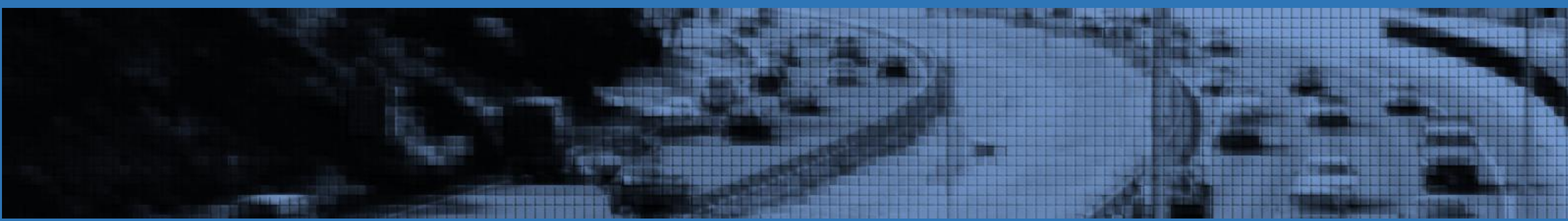
Review of the National Electric Vehicle Strategy (NEVS) Consultation Paper



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Transport Emission Energy Research

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1. Introduction

Transport Energy/Emission Research (TER) has reviewed the National Electric Vehicle Strategy (NEVS) Consultation Paper (September 2022) and supports the Strategy. The Strategy is an important and overdue step towards a more sustainable future in Australian transport.

However, TER suggests that implementation will require careful consideration of the details, which can 'make or break' a successful outcome. TER has identified a number of gaps or risks in relation to effective emission reduction – based on the latest scientific research. TER would like to recommend that the following points are considered and addressed in the NEVS, new fuel efficiency standards and any new policy measures. Not doing so is expected to significantly reduce the (cost) effectiveness of the overall strategy and to undermine real reductions in greenhouse gas (GHG) emissions from the transport sector, imposing more (damage) costs on society and the environment.

- Consider emissions for all relevant greenhouse gases.
- Consider the full life cycle impacts of vehicles.
- Consider all transport sectors.
- Base the strategy, policies and regulations explicitly on real-world emissions.
- Drop the use of the NEDC and replace with test procedures currently used (EU or US).
- Revive a nationally coordinated real-world vehicle emissions testing program.
- Publish emissions data in a transparent and robust manner (uncertainty estimation).
- Consider the risks for different EV technology regarding actual emission reduction.
- Make energy efficiency front and centre in policy development and new regulations.
- Promote lighter passenger vehicles and reverse the sustained trend of larger vehicles.
- Implement a broad range of mutually supportive policies and regulations.

A more detailed explanation of each point follows, but more can be said about each topic. TER has contractual arrangements in place with well-respected transport emission experts in Australia, Europe and the United States and would be happy to form an international team to support the Government and to provide independent and evidence-based advice or review work.

2. You can't manage what you don't measure – but how this is done is critical to success.

Australia needs real and rapid reductions in greenhouse gas emissions from the transport sector over the coming decades to start addressing increasingly severe climate change impacts. Estimating and tracking of annual emissions from the transport sector will be a key aspect of successful implementation of the strategy. If done properly, it will ensure that emission reduction policies will translate into actual, significant and meaningful emission reductions and, importantly, allow for corrective action if the need arises, for instance through policy change. Transport emissions therefore need to be quantified in a comprehensive, transparent, accurate and robust manner. Several considerations apply to the NEVS, fuel efficiency standards and related policies and a few important ones are pointed out in this letter, but it is by no means exhaustive.

2.1 Policy scope

The scope of the strategy, subsequent policies and regulation – what is included in and what is not – is fundamental to a successful emission reduction strategy and effective targets.

Fuel efficiency and CO_2 emissions are not exactly the same as greenhouse gas (GHG) emissions. Greenhouse gases include CO_2 but other substances as well, such as methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs). They also include less obvious greenhouse gases such as hydrogen (e.g. leakage from hydrogen infrastructure), which has an indirect effect on climate change. Effective policy should, in principle, include all GHGs that are relevant for road transport. This would help prevent adverse and undesirable policy outcomes. For instance, omission of methane emission reduction policies and regulation, could indirectly promote CNG (compressed natural gas) vehicles without taking into account the issue of 'methane slip'[1] from this type of vehicles.

In addition, all aspects of a vehicle's life need to be included. Life-cycle assessment or LCA is a method used to quantify the environmental impacts of a product's manufacture, on-road use and end-of-life. A recent study[2] conducted this type of assessment for the Australian on-road vehicle fleet and compared short term and long-term impacts of fossil-fuelled vehicles and battery electric vehicles (BEVs). The good news is that in all Australian jurisdictions' emissions released from the beginning to the end of the electric vehicle's life are expected to be significantly less than for fossil-fuelled cars. Each, however, varies in the extent emissions will be reduced, as shown in Figure 1.

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[1] *Renewable and Sustainable Energy Reviews*, 2016, 66, 702-741.

[2] Detailed results can be found here: https://www.mdpi.com/2071-1050/14/6/3444.

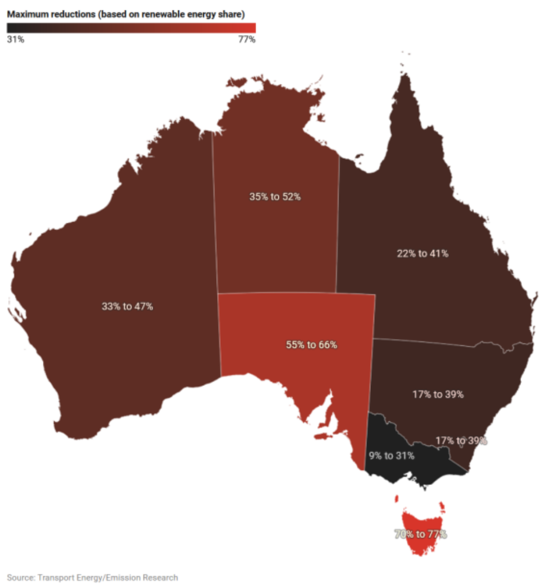

Figure 1 - How much did battery electric vehicles reduce emissions in each state in 2018? [3]

The study estimates that for the whole of Australia, BEVs reduced GHG emission rates within a range of 29% to 41% after considering the emission intensity of the 2018 Australian electricity mix (80% fossil fuels). For the future, BEVs are estimated to reduce GHG emission rates within 74% to 80% after considering the emission intensity of a renewable Australian electricity mix (10% fossil fuels). This level of reduction is already achieved in Tasmania with about 95% of its electricity generation already coming from renewables (hydro and wind).

Although road transport makes up the bulk of total GHG emissions from road transport, a more comprehensive strategy is required that includes all forms of transport (road, rail, shipping, aircraft). See for instance, the recently developed Framework for an Australian Clean Transport strategy (FACTS).[4]

2.2 Real-world emissions

It is critical that any emission estimates to underpin the NEVS and new policy development reflect real-world emissions. A clear example how this should not be done is the continued use of an outdated legislative emission test procedure in Australia – the NEDC (New European Drive Cycle) – to track the GHG emissions performance of newly sold passenger vehicles. This test increasingly and substantially underestimates on-road greenhouse gas emissions from road transport. The use of the NEDC test procedure may sound modern, but this is deceptive. The NEDC laboratory emissions test is out of date and no longer used overseas. The test cycle was developed in the early 1970s resulting in a straight-line driving profile that operators follow during the emission test, as shown below. No one drives this way. The reason for emulating this unrealistic driving behaviour was that test facilities in the 70s could not deal with significant changes in speed.

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[3] https://theconversation.com/how-climate-friendly-is-an-electric-car-it-all-comes-down-to-where-you-live-179003.

[4] https://transportfacts.org/.

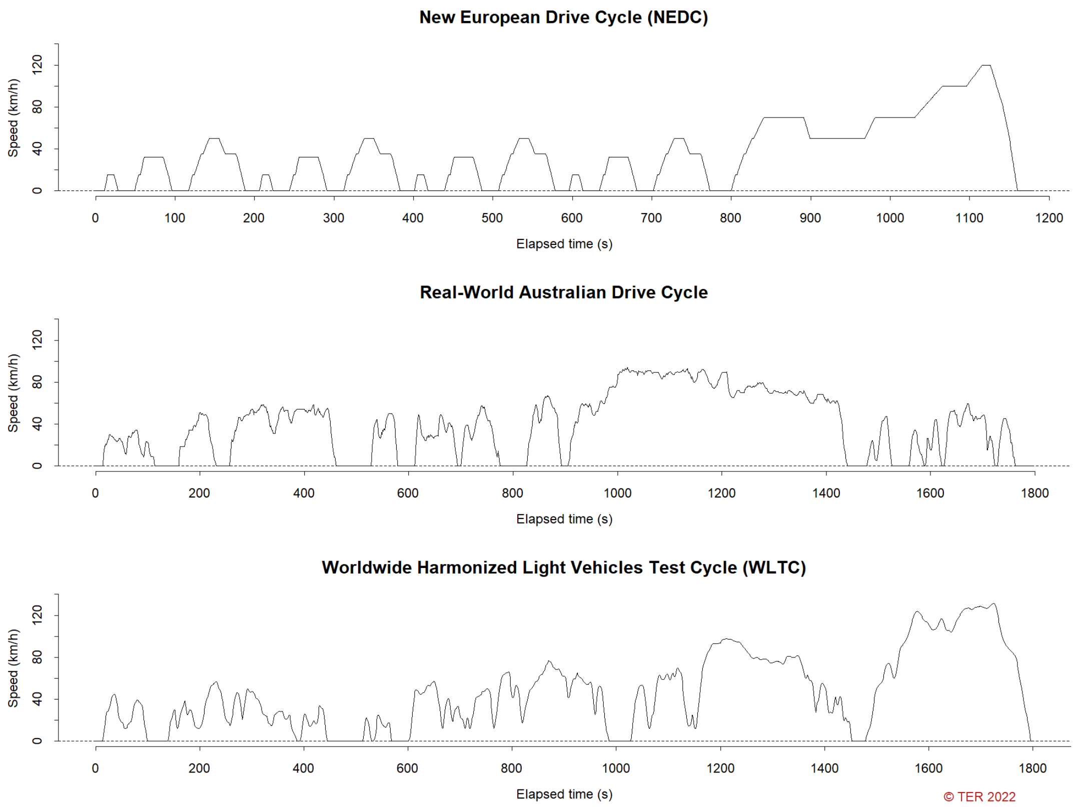

Figure 2 – NEDC versus real-world driving profiles.

The way people actually drive in the real-world is also shown for comparison. A real-world Australian test cycle reflects actual driving data collected in Australian cities. Also shown is the Worldwide Harmonized Light-duty Test Cycle, which replaced the NEDC and was adopted in the EU in 2017 to address the well-known issues with the NEDC.

So why is this important? The problem is that real-world emissions and fuel consumption are increasingly higher than official NEDC figures on which the standard is based. This issue is well known, and often referred to as the 'gap'. The gap has increased over time, for instance, reportedly from about 10% in 2005 to about 40% in 2015, on average.

TER research in 2019 suggests that fleet-average CO_2 emissions rates (g/km) for Australian new passenger vehicles have not gone down as reported officially using NEDC figures, but are actually increasing with a few percent each year since 2015.[5] A continuous increase in vehicle size and weight and a shift to the sale of more 4WD vehicles in Australia, in particular for diesel cars/SUVs, are likely factors that have contributed to this trend.

So tracking Australian greenhouse gas emissions using the NEDC test gives the false impression that GHG emissions are reduced, where in reality this is not the case. To address climate change, Australia needs to make sure we have effective and real reductions in GHG emissions. Continued use of NEDC emissions data confuses the debate and undermines effective emission reduction policy and

[5] The research report can be found here: https://www.transport-e-research.com/publications (2019a).

regulation. The NEDC should therefore be dropped and replaced with the most recent EU or US test protocols, or even better, use real-world emissions data only.

Reliable emission prediction underpins policy development and critically relies on measured data from real-world emissions testing programs, as is common practice around the world. Extensive vehicle emission testing programs were conducted in Australia until 2008, but since then ongoing and coordinated emissions testing in Australia has been absent. This is an issue as overseas emissions data do not reflect the significant differences between the Australian on-road fleet with those in, for instance, the EU or USA.

The results[6] from recent on-board emission testing, tunnel measurements and remote sensing in Sydney, Brisbane and Perth found, for instance, relatively high emission levels in modern Australian diesel SUVs and LCVs.

Figure 3 – An example of recent emission testing in Australia.[6]

Suitable tools are already available in Australia to estimate real-world emissions. Emission prediction software such as COPERT Australia[7] does not use NEDC emissions data and estimates real-world emissions from the Australian on-road fleet. The COPERT software is well-established internationally and used by most Australian jurisdictions. It is supported by training programs and various technical background papers have been published in national and international peer-reviewed journals.

2.3 Assessment method

The choice of method used to estimate and track GHG emissions is important. To verify the robustness of the strategy and related policy measures TER recommends that uncertainty and probability of success or risk of failure are explicitly considered. There are various methods[8] to quantify uncertainty in transport emission predictions. This is important for policy makers as it provides them with information regarding the likelihood that a particular policy measure will be successful and provides an assessment of the relative risk of failure for different policy options. An

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[6] An overview of Australian measurement programs can be found here: https://www.transport-e-research.com/publications (2022a).

[7] More information can be found here: https://www.transport-e-research.com/copert-australia.

[8] Examples of these types of assessment can be found here: https://www.mdpi.com/2071-1050/14/6/3444 and https://www.transport-e-research.com/publications (2022d).

example of this approach was already shown in Figure 1 where a plausible range of emission reduction through electrification was shown for each state and territory, rather than a single number.

TER has recently developed `n0vem` (Net Zero vehicle emission model), which expands COPERT Australia and predicts real-world fuel use, electricity use, energy use and emissions for almost 1,000 Australian vehicle classes (passenger cars, SUVs, vans, trucks, buses, etc.) including hybrid electric vehicles, plug-in hybrid electric vehicles, battery electric vehicles and fuel cell electric vehicles. A comprehensive tool like this will be important to make a realistic assessment of the impacts of different future technology scenarios on on-road energy use and greenhouse gas emissions.

TER recommends transparency in the methods used by the Government to estimate and track GHG emissions, including the assumptions made. This will allow scientists, industry experts and the general public to review and understand the calculations, and potentially provide feedback.

3. Not every EV is the same – there are different technology risks in abating emissions.

There are a number of risks regarding effective emission reduction that are emerging from current international research work and that TER recommends should be considered and addressed in the strategy and related policy measures. When people talk about “electric vehicles” (EVs) we normally mean battery electric vehicles (BEVs). These vehicles simply have an electric battery, which is charged from the electricity grid (power point or integrated system with solar panels) and which drives the wheels via an electric motor. There are, however, other types of electric vehicle that are already being sold or are expected, by some experts, to become more important in the future. These other EVs have different risk profiles when compared with for instance BEVs when we look at effective and real reduction of greenhouse gas emissions. TER suggest this needs to be explicitly assessed and considered in the implementation of the NEVS.

This could be done, for example, by promoting and focussing policy efforts and regulation on ‘climate safe’ vehicle technologies that will ensure or have a higher chance of success for actual GHG emissions reduction from transport. Not doing so will impose a significant risk of missing the net zero targets.

3.1 Plug-in hybrid electric vehicles (PHEVs)

PHEVs combine an electric motor and conventional combustion engine (e.g. petrol of diesel). They have the potential to reduce global greenhouse gas (GHG) emissions and local air pollution, but only if they drive mainly on electricity. Recent studies into the actual use of PHEVs have shown that electric drive is often only used for a small portion of total travel, in the order of 20% to 40%.[9] The official emission test procedure typically assumes a much higher portion of electric drive and therefore overestimates the greenhouse gas emission benefits of PHEVs. These numbers are published and are what consumers see when they consider buying a new vehicle. Limited use of electric drive by PHEV owners, and associated higher GHG emission rates per kilometre, could be considered a risk factor for this technology when compared with BEVs, which are guaranteed 100% electric with associated low emission levels per kilometre.

3.2 Fuel cell electric vehicles (FCEVs)

A FCEV includes a fuel cell that generates electricity on-board from a fuel such as hydrogen, either to charge a battery or to drive a motor to power the wheels. This is a new technology and hardly any FCEVs have been sold in Australia to date. The technological development of FCEVs is dynamic and relatively uncertain in terms of longer-term emission improvements.

Nevertheless, 'hydrogen in transport' features strongly in policy and strategy documents at state and national level, including the NEVS. Hydrogen will likely play an important role in the decarbonisation of specific sectors of the future economy. However, there are several aspects of hydrogen in transport that are often not talked about, but that will significantly impact on effective emission reduction, if not resolved. Almost all hydrogen today is produced using fossil fuels (natural gas and coal). Indeed if Steam Methane Reforming (SMR) were used to produce hydrogen for Australian road transport, then actual GHG emission reductions would be marginal at best, possibly in the order of only 20%. This would create a new market for the fossil fuel industry, but would also mean a failure of meeting the emission reduction objectives of the NVES.

Hydrogen is clean and climate friendly only if it's produced from renewable sources of energy, such as solar, wind and hydro. This process uses electrolysis to convert water into hydrogen, and is called "green hydrogen". However, this creates another significant challenge: there are many more steps in the hydrogen production process, compared with the simpler and direct use of electricity in BEVs. Each step in the process incurs an energy penalty, and therefore an efficiency loss. The sum of these losses ultimately explains why hydrogen fuel cell vehicles, on average, require three to four times more energy than same size BEVs, per kilometre travelled.[10]

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[9] See, for instance, reports from the International Council on Clean Transportation (ICCT): https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/ and https://theicct.org/publication/real-world-usage-of-plug-in-hybrid-electric-vehicles-fuel-consumption-electric-driving-and-co2-emissions/.

[10] https://theconversation.com/why-battery-powered-vehicles-stack-up-better-than-hydrogen-106844.

Although we anticipate that it is unlikely that FCEVs will play a significant role in the passenger vehicle market and public transport, hydrogen may play a more significant role in the long-haul truck market in the future. The stated benefits for fuel cell electric trucks include a long drive range and short refuelling times, which are important for this sector. But hydrogen competes with a dynamic and fast-moving electric truck market, which shows significant and continuous annual improvements in battery energy density and prices. The often-stated benefits of hydrogen dissipate when compared with alternative electric truck technology. This includes battery swapping, which also allows for short 'refuelling times', and the development of e-highways (roads that automatically recharge vehicles when they drive along them).[11]

Finally, a specific risk for hydrogen vehicles is the need for clean fresh water, and lots of it. A single hydrogen fuel cell car requires about 9 litres of clean, demineralized water for every 100 km driven. For a large truck, this would be over 50 litres per kilometre. If sea water and desalination plants were used to produce the water, another energy loss would be added to the production process, penalising overall energy efficiency even further.[10]

4. Yes, Australia needs fuel efficiency standards – but a proper design is critical.

There is ample evidence[12] that mandatory CO_2 emission or fuel efficiency standards have reduced total GHG emissions from road transport in other countries. Indeed, mandatory CO_2 emission or fuel efficiency standards are at the core of overseas energy and transport policy.[13] There is a significant risk that Australia will become a dumping ground for the least efficient and high CO_2 emitting vehicles, as it is one of the few remaining OECD countries without mandatory standards. This effect has been observed in the US where car manufacturers were selling high-emitting vehicles in US states that had not adopted their own state regulation (such as the Zero Emission Vehicle Mandate) – offsetting gains in GHG emission reductions in states that did.[14]

Either US or EU emission or fuel efficiency regulation could be adopted in Australia, after calibration to the Australian fleet. However, careful consideration and fixing of 'loopholes' in overseas emission regulations is required to prevent perverse or weakened policy outcomes. It has been demonstrated in both the EU and the US that car manufacturers devise strategies and explore these loopholes to minimise compliance costs and maximise profits. This behaviour means that companies comply with regulations, but do not actually reduce emissions, at least not to the extent intended by the regulation.[15]

[11] https://theconversation.com/we-must-rapidly-decarbonise-transport-but-hydrogens-not-the-answer-166830.

[12] E.g. *Energy Policy*, 2017, 103, 212-222; *Environmental Science & Technology*, 2019, 53, 564-574.

[13] E.g. *Energy Economics*, 2015, 52, S41-S52; *Journal of the Assoc. Environmental and Resource Economists*, 2019, 6 (1), S37-S63.

[14] *Environmental Science & Technology*, 2019, 53, 564-574.

[15] *Environ. Innov. Soc. Transit.*, 2015, 16, 87–105.

For instance, in the US, car manufactures continually increased car size (footprints) and produced flex-fuel vehicles to achieve more lenient emission standards, leading to higher emissions.[16] In fact the "flex-fuel vehicle loophole" was so lucrative for car manufacturers that many generated large stores of surplus credits. [17] The credits allowed manufacturers to keep producing less fuel-efficient vehicles.

Another distortion in the US legislation is that 'trucks' (large passenger cars) received the most lenient targets, which have encouraged the sale of more trucks at the expense of smaller cars. This also encouraged manufacturers to classify as many cars as possible as 'trucks'. A classic example is a vehicle Chrysler manufactured called the PT Cruiser. In the early 2000s, Chrysler was making large profits on its Dodge Ram pickups and wanted to sell more, but was running up against the fuel efficiency standard constraint. Chrysler responded by introducing the PT Cruiser, which looked like a car but was built on a "truck" platform, allowing Chrysler to sell more fuel-inefficient pick-ups.

For the EU, 'flexibilities' in the outdated NEDC test procedure (Section 1.2) were increasingly exploited by car manufacturers. The EU regulation allowed manufacturers to define resistances for the official test for a pre-production vehicle. Manufacturers could strip a vehicle from auxiliaries, use low-resistance and overinflated tires, use high-performance lubricants, and carefully select a favourable test track, among other options. This led to unrealistically low resistance settings (and, as a consequence, emissions) in the laboratory.[18] Indeed, the large and increasing difference with actual (real-world) emission rates demonstrates that emission standards can become quite ineffective, if parts of the regulation are not rectified in a timely fashion to close loopholes (e.g. replacing the NEDC with the Worldwide Harmonised Light Vehicle Test Procedure or WLTP as was done in the EU).[19]

5. For effective emission reduction policy – make energy efficiency front and centre in policy development.

Australia needs to seriously consider energy efficiency again to ensure we meet Net Zero targets. Energy efficiency used to be one of the pillars of sound environmental policy around the globe and we recommend that this policy aspect is explicitly included in the development of new emission reduction policies and regulation. As an example, TER points to an overlooked but fundamental issue with using hydrogen in transport: its low energy efficiency (well-to-wheel). Hydrogen is not an energy source; it is an energy carrier. This means it needs to be generated, compressed or liquefied, transported and converted back into useful energy – and each step of the process incurs a substantial energy loss. In addition, hydrogen may significantly leak during these processes and clean water will need to produced adding to more energy requirements.

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[16] *Journal of Environmental Economics and Management*, 2012, 63, 187-207; *Environmental Science & Technology*, 2016, 50 (5), 2165-2174; *Environmental Science & Technology*, 2017, 51, 10307–10315.

[17] *Journal of the Assoc. Environmental and Resource Economists*, 2019, 6 (1), S37-S63.

[18] *Energy Policy*, 2014, 67, 403-411; *Energy Policy*, 2017, 103, 212-222.

[19] See for instance: https://www.wltpfacts.eu/what-is-wltp-how-will-it-work/.

In fact, hydrogen vehicles and vehicles that run on petrol or diesel have a similarly low energy performance: just 15-30% of the available energy in the fuels is used for actual driving, the rest is lost in the fuel production process and heat loss. Compare this to battery electric vehicles, which use 70-90% of the available energy.[20] In other words, the amount of renewable energy required for a green hydrogen vehicle to drive one kilometre is the same as what's required for three to four electric vehicles to drive the same distance. This is an important issue. The production of renewable energy costs money, and both energy and money are a limited resource. The more energy required for transport, the more renewable energy needs to be generated, the higher the cost and the more difficult it becomes to decarbonise the Australian economy rapidly and at scale – a critical condition to address climate change and minimise damage costs to society and the tax payer.

The future significance of low energy efficiency has been illustrated through estimation of the potential electricity grid impacts in 2018. If Australia's existing 14 million light vehicles were electric, they would need about 37 terawatt-hours (TWh) of electricity per year — a 15% increase in national electricity generation. But if this same fleet was converted to run on hydrogen, it would need more than four times the electricity: roughly 157 TWh a year. This would entail a 63% increase in national electricity generation.[21] For urgent, rapid and cost-effective greenhouse gas emission reduction the available evidence suggests that Australia should electrify transport where possible and use other options like green hydrogen where electrification faces insurmountable barriers (for instance long distance shipping and aviation, steel, chemical feedstocks).

6. Size and weight matters – the forgotten issue.

But electrification is not enough.

The sustained and increasing proportion of large and heavy passenger vehicles in on-road fleets around the world[22] and particularly in Australia[23] has a detrimental effect on energy efficiency and GHG emissions. SUVs are larger and heavier than conventional passenger cars and the laws of physics dictate they need quite a bit more energy and fuel per kilometre of driving when compared with smaller and lighter passenger cars.[24]

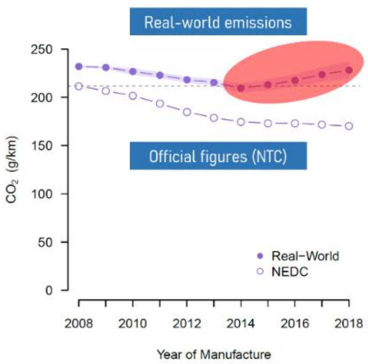

Figure 4 – Fleet average CO_2 emission rates for new Australian passenger vehicles.[23]

Previous TER research from 2019 estimated that fleet average greenhouse gas emissions for new Australian cars and SUVs have been increasing by 2-3% percent per year since 2015, rather than

[20] https://theconversation.com/we-must-rapidly-decarbonise-transport-but-hydrogens-not-the-answer-166830.

[21] https://theconversation.com/why-battery-powered-vehicles-stack-up-better-than-hydrogen-106844.

[22] *Progress in Energy and Combustion Science*, 2017, 60, 97-131; *Atmospheric Environment*, 2019, 198, 122-132; US EPA-420-S-19-001, March 2019.

[23] https://www.transport-e-research.com/publications (2019a).

[24] https://theconversation.com/we-may-be-underestimating-just-how-bad-carbon-belching-suvs-are-for-the-climate-and-for-our-health-190743.

the annual reduction reported by, for instance, the National Transport Commission (Figure 4). This detailed analysis found that a sustained increase in vehicle weight and a shift to the sale of more four-wheel-drive cars (in other words, SUVs and large Utes) are probably the main factors contributing to this change.[23]

Another way to look at this is to compare vehicle technologies after estimating how many kilometres can be driven before one kilogram of CO_2 is emitted. This is illustrated in Figure 5.

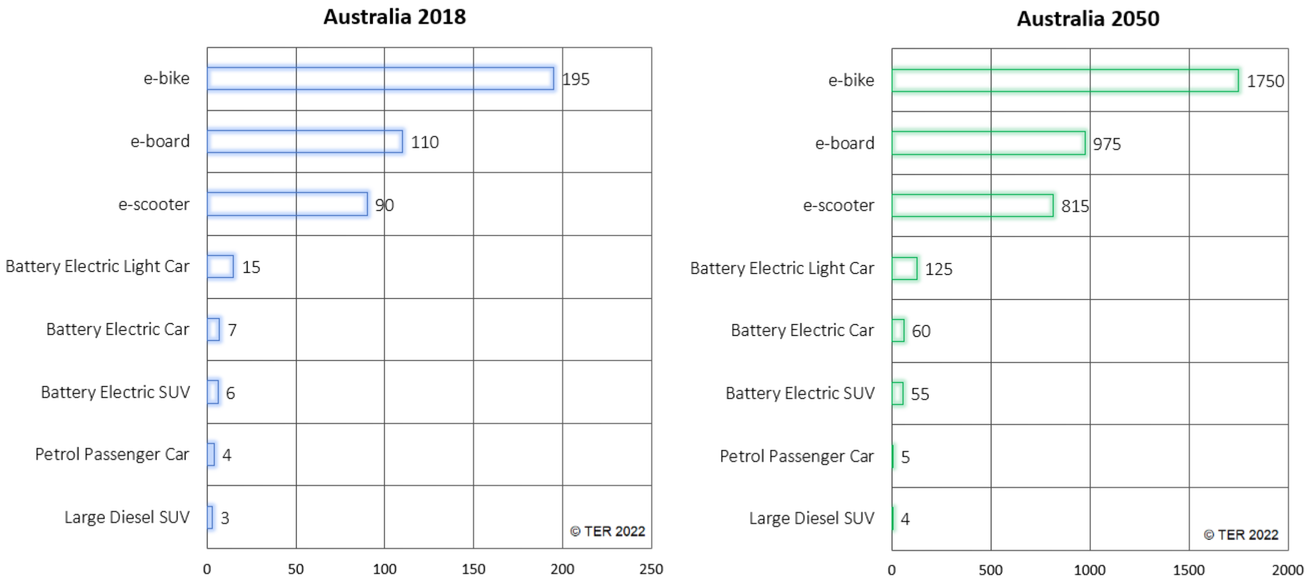

Figure 5 – Comparing the energy efficiency for different vehicle types showing the number of kilometres travelled to emit one kilogram of CO_2 for two different years. These numbers are approximate values for real-world on-road driving (not life cycle) and for illustration purposes only.

A few important points are clear from Figure 5.

- First, the effect of vehicle size and weight on GHG emissions is large. Whereas a large diesel SUV currently drives only 3 kilometres to emit a kilogram of CO_2, it will take about 200 kilometres for an e-bike to do the same.

- Second, decarbonisation of the Australian electricity grid will reduce GHG emissions from battery electric vehicles significantly, whereas future improvements for petrol and diesel combustion engine vehicles (without hybridisation) are expected to be marginal. A battery electric car will currently drive about 7 kilometres before emitting one kilogram of CO_2, but in 2050 this is expected to be in the order of 60 kilometres. Lightweighting a battery electric car will more than double the distance again to 125 km per kilogram of CO_2.

With the right policies and regulations, we can make a step change in energy efficiency and achieve large cuts in GHG emission levels. We are unlikely to reach Net Zero in 2050 with electrification and use of hydrogen in road transport alone, while allowing the trend of ever larger and heavier vehicles to continue.

TER expects that lightweighting and energy efficiency optimization in transport will be critical to reach significant reductions in GHG emissions and meet our targets. We note that the life-cycle impacts of lightweighting on GHG emissions will need to be assessed to ensure these step change reductions in emissions will happen to the maximum extent. Policies that promote the sale of light (electric) vehicles could produce a substantial reduction in greenhouse gas emissions from road transport if effective. For instance, dedicated information campaigns for the general public could inform consumers about the basic principles of on-road energy and fuel consumption and the impact of their purchasing decisions on greenhouse gas emissions.

Neither the US nor EU emission standards are designed to address this issue, for instance, by promoting the sale of more fuel-efficient smaller and lighter vehicles. In fact, the use of footprint or weight dependent standards, may well have contributed to the trend of increasing vehicle size and weight.[25] Other measures are therefore needed to complement mandatory standards, as will be discussed in the next section.

7. Other policy measures – Yes Australia needs those too.

It can be easier politically to introduce fuel economy or CO_2 emission standards, but that does not mean they are the best or only option. It is generally agreed that fuel (or carbon) taxes are a substantially more effective and direct way to reduce total GHG emissions, and unusually cost-efficient (about 3-14 times cheaper), as compared with mandatory CO_2 or efficiency standards.[26] In fact, 90% of top economists prefer a fuel tax over fuel efficiency standards.[27]

Fuel and energy/electricity prices are a key factor in relation to GHG emissions and they have systematic impacts. For example, low fuel prices in the US have contributed to a trend to larger and heavier high emissions vehicles – which would equally apply to Australia – whereas high fuel prices in Europe have encouraged smaller and more fuel-efficient vehicles, until recently.[28]

An increase in fuel prices will affect all other prices in the economy as a result of increased transport costs, adding to the current challenge of curbing inflation, which may be particularly detrimental to poor households. So a fair re-distribution of fuel tax revenues would be important to consider.[27] But importantly this type of tax could be refined and diversified, for instance taxing climate damaging fuels, while financially supporting the use of climate friendly fuels (cost neutral bonus – malus approach).

There are, of course, several public benefits of reduced fossil fuel consumption, and less energy use in transport in general, including, but not limited to, effective reduction of GHG emissions addressing climate change, reduced air pollution and associated health impacts and improved energy security.

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[25] *Environmental Science & Technology*, 2016, 50 (5), 2165-2174.

[26] E.g. *Environmental Science & Technology, 2016*, 50 (5), 2165-2174; *Environmental Science & Technology*, 2019, 53, 564-574; *Fuel Taxation in Europe*, 2012, Springer Science + Business Media.

[27] *Journal of the Association of Environmental and Resource Economists*, 2019, 6 (1), S37-S63.

[28] *Fuel Taxation in Europe*, 2012, Springer Science + Business Media.

However, it is not a matter of either emission standards, fiscal measures or other supporting policies. A mix of complementary policy instruments is believed to achieve optimum results.

A portfolio of broad policy measures to mitigate GHG emissions has therefore been used in Europe.[29] Europe has mandatory standards, but has also implemented fiscal measures. Fiscal measures in Europe include fuel taxes to directly reduce travel and affect consumer behaviour (e.g. buying more fuel-efficient vehicles), and one-off purchase and/or annual ownership taxes to influence car purchasing behaviour, where fee levels are dependent on fuel efficiency, CO_2 emissions or related variables (e.g. engine capacity, weight, rated power).

The NVES already pointed towards a range of policy measures and regulations (e.g. Figure 4 in the NVES) and TER supports this broad approach.

[29] *Energy Efficiency*, 2016, 9, 925-937.