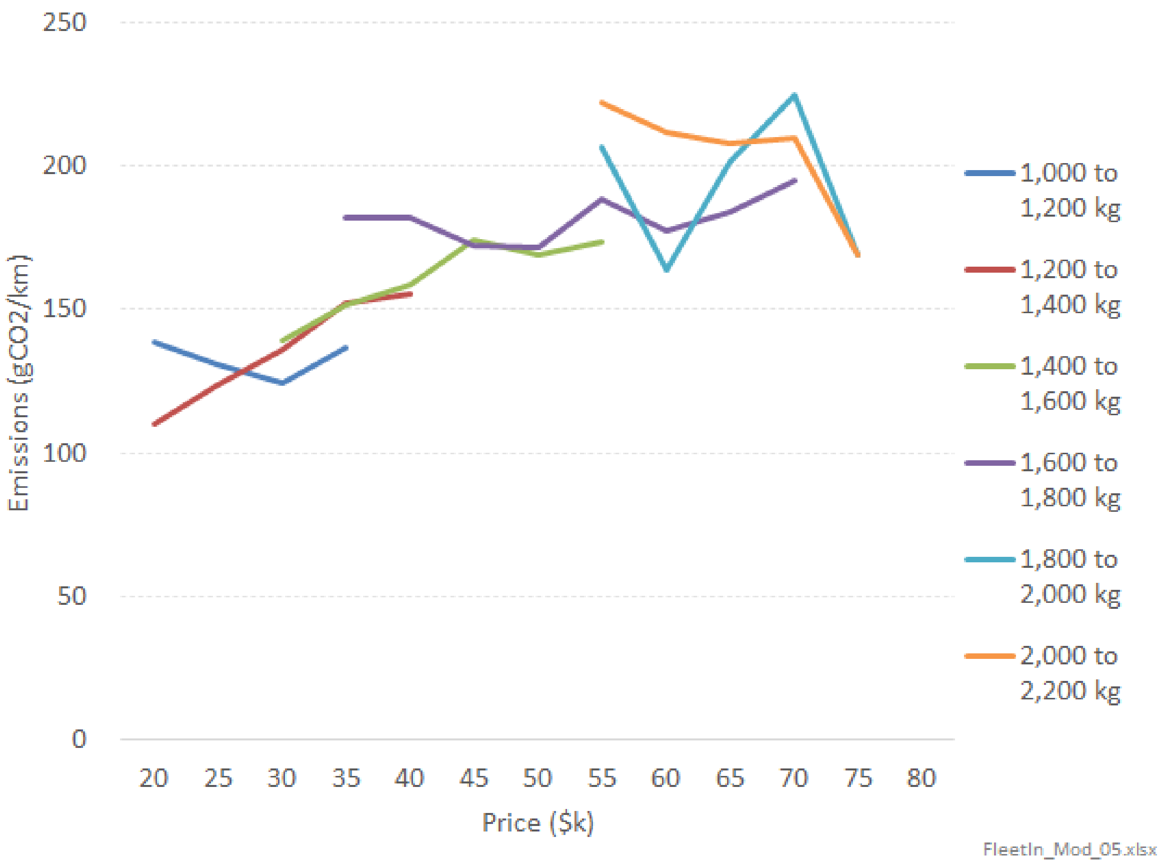
- There are currently relatively few BEV and PHEV models available for purchase. As such, there is a high likelihood of a consumer not being able to purchase a plug-in model which meets their requirements. The same is true, although to a lesser extent, of HEVs which also have significantly fewer models available than ICEs – although a much greater number than was available even just a couple of years ago.
- Furthermore, even if there were sufficient numbers of BEV and PHEV models available, their current high purchase price means their TCO is generally higher than the most cost-effective ICE option – albeit with the TCO of plug-in EVs in some situations, particularly consumers who drive a relatively large amount, reaching parity with ICEs. Plus, the TCO of plug-ins is almost always higher than the TCO of an HEV.

However, it would appear appropriate to set an initial standard at the lower end of current ICE efficiencies – i.e. 12% lower than the current average emissions level, given the analysis highlighted on page 29 previously which indicated that on average for a given price and weight bracket the most efficient tercile of ICE models have 88% of the emissions of the average tercile of ICE models.

A review of the different models being sold indicates that, once weight is corrected for, there are not significant differences in utility between different vehicles with different emission efficiencies. (Other than for sports cars, where the significantly bigger engines deliver the utility of being able to accelerate very fast).

Furthermore, it does not appear that more emissions-efficient ICE vehicles cost more, as illustrated in Figure 24 below.

Figure 24: Relationship between average emissions and price for New ICE Light passenger vehicles sold in 2019 for different weight bands



Source: Concept analysis of MIA data including RRP price schedules

For a given weight category, the fact that the lines generally slope down to the left indicate that lower emissions ICEs cost less than higher emissions ICEs.

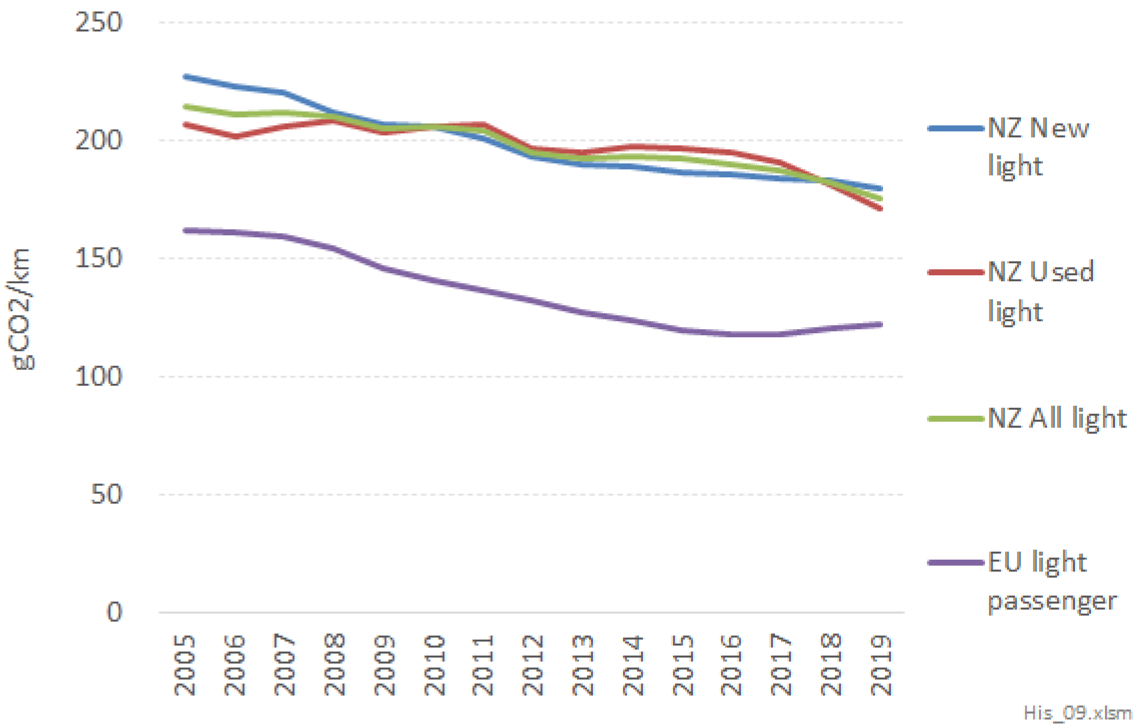
As such, setting an initial FES standard / Feebate pivot at the lower end of the current ICE range would appear to enable most consumers to choose ICE vehicles which still met their utility requirements, and deliver them a lower TCO, with such lower TCO being achieved through lower fuel costs and from not having to pay any more to purchase a lower emissions ICE.

That said, there is a practical implementation issue for implementing a Fleet Emissions Standard for New vehicles. Vehicle suppliers need time to alter the mix of vehicles they bring into the country. In this respect, there is almost no flexibility within a six-month period as orders for bringing New vehicles into New Zealand will already have been 'locked-in', some flexibility within an eighteen-month period, and considerably more flexibility beyond a three-year period. We understand this flexibility also varies between manufacturers. Some brands have greater ability to change their model mix over a short time period than others.

Given this dynamic it would appear appropriate that a transition to the target being set at the lower end of current ICE emissions occur over a period of two to three years.

However, setting a FES standard / Feebate pivot at the current lower end of ICE emissions from New vehicles entering the country should not be the end point. Apart from anything else, for ICE Light passenger vehicles there is the potential to achieve significantly better efficiencies than the range currently being brought into the country – as evidenced in Figure 25 below by the significantly lower average ICE emissions for European countries.

Figure 25: Historical emissions efficiencies of vehicles entering NZ and EU fleets



Source: Concept analysis of MoT and Jato.com data

Note: The EU data is for light passenger vehicles, whereas the NZ data is for all light vehicles, including light commercial vehicles. Our analysis of the sales of new vehicles in 2019 indicates that if light commercial vehicles were excluded, the emissions for new light passenger vehicles would be 160 gCO_2/km.

There does not appear to be any inherent reason why, for Light passenger vehicles, the driving needs of New Zealand's motorists should require materially less emissions efficient vehicles than in Europe. The sub-section on page 38 later, addresses the extent to which a different standard should apply for Light commercial vehicles.

Furthermore, and much more importantly, the continued rapid improvements in cost and performance of EVs, and the continued rapid increase in the number of EV models available, means that in a relatively small amount of time EVs will pass the test for being considered an appropriate benchmark for setting an emissions standard:

- There should be sufficient models available that will meet the utility requirements of the significant majority of motorists. Our assessment, from reviewing various international studies and from various discussions with industry parties, is that internationally, for every 100 ICE models available:
  - by 2025 there will be 75 HEV models, 60 PHEV models, and 50 BEV models
  - by 2030 there will be 98 HEV models, 95 PHEV models, and 90 BEV models
- Their purchase price will have dropped to the point where the total cost of ownership will be less than their ICE alternatives. Indeed, an increasing number of global analysts are projecting that the purchase price of EVs will reach parity with ICEs within four to six years. Given the much lower running costs of EVs, this means that TCO parity will be achieved within one to three years. This is consistent with our analysis that TCO parity is already being reached for some LPV use segments with relatively high annual kilometres travelled.

It is potentially the case that this pace of development may be slightly slower for New Zealand, given our small, RHD market. However, particularly given the commitments announced by the large RHD market of the UK to ban new ICE vehicles by 2030, it seems unlikely that New Zealand will be any more than two years' behind the pace of development overseas.

This would suggest that, by around the middle of this decade, a FES standard / Feebate pivot for New Light passenger vehicles should at least be set at a level consistent with HEVs (i.e. 65% of current average ICE emissions levels), and that by the end of this decade a FES standard / Feebate pivot for New Light passenger vehicles should be set at a level close to that for PHEVs (i.e. 20 to 30% of current average ICE emissions levels).

For comparison with the 2019 proposals which applied to all light vehicles (i.e. LPVs and LCVs) a standard set at 65% of current average ICE emissions levels is very close to the reduction implied by the 105 gCO_2/km standard proposed for 2025.

For these settings to be met clearly requires a significant transition from our ICE-dominated purchases of today, to the significant majority of New Light passenger vehicles purchased in 2030 being plug-in EVs (PHEVs or BEVs) and almost no pure ICE vehicles – i.e. the remainder of non-plug-in vehicles being purchased being HEVs.

However, given the projected significant continued cost and model choice improvements in EVs, our analysis suggests this transition would be both economically and environmentally beneficial for New Zealand. Thus, as section 3 sets out, achieving higher rates of EV uptake out to 2050 from that that would likely be achieved without policy interventions would deliver 79 MtCO_2e of emissions savings, and save New Zealand approximate $10-15bn in costs.

Furthermore, not to have such rates of uptake would be inconsistent with a central plank of government policy, namely achieving net-zero emissions by 2050. In this respect, section 3 also shows that not having rates of uptake consistent with the standard levels proposed above would significantly impair our ability to meet our net-zero-by-50 target.

This conclusion is also consistent with analyses by other countries considering the same issue. For example,

- the UK and Japanese governments' decisions to bring forward / introduce light passenger vehicle ICE bans were driven by their analyses that not to do so would mean they would be unable to meet their emissions commitments
- In the US, the Rocky Mountain Institute's modelling of what transition of the US vehicle fleet would be required in order to meet climate goal targets consistent with limiting global warming to less than 2˚C has also concluded a light vehicle ICE ban by 2030 is required.[27]
- In Europe, a consortium of truck manufacturers has recently concluded that if Europe is to meet its emissions targets, all truck sales from 2040 must be completely fossil-free (i.e. not even allowing PHEVs).[28]

Given this dynamic of needing to transition to close to 100% EV uptake by 2030 in order to meet a key government target, it would seem inconsistent to set a Fleet Emissions Standard / Feebate pivot which didn't match this goal – particularly when such a rate of transition is projected to also deliver significant economic benefits.

[27] https://evadoption.com/can-the-us-reach-50-million-evs-in-operation-by-2030/
[28] https://www.acea.be/uploads/publications/acea-pik-joint-statement-the-transition-to-zero-emission-road-freight-trans.pdf

What level of FES penalty or Feebate fee/rebate schedule should apply?

We have considered two approaches for setting such a price schedule:

- Comparison with overseas
- First-principles consideration of what price differential is likely to be required to get consumers to switch.

Turning first to comparisons with overseas, the non-linear nature of most overseas feebate schedules makes comparison more difficult. See for example, Figure 26 and Figure 27 below which show the feebate schedules for France and Sweden.

Figure 26: Change in Feebate settings between 2008 & 2017 in France

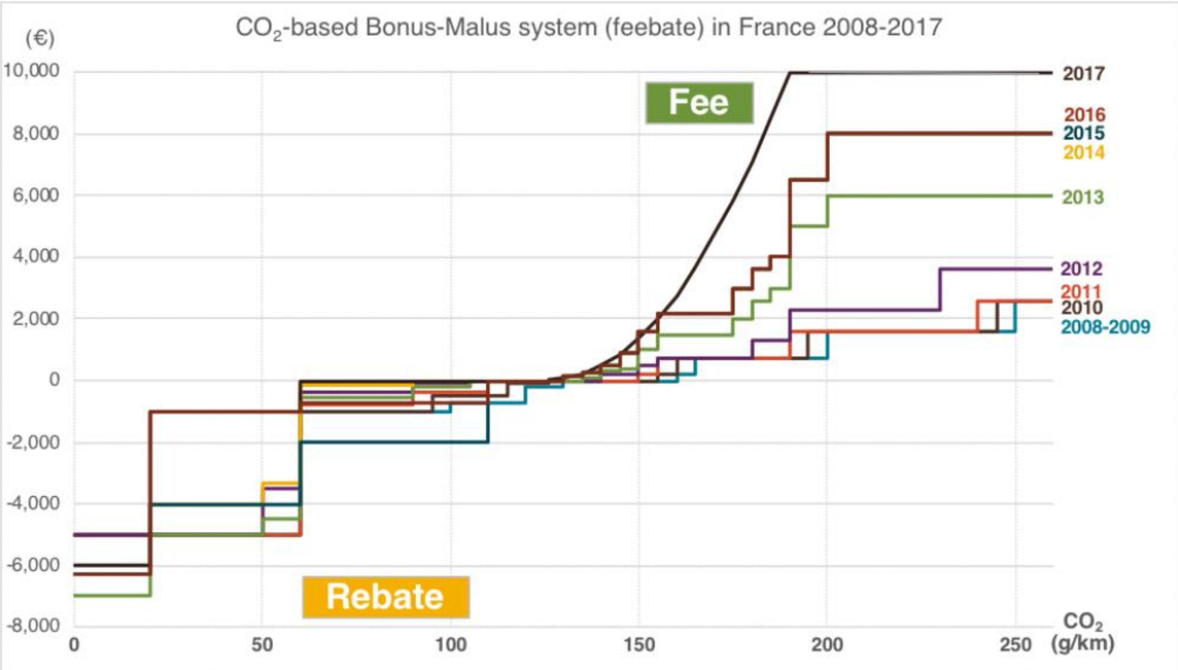
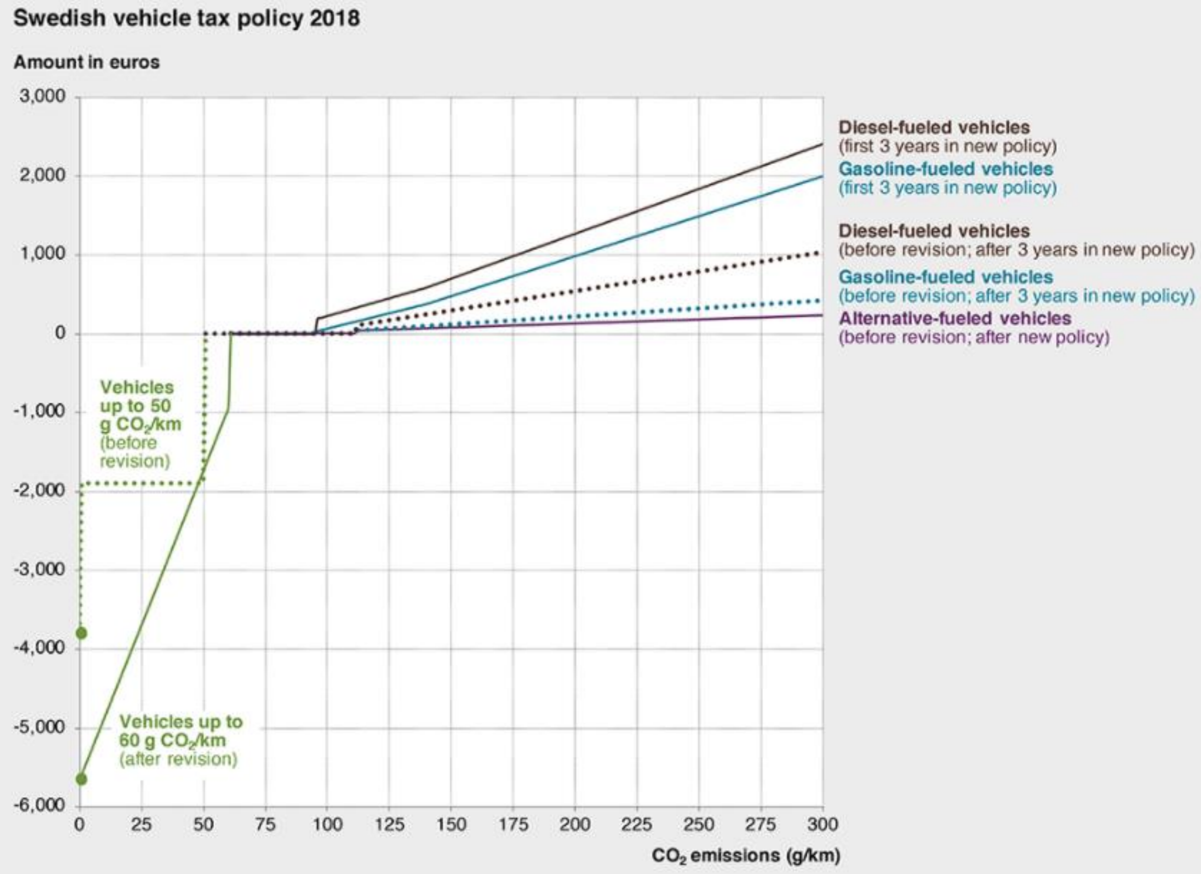


Figure 1: Evolution of Bonus-Malus system from 2008 to 2017

Source: *"Practical lessons in vehicle efficiency policy: The 10-year evolution of France's CO2-based bonus-malus (feebate) system"* https://theicct.org/blog/staff/practical-lessons-vehicle-efficiency-policy-10-year-evolution-frances-co2-based-bonus

Figure 27: Change in Swedish Feebate settings between initial implemenation and 2018 revision

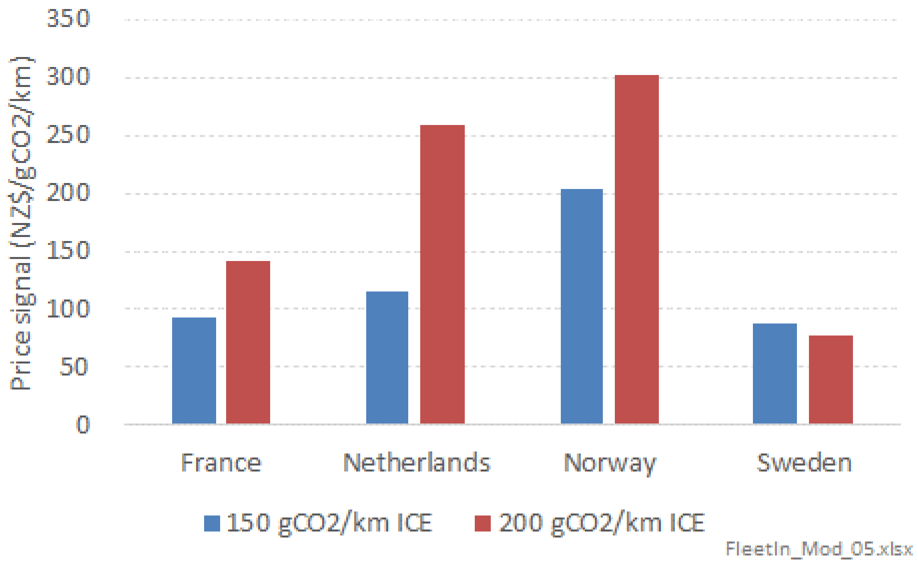


Source: *"Sweden's new bonus-malus scheme: From rocky roads to rounded fells?"* https://theicct.org/blog/staff/swedens-feebate-system-20181008

Despite the non-linear nature of such schedules, we have sought to 'normalise' the price signal between these different schemes by calculating the effective NZ$/g$CO_2$/km price effect of the Feebates for considering purchasing a BEV (with zero gCO_2/km emissions) versus both a medium and high emissions ICE vehicle (with 150 and 200 gCO_2/km emissions respectively).[29] The results of this are shown in Figure 28 below.

[29] This calculation is simply (ICE fee - BEV rebate) ÷ ICE emissions * NZ$/€ exchange rate

Figure 28: Price effect for a consumer choosing between a BEV and two different ICE vehicles with different emissions efficiencies based on 2018 overseas feebate schedules



Thus, if the objective in setting New Zealand's policies is to achieve consistency with overseas approaches, it would appear that a price signal in the range NZ\$60 to \$200/gCO_2/km would appear appropriate.

In this respect, the price signal within New Zealand's 2019 proposed Clean Car Discount was approximately \$45/gCO_2/km, and would have been complemented by the \$100/gCO_2/km penalty within the Clean Car Standard – noting that, as set out earlier in section 4.1.1, the extent to which some of the penalty in the Standard would also flow through to vehicle prices would depend on whether the price change due to the Clean Car Discount would alter vehicle purchasing from high to low emissions vehicles sufficient to meet the Standard.

As such, the price settings in the 2019 proposals seem broadly consistent with those European approaches that have delivered the highest rates of EV uptake.

In order to consider from first principles what level of price signal is likely to be required to make consumers switch from a high to a low emissions vehicle, we have built a model which considers the perceived cost differential of the two options on a total cost of ownership basis, but taking into account:

- the likely purchase price differential of the vehicles and how this may change in the future
- the effect of CO_2 pricing and other mechanisms to incentivise EV uptake (e.g. the current (but soon-to-expire) RUC exemption.
- the potential effect of consumers applying time-inconsistent approaches to evaluating the benefit of the different vehicles.

As inputs for the model, we took the detailed vehicle emissions and weight data represented by Figure 22, and combined it with price schedules provided by the MIA for the majority of the different models represented. The available price data meant we were able to get over 80% coverage of the New vehicles sold in 2019, and spanning the range of vehicle types, sizes and price brackets. We subsequently segmented the data into terciles in terms of model size, weight, price bracket and emissions. This enabled consideration of the outcomes of different policies for different vehicle situations.

Using this model our central estimate is that the required price signal to persuade consumers in 2022 to switch from an ICE model to a BEV based purely on perceived costs (i.e. taking no account of any penalty consumers may place on BEVs because of perceived range anxiety or other performance attributes) would be approximately $70/g$CO_2$/km. There is some variation in this around the segments based on based on the data set we have, but with no consistent pattern across price brackets, size of vehicle and the like.

This is at the low end of price signal from some of the most successful European feebate mechanisms in recent years, but reflects the projected fall in EV prices by 2022 and consequent reduced level of price change required to alter consumer purchases.

Further, as the cost of EVs continue to fall, it would be appropriate to progressively reduce this price signal accordingly. Thus, in five to seven years' time, if the purchase price of BEVs is approaching that of ICEs the level of price incentive to persuade consumers to choose BEVs is likely to be a lot less than today when the purchase price differential can be $30,000.

Given uncertainty over the rate of change in EV prices, it would seem appropriate to signal the mechanisms by which the feebate schedule would change in response to changing EV prices, rather than attempt to lock-in a schedule of price changes ahead of time.

This need to reduce the price signal is principally an issue for a Feebate which fixes a price schedule. In contrast, the price signal from a Fleet Emissions Standard should be 'self-correcting' in that it will only cause vehicle prices to move to the level required for consumer purchases to alter to meet the standard. Thus, if future falls in EV prices were to occur the extent to which relative prices would need to change to meet a Standard would also fall. As such, we believe the 2019 proposal for the Clean Car Standard of a $100/gCO2/km penalty is appropriate. We note it is lower than the €95/gCO2/km (≈$163/tCO2/km) penalty for the European standard, but still high enough to deliver a strong incentive to suppliers and deliver meaningful price signals if required (e.g. if there were no Feebate implemented).

Other potentially desirable design features

With regards to Fleet Emissions Standards, section 4.1.1 previously identified that most Fleet Emissions Standards (including the proposed 2019 Clean Car Standard) recognised the inherently greater energy needs for larger vehicles than smaller vehicles by varying the standard with vehicle weight using a mass-based attribute limit curve. This seems sensible, as not to do so would end up penalising consumers whose utility needs require them to purchase larger vehicles.

However, whereas the 2019 Clean Car Standard used a stepped mass-based attribute limit curve, we believe this would benefit from moving to a continuous function to avoid the type of boundary effects that can occur whereby high proportions of vehicles are supplied / purchased that are just below a step threshold.

With regards to Feebates, as illustrated in Figure 26 and Figure 27 previously, we note that overseas Feebates have progressively developed significantly non-linear 'structured curves' to represent the schedule of fees and rebates at different levels of emissions. We believe this has been in response to the non-linear cost and emissions characteristics of the different types of vehicle (ICE, HEV, PHEV and BEV) and allowed more fine-tuning of the mechanisms to deliver more targeted support to different types of low-emissions vehicle.

Such an approach may have merit in New Zealand. In particular, we believe moving away from the stepped approach in the 2019 Clean Car Discount proposals to a continuous function would help avoid the boundary effects that were detailed above in relation to having a stepped Fleet Emissions Standard.

What differences should apply to different types of vehicle?

Any significant transition will inevitably favour some sections of society more than others, and may potentially adversely impact some segments.

Thus, while the above analysis indicates that the proposed transition will be beneficial for the vast majority of consumers of New Light passenger vehicles, such a rapid transition may not be beneficial for all segments of society. We consider four specific segments to determine whether there are grounds for altering the proposed settings set out above New Light passenger vehicles, or even using different policy mechanisms.

- Consumers of light commercial vehicles and trucks.
- Consumers who have unusual transport requirements
- Consumers of Used LPVs
- Vehicle suppliers

Consumers of light commercial vehicles and trucks

There are two reasons why both the level and rate of transition that we propose for new light passenger vehicles would not be appropriate for light commercial vehicles and trucks.

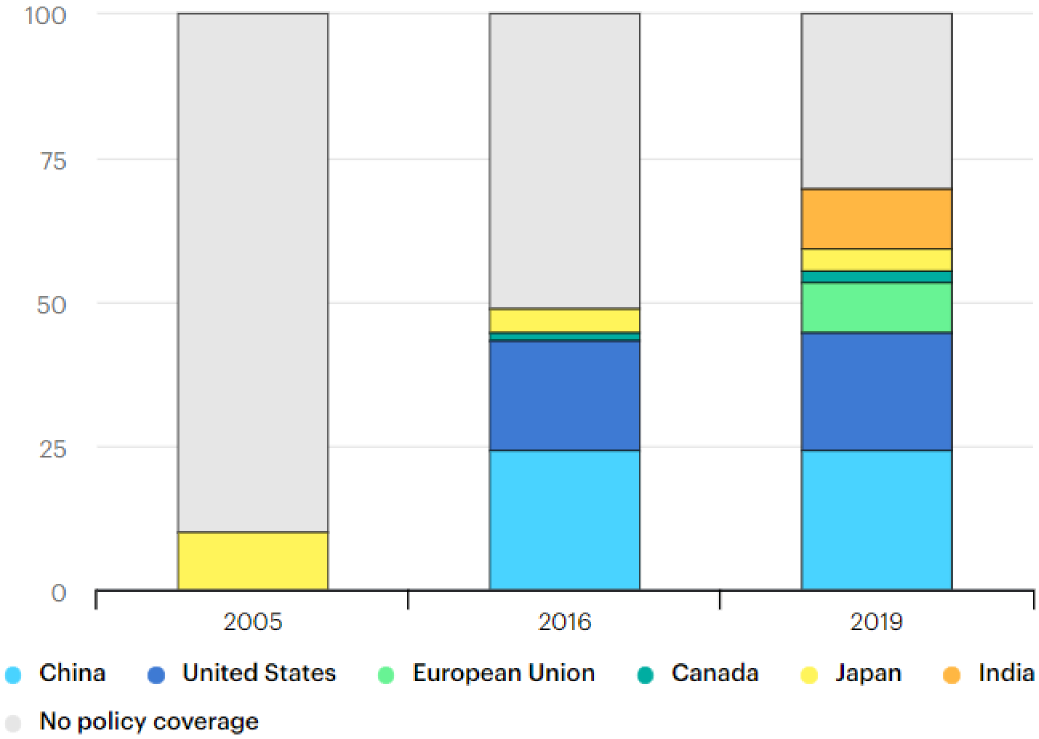
- Firstly, these vehicles have greater motive power requirements. As such, an emissions standard or feebate pivot-point for LPVs would be too low for LCVs and trucks. While having a mass-based attribute limit curve will address this to a certain extent, it is not clear that the relationship between mass and motive power requirements is entirely consistent across all these different classes of vehicle. Therefore, this would most appropriately be addressed by having specific standards or feebate schedules for specific classes of these non-Light Passenger Vehicle. In this respect, we note that the European emissions standard has different settings for light passenger and light commercial vehicles.
- Secondly, and perhaps more importantly, the rate at which EV models become available for these classes of vehicle is projected to be slower than for LPVs. As such, it would be inappropriate to have the same rate of transition to EV-consistent emissions requirements as for LPVs.

However, while the specifics of what emissions standard to apply and the rate of transition to EV-consistent levels may differ from LPVs, the general benefits of using a Fleet Emissions Standard or Feebate to improve the emissions for these classes of vehicle still hold.

As such, we would strongly recommend introducing Fleet Emissions Standards for these classes of vehicle, ideally accompanied by Feebate mechanisms.

In this, it is notable that New Zealand is now in the minority of countries (by vehicle sales) who haven't introduced a Fleet Emissions Standard for trucks (as illustrated by Figure 29 below). Appendix A sets out the details of the comprehensive Fleet Emissions Standard that the European Union has implemented for trucks.

Figure 29: Percentage of global heavy-duty vehicle sales covered by efficiency standards



Source: https://www.iea.org/reports/trucks-and-buses

Consumers who have unusual transport requirements

With regards to consumers who have unusual transport requirements, it is inevitable that a standard will not be appropriate for 100% of consumers' vehicle requirements. However, this is a common feature of almost all rules and regulations that apply in other parts of our society. And as with these other aspects, provided the significant majority of consumers are better off from the regulations, it would not be appropriate to bring the standards down to the level of the 'lowest common denominator' – i.e. weaken them to the point where they don't disadvantage any transport user with unusual transport requirements – unless it could be demonstrated that those unusual users would suffer exceptional harm that could not be mitigated via other means. This does not appear to apply in the case of road vehicles. In large part, the justification for not weakening them is that such an action would inherently harm other consumers – by not bringing forward the significant economic benefits associated with a stricter standard.

The main caveat relates to consumers who don't have access to at-home charging. This is a material issue (although much less than in most overseas countries) and needs to be addressed by improving access to on-street charging. This is a topic that we will address in the second report in this study.

Consumers of Used Light passenger vehicles

With regards to consumers of Used LPVs, our analysis set out below in section 5 later indicates that there could be problems if a standard that applies to New LPVs was also applied to Used LPVs. This is almost entirely because the supply of Used vehicles won't have sufficient proportions of plug-in EVs available to meet New Zealand's demand for Used vehicles for at least a decade. As such, setting a standard which, over the decade, transitions to levels consistent with plug-in electric would penalise those consumers for whom plug-in electric options are not available. For the reasons set out in section 5, this group will predominantly be low-income consumers. As such, there would be regressive outcomes. Therefore, we believe that different mechanism settings – and potentially a completely different policy instrument – be applied to this category of vehicle.

Vehicle suppliers

With regards to vehicle suppliers, we believe the proposed pace of transition to EVs is likely to result in winners and losers. This effect will be predominantly as between different vehicle manufacturers (Toyota, Volkswagen, Tesla, Ford, etc.) rather than vehicle wholesalers and retailers (non-manufacturer parties who bring in New or Used vehicles from overseas for sale in New Zealand). Thus, those manufacturers who are relatively ahead in their electrification transition are likely to be winners – gaining market share and profitability – whereas those who are behind are likely to be losers – losing market share and profitability. The more stringent are the policy settings, the more likely it is that we would get significant shifts in market share between different suppliers.

However, provided the settings are set such that the revised mix of vehicles is, on average, more beneficial for New Zealand, this would not appear to be a good reason for New Zealand not adopting the type of targets set out above.

4.2 Internal combustion engine ('ICE') bans

4.2.1 What are 'ICE bans'?

An ICE ban is a prohibition the sale or first registration of vehicles which solely use petrol or diesel fuel (i.e. including hybrid electric vehicles, but excluding plug-in hybrid electric vehicles). It is a policy which is increasingly being implemented overseas as an addition to other policies to decarbonise transport fleets.

Table 1 below lists (at the time of writing) the main overseas jurisdictions that have announced ICE bans, along with the date that the proposed restriction commences, and whether vehicles there are left-hand drive (LHD) or right-hand drive (RHD).

Table 1: Notable jurisdictions with light vehicle ICE bans

Country / State	Year of ban	LHD / RHD
Norway	2025	LHD
South Korea		
Belgium	2026	
Austria	2027	
Washington		
Denmark	2030	
Germany		
Iceland		
Israel		
Netherlands		
Slovenia		
Sweden		
India		RHD
Ireland		
UK		
California	2035	LHD
Japan		RHD
Canada	2040	LHD
China		
Egypt		
France		
New Jersey		
Portugal		
Spain		
Taiwan		
Singapore		RHD
Sri Lanka		
Colorado	2050	LHD
Costa Rica	2050	

Misc EV analysis v01.xlsx

Consumer bans on certain technologies to help meet decarbonisation objectives have precedents in other sectors, for example the installation of gas and other fossil fuel heating in new homes in the UK is not permitted from 2025.

A ban on ICE use in specific local areas, such as city centres, are more commonly referred to as Zero Emission Zones and are covered in section 6 as one of the possible complementary 'second-tier' policy options.

ICE bans have usually only applied to light vehicles, but some jurisdictions have also started to set bans for heavy vehicles. For example, California has just introduced a requirement for the industry to have a certain percentage of sales of its freight vehicles as non-ICE vehicles by certain dates, with all trucks zero emission by 2045. As in the California example, such heavy vehicle ICE bans apply from later dates than the light vehicle ICE bans (which is 2035 for light vehicles in California), recognising that the development of non-ICE models for heavy vehicles is progressing at a slower rate than for the light fleet.

In a similar vein, exemptions have been given in some cases for niche light vehicle applications where non-ICE options are not yet viable.

4.2.2 What are the pros and cons of ICE bans?

In the majority of overseas countries where ICE bans have been implemented, it is notable that they are in addition to other de-carbonisation policy instruments – both transport sector specific (e.g. Fleet Emissions Standards or Feebates) as well as economy-wide (e.g. carbon pricing). Thus, ICE bans are viewed as *complementary* to these other policies.

ICE bans can be viewed as having both supply-side and demand-side effects.

On the supply side, one of the principal advantages of ICE bans is to signal in advance to the global motor industry to modify their R&D investment, product planning and production to help deliver a sufficient supply of EVs by the ban date. This removes OEM uncertainty regarding consumer demand for EVs, encouraging mass production, and bringing down the costs of EVs and increasing model choice more quickly than might otherwise be expected.

This signalling to the motor industry has been held out as being particularly relevant for larger jurisdictions such as Europe and the US whose consumers are large relative to global motor sales.

While New Zealand's market is very small compared to these major auto markets, an ICE ban for New Zealand will contribute just as much on a per person basis to global supplier incentives to shift away from ICE production as a ban in a larger jurisdiction. Indeed, because New Zealand is a separate country, it is likely that New Zealand's contribution is greater on a per person basis, as the total number of jurisdictions implementing bans is a relevant consideration for manufacturers.

From a New Zealand specific supply perspective, an ICE ban is a clear signal that OEMs need to plan to supply sufficient volume of EVs to the New Zealand market, and removes the risk that New Zealand becomes a dumping ground for ICE vehicles when other countries with RHD vehicles have implemented a ban.

On the demand side, one of the key advantages of an ICE ban is that it clearly signals to consumers the direction that vehicle technology will be going, and that systems around EVs such as public charging and EV servicing can be expected to continue to develop. This will provide confidence for consumers to consider and purchase EVs even prior to an ICE ban coming into effect.

As well as improving consumer confidence in purchasing EVs, an ICE ban can contribute to shifting public opinion such that ICE vehicles become increasingly socially unacceptable due to their high emissions. In turn, this will tend to reduce the residual value of ICE vehicles in the second-hand market as they become less desirable. A lower residual value of ICE vehicles would increase their total cost of ownership in comparison with EVs.

ICE bans can also help deliver a transition without price mechanisms needing to reach such high levels.

The principal potential disadvantage of an ICE ban is that it is implemented too soon, and it would be prohibiting ICE vehicles which have a total cost of ownership that is lower than the EVs which are replacing them. For example, were New Zealand to implement a ban from 2022, say, the higher *average* capital costs of EVs purchased in 2022 would likely outweigh the *average* fuel and emissions savings from the ICE vehicles they were replacing. (The italicisation of 'average' is to imply that there will likely be a material number of vehicle situations where EVs will be lower TCO options than ICEs. It is just that, on average, ICEs will still be lower cost than EVs). Further, the currently limited model choice of EVs means that a significant number of consumers could find themselves being forced to purchase a vehicle which doesn't meet their utility requirements.

Conversely, putting in place a ban for some very distant time in the future (2050, say) becomes a pointless exercise. Indeed, it may have a negative effect on consumer perceptions of when they should start considering purchasing EVs.

Another potential downside of an ICE ban is that it precludes the potential development of low-carbon combustion engine fuels such as biofuels or synthetic e-fuels from renewable hydrogen. Our evaluation, and the evaluation of overseas jurisdictions which have implemented such bans, is that for most light vehicles and medium weight trucks EVs will be inherently cheaper than ICE vehicles fuelled by such low-carbon liquid fuels. As such, there is little potential upside from not having an ICE ban, but significant likely downside.

That said, we see there is potential for wood-derived drop-in liquid fuels for the harder-to-electrify transport modes of aviation, marine (particularly international), and heavy, long-distance trucks. Further, such drop-in fuels can help decarbonise the existing ICE road fleet until such time they are scrapped – which could be many decades for some of the heaviest vehicles.

4.2.3 How might an ICE ban be implemented in New Zealand?

From a practical perspective, ICE bans are relatively low cost and simple to implement and enforce. In New Zealand, it may be that existing Minimum Energy Performance Standards (MEPS) legislation and regulations can be used.

New Zealand has had MEPS in place for a variety of consumer appliances and commercial/industrial equipment for many years. These restrict the import, manufacture and sale of appliances and equipment to those that meet a certain level of energy efficiency.

The Energy Efficiency and Conservation Act 2000 allows for MEPS regulation for all vehicles. This existing legislative mechanism could be used to implement an ICE ban. An ICE ban for vehicles could be considered as a type of MEPS with the performance standard being a tailpipe emissions standard of 0 gCO_2e/km if the ban included restrictions on PHEVs, or say, 50 g gCO_2e/km if the policy allowed both BEVs and PHEVs.

The key challenge with ICE bans is determining when in the future such a ban should be put in place. If ICE ban targets are announced ahead of widespread consumer understanding of the future availability and characteristics of EVs, then there may well be consumer backlash against the policy, as it could be perceived as taking away a vital source of mobility. An example of this was when it was proposed to introduce MEPS for lighting that would have had the effect of banning incandescent lightbulbs. The opposition political party at the time generated negative publicity regarding the "nanny state". Such an outcome is most likely if New Zealand were to be seen to be going it alone, or proposing a ban date which is perceived to be too far in advance of the rest of the world.

Given New Zealand's relatively small size, it would seem appropriate to link the timing of when a ban should come into force to significant RHD overseas jurisdictions who are implementing such a ban. This should ensure there are sufficient models available for New Zealand consumers.

In this, the UK and Ireland's ban on light ICE vehicles from 2030 is significant. Were New Zealand to implement a date earlier than this, there would be a risk that there would be insufficient models to meet New Zealand's consumers' needs by that time.

However, given that EVs are projected to be lower TCO vehicle options by the first half of this decade, and that there will be an equivalent range of EV models as ICE models by the end of the decade for almost all light passenger vehicle requirements, there would not appear to be merit in implementing a ban too many years' later than the UK and Ireland dates.

That said, we currently get a greater proportion of vehicles from Japan, and Japan's ban is currently only from 2035.

On balance it would appear appropriate that an ICE ban on new light passenger vehicles for New Zealand should be no later than 2035, and probably earlier subject to further analysis.

Further, whatever date is selected, it would also be important to signal that the date will be periodically reviewed to determine whether it could be brought forward as a result in technology advances, or should be brought forward because of growing concern about our ability to take measures to meet our emissions reduction commitments – being the reason for the UK bringing forward its ICE ban from 2035 to 2030.

It may also be appropriate to signal that, while PHEVs may initially be allowed under an ICE ban, these will also be banned from a point five or so years on from when the initial ICE ban comes into effect – an approach that an increasing number of overseas jurisdictions who've implemented bans are taking. In this respect, projections of battery cost and performance indicate that by the time an initial ICE ban comes into effect, BEVs will have a materially lower TCO than PHEVs for the vast majority of use cases.

As with other policy instruments such as Fleet Emissions Standards or Feebates, a key challenge will be in determining whether arrangements which are appropriate, for New Light passenger vehicles are also appropriate for other vehicle situations, including:

- Used Light passenger vehicles
- Light commercial vehicles, Trucks and Buses
- Specific special cases

With regards to Used LPVs, the analysis set out later in 5 indicates that implementing a ban on the import of Used ICE LPVs by a certain date may be more challenging than New ICE LPVs, due to more limited availability of Used non-ICE LPVs.

One option to address this may be to implement an ICE ban for Used vehicles from a later date. However, this may introduce incentives on New car purchasers to purchase a Used ICE rather than a New EV.

As such, it would seem appropriate to incorporate Used LPVs that are up to seven years' old within the same ICE ban timing for New LPVs. This is because:

- Used vehicles older than this age are not considered to be sufficient substitutes to New vehicles such that New EV → Used ICE switching will occur in significant numbers
- By the time an ICE ban is implemented Used LPVs less than seven years' old should not suffer the same EV supply unavailability as older Used vehicles.

If such an age-differentiated Used LPV ICE ban were implemented, it would seem appropriate to progressively increase the age of Used vehicles that an ICE ban applies to, such that after seven years, say, the ICE ban equally applied to Used LPVs as well as New LPVs. Our modelling described in section 5, indicates that by 2040 the supply of older EVs from overseas countries should be sufficient to meet the requirements of those consumers who rely on purchasing older vehicles for their travel requirements.

With regards to light commercial vehicles, trucks and buses, it would be appropriate to have a different date for a ban to recognise that the development of EV models for these categories of vehicles is progressing at a different rate than for LPVs. Thus, for LCVs and trucks a later date would seem appropriate. Conversely, an earlier date for buses could be feasible, noting that an increasing number of regional councils are implementing their own ICE bans for this category of vehicle. Thus, Auckland and Christchurch already have policies of procuring no new diesel public transport buses after 2025, and Greater Wellington Regional Council has gone even further by proposing that all existing diesel public transport buses will be removed from service and replaced by electric by 2030.

It has already been proven that cities can electrify their bus fleets with Shenzhen, China electrifying their entire bus fleet of about 16,000 by the end of 2017. The city has also just done the same to its 22,000 taxis.

It may be appropriate to split these categories into sub-categories to recognise the different pace of development. Thus, it may be appropriate to have a later date for the heaviest class of truck. Likewise, it may be appropriate to split light commercial vehicles into vans and utes, recognising that the international development of EV vans is progressing faster than utes, due to the much larger market for vans than utes.

In this we think it is hugely significant that Europe's truck manufacturers have pledged that they will start working towards ensuring that by 2040 all new trucks sold will be fossil free.[30] As such, it seems highly likely that New Zealand will be able to implement a ban on ICE trucks from about this date as well.

Lastly, it would be appropriate to have an exemption regime which allowed certain organisations to import ICE vehicles if there are no non-ICE models that meet their requirements. In addition to military and emergency service vehicles, this could apply to certain organisations requiring vehicles for operation in remote locations for extended periods of time.

4.3 Emissions pricing

Given that global warming is the principal driver behind the move to transition from ICE vehicles to EVs or other low-emissions technologies, a number of commentators in New Zealand and overseas have suggested that pricing carbon emissions within petrol and diesel prices would be the best means of addressing this problem.

Internalising this externality, they argue, would be the most appropriate way of ensuring that parties face the cost-consequences of their actions, thereby incentivising them to make the switch to an EV if it is cost-effective to do so.

New Zealand motorists already face a carbon price in that the supply of petroleum fuels is subject to the same economy-wide carbon price under the New Zealand Emissions Trading Scheme as other emitters (with the exception of agricultural emissions). However, the current level of the carbon price (NZ$37 in late Dec'20) is significantly lower than the level which an increasing number of international and New Zealand studies are indicating is likely to be required for the world to achieve emissions reductions consistent with limiting global warming to 1.5˚C. These studies are indicating a '1.5˚C-consistent' price is more likely to be of the order of NZ$200/t$CO_2$, and in many cases, significantly above this level. For example, the German government's estimate of climate damage costs (which it uses to evaluate the likely cost-benefit of initiatives which affect emissions) is €180/tCO_2 (NZ$305/t$CO_2$) – a value which is based on the work by the Intergovernmental Panel on Climate Change. And the European Investment Bank is using a 1.5˚C-consistent shadow carbon price to evaluate its decisions. This is currently stated to increase to €250/tCO_2 by 2030 (NZ$420/t$CO_2$), then rise to €800/t$CO_2$ by 2050 (NZ$1,345/t$CO_2$).

However, even if New Zealand carbon prices were to rise to '1.5˚C-consistent' levels, there are two key reasons why solely relying on incorporating carbon prices within petrol pump prices is unlikely to be the most cost-effective, or appropriate, way to achieve the desired transition of our vehicle fleet to non-ICE technologies.

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[30] https://www.acea.be/uploads/publications/acea-pik-joint-statement-the-transition-to-zero-emission-road-freight-trans.pdf

Firstly, the consumer behavioural biases identified in section 2.1 suggest that an intervention which alters the up-front costs of vehicles is far more effective than one which alters the ongoing running costs of such vehicles.

Thus, if a carbon price is to do all the heavy lifting to correct behavioural biases, we estimate this would equate to a carbon charge of approximately NZ$575 in 2022.[31]

Secondly, relying on carbon price to drive a change in vehicle fleet composition is likely to be significantly more regressive than other policies aimed at transitioning our vehicle fleet. This is because, for the reasons set out in section 5 below, it will be new vehicle purchasers who will be able to transition away most cost-effectively from ICEs as global OEMs progressively roll-out more EV models. However, it will be at least a decade or more before consumers whose budget limitations mean they rely on purchasing used vehicles will be able to buy non-ICE vehicles. In the intervening decade or so, imposing high carbon prices on petrol will impose high costs on this group of consumers, with limited ability for them to respond by switching to non-ICE alternatives. Such a situation is not only undesirable, but may not be politically sustainable. It may cause public backlash, similar to the mass 'Gilet Jaune' protests seen in France in 2018 opposing the increase in taxes on petrol.

Although a carbon price is not the best tool for the transport sector, it may be for other sectors

This relative undesirability of using carbon price as the principal mechanism for decarbonising the road transport sector is a significant problem because, in other sectors of the economy, a carbon price is likely to be the most cost-effective and appropriate means of achieving the required transition to a low-emissions economy.

Thus, for major industry and electricity generation, a carbon price is likely to be the most important tool to achieve decarbonisation, albeit complemented in many cases by other supporting instruments.

Therefore, if tensions associated with applying a high carbon price at the petrol pump mean that a New Zealand-wide carbon price is set lower than it should be, New Zealand will not achieve the economy-wide level of fossil reductions consistent with limiting global warming to 1.5˚C.

To address this political dynamic, we recommend the government investigate approaches which either effectively allow for different carbon price to apply in different situations, or which allow for a common (and sufficiently high) carbon price but manage the regressive impacts and public acceptability dynamic.

One potential option to allow for different carbon prices to apply in different situations could be an arrangement where all fossil fuels face the full carbon price (as is currently the case under the NZ ETS), but petrol stations receive a rebate based on their petrol pump sales. This would ensure other consumers of oil-based fuels where the effectiveness / regressiveness problems of a carbon price set out above don't apply (e.g. airlines, coastal shipping, industrial diesel/fuel-oil consumers) would continue to face the full carbon price, but road users would face a discounted carbon price.

This would allow the full carbon price to apply in non-road transport situations, with other instruments such as a Fuel Emissions Standard or ICE ban being the principal instruments for the road transport sector.

[31] We have used our model of the economics of EVs and ICEs from both a public and private perspective to estimate the scale of carbon price required to deliver the same level of switching from ICE to BEV as would be achieved from altering the relative up-front purchase prices of such vehicles.

Such a proposed arrangement is analogous to the current situation under the NZ ETS where Emissions-Intensive Trace-Exposed (EITE) industries get relief from being exposed to the full carbon price due to the risk of undesirable outcomes. (Carbon leakage in the EITE case).

An alternative approach which may allow for a common (and sufficiently high) carbon price but manage the regressiveness and public acceptability dynamic is being implemented in Canada. Under this proposal, the government receipts from a carbon tax will be rebated to consumers on a per household basis.

It is beyond the scope of this report to address the relative merits of these and other potential mechanisms to address this dynamic of a carbon charge being the most appropriate mechanism to achieve emissions reductions in some sections of the economy but not in others.

5 Are the policy settings for incentivising New low emissions vehicles equally appropriate for incentivising Used vehicles?

The previous sections have identified that the projected rate at which global vehicle manufacturers are bringing out new plug-in electric models for light vehicles, and the projected continued improvement in cost and performance of EVs, is such that by the end of the decade new vehicles entering our fleet could be predominantly electric – and cost-effectively so.

Furthermore, such a rate of uptake will be necessary to meet our climate policy objectives.

However, such a rapid transition may not be achievable for the second-hand, 'Used' vehicles entering our fleet from overseas. This matters for consideration of policies to facilitate a transition to low-emissions vehicles because Used vehicles account for half the light vehicles entering the fleet each year.[32]

5.1 What are the dynamics driving the ability to transition our Used imports to low emission vehicles?

To date, the rate at which plug-in EVs have entered the fleet has been roughly the same for both the New and Used fleets. (Indeed, very slightly higher for Used than New: In 2019 60% of plug-in EVs entering the fleet were Used, compared to 57% of all Light passenger vehicles entering the fleet being Used).

If this rate of EV adoption for Used could keep pace with that for New, then New Zealand should be able to transition to very high levels of EV uptake by the end of the decade for all the light vehicles entering its fleet.

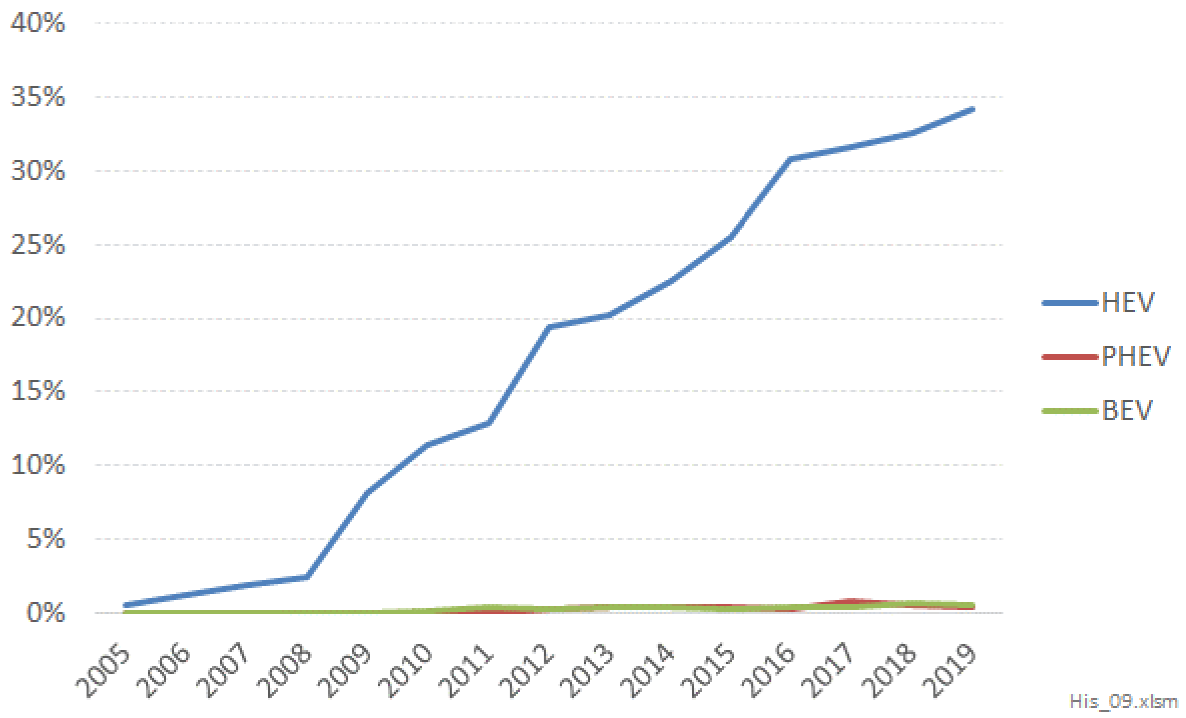
However, for a rapid transition to plug-in electric for our Used fleet to be feasible, the countries we are sourcing our Used vehicles from must also be transitioning at a similarly rapid rate. Indeed, almost certainly more rapid given that we purchase Used vehicles several years after they have first been registered as New in the source country.

And the country whose electrification transition matters most in this context is Japan, given that in 2019, 83% of our Used light vehicles came from this country, with 7% coming from Europe (principally the RHD markets of the UK and Ireland) and the remaining 10% from 'Other' (significantly from Australia).

[32] In 2019, 57% of Light passenger vehicles entering the fleet were Used, compared to 17% of light commercial vehicles entering the fleet. The weighted average across both these fleets was 50%.

However, as Figure 30 below shows, while Japan has rapidly adopted hybrid electric technology, to-date it has had very low rates of adoption of plug-in electric vehicles (PHEVs or BEVs).

Figure 30: Percentage of all new registrations in Japan which are electric

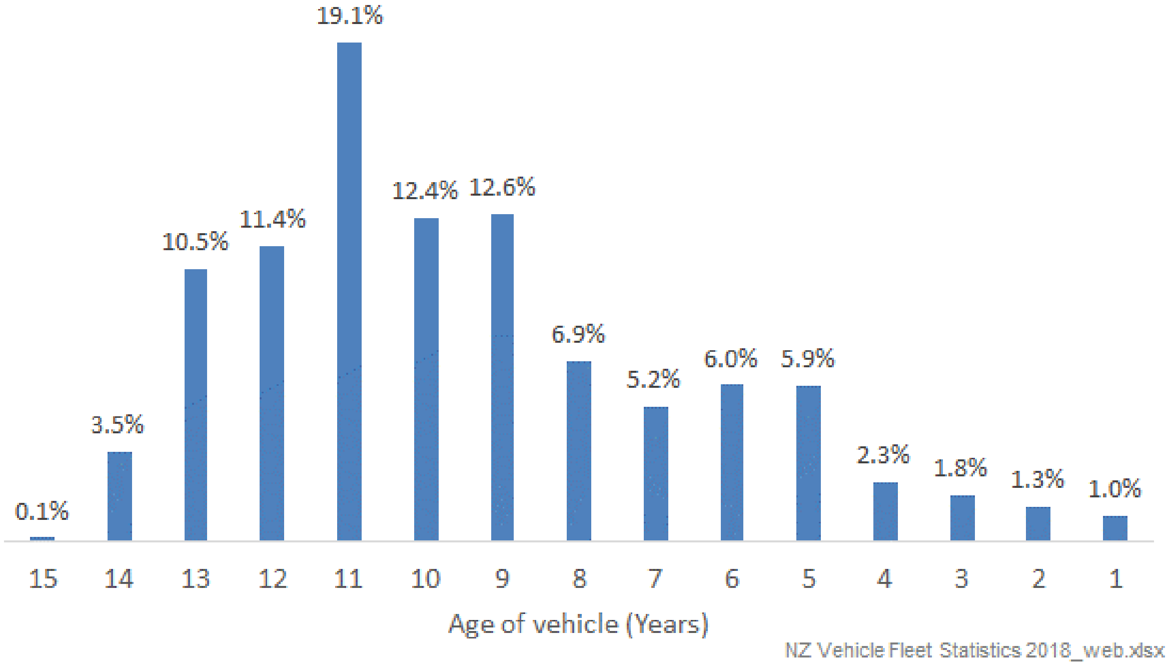


Source: Concept analysis of Japan Automobile Manufacturers Association data

This matters, because what New vehicles Japanese consumers buy 'now' will determine what Used vehicles are available to be purchased by New Zealand consumers 'later'.

This is particularly the case because there is a significant time delay from a vehicle being purchased New in Japan, to it subsequently being sold as Used to overseas markets such as New Zealand. Thus, as illustrated in Figure 31 below, the average age of a Used light vehicle entering New Zealand is 10 years' old, and 66% are between 9 and 13 years old at the time of importation. Therefore, if we are to have high rates of EV uptake for our Used fleet in 2030, on average there will need to have been high rates of EV uptake in Japan starting 3 years' ago!

Figure 31: Age profile of Used light vehicles entering New Zealand in 2018



Source: Concept analysis of MoT data

The fact that Japan is such a large market compared to ours is unlikely to help. Thus, although New Zealand's Used imports are equivalent to only 3.5% of Japanese new registrations each year, Japan only sells approximately 30% of its fleet as second-hand overseas. (The remaining 70% are sold second-hand within the Japanese market and driven to the point of scrappage within Japan).

Further, New Zealand is competing with many other nations for purchase of Used Japanese vehicles. Thus, in the last two years, New Zealand accounted for only 8.5% of all sales (ICE and EV) of Used Japanese vehicles.[33] (In 2019 we were third, behind UAE and Russia).

That said, in the last couple of years, our analysis of Japanese and New Zealand data indicates that we have accounted for a far higher proportion of sales of Used Japanese plug-in electric vehicles:

- Approximately 50% of sales of Used Japanese PHEVs
- Over 75% of sales of Used Japanese BEVs

Were New Zealand able to continue to dominate purchase of Used Japanese EVs, our ability to electrify our Used fleet would be easier. However, this state of affairs is unlikely to continue:

- Other markets which take Japanese Used output are likely to want to electrify their fleets and start wanting to purchase Used Japanese EVs. (Indeed, we should hope this is the case, as it would be consistent with them taking similar action to New Zealand to meet their commitments to limit global warming.) As such, over time, it should be expected that New Zealand's share of Used Japanese plug-in electric sales should revert to being the same proportion as our overall share of sales of Used Japanese vehicles.
- Some countries which traditionally haven't purchase Japanese Used vehicles may start to purchase Used Japanese EVs. In this it is significant that Australia is starting to remove the prohibitions on importing Used vehicles into its market following the closure of its last remaining

[33] Source: Concept (in association with Google Translate!) analysis of Japanese International Auto Trade Association data.

vehicle manufacturing plant. And the type of vehicle for which Australia is relaxing these Used import restrictions first are low emissions vehicles.

5.2 How quickly might New Zealand be able to achieve high levels of EV uptake for Used imports?

To help consideration of the extent to which these factors may impact on the ability for New Zealand to electrify its Used fleet, Concept has built a model which allows for projections of different rates of EV uptake in source countries, and the implications for New Zealand's ability to electrify its Used fleet.

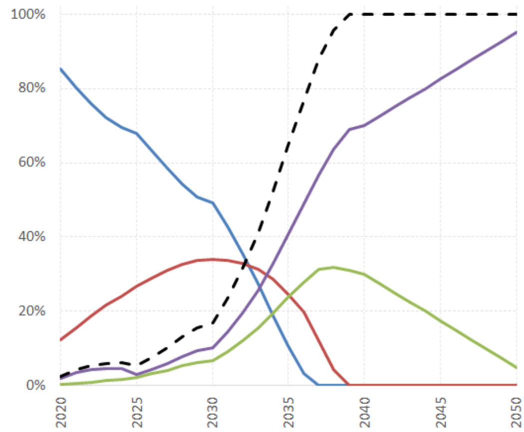
The key moving parts to this model include:

- Projections of source country (i.e. predominantly Japanese) whole-of-fleet (ICE and EV) New registrations. For this, we have assumed similar rates of change to that observed over the last decade
- Projections of rates of uptake in the source countries for the different EV technologies (HEV, PHEV, and BEV). This is varied on a scenario basis, with the key assumption being which year the source countries achieve 100% plug-in EV uptake.
- The age profile of vehicles sold by the source countries. This is assumed to be the age profile shown in Figure 31. Combined with the assumption around the rates of EV uptake for New registrations for source countries, this determines the amount of Used EVs being made available for sale to countries such as New Zealand.
- The proportion of Used EVs being sold by source countries that New Zealand procures. For this analysis we have assumed that this transitions over a ten-year period from the very high proportions that New Zealand has secured over the last two years, to the proportions that New Zealand currently accounts for across all vehicle types (ICE and EV).

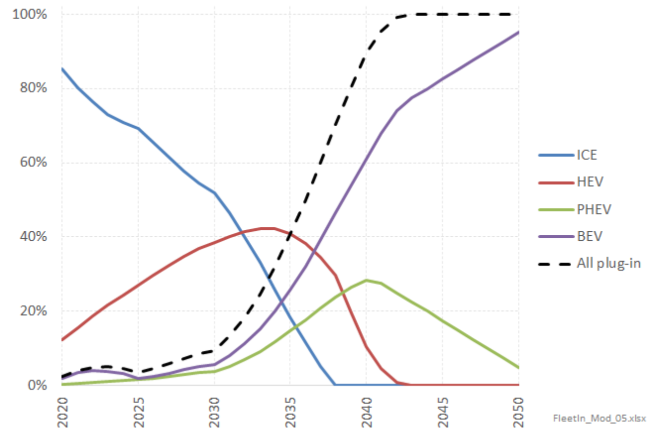
The results of this analysis are shown in Figure 32. This shows the proportion of Used vehicles entering New Zealand in a given year that are of a different fuel type, with four variations based on the year when the source countries for New Zealand's Used vehicles achieve 100% plug-in electric uptake.

Figure 32: Projections of maximum rates of uptake of electric vehicle for New Zealand's Used light fleet for different scenarios of source Used vehicle markets' 100% electrification[34]

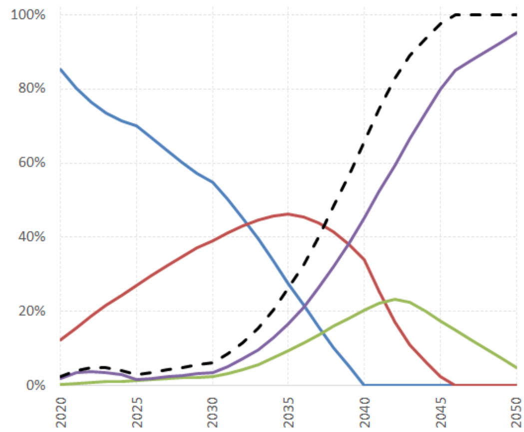
100% EV uptake in source market by 2030



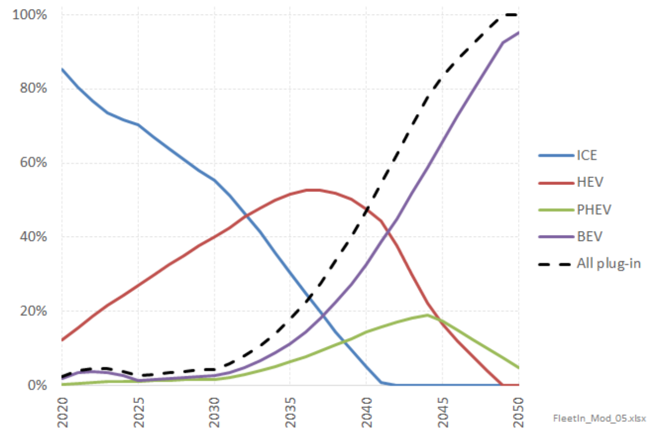
100% EV uptake in source market by 2035



100% EV uptake in source market by 2040



100% EV uptake in source market by 2045



As can be seen, it is not only going to be extremely challenging to move to 100% electric uptake of our Used fleet by 2030, but also difficult to do so by 2040. However, with the uptake of HEVs, we should be able to move away from pure ICE imports of Used vehicles more quickly.

5.3 What are the implications of our constrained ability to quickly transition our Used imports to EVs?

This conclusion that it will be harder to move as quickly to 100% uptake of Used vehicle as we will be able to achieve for New vehicles has significant implications for the design of EV-uptake policies in New Zealand, and highlights some challenging trade-offs.

In simple terms, policies which penalise all high emissions vehicles entering New Zealand in order to reward all low emissions vehicles entering New Zealand are likely to deliver significant economic and environmental benefits to New Zealand, but are likely to be highly regressive: Low-income consumers (who are the group which most depend on the nine to fourteen year-old vehicles coming out of Japan) will not have the option of purchasing EVs for many years, and will face increased

[34] The fall in rates of EV uptake to 2025 is due to the assumption that other countries who purchase Used vehicles will soon start to demand EVs, and thus New Zealand's ability to secure the very high proportions of EVs from source markets that it has achieved to date will fall away.

vehicle purchase prices in order to subsidise the purchase of low emissions vehicles by predominantly middle and upper income consumers.

Conversely, if policies to incentivise low-emissions vehicles are weakened so that they don't have such a significant impact on low-income consumers, they will be far less effective at incentivising the uptake of low emissions vehicles, with consequent economic and environmental impacts.

It should be noted that this issue is unique to New Zealand, and that therefore a unique solution may be required.

This uniqueness stems from the fact that no other Western economy has such a high proportion of Used vehicles entering their fleets.[35] In large part this is because New Zealand hasn't put in place the same restrictions on importing Used vehicles that most other developed nations have. Such restrictions have generally been introduced as part of measures to protect domestic vehicle manufacturing industries – something that New Zealand does not have.

Arguably, not having had such protectionist measures has been good for New Zealand consumers in that it has given them access to lower cost vehicles than would otherwise have been the case. (Although, on the flip-side, this has also contributed to New Zealand's car culture, with very high levels of vehicle ownership compared to other countries, and the attendant problems from excessive reliance of private vehicles for meeting our transport needs).

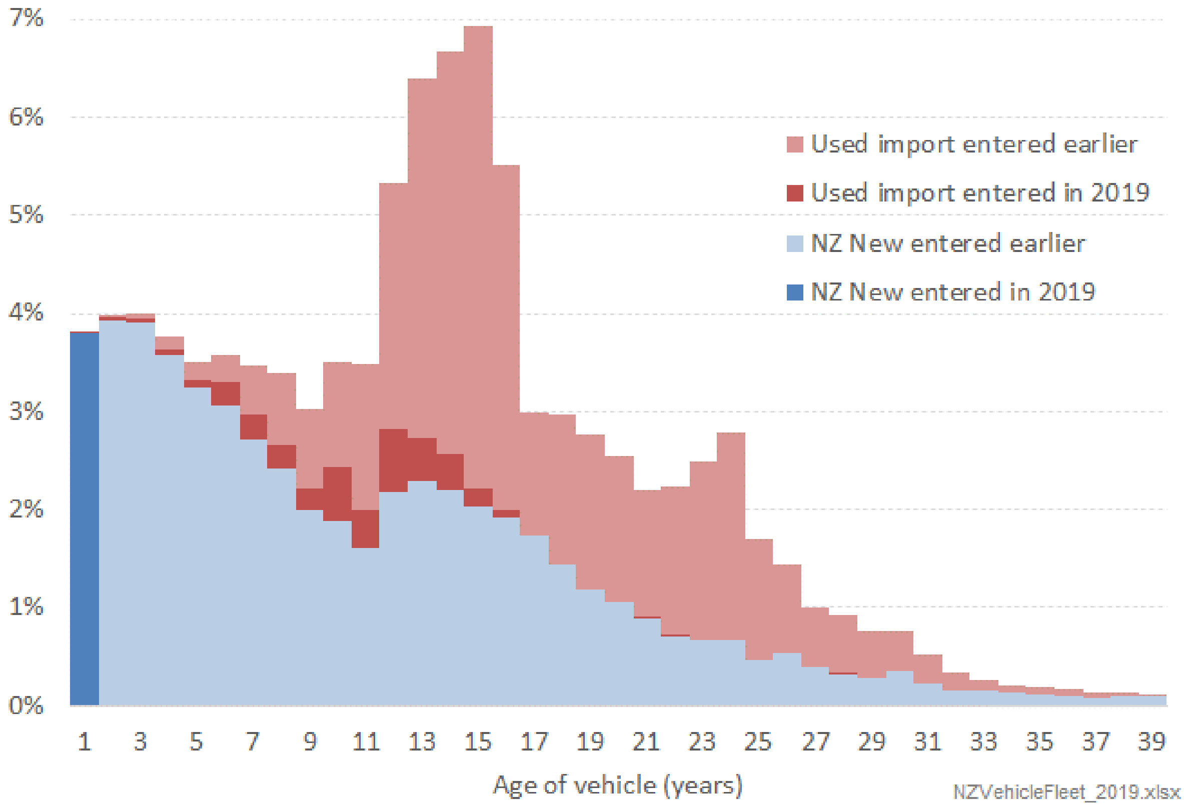
However, it does raise this unique problem that, as the world transitions its New vehicles from ICE to EV technologies, policies which are put in place to facilitate this transition in New Zealand could excessively penalise those consumers who rely on Used vehicles from overseas.

This transition problem doesn't occur for other Western countries because their consumers who rely on purchasing Used vehicles, do so within the country (or, in the case of Europe, region) – i.e. almost all such vehicles will have started out as New in the same jurisdiction. Therefore, policies aimed at increasing the price of high emissions vehicles and lowering the price of low-emissions vehicles when they are first brought into the jurisdiction won't affect consumers who subsequently buy them as second-hand several years' later.

Figure 33 helps illustrate the uniqueness of New Zealand's situation.

[35] Some European countries import significant numbers of Used vehicles from other European countries, however, these are not captured by the policies such as the European emissions standard.

Figure 33: Age distribution of New Zealand's light fleet in 2019[36]



Source: Concept analysis of MoT data

As can be seen, New Zealand has a relatively old fleet (the average vehicle age is 14 years) because so many of our vehicles enter our fleet as Used from overseas with an average age of 10 years.

In contrast, a country such as the UK will have a vehicle age distribution that is much more similar to the NZ New data series in Figure 33, and consequently much younger. Indeed, the average age of a car in the UK is just over 8 years' old.[37]

As well as having a younger fleet, it also means that policies in the UK which impact vehicles entering the country will only significantly affect vehicles manufactured in that year (or the year previous), whereas in New Zealand such policies will also significantly affect the import of vehicles manufactured many years earlier.

In considering policies to promote the uptake of low emissions vehicles in New Zealand, there are some tricky trade-offs to be considered here. Excluding Used vehicles from mechanisms to promote clean vehicle uptake may address possible undesirable regressive outcomes, but could cause unintended poor environmental and economic outcomes. For example,

- some consumers who might have bought a lower-emissions New vehicle, switching to purchasing a higher-emissions Used vehicle

[36] The unusual jump up in NZ New for 12-year-old vehicles reflects the significant drop in vehicle purchases 11 years' ago following the 2008 global financial crisis (GFC). The unusual jumps in Used imports are partly due to the GFC, but more due to a new rule coming into force which restricted the import of vehicles which could not meet new exhaust emission rules. The rule, which restricted vehicles from 2007, was signalled in advance so the used import industry stocked up ahead of the rule. The frontal impact rule that came into force in 1996 produced the other older hump.

[37] Source: https://www.nimblefins.co.uk/average-age-cars-great-britain

- consumers purchasing a higher-emissions Used vehicle, rather than a lower-emissions (but higher capital cost) Used vehicle.

To address this issue, we believe one of the best approaches could be to have the measures which apply to New vehicles also apply to Used vehicles, *but only those Used vehicles which are below a certain age*.

Providing the cut-off age is not too young, this would give rise to a lot of benefits compared to having the situation of Used vehicles being treated exactly the same as New vehicles, or compared to all Used vehicles having a completely different mechanism:

- Having relatively young Used vehicles within the mechanism that applied to New would preserve the incentives for purchasers of such Used vehicles to switch to low-emissions vehicles as they become available, but it would not cause regressive outcomes for purchasers of relatively old Used vehicles for whom such low-emissions options do not exist
- It would avoid the outcomes of potential purchasers of New vehicles switching to Used, as a 5-year-old Used vehicle is not a ready substitute for a New vehicle in most cases.

For the import of Used vehicles that are above this threshold age, we believe it would be appropriate to have a Fleet Emissions Standard mechanism, but with the parameters set at different levels to reflect the inability of these older imports to transition to plug-in EVs as quickly. i.e. to incentivise the uptake of better efficiency ICE vehicles and HEVs to the extent they are available, but not penalise consumers who can't purchase a lower emissions because they are not available.

Over time, as the likes of Japan increasingly move to plug-in vehicles and then, subsequently start selling off such vehicles in the Used market, there will be increased opportunities for New Zealand consumers of Used vehicles to purchase such vehicles. To preserve this incentive, it would be appropriate to progressively increase the cut-off age for Used vehicles to be incorporated within the New vehicles standard.

To consider this issue, we have adapted our fleet segmentation model which we've populated with a similar price and emissions data set to that used for our analysis of New vehicle situations[38], and combined it with our model projecting the availability of Used EVs for New Zealand to purchase over the next couple of decades.

This allows consideration of where such an initial cut-off age should be set, and how quickly this age could be increased.

Using this, we estimate that it would be appropriate to have this cut-off age initially set at five years. However, it may not be feasible to significantly increase this cut-off age before 2030 without starting to cause regressive outcomes.

That said, the standard for these older Used vehicles could be set initially at a lower level than for New vehicles, reflecting the lower average emissions of Used ICE vehicles compared to New ICE vehicles.

At the other end of the scale, it may be necessary to implement an age ban prohibiting the import of vehicles older than a certain age – with exceptions to allow the import of 'classic cars' and other special purpose vehicles. Otherwise, there is a risk that New Zealand would increasingly become the dumping ground for very old second-hand ICE vehicles. In this we think it is significant that New

[38] We did an extract from the Motor Vehicle Registry looking at every Used vehicle that entered New Zealand, matched it with the schedule of emissions data for each vehicle type provided by the VIA in its submission to the 2019 consultation, derived a price data set based on schedules of vehicle prices provided by the VIA for these overseas models coupled with a depreciation model based on estimates provided by the VIA and using the vehicle age in the Motor Vehicle Registry.

Zealand is the only country of the top 5 countries which import vehicles from Japan (accounting collectively for 45% of all second-hand Japanese exports) that doesn't have such an age ban.[39]

In addition to having a Used-vehicles specific Fleet Emissions Standard, we think it would also be appropriate to have a Feebate mechanism for Used vehicles whose emissions mid-point matches that of the Used vehicles Standard.

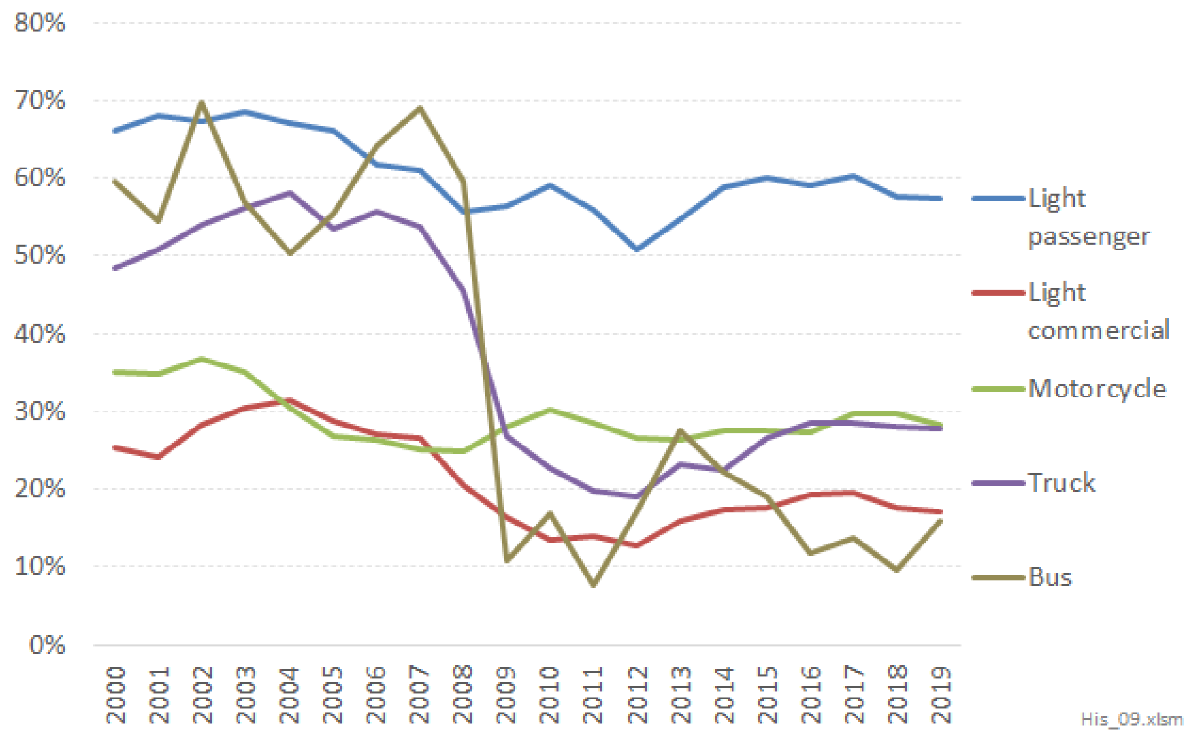
In addition, as set out in section 6, we believe there is a need for some support measures specifically for low-income consumers.

5.4 Having different approaches for Used imports is only necessary for light passenger vehicles.

We consider that this issue of potentially needing to develop different arrangements for Used vehicles rather than New vehicles is only necessary for the purchase of Light passenger vehicles. This is for two reasons:

- As Figure 34 below shows, this is the only segment whose entry is dominated by Used vehicles.
- Perhaps more importantly, it is the only segment where social policy dynamics around impacts on low-income consumers are significant. Thus, incentives to promote low-emissions trucks and light commercial vehicles are very unlikely to adversely affect low-income consumers as these are not the type of vehicles they purchase.

Figure 34: Proportions of vehicles entering New Zealand which are Used



Source: Concept analysis of MoT data

[39] The Russian age limit on used vehicles entering their country is five years, UAE's is ten years, Chile's is five years, and Kenya's is eight years.

6 Evaluation of possible complementary policy mechanisms

In addition to the mechanisms detailed in section 4, various other mechanisms have been used by jurisdictions in New Zealand and overseas to promote EV uptake. This section of the report addresses these possible complementary policy mechanisms. While each of these are unlikely to have the scale of effect of the core policies set out in section 4, they will collectively improve the effectiveness of these core policies.

Some are also important to address particular dynamics, for example:

- targeted financing mechanisms to help address issues with low-income consumers' transition to EVs; or
- critical 'pre-cursor' policies for technologies which are at an earlier stage of their development and thus for whom the core policies are not so appropriate. E.g. demonstration project mechanisms for heavy BEV trucks.

Because their effect is likely to be "supportive rather than determinative" compared to the core policies detailed in section 4, the analysis of these complementary policies is more qualitative, and less quantitative than that for the core policies.

6.1 Road funding charge adjustments

Revenue for funding government expenditure on land transport is collected in two ways depending on the type of fuel used to power a vehicle:

- For petrol vehicles, it is collected via the national land transport fund component of Fuel Excise Duty (FED).

  This is levied at the pump per litre of petrol sold. The current national land transport fund component rate is 70.024 c/l, excl. GST.[40]

- For diesel vehicles, and other vehicles which use energy sources which are not subject to FED, it is collected via Road User Charges (RUC).

  RUC is charged at a flat rate per km driven. The current RUC rate for vehicles under 3.5 tonnes is $76/1,000km[41] (incl. GST). For heavy vehicles, the RUC rate is determined by the vehicle weight, configuration, and the number of axles and tyres. RUC rates for heavy vehicles vary between $80 and $435 per 1,000 km (incl. GST). In addition to this, unpowered truck trailers used with the truck prime mover also attract RUC between $41 and $318 (excluding GST) per 1,000 km[42].

  RUC is purchased in advance of the driving distance from NZTA or its agents and is specific to the vehicle registration. Most light vehicles use distance licences to pay RUC. Distance licences are purchased in units of 1,000km for purchase of RUC in one transaction. An administration fee is charged for each RUC purchase transaction. Most light vehicle owners need to watch their odometer to determine when they need to renew their distance licence.

Because plug-in electric vehicles (BEVs and PHEVs) use "*energy sources which are not subject to FED*" (i.e. grid electricity) they would be liable for paying RUCs. However, they are currently exempt from

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[40] In addition to the national land transport fund component, ACC levies, the Petroleum or Engine Fuel Monitoring Levy, and the Local Authorities Fuel Tax are also levied at the pump, bringing total Fuel Excise Duty to 77.294 c/l excluding GST. Ref: https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-generation-and-markets/liquid-fuel-market/duties-taxes-and-direct-levies-on-motor-fuels-in-new-zealand

[41] https://www.nzta.govt.nz/vehicles/licensing-rego/road-user-charges/ruc-rates-and-transaction-fees/

[42] https://www.nzta.govt.nz/assets/resources/road-user-charges/docs/road-user-charges-handbook.pdf

having to pay RUC – a policy to support EV uptake that was introduced in 2009 and was extended in 2016 and again in 2017 to include heavy electric vehicles such as buses and trucks.

For a NZ New light passenger vehicle driven the average amount of km in the first four years of its life (14,200 km/yr), this avoids paying approximately $1,070 per year in RUC (incl. GST).

The most recent exemption granted plug-in EVs from paying RUC is due to expire from 31 December 2021 for light vehicles (vehicles under 3.5 tonnes), and from 31 December 2025 for heavy vehicles.

Because of the consumer behaviour barriers set out in section 2.1, we think a usage-based mechanism to incentive EV uptake – such as a RUC exemption – is likely to be less cost-effective than measures which alter the up-front purchase costs (such as a feebate or fleet emissions standard). Further, as the proportion of EVs in the vehicle fleet grows, continuing with a RUC exemption for EVs will become increasingly unsustainable. As such, we consider that the RUC exemption will need to be removed at some point in the future.

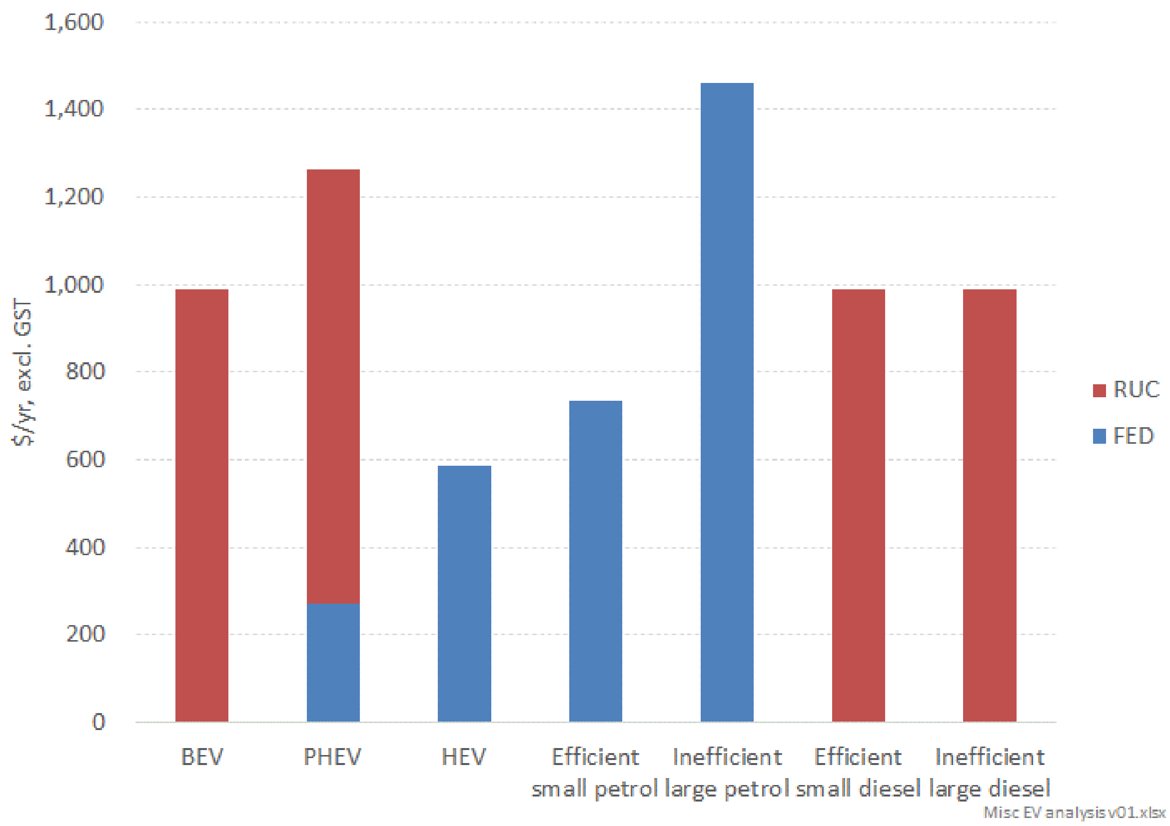
However, removing it for light vehicles by the end of 2021 in the absence of any other policy initiatives will result in EVs having no material mechanism to specifically incentivise their uptake, despite the many disincentives set out in section 2. This would have a significant negative effect on non-ICE vehicle uptake.

And for heavy vehicles, with only four years left of the RUC exemption before it expires at the end of 2025, we would expect this expected removal date to increasingly adversely affect non-diesel truck uptake as commercial vehicle operators place greater weight on usage costs than passenger vehicle owners.

As such, we would strongly recommend that the RUC exemption on plug-in EVs is extended until alternative and stronger incentive mechanisms are put in place.

In addition, when the exemption is removed the current fuel excise and RUC structures should be overhauled. This is because they create significant distortions in how much different types of vehicles contribute to road funding. Figure 35 below shows the levies payable for road infrastructure funding from light vehicles (i.e. less than 3.5 t) of different types once the RUC exemption for plug-in EVs expires.

Figure 35: Annual transport levies from different light vehicles - all travelling 15,000 km per year[43]



As can be seen, the mix of FED and RUC-based approaches causes significant variations in how much vehicle owners contribute to road infrastructure funding. This creates significant distortions to incentives to purchase different types of vehicle. This includes PHEVs paying two lots of road-user funding levies:

- FED from the petrol they consume[44]; and
- RUC as they are classed as a vehicle which use energy sources which are not subject to FED (i.e. in the case of PHEVS, electricity from the grid).

Thus, consumers will face a material incentive to purchase a relatively efficient petrol ICE vehicle, rather than a far more emissions-efficient plug-in electric vehicle. As plug-in electrics move to become lowest cost options on a TCO basis in the next couple of years, these distortions will increasingly result in material economic costs to New Zealand.

Coming up with a new road funding approach, although urgent, is outside the scope of this study. However, we would note that in considering the relative merits of different approaches (e.g. different RUC rates for EVs), the non-price transaction costs of different approaches should be taken into account. In particular, the non-price transaction costs of purchasing RUCs (or potentially requesting rebates for some proportion of RUCs in the case of PHEVs) is likely to be viewed as a material hassle for many motorists, and hinder switching from a petrol vehicle to an EV. We believe

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[43] For interest, for a petrol vehicle to pay as much in FED as a diesel pays in RUC, the petrol vehicle's fuel efficiency would need to be 9.4 l/100km.

[44] It would be possible for consumers to apply for FED to be rebated, and there are mechanisms in place for this. For example, at the time when New Zealand had some CNG buses, they got their excise duty on CNG rebated as they also paid RUC as a heavy vehicle. However, applying for rebates based on the amount of petrol consumed would impose significant transaction costs on PHEV owners.

this should be a material consideration in evaluating whether road funding should continue to be based on a mix of FED and RUC-based approaches.

6.2 Fringe Benefit Tax (FBT) adjustments

A fringe benefit is an extra benefit provided by an employer to an employee, supplementing an employee's monetary wage or salary. For example, a company car, private health insurance, etc. In such situations the employer (not the employee) must pay fringe benefit tax (FBT) to the IRD.

FBT is levied on company vehicles if a vehicle is available for employees to use privately, even if they do not actually use it.

There are two areas where FBT on company vehicles is causing distortions which are causing poor transport emissions outcomes:

- FBT only being applied to the capital cost of vehicles, not their operating costs, which acts against EVs relative to ICE vehicles.
- Lack of compliance enforcement around FBT exemptions on work vehicles, encouraging excessive uptake of utes.

6.2.1 Application of FBT only on capital costs

The problem

For simplicity, FBT is applied only to the capital costs of vehicles, as a proxy for the capital, fuel and maintenance cost private benefits that accrue to private use of a company vehicle. The high (relative to corporate and income tax) FBT rate of 49.25%[45] in part reflects this, as well as acting as a general incentive on companies to move away from providing benefits in kind to benefits primarily through wages or salary.

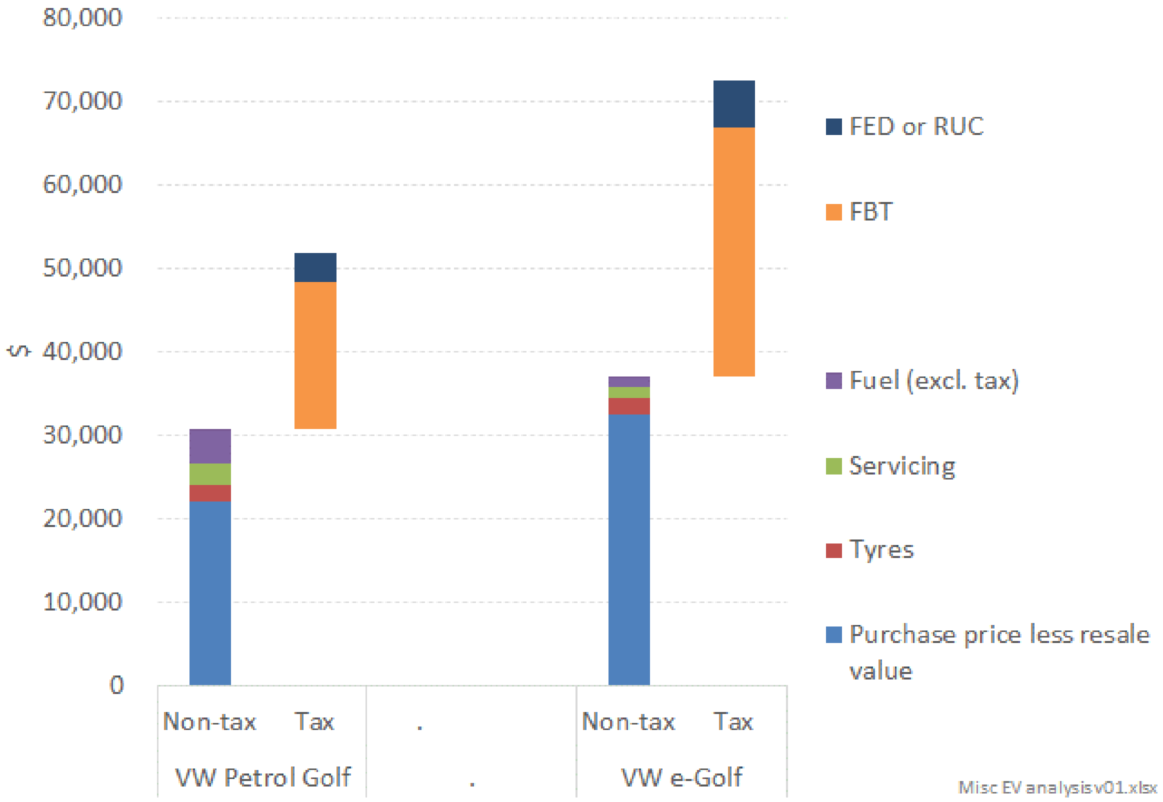
While only charging FBT on vehicle capital costs may not have caused too many distortions around vehicle choice when ICE vehicles were the only option, it is causing significant distortions now that companies have a choice between EVs and ICE vehicles.

This is because EVs currently have higher up-front capital costs and significantly lower fuel and maintenance costs. Consequently, EVs attract much higher effective FBT than an equivalent ICE vehicle. This tax distortion is a barrier to the uptake of EVs, and is significant because employers and companies purchase around half of all New light passenger vehicles entering the national fleet.

Figure 36 below shows the effect of FBT on the four-year cost of ownership for a model which comes with both petrol and electric variants (VW Golf). Also shown is the effect of FED and RUC, once the current RUC exemption for EVs expires at the end of this year.

[45] If employees earn less than $70,000 per year, a lower rate of 42% applies.

Figure 36: Four-year costs of ownership for ICE and EV equivalents, excl. GST[46]



The e-Golf pays $12,000 more in FBT than the petrol Golf. This scale of FBT disbenefit for employers buying EVs is equivalent to the level of subsidies applied to EVs incentivising their purchase in many countries (as described in section 3.1.6) and so will be clearly impact employer/employee vehicle choice.

Once the RUC exemption is removed, this will add a further $2,000 more that the e-Golf pays in taxes over the four-year period than the petrol Golf.

Possible remedies

Given that EVs are projected to be lower cost transport options on a TCO basis within the next couple of years, this distortion is likely to cause considerable public cost to New Zealand.

For example, continuing with the VW Golf example shown in Figure 36 above, if e-Golf purchase prices fall by 18.5% the non-tax 4-year total-cost-of-ownership (TCO) of the ICE and EV models will be equivalent. However, once FBT is included, the e-Golf TCO will be $6.6k higher (14% higher) to the individual than the ICE Golf. ($8.6k if you also include the distortions arising from FED versus RUC). In order, for the e-Golf to have an equivalent private TCO after taking account of FBT, its purchase price will need to fall by 29.5%.

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[46] The vehicle cost data is from EECA's Vehicle Total Cost of Ownership tool (https://tools.genless.govt.nz/businesses/vehicle-total-cost-of-ownership-tool/) for a vehicle owned from new before it is on sold. It uses the EECA tool's assumptions for annual vkt for a company vehicle (21,250 km/yr), residual value after 36 months, tyres, relicensing and other costs typical of corporate fleet ownership. It includes petrol at $1.66 per litre (including FED, but excluding GST – $1.85 if GST included) and electricity at $0.13 per kWh (excl. GST), interest costs at 9%, straight line depreciation at 21%, FED and RUC rates are as published by MBIE and NZTA and exclude the Auckland Regional Fuel Tax. FBT is at the single rate of 49.25% with the vehicle available for private use for 90 days per quarter.

To address this, EV advocacy group Drive Electric[47] has proposed that FBT is applied to an EV at the rate of an equivalent ICE vehicle rather than the full EV cost – i.e. setting the FBT rate for an EV so that it pays an equivalent amount of FBT in absolute dollar terms as its ICE equivalent.

It would be impractical to calculate specific FBT levels to apply in each vehicle situation (noting that there is some variance among vehicles between the EV capital cost and the capital cost of an 'equivalent' ICE vehicle). However, an EV FBT % adjustment set which reflects typical capital cost differentials would be a pragmatic, and relatively easy to implement approach.

This relative reduction in FBT levied on EVs should be progressively reduced as their capital costs fall, and the consequent distortive effect from the current FBT settings is reduced. We would suggest a pragmatic approach would be to set in place this progressive removal at the same time as the initial reduction is put in place, and for such a removal regime to be a straight-line from the date when the FBT adjustment is put in place to the time when EVs are projected to have the same capital cost as ICE vehicles.

Although we are wary of altering general tax settings to address specific distortions in certain areas, we believe that the scale of cost effect arising from this particular distortion means that in this case it is likely to be justified – particularly if it is implemented with an effective sunset clause.

Other countries have adopted similar approaches to that set out above to address the FBT distortion on EVs. For example, in April 2020, the UK set the rate of Benefit in Kind (BIK), equivalent to FBT, on BEVs at zero for 2020/21, with progressively higher BIK rates based on vehicle's emissions intensity up to a maximum of 37% for vehicles emitting 170 gCO2/km or more. All rates will rise by 2% by 2022/23, and then be held at that level to 2024/25 to provide certainty and encourage corporate EV uptake.[48]

6.2.2 FBT exemptions

The problem

FBT is exempted from vehicles which are "mainly designed to carry goods or goods and passengers equally" (such as vans and utes), are sign-written, and the employer informs employees in writing that the vehicle is not available for private use.

Given the challenges of enforcing this rule and subsequent lack of penalties imposed by IRD on non-compliance, there now appears to be widespread non-compliance with the existing FBT rules and a perception that utes automatically qualify for the "work-related vehicle" exemption from FBT as long as they are sign-written. i.e. people perceive that if they choose a ute they don't need to pay FBT whereas if they choose a station wagon or saloon, say, they would need to pay FBT.

This is resulting in people choosing utes when another vehicle such as a station wagon or even a saloon would have met their requirements.

This problem with unintended consequences from FBT applying to vehicles has been known for some time. A 2012 research report for NZTA on FBT identified that "*some current policies unintentionally encourage employees to choose larger vehicles, drive more kilometres annually, reduce use of alternative modes and choose more dispersed, automobile-dependent locations than would otherwise occur*".[49]

Utes are now the top selling light vehicles in NZ. For example, in 2019 three of the top five selling new light vehicles were utes, with the Ford Ranger ute being top overall. This compares with 2009

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[47] https://driveelectric.org.nz/media-release-fbt-switch-scheme-for-electric-vehicles-entering-corporate-fleets-would-drive-more-corporate-demand/
[48] https://www.goultralow.com/fleets-and-businesses/tax-benefits/
[49] https://www.nzta.govt.nz/assets/resources/research/reports/474/docs/474.pdf

when only one of the top five selling new vehicles was a ute, and the top selling vehicle was the Toyota Corolla passenger car. This also contrasts with Europe and Japan where far fewer utes are sold.

This lax FBT exemption policy is not only resulting in less tax being collected than should be the case, but is also having negative emissions consequences because:

- ICE utes are less fuel efficient than ICE station wagons or saloons
- The development of EV models for utes is approximately five years behind that of EV models for other light vehicles.[50] As such, this incentive to purchase utes will frustrate the uptake of EVs.

Possible remedies

The FBT exemption on vehicles which are "mainly designed to carry goods or goods and passengers equally" was introduced at a time when utes used to have relatively low comfort levels and specifications and so would only be selected by buyers needing to transport equipment, livestock and goods where 4-wheel drive capability was needed such as construction sites, unsealed roads and farms. i.e. it was intended for vehicles which were extremely unlikely to be materially used for private passenger use.

However modern twin-cab utes typically have equivalent comfort levels and interior specifications to passenger cars, and so have become popular as every-day vehicles, often competing in the same market segment as large passenger cars and SUVs.

As such, it would seem that appropriate to remove this exemption, and have the basis for application of FBT on utes the same as that for other light vehicles. i.e. commercial vehicles such as utes which are used strictly for work purposes only would not attract FBT, but any light vehicle (ute, saloon, or SUV) which is also used for private purposes would need to pay FBT.

The regressive outcomes from removal of this de-facto FBT exemption on utes are likely to be limited, as many of those avoiding paying tax (FBT) on utes are likely to be higher income earners. That said, removal of a de-facto means of avoiding tax is likely to be unpopular from the business and rural community.

6.2.3 Other work-supplied vehicle policy issues

WorkSafe have issued guidance that if an employee charges a work-supplied vehicle at their home, then the employee's garage is considered a workplace for the purposes of EV charging. This guidance has been raised as a potential discouragement for businesses bringing EVs into their fleet due to possible workplace liability issues.

Although not an FBT issue, this potential institutional barrier has been grouped in the FBT section as it relates to the private use of a work-supplied vehicle.

It would seem appropriate to alter this guidance from WorkSafe to state that an employee's home garage is not considered a workplace for the purposes of EV charging, and more appropriately clarify employers' responsibilities with regards to the charging of work-supplied EVs at employees' homes.

6.3 Public sector procurement

Central and local government account for around 5% of all new vehicle purchases in New Zealand. Both central and local government each purchase 4-5,000 new vehicles per year. Detailed statistics

[50] This is due to utes being a small segment internationally. As such, vehicle manufacturers are focussing their efforts on producing EV models for segments with the highest proportion of sales (cars, SUVs and even vans).

on the central government fleet and its CO_2 emissions is available publicly on the government procurement website.[51]

In addition to the type of barriers detailed in section 2, public sector procurement often faces institutional barriers in the form of budgets typically being separated into capital cost budgets and operating cost budgets. This can create a barrier to EV uptake if the reduced energy costs provide savings for the operating cost budget, but the capex budget (where the initial decision to purchase rests) sees higher costs.

To overcome the barriers requires positive policies. For example:

- A requirement that all light vehicles purchased by government should be non-ICE after a certain date, unless for exceptional uses where justification can be provided – effectively an ICE ban for government sector procurement.
- A requirement that on average the emissions of government purchased vehicles must reduce over time – effectively a Fleet Emissions Standard for government vehicles
- Require that a certain percentage of fleet vehicles must be EVs, increasing this over time – this can include existing fleet vehicles, not just new entrants to the fleet, so that the replacement of vehicles is encouraged.

In considering the efficacy of such measures, we think that government is better placed to implement measures to improve its own vehicle purchases than the private sector:

- Government is better able (indeed should) evaluate the relative cost of ICE and EV options on a lifetime total cost of ownership basis incorporating all externalities. (i.e. taking a public, rather than private, perspective)
- In considering this public benefit, it can incorporate the leveraging effect of increased uptake of EVs by some consumers resulting in greater familiarity and understanding of EVs by other consumers, increasing their propensity to switch and accelerating the general rate of EV uptake. We think this effect is material.[52]

Our evaluation is that for light passenger vehicles, the total cost of ownership of HEVs is already lower than ICEs, and that these will be overtaken for plug-in EVs within a couple of years – particularly when this public perspective is considered. For buses too, the economics of electric buses also look very compelling – noting that the human health costs from diesel emissions are particular significant for buses (as detailed further in section 6.6).

As such, it is encouraging that New Zealand central and local government is starting to adopt these measures, as not only will these deliver reduced emissions, but also reduced transport costs for New Zealand.

- As part of the government's recent announcement that the public sector will be climate neutral by 2025, it has also announced that government must "*purchase electric vehicles or hybrids where EVs are not appropriate for the required use, unless their operational requirements or other circumstances require*"[53]. The announcement also included a requirement for mandated agencies to optimise their car fleet with the aim of reducing the number of vehicles in the Government fleet.

[51] https://www.procurement.govt.nz/broader-outcomes/reducing-emissions-and-waste/reducing-government-fleet-emissions/
[52] Numerous studies have indicated that mass uptake of a new technology will not occur before the level of technology penetration has passed a certain point – leading to 'tipping point' phenomena. The size of the government fleet is such that it can play a material role in achieving this transition.
[53] https://www.beehive.govt.nz/release/public-sector-be-carbon-neutral-2025

- As an example of a local government initiative, since 2016, Greater Wellington has had a policy for its own passenger vehicle fleet that no new ICE vehicles are procured for its own fleet unless a case is made that there is no suitable alternative[54].
- Significant developments are also occurring on buses, with Auckland and Christchurch already having policies of mandating no new diesel public transport buses after 2025, and Greater Wellington Regional Council has gone even further by proposing that all existing diesel public transport buses will be removed from service and replaced by electric by 2030.

Complementary initiatives can enhance the effectiveness of public sector procurement

We think a set of complementary initiatives would further enhance the effectiveness of public sector procurement.

Combining procurement with a fleet audit approach aligns with good fleet management practice. It has the potential to deliver capital cost savings from selling underutilised ICE vehicles which may partly or fully offset any additional costs of EV procurement. It may identify other cost savings from improving management of the existing ICE vehicle fleet, driver behaviour change and modal shift (including to EV car share such as Mevo or Zilch which corporate clients using them as alternatives to fleet ownership). The fleet audit approach is currently being trialled through an EECA Low Emission Vehicle Contestable Fund project, providing evidence of effectiveness and a programme which can be quickly expanded.

An initial first step could be that Government requires all agencies with vehicle fleets to undertake a fleet audit to identify ICE vehicles practical for replacement with an EV and underutilised ICE vehicles.

Combining procurement with a fleet audit approach aligns with good fleet management practice. It has the potential to deliver capital cost savings from selling underutilised ICE vehicles which may partly or fully offset any additional costs of EV procurement. It may identify other cost savings from improving management of the existing ICE vehicle fleet, driver behaviour change and modal shift (including to EV car share such as Mevo or Zilch which corporate clients using them as alternatives to fleet ownership). The fleet audit approach is currently being trialled through an EECA Low Emission Vehicle Contestable Fund project, providing evidence of success and a programme which can be quickly expanded.

The public sector can also influence electric vehicle procurement in the private sector through its tenders and contracts. For example, Government tenders for short term rental vehicles, taxi services, courier and freight services can specify that weighting is given to providers with electric vehicles or include a requirement for electric vehicles. This can potentially be expanded to procurement wider than transport services, such tenders for other goods and services, such as office cleaning services, to use electric vehicles in their operations.

The capital budgeting issue can be addressed through:

- Public sector financing schemes such as EECA's Crown Energy Efficiency Loan Scheme[55].
- Implementing arrangements for the public sector to lease vehicles rather than purchasing. Leasing is a very common approach for procurement in Europe for both the private and public sector. Section 6.5.2 provides more details about leasing.

[54] https://www.gw.govt.nz/assets/Climate-change/GWRCelectric-vehicle-policy-2016.pdf
[55] https://genless.govt.nz/running-a-business/co-funding-and-support/business-co-funding-and-support-programmes/crown-loans/

6.4 Demonstration projects

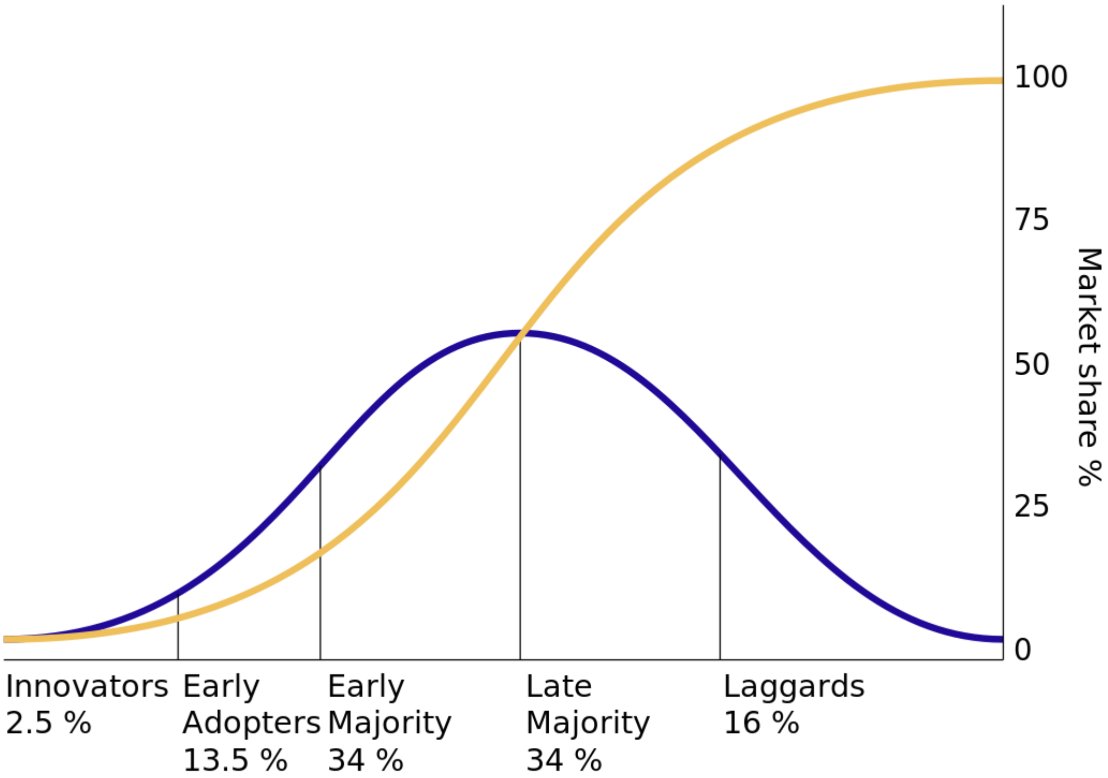
6.4.1 What are demonstration projects?

When new, unfamiliar technologies are introduced into different market segments, the first movers bear more risk and often the technology is more expensive for early adopters than for later adopters. People wait to see if the new technology performs when used by other people first. This slows the uptake of new technology.

Demonstration projects can be extremely cost-effective means of providing support to help technologies get past the early stages of uptake.

Demonstration projects provide a financial subsidy (generally with co-funding from the recipient) to help share first mover risk and higher costs for projects which show that a technology works and reveal what benefits are delivered at what costs in a particular market segment, application and/or location. They are targeted at the innovator segment of the technology diffusion curve, as illustrated in Figure 37 below.

Figure 37: Illustrative technology diffusion curve



Bringing forward the uptake of beneficial technologies means that the benefit-cost ratio for demonstration projects can be considerable.

Funding of demonstration projects is typically available via one of two mechanisms: competitive funding rounds which occur periodically, or a pool of funding which is allocated on a 'first come' basis for projects meeting specified criteria. The competitive allocation method may delay supporting some projects until a new funding round is available. It requires applicants to make a case for why their projects should be funded over others, creating additional administration for both the applicant and the funder. The pool method of allocation reduces administration but risks funding a poorer, early project over better later project if the funding pool is insufficient to fund both.

Dissemination and promotion of project results and lessons learned is an important part of demonstration projects, and it is important that resourcing is available for this. Other potential users of the technology can then learn from the demonstration project results to determine with greater certainty whether the technology is appropriate for them. The overall result is increased consumer awareness and acceptance of the technology, catalysing faster uptake than might otherwise have been the case.

6.4.2 Examples of transport-focussed demonstration mechanisms

There are many international examples of successful demonstration programmes aimed at decarbonising transport through vehicle electrification. Some examples include:

- Canada has a funding scheme in place for commercial-scale EV charging infrastructure demonstration projects. The fund specifies that projects must achieve a move between specified Technology Readiness Levels[56].
- UK Innovation and UK Power Networks have supported UK Vehicle-to-grid (V2G) demonstration projects, and identified other V2G demonstration projects around the world. Their report on global V2G demonstration projects is a good example of communication of demonstration projects to help wider understanding and uptake[57]. It covers over 70 projects globally, including one in New Zealand supported by EECA's Fund.
- China has declared Shanghai an International EV Demonstration City. The city includes an EV Demonstration Zone with more than 50 industry partners providing EVs sales, public test drives, EV carsharing, rentals), data collection, service and maintenance and infrastructure support. The city also operates an effective Zero Emissions Zone.
- California's Advanced Technology Demonstration Projects funds on-road and off-road demonstrations of electric and other low/zero carbon technologies, including electric school buses, zero-emission trucks, ferries and locomotives.
- The Zero Emission Urban Bus System (ZeEUS) project in the European Union has designated zero-emission urban bus demonstration cities, including Barcelona, Bonn, Cagliari, Eindhoven, London, Münster, Paris, Plzen, Stockholm, and Warsaw. The programme findings help influence bus operators and public transport agencies to support and procure electric buses.

In New Zealand, EECA's Low Emission Vehicles Contestable Fund is aimed at EV demonstration projects and has been operating since 2017, with funding rounds held every six months. The Fund has assisted a wide variety of electric vehicle demonstrations, including the first EV car share schemes, EV taxi fleets, rental EVs, electric buses, electric trucks, and different types of public and workplace EV charging[58].

Most of these EECA-funded projects have gone on to be replicated or expanded. For example, following demonstration in Wellington, EV carshare schemes are now operating in Christchurch, Auckland and Hamilton. The first electric bus was demonstrated with support from the Fund, and there are now over 40 electric buses in operation around the country, with around 100 further e-buses on order. Many of these buses have been assembled in New Zealand. The Fund has also supported the installation of over 600 EV charging points to date.

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[56] https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/innovation-and-clean-growth-research-development-and-demonstration-programs/20024

[57] https://www.v2g-hub.com/insights

[58] https://genless.govt.nz/running-a-business/co-funding-and-support/low-emission-vehicles-contestable-fund/summaries-of-approved-projects/

6.4.3 Where might future EV-related demonstration funding be required?

At some point, policy support may need to transition from influencing innovators (where demonstration funding is ideally suited) to influencing early adopters (where other mechanisms are better suited such as, in the case of EVs, the core policies detailed in section 4).

For example, since its introduction in 2017 much of the EECA demonstration funding for charging infrastructure has moved from demonstrating new technology to facilitating the development of a nationwide network of charging infrastructure. Charging technology and the level of infrastructure roll-out have now reached the point where the development of a charging network might now be better supported through a new policy mechanism than demonstration funding. This will be the subject of our next report in this EV study series.

However, there are still many transport decarbonisation areas where demonstration funding is likely to continue to be important for the next few years. These include:

- Electric trucks. Global truck manufacturers are starting to go electric, as rapid and continuing improvements in battery performance and cost have started to make it cost-effective for electric trucks to displace diesel. However, many truck operators in New Zealand may be reluctant to be one of the first to deploy this new technology. Demonstration project co-funding will be an important tool to help kick-start this transition. Such funding can be an extremely cost-effective use of public money.
- Developing the technology and associated systems and processes to optimise EV charging, including accessing the significant potential from vehicle-to-grid (V2G) technology.

6.5 Financing mechanisms

The current higher capital costs of electric vehicles can be a barrier to consumers purchasing EVs even when their total cost of ownership is lower than ICE vehicles.

Financing mechanisms have been put forward as a means of helping overcome this barrier. This section briefly reviews three mechanisms:

- Soft loans
- Vehicle leasing
- Accelerated depreciation

6.5.1 Soft loans

General approach

Soft loans are loans with below market interest rates and/or relaxed loan eligibility criteria. A number of jurisdictions have used them for financing an EV purchase, to make it easier for those buyers to choose an EV over an ICE at the time of their next vehicle purchase.

Some overseas examples of these EV-specific financing mechanisms include:

- Scotland offers interest-free loans over a term of up to five years for the purchase of new or used EVs, including electric vans and electric motorbikes. The loans are available to both individuals and businesses.[59] There is no income test or business size limit, but loans are available for only one EV per applicant, there is a cap on the loan amount, and a maximum price for vehicles eligible for the loan. The programme had supported loans totalling GBP85 million as at September 2020.

[59] https://energysavingtrust.org.uk/grants-and-loans/used-electric-vehicle-loan/

- In California, loans are available to businesses with less than 1,000 employees to help install workplace charging infrastructure and to landlords of multi-unit dwellings[60]. Up to US$500,000 per business is available. Availability of workplace charging infrastructure has been shown to result in the increased uptake of EVs. Workplace charging assists employees with limited transport options, such as those working shift-work or in locations away from city centres, to consider buying EVs as an alternative to ICE vehicles for their commute.

  Apartment buildings pose a particular challenge for home charging of EVs, as the landlord does not benefit directly from the tenants being able to charge. If the landlord passes the costs of installing EV charging infrastructure onto the first tenant with an EV, the tenant may face a much higher cost than subsequent tenants needing additional infrastructure. While there may be staff retention/attraction benefits for workplaces installing charging, and the potential for landlords to slightly raise rents in the future as a result of the additional amenity of installing charging infrastructure, at this stage of EV market development, these benefits may be considered very uncertain by the businesses and accrue only over the longer term. The California programme of loans for landlords directly addresses these barriers to EV uptake.

  Commercial lenders are able to participate in these Californian soft loan schemes, and the programme provider contributes funds to the commercial lenders' loan loss reserve account for each loan, with higher contributions for loans provided to disadvantaged communities. This approach helps ensure that a variety of loan finance options are available for the programme, and that those most needing finance for EVs are able to access it.

- In India, income tax deductions are allowed on the interest paid on loans for electric vehicles. This policy provides an alternative route to softening the cost of finance for EVs without interfering with the finance market[61].

In New Zealand, the Crown loans scheme allows public sector organisations to access the loans to fund the price difference between an EV and an ICE and the cost of installing a charging point.

Targeting low-income consumers

Some low-income consumers struggle to access finance for capital investments. Even though interest rates are at historic lows, issues such as poor credit ratings mean they are unable to access lending at the low rates that are available to the majority of the population. In many cases they turn to so-called payday lenders charging much higher interest rates when an unexpected one-off cost needs to be incurred.

A study by MBIE has shown that vehicle repairs are the single highest source of problem debt amongst low-income households, accounting for 16% of issues, with vehicle purchase accounting for a further 3%.[62] Low-income households tend to have older ICE vehicles which often need expensive maintenance to keep operational, are less fuel efficient, and have low occupant safety levels. In many cases, the inability to raise capital to purchase a newer vehicle forces low-income households into a cycle of purchasing older vehicles which may be 'cheap' to purchase, but which have significant ongoing reliability and associated maintenance costs resulting in a higher total cost of ownership than a newer vehicle – particularly if maintenance costs are financed with penal interest rates.

It should be noted that these households are often located in areas poorly served by public transport, have members who may have shift-work at hours that make other forms of transport

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[60] https://www.treasurer.ca.gov/cpcfa/calcap/evcs/index.asp
[61] https://www.iea.org/reports/global-ev-outlook-2020
[62] https://www.consumerprotection.govt.nz/assets/uploads/documents/safer-credit-financial-inclusion-strategy.pdf

unavailable or has increased personal safety concerns, or require the transport of children and other dependents. While car share schemes, where cars can be leased by the hour, are now operating in major cities in New Zealand, car share schemes do not provide well for families. This is because vehicles for families with young children need to be fitted with car seats appropriate to the children's age/size.

As such, for all the above reasons, private car travel for such households is often the most convenient or only practical option.

While vehicle financing is a general issue for low-income consumers, it is also going to be a specific problem for a transition to EVs. This is because, even though EVs are starting to reach the point of having a lower total cost of ownership compared to ICE vehicles, they are likely to have higher up-front purchase costs for many more years.

Because of these problems with vehicle financing, soft loans targeted at low-income households could be an effective mechanism at helping both the general issue of problem debt, as well as the specific issue of helping low-income households transition away from ICEs to EVs.

As such, we are very supportive of a new programme to pilot Vehicle Social Leasing to low-income households which is about to commence in South Auckland. The programme partners including MBIE Consumer Protection, NZTA, Auckland Council, Akina Foundation and Manukau Urban Māori Authority. The project aligns with the Safer Credit and Financial Inclusion Strategy developed jointly by Ministry of Social Development, MBIE and Te Puni Kōkiri[63]. The aim of the pilot project is to help move low-income households into safer vehicles through an affordable leasing programme.

At this stage, electric vehicles are not included in the programme but have the potential to be in the future, should the pilot prove successful and CO_2 emissions reductions included as a specific programme objective. A good overseas example of such an initiative is in California, where low interest loans to buy an EV are offered to low-income households alongside grants and assistance with installing charging infrastructure at home. Households accepting the loan must also undertake a course on financial management.

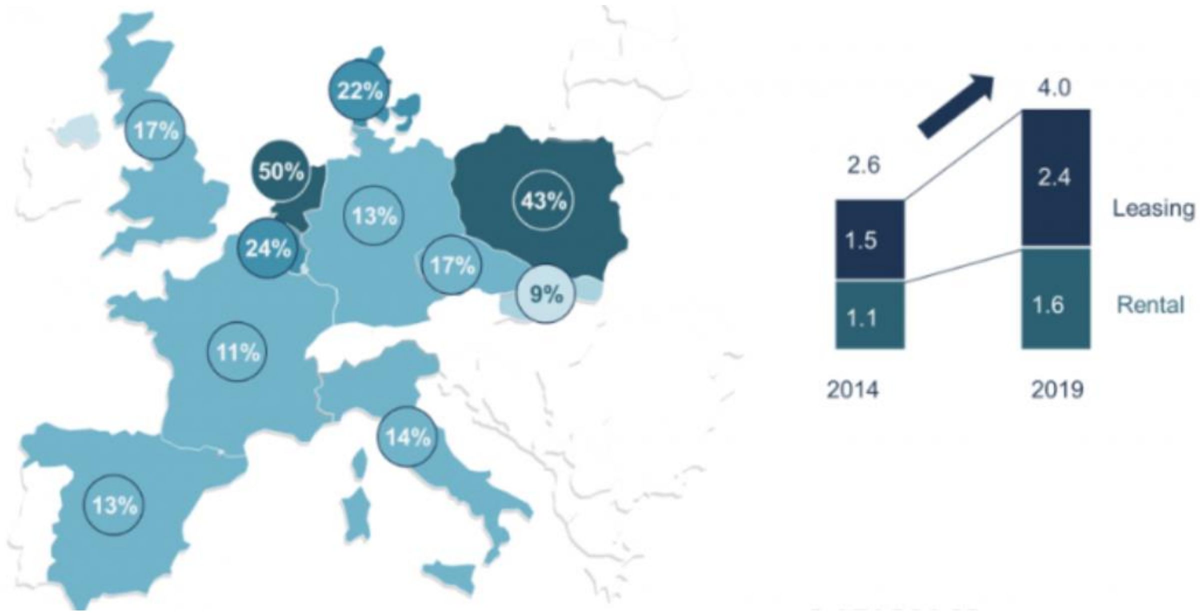
6.5.2 Vehicle leasing

Under vehicle leasing, a consumer will lease a vehicle from a vehicle leasing company, rather than own it outright. Typically, a consumer will lease a new vehicle by paying an up-front down payment (generally less than 20% of the car's purchase price) followed by monthly payments for the term of the lease. When the term expires, the car is returned.

As the following figure shows, vehicle leasing has been growing in Europe.

[63] https://www.consumerprotection.govt.nz/resources-2/safer-credit-and-financial-inclusion-strategy/

Figure 38: Proportion of cars leased in Europe



Source: https://www.globalfleet.com/en/financial-models/europe/analysis/europeans-lease-and-rent-more-cars-ever?a=BUY03&t%5B0%5D=Dataforce&curl=1

The historic low interest rates have contributed to this shift towards leasing. For corporate purchasers (by far the biggest group who have moved to leasing) this shift has also been driven by being able to take advantage of tax and balance sheet advantages, as well as outsourcing of fleet management.[64]

Leasing is far less common in New Zealand. In part this is because there are not the same tax advantages as in many European countries. However, it is also understood to be because of our much smaller market and the associated higher transaction costs and much smaller pool of potential purchasers into which leasing companies can sell vehicles once they have finished being leased. In contrast, the European single market has enabled leasing providers to trade vehicles across EU Member States, so vehicles that have finished being leased are sold into those markets in which their residual value is highest.

Although leasing reduces the need for consumers to make a large up-front payment, leasing does not seem to have been strongly associated with a move to EV uptake in Europe.

Further, although there is no need to make the same up-front payment as purchasing outright, leasing will generally cost more than purchasing outright and accessing the capital from a bank. i.e. the leasing company makes money from charging higher implicit interest rates in the lease, and also from making a margin on the sale of the vehicle at the end of the term of the lease.

As such, leasing does not seem to be a mechanism which necessarily will significantly improve EV uptake, with improving access to finance being a more beneficial mechanism.

6.6 Low/Zero Emission Zones

6.6.1 Problem definition

Dense urban areas typically have both poor air quality from vehicle exhaust pollution and greatest human exposure to poor air quality and traffic noise. These areas have greater public benefit than other areas from the uptake of vehicles with no tailpipe emissions and quiet operation, such as EVs.

[64] https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/ldv_leasing_en.pdf

6.6.2 How low/zero emission areas work

Defined city centres are designated as clean air, low emission zones (LEZ) or zero emission zones (ZEZ). The use of some or all ICE vehicles within these zones is restricted, either by them having to pay a fee to enter the zones, or are banned from entering at certain times or at all times with a penalty to be paid for non-compliance.

Low or zero emission zones can set rules to restrict certain types of ICE vehicles, particularly those with high air quality emissions such as diesel vehicles and/or older vehicles which do not meet more recent pollution emission standards.

Over 250 cities in Europe have already implemented designated low emission zones. Some of these cities are now transitioning from low to zero emission zones in their city centres where vehicle entry will be restricted to EVs only (or other zero emission vehicles such as hydrogen fuel cell vehicles). These cities include London, Amsterdam, Madrid, Paris and Brussels[65].

Madrid has a zero emissions zone in place with the following restrictions for different types of vehicles in central Madrid (unless vehicles are owned by residents or drivers with a disability)[66]: Electric vehicles are allowed to circulate freely in the zone and park on street without any time restrictions. Ultra low emission vehicles are allowed to enter the zone and park for up to two hours. Low emission vehicles can enter if they can park off-street.

The city of Oxford in the UK is introducing a Zero Emissions Zone[67] which will see vehicles having to pay to enter the city during the hours of 7 am to 7 pm unless they are BEVs or hydrogen vehicles. The initial ZEZ was due to be in place during 2020, but was delayed due to COVID-19.

Amsterdam has set out in its Clean Air Action Plan[68] steps towards a completely emissions free city. These steps include:

- From 2022 goods vehicles will only be allowed inside the city ring road if they are zero emissions, Euro 6 diesel or petrol
- From 2025 only electric scooters and mopeds will be allowed in the built-up area of Amsterdam. Goods vehicles, buses, taxis, ferries, canal boats and pleasure boats will only be allowed inside the area defined by the city ring road if they are zero emission.
- From 2030 only zero emission vehicles will be allowed in the built-up area of Amsterdam.

As the above Amsterdam example indicates, a number of cities around the world are also introducing Zero Emission Freight Zones where the delivery of goods by freight vehicles is restricted to EVs and hydrogen vehicles only in certain demarcated central city areas. Other examples of such cities include Santa Monica in California[69], Beijing, Shanghai and Shenzhen in China.

6.6.3 What are the pros and cons of low/zero emission areas?

Low/Zero emission areas principally deliver the public benefits of improved air quality with positive human health, amenity and wider environmental outcomes. Lower-socio economic groups tend to live and work in areas with poor air quality, so may have greatest health benefits from air quality improvements.

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[65] https://www.transportenvironment.org/sites/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf
[66] https://urbanaccessregulations.eu/countries-mainmenu-147/spain/madrid-access-restriction
[67] https://www.oxford.gov.uk/info/20299/air_quality_projects/1306/oxford_zero_emission_zone_zez_frequently_asked_questions
[68] https://www.amsterdam.nl/en/policy/sustainability/clean-air/
[69] https://laincubator.org/zedz-rfi/

Low/Zero emissions areas also contribute to CO_2 emissions reductions and noise reduction, and be part of initiatives to alleviate congestion, improve road safety, and deliver general quality of life improvements through creating more liveable cities.

To estimate the potential scale of health benefit of Low/Zero emissions areas, we calculated the value of emissions savings drawing upon two different sources (to cross-check):

- Firstly, we took the results from the "Updated Health & Air Pollution in New Zealand" 2012 study for MoT. This indicated that the health costs from road vehicles (both due to exhaust emissions and particulates arising from other aspects of vehicle use) were approximately $1bn per year. We combined this with other data from a study of sources of road-vehicle-derived particulates[70] which indicated that 17% of the particulates were from ICE exhaust emissions, 19% from brake pad wear and tear – something which EVs also suffer from but to a much lesser extent due to using regenerative braking to deliver much of their deceleration requirements. The remainder being from tyre wear and tear and road dust – something which EVs actually cause more of, due to heavier weights causing more tyre wear-and-tear. We have also taken information on the extent to which diesel exhaust emissions cause more particulates per litre of fuel combusted than petrol emissions.
- Secondly, we calculated the emissions costs from the g/km emissions factors produced by the Vehicle Emissions Prediction Model published by NZTA[71], and the $/g emissions damage costs from the Monetised Benefits and Costs Manual published by NZTA.[72]

These produced very similar numbers in terms of $/km and $/l.

We have estimated the health costs saved per litre of fuel combusted from switching from petrol or diesel vehicles to zero emission transport. These are $0.05/litre for petrol and $0.53/litre for diesel. These are large numbers, as in $/tCO2 terms this equates to $20/t$CO_2$ for petrol and $200/t$CO_2$ for diesel. i.e. the health costs are a similar order of magnitude to the climate change costs – particularly for diesel.

That said, it should be noted that there have been material improvements in exhaust emissions over the past couple of decades. As such, the exhaust emission-related aspect of new petrol and diesel vehicles will be lower than the 2012 health cost number which was based on the cumulative effect of an older fleet of vehicles.

Offsetting this consideration is the fact that the health costs from road transport are heavily concentrated in urban areas where the concentration of vehicles and associated particulates are co-located with concentrations of people. In the context of low/zero emissions areas this is particularly significant, as they are only being considered for urban centres.

As such, we believe the above estimates of the human health costs from petrol and diesel vehicles would suggest they are likely to deliver significant net public benefit. The diesel costs in particular would suggest that prohibitions on diesel buses and trucks in urban areas would deliver significant health benefits.

In addition to the health costs, Low/Zero Emission Zones would provide additional impetus towards EV uptake – both from positive financial incentives (if LEZs are associated with fees or penalties), convenience incentives, as well as through signage and EVs operating in the zone raising awareness of EVs and helping normalise EVs with the local population.

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[70] https://www.tandfonline.com/doi/full/10.1080/10962247.2019.1704939
[71] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/vehicle-emissions-prediction-model/
[72] https://www.nzta.govt.nz/assets/resources/monetised-benefits-and-costs-manual/Monetised-benefits-and-costs-manual.pdf

It should be noted that Low/Zero Emission Areas are complex to design, implement and administer. However, they are often evolutions from existing complex administrative processes managing parking and road corridor space allocation, congestion, and modal shift initiatives. Extensive consultation and information provision is needed for residents, workers/commuters and business operators is required ahead of implementation. Fees or fines need to be high enough to encourage behaviour change, and can impact lower socio-economic groups disproportionately.

Low or zero emission zones can set rules to restrict certain types of ICE vehicles, particularly those with high air quality emissions such as diesel vehicles and/or older vehicles.

6.6.4 Potential for New Zealand

Auckland city centre is the geographical area most likely to benefit from a low/zero emission zone.

As part of the Auckland City Centre Masterplan, New Zealand's first ZEZ is proposed for the Queen Street Valley in central Auckland and will also be a pedestrian-priority area, as indicated in Figure 39 below (in pink). The city centre will also have a series of through-traffic restricted low-traffic neighbourhoods (in orange). Implementing the Queen Street Valley Zero Emission Area will require a change in legislation. The Plan anticipates that the Zero Emission Area will be implemented by 2030.

The Zero Emissions Area is part of Auckland Council's commitment to the C40 Fossil Free Streets Declaration[73]. This commits signatory cities to two principal actions:

- Procuring, with partners, only zero-emission buses from 2025.
- Ensuring that a major area of the city is zero emission by 2030.

As part of its Low Emissions Bus Roadmap, Auckland Transport has committed to procuring only zero emission buses by 2025. Auckland is the only city in Australasia that has signed the Fossil Free Streets Declaration.

[73] https://www.c40knowledgehub.org/s/article/Green-and-Healthy-Streets-The-C40-Fossil-Fuel-Free-Streets-Declaration?language=en_US

Figure 39: Map of proposed Queen Street Valley Zero Emissions Area and surrounding through-traffic restricted areas[74]

Other New Zealand urban centres in Hamilton, Tauranga, Wellington, Christchurch and Dunedin may also be suitable for ZEZs.

6.7 Use incentives (Priority access to roads and parking)

General approach

A number of jurisdictions, particularly in Europe and North America, have introduced priority access arrangements, which we refer to as 'use incentives'. Under these arrangements EVs have been permitted to use special vehicle lanes and transport infrastructure that ICE vehicles are not, including some or all of the following:

- Bus lanes
- Allowing EVs with only one occupant to use transit lanes reserved for higher occupancy vehicles (HOVs) with more than one occupant (T2 or T3 lanes)
- Motorway on-ramps restricted to freight vehicles, buses, and vehicles with more than one occupant
- Priority parking areas reserved for EVs.

Norway is the leading country to have introduced use incentives for EVs. These have included EV priority access to bus lanes, free municipal parking and low-cost public car ferry transport for EVs. These have been alongside other policies such as purchase price incentives and Fleet Emissions Standards.

[74] https://aucklandccmp.co.nz/access-for-everyone-a4e/zero-emissions-area-zea/

In many cases where use incentives have been implemented, they are a relatively low-cost way to provide some additional benefits to EV owners. They provide additional utility, such as journey time savings, as a reward to EV owners. They also raise awareness of EVs to the motoring public through signage of priority and special use transport infrastructure and seeing EVs using this on a daily basis. They can be used by both central and local government to encourage EV use, and in some cases by the private sector such as at private car parking facilities.

The California Energy Commission's research has shown that providing HOV lane access for EVs can encourage EV adoption and that it is most valued by corporate fleet EV owners[75].

That said, the devil is in the detail.

- Use incentives require investment in clear signage and enforcement to be effective. Penalties for misuse by ICE vehicles need to be significant enough to act as a deterrent. However, they should not be so high that they risk being seen by ICE vehicle owners as a money-grab who may not yet understand the purpose of EV facilities or recognise the signage for these.
- Some use incentives such as EV use of bus lanes risks incentivising private vehicle use over public transport, as they deliver faster EV access but could slow public transport users bus lanes. This would particularly be the case as special lanes start to be heavily utilised by EVs at peak times negating their original transport system purpose.
- ICE vehicles may block priority parking areas for EVs as they are placed conveniently and, particularly in the early stages of uptake, may be frequently vacant. This is already an issue for public charging infrastructure located in car parks. As a consequence, new public charging facilities in car parks are often sited in underutilised parking spaces to avoid them being blocked or "ICE'd" by parked ICE vehicles.

Further, use incentives can only be a transitional mechanism to improve the attractiveness of EVs and increase general public awareness during the early stages of EV adoption. Once EV penetration rises above a certain point, they need to be progressively scaled back. For example, as EV uptake has grown rapidly in Norway, some of their use incentives have recently been rolled back. EVs can now only use bus lanes if they have more than one occupant and free parking for EVs has been replaced by half price municipal parking for EVs.

New Zealand experience

In 2017/18 NZTA undertook a one-year trial of EV access to restricted bypass lanes on motorway on-ramps in Auckland. This included development of by-laws, signage, monitoring and enforcement mechanisms.

Towards the end of the year, Auckland based EV owners were surveyed by NZTA to determine their response to the priority lanes. The survey responses showed that EV owners considered the access to be a benefit of EV ownership, but was not a significant factor in their decision to purchase an EV[76]. NZTA discontinued the trial after the first year as "*the ability to access priority lanes didn't have any significant impact on peoples' decision to buy an EV*."

Conclusion on use incentives

It is not expected that priority lane access, or other use incentives, would be the main motivator for EV purchase, but in some cases, they may be an additional deciding factor on top of other benefits

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[75] https://www.nrel.gov/transportation/secure-transportation-data/assets/pdfs/cec_2015-2017_california_vehicle_survey_report.pdf
[76] https://www.nzta.govt.nz/media-releases/auckland-electric-vehicle-priority-lane-trial-ends-this-week/

for some consumers, particularly if a vehicle purchaser's journey times are positively impacted by the policy.

Further, use incentives increase the wider public awareness of EVs. Given that awareness is a critical pre-cursor before adoption, this would suggest that well-designed use incentive schemes could help improve EV adoption – although we suspect their effect will be far less significant than other policies.

In many cases these would best be delivered through local government as part of a suite of initiatives for moving towards low emissions communities.

6.8 Scrappage incentive schemes

How scrappage programmes work

In simple terms, scrappage schemes involve giving consumers a financial incentive to scrap older vehicles. This has the effect of increasing the 'churn' of the vehicle fleet, bringing forward the uptake of new vehicles, and generally acting to reduce the age of the fleet.

The schemes have most commonly been used by countries with a vehicle manufacturing industry during times of economic downturn, with a primary driver of stimulating vehicle production for economic benefit. However, they can also deliver safety and environmental benefits, as older vehicles tend to have worse safety ratings and fuel economy.

Scrappage programmes introduced to achieve environmental objectives are generally complementary policies, working in tandem with policies influencing EV purchase price such as feebates, fleet emissions standards, subsidies or soft loans, or alongside Low or Zero Emission Zones.

International examples

One of the best known scrappage schemes is the "Cash for Clunkers" programme (Consumer Assistance to Recycle and Save - CARS) implemented in the USA in 2009 with goals of stimulating the vehicle manufacturing sector after the Global Financial Crisis and improving vehicle fleet fuel efficiency. This offered rebates of up to US$4,500 to vehicle owners trading-in defined low fuel efficiency vehicles (with a maximum vehicle age of 25 years) for the purchase of new fuel-efficient vehicles and EVs. The engines of traded-in vehicles were then required to be disabled by the dealers (by injecting a compound into the engine which turns solid) to take them out of circulation. Around 700,000 cars were scrapped within the two to three months the programme operated (around 0.3% of the US light vehicle fleet) at a cost of US$3 billion.

Various analyses of the "Cash for Clunkers" programme have been undertaken with most reporting a positive but small impact on average USA light vehicle fuel efficiency and a one-off positive impact on reducing CO_2 emissions. One study looked at lifecycle emissions and showed that the in-use CO_2 emissions reductions benefits resulting from the scheme significantly outweighed the additional CO_2 emissions from vehicle manufacturing.[77]

France has recently expanded its existing scrappage scheme to stimulate vehicle manufacturing after the early impacts of COVID-19 on vehicle manufacturing in the country. This saw the scrappage of 200,000 vehicles in two months – eligible vehicles for the scrappage programme were diesel vehicles registered before 2011 and petrol vehicles registered before 2006. This also had an environmental and social dimension as, dependent on their income, participants receive up to €5,000 towards the purchase of an EV or €2,500 towards a PHEV.

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[77] http://css.umich.edu/publication/impact-cash-clunkers%E2%80%9D-greenhouse-gas-emissions-life-cycle-perspective

In October 2020 Scotland introduced a scrappage scheme which targets low-income households and small businesses (less than 10 employees) based in the Low Emission Zone areas of Aberdeen, Dundee, Edinburgh and Glasgow[78]. £2,000 per vehicle is offered to remove the vehicle and a further £500 is available as a voucher to purchase a bicycle, e-bike or public transport passes.

There are also a few examples of scrappage schemes being applied to heavy vehicles. Japan's 2009/2010 scrappage scheme covered heavy duty as well as light duty vehicles[79]. The city of London has recently announced a heavy vehicle scrappage scheme ahead of the tightening of Low Emission Zone standards in London in March 2021. The scheme offers grants of up to £15,000 (NZ$28,000) to scrap heavy vehicles and replace them with vehicles meeting the latest Euro 6 emission standards[80].

New Zealand experience

Scrappage schemes have been trialled in NZ previously (2007 and 2009) with the policy focus of the trials being air quality. The first pilot scheme was held in Auckland in 2007. Ministry of Transport's report on the trial[81] showed it was successful, as the benefits exceeded the costs. Conversely, a second trial in Wellington and Christchurch in 2009 had low response rates and delivered low overall social and environmental benefits, relative to the costs.

In both trials, the target group was vehicles which had just failed their Warrant of Fitness or were about to fail it. In Auckland, vehicle owners were offered two months of free public transport passes (equivalent to around $400) to scrap their vehicles. The average age of vehicles scrapped in the Auckland trial was 18 years, and most vehicles having an odometer reading of 200-250,000 km. The most common reason given for making the decision to scrap the vehicle was the need for new tyres/wheels. For the 36% of programme participants that replaced their scrapped car, the average age of the replacement vehicle was 11 years.

In Christchurch and Wellington, scheme participants were offered $250 public transport credit and received cash from the scrap metal companies based on the weight of their vehicle ($100-200), and a chance to win a new Toyota Corolla. The average age of the scrapped vehicles was 20 years, and the average age of replacement vehicles was 12 years. Mechanical reliability was the main reason given for deciding to scrap the vehicle.

In all trials there was no trend in the income of households scrapping older vehicles, with households of all income levels participating.

The New Zealand trials had very low levels of benefits for participants in comparison with schemes overseas, and were not tied to any other new policy initiatives or change. Both these factors are likely to have reduced the effectiveness of the schemes. Despite this, the Auckland trial had an overall positive benefit cost ratio.

6.8.1 What are the pros and cons of scrappage schemes?

Scrappage schemes are an area where the devil is in the detail.

It is almost inevitably the case that a proportion of scrappage payments will not deliver any additionality (i.e. consumers being paid to scrap a vehicle they were planning to scrap anyway, as has been the case for other scrappage schemes in the past, including EECA's fridge scrappage program in the 2000's). Taking account of, and seeking to introduce design elements to minimise, this inevitable free-rider effect will be an important element in its cost-effectiveness.

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[78] https://www.transport.gov.scot/news/low-emission-zones-to-help-households-travel-better/
[79] https://theicct.org/sites/default/files/publications/Vehicle-replacement-programs-COVID-Jun2020.pdf
[80] https://www.greencarcongress.com/2020/10/20201007-london.html
[81] https://www.transport.govt.nz//assets/Uploads/Report/Vehicle-Scrap-Report30July-2.pdf

In environmental terms, poorly designed schemes may result in an older ICE vehicle being replaced with a newer ICE vehicle rather than an EV.

In addition, older vehicles tend to do a lower mileage than younger vehicles and have only a few years of life left, so money invested in incentives at this end of the fleet life may not deliver as much CO_2 reduction benefit as focusing the same level of funding at new vehicles which tend to high mileages and have long lives in the national fleet.

That said, scrappage schemes which carefully specify the eligibility of scrapped and replacement vehicles can deliver CO_2 emissions reduction benefits and encourage EV uptake, particularly if they are used alongside the introduction or tightening of other policies such as the introduction of Fuel Efficiency Standards. Linking scrappage programmes to the introduction of EV purchase incentives can help ensure that encouraging EV purchase does not simply add another vehicle to the national fleet rather than replacing an existing ICE vehicle.

Programme design details can be used to target which vehicles are eligible for scrapping, and which vehicles are eligible for any rebates on replacement vehicles to tailor their response. Schemes can also be focused on lower socio-economic groups or other target groups to deliver social benefits.

Scrappage schemes also facilitate responsible recycling of end-of-life vehicles.

On balance, we think scrappage schemes are unlikely to deliver significant benefits compared to other mechanisms in New Zealand. That said, a carefully designed mechanism could be net positive, and be complementary to other 'core' vehicle policies. It is beyond the scope of this study to consider the design elements of a scrappage scheme which would deliver the greatest benefit, but aspects which should be considered include:

- Targeting at low fuel efficiency vehicles, rather than vehicles which have just failed a WOF or about to fail. This would lower the risk that vehicles would be scrapped anyway improving the scheme cost-effectiveness.
- Incentives could include public transport credits, bicycle or e-bike vouchers or limiting the incentive to being a rebate against the purchase of a New or Used vehicle with CO_2 emissions below a certain threshold.
- Adjusting the rebate level, with higher rebates for EVs to maximise environmental benefits, and/or eligibility for the rebate being based on income level to maximise social benefits.

6.9 Information programmes

For most people, EVs remain an unfamiliar technology and they do not understand the different performance characteristics of EVs in comparison with ICE vehicles, the ways that EVs can be charged and what charging EVs costs, the availability of public charging infrastructure, the maintenance requirements for EVs and where they can access EV maintenance services. This lack of understanding has been shown to be a significant barrier to consumers considering EVs as a purchase option.

The presence of EVs and public charging infrastructure are also not readily apparent to ICE vehicle drivers, reducing their awareness of EVs. Awareness is the first step to behaviour change, ahead of acquiring information.

Providing information

The provision of information and education can provide wider public benefits. Informed consumers are more likely to make better purchase decisions. Information on EVs can be provided in a number of ways, ranging from independent websites to face-to-face interaction during EV test drives to accredited education courses for vehicle technicians.

One of the most important ways to influence vehicle buyers about the on-going fuel costs of different types of vehicles in comparison with their up-front purchase cost is with the use of a vehicle fuel efficiency label displayed at the point of vehicle sale, including car yards and on-line car sales websites. Such labels are similar to the energy efficiency labels also seen on appliances. The provision of vehicle efficiency labelling is mandated in New Zealand as well as many other countries.

Below are examples of vehicle labels used in Canada for petrol and battery electric vehicles, with key features indicated. The labels highlight the typical annual running costs of the vehicles which readily allows consumers to consider energy costs alongside consideration of up-front purchase costs.

Independent EV information is available through a wide range of official government and NGO websites in many countries. These often include on-line tools to help people choose EVs based on their needs, get vehicle pricing and running costs information and comparisons, and find details of EV specifications.

In Milton Keynes in the UK, they have gone one step further and opened an EV Information Centre, located in a popular shopping mall, which does not sell EVs but provides brand neutral, face-to-face information on EVs, the ability to view and test drive EVs from different manufacturers, and physically practice what it is like to plug in an EV using different EV charging infrastructure methods.

Consumer surveys are an important part of developing an information campaign, and should be designed to ascertain what they key information gaps and barriers to EV uptake for different consumer groups and how they prefer to receive information. They are also used to ascertain existing levels of awareness and consideration of EV purchase over time, helping indicate the effectiveness of the information campaign.

Increasing awareness

Beyond information campaigns, there are a number of ways that awareness of EVs can be raised by transport authorities. The main methods are:

- voluntary or regulated EV identification using number plates or vehicle symbols
- providing clear, standardised road signage for public charging infrastructure.

In Norway, all electric vehicle number plates commence with the letters EL, EK, EV, EB, EC, ED or EE allowing ready identification as an electric vehicle. Green coloured number plates are used in India to identify electric vehicles.

In the UK, the government has introduced a mechanism whereby electric vehicles have a green number plate. This was based on work from its Behavioural Insights Team which identified the importance of greater awareness of EVs to achieve greater levels of adoption.

Prominent road signage advising of public EV charging infrastructure not only assists in wayfinding and enforcement functions, but also facilities raised awareness of EVs with road users, particularly as public charging infrastructure is modest in size and unfamiliar.

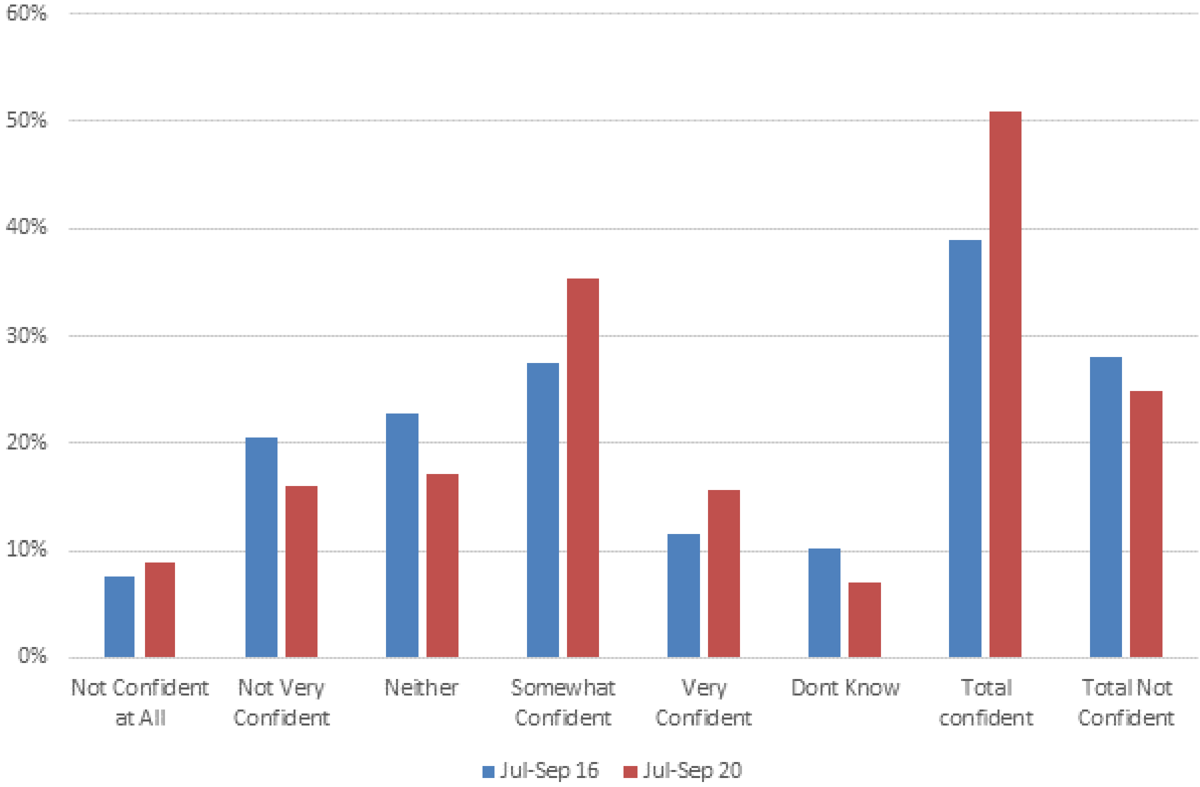
New Zealand information programmes

New Zealand has had a comprehensive EV information programme in place since 2016, supported by other activities. This has included:

- Website information
- On-line tools including EECA's Vehicle Total Cost of Ownership tool aimed at fleet buyers
- Funding community delivery of EV test-drive and information days utilising the enthusiasm of early EV adopters and allowing motorists to ask questions of existing EV owners
- Social media campaigns
- Billboard and bus stop advertising promotion linked to social media campaigns
- Advertorials and opinion pieces in media
- Buyers' and dealers' guides
- TV campaign (awareness)
- Development and deployment of official symbols and signage for road signage for EVs and charging infrastructure
- Development of a voluntary symbol to identify an EV (no longer available)
- Detailed statistics on EV uptake.

In the first three years of operation, these information campaigns have contributed to an improvement in New Zealander's confidence that EVs can meet their needs, as shown by the following results of surveys over this time period.

Figure 40: New Zealander's confidence that EVs can meet their needs



Recommendations on information programmes

We believe such information initiatives should continue, as changing attitudes and behaviour is a long-term game and government funding investment in information and promotion needs to have a long-term commitment to deliver tangible results.

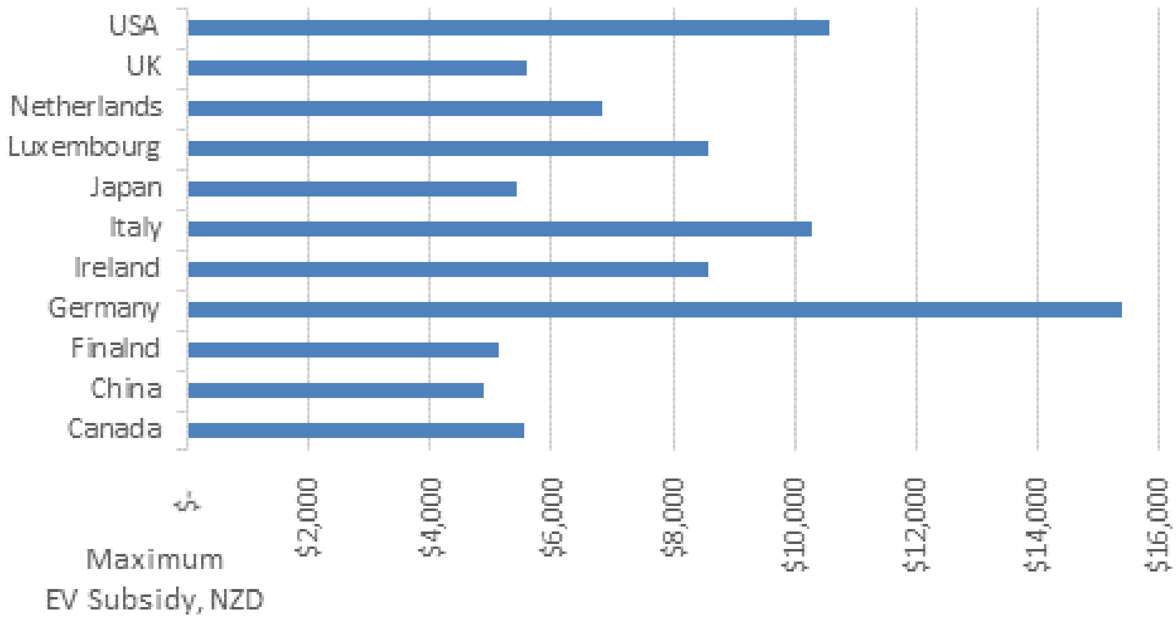
We also think serious consideration should be given to mandating some form of EV identification of plug-in EVs through number plates (e.g. applying a green flash). This could be a relatively low-cost means of increasing EV uptake through increasing wider public awareness.

Lastly, given that much of the information that consumers get about their vehicle options is from vehicle dealers, and given that such dealers are looking at reduced earnings from vehicle servicing and repairs compared to selling an ICE, we believe that significant focus should be on improving the information dealers to provide consumers about the relative benefits of EVs versus ICEs. This may require approaches to incentivise and educate dealers around such matters.

6.10 EV purchase price subsidies

Several countries, municipalities, and states provide a direct subsidy on the purchase price of EVs. Examples are shown in Figure 41.

Figure 41: Maximum EV subsidy available in selected countries



Methods of paying the subsidy include some combination of tax credits to an individual or company, a grant paid directly to the vehicle owner, or a grant applied directly to the purchase price by a dealer.

The levels of subsidy are lower for PHEVs relative to BEVs in most countries with subsidies. Some countries offer higher subsidies dependent on scrapping the ICE vehicle being replaced. Subsidies in some countries vary according to EV range, electrical energy efficiency or other specific vehicle design criteria.

In some jurisdictions, subsidies are linked to household income. For example, California has introduced subsidies which are dependent on the vehicle purchaser's household income, with high income households receiving no subsidy, middle income households a standard subsidy rate, and low income households a higher subsidy rate.

What are the pros and cons of EV purchase subsidies?

Purchase price subsidies are a proven mechanism for accelerating EV uptake. As they are a policy impacting purchase price, as detailed in section 2.1, not only are these more cost effective than policies affecting usage costs, they are also less regressive.

As a policy which affects purchase price, their effect, and many of the key design considerations are similar to that of feebates and (to a much lesser extent) fleet emissions standards described in section 4. We do not repeat such discussions here.

Their main difference is that subsidies are funded from general taxation, whereas the reduction in purchase price for EVs arising from feebates or fleet emissions standards are principally funded by increases in vehicle prices for higher emissions ICE vehicles.

We believe this dynamic in feebates and fleet emissions standards does a better job of applying a 'polluter pays' approach to supporting low emissions vehicle uptake than subsidies funded by general taxation. As such, we think taxation-funded subsidies are not preferred compared to these other mechanisms.

The main area where subsidies are likely to be useful complements to feebates and fleet emissions standards is in providing targeted additional support to specific sections of society such as low-income households. Given the social driver behind such mechanisms, it would seem appropriate that they are funded through general taxation.

6.11 Differential vehicle registration/licencing fees

Under differential vehicle registration/licencing fee mechanisms, different rates are charged when first registered, or as part of annual relicensing, according to the CO_2 emissions rating (or similar) of the vehicle, with low or no fees applying to EVs.

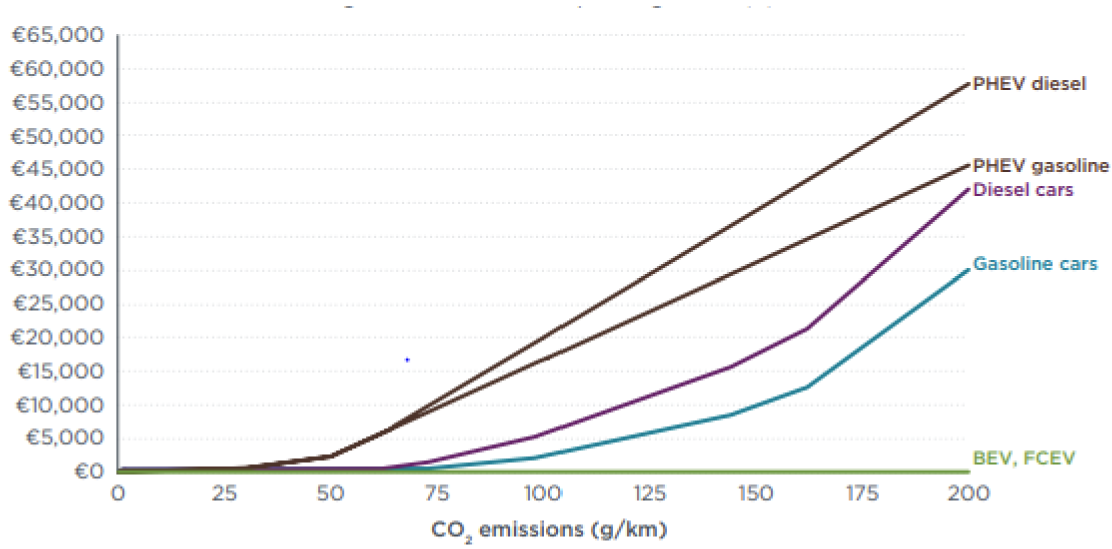
If the lost revenue from lower fees for low emissions vehicles are made up from higher fees for high emissions vehicles the mechanism is essentially a feebate scheme, otherwise it is more akin to a taxpayer funded subsidy.

What are the pros and cons of differential vehicle registration/licencing fees?

On the plus side, differential registration and licencing fees are relatively simple to implement and administer.

However, in order to be effective, the level of differential between high and low emissions vehicles needs to be significant. In this respect, countries which have managed to influence EV uptake through such mechanisms (e.g. Germany and the Netherlands) have done so where the differential fees relate to much more significant vehicle taxes. For example, the Netherlands has a system which imposes a significant tax on first registration of a vehicle, and which has applied an emissions-based differential mechanism against this as shown in 42.

Figure 42: Level of tax on first registration of vehicles in the Netherlands by vehicle type



In contrast, New Zealand's initial first registration fee and annual licensing fees for light passenger vehicles are much smaller, being between $74 and $232 (based on engine size) for first registration, and $110 (petrol) or $176 (diesel) for annual licencing.[82] Applying an emissions-based differential against this low level is unlikely to materially influence buyers' vehicle purchase decisions.

Further, the most significant component of New Zealand's registration / licencing fees are applied on an annual basis. As such, to the extent that an emissions-based differential were applied to such fees, they would have an effect akin to other mechanisms that alter the ongoing usage costs of such vehicles. Thus, due to the consumer behaviour issues noted in section 2.1, they are likely to be less effective than mechanisms which alter up-front costs at time of purchase, and they are also likely to

[82] http://www.legislation.govt.nz/regulation/public/2011/0079/latest/whole.html, and https://www.nzta.govt.nz/vehicles/licensing-rego/vehicle-fees/licensing-fees/

be more regressive, as low-income households are most likely to be the section of society that are last to transition away from older ICE vehicles.

In this respect, it is worth noting that differential rates of ACC levies, which are a component of annual licencing fees, were in place for a short period of time and reflected the relative safety of different light vehicles. However, this differential rate was removed because there was no clear evidence that the differential rates encouraged the purchase of safer cars, and it placed a burden on low-income people and families who are generally less able to afford cars with better safety ratings.

Appendix A. Description of the EU Fleet Emissions Standard applying to trucks

Trucks and buses account for about a quarter of CO_2 emissions from road transport in the EU and about 6% of total EU emissions. Although fuel consumption efficiency for these vehicles has improved in recent years, their emissions are still increasing mainly due to more road freight traffic.

The EU adopted a CO_2 emission standard for heavy-duty vehicles in 2019 which set targets for reducing the average emissions from new trucks for 2025 and 2030.

Regulation (EU) 2019/1242 setting CO_2 emission standards for heavy-duty vehicles entered into force on 14 August 2019.

The Regulation also includes a mechanism to incentivise the uptake of zero- and low-emission vehicles, in a technology-neutral way by offering super credits and rewards for low/ no carbon emitting trucks

The expected benefits of the regulation are:

- Estimated 54 million tonnes of CO_2 reduced in the period 2020 to 2030
- Fuel savings of around €25 000 in the first 5 years of use for a new truck bought in 2025 and up to about €55 000 in the first 5 years of use for a new truck bought in 2030
- Total fuel savings of up to 170 million tonnes of oil over the period 2020 to 2040

As a first step, the EU CO_2 emission standards will cover large trucks, which account for 65% to 70% of all CO_2 emissions from heavy-duty vehicles.

From 2025, manufacturers will have to meet the targets set for the fleet-wide average CO_2 emissions of their new trucks registered in a given calendar year. Stricter targets will start applying from 2030 on.

The targets are expressed as a percentage reduction of emissions compared to EU average in the reference period (1 July 2019–30 June 2020):

- from 2025 onwards: 15% reduction
- from 2030 onwards: 30% reduction

As part of the 2022 review, the Commission should assess the extension of the scope to **other vehicle types** such as smaller lorries, buses, coaches and trailers

The Regulation includes an incentive mechanism for

- **zero-emission vehicles** (ZEV), trucks with no tailpipe CO_2 emissions
- **low-emission vehicles** (LEV), trucks with a permissible maximum laden mass of more than 16t, with CO_2 emissions of less than half of the average CO_2 emissions of all vehicles in its group registered in the 2019 reporting period.

To incentivise the uptake of ZLEV and reward early action, a **super-credits system** applies from 2019 until 2024, and can be used to comply with the target in 2025. A multiplier of 2 applies for ZEV, and a multiplier between 1 and 2 applies for LEV, depending on their CO_2 emissions. An overall cap of 3% is set to preserve the environmental integrity of the system.

From 2025 onwards, the super-credits system is replaced by a benchmark-based crediting system, with a benchmark set at 2%. The 2030 benchmark level will have to be set in the context of the 2022 review.

There are elements to support cost-effective implementation:

- Banking and borrowing to take account of long production cycles, including a reward for early action, while maintaining the environmental integrity of the targets.
- Full flexibility for manufacturers to balance emissions between the different groups of vehicles within their portfolio.
- Vehicles such as garbage trucks and construction vehicles, are exempted due to their limited potential for cost-efficient CO_2 reduction.
- Financial penalties are severe for non-compliance with the CO2 targets. The level of the penalties is set to 4,250 euro per gCO2/tkm in 2025 and 6,800 euro per gCO2/tkm in 2030.