Submission No 184

SUSTAINABILITY OF ENERGY SUPPLY AND RESOURCES IN NSW

Organisation: Beyond Zero Emissions

Date Received: 15 September 2019

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Chair, Committee on Environment and Planning
Parliament House
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15th September, 2019

Re: Inquiry into sustainability of energy supply and resources in NSW
Terms of reference (NSW Parliament 2019)

Beyond Zero Emissions (BZE) would like to thank the Chairperson of the Inquiry for the invitation to make a submission, and would appreciate an opportunity to discuss this matter with the committee of the Inquiry.

Please find our submission attached, which comprises:

- Submissions
- Attachment A: About Beyond Zero Emissions
- Attachment B: References
- Attachment C: Renewable Hydrogen.

Yours sincerely,
Vanessa Petrie

CEO
Beyond Zero Emissions

Contents

1. The capacity and economic opportunities of renewable energy

The world is moving from the fossil energy era to the renewable energy era and Australia has a unique advantage: unparalleled resources in solar and wind energy.

Putting NSW at the forefront of this global transition puts the state in a prime position to create jobs, attract investment and secure a safe climate through its leadership and action.

NSW is exposed to climate, geopolitical and resource risks

NSW is a geographically central state within the National Electricity Market. Regional NSW is the largest, most diverse regional economy in Australia, yet the economies of some local government areas in NSW are overwhelming dominated by coal mining and coal power generation.

So for NSW:

- over 94% of the total energy used comes from carbon polluting, non-renewable sources such as oil, coal and gas (NSW EPA 2018)
- while almost half (45%) of the energy used is for transport (NSW EPA 2018), NSW no longer has any transport fuel refining or production capacity of its own (AIP 2017, Blackburn 2014).
- about 75% of its coal exports are destined for Japan, South Korea and China, representing more than $15 billion or more than 50% of current NSW exports destined outside of Australia (DFAT 2018).

NSW is particularly vulnerable to climate change:

- its largest three cities are near the sea and on Low Elevation Coastal Zones
- airports, seaports railways, houses and other infrastructure are exposed to storms, swells, and erosion, and
- large areas of land are vulnerable to bushfires (which are becoming more severe over an extended period), particularly in times of drought, and affecting our productivity.

NSW can lower these risks by transitioning to renewable energy

In a risky geopolitical world where we depend on global trade for oil and manufactured goods - and as extreme weather events increase - a great opportunity exists for NSW to lower these risks by:

- lowering its total energy demand through improved energy efficiencies and adopting best practices across sectors, but particularly for the vulnerable land use, transport and power sectors
- adopting a renewable energy economy and moving to a zero carbon economy by 2030 to help stabilise the global climate and extreme events, and
- capitalising on the abundance of NSW's renewable energy resources to grow its economy.

The benefit of adopting these strategies (which are set out in Beyond Zero emissions' Zero Carbon Australia research plans) include:

- reducing geopolitical risks – whether in coal communities or in the Asia-Pacific Economic Community
- ensuring NSW continues with its powerhouse economy, and
- securing NSW's sustainable future for energy, food, water (e.g. by using less water for energy supply) and transport.

This will bring down electricity and transport costs and provide sustainable energy to support the electricity grid within NSW and abroad in the NEM with high penetration renewables. This will sustain existing and future mineral processing and metal manufacturing in NSW as ageing coal infrastructure retires.

NSW also has the technical knowledge and capacity to produce ammonia on a globally competitive basis using renewable energy rather than natural gas, and could export Hydrogen from what currently is the largest coal exporting port in the world. For more details on the potential of Hydrogen, see Appendix C.

Australia and NSW as a Renewable Energy Superpower

Australia has sufficient renewable energy to be a net renewable energy exporter, with 5,000 ExaJoules per year (the *economically feasible 4%* of Australia's total renewable energy resource), as revealed in the research conducted for Beyond Zero Emissions' *Renewable Energy Superpower* plan (2015). This is enough to *power the whole world ten times over* (WCA 2018).

NSW Renewable Capacity

The renewable energy generation and storage possibilities for NSW include:

- Significant **wind potential** in NSW - wind turbines can be located on Great Dividing Range with high wind capacity, or offshore
- Rooftop **solar photovoltaic** (PV) power could boost renewable generation
- Householders solar PV panels could be encouraged and supported to invest in **local storage**, and this could help stabilise voltages across the network when there is excess renewable energy
- **Large solar farms**, with good potential in Western NSW where there is the best solar irradiance.
- In the medium to longer term when they are more economically viable, **Concentrated Solar Thermal (CST) plants** (which have molten salt reservoirs that can store heat for around 24 hours) can be sited at existing power stations or other locations with good connectivity
- Many **pumped storage sites** exist in NSW (DP&E, 2018; Parkinson, 2017), including where there are lakes or coal mines and mountains. Two of the highest quality opportunities for expanded pumped hydro storage in NSW are found in the Snowy Mountains region (e.g. Snowy 2.0) and the Great Dividing range between Coffs Harbour, Armidale, Musswelbrook, Wollongong, and Newcastle (North East and Lower North Coast regions)
- **Large scale batteries** such as the SA Hornsdale Tesla battery could be located at substations or Power Station sites where there are good network facilities, and close to skilled labour sources.
- **Strong grid connectivity** for electricity sourced from "Potential Priority Energy Zones in NSW" centered on Dubbo and Armidale, as described by the *NSW Government Submission on AEMO's Integrated System Plan (ISP).* (NSW Gov 2018), and these may be extended to include Moree and Nyngan (AERA, 2019).
    - that said, some network links are too small (e.g. the proposed Walcha Energy project http://www.walchaenergy.com.au of combined solar, wind and pumped hydro is 4GW, but the transmission link to the Hunter valley is too weak for this capacity and other projects being planned for that region)
    - projects such as these need to be increased in capacity urgently since they will be on the critical path (Diesendorf, 2018 p.20)

> *"…upgrading the NSW-Qld transmission links and associated transmission lines in northern NSW is urgently needed. Combining ISP's Group 1 [most urgent category] and 2 recommendations for this link would entail an immediate start to an upgrade of 568 MW of*

transmission capacity. Uprating the existing lines between Armidale and the Hunter Valley is an essential first step, but a commitment to a New England Renewable Energy Hub, as proposed by the NSW Government in its submission to the ISP, and ***a new double circuit connection to the Hunter Valley must also be expedited to take advantage of the synergy of both wind and solar energy resources in the one locality*** *that also has excellent pumped storage potential."*

Source: Diesendorf, 2018 (bolding by the author)

Productivity and Energy Efficiency Improvements

BZE's Zero Carbon Australia research includes productivity and energy efficiency improvements which reduce the energy required in the future, compared to business as usual.

Energy improvements can also provide sustainable jobs such as:

- retrofitting all buildings in Australia to zero carbon in 10 years as per the *Buildings Plan* (BZE 2013),
- providing pathways to use alternatives to the energy intensive Portland Cement as determined in the *Rethinking Cement* plan (BZE 2017), and
- reducing the energy required for manufacturing, including for mineral processing, food processing and agriculture. *Electrifying Industry* research (BZE, 2018) shows that industrial heat processes can be much more energy efficient, with reduced costs and much lower carbon emissions, by fuel switching and using renewable energy.

Renewable Energy Labour Capacity: The Hunter and Central Coast (HCC) Region Case Study

The Hunter and Central Coast (HCC) region provides an interesting case study for the skills which already exist in NSW and which can be leveraged to boost the Renewable Energy sector.

NSW has good renewable energy potential, and the Hunter and Central Coast has a well-trained workforce, providing opportunities to develop:

- More rooftop solar systems (with many businesses developing skills in supplying and installing solar energy) and which are very popular in the lower Hunter for:
    - Households, and
    - commercial businesses
- A renewable energy workforce in the power industry due to the presence of:
    - The existing power stations of Bayswater and Liddell (AGL), Eraring (Origin) and Vales Point (Sunset Power International).
    - Workers skilled in the power and associated industries e.g. 4,100 people employed in "Electricity, Gas, Water and Waste Services" in the Hunter (LMIP 2019), and

    - Good TAFE and University facilities.
- More examples of renewable solar thermal power systems such as:
    - The pre-heat system installed in Liddell power station, and
    - The 2 prototype Concentrated Thermasolar Powerplants at the CSIRO Energy Centre at Mayfield
- Installations of wind and solar farms which are already underway for the Liddell replacement of generation
- Pumped storage facilities, adding to the feasibility already conducted for AGL
- A degree of under-utilized quality industrial land close to sea port facilities, e.g. Newcastle's Kooragang Island, and Mayfield North (Google maps 2019)
- Established ammonia and ammonium nitrate manufacturing facilities on Kooragang Island.

Manufacturing is the 3rd largest employer in the Hunter after Healthcare and Retail, followed by Accommodation and Food services (HRF 2014). The Food and Beverage sector in particular (with manufacturers in the HCC including Mars, Sanitarium) can benefit by electrifying and reducing costs including by using local renewable energy to reduce network costs (BZE, 2018).

Other key manufacturers include:

- Liberty OneSteel, which includes NSW operations at Newcastle (Rod and Wire Mills), and Sydney (an Electric Arc Furnace (EAF)). Liberty OneSteel has energy growth plans and will use sustainably generated energy from GFG Alliance's SIMEC Zen Energy (Liberty 2018). As an indicator of the scale of Liberty OneSteel's interest in renewable energy, Ben Potter reports on "a $700 million solar, battery and pumped hydro storage project to deliver power to Mr Gupta's Liberty OneSteel works in Whyalla". (Potter 2017). Also, Rebecca Puddy describes how "The 280-megawatt will begin construction in early 2019, employing 350 workers during construction and providing greater energy security to the Whyalla Liberty OneSteel steelworks". This is the "first project in a US$1 billion nationwide renewable energy program which has been launched near Whyalla, in South Australia, as part of a push to bring down Australia's electricity prices." (Puddy, 2019)
- Moly-Cop which is the world's largest supplier of grinding media used in mining and construction and has just signed a large renewable energy agreement for 100,000kWh per year for half its consumption (Moly-cop 2019). Moly-Cop at Waratah has "an onsite EAF (electric arc furnace) [and is] is a fully integrated steel business built on recycling. About 1,000 old cars a day supply feedstock scrap for the production of high-quality steel products" (Moly-Cop 2018)
- Orica, which is one of the largest commercial users of gas in Australia with opportunities to electrify
- Tomago Aluminium, which is one of the largest commercial users (840MW) of electricity in Australia, with a need for low cost reliable electricity.

Newcastle in particular has:

- A good source of high quality technical labour.
- Well-connected transport infrastructure (road, rail and sea).
- A large source of labour being the second largest non-capital region in Australia (Wiki 2019); The untapped potential of this city and the broader Hunter Valley have been overlooked since coal was first mined there in 1790!
- Newcastle's first class harbour, highly educated population and stable climate provide the foundation for any new or emerging industry, but the energy infrastructure, already installed to service the ageing coal fired power stations, gives a clear advantage to the creation of a renewable energy Mecca.

Driving economic growth in NSW with renewable energy

The renewable energy potential, existing infrastructure and established manufacturing sector forms a vital foundation for NSW to grow revenue and jobs in the zero carbon economy.

By way of example, in June 2019 Beyond Zero Emissions launched an economic development plan based on renewables plan (*The 10 Gigawatt Vision*, BZE 2019), for the Northern Territory. The plan showed that a 10 MW solar build out has the potential to boost annual revenue by $2 Billion and grow 8,000 new jobs.

Within weeks, the Chief Minister embraced the opportunity, and SunCable publicly announced its project - 10GW solar farm near Tennant Creek, exporting renewable electricity to Singapore. On 22 July 2019 the NT Government gave the proposal major project status.

This illustrates how the potential was quickly grasped and realised for rapid growth in employment in the

Using the BZE Zero Carbon Australia Research

The BZE research plans, to get Australia to Zero Carbon and which are costed over 10 years, shows there is much potential work available across the sectors:

- Stationary Energy - $370bn
- Buildings Plan - $270bn
- Electric Vehicle - $200bn (which also reduces oil imports)
- Land Use - $100bn
- High Speed Rail - $84bn

It is evident that these employment costings over 10 years could lead to economic growth of around $1,000bn/10 years = $100bn/year of sustainable jobs which is about 10% of the Australian economy. The plans also showed good returns on investment compared to business as usual due to the rising costs of energy.

If NSW seizes the opportunity to become a renewable energy powerhouse, it can create many jobs in the future with opportunities for:

- those who are employed in sunset industries and
- those who will be added to the workforce due to population increase including immigration intakes.

Beyond Zero Emissions new initiative: Hunter Renewable Power and Diversification Project

BZE has a team in Newcastle which has begun a project in the Hunter and Central Coast to support governments, business and the community to

- lower the HCC's carbon emissions, and
- understand future diversification opportunities.

BZE is looking forward to working collaboratively with the NSW Government and business stakeholders to develop this work, and would welcome an opportunity to discuss this with Parliament and the Government.

The Newcastle BZE team:

- raises awareness of BZE's well regarded research and reports with industry and local governments
- connects with local communities on actions that can be undertaken at the individual level to reduce emissions, and
- contributes to the research reports across diverse industries.

All Newcastle BZE members are volunteers, many with a great depth of expertise and experience across renewable energy (large scale utility design), engineering, management, IT, buildings, and energy efficiency. They are researching local dispatchable renewable energy solutions to meet projected energy demands in 2030. These energy demands will include high and low population and industry growth scenarios, while using energy efficiency scenarios and modern grid technology identified across the Zero Carbon Australia sector plans to improve and help reduce demand.

Research has begun into diversifying the economy and identifying the sustainable, healthy and prosperous jobs of the future for the Hunter, including in regional areas.

The strong grid connectivity discussed above, and other existing power generation culture in the Hunter valley will help promote the development of an expanding renewable electricity generation industry in the Hunter valley. As an example, using the AEMO's visualization tool, the transmission and generation infrastructure near and about Liddell and Bayswater has a notable presence (AEMO 2019).

The Hunter region's advantage of established transmission and generation infrastructure and culture is a bonus in developing a prosperous post zero emissions economy.

2. Emerging trends in energy supply and exports, including investment and finance

Institutional Investors are signalling their intention to diverts from carbon exposure, and invest in low carbon opportunities. A recent survey by the Investor Group on Climate Change found that:

> "It finds that investor appetite for climate aligned investment continues to grow and activity accelerate. Even as the political landscape in Australia remains challenging, and doing deals is not easy." (Accelerating Change: Capital Growth in Climate Solutions: IGCC 2019)

Financial regulators are also increasingly raising the issue of carbon, financial risk. Both APRA and ASIC have warned that "Climate risk is all-pervading."

Finally, major global corporations are setting science-based targets to future-proof their business. Many companies are setting decarbonisation targets across their entire supply chain.

These major global reforms and trends are an opportunity for NSW. Conversely, delaying transition to a zero carbon economy will leave NSW exposed to significant economic and financial impacts.

2a. Emerging trends in energy supply

The Clean Energy Council's most recent report *Clean Energy Australia Report* shows a very large renewable energy pipeline with 14.8 gigawatts (GW) and $24.5b under construction providing 13,233 jobs (CEC 2019 p:13-14). However, NSW has only 3.8GW underway for this new industry, and is losing new energy supply market-share to other states.

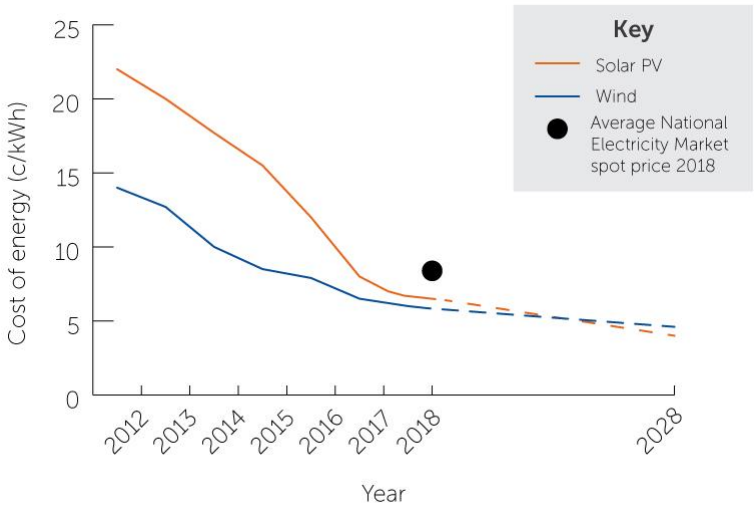
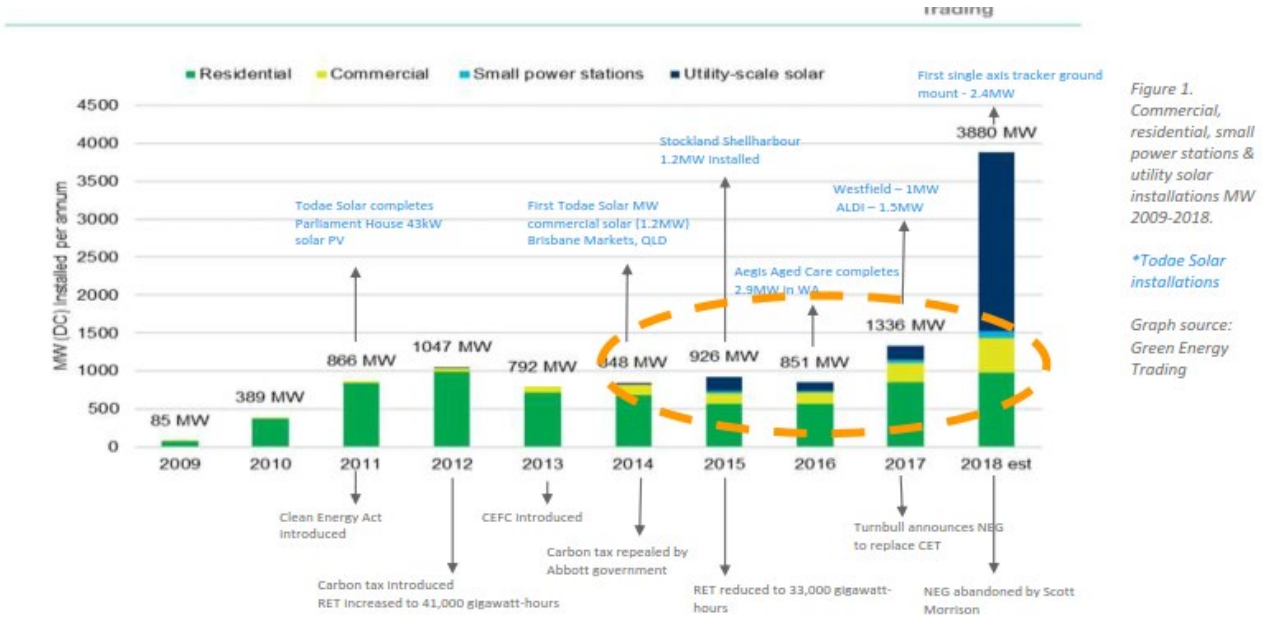


Figure 1 – Falling cost of renewable energy (Source: Electrifying Industry BZE, 2018)

This renewable energy pipeline is a direct result of the recent drop in renewable energy prices (see Figure 1 which illustrates the game-changing fall in the recent price of renewable energy.) This drop in renewable energy prices is driving the acceleration in commercial and utility scale solar photovoltaic installations occurring in Australia over recent years (See Figure 2).



Source: (Lazarus 2018: p12)

Figure 2 - Solar Uptake in Australia

AEMO also recently announced it will, for the first time, plan for a scenario of 80% reduction in emissions from grid (Parkinson 2019). BZE applauds AEMO for developing this important scenario since

it provides a pathway to support Australia's Paris commitments re the IPCC's global initiative to limit temperature rise to 1.5°C by 2030 (OCE 2018).

Renewable energy generation, and storage, systems are becoming pragmatically competitive with legacy fossil fuel assets, such as coal, oil, and gas. A massive 'changeout' of energy generation and storage assets and businesses is occurring due to lower prices and due to potent environmental concerns.

Recent technological progress

Recent technological progress has occurred in many areas:

- Solar PV technology where:
    - The price per Watt has been dropping very fast (see Figure 1), and coal-based assets risk becoming stranded, non-funded and even un-insurable when climate change risks are included
    - The power intensity of the latest commercial panels has increased to 400W per panel, with an efficiency of 22% and warranty of 25 years (CER 2019)
    - Solar paint cells are in pilot production in Newcastle (Dastoor 2018)
    - Solar cell efficiencies have continued to improve in recent years to over 26% (Green 2019)
    - There are Perovskite solar cells being developed with great promise, with most likely commercial application as high efficiency low cost tandem/multijunction cells with Silicon
    - Concentrated solar photovoltaics using multijunction cells have achieved 33% efficiency outdoors.
- Wind turbines with larger blades are increasing their efficiency, although ultimately limited per turbine by the speed of sound in air at the blade tips.
- Large-scale production of batteries are reducing the cost of utility batteries (e.g. the Hornsdale Tesla battery in SA).
- Concentrated thermosolar power stations have storage technology, and a Newcastle CSIRO energy research facility is exploring its potential using readily available technology to lower costs.

2b. Emerging trends in energy exports

Petroleum imports in 2014 were Australia's largest liability at $40.8bn (BZE, 2015).

While Australia recently has become one of the world's largest **Liquid Natural Gas exporter**s, this is at enormous environmental cost, since it has been shown that fracking in the US has caused a significant spike in methane emissions (Ambrose, 2019; Hanley, 2018), with subsequent climate change repercussions.

Indications are that Australian **coal** exports have peaked and "entered a long-term decline", with the export volumes from Newcastle having peaked in 2016. At least 75% of NSW Coal Export demand at clearly high risk of reduction by 2030 by destination countries embarking on decarbonisation (Buckley, 2018; Nicholas, S., & Buckley, T. 2019a; 2019b).

- Japan (METI, 2017) (DFAT, 2018)
    - Imported 45% of NSW thermal coal in 2016-2017
    - Has a Paris commitment reduction of 26% in CO2 emissions below FY2013 levels by FY2030
- South Korea (FuelCellworks, 2019) (DFAT, 2018)
    - Imported around 13% of NSW thermal coal in 2016-2017
    - Has a Paris commitment of 18% reduction in CO2 emissions below FY2010 levels by FY2030
- China (Xinhau, 2019) (DFAT, 2018)
    - Imported around 17% of NSW thermal coal in 2016-2017, but the NSW Coal exports are highly exposed to the US-China trade war by
        - The US-China coal export deal (West Virginia coal) or
        - The downturn caused by no US-China deals.

2c. Investor risk

Many institutions and regions are now recognising there is an urgent need to promptly eliminate fossil carbon from the global economy (see the Table in Part 2 attachment) for regions in Australia taking urgent actions on climate change). This zero carbon economy must simultaneously maintain and enhance the quality of life of citizens; domestic and foreign. The great bulk of NSW fossil carbon emissions are energy related.

Some examples of business opportunities and risks are described below:

- Christiana Figueres reports that "Investors [...] are growing wary of carbon risks", [for example] fund managers BlackRock and Vanguard "voted [...] against ExxonMobil management at its annual general meeting on 31 May and instructed the company to report on the profit impact of global measures to keep climate change below 2 °C" (Figueres 2017).
- Figueres also comments on the rapid growth of "'green bonds' to finance climate-mitigation efforts", and where the "financial sector has rethought how it deploys capital and is mobilizing at least $1 trillion a year for climate action (Figueres 2017).

As previously discussed, at least 75% of NSW Coal Export demand is at high risk of reduction by 2030 by the decarbonisation of the destination countries Japan, South Korea and China (Buckley, 2018; Nicholas, S., & Buckley, T. 2019a; 2019b).

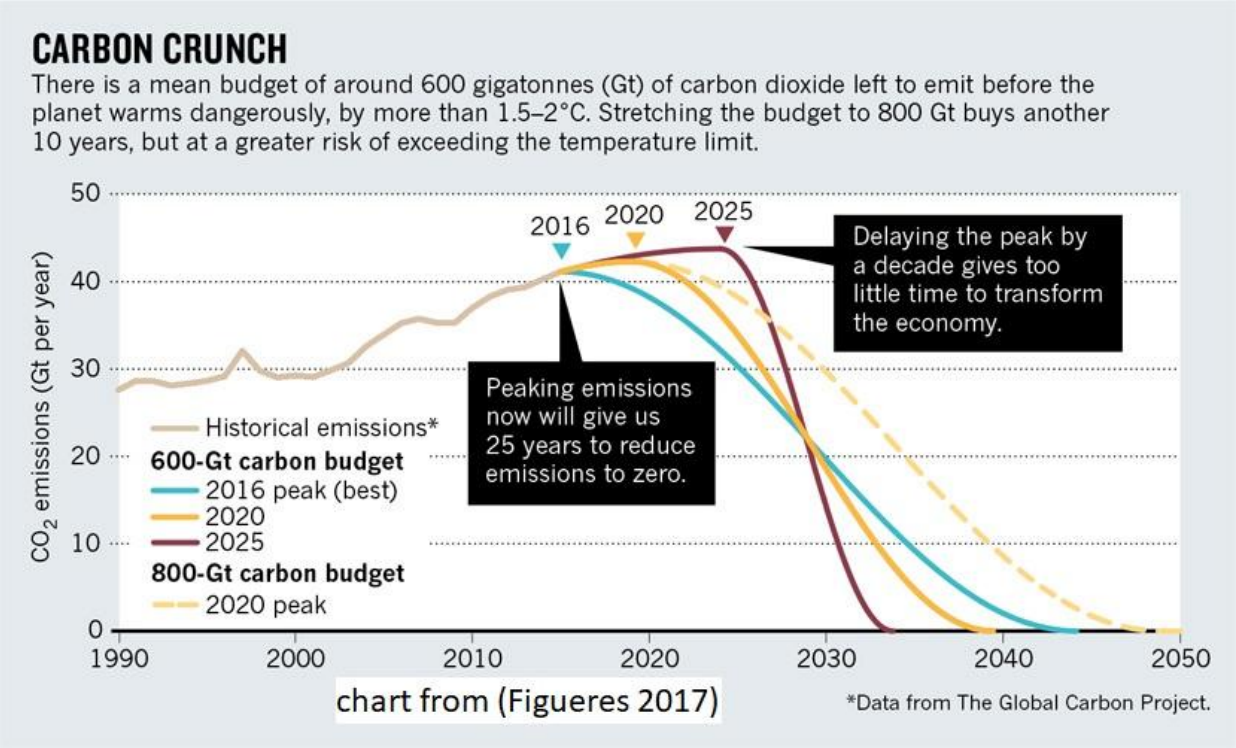
The risks of **developing new fossil fuel extraction facilities** in Australia have been highlighted recently with the recent legal cases where:

- a coal mine was not approved by a judge (Hannam, 2019), and

- a mine has only been given approval to export to countries who are party to the Paris climate agreement, or have a similar plan to bring down emissions (Ludlow, 2019).

The transformation of the economy needs to occur rapidly to zero carbon but will create great business opportunities, and also business risks:

- Christiana Figueres notes that the avoidance of warming "more than 1.5–2 °C" needs a prompt transition. Delaying this transition would lead to the crumbling of the available practical time frame for the transition as shown in Figure 3 (Figueres 2017)
- Had 'peak carbon' been in 2016 then the economy could have had a more manageable 30 years to reduce emissions to zero. (from 2016 to 2045)
- If we start now (2020) the transition to zero carbon economies will a difficult twenty years (from 2020 to 2040)
- If however peak carbon is delayed until 2025 then the needed transition would have to harshly crash to zero in about eight years (from 2025 to 2033)
- Transforming the global economy to zero carbon in ten to twenty years is a mighty challenge. To scale the issue, we can attempt to understand how much of NSW's GHG emissions are related to energy. For direct indications of the proportions of carbon emissions from NSW, we can refer to NSW government data. Adapt NSW reports that:
    - "Over eighty percent of NSW emissions came from the extraction, processing and burning of fossil fuels, primarily coal in 2015/16" (DEE 2016)
- Risks to business from climate change are analysed in Australian Greenhouse Office's 2006 report Climate Change Impacts & Risk Management - A Guide for Business and Government. This guide provides for example, a risk management framework to "to assist Australian businesses and organisations to adapt to climate change". Risks include changing frequency of heatwaves, disruption to agricultural production, and weather related public health problems. (Australian Greenhouse Office 2006)
- Lily Trager, of Morgan Stanley, discusses climate change related issues of "Damage to Buildings and Operations", "Reputational Risk", and "Disruption of Food and Water Supply".



Source: (Figueres, 2017)

Figure 3 - Carbon Crunch

2d. Financial Trends

Current global financial market trend related to carbon emissions and the fossil fuels include:

- insurance institutions are rapidly withdrawing support from fossil-fuel assets (Hannam, 2019; Wiki, 2019)
- superannuation funds, such as Australian Ethical are directing their investments toward "seeking out environmentally responsible investments" and "exclude[ing] all companies whose main business is fossil fuels, as well as diversified companies that earn some fossil fuel revenue and aren't creating a positive impact with their other activities." (Australian Ethical, 2019).
- Morgan Stanley & Co. finds that the opportunity in "green bonds" is vast: around $90 trillion will be required in infrastructure investment over the next 15 years to transition to low-carbon economies. Green bonds will be a key financing instrument in achieving this." (Trager 2019)

3. The status of and forecasts for energy and resource markets

NSW has been well served by fossil fuel industries, but current and future trends are:

- The overseas market in Asia is declining for thermal coal (Buckley 2018; Nicholas & Buckley 2019, March 29; July 9).
- Renewable technology is already available e.g. a recent ARENA report led by Dr Keith Lovegrove showed that we already have the existing technology that is needed for affordable dispatchable power across all timescales (ARENA 2018).
- AEMO is planning a scenario where there is up to 80% reduction in electricity emission in a future grid (Parkinson 2019)
- BZE has conducted Zero Carbon Australia sector-based research which showed:
    - reductions in energy demand:
        - of 15% for all buildings in Australia after retrofitting them as part of the Buildings Plan (BZE 2013) which conducted the first inventory of all buildings in Australia. It estimated their loads for 10 years
        - for making cement if the recommendations in the "Rethinking Cement" research plan (BZE 2017) were adopted
        - of up to 9% for manufacturing heat processes if fuel switching recommendations were adopted as shown in the BZE "Electrifying Industry" research report (BZE 2108).
    - increases in demand (allowing new renewable energy markets) shown by the Renewable Energy Superpower plan (BZE 2015). Australia has sufficient renewable energy to be a net exporter of renewable energy, allowing:
        - The NT government recently endorsed BZE's *10 Gigawatt Vision* (BZE, 2019) to power jobs and investment in the Northern Territory, including exporting renewable energy to Asia.
        - the High Speed Rail plan (BZE 2014) to proceed, avoiding the high cost of Sydney's second airport while lowering travel emissions and the risk of higher costs of oil imports.
        - The Electric Vehicles (BZE 2016) plan to proceed with the benefits:
            - A shift to 100 per cent electric vehicles would eliminate at least six per cent of Australia's greenhouse emissions
            - A rapid shift to electric vehicles operating on 100 per cent renewable electricity is both realistic and affordable
            - A rapid shift to electric buses operating on 100 per cent renewable electricity is also feasible, and affordable
            - This also off-sets Australia's unsustainable and high reliance on oil imports

4. Effects on regional communities, water security, the environment and public health

We're already seeing significant, disruptive and catastrophic impact on humans and environment from increases in temperatures e.g. bushfires (Hughes and Steffen, 2017; L. Williams, 2011), heat wave deaths (Blumer and Mayers, 2017; O'Neill, 2014; Robb, 2016). Here is a snap shot of global evidence:

- Temperatures have risen in Australia by more than 1°C since 1910, and have rapidly risen since 1950 (CSIRO & BoM 2018),

- The IPCC and other experts show that:
    - "Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (high confidence)" (IPCC 2018: 8). This due to the existing CO2-e in the stratosphere and the current rate of CO2-e increase
    - Australia like other rich countries is not doing its fair share of the global greenhouse gas reductions, according to our cumulative emissions, our wealth and the timing of when we put our emissions into the atmosphere. We need to reach zero emissions well before 2050 (Jackson 2016: 5) and all rich countries need to reach zero emissions by 2030 to meet our Paris commitments.

We need to act now to protect NSW:

- The bushfires of the summer of 2017 were so unlikely (5 standard deviations from the average in actuarial risk tables) that it was probably a climate change event (Actuaries Institute, 2019). Other unlikely events recorded by the Actuaries Institute which had catastrophic effects included:
    - the April 2015 Dungog inundation where houses were washed away was 2m above the 1% Annual Exceedance Probability (1 in 100 year flood event) for the Myall Creek used as basis for flood planning
    - The June 2007 Newcastle flooding including the "Pasha Bulka" beaching. Notably the peak level of flooding of King and Steel Street Newcastle on the 8th June 2007 is similar to future sea level rise by 2090 in the prevailing trajectory of 4.3°C temperature rise by 2100 (RCP 8.5 scenario).
    - The accentuated recent drought, exacerbating cattle, wheat and other farmer income stress,
    - The shortfall of rain into the Murray-Darling system, leading to the Menindee Lakes fish kills (climate change trends show a drop in rainfall in the South-East of Australia).

We need to avert the serious human health effects to prevent the 51% increase in serious health claims in the mining industry in the 12 years from 2001 to 2013 (Wundersitz, 2017).

In addition, coal-fired power stations (Allen, 2019; Winn et al, 2019; Ewald, 2018) are responsible for:

- Extraction of large amounts of water
- Fugitive methane emissions
- Carcinogenic fine particulates
- Toxins from burning coal e.g. sulphur and nitrous oxide emissions
- Changes to local water temperatures and purity
- Leaching of toxic ash waste-streams into our soils, water tables and lakes.

Coal generation and its associated mining and transport is responsible for many illnesses (Ewald 2018), including:

- Asthma attacks

- Heart disease & stroke
- Lung cancer
- Higher mortality rates including deaths in coal mines,
- Low birth-weight of babies, and
- New onset diabetes.

5. Opportunities to support regions with changed markets for sustainable economic development

Our BZE research show transforming all economic sectors to zero carbon:

- provides significant employment opportunities through diversifying local economies in NSW that are currently exposed to the negative consequences of a downturn in coal mining and exports, and
- will continue the economic growth and prosperity of the NSW economy as the burning of fossil fuels is limited and its exports diminish are depleted.

Transition and diversification studies for the Hunter (Perry & Hewitson, 2019; Bill et al., 2008) have been conducted and they, and similar studies, have found there will be large job losses as coal-based assets close. An independent transition process is needed, with collaboration needed between the NSW Government and power generation and mining companies to invest in:

- clean technologies
- mine rehabilitation
- retraining
- skill development for the workforce, and
- for compensation to the community and the workers.

Legislation and policies are required to:

- have a 2030 zero carbon target to urgently prevent global 2°C rise
- Develop of transition plans
- Fund and resource transition strategies for impacted communities

To realise opportunities, and avert risks, Beyond Zero Emissions recommend that the Committee consider:

- **Reinstate the Carbon Trading** scheme which was abolished when the Federal Government implemented its Carbon Price.
- Develop **zero carbon industrial strategy** with three aims:
    - Stimulate growth in NSW exports of intellectual property, due to the zero carbon footprint of valuable ideas compared with material goods
    - Stimulate growth in NSW low-carbon flexible manufacturing, capitalising on our unique renewable energy resources

    - Rapidly reduce industrial emissions to zero, with a focus on electrifying industrial heat processes.
- Support **low-carbon goods** through NSW government procurement standards and targets.
- Develop a massive R&D investment in low-carbon innovation and flexible manufacturing, financial incentives for manufacturers to switch from fossil fuels to renewable energy and diversify the potential product range they can produce from the same production line sunk investment.
- Invest in School education
- Invest in TAFE and University courses for advanced manufacturing e.g. with an "Advanced Applied Technology" course to support new industry technology, such as the AiGroup's supported Victorian 22460VIC Diploma of Applied Technologies (DET, 2018),
- Enhanced community literacy in the innovation system, including through school and TAFE curriculum
- Developing outreach and Continual Professional Development programs with those employed in industries at risk of closure like coal mining and coal-power generation.
- Expand Innovation NSW within the NSW Department of Customer Service to support increased availability of low cost startup and R&D advisory services as part of existing innovation networks (eg the University of Newcastle's Integrated Innovation Network (I2N)), so that innovators can successfully navigate key early hurdles like intellectual property and funding.
- Deploy a one-stop advisory service to help businesses large and small with the switch from fossil fuels to renewable energy. Large energy consuming business should be mandatorily required to interact with the NSW advisory service both as an expectation of maintained social license and to allow the NSW state government to continually assess social and economic risks.
- Consider adding an additional required topic to the Maintenance of Competence Scheme for Practising Certificates for Work Health and Safety (Mines and Petroleum Sites) Regulations 2014 for competency in the Australian Innovation System in general and awareness of the opportunities and services available in NSW (eg I2N, mentioned previously for Newcastle & Hunter) in particular. The future health and well being of coal mine workers, their families and communities is a general health and safety issue.
- Provide information and materials for the office of NSW Business Connect and NSW Invest to support existing and emerging business to engage with the NSW Renewable Energy Action plan as potential zero carbon energy consumers, particularly for globally active energy intensive manufacturers and miners/mineral processors seeking low cost reliable energy for expanded operations.
- Support Indigenous enterprises to be equity partners in 100% renewable energy projects and carbon farming projects throughout NSW, from inner city rooftops to rural and remote. NSW is the home of and/or covers the traditional lands of the most Indigenous Australians by population amongst all states and territories in Australia, and some 42% of NSW Indigenous Australians live in Urban locations compared with only 5% in remote locations.

- Offer interest-free loans, payroll tax holidays, and cheap land to targeted companies that employ workers with dignified opportunities in diverse industries in regions where the local economy is heavily exposed to a global downturn in coal.
- Set targets for mines to transition to 100% renewable energy, including machinery and vehicles
- Create incentives for downstream processing of minerals within NSW using low-emissions energy and processes, for example for the possible future zero emission production of carbon fibre using coal as a material feedstock only.
- Put in place a domestic reservation system for Hydrogen and incentives for Hydrogen facilities to supply FCAS, SRAS and inertia services to the NEM so that NSW energy costs become structurally lower than global and even interstate competitors due to NSW's geographically central location within the NEM.
- Support the increased capacity within the NEM of interconnects between NSW and all three of Victoria, South Australia and Queensland so that NSW can provide reserve capacity into any of these states, backed by local storage projects like hydroelectricity and hydrogen project, and benefit from the geographic diversity that the neighbours supply.

Incentives for industry

Governments in Australia must join other countries like Japan and South Korea by developing a coordinated strategy with the explicit aim of decarbonising industry. NSW is particularly exposed to Japan and South Korea decarbonisation and so coordination, rather than reaction, is vital.

- High-technology manufacturing operations can bring a job-multiplier effect as high as 10-to-1.
- Proportionally, manufacturers spend more on innovation than any other sector of the Australian economy
- Carbon footprint of intellectual property and valuable ideas is very low (notionally zero) compared with material goods production

Any other related matters

Narara Ecovillage Co-operative Case Study

The Narara Ecovillage near Gosford, NSW is an example of how sustainable vision and community leadership, supported by all three levels of Government, can drive innovative local solutions, while building a thriving community. Here is a brief summary of how this was achieved:

- The Sydney Coastal Ecovillage (SCEV) was formed in 2004 and used newsletters, meetings and other events to find those who would like to join the founder, Lyndall Parris who wanted to live sustainably.
- Narara Ecovillage Co-operative Ltd (NEV) was formed in 2012 as the vehicle to fund and purchase 63 ha of land near Gosford. NEV has attracted members with strong expertise in

community, sustainable, governance, financial and technical areas, including in the power industry.

- NEV submitted the Stage 1 DA in December 2013, and it was approved in August 2014, with only 4 objections, and Gosford City Council viewing it as an exemplary development.
- NEV won a grant in March 2015 from the State Government (NSW's OEH) for $70,000 to research a 'smart grid', which showed that this was a feasible concept.
- In September 2016, NEV won a $1.16m grant from the Federal Australian Renewable Energy Agency (ARENA) to build one of Australia's first community-led microgrids. It is designed to use solar photovoltaic (PV) panels and a large battery for storage, with intelligent balancing of the village power generation and loads. The NEV power solution should dramatically lower the energy demand from the grid, with much lower carbon emissions than usual by just expanding the grid. NEV is contributing 57% of the funds, and will share the ground-breaking knowledge.
- There have been many challenges overcome along the way (including the amalgamation of Gosford and Wyong Councils into the Central Coast Council), but NEV is grateful that the three levels of government have been able to contribute to create a sustainable community.
- Meanwhile, the community has grown with Stage 1 sold out, and a half dozen houses have completed by Quarter 3, 2019. About 30 houses are expected to be completed by the end of 2019 and Stage 2 is being planned for submission to the council.

Appendix 1 - About Beyond Zero Emissions

Beyond Zero Emissions is an internationally recognised climate change think tank.

We produce independent and innovative research solutions demonstrating that a zero emissions Australia is achievable and affordable now.

Our reports provide detailed pathways for a ten-year transition in each major sector of Australia's economy.

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13,760 Mtoe = 13,760,000,000 toe

= 13,760,000,000 toe x 41.868 GJ /1 toe (since 1 toe = 41.868 GJ)

= 576,000,000,000 GJ = 576 exajoules (EJ)

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PART 2 – Attachment

Section 1 – Hydrogen from Renewable Energy

The capacity and economic opportunities of renewable energy - Australia's Competitive Advantage

Australia's large Renewable Energy resource potential could fulfil a looming demand from China, Japan, South Korea and Singapore for as much as 3.8 million tonnes Hydrogen in 2030 (˜AUD9.5 billion) (Bruce et al., 2019 p.xix)(METI, 2017)(Yonhap, 2019)(Xinhau, 2019)(COAG, 2019)

The Asian Renewable Energy Hub plan (BZE, 2018) is being developed in Western Australia and is currently at Major Project Status by the WA Government. Its aim is to produce large scale green hydrogen products for domestic and export markets.

The case for Hydrogen may even be stronger in NSW than WA, because:

- the growth of the Asian Hydrogen market is likely to correlate with the decline of NSW coal exports and the opening up for other uses existing deep sea port assets and existing gas storage facilities with strong grid connections such as those in Newcastle (Jemena 2019)
- the existing ammonia and ammonia nitrate plant in Newcastle is smaller in global terms, and so expansion plans more likely so as to achieve economies of scale. For more information, see the Ammonia case study in "Electrifying Industry" (BZE 2018).
- as renewables penetration increases near large load centres, the grid will require low cost storage to provide resource adequacy, frequency management, voltage management and system restoration services to remain competitively priced for industry (AEMO 2018)
- future air and sea transport may be carbon constrained requiring fuels based on renewable energy available at key NSW ports, with logistics factors strongly favouring local production.

Key opportunities, developments and risks to Hydrogen over the next decade include:

- the opportunity for NSW to earn significant State revenues from Hydrogen exports
- the development by TUDelft in conjuction with Vatenfall Nuon at the Magnox Power Plant in the Netherlands of a "Battolyser" hydrogen plant (Mulder, 2017) capable of supporting the full range of grid services with high asset utilisation so much so that the grid services alone can justify the capital costs whilst limiting electricity prices, producing green hydrogen competitive with natural gas.
- the development and mass production of electric and/or hydrogen vehicles by many major manufacturers (Toyota, 2019) (Hyundai, 2017), seeking incentives and infrastructure to grow.
- the development by Alstom of the Coradia iLint Hydrogen regional train being deployed in Lower Saxony, Germany. (Alstom, 2018)
- the risk that leaked Hydrogen alters the ozone layer and thus acts as an indirect greenhouse gas of GWP 5.8 over 100 year time horizon (Derwent, 2006) (Tromp, 2003)

Section 2 - Australian Commitments for Climate Change

Table 1 (*reprinted from 100% Renewables Pty Ltd's blog, Albert, 2018)* shows the regions in Australia committed to taking action on Climate Change at the end of last year.

Table 1 - **Australian Commitments for Carbon Emissions and Renewable Energy**

Source: Albert, 2018

State, Territory	**Renewable Energy Commitment**	**Carbon Commitment**
Australia	~20% from renewable energy sources by 2020 (33,000 GWh by 2020)	26-28% emissions reduction from 2005 levels by 2030
ACT	100% renewable electricity by 2020	40% reduction in greenhouse gas emissions on 1990 levels by 2020
		Zero net emissions by 2045
NSW	20% from renewable energy in line with the RET	Zero net emissions by 2050
NT	50% renewable energy by 2030	
SA	No new target. 50% renewables target by 2025 largely met.	Zero net emissions by 2050
QLD	50% renewable energy by 2030	Zero net emissions by 2050
VIC	40% renewable energy by 2025	Zero net emissions by 2050
TAS	100% renewable energy by 2022	Commitment to establish a zero net emissions target by 2050
WA	No target	No target
Capital City	**Commitment**	
ACT Government	Carbon neutral by 2020	
City of Adelaide	Zero net emissions from council operations by 2020. First carbon neutral town by 2050	
Brisbane City Council	Carbon neutral council from 2017	
Melbourne City Council	Carbon neutral council by 2020	
City of Perth	Reduce council emissions by 20% by 2020	
	Facilitate a 32% reduction in citywide emissions by 2031	
City of Sydney*	Reduce emissions by 70% for the LGA by 2030	
	50% renewable energy for the LGA by 2030	
	Net zero emissions for the LGA by 2050	
Council or LGA	**Commitment**	
Byron Shire Council	100% renewable energy by 2027	
	Net zero emissions by 2025	
Byron Bay community	Plan for first zero net emissions community	

State, Territory	Renewable Energy Commitment	Carbon Commitment
City of Greater Bendigo	100% renewable energy by 2036	
Coffs Harbour City Council	100% renewable energy by 2030	
Eurobodalla Shire Council	100% renewable energy by 2030	
City of Fremantle	100% renewable energy by 2025	
	Carbon neutral since 2009	
	Zero carbon for LGA by 2025	
Gold Coast City Council	Carbon neutral by 2020	
City of Greater Geelong	Zero carbon council by 2050	
Lismore City Council	Self-generate all electricity needs from renewable sources by 2023	
Mullumbimby	100% renewable energy by 2020	
Newstead Village	100% renewable energy by 2017	
City of Parramatta	Carbon neutral by 2022 with 60% emissions reduction by 2038 based on 2015 levels	
Port Macquarie-Hastings Council	100% renewable energy by 2027	
City of Port Phillip	Zero net emissions by 2020	
Tweed Shire Council	50% renewable energy by 2025	
Tyalgum Village	Plan to be off the grid, 100% renewable energy, with batteries	
Uralla Town	Plan to be first zero net energy town	
Yackandandah Town	100% renewable energy by 2022	
Moreland Council	100% renewable energy by 2019	
	Carbon neutral for operations since 2012	
	Zero carbon emissions Moreland by 2040	
City of Darebin	Zero net carbon emissions across Darebin by 2020	
Broken Hill Council	100% renewable energy status by 2030	
Logan Council	Carbon neutral by 2022	
Noosa Council	Net zero emissions by 2026	

State, Territory	Renewable Energy Commitment	Carbon Commitment
Hepburn Council	Carbon neutral by 2021	
Mornington Peninsula Council	Carbon neutral by 2021	
Warrnambool Council	Carbon neutral city by 2040	
Nambucca Council	Zero net carbon emissions within the 2030 to 2050 time frame	
Randwick Council	Zero emissions by 2030	

Section 3 – References for PART 2

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