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**To: Inquiry Secretary**
**Inquiry into Australia's Transition to a Green Energy Superpower**
**Joint Standing Committee on Trade and Investment Growth**

Dear Sir/Madam,

The Joint Standing Committee on Trade and Investment Growth is inquiring into "how trade and investment can support Australia's transition to a green energy superpower".

This submission is provided by the Australian Electric Vehicle Association Ltd (AEVA). We are a volunteer-run, not-for-profit organisation dedicated to switching Australia's transport networks to electric drive as quickly as possible. Formed in 1973, AEVA continues to serve as a vital public forum for Australians to learn about electric vehicles (EVs) and the enormous benefits the technology provides. Our membership consists of end-users of EV technology – the drivers and riders, as well as many businesses involved in all aspects of electrified transport.

We thank the Committee for the opportunity to provide a submission to this Inquiry. We hope our contribution will provide a useful perspective, coming from an organisation that is committed to the electrification of transport and of Australia's wider energy economy.

Our submission deals with five questions:

- What are Australia's inherent strengths in energy production?
- Where can Australia reduce its dependence on imported energy?
- What are Australia's energy export opportunities?
- What role could hydrogen play in Australia's energy economy?
- Where can Australia build on its energy advantages to replace imports with domestic manufacturing and services?

At some points in our submission, we have quoted from Saul Griffith's book *The Big Switch*. This reflects the fact that AEVA shares Griffith's perspective that addressing climate change is our highest priority as a nation, and that the electrification of (almost) everything, including our vehicles, is the key response to this challenge.

**What are Australia's inherent strengths in energy production?**

Saul Griffith argues[1] that Australia has unique advantages in energy production due to its combination of vast land area, low population density and consistent, high solar radiation and wind resources. Indeed, Geoscience Australia has noted[2] the continent has the highest solar radiation per square metre of any continent. It receives an average of 58 million petajoules of solar radiation per year, approximately 10,000 times larger than its total energy consumption. Accordingly, ARENA's Solar Energy Assessment[3] confirms that the total solar radiation received by Australia is approximately 10,000 times larger than its total energy consumption, which was 5772 petajoules (PJ) in 2007–08. Theoretically, then, if only 0.1 per cent of the incoming radiation could be converted into usable energy at an efficiency of 10 per cent, all of Australia's energy needs could be supplied by solar energy. Australia's energy consumption has clearly risen significantly since 2007-08, but the general point remains valid.

The coupling of Australia's natural advantages in renewable energy with the rapid drop in the costs of this energy in the second decade of this century was the motivation for Ross Garnaut's book *Superpower*[4]. In this book, Garnaut envisages a thriving future for Australian heavy industries such as aluminium and steel manufacture, based on the use of renewable energy in the manufacturing processes. He also envisages major economic opportunities in the supply of silicon, lithium and rare earth minerals to support the world's photovoltaic, IT and battery-based products.

For example, Garnaut claims that "Aluminium making will die in Australia in the 2020s if we stick with coal. It can be an expanding industry if we use the opportunity to reduce energy costs with high-quality renewables."[5]

For the past decade, Australia has been moving to capitalise on its natural renewable energy advantages. According to the Clean Energy Council[6], renewable energy accounted for 32.5 per cent of Australia's total electricity generation in 2021, an increase of almost 5 percentage points compared to 2020. This growth was led by small-scale solar, which added 3.3 GW of new capacity during the year to record its fifth-straight record-breaking year. The large-scale sector also made good progress in 2021, adding 3.0 GW across 27 projects.

It is this key advantage – abundant renewable energy – which AEVA believes should be the centrepiece of any major industrial investments.

[1] Griffith, Saul. The big switch: Australia's electric future. Black Inc. Books, 2022. Pages 37-39. https://trove.nla.gov.au/work/249283750
[2] Geoscience Australia. Solar energy. https://www.ga.gov.au/scientific-topics/energy/resources/other-renewable-energy-resources/solar-energy
[3] Australian Renewable Energy Agency. Australian Energy Resource Assessment. Chapter 10: Solar energy. https://arena.gov.au/assets/2013/08/Chapter-10-Solar-Energy.pdf
[4] Garnaut, Ross. Super-power: Australia's low-carbon opportunity. https://trove.nla.gov.au/work/237178833
[5] Our green super future. Deal Magazine, The Australian 20 March 2020. https://cpb-ap-se2.wpmucdn.com/blogs.unimelb.edu.au/dist/a/142/files/2020/03/200320_theDEAL_TheAus.pdf
[6] Clean Energy Council. Clean energy Australia report. April 2022. https://www.cleanenergycouncil.org.au/resources/resources-hub/clean-energy-australia-report

**Where can Australia reduce its dependence on imported energy?**

The AEVA has long argued that switching our transport networks to electric drive will effectively end our reliance on imported energy in the form of liquid fuels. Decreasing our reliance on imported energy is essential, but as Australia is currently a net exporter of energy in the form of coal and gas, efforts must be made to ensure that we replace these with exports of clean, renewable-sourced energy.

Australia currently imports around 2400 PJ of energy in the form of crude oil and refined petroleum at a total cost of around $40B. This import dependence represents an energy security problem, because Australia lacks a safe level of strategic fuel reserves[7].

Electrification of all our transport networks, including roads, rail and shipping will extend our safety margin, and make the nation far more resilient to energy price shocks like the current one, provided reserve policies are observed.

Defence analysts such as retired Air Vice-Marshal John Blackburn have called for Australia to speed up its transition to electric vehicles and other forms of green transport, saying the country's heavy reliance on imported oil is a "massive" security weakness.

Blackburn notes[8] that Australia is the only member country of the IEA (International Energy Agency) which fails to meet its stockholding obligations. We currently import more than 90% of our transport fuels. His assessment is that the action taken by the Australian Government in 2018 will “do little to improve our domestic energy security and resilience”. He concludes that Australia needs to “grasp the energy transformation challenge opportunity and drive a significant proportion of its … transport dependence away from imported fuels as soon as possible”.

Michael Shoebridge, the Director of Defence, Strategy and National Security at the Australian Strategic Policy Institute, has said[9] that there is “a pressing need to fast-track the adoption of green transport to help Australia wean itself off imports of fossil fuels, particularly oil”.

It has not escaped our notice that 40% of international shipping cargo is fossil fuels[10]. Thus, any international transition to electrify land transport would bring a bonus reduction in emissions from the shipping sector.

In our view, to deal with the above imperatives, Australia should aim to reduce its level of oil imports to near zero by 2045, and this must be driven by a transition to full electrification of transport.

Plans to reduce oil imports should be closely related to the National EV Strategy. In AEVA’s view, this transition should be encouraged and accelerated, both by incentivising the take-up of EVs, and by de-incentivising the purchase or retention of internal

[7] The Guardian, 23 August 2022. https://www.theguardian.com/australia-news/2022/aug/23/australias-emergency-fuel-storage-down-to-only-58-days-as-labor-looks-at-increasing-reserves
[8] Defense.info, 17 March 2022. https://defense.info/re-shaping-defense-security/2022/03/australias-perilous-over-dependence-on-imported-fuel/
[9] ABC news, 21 March 2022. https://www.abc.net.au/news/2022-03-21/calls-for-evs-to-wean-australia-off-foreign-oil-imports/100911930
[10] Quartz, 14 January 2022. https://qz.com/2113243/forty-percent-of-all-shipping-cargo-consists-of-fossil-fuels

combustion engine (ICE) vehicles. More details of our views can be found in our response[11] to the National EV Strategy Consultation Paper.

**What are Australia's energy export opportunities?**

Saul Griffith has addressed this question in Chapter 8 of *The Big Switch*. His key points are:

- Australia's export *profits* from coal and liquefied natural gas total about $36B, but this *is still less than the cost of Australia's imports of crude oil and petroleum products*
- Instead of exporting iron ore at $100 per tonne, Australia could turn that iron ore into steel which can be sold for roughly $1000 per tonne, and the steel could be made using hydrogen or electrochemical processes, based on Australian renewable energy, instead of coking coal
- Using Australian renewable energy, Australia could move to increase the proportion of bauxite that is refined to alumina, and increase the proportion of alumina that is smelted into aluminium, with a boost to export incomes
- There are significant opportunities to export ammonia, both as a fertiliser feedstock and as a source of hydrogen: again, Australian renewable energy can play a major role in producing the ammonia
- Electricity can be exported directly using underwater direct current (DC) cables, as is currently planned by Sun Cable's planned Australia-Asia Powerlink[12].

**What role could hydrogen play in Australia's energy economy?**

Our short answer is as follows:

- Hydrogen's best application is through the production of strategic chemical feedstock, and for the reduction of metal oxides and ores to base metals
- Thus, it is essential that all hydrogen used for these purposes be "green" hydrogen; that is, generated via electrolysis, replacing fossil fuel sources of hydrogen
- Hydrogen (transformed temporarily into ammonia) may play an important role in energy exports, however global demand for fertiliser and metallurgical reduction will dwarf the energy market, as noted in the "Clean Hydrogen Ladder"[13]
- Hydrogen may play some role as a transport fuel for heavy vehicles, rail and international shipping, but it has no useful role as a transport fuel for other vehicles.

Current worldwide production of hydrogen was 94Mt in 2021, almost all of which was derived from unabated fossil fuels[14]. The most efficient possible electrolyser could be anticipated to operate at around 95% efficiency or 41.5 kWh/kg [15]. It can therefore be calculated that just providing green hydrogen for *existing applications* would require at least 3900 TWh. Australia's total annual electricity generation in 2020/21 was about

[11] Australian Electric Vehicle Association. Response to the National EV Strategy Consultation Paper. https://www.aeva.asn.au/files/1730
[12] Sun Cable: Australia-Asia Powerlink, https://aapowerlink.sg/
[13] Clean Hydrogen Ladder. https://www.linkedin.com/pulse/clean-hydrogen-ladder-v40-michael-liebreich/
[14] International Energy Agency. Hydrogen. https://www.iea.org/reports/hydrogen
[15] Renew economy, 16 March 2022. https://reneweconomy.com.au/australian-electrolyser-breakthrough-promises-worlds-cheapest-green-hydrogen/

266TWh [16]. Clearly there is ample opportunity to supply green hydrogen, even without the development of any new applications or demand for hydrogen.

We noted above that ammonia is used to make fertiliser products, but it is also the best way to transport hydrogen between nations, given that it is easier to contain and is a more stable compound than pure hydrogen. It must be noted however that liquefied ammonia presents a significant environmental hazard to sea life should a vessel become distressed.

According to the British commentator Chris Goodall, about 8% of the world's emissions arise from the manufacturing of steel[17]. His assessment is that a move to hydrogen as the reducing agent for steel production would require very large amounts of new renewable capacity if 'green' hydrogen is used, and the steel industry would need to invest billions in the new plants required. This in turn would require appropriate government incentives for the use of hydrogen and disincentives for the continued use of coking coal.

BHP's Sustainability Vice President, Fiona Wild, has said that she does not expect hydrogen to substitute meaningful volumes of coking coal in steel making until the late 2030s or early 2040s[18], but progress is being made by steelmakers in Sweden[19].

There may be opportunities for hydrogen to be used as a transportable fuel for heavy haulage and shipping. For example, the shipping industry is examining hydrogen as a replacement fuel for the current heavy bunker oils[20].

In terms of light transport within Australia, AEVA's view is that hydrogen is simply not a suitable fuel. The conversion of renewable electricity to $H_2$ gas and then converting this gas into motion through a fuel cell is at best 30% efficient. Figures like this are inferior to a battery EV (efficiency up to 90%) and we believe diverting public resources to hydrogen refuelling stations would constitute a poor return on investment in the medium-term.

For ordinary light vehicles, hydrogen fuel cell EVs are in our view, a solution in search of a problem. The problem they purport to address is recharging speed, but most people, most of the time, charge at home or perhaps at work or while shopping where charging does not need to be fast. During long trips, current models of battery EVs can add sufficient charge for several hundred kilometres of range in the time that is needed for short toilet or coffee or meal breaks.

Even for heavy, long-distance trucking it is not at all clear that hydrogen offers compelling advantages over battery-electric. For example, battery swap systems along major highway routes could eliminate any advantage in refuelling speed[21].

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[16] Energy.gov.au. Electricity generation. https://www.energy.gov.au/data/electricity-generation
[17] Carbon commentary, 4 November 2020. https://www.carboncommentary.com/blog/2020/11/4/how-much-hydrogen-will-be-needed-to-replace-coal-in-making-steel
[18] Australian Financial Review, 18 October 2022. https://www.afr.com/companies/energy/finkel-says-binary-truth-arguments-not-helpful-for-hydrogen-20221018-p5bqs2
[19] The Guardian, 19 August 2021. https://www.theguardian.com/science/2021/aug/19/green-steel-swedish-company-ships-first-batch-made-without-using-coal
[20] Center for Strategic and International Studies, 13 April 2021. https://www.csis.org/analysis/hydrogen-key-decarbonizing-global-shipping-industry
[21] Big rigs, 2 October 2022. https://bigrigs.com.au/index.php/2022/10/02/janus-electric-trucks-given-go-ahead-to-start-commercial-trials/

Hydrogen may be needed (directly or in a carrier form such as ammonia or synthetic hydrocarbons) for extremely heavy, extremely long-range vehicles such as international shipping and potentially aircraft[22] but it is very unlikely for light vehicles such as ordinary cars. This is well summarised in the "Clean Hydrogen Ladder" [23] where applications are ranked from 'unavoidable' to 'uncompetitive' (trains, buses, cars).

Finally, it has recently been recognised that hydrogen has a very considerable indirect Global Warming Potential (GWP) from its ability to increase the residence time of methane in the atmosphere[24] so it is very important to ensure that hydrogen leakage is avoided. Avoiding leakage is a difficult task since hydrogen is the smallest molecule that exists.

**Where can Australia build on its energy advantages to replace imports with domestic manufacturing and services?**

The commentary above has referred to manufacturing opportunities in fields such as aluminium and steel making. We also wish to draw attention to the opportunities in the electric vehicle (EV) sector.

In our view, Australian manufacturers will seek opportunities to establish an industry around the key components of the EV value chain. To support this, finance could be offered through the Clean Energy Finance Corporation. The Government could also provide access to land for factories developing EV components, while investing significantly in Australia's research capacity through ARC-Linkage grants to universities where advanced EV components may be researched and developed. We urge the Federal Government to maintain and strengthen the capability of the Clean Energy Finance Corporation to provide such investment support.

Whole EVs could also be made in Australia. Substantial talent and intellectual capital remains from our once-vibrant vehicle manufacturing plants. This talent must be nurtured and directed into these new industries. Tesla chair Robyn Denholm recently said that Australia should revive its auto industry by making batteries and electric vehicles to meet soaring global demand and help speed up the transition from internal combustion engine cars[25]. The Government should examine incentives and the provision of start-up financing for local assembly and manufacture of EVs in Australia.

Safe transport of high energy batteries introduces significant costs, but at the same time provides opportunities for Australian manufacturing through advanced recycling and resource recovery programs. In addition, the re-purposing of EV batteries for stationary energy storage is a popular and responsible way to keep valuable materials out of landfill while serving the electricity grid. High value chemicals and cathode materials for EVs represents a major export opportunity for Australia, and should be supported through finance and research support, including ongoing support for the likes of the Perth-based Future Battery Industries CRC.

[22] ZeroAvia completes first high-power ground tests of new 600 kW hydrogen-fuel-cell powertrain for aviation. https://www.greencarcongress.com/2021/08/20210811-za600.html
[23] Clean Hydrogen Ladder. https://www.linkedin.com/pulse/clean-hydrogen-ladder-v40-michael-liebreich/
[24] Euractiv, 14 October 2021. https://www.euractiv.com/section/energy/news/scientists-warn-against-global-warming-effect-of-hydrogen-leaks/
[25] Sydney Morning Herald, 14 September 2022. https://www.smh.com.au/politics/federal/australia-could-revive-its-car-industry-with-ev-says-tesla-chair-20220914-p5bi0z.html

For almost 50 years AEVA has helped many enthusiastic members to convert their own vehicles to electric drive. There are hundreds of converted EVs on Australia's roads, many of which have been driving for decades. Converting vehicles is not always cost effective, but there is a growing industry in custom and niche vehicle electrification. AEVA believes these industries and the skills they foster should continue unhindered.

Australia is well placed to manufacture electric heavy vehicles for the domestic and export markets. Several Australian businesses are either developing or already producing roll-in, drop-in electric drive train solutions for road-going heavy vehicles, but are constrained by the cost of importing components. Thus, initiatives to enhance advanced manufacturing technology on Australian shores would reduce costs, while a local battery production industry would ensure security of supply.

Similarly, Australia is well placed to develop electric railway rolling stock, both overhead catenary and battery-electric. State Governments should be commended for ensuring passenger railway rolling stock is fabricated locally, and should be supported as they expand their suburban and inter-urban networks. Investment into electric freight rail on key corridors along with key intermodal facilities is essential to reducing transport emissions from the heavy haulage sector. The Australian Government Climate Change Authority correctly notes[26] that despite moving half of all freight (including grain, coal and iron ore) rail represents just 4% of all transport emissions – the opportunities to reduce emissions through investment in rail are substantial.

Manufacturing has now become a security issue, with many major industries being held captive by global supply chain constraints. This presents an opportunity for electric transport industries to add value to their offerings; from resource extraction and recycling through to battery manufacturing and whole EVs, Australia should on-shore much of this activity and take advantage of our position.

We conclude with this quote from Saul Griffith:

*Here is a radical idea: we could make stuff again. We could make batteries, we could make offshore wind platforms and turbine towers. We could even make cars, or parts of cars… The traditional excuses for Australia's underperformance in technology and innovation – that we are too small, or too far away – no longer hold*[27].

Once again, the AEVA thanks the Committee for the opportunity to contribute to this important conversation about Australia's trade and manufacturing opportunities in an era of low-cost renewable energy.

[26] Climate Change Authority. Fact sheet 6: Transport, February 2021. https://www.climatechangeauthority.gov.au/sites/default/files/2021-03/2021Fact%20sheet%20-%20Transport.pdf

[27] Griffith, Saul. The big switch, page 126.

We are happy to provide follow-up responses to any queries or concerns.

Yours sincerely,

Chris Jones
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