

# How quickly can Australia move to 100% renewable energy only?

For the Uniting Church Vic/Tas

Justice and International Mission Cluster

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## An ageing, inflexible and unreliable coal fleet

The majority of Australian electricity industry (generators, distribution and retailer companies and the market regulators) are working on the assumption that Australia will get to 100% (or close to) renewable energy sometime in the future.

This industry consensus now includes all Australian States and Territories Minister for Energy, regardless of their political persuasion. For the electricity industry, this inevitable transition to 100% renewable electricity grid is just a question of when and how smooth the transition be?

The views of the electricity industry are informed by the following analysis of the technologies and the market.

Australia has an ageing coal fleet, which is not flexible and not reliable. According to a 2017 Climate Council report 'Powering a 21<sup>st</sup> Century Economy: secure, clean affordable electricity'

“Within a decade, over two thirds of coal plants in Australia’s National Electricity Market will be 50 years or older, technically obsolete, unreliable and costly to maintain. Australia must prepare for a major energy transition, which is already underway.”<sup>1</sup>

Many of Australia’s coal powered stations can only be maintained for a few more years, because it is just too costly to keep maintaining and repairing old power stations that are not particularly efficient. The older coal power stations have proved to not be very reliable. Whilst 96.6% of power blackouts result from poles and wires failures, 3.2% is due to generator failure<sup>2</sup> which place real pressure on the electricity grid. For example during the February 2017 heatwave, 14% of the coal and gas generators failed – on average over 2017 summer one of the coal and gas power stations trip ever 3-4 days.<sup>3</sup>



Figure 1- Hazelwood Power station - closed 2017 Photo John Donegan, The Age

“Fossil-fuelled power plant failures at times of peak demand on hot days not only lead to high prices, but also blackouts and load shedding which hurt people and industry.”<sup>4</sup>

Regardless of the politics, economics will dictate more closures of these old coal power stations in the coming years. An orderly closure would be advantageous to all – the industry, large and domestic users included.

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<sup>1</sup> <https://www.climatecouncil.org.au/resources/powering-a-21st-century/> Key Findings 1, p. ii

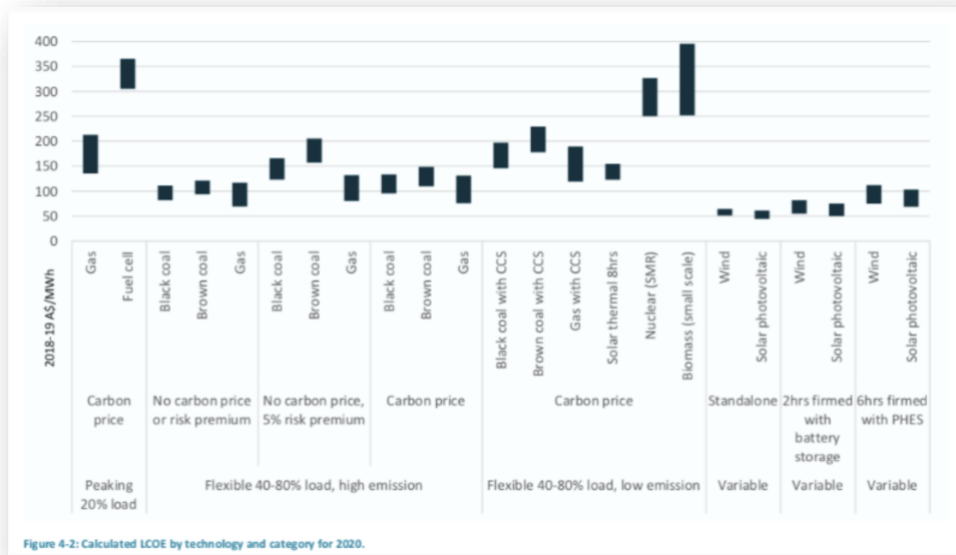
<sup>2</sup> <https://www.theguardian.com/commentisfree/2019/jan/31/what-happened-to-our-electricity-system-in-the-heat-coal-and-gas-plants-failed>

<sup>3</sup> <https://www.tai.org.au/content/why-can%E2%80%99t-gas-and-coal-hack-it-heat>

<sup>4</sup> <https://www.climatecouncil.org.au/resources/powering-a-21st-century/> p.17

# Renewable energy is the cheapest form of new generation

In comparing the 'levelized cost of electricity (LCOE)'<sup>5</sup> for differing generating technologies, it is clear that renewables are cheaper than the fossil fuel alternatives. The following table from Australian Electricity Market Operator (AEMO) and CSIRO from their Generation Cost report<sup>6</sup>, published in Dec 2018 highlights the differing levelized cost of electricity (LCOE) costs ranges and median prices, with or without a carbon price.



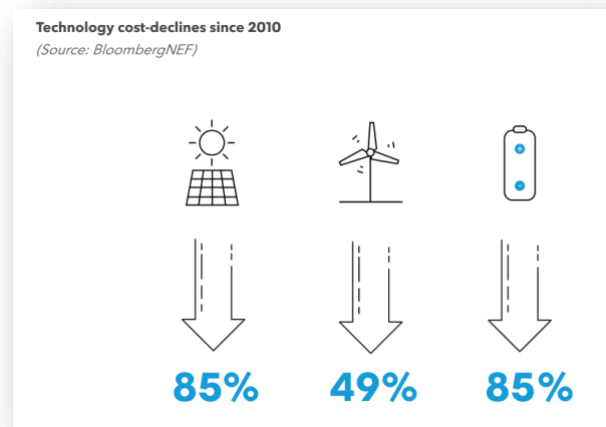
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The Australian Government's own data from AEMO (independent grid operator established by COAG) and CSIRO indicates that renewable energy is the cheapest form of new build electricity even with 2 hrs of battery firming or 6 hrs (pumped hydro energy storage) firmed supply.

Over the last 10 years, two generation market trends have been made very clear. Fossil fuel generation is becoming more expensive for a few reasons including: fuels costs generally have been increasing, low rates of technology improvement and the financial market is incorporating a 'carbon price' in order to avoid the significant risk of funding a 'stranded asset'.

The opposite market trends are also becoming very transparent. Renewable energy is becoming cheaper because of very significant technology improvements (sometimes called the Learning curve) in solar (cost reduction of 85% since 2010), in wind (45% cost reductions since) and in batteries (cost reductions 85%)<sup>8</sup>.

The electricity and finance market is working on the assumption that renewables will continue this



<sup>5</sup> To compare production costs, the electricity industry calculates the full cost of production in current dollars per unit (\$/MegaWatt-hour or \$/MWh) over the lifetime of the facility, including fuel and operational costs and capital and financing costs, which is known as the levelized cost of electricity. Analysts also use a LCOE which factors in an anticipated 'price on carbon'.

<sup>6</sup> Graham, P, Hayward, J, Foster, J, Story, O & Havas, L 2018, GenCost 2018: Updated projections of electricity generation technology costs, <https://publications.csiro.au/rpr/download?pid=csiro:EP189502&dsid=DS1>

<sup>7</sup> <https://arena.gov.au/blog/aemo-and-csiro-report-finds-renewables-cheapest/>

<sup>8</sup> <https://about.bnef.com/new-energy-outlook/> downloaded - 24 Feb 2020

learning curve trend to lower LCOE and that at best fossil fuels will at best maintain LCOE or worst have higher costs.

A recent report by Professor Andrew Blakers and Matthew Stocks, from the research School of Electrical, Energy and Materials Engineering at Australian National University, indicated that based on current trends in solar PV module efficiency and cost, PV electricity will be able to be produced in Australia at \$30/MWh by 2030.

“This is below the operational costs of most coal and gas fired power stations in Australia. Continued installs of rooftop and utility scale solar will likely lead to a wave of retirements of existing coal fired power stations during the 2020s. This price is also competitive with industrial gas heating.”<sup>9</sup>.

For a moment the focus will shift slightly from the economics of renewable energy to the carbon implications of renewable energy, which in turn then informs the discussion about subsidies of renewable energy and fossil fuels.

## Carbon intensity of renewable energy is very low

A major driver for the transition from fossil fuels to renewable energy is to reduce carbon emissions. Australia has one of the higher carbon intensity electricity systems in the OECD.

It is to be noted that there is a difference between electricity carbon emission intensity and energy returned on investment (EROI). Carbon emissions intensity reflects the amount of carbon produced (tonnes of carbon dioxide CO<sub>2</sub>) to generate a unit of electricity (MWh). Energy returned on investment, reflects the amount of energy generated by a production unit e.g. wind turbine or solar PV panel, compared with the amount of energy required to make that production unit. An EROI is therefore a ratio, with ratios higher than 1 being positive.

In 2011, the average emissions intensity of Australian electricity was 0.823 tonnes CO<sub>2</sub> per MWh, which didn't compare favourably with USA (0.503 tonnes CO<sub>2</sub> per MWh), OECD average (0.434 tonnes CO<sub>2</sub> per MWh) or UK (0.441 tonnes CO<sub>2</sub> per MWh). In 2011, Australia's electricity emissions were nearly 90% higher than average OECD countries.<sup>10</sup>

A major reason for Australian electricity emission intensity is the high percentage of fossil fuel generation in the electricity mix. In Australia, the 2012 respective emissions intensity were

- black coal produces 0.85 to 1.1 tonnes of CO<sub>2</sub> per MWh;
- brown coal produces 1.2 to 1.5 tonnes of CO<sub>2</sub> per MWh;
- gas turbine plants fuelled by natural gas produce less at 0.4 to 0.7 tonnes of CO<sub>2</sub> per MWh (more for open cycle plants, less for combined cycle) which exclude fugitive emissions<sup>11</sup>.

Solar PV and wind produce no emissions during electricity generation and generally considered zero. If however a lifecycle approach is taken, incorporating the embedded emissions in the manufacturing of the equipment, a 2012 analysis show

- solar PV produces between 0.04 - 0.05 tonnes CO<sub>2</sub> per MWh; and
- wind produce 0.03 tonnes CO<sub>2</sub> per MWh<sup>12</sup>.

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<sup>9</sup> <https://reneweconomy.com.au/technology-leaps-driving-cost-of-solar-pv-electricity-in-australia-to-just-a30-mwh-42052/>

<sup>10</sup> [https://www.climatecouncil.org.au/resources/australia-s-electricity-sector-ageing-inefficient-and-unprepared/?atb=DSA01b&gclid=CjwKCAjwyo36BRAXEiwA24CwGRqm4pyL2dkehxTeCs6V-XuXJmrb0ZHxK-lwT0zLXdLbcyLqJEPRRoCpYMQAvD\\_BwE](https://www.climatecouncil.org.au/resources/australia-s-electricity-sector-ageing-inefficient-and-unprepared/?atb=DSA01b&gclid=CjwKCAjwyo36BRAXEiwA24CwGRqm4pyL2dkehxTeCs6V-XuXJmrb0ZHxK-lwT0zLXdLbcyLqJEPRRoCpYMQAvD_BwE) Table 2, p.8

<sup>11</sup> same report p.14

<sup>12</sup> [https://en.wikipedia.org/wiki/Life-cycle\\_greenhouse\\_gas\\_emissions\\_of\\_energy\\_sources](https://en.wikipedia.org/wiki/Life-cycle_greenhouse_gas_emissions_of_energy_sources)

## Energy return on investment (EROI)

One of the mythical criticisms of renewable energy is that more energy is required to produce a wind turbine or solar PV panel than they produce over their useful lifetime.<sup>13</sup> Most of these inaccurate claims are based on 30 year old data which are no longer relevant to the industry.

The electricity industry has generally agreed that the energy returned on energy invested (EROI) for renewable energy is very large. According to Associate Professor Mark Diesendorf, Environment & Governance Group UNSW recent evaluations show that renewable EROI's are increasing as the industry becomes more efficient explains that

- 'a large wind turbine generates the energy required to build itself in 3-6 months, while its lifetime is 25-30 years.
- solar PV panel generates the energy required to build itself in 1-2 years, while its lifetime is 20-25 years.'<sup>14</sup>

## Subsidies for renewable energy and fossil fuel sector

There has been much discussion about the cost and value of subsidies to the renewable energy sector and the fossil fuel sectors. Discussion can be complex and confusing.

The ABC Fact Checker reviewed the claim that a 2019 International Monetary Fund (IMF) working paper found fossil fuels in Australia received US\$29 billion in subsidies in 2015. As the article points out different groups use the word subsidise with different meanings.

'The \$US29 billion figure contained in this report reflects the gap between what consumers currently pay for fossil fuels and what they would theoretically pay if prices reflected three things: the full cost of supply; consumer taxes; and the cost of any "adverse effects on society".

Consequently, the IMF counts "negative externalities" in its definition. These are costs imposed on society and the environment that are typically not borne privately by fossil fuel producers, including traffic congestion, road accidents, localised air pollution and greenhouse gas emissions.'<sup>15</sup>

In the same Fact Check review Senator Matt Canavan is quoted as claiming the fossil fuel industry does not receive any subsidy in Australia. Climate advocacy group Market Forces claims that Australia has

'National tax-based subsidies that encourage fossil fuel production and consumption add up to a whopping \$12 billion every year.'<sup>16</sup>

The renewable energy has also been subsidised/incentivised through the Renewable Energy Target. Australia Institute chief Economist, Richard Denniss however argues the RET should be called

'a pollution control measure. When politicians insist that cars have mufflers to reduce noise pollution, and air bags to reduce deaths, no one calls such measures a "subsidy" to the muffler industry or the air bag industry.'<sup>17</sup>

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<sup>13</sup> This false claim was recently made in the Jeff Gibbs/Michael Moore film 2020 'Planet of the Humans'

<sup>14</sup> <https://reneweconomy.com.au/debunking-michael-moores-myth-about-life-cycle-energy-needs-of-wind-and-solar-97798/>

<sup>15</sup> <https://www.abc.net.au/news/2020-07-29/fact-check-matt-canavan-fossil-fuel-industry-subsidies/12496310>

<sup>16</sup> <https://www.marketforces.org.au/campaigns/ffs/tax-based-subsidies/#:~:text=National%20tax%2Dbased%20subsidies%20that,filthy%20rich%20fossil%20fuel%20business.>

<sup>17</sup> <https://www.theguardian.com/commentisfree/2019/mar/20/heres-why-australia-needs-to-keep-subsidising-renewables#:~:text=The%20first%20is%20that%20we,in%20a%20race%20against%20physics.&text=make%20emission%20fall,-Subsidies%20that%20encourage%20people%20to%20install%20solar%20and%20batteries%20on,power%20stations%20out%20of%20business.>

For many the issue revolves around the fact that the fossil fuel industry in Australia does not pay the externality costs of carbon pollution or air pollution (particulates and noxious gases). Subsidies should be provided to the newer and emerging renewable energy sector to solve the climate dilemma,

A final comment by Richard Denniss reflects that renewable energy is operating in a different market to when the fossil fuel incumbents were established by the public sector and subsidised by the taxpayer.



‘nearly all of the coal-fired power stations, and the transmission grids that they rely on, were built and subsidised by taxpayers. It wasn’t “market forces” that built the enormous network of coal-fired power stations and the electricity grids that provide nearly all Australians with electricity, it was the public sector. And the decision to string hundreds of kilometres of wires to link small towns to the national grid wasn’t based on economics, but equity. To suggest that all new investments in the electricity industry have to meet a criteria that the existing investments never did, provides an incredible advantage to the (recently privatised) electricity incumbents.’<sup>18</sup>

## Financial markets moving away from thermal coal

Financial markets around the world and in Australia (institutional investors, superannuation funds and insurance industries) are very concerned about the future viability of coal power. Investors in coal power would typically expect to recover the large capital costs over a 40 year lifespan of the plant.

Given that the majority of countries committed to the UN Paris Agreements, effectively commits countries to becoming zero net emissions by 2050, investors are nervous that they will not be able to recover costs in the remaining time and consequently left with ‘stranded assets’. As a result of Paris Agreements, communities around the world and in Australia are gradually removing the coal power’s ‘social licence’ to operate.

Recent announcements by leading financial investors to withdraw from the ‘thermal coal’ markets, confirms this analysis. Some of the major announcements were:

- BlackRock, the world's largest fund manager recently pledged to reduce its exposure to thermal coal. Blackrock CEO and chairman Larry Fink says climate change will lead to a "fundamental reshaping of finance" by pledging to reduce exposure to thermal coal in its \$US1.8 trillion of actively-managed assets<sup>19</sup>.
- Norway’s Government Pension Fund Global, the world largest superannuation fund (nearly 1.5 per cent of the world’s stocks and shares worth around \$1.6 trillion), announced in Dec. 2019 that it would exclude investment from companies that earned more than 30% or more of income from thermal coal or base 30% or more of their operation on thermal coal, produce more than 20m tones of thermal coal and produce more than 10,000Mw from thermal coal. In light of the above decision, the Pension Fund has recently divested from Australian generator/retailer AGL and put Australian mining company BHP on it ‘observation list’<sup>20</sup>.
- New York’s \$189bn pension fund will divested from fossil fuel companies within five years from Jan 2018.<sup>21</sup>

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<sup>18</sup> Same article

<sup>19</sup> <https://www.abc.net.au/news/2020-01-15/worlds-largest-fund-manager-to-cut-thermal-coal-exposure/11869300>

<sup>20</sup> <https://www.theguardian.com/australia-news/2020/may/14/norways-giant-oil-fund-ditches-stake-in-australias-agl-over-fossil-fuel-concerns>

<sup>21</sup> <https://www.theguardian.com/us-news/2018/jan/10/new-york-city-plans-to-divest-5bn-from-fossil-fuels-and-sue-oil-companies>

- Allianz, Europe's largest insurer will no longer insure coal power plants and coal mines, not invest in companies building more the 500MW of new coal and will phase all coal investments by 2040<sup>22</sup>.
- According to Australian energy finance analyst Tim Buckley '133 globally significant financial institutions have announced their exit from coal, 10 in the past two weeks (May 2020)<sup>23</sup>;
- BHP the world's largest mining company has committed to exit thermal coal within 2 years; and
- Suncorp a major Australian insurer will end any financing or insuring of the oil and gas industry by 2025, adding to the group's existing ban on support for new thermal coal projects<sup>24</sup>.

The market has spoken and is speaking<sup>25</sup>. Not only are corporations becoming concerned about having 'stranded assets' they are becoming increasingly concerned and sensitive to investors' concerns.

## Additional benefits from renewable energy

In addition to the economic and climate change benefits, there are a number of other benefits in transitioning from fossil fuels to renewable energy.

### Potable water savings

Coal power uses a considerable amount of potable (drinking) water to produce to electricity. In a 2020 research report on NSW and QLD coal power production, the contrast in water consumption of coal power and renewable energy is considerable:

'Solar and wind power, for example, use approximately 10 litres of water per megawatt hour (L/MWh) compared to 1,254 L/MWh for average energy generation from black coal. This means that coal uses approximately 120 times the water to generate the same amount of electricity as solar or wind. If you include the water required for the coal fuel source for the coal-fired power stations that adds another approximately 306 L/MWh.'<sup>26</sup>

The availability and reliability of our water supplies are an issue in our changing climate. Shifting to renewable energy will save a significant amount of potable water and help to secure potable water supplies in the future.

### Improved community health and reduction in lives lost due to air pollution

The burning of coal is responsible for considerable 'air pollution' including sulphur dioxide, nitrous oxide, volatile organic compounds, ammonia and fine particle matter (PM2.5 and PM10). PM2.5 (particles smaller than 2.5 microns) are usually inhalable and exposure to them can lead to heart disease, stroke, asthma, bronchitis, lung cancer and chronic obstructive pulmonary disease and related death. Power generation is responsible for 28% of the total national PM2.5 emissions. Coal mining is responsible for a further 26%.<sup>27</sup>

<sup>22</sup> <https://www.insurancebusinessmag.com/au/news/breaking-news/allianz-succumbs-to-pressure-reveals-it-will-stop-insuring-coal-firms-99779.aspx>

<sup>23</sup> <https://www.smh.com.au/environment/climate-change/while-the-world-looked-the-other-way-corporate-giants-abandoned-coal-20200514-p54ssj.html>

<sup>24</sup> <https://ieefa.org/australias-suncorp-to-stop-financing-insuring-oil-and-gas-industry-by-2025/>

<sup>25</sup> <https://www.abc.net.au/triplej/programs/hack/world-global-coal-power-capacity-has-fell-in-2020/12523904#:~:text=World%20is%20now%20shutting%20down%20coal%20plants%20faster%20than%20it's%20opening%20them,-By%20James%20Purtill&text=Coal%20power%20capacity%20fell%20by,which%20monitors%20fossil%20fuel%20developments.>

<sup>26</sup> Overton IC (2020) Water for coal: Coal mining and coal-fired power generation impacts on water availability and quality in New South Wales and Queensland. Report prepared by Natural Economy for the Australian Conservation Foundation. p4.

<sup>27</sup> National Pollutant Inventory emission data (2015), 2013- 14, Department of the Environment.

According to a UNSW 'Climate Change, Air Pollution and Health in Australia' report

'air pollution from burning fossil fuels and from industrial processes causes about 3,000 premature deaths a year. That's eight premature deaths a day, a figure almost three times the national road toll'<sup>28</sup>.

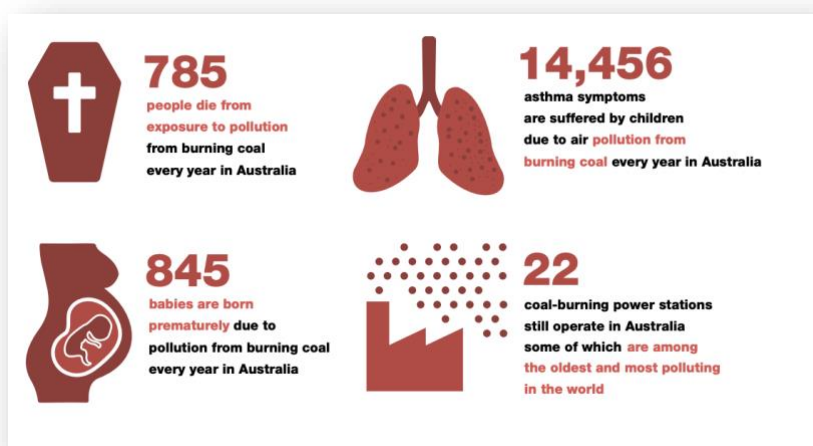
The report further adds

'Air pollution is already a significant health problem in Australia, and on current trends will worsen in the future. The estimated financial cost of premature deaths due to air pollution ranges from roughly \$11 billion to \$24 billion per year'<sup>29</sup>.

A 2016 study of changes to four coal power plants in Louisville, Kentucky US revealed significant decrease in the severity of asthma. Between 2013-2016 the four coal power plants were either closed, retrofitted to gas or installed sulphur dioxide emission controls resulting in: 17% less rescue inhaler use, 32% reduction in high rescue inhaler use and 400 avoided hospitalisations and hospital emergency visits.<sup>30</sup>

The August 2020 report 'Lethal Power: How coal is killing people in Australia' by Dr Aidan Farrow, air quality modelling specialist and Lauri Myllvirta, coal and air pollution expert, for Greenpeace Australia documents the health implications (deaths, premature birth, respiratory disease summarised in the graphic) of continued coal power production in Australia.

Esteemed epidemiologist Professor Fiona Stanley said



"The death and illness outlined in this report were not caused by some Chernobyl like mishap. Death and disease are the tragic by-products of coal-fired power generation, by design. But we no longer need to sacrifice lives to coal power when we can generate all the electricity we need from clean and renewable sources like wind and solar."<sup>31</sup>

In addition it has been noted that air pollution exacerbates issues with SARS-CoV-2 / COVID-19.

'Previous research has revealed evidence that exposure to air pollution increases both the risk of infection with the SARS-CoV-2 virus, as well as the severity and mortality of the associated COVID-19 disease. This means that exposure to air pollution can exacerbate the health effects of the coronavirus pandemic. Therefore, addressing air pollution from Australia's poorly regulated coal-burning power stations would not only reduce the health impacts studied in this report but also lower the risk posed by COVID-19.'<sup>32</sup>

Reducing the mining, burning of coal and other fossil fuels will significantly improve air quality and lead to improved community health outcomes for all Australians, especially those who live and work in proximity to coal power stations and mines.

<sup>28</sup> Climate Change, Air Pollution and Health in Australia, 2017. A. Dean, D. Green. UNSW Sydney, Grand Challenges, Sydney Australia. p2.

<sup>29</sup> Same p3.

<sup>30</sup> Casey, J.A., Su, J.G., Henneman, L.R.F. *et al.* Coal-fired power plant closures and retrofits reduce asthma morbidity in the local population. *Nat Energy* (2020). <https://doi.org/10.1038/s41560-020>

<sup>31</sup> <https://www.greenpeace.org.au/news/air-pollution-from-burning-coal-kills-800-people-in-australia-each-year-and-makes-thousands-more-ill/>

<sup>32</sup> <https://www.greenpeace.org.au/wp/wp-content/uploads/2020/08/GPAP-Lethal-Power-Report-Summary.pdf> p.4

## Technological advantages of renewable energy

Renewable energy technologies are in many respects superior to the fossil fuel. Coal power plants are very large and expensive pieces of infrastructure to build and maintain. Australia's electricity distribution network has been built around these large generators and consequently is quite linear. The network is quite vulnerable therefore to failure of the transmission line. Solar and wind tend to be smaller in scale (output of MWh) and positioned in more diverse locations. This is more likely to lead to a distributive network, which can be less vulnerable to singular failure of a transmission line or generator.

### Flexible technology

Grid stabilisation services are an important aspect of electricity grid management, which include voltage and power stabilisation and inertia services. Grid stabilisation services have traditionally been provided by 'the large spinning forces' of coal power turbines or fast response gas-peaking plants. The Hornsdale Power Reserve (commonly known as the South Australian Tesla Big Battery) has been providing voltage and power stabilisation services in superior quality than the coal and gas alternatives. The Tesla battery has been able to react to grid stability issues and provide ancillary voltage and power in 'milli-seconds', something which gas-peaking plants are not able to do in the same time frame, and thus making the grid more stable.

### Flexible solar and battery technology for bushfire relief

An example of the flexibility of renewable energy as a technology is how the Resilient Energy Collective<sup>33</sup> was able to provide stand-alone solar and battery storage systems for bushfire affected communities this last Australian summer. The horrendous bush fires and storms had cut off many properties and small towns from the electricity. It would likely be months before grid electricity was reconnected to these communities and they would have been dependent on noisy, polluting and expensive diesel generators.



The Resilience Collective can install in 1 day up to 200kW or 5days 1,000kW solar PV and battery system which provides electricity 24/7 for a home, a dairy, a community centre as required. Bush fire affected locals have been amazed how quickly the technology can be installed providing day and night operation. The solar and battery systems are relocatable.

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<sup>33</sup> <https://www.resilientenergy.com.au/> - a partnership with Australian entrepreneur Michael Cannon-Brookes, solar company 5B and battery company Tesla with a goal of installing 100 systems in 100 days

## Higher levels of employment in renewable energy sector

The fossil fuel industry is a significant employer in the Australian economy. However renewable sector is also a significant employer, coming off a smaller base.

“About 24,000 people work in thermal coal mining for both domestic use and export – slightly fewer than the current renewable energy workforce.”<sup>34</sup>

According to the Australian Bureau of Statistics Employment in renewable energy sector in 2018-19 increased by 27% to just under 27,000 full-time equivalent jobs.<sup>35</sup> Researchers have concluded that with the right Australian policy settings, in line with the UN Paris agreement

‘This would create a jobs boom: renewable energy employment would grow to 45,000 by 2025 and average around 35,000 jobs each year to 2035. Up to two-thirds are in regional areas.’<sup>36</sup>

If employment is a consideration in the selection of power technologies, then renewables particularly wind and solar are a significantly better choices.

## A safe and secure transition from coal and gas.

The transition to renewables can be done in a way that ensures that employees of the fossil fuel industries do not bear the brunt of the cost of the transition, which is of course an important social justice question.

A great example of transition comes from northern Germany, where 180 coal mines employing 607,000 miners were closed between 1950 and 2018. Business, unions and government worked together to re-train employees, establish new universities and businesses and rehabilitate waterways and mines.<sup>37</sup>

If Australia is able to learn from German experience, all fossil fuel industry employees will not need to fear job losses be welcomed to join in the zero carbon future. There is an important opportunity for the Church to start initiating some of difficult conversations and provide leadership in this transition time. The Church could play a significant role with industry, unions<sup>38</sup> and the community to ensure a there is a safe, fair and healthy transition to a zero carbon economy.

## Summary of technology differences and advantages

Many commentators have noted, Australia, like the rest of the world is in the middle of a major energy transformation, on the same scale as the industrial (steam/coal) revolution. The commentators/analysts say that it is an inevitable transition from fossil fuels to clean energy. Some have used the terminology as a transition from ‘analog’ to ‘digital’ technology. A summary of the characteristics of the old and new energy follow.<sup>39</sup>

### Analog, fire-based technology

- Inefficient
- Polluting
- Centralised
- Expensive
- High-maintenance
- Long supply chain
- Dependence



### Digital, electrical technology

- Efficient
- Clean
- Distributed / Modular
- Cost-effective
- Low running cost
- Scalable
- Self-reliant

<sup>34</sup> <https://theconversation.com/45-000-renewables-jobs-are-australias-for-the-taking-but-how-many-will-go-to-coal-workers-141531>

<sup>35</sup> <https://reneweconomy.com.au/australian-renewable-energy-jobs-surged-to-new-record-levels-in-2018-19-62483/#:~:text=In%20the%20latest%20annual%20update,record%20for%20the%20Australian%20industry.>

<sup>36</sup> <https://theconversation.com/45-000-renewables-jobs-are-australias-for-the-taking-but-how-many-will-go-to-coal-workers-141531>

<sup>37</sup> <https://theconversation.com/how-to-transition-from-coal-4-lessons-for-australia-from-around-the-world-115558>  
<https://www.smh.com.au/environment/climate-change/how-germany-closed-its-coal-industry-without-sacking-a-single-miner-20190711-p526ez.html>

<sup>38</sup> Climate Justice Alliance, 2018, Just Transition: A framework for change, <https://climatejusticealliance.org/just-transition/>

<sup>39</sup> Taken from Eytan Lenko, Chair and Acting CEO, Beyond Zero Emissions presentation on forthcoming ‘A million Jobs Plan’, 6 May 2021 [https://bze.org.au/wp-content/uploads/BZE\\_Million\\_Jobs\\_Plan\\_May\\_2020.pdf](https://bze.org.au/wp-content/uploads/BZE_Million_Jobs_Plan_May_2020.pdf)

Based on the advantages of the new energy system, of which many have been briefly highlighted, the Australian electricity market considers the transition to renewable energy inevitable, cost effective and advantageous.

It is to be noted that the 'only market players' resisting this inevitable transition are those with direct and significant financial interests in the continued use of fossil fuels: the coal mining and gas industries and the fossil fuel powered station owners.

It is interesting to note that within Australian business community there is now have a very broad coalition of industry groups calling on the Australian Government to commit to net-zero carbon emissions by 2050 which includes: the National Farmers Federation – the peak farm industry body, the Australian Industry Group and many of the major financial institution including banks, insurers and superannuation funds. Making a commitment to net-zero emission, necessitates 100% renewable energy, much earlier than 2050.

NSW Minister for Energy and the Environment (Liberal), Matt Kean sums up the market situation well;

“The community has moved on, the market has moved on, the capital has moved on. The only people standing in the way are those defending vested interests, the beneficiaries of the fossil fuel industry. Those MPs are defending Blockbuster in a Netflix world.”<sup>40</sup>

Kean also points out, as others have there is an economic trading aspect to the energy question. “Take climate change out. There are global megatrends moving. If you are still producing goods high in carbon intensity, you won't be able to export.”<sup>41</sup>

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<sup>40</sup> <https://www.smh.com.au/environment/climate-change/draining-the-nation-s-energy-how-canberra-lags-industry-on-green-power-20200821-p55o6e.html>

<sup>41</sup> Same article

# Can the Australian electricity grid operate on or near 100% renewable energy?

A number of studies have been undertaken over the years of the Australian electricity network with regard to the capacity of the network to run on renewable energy. The Australian National Electricity Market (NEM), is the network of electricity markets the across South Australia, Tasmania, Victoria, New South Wales and Queensland. The NEM does not include the NT and WA electricity networks which operate independently. The NEM is operated by the Australian Energy Market Operator (AEMO).

## Industry experts and modelling

Numerous studies have consistently found there are no technical barriers to Australia achieving secure power from a very high to 100% proportion of renewable electricity. The more significant studies over the last 10 years are listed in **Appendix 1 – 100% renewable energy studies of the Australian electricity network**.

Two of the earliest studies regarding the potential of a 100% renewable energy grid in Australia were the:

- 2010 Beyond Zero Emissions study called 'Zero Carbon Australia 2020' – a 10 year plan to phase out fossil fuels, with modelling being completed by Melbourne Energy Institute, University of Melbourne. The was the earliest study of 100% renewable energy completed by a non-government organisation Beyond Zero Emissions.
- 2012 Commonwealth Scientific and Industrial Research Organisation (CSIRO) modelling of 4 scenarios, one of which was 100% renewables by 2050 and only nominally more expensive (\$940m) than the baseline scenario (\$850m).

Since these early studies, the more recent studies have modelled scenarios based on both improved outputs of wind and solar PV and reduced capital costs for wind and solar PV.

## Centre for Energy and Environmental Markets, UNSW – 2016

The '100% renewables in Australia: A research summary' review by UNSW published in 2016, concluded:

"The available research, by UNSW and others (including the Australian Energy Market Operator) now shows that 100% renewable electricity portfolios are likely to be feasible for Australia. The technical challenges can be managed, and the costs are likely to be competitive with other kinds of portfolios that may be operating in 2030.

A 100% renewable power system will be very different to the one we operate at present in Australia, and the transition will be significant. However, no convincing reason why 100% renewables is not feasible for Australia has been identified."<sup>42</sup>

## Alternative Technology Association (Renew) – 2016

The Alternative Technology Association reviewed existing studies and technologies in the '100% Renewable Grid – Feasible?' report. Their conclusion was:

'A reliable, 100% renewable electricity grid is entirely possible, using a mix of technologies beyond current wind and solar farm designs. A coordinated, far-sighted approach is required, which will be challenging to sustain under the current energy market design and regulatory regime.

Several studies have indicated that the cost of this transition is likely to be moderate, compared to the inevitable "business as usual" costs such as replacing ageing coal-fired power stations. Once complete, the transition will put downward pressure on bills and help make them more stable."<sup>43</sup>

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<sup>42</sup> Centre for Energy and Environmental Markets, UNSW, '100% renewables in Australia: A research summary', March 2016, p.38

<sup>43</sup> [https://renew.org.au/wp-content/uploads/2019/01/One\\_Hundred\\_Percent\\_Renewable\\_Grid.pdf](https://renew.org.au/wp-content/uploads/2019/01/One_Hundred_Percent_Renewable_Grid.pdf) p.21

## Institute for Sustainable Futures, UTS - 2016

The March 2016, '100% Renewable Energy for Australia' report, prepared by the Institute for Sustainable Futures, University of Technology Sydney modelled the feasibility of three scenarios for the Australian electricity grid<sup>44</sup> (for GetUp! and Solar Citizens). The 'Renewables' scenario could see electricity production from renewable sources of 33% by 2020, 68% by 2030 and 90% by 2035. This renewables scenario modelling showed by 2050, 97% of the electricity produced in Australia could come from renewable energy sources, with the remaining 3% from gas, with installed generation capacity of renewables reaching about 151 GW in 2035 and 260 GW in 2050.

The report noted that wind and solar PV technologies are now mature and enjoyed significant price reductions, making renewables an economically attractive alternative to coal power. The conclusion of the report was

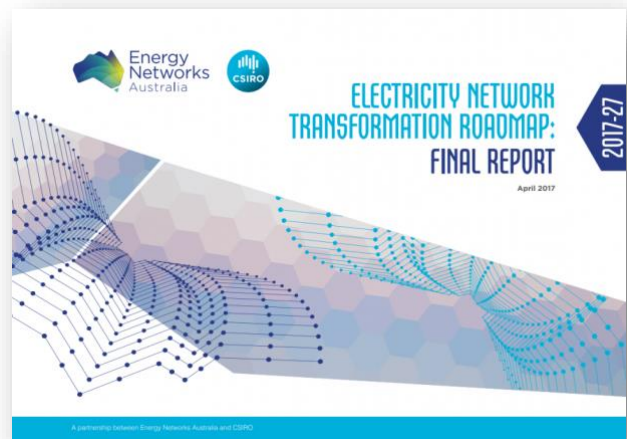
'The transition towards 100% renewable energy supply is technically and economically viable for Australia. The abundant local renewable energy potentials of solar, wind, geothermal and sustainable bioenergy production exceed the current and future energy demand by an order of magnitude.'<sup>45</sup>.

## CSIRO and Energy Networks Association – 2017

CSIRO and the Energy Networks Association market modelling, reported in the 2017 'Electricity Network Transformation Roadmap'<sup>46</sup> with the:

- electricity sector carbon abatement to reaching 40% by 2030 – greater than current national target of 26-28% and
- electricity sector achieving Zero Net Emissions by 2050 – effectively 100% renewable.

It is interesting to note, that the CSIRO modelling is based 'on a future where up to 45% of all electricity is generated by customers in 2050', so a highly decentralised generating network. In addition to storage by battery or pumped hydro, demand management can assist the transition and high levels of intermittent power generation.<sup>47</sup>



## Australian National University (ANU) – 2019

The ANU study completed an 'hourly energy balance' analysis to review a 100% renewable energy scenario. In this scenario wind and solar supplies around 90% of the electricity demand over a year and hydro-electricity and biomass supplies the balance of electricity demand. The modelling analysis was based on wind and solar technology being used at the time and did not model any 'future technological advances'.

'Additional energy storage and stronger interconnection between regions was found to be necessary for stability. Pumped hydro-energy storage (PHES) constitutes 97% of worldwide electricity storage,

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<sup>44</sup> Teske, S., Dominish, E., Ison, N. and Maras, K. (2016) 100% Renewable Energy for Australia – Decarbonising Australia's Energy Sector within one Generation. Report prepared by ISF for GetUp! and Solar Citizens, March 2016.

<sup>45</sup> Teske, S., Dominish, E., Ison, N. and Maras, K. (2016) 100% Renewable Energy for Australia – Decarbonising Australia's Energy Sector within one Generation. p.34

<sup>46</sup> CSIRO & Energy Networks Australia, 2017, Electricity network transformation roadmap: Final report, 7. <https://www.energynetworks.com.au/projects/electricity-network-transformation-roadmap/>

<sup>47</sup> Energy Networks Australia, 2018, Demand management is the new black, <https://www.energynetworks.com.au/news/energy-insider/demand-management-is-the-new-black/>

and is adopted in this work. ... The additional cost of balancing renewable energy supply with demand on an hourly rather than annual basis is found to be modest AU\$25.30/MWh.<sup>48</sup>

## RepuTex - 2020

Wholesale electricity modelling completed by industry analyst RepuTex<sup>49</sup> in April, 2020 of the Australian grid, based on the current transition indicates that:

- by 2030 will reach 50% renewable energy generation renewables, 'despite the absence of a federal policy framework beyond the Underwriting New Generation Investment scheme.'
- by 2040 will reach in excess of 75% renewable energy generation.

In addition, RepuTex has modelled 'Under the Alternative - Step Change' case, characterised by more aggressive action on climate change, the grid would see renewable energy generation growing to 90% by 2040, without a price rise.

'Replacing Australia's aging thermal power stations with new flexible capacity is therefore able to maintain lower wholesale prices.'<sup>50</sup>

## Network Operator AEMO - 2020

In April 2020, AEMO in the Renewable Integration Study: Stage 1 reported that the NEM could be securely operated with very high penetrations of renewable energy<sup>51</sup>. AEMO updated the June 2019 study by indicating that

'Australia already has the technical capacity to safely run a power grid in which 75% of the electricity comes from wind and solar and, if it gets regulations right, should occasionally reach this level within five years'<sup>52</sup>.

In addition, AEMO indicated that

'Beyond 2025, AEMO has not identified any insurmountable reasons why the NEM cannot operate securely at even higher levels of instantaneous wind and solar penetration, especially with ongoing technological advancement worldwide'<sup>53</sup>.

AEMO has acknowledged that transmission constraints have resulted in some 'curtailment' or choking of output from some renewable generators. AEMO has reported that with both the funding of transmission works and appropriate regulation changes to support a more 'distributed' electricity network, the NEM can support a very high percentage of renewable electricity.

Through the Integrated System Plan, AEMO is mapping out a path of how the electricity grid can safely managed with a 90+% share of renewables generation by 2040.

## ClimateWorks – 2020

The ClimateWorks 'Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia' report states that Australia's electricity market must be 100% renewable energy by 2035 to enable Australia any chance to achieve net zero emissions by 2050.

ClimateWorks uses a four pillar approach to show how the Australian economy can be decarbonised - as illustrated below. 100% renewable energy is one of four decarbonisation pillars.

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<sup>48</sup> Blakers, A, Lu, B & Stocks, M, '100% renewable electricity in Australia', *Energy* Vol. 133 (2017), pp. 471-482

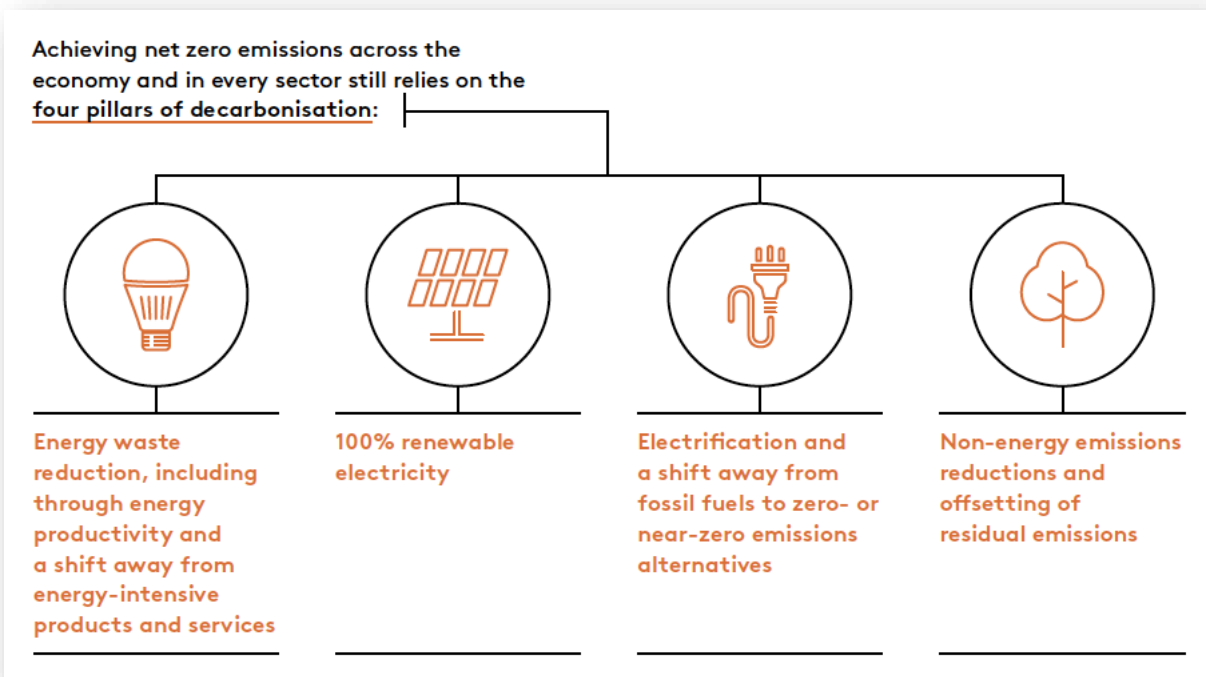
<sup>49</sup> <https://www.reputex.com/research-insights/wholesale-electricity-prices-to-2040-under-a-1-5-2c-step-change-scenario/>

<sup>50</sup> <https://www.reputex.com/research-insights/wholesale-electricity-prices-to-2040-under-a-1-5-2c-step-change-scenario/>

<sup>51</sup> <https://www.aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf>

<sup>52</sup> <https://www.theguardian.com/australia-news/2020/apr/30/australias-electricity-grid-could-run-with-75-renewables-market-operator-says>

<sup>53</sup> <https://www.aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf>, p. 4



Acknowledging other renewable energy studies (Blakers et al, 2017; Ueckerdt et al, 2019 and CSIRO & Energy Networks Australia, 2017), ClimateWorks confidently states

‘Australia can transition to 100% renewable electricity generation while reducing costs across electricity networks.’<sup>54</sup>

The Decarbonisation report models three scenarios for Australia to get to zero emissions by 2050: two scenarios compatible with a 2°C global temperature limit and one scenario with a 1.5°C temperature limit, aligning with Paris climate agreement goals<sup>55</sup>. The report notes that in all three scenarios the electricity sector must be decarbonised.

‘Most of the solutions required to achieve zero emissions in the electricity sector are mature and commercially competitive or have been demonstrated at scale. The key challenge for the sector is to achieve widespread adoption over a short period of time.’<sup>56</sup>

ClimateWorks indicates that Australia renewable energy in the '2C Deploy' and '2C Innovate' scenarios must reach 74% and 70% respectively by 2030 and in the '1.5C All-in' scenario reach 79% by 2030. In the '2C Deploy' and the '1.5C All-in' scenarios renewables must effectively reach 100% by 2035. The report concludes that

‘Although the modelled benchmarks might seem ambitious, they are by no means impossible. To reach net zero emissions before 2050, Australia must accelerate the deployment of mature and demonstrated zero-emissions technologies, and quickly develop zero-emissions technologies in sectors facing greater challenges.’<sup>57</sup>

<sup>54</sup> <https://www.climateworksaustralia.org/resource/decarbonisation-futures-solutions-actions-and-benchmarks-for-a-net-zero-emissions-australia/> p.36

<sup>55</sup> Signed by 180 countries, the UN Paris Agreement, aims to keep global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C (UNFCCC, 2015).

<sup>56</sup> <https://www.climateworksaustralia.org/resource/decarbonisation-futures-solutions-actions-and-benchmarks-for-a-net-zero-emissions-australia/> p.34

<sup>57</sup> Same report p.121

## Is there a need for more gas to support the transition?

Both the Federal Minister for Energy and Emissions Reduction Angus Taylor and the Head of National COVID-19 Coordination Commission have stated Australia needs a 'gas-led recovery'. At the Prime Minister's National Press Club address on 29 Jan 2020, Scott Morrison stated that:

'There is no credible energy transition plan for an economy like Australia in particular, that does not involve the greater use of gas as an important transition fuel.'<sup>58</sup>

Part of the justification for a 'gas-led recovery' has been the view that higher levels of gas power generation are required to support higher levels of intermittent renewable energy in Australia's electricity grid.

### Gas has become an uncompetitive fuel source for power generation in Australia

The linking of domestic gas market with the Asian export market has resulted in gas prices increases. Despite a tripling gas supply on the east coast of Australia, domestic gas prices have also tripled since 2014.

According Robertson AEMO's latest forecasts indicate

'In Australia, there is currently no committed new investment into gas-fired power generation, and only a handful of proposed investments.'<sup>59</sup>

### Is more gas needed to stabilise a renewable energy grid?

Simon Holmes à Court, senior adviser to the Climate and Energy College, Melbourne University reviewed 14 deep decarbonisation studies (100% or high levels of renewable energy) and found that not one study called for an increase in gas powered generation. The conclusions were:

'There's no doubt that gas has played a very important role in keeping the lights on. Morrison claims we need a lot more of it to continue the energy transition already in play. The experts disagree. ... a future where Australia burns far less fossil gas (and coal), the lights stay on and electricity is affordable. Trilemma solved!'<sup>60</sup>

Holmes à Court acknowledged that there is a continued need for gas to provide grid stability, but this is not an increase in gas power generation. The 2019 Energy Transition Hub study 'Australia's power advantage - Energy transition and hydrogen export scenarios'<sup>61</sup> showed that Australia has

'demonstrated a pathway to deep decarbonisation and the birth of a significant clean energy export industry – a 500% increase in energy by 2050, with a reduction in power prices. Again, the study showed a declining role for gas, petering out to zero by 2030.'<sup>62</sup>

The independent grid operator AEMO in the 2020 Integrated System Plan, reveals that in their Central Scenario of 76% renewable energy in 2042 and the Step-Up Scenario of 92% renewable energy in 2042, both show much less gas to be used than present.

### Gas is not the energy source that gets Australia to zero emissions

Most analysts have noted that gas is not a zero-emissions fuel and there is a significant issue with 'fugitive methane emissions'<sup>63</sup> associated with gas production. Bruce Robertson, gas/LNG analyst with the Institute for Energy Economics and Financial Analysis points out that

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<sup>58</sup> <https://www.pm.gov.au/media/address-national-press-club>

<sup>59</sup> <https://ieefa.org/ieefa-australia-gas-is-not-a-transition-fuel-prime-minister/>

<sup>60</sup> <https://www.theguardian.com/commentisfree/2020/feb/01/scott-morrison-is-stuck-in-a-time-warp-more-gas-is-not-the-answer>

<sup>61</sup> Energy Transition Hub, Australia's power advantage - Energy transition and hydrogen export scenarios' [https://www.energy-transition-hub.org/files/resource/attachment/australia\\_power\\_advantage\\_0.pdf](https://www.energy-transition-hub.org/files/resource/attachment/australia_power_advantage_0.pdf)

<sup>62</sup> <https://www.theguardian.com/commentisfree/2020/feb/01/scott-morrison-is-stuck-in-a-time-warp-more-gas-is-not-the-answer> - Disclosure: Simon Holmes à Court is an adviser to the ETH, but was not involved in the study.

<sup>63</sup> Fugitive emissions are emissions of gases or vapours during extraction, processing and distribution, including release from pressure valves or other unintended releases of gases. Natural gas is predominantly methane. Over a 20 year timeframe, methane has 86 times more global warming potential than carbon dioxide.

[https://en.wikipedia.org/wiki/Atmospheric\\_methane](https://en.wikipedia.org/wiki/Atmospheric_methane)

'Methane is the greatest threat to the warming climate. If you leak more than 2% to 3% of methane, it is worse for the climate than coal.

In a recent Bloomberg story, about BP installing new methane leak detectors on new gas producing projects, there was this quote: "The company said the wider energy industry leaks about 3.2% of the gas it produces, which is probably almost enough to offset the benefit of switching from coal to gas."<sup>64</sup>

As noted in Australia's 2020 Technology Investment Roadmap:

"According to the International Energy Agency (IEA), switching from coal to gas can provide 'quick wins' for global emissions reductions and has the potential to reduce electricity sector emissions by 10 per cent."<sup>65</sup>

Reducing emissions by 10% compared to the high emitting coal is at best only a marginal progression towards net zero emissions. At the very best, gas is only marginally better than coal and in many cases it is worse. Switching to or expanding gas does not get Australia to a zero emissions economy and future.<sup>66</sup>

In August 2020, 25 highly qualified and respected Australian scientists wrote an open letter to Australia's Chief Scientist, Dr Alan Finkel, indicating Dr Finkel's support for gas as an energy source "is not consistent with a safe climate".

"Our concern ... relates to the scale and speed of the decarbonisation challenge required to meet the Paris Agreement, and, in particular, your support for the use of gas as a transition fuel over 'many decades'. Unfortunately, that approach is not consistent with a safe climate nor, more specifically, with the Paris Agreement. There is no role for an expansion of the gas industry.

The combustion of natural gas is now the fastest growing source of carbon dioxide to the atmosphere, the most important greenhouse gas driving climate change.

On a decadal time frame, methane is a far more potent greenhouse gas than carbon dioxide. In Australia, the rapid rise in methane emissions is due to the expansion of the natural gas industry. The rate of methane leakage from the full gas economy, from exploration through to end use, has far exceeded earlier estimates."

Professor Steffen, inaugural director of the Australian National University climate change institute and one of the signatories to the letter said the Chief Scientist

"seems to be speaking in ignorance of or [to be] ignoring the overwhelming amount of evidence gathered by his own scientific community about the impact of the gas industry on the climate."<sup>67</sup>

Former chief scientist Penny Sackett, who had not signed the letter, was quoted as saying there is no time for a switch from coal to gas.

"'Fuel switching' from coal to gas is policy based on factors that were at play around the turn of the century or before, not in today's world and beyond. The last thing we need is to increase fossil fuel production at a time when coal, gas and oil must all decline starting now in order to stay well below 2°C of global heating."<sup>68</sup>

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<sup>64</sup> [https://ieefa.org/wp-content/uploads/2020/06/Gas-Cannot-Stimulate-the-Economy-Reduce-Emissions-or-Provide-Cheap-Power\\_June-2020.pdf](https://ieefa.org/wp-content/uploads/2020/06/Gas-Cannot-Stimulate-the-Economy-Reduce-Emissions-or-Provide-Cheap-Power_June-2020.pdf), 20.

<sup>65</sup> [https://consult.industry.gov.au/climate-change/technology-investment-roadmap/supporting\\_documents/technologyinvestmentroadmapdiscussionpaper.pdf](https://consult.industry.gov.au/climate-change/technology-investment-roadmap/supporting_documents/technologyinvestmentroadmapdiscussionpaper.pdf), 28.

<sup>67</sup> <https://www.smh.com.au/environment/climate-change/australia-s-chief-scientist-is-wrong-on-gas-say-leading-experts-20200824-p55oty.html>

<sup>68</sup> <https://www.smh.com.au/environment/climate-change/chief-scientist-alan-finkel-responds-to-criticism-from-colleagues-20200825-p55p8l.html>

## Summary of the 100% renewable energy studies

In short, all of the main studies over the last 10 years have concluded that Australia can technically manage and safely operate a 100% renewable energy grid, in particular the NEM network.

As AEMO has indicated changes are required in the NEM market to enable the renewable energy to increase comfortably from 50% share to the 74% - 92% scenarios in 2042 in their 20 year plans. The transition will require new generation and firming (storage capacity), addition transmission systems to move from a linear to a decentralised network and regulatory changes to facilitate the transition.

A 100% (or near) renewable electricity grid is likely to be more resilient and stable than the existing linear system which at the moment is critically dependent on ageing and 'unreliable in the heat' coal and gas power stations.

Earlier studies concluded there was a 'modest' financial cost to transition to zero carbon electricity. The later studies have concluded that based on the reduced cost of solar, wind and batteries, the transition costs at worst would be no more than 'Business as Usual' but are more likely to be cheaper than 'Business as Usual'.

The Climate Council 'Powering a 21<sup>st</sup> Century economy' report concludes in its summary of renewable energy studies:

'Australia can transition directly to a secure, reliable and affordable power system which dramatically cuts electricity sector emissions within a decade.'

# When could a 100% renewable energy grid be built?

This is a challenging question to answer because it depends on a number of unknown factors. Australian Government policy on renewable energy is likely to be the biggest influence on the timeframe in getting to 100% renewable energy.

## A world leading pace – the renewables boom from 2018 to 2019

Over the last decade, there has been a significant increase in the installation of renewable energy in Australia, both at residential and utility scale. The ANU team of Blakers, Lu and Stocks in a February 2019 paper noted this increase in deployment and increase in planned projects in Australia.

‘In 2018 Australia deployed 5.1 GW of PV and wind systems (3.4 GW ground-mounted, 1.7 GW roof-mounted). The speed of deployment is accelerating and Clean Energy Regulator data indicates that the current ground-mounted PV and wind pipeline is about 4.3 GW per year. Roof-mounted PV is increasing by about 50% per year and might exceed 2 GW in 2019, for a total renewables deployment of about 6.3 GW. At this rate, **Australia is on track to reach 50% renewable electricity in 2024 and 100% in 2032.**’<sup>69</sup>

In an 2020 update Blakers et al have noted that:

‘Tracking by the Clean Energy Regulator suggests that Australia will deploy about 22 gigawatts of new solar and wind over 2018-21.’<sup>70</sup>

A significant percentage of the solar PV uptake is rooftop solar. More than two million or 21 percent of Australian households now have rooftop solar PV, with a combined capacity exceeding 10 GW.<sup>71</sup>

As noted in the Blakers et al 2019 report Australia’s rooftop solar:

‘is by far the largest per capita rooftop-PV deployment in the world. Australian cities have good sunshine by world standards, and the cost of electricity from rooftop PV systems is far below the retail tariff for most home owners and businesses.’<sup>72</sup>

Getting to very high levels of renewable energy in the NEM grid would require grid stabilisation, including energy storage from batteries and pumped hydro<sup>73</sup> but the authors indicate that:

‘Stabilising the electricity grid when it has 50-100% renewable energy is straightforward using off-the-shelf techniques that are already widely used in Australia.’<sup>74</sup>

In the 2020 update report, Blakers et al indicate that based on the latest International Renewable Energy Agency statistics

‘Australia is deploying new renewables 10 times faster per capita than the global average and 4 times faster per capita than in Europe, China, Japan or the US’.<sup>75</sup>

Over Easter 2020 energy analyst Dr Hugh Sadler highlighted that the NEM reached a significant milestone

“on Easter Saturday, renewables generated half of Australia’s electricity for nearly two hours, an impressive new milestone that has only been achieved for a few minutes in the past.”<sup>76</sup>

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<sup>69</sup> <http://re100.eng.anu.edu.au/publications/assets/100renewables.pdf>, 2. Highlighting by the Author.

<sup>70</sup> <https://energy.anu.edu.au/news-events/australia-deploying-new-renewables-ten-times-global-average>

<sup>71</sup> <https://arena.gov.au/renewable-energy/solar-pv-rd/> 24 Feb 2020

<sup>72</sup> <http://re100.eng.anu.edu.au/publications/assets/100renewables.pdf>, 2.

<sup>73</sup> Climate Council, 2018, Fully charged: Renewables and storage powering Australia, <https://www.climatecouncil.org.au/wp-content/uploads/2018/03/Fully-Charged-Renewables-and-Storage-Powering-Australia.pdf>, 2.

<sup>74</sup> Same report, p. 2

<sup>75</sup> <https://energy.anu.edu.au/news-events/australia-deploying-new-renewables-ten-times-global-average>

<sup>76</sup> <https://www.tai.org.au/content/pandemic-response-impact-electricity-emissions-minimal-national-energy-emissions-audit>

In summary, in early 2019, the uptake of renewables in Australia had been at a world leading pace. Based on the ‘boom’ rate of deployment of renewables, ANU renewable energy experts reported Australia could reach 100% renewable energy by 2032, at that time within 13 years.

## Slow-down and investment cut by half in late 2019

In the latter half of 2019 there was a significant slow-down of investment and construction, prior to Covid-19 pandemic influence. The trend was noted by the renewable energy industry peak body the Clean Energy Council, energy consultants Bloomberg New Energy Finance and the Reserve Bank of Australia.<sup>77</sup> Commentators have observed that this is primarily due to investment uncertainty emanating from Australia renewable energy policy settings.

The Federal Government renewable energy target (RET) was reduced in 2015 to 33,000 GWh of renewable energy or approximately 23% of electricity demand. This revised RET target was met in September 2019 and the Federal Government has not set a new renewable energy target.

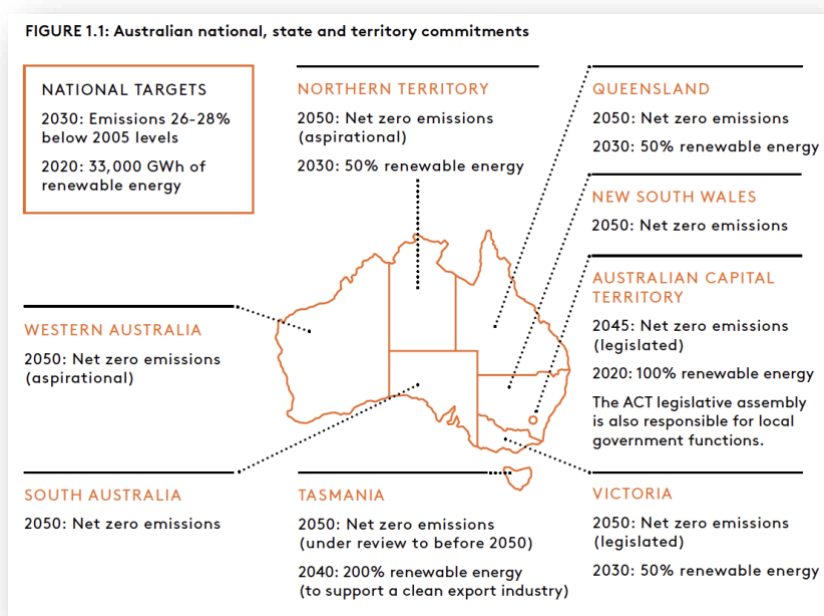
Under the Turnbull led Federal Government, Australia was pursuing the National Energy Guarantee (NEG) policy to stimulate renewable energy demand. However, under the Morrison led Government the NEG was dropped in May 2019 and there has been no further policy development until the draft ‘Technology Investment Roadmap’ was introduced for consultation in May 2020<sup>78</sup>.

A commitment to zero carbon emissions future is one of the key drivers of renewable energy. In May 2020, the Minister for Energy and Emissions Reduction Angus Taylor made the Federal Government’s view very clear:

‘it is not the Australian government’s policy to reach net zero emissions by 2050’<sup>79</sup>.

Renewable energy investors have been leaving the Australian energy market due to the policy vacuum, uncertainty and the posturing by many Federal Government ministers to fund a new coal (HELE - High Efficiency Low emissions) power station and major gas infrastructure.

## All States and Territories leading the way on renewable energy and emissions targets



Australian States and Territories have been doing the heavy lifting with regard to setting renewable energy targets, facilitating auctions and creating power purchase agreements to procure renewable energy.

The following ClimateWorks graphic summarizes the position of various states and territories.<sup>80</sup>

As the graphic indicates and despite the Federal Government absence of a commitment to net zero emissions, every State and Territory have in effect

<sup>77</sup> <https://www.theguardian.com/australia-news/2020/may/15/australias-reserve-bank-fuels-call-for-post-pandemic-renewables-push>

<sup>78</sup> <https://consult.industry.gov.au/climate-change/technology-investment-roadmap/>

<sup>79</sup> <https://www.theguardian.com/environment/2020/may/19/angus-taylor-says-it-is-not-australian-government-policy-to-achieve-net-zero-emissions-by-2050>

<sup>80</sup> ClimateWorks Australia, 2014, Pathways to deep decarbonisation in 2050: how Australia can proposer in a low carbon world, p. 24

committed to net zero emission by 2050. The State and Territory commitments are consistent with a UN Paris Goal of keeping to under 2% global warming.

The Victoria Government has committed to introduce new legislation to enable fast-tracking of electricity transmission investment, outside the existing system. As Victorian Energy Minister Lily D'Ambrosio explains:

“We have got an energy system, a set of rules, that were set in the 1990s, and haven't budged since then. ... We are seeing a dramatic change in the way electricity is produced. We have rules that don't have the foresight, or don't allow you to plan ahead to have the transmission where the renewable energy generators will be built. ... It has been too slow to evolve.”<sup>81</sup>

In April 2020, AEMO reported on some modelling they had completed on the South Australian (SA) market and AEMO indicated in one scenario the SA market could reach a level of 87% renewables within four years<sup>82</sup>.

The ACT already has reached their 100% renewable energy target and the Tasmanian Government is now exploring 200% renewable energy.

State and Territory government leadership has led to Australia's world leading deployment of renewable energy per capita.

## Up to 800% renewables – Australia the renewable energy superpower

As noted earlier in the ClimateWorks decarbonisation scenario, greater amounts of electricity will be needed to accommodate electric vehicles, all-electric homes and buildings and the electrification of industry and manufacturing. This will be a significant expansion of electricity demand.

Many Australian business people and energy experts have called for Australia to adopt a greater than 100% renewable energy goal – creating new jobs and developing a capacity to export clean energy and clean products<sup>83</sup>.

Prof. Ross Garnaut, author of *Superpower: Australia's Low Carbon Opportunity* is a well-known exponent of calling for Australia to become a 'global superpower in energy, low-carbon industry and absorption of carbon in the landscape'.<sup>84</sup> An significantly expanded 100% renewable electricity system can meet the needs for a decarbonised electricity grid, transport system, and comfortable and safe buildings and manufacturing industries.

Garnaut and others claim that with Australia's great natural solar and wind resources, the country can produce the lowest energy prices in the world. This significant economic advantage in a decarbonised world, could then be used to reindustrialise Australia for the production and export of green steel, green aluminium and other value added products such as lithium batteries. Australia can do more than simply mine and exporting raw materials to other countries<sup>85</sup>.

Former Clean Energy Finance Corporation chief Oliver Yates calls for Australia to develop a green hydrogen economy, to reindustrialise and create new jobs. Yates recently said

‘No longer is Australia headed for 100 per cent renewable energy, we will vastly overshoot it – I have been quoting 500 per cent and already others are talking about 800 per cent or even more. ... The long term cost advantage of renewable energy is clear. Under this scenario we see improved price points and visions of \$35 to \$40 MWh, we should all be proud and excited. Australia now has a

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<sup>81</sup> <https://reneweconomy.com.au/energy-insiders-podcast-victoria-goes-it-alone-to-save-renewable-transition-54340/>

<sup>82</sup> [https://www.aemo.com.au/-/media/files/electricity/nem/planning\\_and\\_forecasting/sa\\_advisory/2020/2020-south-australian-generation-forecasts.pdf?la=en](https://www.aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/sa_advisory/2020/2020-south-australian-generation-forecasts.pdf?la=en)

<sup>83</sup> Ueckerdt, F, Dargaville, R, Gils, H, McConnell, D, Meinshausen, M, Scholz, Y, Schreyer, F & Wang, C, 2019, 'Australia's power advantage: Energy transition and hydrogen export scenarios', Energy Transition Hub.

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<sup>84</sup> Garnaut, R, 2019, *Superpower: Australia's Low Carbon Opportunity*, La Trobe University Press, Carlton, 8.

<sup>85</sup> Lord, M, 2019, From mining to making: Australia's future in zero-emissions metal, <https://www.energytransition-hub.org/resource/mining-making-australias-future-zero-emissions-metal>

nation making opportunity ahead of us and is now the best place in the world to undertake heavy industrial activity using renewable energy.<sup>86</sup>

Australia's Chief Scientist Alan Finkel calls for 800 per cent of renewable energy, because Australia will need the energy to create green hydrogen (transported as ammonia) and for green steel<sup>87</sup>.

'Australia is opening up and (the) road ahead is clear, and 100 per cent renewable energy is nothing, just a speed bump in the road ahead. We are talking about a vastly different energy system. Australia can and should be thinking about the need to reindustrialise, we need to bring the production of these heavy commodities back into Australia. ... Australia has an incredible opportunity in front of us we cannot miss out on. 500 per cent renewable energy is a walk in the prosperous park for Australians, we cannot let others slow us down. ... It's in front of us – and an exciting time with it.'<sup>88</sup>

## The impact of Covid-19 pandemic on renewable energy?

No-one quite knows how the Covid-19 pandemic will impact the generation mix and the transition to renewable energy. The most recent International Energy Agency Global Energy Review (April 2020) summarised the impacts to date of the Covid-19 crisis on global energy demand<sup>89</sup>:

- Global coal demand was hit the hardest, falling by almost 8%
- Oil demand was also hit strongly, down nearly 5%
- Renewables were the only source that posted a growth in demand, driven by larger installed capacity and priority dispatch.

The Australian (and global) trend regardless of Covid-19 is for both closure of coal power stations and less coal power generation in the electricity mix, with an increase in wind and solar generation in the mix.

When solar and wind generation are installed solar and wind generators will always increase their market share, resulting in lower market share (less hours and lower capacity of operation) for coal and gas generators. This is primarily due to renewable energy having zero 'short-run marginal costs of production' because there are no fuel costs. See **Appendix 2 - Zero short-run marginal costs means solar and wind win the bidding competition** for a brief explanation on how this works in the NEM market.

It is likely that due to market uncertainty, some relating to lack of Federal Government policy and some due to Covid-19 pandemic that the rate of deployment of renewable energy deployment will slow down. On the other hand, it is possible that many or all of relevant governments will commit to stimulus funding with renewable energy at the centre of the stimulus packages.

### Covid-19 related stimulus package – a renewable energy led recovery?

The Australian and the 8 state/territory governments have been recognised globally for their leadership and response during the Covid-19 pandemic. A summary of some of the take home messages of the governments, which were supported by the media were<sup>90</sup>:

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<sup>86</sup> <https://www.smartenergy.org.au/news/toward-500-cent-renewable-energy>

<sup>87</sup> Australian Government Chief Scientist, 2018, Proposal for a national hydrogen strategy, <http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/DIIS%20-%20Hydrogen%20Proposal%20-%202020181219.pdf>

<sup>88</sup> <https://www.smartenergy.org.au/news/toward-500-cent-renewable-energy>

<sup>89</sup> <https://www.iea.org/reports/global-energy-review-2020>

<sup>90</sup> Many have observed that most of these messages could/should be equally be applied to the climate emergency crisis <https://www.theguardian.com/commentisfree/2020/may/07/australia-has-found-common-ground-to-respond-to-covid-19-we-can-do-the-same-for-climate-change>

- we are all-in-this together;
- we are listening to the best medical experts and scientists around the world and;
- we will act on that best advice (and implicit in that response is that we will not spare the cost to implement that advice);
- we will go in hard and we will go in early, because the urgent focus needs to be flattening the curve and saving lives – ABC Health Journalist Dr Norman Swan being the most high profile proponent of this view.

An observer would note that all the very sensible Covid-19 public health emergency messages equally relate to the climate emergency and require a similar level of commitment and resourcing. In response to the second Melbourne Covid-19 lockdowns, journalist Kasey Edwards wrote:

‘We know now that acting too late, or not at all, ignoring the best science and medical advice available, or reducing the pandemic to just politicking is a death sentence.’

The governments of Australia (despite often having low levels of community trust pre-Covid-19) have been able to develop a consensus approach to the health (and economic) emergency, build trust<sup>91</sup> and bring the Australian community with them. In crisis and routine times, there have been many instances, where politicians and governments, who have had a vision are able to inspire and sell that vision and bring about considerable change in a short amount of time – a rapid transition<sup>92</sup>.

As Australian Opinion polls show consistently, Australians want a green electricity grid and governments to address the climate emergency. Australian communities want action on emissions reduction, with 75% of Australians want a commitment to zero emissions economy by 2050<sup>93</sup> and 84% want the government to focus on renewable energy<sup>94</sup>.

Australians want affordable, reliable and environmentally responsible energy. The fossil fuel energy sector will struggle from now on to solve the energy trilemma because

‘The price and supply of energy from fossil fuels is vulnerable to natural resource depletion, geopolitical tensions and climate change concerns. This is true not just for oil, but coal and gas too. The only real path to energy security is manufactured energy such as solar panels, wind turbines, electrolyzers, batteries and smart grids.’<sup>95</sup>

Many significant global bodies from the International Energy Agency<sup>96</sup>, the World Bank<sup>97</sup>, International Monetary Fund<sup>98</sup>, global companies and many national bodies<sup>99</sup> have called for a ‘green recovery’, one that builds renewable energy and decarbonised society at the centre of a governments stimulus recovery from the Covid-19 pandemic.

Some of the insights from these institutions and groups include:

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<sup>91</sup> <https://www.theguardian.com/australia-news/2020/apr/07/australians-trust-in-government-and-media-soars-as-coronavirus-crisis-escalates>

<sup>92</sup> <https://www.rapidtransition.org/stories/when-behaviour-changes-overnight-from-stay-at-home-to-smoke-free-air-and-switching-sides-of-the-road/>

<sup>93</sup> <https://www.theguardian.com/australia-news/2020/feb/25/essential-poll-a-majority-of-coalition-voters-support-a-net-zero-emissions-target-for-2050>

<sup>94</sup> <https://lowyinstitutepoll.lowyinstitute.org/themes/climate-change-and-energy/>

<sup>95</sup> <https://theconversation.com/want-an-economic-boost-morrison-use-that-stimulus-money-to-turbocharge-renewables-137074>

<sup>96</sup> <https://www.iea.org/commentaries/how-to-make-the-economic-recovery-from-coronavirus-an-environmentally-sustainable-one>

<sup>97</sup> <https://blogs.worldbank.org/climatechange/planning-economic-recovery-covid-19-coronavirus-sustainability-checklist-policymakers>

<sup>98</sup> <https://www.imf.org/en/News/Articles/2020/04/29/sp042920-md-opening-remarks-at-petersberg-event>

<sup>99</sup> <https://www.climateworksaustralia.org/news/green-stimulus-an-opportunity-for-economic-and-climate-recovery/>

- don't waste 'the crisis' funding short-term solutions which are detrimental to our future but focus on the long-term goal of a decarbonised society and economy;
- focus on job creation, not short term but long-term secure jobs based on 21<sup>st</sup> century technology not the 19<sup>th</sup> century;
- capitalize on Australian strengths of high solar radiation, wind and build a modern and resilient 100%+ energy network;
- reindustrialise Australia building on our natural resources to create green hydrogen, green steel, green aluminium and battery/energy storage sectors;
- while stimulating the economy and communities, let's make it cleaner, healthier, fairer and sustainable.

A May 2020 Oxford University review, conducted by 231 world leading economists, of 700 government stimulus packages around the world concluded that 'green projects' are more economically effective stimulus measures than traditional stimulus packages.

'Green projects create more jobs, deliver higher short-term returns per dollar spend and lead to increased long-term cost savings, by comparison with traditional fiscal stimulus. ...

Examples of this include investment in renewable energy production, such as wind or solar. As previous research has shown, in the short term, clean energy infrastructure construction is particularly labour intensive, creating twice as many jobs per dollar as fossil fuel investments.'<sup>100</sup>

Research by the Institute for Sustainable Futures, University of Technology Sydney, released in June 2020 reveals that the Australian renewable energy sector could employ as many as 44,000 people by 2025 if Australia begins a decisive clean energy transition, with the majority in regional Australia<sup>101</sup>.

Another June 2020 report by professional services firm Ernst & Young (EY) for WWF 'Australian renewable export - COVID-19 recovery package' indicates that in the short term

'Every dollar of stimulus spent on clean projects generates nearly three times as many jobs per dollar than investment in fossil fuel projects.

Over 100,000 direct jobs could be unlocked by accelerating Australia's wind and solar project pipeline, fast-tracking new transmission projects to revitalise Australia's congested transmission network and through a combination of modernised manufacturing, battery projects, electrified buses, local solar and hydrogen.

And in the long term using renewable energy, Australia could become a major manufacturer and exporter of hydrogen. Hydrogen (which produces no Greenhouse Gases when burned) could meet up to 24% of world energy demand by 2050 with annual hydrogen sales of \$700 billion USD.'<sup>102</sup>

In conclusion Australia needs to move beyond the 'climate wars', the incessant planning, but no real action on reducing emissions in line with a safe climate. According to Assoc. Professor Malte Meinshausen, the founding director of the Climate and Energy college.

"We do not need another survey of technologies that might save us in the future. We already know what the technologies are. We need regulatory reform and a plan to use them."<sup>103</sup>

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<sup>100</sup> <http://www.ox.ac.uk/news/2020-05-05-building-back-better-green-covid-19-recovery-packages-will-boost-economic-growth-and>

<sup>101</sup> <https://assets.cleanenergycouncil.org.au/documents/resources/reports/Clean-Energy-at-Work/The-Clean-Energy-Council-Clean-Energy-at-Work-2020.pdf> 12.

<sup>102</sup> Australian renewable export COVID-19 recovery package report – WWF-Australia, 2020, 6.

<sup>103</sup> <https://www.smh.com.au/environment/climate-change/carbon-road-map-winning-few-friends-little-influence-20200522-p54vkh.html>

# Conclusion – 100% renewable energy and more: a cleaner, cheaper and safer future for all

This report has summarised the many studies which have shown that Australia can reach 100+% renewable energy in the grid. It is both technically feasible and manageable, with appropriate additions to the grid. If Australia was to continue the world leading pace from the 2018-19 period, Australia could achieve 100% by the early 2030s.

The studies and analysis has shown that 100% renewable energy will be cheaper than 'Business as usual' fossil fuel mix and address issues associated with potable water constraints, air pollution and public health, carbon pollution and an unstable-unreliable outdated electricity system.



Figure 2- Wind farm western Victoria - Jessica Shapiro

All Australian states and territories and major industry groups are now progressing their plans to get to a zero emission economy by 2050, including 100% renewable energy well before that date. There is wide business, industry and community support for renewable energy and the smooth transition to 100% renewable energy. Many businesses, from farmer, to manufacturing and mining see the risks if the transition is

not made and see many new opportunities for Australia to be an exporter of clean and green energy and manufactured goods.

In a post Covid-19 recovery period it has become even more attractive to move at a great pace to the 100% renewable energy economy. Governments and communities have a responsibility to manage the transition well, to ensure that all benefit from the transition - with the new economy jobs available to all, (especially those moving from the fossil fuel sectors) and that energy becomes more affordable for all (not just lower prices but more efficient use of that energy).

It is clear that there is a small, influential group of fossil fuel industries (coal, oil and gas) and related groups (Minerals Council) who will lose financially from the transition to renewable energy. The fossil fuel industry assets will become stranded assets as they lose their 'social license' to operate. These fossil fuel industries are in a rush to mine and harvest as much fossil fuels as they can before their operations are closed by governments of the day. These fossil fuel industries know the end is nigh.

The energy future is very clear to most analysts and businesses, including the electricity industry – it will be 100% renewable and more. 100% renewable energy will be cleaner and safer, more flexible and smarter, more resilient and cheaper.

Now, let's get on with it.

## Appendix 1 - 100% renewable energy studies of the Australian electricity network.

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## Appendix 2 - Zero short-run marginal costs means solar and wind win the bidding competition

The competitive NEM operates on 5 minutes bidding intervals and the price is averaged over 30 minutes, for every 30 minutes of every day of the year. All successful market generators bidding to supply electricity for that 5 minutes are awarded the price of the last bidder, which is the highest price (typically that is coal, gas or gas peaking generation).

Solar and wind both have zero 'short-run marginal costs of production' because they have no fuel costs, whereas coal and gas generation always have fuel costs. Coal and gas can't afford to bid into the 5 minute interval with any price less than their short-run costs (which include fuel and other items).

Solar and wind will usually bid at zero price and as a result of being price competitive, their generation is usually purchased in the NEM market. As a result the amount of coal and gas electricity produced in the market are reduced.