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"The Vision Splendid": Greening Australia Felix.

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Abstract

This paper takes its lead from the Federal Government publication '*Future Made in Australia'* (2024), and critiques Government plans to make Australia 'an indispensable part of global supply chains'. In view of the Government objective of making Australia a 'Renewable Energy Superpower' from a manufacturing base of clean energy technologies, renewable hydrogen, green metals, and low-carbon liquid fuels, the paper reviews some of the comparative advantages Australia possesses that might make this vision a reality. It also highlights from a historical perspective, some of the disadvantages that might inhibit fulfillment of the Government plans. Following a narrative literature review methodology, the paper finds that any revival of manufacturing in Australia to engage global supply chains would face a steep challenge due to Australia's high wage structure. On a brighter note, possibilities in clean energy domestic manufacturing appear promising. Government plans to achieve 82% renewable energy in electricity grids by 2030 look to be achievable if the present Government retains office, and appropriate public support is forthcoming. Green hydrogen/ammonia power generation looks almost certain to replace aging coal plants, again provided support is appropriate in the critical development stages. On present analysis, this paper finds that Government support and financial assistance to industry towards eventual Renewable Energy Superpower status appears to be substantially less than required for a home-grown industry to develop. International investment partnerships would appear to be the only avenue forward if Australia is to realise its comparative advantage of wide open spaces and abundant wind and sun.

Keywords: Decarbonisation; Manufacturing; Renewable Energy; Energy Superpower; Wage Structure; Green Hydrogen/Ammonia

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"… and he sees the vision splendid of the sunlit plains extended …" (A.B. Paterson, *Clancy of the Overflow)*

1. Introduction

In this 21st century, the Nation States of the world, and in particular the post-industrial developed nations, are facing two unavoidable imperatives for decarbonisation of their economies. The first, and most immediate, is evidenced by the increasingly erratic, extreme weather events being experienced in all corners of the globe (Climate Council, 2024). These events are occurring as the earth's atmosphere responds to the greenhouse heating effect of an unprecedented loading of carbon dioxide and other gases that are arguably, the byproduct of an industry based on fossil fuel energy. The second, and currently blithely ignored by much of industry, is that carbon-based fossil fuels are a non-renewable resource, and as such will be either exhausted, or alternatively, become politically untenable at some point in the future, perhaps the not-too-distant future. At the present time, it is moot whether the earth's climate will become unliveable for many before fossil fuels are phased out, or if a depletion of economically recoverable fossil fuels will intervene to forestall the looming climate catastrophe. Either event occurring in an ill-prepared world threatens to presage a global economic upheaval only slightly less disruptive in its effect than a complete climate collapse.

Fortunately, there are renewable energy technologies, some proven and some still under development, that show promise of being capable of entirely replacing fossil fuels. The success of this transition will be dependent upon the necessary political will being harnessed and directed towards nurturing renewable energy through the development stage to a commercial scale and economy. In anticipation of such a scenario, Australia finds itself fortunately placed to capitalise on its comparative advantage of suitable climate and available space, to develop these 'green' technologies that will not only satisfy our own energy requirement, but potentially allow Australia to become a substantial energy exporting hub to those countries that do not possess our natural advantages. The recent Australian Federal Government initiative of *'A Future Made in Australia'* (2024) shows that the government is alert to many of these possibilities. It is to be hoped that the inevitable political and economic headwinds they encounter will not result in this initiative becoming stillborn.

With the aim of critiquing the Australian Federal Government's plans to develop renewable energies, the main body of this paper will review and elaborate on the various renewable energy technology streams that might be harnessed to decarbonise Australia's energy budget, and potentially, to contribute to our future as a green energy and technology export hub. Australia's comparative advantage in realising these technologies going forward will be considered, as will a perspective of some of the country's disadvantages when it comes to any '*Future Made in Australia'* proposals to rebuild Australian manufacturing for export in a globalised world. The discussion will look at the ramp-up of already proven wind, solar, and battery energy technologies, as well as the developing energy technologies of green ammonia and green hydrogen, and how these might be integrated to secure Australia's future as a major energy exporter

2. Methodology.

The methodology adopted for this study was a narrative literature review, which facilitated the empirical approach of the paper. Literature reviewed includes Australian Federal Government proposals for the future economic resilience of Australia, historical records of manufacturing industry protection, and the current state of renewable energy industries in Australia. The review began with the Treasury document, *'Future Made in Australia'* (2024), to analyse the extent of Federal Government proposed involvement and support for future economic resilience and security. As this Treasury document includes some provision for rebuilding a manufacturing industry in this country, the literature review proceeded to look at the history of manufacturing and industry protection in Australia, reaching a sufficient saturation on this subject after reviewing eight journal articles and one booklet.

To assess the current development of solar and wind generation in Australia, 19 journal articles were selected as addressing advantages and limitations of these technologies in contributing to the decarbonisation of the national electricity grid, and to building a renewable energy future. The review then analysed 15 journal articles outlining the current state of research, development and application of green ammonia and green hydrogen as an energy source, and as a potential energy export. In addition, a further 20 grey literature news sources were consulted to establish the current state of development of alternative energy in this country. All journal articles were subjected to a thematic analysis in NVivo 20, which provided the basis for the argument presented here.

3. Background: Australia's Disadvantage in a Globalising World

The executive summary of the Treasury document, *Future Made in Australia: National Interest Framework* (2024, p. 1) states "Our abundant natural assets and resource endowments create significant opportunities to foster new globally competitive industries that can boost our economic prosperity and resilience, while supporting decarbonisation". Statements such as this in the Treasury document drew an expression of support from the blog *Progress in Political Economy*, which emanates from the Department of Political Economy at the University of Sydney. This publication was enthusiastic in its support for the government's measures to boost Australia's manufacturing capabilities "to strengthen and modernise its capacity to develop and produce a full range of technology-intensive, sustainable, globally marketable manufactured products" (Bryant, Jun 5, 2024). The open letter, countersigned by more than 70 senior Australian academics, went on to suggest that "by rebuilding and modernising sustainable manufacturing and infrastructure, linked fundamentally to the energy and climate transition, Australia could create *hundreds of thousands of well-paying industrial jobs* …" (emphasis added).

In fact, despite the enthusiasm of its executive summary, the Treasury document went on to reveal more restrained ambitions regarding manufacturing employment. It stated that "[T]here *may be a case* for developing domestic capacity where:

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- Global supply is *highly concentrated and vulnerable* to disruption;
- There is limited capacity for the industry to quickly adapt and *respond to any shock*; and
- The consequences of a serious supply disruption *would be significant*" (p. 27, emphasis added).

These statements are further qualified on the following page where it states:

> Strong partnerships will ensure Australia continues to benefit from low-cost technologies manufactured in countries with highly competitive manufacturing cost bases for reasons including economies of scale. For example, China's global competitiveness in manufacturing and government investments over several decades has allowed it to develop significant scale and expertise in clean energy technology, particularly solar photovoltaic (PV) supply chains. Access to these products reduces the cost of renewable energy production in Australia, strengthening Australia's potential to become a renewable energy superpower (p. 28).

As the Albanese Federal Labor Government would have to be aware, there are historical factors in Australia's development as a nation that justify such restraint and qualification when it comes to promoting an economic future based on manufacturing in this country.

Australia has never had a viable manufacturing industry that was not protected by substantial import tariffs (Schedvin, 1987). This is the reason that most Australian manufacturing ceased when protective tariffs were removed, beginning with the 25% across-the-board cuts by the Whitlam Government in 1973. Of the historical factors that have contributed to this state of affairs, the first is that the small domestic market that Australia has always presented has been instrumental in inhibiting local manufacturing from achieving economies of scale necessary to break into export markets (Schedvin, 1987). Related to this is the early success of fine wool exports from Australia, with the result that most research and development was oriented towards rural rather than manufacturing industries.

But the greatest barrier to Australia establishing a viable manufacturing export industry in this globalising world is the legacy of one hundred years of industry tariffs and wage indexation that saw Australian manufacturing workers achieve one of the highest standards of living in the world (Conlon & Perkins, 1999). Characterised as "the domestic defence model" (Castles 1989), or the "Australian Settlement" (Kelly 1992), these measures established wage protection through the Arbitration Courts for workers, and import tariff protection against the resulting high wages, for manufacturing employers. The outcome of this legacy is that the minimum wage today in Australia is US$2,315.00 per month. By comparison, the minimum wage of some of our potential competitors on the global export market are: China, at US$364.00 per month; Indonesia, US$130-325.00 per month; India, US$45.00 per month (velocityglobal.com 2024). Hence, the qualified support from the Albanese Government for re-instating manufacturing in this country.

From these figures it is plain that we could not hope to build, for example, a solar panel manufacturing industry, or a battery storage manufacturing plant in this country capable of competing with China in global markets. The recent collapse of leading American solar giant SunPower, citing an inability to compete with Chinese manufacturers, provides ample evidence of the risk involved (Hill, Aug 7, 2024). Instead, in line with the strategic domestic manufacturing proposed in the Treasury document, Australia should prioritise initiatives such as the manufacture of low carbon liquid fuels (LCLF) as an aid to decarbonising our domestic aviation and transport industries. Another strategic domestic manufacturing industry showing promise is Fortescue's automated electrolyser plant at Gladstone in Queensland. Fortescue Executive Chair, Andrew Forrest emphasised that this facility would be engaged in research and development, as well as production in this rapidly growing industry (Fortescue, Apr 8, 2024). However, any possible development in Australia of a future export industry would be contingent upon being able to exploit Australia's comparative advantages.

4. Australia's Advantages: Why the Future Might Look Green.

Australia's advantages, in comparison to other countries, has always been our abundant natural resources. It has been said more than once that 'Australia rode to riches on the sheep's back.' Fine wool growing on the vast and largely uninhabited inland plains sustained an early export industry that earned Australia the epithet, 'the land of the Golden Fleece.' Following closely on the heels of the sheep flocks came the mining industry. From humble beginnings, this industry received a boost in the great Eastern States gold rushes of 1851 (Blainey, 2010), and the discovery of the fabulous Broken Hill silver-lead-zinc lode in 1883 (Curtis, 1968). Although impressive at the time, such beginnings are today dwarfed by the massive, semi-automated iron ore mines of Western Australia that in 2023, exported nearly 900 million tonnes of ore to global markets (Tibben, Apr 3, 2024).

Impressive as these mining achievements are, they are based on non-renewable resources and a carbon-based technology of extraction. With the world now facing a decarbonisation imperative, Australia's future economic prosperity could lie in the still largely uninhabited inland plains, and the abundant, and infinitely renewable wind and solar resources that may hold the potential of making Australia the green energy exporting superpower of the Government's *Future Made in Australia* plans. All we need to do as a community, is to wholeheartedly accept the challenge. Are we up for this, or more to the point, is the Government up for it? As with any ambitious new venture, it should not come as a surprise to find that adjustments may be necessary along the way as unforeseen problems are encountered. This discussion will now attempt to anticipate some of these difficulties, before addressing what a real Australian Energy Superpower might look like.

5. Just how green might Australia's future be?

As a step towards the proposed 'renewable energy superpower' status, the Australian Government has set a target of 82% renewable energy in our electricity grids by 2030 (Go green with Australia, 2024). As a policy, this has recently run into headwinds with new large-scale wind and solar projects currently "stalled at the gate" (Parkinson, Jul 28, 2024; Aug 1, 2024). Data released by the Australian Energy Market Operator (AEMO) reveals that new approvals of large-scale solar and wind projects are well short of requirements to reach government targets. The one strong component of new capacity over the last 18 months has been battery

storage, with 2.5 GW beginning construction in the first six months of 2024 (Parkinson, Jul 28, 2024).

This shift in emphasis from production to storage suggests that already, difficulties have been encountered by the Market Operator in balancing the grid. Indeed, a recent article in the Australian Financial Review revealed that in December 2023, the State of Victoria experienced what was termed 'a solar juggernaut' from domestic rooftop solar, which resulted in large scale wind and solar farms being forced from the market during peak production periods (Macdonald-Smith, Jan 3, 2024). If this situation is not appropriately addressed it must result in large scale solar and wind becoming a less attractive investment for private enterprise. There have also been moves by State governments to apply a charge, the so-called 'solar tax', to rooftop solar PV systems of individual households that supply excess power to the grid during peak daytime production periods.

Together, such disincentives to investing in renewable energy risk derailing government plans to achieve the projected national grid renewables target by 2030, let alone any thought of becoming a 'renewable energy superpower'. Any renewable, green hydrogen based export industry would require an investment some orders of magnitude greater than that required to 'green the grid', mandating a nationally coordinated approach from the Federal Government if it is to succeed. If appropriate Federal and State Government support and investment is not forthcoming, it risks being disregarded as a 'greenwashing' exercise, which end result will only prolong the use of fossil fuels (Campbell, Jul 18, 2024).

Present government inclination to provide such support might be judged by the experience of Australian company Fortescue, who had proposed a green hydrogen production facility at Gibson Island in Queensland. The project is currently stalled as power prices of at least A$100 per megawatt hour have been quoted to Fortescue by the Queensland Government. To put this into context, a 1999 inquiry into the unprofitable aluminium smelting industry by the Australia Institute found that secret long-term electricity supply agreements between smelters and state governments range up to an estimated A$25.00 per megawatt hour (Hamilton & Turton, 1999). Fortescue has been asking the government for a long-term contract price of A$45.36 per megawatt hour, to little avail to date. No doubt disillusioned, Fortescue is currently discussing hydrogen production with Norway and Morocco among others, with renewable electricity prices quoted in the order of US$30 per megawatt hour (Ker, Mar 11, 2024). Hopefully, this is not to be yet another Australian initiative lost overseas. A further worrying sign for Future Made in Australia plans is the recently announced cancellation of Woodside's proposed 300 megawatt hydrogen/ammonia export project at Bell Bay in Tasmania, citing lack of State Government support and insufficient renewable energy generation (Williamson, Aug 28, 2024). More recently, cancellation of the HyEnergy 12 gigawatt wind and solar project near Carnarvon in Western Australia, also citing lack of government support and time delays for approvals, underlines the parlous state of the industry at present (Parkinson, Aug 29, 2024).

The Australian Federal Government financial commitment to a hydrogen industry, launched in 2019, saw an initial A$500 million targeted to support hydrogen projects (Capurso et al., 2022). In addition, the Government has more recently offered a A$2/kg subsidy to eligible hydrogen producers for up to 10 years (Campbell, Jul 18, 2024). Budget documents have estimated the cost of this subsidy to government as A$6.7 billion over the 10 years, which amounts to 335,000 tonnes of hydrogen per year. The problem here is that Australia currently uses 500,000 tonnes of hydrogen produced from carbon sources each year, in making fertiliser and explosives uses which should have first priority in decarbonisation (Campbell, Jul 18, 2024).

Also in 2019, the Federal Government announced a A$70.2 million package to activate regional hydrogen export hubs (First Low Emissions Technology Statement, 2020), although to date there has been little visible evidence of achievement in this direction. Other nations are outspending Australia on their decarbonising programs, in particular the US, which may exceed A$1.5 trillion for programs including hydrogen production (Hannam, Jul 20, 2024). Competition in green energy export is also expected from Algeria, Argentina, Chile, Iceland, Morocco, Norway, Oman, and Saudi Arabia (Salmon & Banares-Alcantara, 2021). Clearly, a re-evaluation is required by an Australian Government that is in danger of being left behind.

6. Greening the Grid

Before Australia considers exporting renewable energy, there is much decarbonising to be done at home. There is the 500,000 tonnes of hydrogen already being produced with non-renewables that should have priority, and if sufficient R&D incentives are provided, we will most likely be able to largely decarbonise our aviation and heavy transport industries with the domestic manufacture of low carbon liquid fuels (LCLF). The aforementioned wind, solar, and batteries will certainly make it possible to stabilise the national grid for much of the year with an appropriate mix of production and storage capability, but consideration also needs to be given to other non-carbon sources with the capacity to supplement wind and solar supply during extended calm and cloudy periods. Proposed pumped hydro projects and batteries can only be regarded as short-term storage, evening out daily fluctuations, so it will need an energy source capable of providing base-load power during extended shortfalls. This is where the chemical storage provided by green hydrogen and green ammonia can be utilised, thus paving the way to a possible export industry.

Both hydrogen and ammonia, but particularly ammonia can provide long-term carbon-free chemical storage of energy capable of being burned in gas turbines as required to generate electricity, thus future-proofing the national grid. A bonus of developing this energy path is that it only requires scaling up to provide the ammonia feedstock to support a renewable energy export industry. Green hydrogen is produced by the electrolysis of water into its components hydrogen and oxygen, using renewable energy. Green ammonia is then produced by reacting green hydrogen with nitrogen from the air. Both hydrogen and ammonia are fuels in their own right, and each has advantages and disadvantages in production and use that must be considered.

Hydrogen has a major advantage as a fuel in that being carbon-free, it produces only water vapour as a byproduct of its combustion. As an interim measure it can be blended with other fossil-based fuels to reduce CO2 emissions until more suitable fuel combustion technology becomes available. One example of this is the production of sustainable aviation fuel (SAF) by reacting renewable hydrogen with CO2, either from reclaimed waste streams or direct from the atmosphere, to produce a liquid kerosene

alternative (Bauen et al., 2020). A percentage of hydrogen can also be incorporated into the existing natural gas network without modification, allowing a partial reduction of greenhouse gas emissions (Capurso et al., 2022). Apart from combustion, hydrogen can also generate electricity in fuel cells, which may have application provided storage and distribution problems can be overcome.

The use of green hydrogen as a fuel does have substantial drawbacks. It is currently considerably more expensive than fossil alternatives. (Capurso et al., 2022). The physical properties of hydrogen also pose some major challenges for its widespread use as a fuel. Due to its low volumetric energy density, elevated pressure and large storage vessels are required, making it less suitable for any mobile applications. It can be stored as a cryogenic liquid at minus 250°C, but the process is energy intensive which adds to its expense, as does the unavoidable daily boil-off of some of the gas (Salmon & Banares-Alcantara, 2021).

Hydrogen also has a wide flammability range of between 4% and 75% concentration in air (Kurien & Mittal, 2022) which increases the risk of explosion or fire in the event of leaks. More challenges to be overcome are that the gas can cause embrittlement of steel components of storage tanks, compressors, pipelines and engines (Salmon & Banares-Alcantara, 2021). Due to its low energy density, larger diameter pipelines are required for offloading and distribution meaning the existing LNG distribution system must be duplicated for hydrogen. To overcome some of these difficult problems of transport and storage, one alternative being proposed is to produce hydrogen close to the point of end-use by the electrolysis of water with renewable energy. This would enable hydrogen to fuel gas turbine generators for electricity production, either off-grid at a mine site for example, or to support national grid balancing. Used either as a standalone fuel, or initially, as a blend with LNG until suitable gas turbine technology is developed, this would provide substantial short-term decarbonisation to LNG feedstocks. But perhaps the most promising avenue to the more widespread use of hydrogen is to transport and store it in a chemical carrier, for which purpose ammonia (NH3) is showing the greatest promise.

Each molecule of ammonia, as revealed in its chemical formula, is composed of one atom of nitrogen and three atoms of hydrogen. Containing no carbon, green ammonia is produced by reacting green hydrogen with nitrogen from the atmosphere, and can be used as a fuel in its own right, or alternatively, cracked back into its components, releasing hydrogen to be used alone as a fuel, or as a fuel enrichment in combination with ammonia (Capurso et al., 2022). The chemical properties of ammonia allow a much easier, and therefore cheaper, storage and transport process compared to hydrogen. Ammonia has a density and boiling point comparable to that of LPG, allowing its storage and transport as a liquid to be simply adapted from existing LPG practices (Chorowski et al., 2023). With narrower flammability limits and a lower flame speed than hydrogen, ammonia presents far less danger of explosion or fire (Capurso et al., 2022). As a hydrogen carrier, it can be transported in adapted LNG tankers to export markets such as Japan, where after unloading and distribution, it can be cracked back into hydrogen for end use in manufacture, or as a carbon-free fuel.

Although ammonia can be burned as a carbon-free fuel in suitably modified internal combustion engines, as well as combined cycle gas turbines (CCGT), it does have the disadvantage of producing more nitrogen oxides in the exhaust stream than other fuels. As greenhouse gases in their own right, these oxides require catalytic conversion infrastructure to remove them from exhaust gases which will conceivably limit the use of ammonia combustion to large scale or static applications such as shipping, or electricity generation.

Shipping is in particularly urgent need of decarbonisation. To provide perspective, Mallouppas et al., (2021, p. 1) stated that "if the shipping industry were a country, it would rank as the 6th highest emitter [of CO2], ahead of Germany and the UK". In response to this need, marine engine manufacturer Wärtsilä have recently announced the world's first commercially available ammonia fuelled four stroke engine for sustainable shipping (Wärtsilä.com).

Electricity generation is the other pressing need for decarbonisation in which ammonia is likely to play a role. Cesaro et al., (2021) have outlined a proposed three-phase development process in which, in Phase 1, green ammonia is cracked into hydrogen to power a gas turbine producing electricity. In Phase 2, turbines are powered by a mixture of hydrogen and ammonia, and in Phase 3, ammonia alone is used to power the turbines. This author suggests that a likely alternative to Phase 1 in this scenario is the use of a blend of LNG and Hydrogen, leading up to the use of ammonia as a sole fuel as turbine technology is refined. The aging infrastructure of Australia's coal-fired power stations mandates that there is an urgent need to develop green ammonia CCGT technology as a replacement. Phase 1 technology is already achievable. All that is required for this green technology to advance is for the government to legislate a clear path to allow the necessary commitment and investment to decarbonise the nation's electricity grids. Energy export, however, is another matter entirely.

7. A Green Energy Superpower?

As the Australian Energy Market Operator (AEMO) is discovering, it is becoming an increasingly difficult juggling act to balance the nation's electricity grids. Current coal fired power stations have limited capacity to adapt to rapidly varying demand with the result, as recently happened in Victoria when domestic solar PV input peaked during the daytime, there was little alternative but to switch off input from wind and solar farms. This has to be an enormous disincentive to private investment in large-scale renewable farms. In an urgent response to this, energy suppliers are building large-scale storage batteries to enable incoming solar to be diverted into storage rather than being switched off (Parkinson, Jul 25, 2024). This must be seen as a short-term measure, and in no way conducive to Australia's future as a potential energy exporter.

The second barrier to an energy export industry relates to the retail price of power in Australia. Average annual retail power prices above A$100 per megawatt hour in the Eastern States in 2023 (Ker, Mar 11, 2024) have provided a ready investment opportunity in wind and solar farms for private enterprise (Leitch, Aug 1, 2024). However, for any proposed green energy export industry to become viable would require renewable power to retail at around A$45 per megawatt hour for green hydrogen and ammonia production, making further private investment in renewables beyond national grid requirements unlikely at that price. For a future green energy export industry to succeed there must be a sufficient investment in renewable power generation for there to be a substantial surplus over that required to supply the grid, such that power prices to the proposed export industry fall to the required A$45 per megawatt hour.

If government, that same government that set the long-term retail price to the unprofitable and highly subsidised aluminium smelting industry at A$25 per megawatt hour in 1999 (Hamilton & Turton, 1999), is not prepared to bridge that gap, it will remain as an insurmountable barrier. A course of action that presents itself here is for government to redirect to the renewable energy industry the large subsidies currently paid to fossil fuel producers (Riedy & Diesendorf, 2003). This, combined with correcting the current shortcomings of the market by imposing a carbon tax on polluters, would provide government with ample funds to incentivise renewable energy initiatives such as are being proposed, if they are indeed committed to their *Future Made in Australia* policy.

Looming as a third potential barrier to any development of a future green energy export industry, is the Dutton-led LNP Federal Opposition's stated aversion to renewable energy, favouring instead a nuclear powered grid. To be successful, any commitment to developing a green energy export industry must be sustained over the extended and demanding development period, mandating a bipartisan approach from both government and alternative government. If this is not forthcoming, it must diminish the chance of success.

Despite this rather gloomy outlook, all hope of a green energy export industry need not be abandoned just yet. Given the Federal Government's acknowledgement in *'Future Made in Australia'* (2024), of China's global competitiveness and expertise in solar PV technology, along with the Australian Government's stated willingness to access these products through 'strong partnerships' with the Chinese, perhaps the Government could investigate the possibility of a joint partnership with Chinese companies to develop the proposed ammonia/hydrogen export industry. After all, the Chinese Government has expressed a willingness to diversify its interests, and it has a demonstrated way of getting things done. An Australian Government long-term partnership commitment with a suitable Chinese company, state-owned or otherwise, would be very likely to circumvent the barriers discussed above. Given that Chinese state-owned companies already have joint ventures with Rio Tinto in Western Australian iron ore, such a move is not unprecedented (Yeping, Sep 14, 2022).

8. Conclusion

In the *Future Made in Australia: National Interest Framework* (2024) document, the Australian Federal Government was careful to qualify its support for a rebirth of manufacturing in Australia. The discussion in this present paper on historical reasons for Australia's high wage structure and cost of living makes it plain that, except in very specific circumstances, manufacturing for export is not likely to be viable for this country. Despite this, the task of decarbonising our electricity grids by the introduction of renewable energy technology presents ample opportunity for the creation of many industrial jobs, both in homegrown research and development such as is occurring at Fortescue's Gladstone electrolyser plant, and in the installation, upgrading and maintenance of the necessary electricity generating and distribution infrastructure. With the incentives on offer from the Government, there is also every likelihood that Australia will be able to largely decarbonise its transport and aviation industries by establishing a domestic industry for the manufacture of low carbon liquid fuels, supplying further high quality industrial jobs.

Present indications are that the necessity of maintaining the critical balance of supply and demand in Australia's electricity grids have resulted in a pause in the introduction of large wind and solar farms. This is believed to be a temporary situation while battery storage capacity catches up with peak supply, and it is likely to be further alleviated if the promise of green ammonia CCGT generation is realised as our aging coal-fired facilities are phased out. It is arguable that the most substantial threat to the task of achieving these very significant measures to decarbonise Australia's economy is the Federal LNP Opposition's stated plan to halt the rollout of renewables in favour of nuclear power generation. This would appear to be a thinly disguised attempt to prolong the use of fossil fuels for as long as possible in this country.

Although the Federal Government, in its *Future Made in Australia* blueprint, is expressing hope for a future green hydrogen/ammonia energy export industry, the necessary supporting incentives for the protracted research and development phase before anticipated profitability, does not appear at present sufficient to sustain this initiative as a home-grown industry. However, to put this into an appropriate context, the highly successful iron ore mining industry of Western Australia, begun in the 1960s, required financial resources far exceeding those available in Australia at the time, necessitating international partnerships be sought by the 'big four' companies involved. Perhaps, in the decarbonised but still energy dependent world of tomorrow, Australia will again find willing partners to bring this sustainable export industry to fruition.

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