

Submission to the Senate Committee into the retirement of coal-fired power stations

November 2016



67 Payneham Road
College Park SA 5069
P 0422 974 857
E admin@dea.org.au
W www.dea.org.au

Healthy planet, **healthy people.**

DEA Scientific Committee

Prof Michael Kidd AM
Prof Ian Lowe AO
Prof Peter Newman AO
Prof Hugh Possingham
Dr Rosemary Stanton OAM

Prof Stephen Boyden AM
Prof David de Kretser AC
Prof Robyn McDermott
Prof Emeritus Sir Gustav Nossal AC
Prof Lawrie Powell AC
Dr Norman Swan

Prof Peter Doherty AC
Prof Stephen Leeder AO
Prof Lidia Morawska
Prof Fiona Stanley AC

Submission to the Environment and Communications References Committee into the retirement of coal-fired power stations.¹

Doctors for the Environment Australia (DEA) is an independent voluntary organisation of medical doctors and students who work to address the adverse health effects of environmental damage, pollution and anthropogenic global warming in a broad public health context.

DEA welcomes the opportunity to comment regarding the senate inquiry into the retirement of coal-fired power stations. The submission will address each of the specific matters as referred to by the Environment and Communications Reference Committee with a particular emphasis on the health implications.

Recommendations

Recommendations pertinent to each term of reference are listed at the end of that section. On page 22 we detail our overall conclusions and recommendations.

(a) the experience of closures of electricity generators and other large industrial assets on workers and communities, both in Australia and overseas;

An urgent need to address carbon emissions and a move towards renewable energy are creating structural changes in energy supplies that are having, and will have, profound impacts on workers and communities in the energy sector. With knowledge and planning, those impacts can be attenuated, but without such planning, community and social effects can be long lasting.

Recent closures of coal-fired power stations in Australia

When coal-fired power stations have closed, they have done so one at a time. Over the last 5 years, 8 of the 12 most polluting coal-fired power stations have closed in Australia. These power station closures have occurred in 4 states (NSW, QLD, VIC, SA)².

Coal Power station	tCO₂-e/GWh	Notes
Morwell	2,415	Closed 2014, La Trobe Valley, VIC
Playford B	1,390	Closed 2016, Port Augusta, SA, Alinta
Redbank	1,187	Closed 2014, Singleton, NSW
Anglesea	1,090	Closed 2015, Anglesea, VIC
Collinsville	1,090	Closed 2012, Collinsville, QLD
Munmorah	1,070	Closed 2012, Lake Munmorah, NSW
Northern	1,033	Closed 2016, Port Paterson, SA
Swanbank B	1,000	Closed 2012, Ipswich, QLD

Sometimes they have been taken out of service slowly, so that by the time they close there are only a few employees remaining. At other times, they have closed without much warning, leaving many employees out of work which can have devastating effects on the community. Below are outlined a few examples from recent closures.

The recent closures of the Alinta energy resources – the Port Augusta power stations and Leigh Creek coal mine – have caused job losses for 390 workers. While the company is working with government to develop a package of support services to suit employees needs, transition plans have not been in place in time to prevent workers from leaving the areas, with subsequent effects on local and regional businesses. DEA has had a long involvement (2010-2016) with the closures in Port Augusta. This experience is detailed as a case study in Appendix A (page 24).

Redbank also closed quickly. Redbank was a coal-fired power station that used waste coal for electricity generation. It has been termed the “Redbank Project” due to the aim of using waste coal. Consequently, it was difficult to maintain profitability and finally went bankrupt. When it closed in October 2014 there were 39 fulltime employees. The power station was not able to be mothballed and was put in the hands of receivers. The employees lost their jobs. It is unclear how many jobs were created in the decommissioning and other tasks in the power station.^{3,4}

In the Upper Hunter, the dramatic decline in the coal price has resulted in many jobs losses as outlined in the Hunter Research Foundation’s economic indicators, June 2016.⁵

“Following sustained falls from the mining-related peak of late 2013, employment numbers in the Hunter Balance appear to have stabilised since mid-2014, consistent with the slow transition to non-mining investment evident elsewhere in the economy. In July 2015, the number employed had returned to about the level of mid-2010, suggesting a return towards long-term trend level if the transition is sustained.”

There was a fall in unemployment from 8.1% in June 2015 to 5.9% in June 2016.⁶ Consequently, it would appear that the acute loss of employment from the closing of Redbank power station did not have long-term unemployment consequences.

Anglesea was closed in 2015 after Alcoa was unable to find a buyer for its aluminium smelter at Port Henry for which Anglesea supplied 40% of the power. The power station was already 46 years old. Although 85 jobs were lost, it is difficult to gauge the effects on the local community as there were job losses in other sectors at the same time. However, according to the Surf Coast Shire Council the unemployment rate peaked in March 2015 and has continued to decline.⁷

Collinsville was built in 1968 and operated between 1972-1988 and 1996-2013. It was decommissioned in 2013. RATCH-Australia the operator⁸ received cash from the Energy Security Fund as a payment to the operators of the most polluting coal-fired power stations. There were job losses in the coal industry at the same time. Consequently, there have been higher rates of unemployment in this region compared to the rest of Queensland. However, other regional areas in Queensland also have higher unemployment. Apparently during 2015 unemployment rose 8% in Bowen to 14.7%.⁹ This is independent of the closure of the coal-fired power station.

There are plans to convert the Collinsville power plant to solar thermal, or solar photovoltaic and gas generation. This would give a networks-connection savings-cost when compared to a green site solar power station¹⁰.

In summary, many power stations close at short notice causing hardship for the employees and their communities. In most circumstances, there was no transition to other employment. Any employment that was offered was usually in a caretaker mode. There is one example where the infrastructure of the power station might be used to provide alternative energy (Collinsville). If this idea had been raised before the closure of the coal-fired power station, then many job losses may not have occurred.

Consequently, it can be seen that an ordered closure of power stations is better for the employees as well as the local community.

Future closures

The Latrobe Valley is facing the closure of the Hazelwood coal-fired power station in March 2017, giving less than six months warning. The Latrobe Valley has already been the site of major job losses in the 1990s when the State Electricity Commission of Victoria (SECV) was privatised, leading to a major restructure and a loss of 6,000 jobs within the electricity sector. The Latrobe Valley had difficulty improving its inequality and poverty levels in the 1990s compared to other regional areas in Australia. Over the subsequent ten years, there has been high unemployment (currently 9%)¹¹, a loss of population as people moved away from the area, and depressed local business. Because of fewer job opportunities and low family incomes, there is early school leaving and a high incidence of sole parent families¹². In addition, there has been difficulty attracting new businesses, or relocating businesses to the area, which has been noted in other areas where there has been a major industry, the dominance of which may prevent smaller entrepreneurial businesses from emerging.¹³

Other large industrial closures

The impact of the closure of BHP's steelworks in the Hunter Valley is an example of a large industrial closure in Australia. At its peak, BHP employed 13,000 people, but after shedding jobs over the decades marking the industry's decline, the steelworks was employing only 4,000 people at the time of its closure in 1999. Federal and state governments invested \$175 million in the early 1990s to relocate businesses to the Hunter Valley, and towards diversification and new business opportunities.¹⁴

This effort created a structural change, away from the dominance of primary and secondary industries, and towards growth in the tertiary and services sector. Immediately after the closure in 1999, another \$30 million was invested in a "Hunter's Advantage" fund, focusing on job creation over the subsequent two years. The Hunter Valley's employment rate is now 5.4% (below the national average) and its workforce has increased by 60,000 in the decade to 2010. Success in the Hunter Valley has been due to diversification and change, with strong community collaboration and approval.¹⁵

A healthy lifestyle, vibrant culture and the natural beauty of the area can encourage valuable skilled employees to stay, and attract others to the area.

Environment Victoria's recent report, *Life After Coal*¹⁶, describes the effects of closure of major industrial assets on two overseas communities in order to draw conclusions for the management of Latrobe closures.

Kodak was the major employer in the US town of Rochester, the company generating revenue of US\$14 billion only seven years before it declared bankruptcy in 2012. Over the three-decade period prior to 2012, Kodak shed 50,000 jobs, but 90,000 new jobs were created through government, private funding and community action to encourage diversification and new opportunities. Employment was found in new and emerging industries such as optics and photonics, in the education and health sectors, and in cultural institutions.¹⁷

In contrast, the effects of the closure of coal mines in Wales, after a decade-long industrial dispute are still being felt. There was no community support or transition plans from government or community after mine closures in the 1980s. 25,000 Welsh miners lost their jobs over a decade. Poverty levels and unemployment rates in the area are still higher than the national average, with poor health and high rates of disability benefits indicating long-standing economic and social consequences.¹⁸

The Report concludes¹⁹ that a planned transition should include a timetable for the orderly phase out of the four power stations and three

associated mines, support for power station workers and comprehensive mine rehabilitation. The Report identified five potential new industries for sustainable economic development.

Conclusion

It is evident that it takes time for new businesses and economic opportunities to become established within an area and within communities. When change comes, it often comes quickly, as in the cases of closures of Port Augusta power stations, Leigh Creek coal mine, and now Hazelwood power station. However, all could have been anticipated for several years in view of the health harms and the demands of climate policy. Without timely planning and establishment of alternative pathways of employment before industrial decline, there is more likely to be adverse economic impact and upheaval.²⁰ In addition, transition is more effective when it involves both community leaders and government, and opportunities should capitalise on existing skills and assets of the region.

Recommendations

1. Detailed planning for community employment and development in relation to every coal-fired power station in Australia should be implemented now.
2. Renewable energy development should be the development of choice to replace the energy requirements of closing these coal-fired power stations.
3. The degree of pollution and its danger to local communities should be a major factor in deciding priority for closure and in advising community and workers of the need for closure (see section c, ii).
4. In determining the degree of local pollution, air quality data monitoring in relation to all power stations should be subject to independent review, be transparent, immediately available and conducted by the state Environmental Protection Authority and not the operator.

(b) the role that alternative mechanisms can play in alleviating and minimising the economic, social and community costs of large electricity generation and other industrial asset closures, drawing on experiences in Australia and overseas;

These mechanisms are addressed in the next section.

(c) policy mechanisms to encourage the retirement of coal-fired power stations from the National Electricity Market, having regard to:

(i) the 'Paris Agreement' to keep global warming below 2 degrees celsius, and ideally below 1.5 degrees celsius,

In having regard to the 'Paris Agreement's' (PA) primary aim of limiting global temperature increase, the policy mechanisms for retirement of coal-fired power plants will need to be governed by a sense of urgency. There are other components of the 'Paris Agreement' which should also influence policy, but as these are covered elsewhere in the submission, they will be considered only briefly here.

The need for urgency

The 'Paris Agreement' states "*The Parties to this Agreement...Recognizing the need for an effective and progressive response to the urgent threat of climate change on the basis of the best available scientific knowledge,*"²¹ and "*to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:*

*(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change;"*²²

Many commentators have concluded that limiting temperature rise to 1.5°C is now impossible and that very strong efforts are required to limit temperature rise to 2°C.²³

This sense of urgency is also explicit in the following extract of the Agreement.

*"In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty."*²⁴

Therefore, any policy for retirement needs to contain mechanisms to allow the process to start with an urgency compatible with the degree of global warming which has already occurred, and compatible with the emphasis of urgency contained in the 'Paris Agreement'.

Opponents of strong policy often use the argument that Australia's global emissions at 1.3% are comparatively low such that action will not make any difference. However, the 'Paris Agreement' iterates that all countries must play their part in recognising that climate change is a "common concern of mankind" and that "As nationally determined contributions to the global response to climate change, all Parties are to undertake and communicate ambitious efforts..." and "The efforts of all Parties will represent a progression over time, while recognizing the need to support developing country Parties for the effective implementation of this Agreement."²⁵

While we are one of 179 of the world's 186 nations with emission contributions of less than 2%, these 179 nations together contribute 43% of the world's CO₂ emissions.²⁶

Therefore, Australia must act as a member of a global team and play its fair share in emission reduction, particularly when its emissions have actually been increasing rather than reducing in the last few years.²⁷ If all team members adopted the attitude that their meagre contributions did not matter, global warming would be unstoppable.

The degree of urgency can also be gauged by the concept of the carbon budget. Using this concept, with current 'business as usual' the world will emit sufficient carbon to have a 75% chance of meeting the 2°C warming limit in only 12 years. Extrapolating to Australia's reserves of coal, it is calculated that over 90% of our known reserves must stay in

the ground for the time-being, which gives us only a few decades of diminishing use for electricity generation.²⁸

Incentive for urgent action for Australia to retire coal-fired power stations is also provided by the recent death of substantial parts of the Great Barrier Reef.²⁹ Warming of the oceans even to a depth of 2 km can now be reliably attributed to global warming from greenhouse gas emissions.³⁰

For Australia, reducing emissions will be a major step in support of its Pacific neighbours who are already having to deal with the emerging effects of climate change. Here, Australia would be responding to *“Also recognizing the specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, as provided for in the Convention”*.^{21,31}

The need for ambitious efforts

That ambitious efforts should be an important part of policy is referred to several times in the *‘Paris Agreement’*: *“Each Party’s successive nationally determined contribution will represent a progression beyond the Party’s then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.”*³²

“Different national circumstances” for Australia can mean that we have an abundant supply of resources of solar and wind energy together with the capacity to explore the possibilities of wave, tidal and other renewable sources. We can also employ solar-pumped-hydro and the many methods of energy storage which are already being introduced in other countries.

The need for care of the workforce

As is covered elsewhere in this submission, the *‘Paris Agreement’*, in line with the endeavours of all political parties and law-makers, recognises the need to maintain the entitlements of the workforce in the transition away from coal.

“Taking into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities”.³³

The need to preserve sustainability

Preserving sustainability is an important component of the 'Paris Agreement'.

"Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of "climate justice", when taking action to address climate change"³³, and "Also recognizing that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change"³³.

Currently, the planet is on an unsustainable course in so many of its vital requirements, so the need for sustainability should be used to encourage the retirement of coal-fired power stations.³⁴

The importance of technological innovation

The 'Paris Agreement' clearly encourages the exploration of newer technologies when moving away from coal-fired power.

"Parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions"³⁵ and "Accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development. Such effort shall be, as appropriate, supported, including by the Technology Mechanism and, through financial means, by the Financial Mechanism of the Convention, for collaborative approaches to research and development, and facilitating access to technology, in particular for early stages of the technology cycle, to developing country Parties".³⁶

Australia has been slow to investigate and incorporate new power generation and storage techniques but consideration of these must be included in the policy mechanisms to assist in retirement of coal-fired power stations.

Recommendations

1. The Federal government needs to ratify the "Paris Agreement" as a priority. Having done so will mean that planning the retirement of all coal-fired power stations in Australia will become a constant endeavour.

2. Policies for power station retirements need to be mindful of ambitious targets in carbon emission reduction.
3. In facilitating the urgency there also needs to be care for the workforce.
4. Technological innovation is critical in order to facilitate ambitious emission reduction. As the global community, including Australia, is lagging in efforts to honour the Paris Agreement, technologies to remove atmospheric carbon may also become essential.

(ii) the state and expected life span of Australia's coal-fired power plants,

Coal-fired power plants are substantial sources of air pollutants which cause significant health problems. The three main pollutants are sulphur dioxide, SO₂, a mix of nitrogen oxides referred to as NO_x, and particulate matter in the PM₁₀ or PM_{2.5} size range. SO₂ and NO_x are both powerful respiratory irritants, causing asthma, chronic lung disease, and restricted lung growth in children. Fine particle pollution causes similar respiratory problems but is also associated with ischaemic heart disease, lung cancer, and increased mortality.

The pollutants can travel long distances, so even though power stations are located outside cities they are contributing to major city pollution as well as having higher impacts on the local towns. This has been illustrated in Sydney where research by CSIRO and the Australian Nuclear Science Technology Organisation (ANSTO) showed that half of the sulphate particles at Richmond in western Sydney could be traced back to one of the coal-fired power stations despite these being located 70, 90 and 140 Km away³⁷.

Particulate air pollution is measured and reported according to the particle size. Of the particles, those less than 2.5 micron in size (PM_{2.5}) have the greatest health impact, affecting both the lungs and cardiovascular systems. Bigger particles affect mostly the respiratory system. The reporting metric PM₁₀ however includes PM_{2.5} as a subset. There are two other important pollutants from coal-fired power: mercury and fluoride, but the amounts are small.

While the climate change effects of coal-fired power are distant and delayed, the air pollution effects are regional and immediate, so should be taken into consideration in planning the transition of power generation away from fossil fuels. The best estimate of the dollar value of the health harm from coal-fired power in Australia is AUD \$13 per

MWh, from a 2009 report by the Australian Academy of Technological Science and Engineering.³⁸

There is considerable difference in emissions intensity between the various coal-fired power stations in Australia. The amounts of these pollutants from each plant are reported annually to the National Pollutant Inventory (NPI) and are publicly available³⁹. Total emissions fluctuate with how hard the plant is being driven, so emissions (in Kg) should be divided by the amount of power (in GWh) produced. The emission intensities of these pollutants vary from year to year depending on how the plant is managed and the quality of the fuel burned. The following table shows the NPI declared emissions divided by the Australian Energy Market Operator (AEMO)-reported power production for each of 4 years, for each of the big coal-fired generators in the eastern states.⁴⁰

Kg per GWh	2011-12	2012-13	2013-14	2014-15	Year commissioned and nameplate output
New South Wales					
Bayswater					
					1986
SO ₂	4311	3785	3767	4396	GW 2.64
NO _x	2561	2245	2680	2916	
PM _{2.5}	19	31	8	14	
PM ₁₀	25	56	55	60	
CO ₂	992,000				
Liddell					
					1973
SO ₂	4280	4488	3581	3857	GW 2.0
NO _x	2388	2319	2445	2164	
PM _{2.5}	53	24	19	20	
PM ₁₀	94	44	63	61	
CO ₂	1,081,000				
Eraring					
					1984
SO ₂	2126	2030	2240	2033	GW 2.88
NO _x	1530	1381	1364	1406	
PM _{2.5}	21	18	18	31	
PM ₁₀	40	34	36	59	
CO ₂	999,000				
Vales Point					
					1966
SO ₂	2489	2125	2054	1730	GW 1.32
NO _x	2655	2922	3228	3027	After scale back
PM _{2.5}	17		4	3	
PM ₁₀	33	5	12	10	
CO ₂	1,032,000				
Mt Piper					
					1993
SO ₂	4734	4279	4768	5728	GW 1.4
NO _x	3051	2743	3073	3818	
PM _{2.5}	15	18	22	21	
PM ₁₀	29	35	43	41	
CO ₂	935,000				

Kg per GWh	2011-12	2012-13	2013-14	2014-15	Year commissioned and nameplate output
Victoria					
Hazelwood					
					1964
SO ₂	960	1128	1244	1903	GW 1.6
NO _x	1953	2213	2282	2618	
PM _{2.5}	48	48	54	80	
PM ₁₀	243	263	382	524	
CO ₂	1,527,000				
Yallourn					
					1974
SO ₂	1690	2286	2082	1813	GW 1.48
NO _x	1628	1785	1691	1357	
PM _{2.5}	172	170	158	173	
PM ₁₀	264	262	268	283	
CO ₂	1,422,000				
Loy Yang A					
					1985
SO ₂	3276	3028	3732	3728	GW 2.2
NO _x	1255	1495	1414	1439	
PM _{2.5}	107	107	87	36	
PM ₁₀	214	210	189	199	
CO ₂	1,221,000				
Loy Yang B					
					1993
SO ₂	2629	2641	3586	2430	GW 1.05
NO _x	1713	1635	1889	1437	
PM _{2.5}	105	90	138	89	
PM ₁₀	183	163	237	116	
CO ₂	1,242,000				
Queensland					
Stanwell					
	2011-12	2012-13	20113-14	2014-15	1996
SO ₂	3496	3559	3616	3349	GW 1.45
NO _x	2585	2017	1987	1933	
PM _{2.5}	38	38	38	37	
PM ₁₀	114	116	117	111	
CO ₂	914,000				
Millmerran					
					2002
SO ₂	4230	3834	3859	8251	MW 850
NO _x	1988	2556	2096	1904	
PM _{2.5}	-	-	-	-	
PM ₁₀	14	13	12	8	
CO ₂	902,000				
Gladstone					
					1976
SO ₂	3472	3477	3665	3326	GW 1.68
NO _x	4456	4380	4372	4317	
PM _{2.5}	10	11	13	14	
PM ₁₀	41	31	45	36	
CO ₂	1,070,000				
Kogan Creek					
					2007
SO ₂	2651	2712	2708	2449	MW 750
NO _x	1110	1010	887	1020	
PM _{2.5}	12	15	11	7	
PM ₁₀	29	35	47	28	
CO ₂	935,000				

Kg per GWh	2011-12	2012-13	2013-14	2014-15	Year commissioned and nameplate output
Tarong (not north)					1985
SO ₂	5170	4568	2896	6034	GW 1.4
NO _x	4507	4242	2905	6035	
PM _{2.5}					
PM ₁₀	1246	780	294	605	
CO ₂	864,000				
Tarong North					2003
SO ₂	2108	2405	1957	2066	MW 443
NO _x	2010	2445	2116	2236	Bag filters
PM _{2.5}	18	10	46	66	
PM ₁₀	35	17	80	115	
CO ₂	864,000				
Callide C					2001
SO ₂	1743	1851	1940	1443	MW 900
NO _x	1094	1224	1164	1115	
PM _{2.5}	53	54	60	51	
PM ₁₀	93	94	104	89	
CO ₂	919,000				
Callide A&B					1988
SO ₂	1869	1742	2022	1521	MW 730
NO _x	4505	3935	4308	4262	
PM _{2.5}	72	72	78	74	
PM ₁₀	168	166	184	182	
CO ₂	1,034,000				

Summary of emissions intensity

The Victorian plants are consistently worst for CO₂ and for particulates. The New South Wales plants are better for CO₂ and particulates but have higher SO₂, particularly the one remaining plant near Lithgow (Mt Piper) and the two upper Hunter plants, Bayswater and Liddell.

The least worst plants are the 2 at Lake Macquarie near Newcastle: Eraring and Vales Point.

The Queensland plants are in general more modern, with slightly lower CO₂ emission intensities. Tarong (not north) is especially high in SO₂, NO_x and PM₁₀ making it a candidate for early closure.

Closure sequence informed by health considerations

As the health impact of air pollution is a small risk multiplied by a large number of exposed people, the proximity of plants to population centres and direction of prevailing winds are important. All the New South Wales and Victorian plants are in the range of 86Km to 140Km from capital

cities, so the population exposures are roughly equivalent. The dispersion of pollutants and the prevailing winds are topics that require research. Taking health considerations into account, this analysis points to closure sequence of Hazelwood/Yallourn/Loy Yang A&B/Mt Piper/Liddell & Bayswater/Eraring & Vales Point. To be finished with coal-fired electricity by 2050 requires closing a plant every three and a half years.

Mechanisms for including multiple air pollutants in economic decisions

The health effects of air pollution are substantial and immediate, so the Australian community would benefit from a decision-making framework that includes health considerations rather than being based purely on the age of plants and carbon dioxide emissions.

Applying the polluter pays principle to impose pollution licensing fees is a simple and transparent way of bringing health considerations into the process. New South Wales has a load-based licensing system that imposes a licence fee on large scale industrial polluters that has the objective of providing an economic incentive for cleaner production, or in some cases will make the dirtiest plants less economically attractive and hasten their closure.⁴¹ The New South Wales system has been in place since 1999 but has to date been ineffective due to the inadequate scale of fees imposed. Western Australia and South Australia have similarly ineffective LBL schemes.

A typical power station pays pollution fees of less than 1% of the value of production. The load based licensing system however is well designed and with suitable fees would be a valuable tool to improve health of Australians. The optimal level of the load-based fees would be to match the air pollution externalities, of \$13 per megawatt hour. Based on 2014 figures for NSW, to correctly price this externality, the load based licencing fee would have to be 49 times higher than the current rate. As it may be unpopular to increase the price of electricity, the licence fees could be returned to generators in proportion to their production. This in effect becomes a transfer from dirty generators to clean generators with negligible effect on wholesale prices.

Recommendations

1. When deciding which coal-fired power stations are to be the first to close, health impacts should be an important consideration.

2. For New South Wales and Victoria, the order of closure should be: Hazelwood/Yallourn/Loy Yang A&B/Mt Piper/Liddell & Bayswater/Eraring & Vales Point.
3. New South Wales' load-based licencing scheme should be enhanced so that the cost of the licence fee becomes an incentive for cleaner production.
4. That Victoria and Queensland adopt load-based licencing for electricity generators.
5. The scale of the fees reflects the full externality cost and is harmonised between states.

(iii) the increasing amount of electricity generated by renewable energy and likely future electricity demand

Australia's total emissions for 2013-14 are estimated to have been 548 Mt CO₂-e. 33% of this comes from the generation of electricity.⁴² There was a significant (15%) decrease in emissions from electricity generation since emissions peaked in 2008-09 to 2013-14 due to a number of factors. These included the impact of energy efficiency programmes, the closure of electricity intensive industrial facilities (such as aluminium smelters), consumer responses to rising electricity prices and the increasing penetration of renewable energy.²⁹

However, emissions from the electricity sector are expected to increase which, "*reflects higher expected levels of coal-fired generation... following the repeal of the carbon tax from July 2014*"²⁹. Consequently, it is predicted that by 2019-20 there will be a 12% increase in emissions and by 2029-30 a 24% increase in emissions. Obviously from the point of view of health as well as Australia's commitment to the "*Paris Agreement*" this is not an acceptable situation.

According to the latest Australia Institute National Market Update, March 2016⁴³, "*Total emissions from electricity generation in the NEM increased again in the year to March 2016. Annual emissions were 5.5% higher than in the year to June 2014.*"

Furthermore, "*The year to March 2016 saw increases in electricity demand, electricity generation and emissions from generation in the NEM.*" This continued the general pattern of the past seventeen months.

Total electricity demand increased for the thirteenth successive month in the NEM and the seventh successive month in WA. There can be little doubt that the period of falling demand for electricity across Australia

has now ended. Total annual demand in the NEM is now 2.5% higher than the low point recorded in the year to February 2015. Sustained demand growth at this sort of rate was considered normal in the electricity industry up to about 2004, but until now had not been seen since then.

Total coal generation was 76.1%, compared with a minimum of 72.3% in the year to July 2014. Gas generation recorded another small reduction, notwithstanding an increase in Tasmania to meet the supply shortfall caused by the failure of Basslink.

As far as renewable energy is concerned, "Total renewable generation reached 13.2% in the year to March 2016, its highest level for several decades outside the period affected by the carbon price, despite a small reduction in wind generation. There was a small increase in hydro generation and also a modest contribution from the three new grid scale solar farms, the most recent of which, Moree, came on line in late February."

Recommendations

1. Urgent action is required to reverse the increase in emissions from the electricity sector that has been seen since 2013-14.
2. Urgent action is required to increase the use of renewable energy.
3. The Renewable Energy Target should be extended beyond 2020 with an ambitious 2030 target of 70,000 GWh, along with financing via the Australian Renewable Energy Agency.

(iv) maintenance of electricity supply, affordability and security

In South Australia in July 2016, during a time when electricity from wind generation was low, there was a large spike in the spot price of electricity. Then in September an extreme weather event brought down pylons carrying supply at a time when the interconnector to Victoria was operating at near maximum capacity; it shut down, and was unavailable to back up supply. The state experienced a total blackout for a day.

While this event is still subject to full analysis and an enquiry led by the Chief Scientist it is clear that renewable energy was not to blame.⁴⁴ It is likely, however, that default settings in computers controlling energy generators in South Australia triggered shut-downs in the absence of a

powerful synchronising signal from 'the grid' – primarily from failure of the interconnector from Victoria. Clearly, all States require a strong synchronising signal to maintain grid stability. Options include continuous high-output power sources. In the past, such sources have been fossil-fuel-powered power-stations, discussed below. Given the unacceptability of continuing to rely on these, Australia needs to develop replacement sources of electricity powered, for example, by solar-thermal, geo-thermal and pumped-hydro, or to develop sophisticated power networks capable of handling distributed small-scale power-generators. Pumped-hydro power, an old idea, is efficient, scalable, and reliable.⁴⁵

Maintaining fossil-fuel-powered power stations is unacceptable given current knowledge about their contribution to greenhouse gases. Using coal-fired stations for 'base load' power is the worst possible solution as they must be kept burning even when demand is low. Gas is not the answer, either. Firstly, it is a fossil fuel, albeit with lower emissions than coal, but its combustion produces CO₂. Secondly, studies in the USA have shown that the escape of methane (fugitive emissions), a very powerful greenhouse gas, during all phases of the gas chain, may be as high as 17%, so challenging its benefit vs coal as a lesser source of greenhouse gases. Thirdly, the mining of unconventional gas has adverse health impacts on local communities with low birth weight infants, asthma and other respiratory problems.^{46,47,48,49,50}

High electricity costs impact families and business. However, there is no evidence that power prices in South Australia or elsewhere are related to renewable energy. Queensland with very low levels of renewable energy also experiences price spikes. The question of whether the gas companies exploited a supply shortage in South Australia has not been adequately answered. According to the International Renewable Energy Agency, renewable technologies "*are typically the most economic solution for new grid connected capacity where good resources are available*" ie wind and solar⁵¹. According to the International Energy Agency renewable projects in diverse markets "*signal a clear acceleration in cost reductions, increasing the affordability and improving the attractiveness of renewables among policy makers and investors*".⁵² In a properly regulated market, 'gaming the system' would not be tolerated and the advent of renewable sources of power portends reductions in energy costs, not increases.

The massive global investment in renewable energy (more than coal in the last 12 months) is now focussing more on storage solutions, grid solutions, and energy efficiency. Concentrated Solar Thermal, 'as promised by both sides of politics before the federal election', is a proven technology now operating in Nevada and elsewhere.

Recommendations

1. Continued transition to renewable energy sources.
2. Undertake modification of the National Energy Grid to deal with multi-focal sources of renewable energy.

(v) any other relevant matters

Upgrading old power stations

The upgrading of old power stations in order to maintain electricity supplies and increase the longevity of the coal-fired power stations is unacceptable. For example, the proposed turbine retrofit for Loy Yang B would improve the greenhouse gas emission intensity of the power plant relative to other brown coal power plants in Victoria. However, any benefits in terms of reduction in the intensity of carbon emissions would be outweighed by increasing the amount of coal burnt, according to the company's plans outlined in the Loy Yang B Works Approval Application. The net increase in absolute total carbon dioxide and other greenhouse gas emissions is at odds with the State government's commitment to seriously address climate change.

(d) policy mechanisms to give effect to a just transition for affected workers and communities likely impacted by generator closures, as agreed in the 'Paris Agreement'

Australia's coal-fired power stations are located in diverse regions. Each of these regions has their own local population and climate. Each of the power stations has their own unique characteristics (see section c, ii). Each of these stations supply a variable amount of electricity to variable locations. Consequently, when developing policy mechanisms to close a particular generator, a specific plan needs to be made for each location.

The aim of the policy mechanisms should be to facilitate closure of the coal-fired power stations as quickly as possible, ensure adequate employment for the employees displaced by the closure, repatriation of the site and development of alternative electricity generation.

Closure of coal-fired power stations

A number of policy mechanisms will be needed to facilitate the closure of a power generator. Mechanisms include direct payments to the polluters as an incentive to close the power station. This has been seen in Collinsville where RATCH-Australia received a cash payment from the Energy Security Fund which facilitated the closure of the coal-fired power station. The Energy Security Fund was a \$1 Billion fund designed to close 2,000 MW of the dirtiest power stations by 2020. At this time Australia's emissions did decline, so there was some success with this mechanism. Since this fund was closed and the 'Carbon Tax' was abolished in July 2014, there has been an increase in emissions from the electricity generating sector⁵³.

Ensure Adequate Employment

Closure of a coal-fired power station will result in job losses but these losses can be diminished with adequate planning. Alternative employment can be provided by the decommissioning of the power station and by employing people in renewable technologies. An example of this can be seen in Port Augusta (see Appendix A (page 24)). Policy mechanisms will be necessary for each of the individual localities.

Rehabilitation of power generator site

The power generation sites have toxicity issues, especially in the form of coal-ash deposits, that will need to be managed. The process of dealing with this toxicity will improve the environment, diminish the risk of local illness and generate employment for those displaced from employment.

Development of Alternative Electricity Generation

It has been well shown that a transition to renewable energy is technically possible and economically viable⁵⁴. A transition to renewable forms of power-generation will give the local population health benefits from the decrease in pollution and be able to provide them with employment resulting in benefits to social structure.

(e) the appropriate role for the Federal Government

Australia is committed to the '*Paris Agreement*'. Australia is yet to ratify this agreement, but if it is to maintain its standing in the global community, it must do so without delay. In order to fulfil its commitment, Australia must reduce its emissions from electricity generation which in recent times have actually increased. DEA has already outlined how reducing emissions will have health benefits for the future.

The second task for the Federal government is to put in place policy changes that will allow the rapid expansion of renewable energies. This is the only way Australia will be able to reduce its emissions. 33% of Australia's emissions are from the electricity generating sector yet only 13.2% of our electricity is from renewable sources.

Thirdly, the Federal government needs to recognise the importance of renewable energies and make it clear to the population that renewable energies are imperative if we are to mitigate against the effects of climate change.

Federal government needs to assist and work with the states which have more ambitious targets and programs, recognising that each state has different circumstances and therefore different solutions. Federal government cannot become a barrier to states ambitions.

Federal government needs to acknowledge the importance of the environmental and health impacts of coal-fired power stations, from local to global, in all conversations and decisions regarding power generation.

Finally, the Federal government needs to take an overarching review process to make sure that it is achieving the desired outcome of zero emissions as soon as possible.

Summary and recommendations

Doctors for the Environment commends the Senate on initiating an inquiry regarding the retirement of coal-fired power stations. This is a crucial issue in the mitigation of the effects of climate change. The Lancet in 2009 stated, "*Climate change is the biggest global health threat of the 21st century*". It cannot be more strongly stressed, mitigating against the effects of climate change will have a huge positive impact on the health of the population.

These benefits will arise from decreased pollution, minimising extreme weather events, decreasing the risk of fires and heatwaves which will result in better food and water security. The alternative is instability in the climate resulting in a loss of food and water security, increased illness from pollution, ozone, infections, mental illness and social instability. 33% of Australia's emissions come from the electricity generation sector, predominantly from the burning of coal in coal-fired power stations. In order to minimise the effect of climate change, it will not be possible to continue to burn coal.

Victoria and South Australia have zero emission targets by 2050 and New South Wales has recently proposed the same target by 2050. In order to achieve this outcome coal-fired power stations will need to close. Federal, State and Local governments will need to be involved in order for this to be successful. Specific plans need to be made for each jurisdiction. Electricity demand continues to rise so it is imperative that a plan is urgently made to reduce the dependency on coal-fired power stations.

DEA makes the following recommendations:

1. A transition plan needs to be urgently developed for each coal-fired power station. Each coal-fired power station has its own unique characteristics and locality. By developing a plan for each coal-fired power station, plans can be made to provide electricity for the local region as well as providing employment for the local community. Above all, the health of the local community (as well as distant communities) will be improved and the effects of climate change will be mitigated.
2. The recommended order of closure is: Hazelwood/Yallourn/Loy Yang A&B/Mt Piper/Liddell & Bayswater/Eraring & Vales Point power stations.
3. Base-Load licencing. Since 1999, New South Wales has a base-load licencing scheme that imposes a license fee on large scale polluters. This is the ideal mechanism by which polluters can be charged for their emissions. Currently the fee is less than 1% of the value of electricity production. DEA recommends that this fee is increased to reflect the true economic cost of burning coal and that this scheme

is adopted by Victoria and Queensland. Money that is raised could be used to compensate those who are disadvantaged by the higher cost of electricity or to subsidise renewable energy.

4. Retain workers. Undoubtedly jobs will be lost with the closure of coal-fired power stations. Obviously, electricity will still need to be produced. Workers for coal-fired power stations need to be retained to work in other forms of electricity generation. Depending on the particular plan for the individual coal-fired power station (see recommendation 1 above), the workers will be involved in industries such as solar, wind or biomass. Similarly, there are significant employment opportunities in the rehabilitation of old mine sites.
5. Urgent need to increase the amount of electricity that is produced from renewable sources. Currently, Australia's emissions from the production of electricity are rising. It is imperative that this ceases to be the case. Other forms of fossil fuels will not be the solution.
6. Develop new technologies to produce and store electricity in a carbon neutral way. Similarly, technologies should be improved to remove carbon from the atmosphere. The effects of climate change will continue to be felt even after the world's emissions are reduced to zero. The next challenge will be to remove carbon from the atmosphere. Technologies and industries need to be developed to remove carbon from the atmosphere to counteract the effects of burning coal.

APPENDIX A

Lessons learned in the closure of the Port Augusta power stations

Background

October 29, 2016, was the fifth anniversary of the start of the community campaign against the polluting power stations in Port Augusta and the coincidence of this landmark with current Senate enquiry provided the opportunity to review a range of issues that will allow governments to improve their performance in the necessary closure of polluting power stations. A summary of the following documentation appeared in Croakey.⁵⁵

It was apparent to Doctors for the Environment Australia in 2010 that the national transition from coal-fired power to clean forms of energy was essential on health-, climate change- and economy-related grounds. The necessary strategies were developed to brief governments and the local communities by DEA and by colleagues in other community organisations.

Closure of Playford B occurred in 2013 and the Northern power station, as well as the Leigh Creek mine, closed in 2016. They had produced 780 MW/base-load of electricity, historically providing 35% of the state's power. The Leigh Creek mine, 250 km to the north of Port Augusta had produced brown coal for the power stations

In 2011 Port Augusta had a population of 13,500, the power stations were a major employer in a town which had little industry and diminishing employment in this railway-hub town.

This review will consider three key issues which demanded transition: the existing poor health of the community, the role of air pollution and its inadequate documentation and management, and the availability of alternative energy sources without adverse health impacts. We will also review the role of governments and media in the events 2010-2016

It was important for the transition to be presented to the community as a comprehensive problem with a solution. Therefore, the campaign opened with a community meeting in Port Augusta attended by 120-150 citizens, many of whom were workers and their families from the power station. The meeting was organised by CLEANSA⁵⁶. The speakers were: Mark Ogge from BZE who described the recommended solution, concentrated solar thermal technology (CST), David Shearman (from Doctors for the Environment Australia), Tim Kelly from the Conservation Council of South Australia and the Mayor Joy Baluch. The health theme

was simple, 'Doctors diagnose illness from pollution at Port Augusta. Doctors Prescribe Solar Thermal Treatment'. The event was accurately reported by the Green Left Weekly.⁵⁷

Governments and industry were presented with a united community, supported by health and technical experts, the town Council, unions and small business, and many community groups, all recognising the future pathway for Australian energy and innovation. These groups came together as the community driving force named Repower Port Augusta⁵⁸ and progressively ran the successful campaign. Governments were largely indolent to the challenge and we will analyse the possible reasons.

1. Health of Port Augustans

The health of Port Augustans, detailed in publications from the medical literature, and air pollution data from the EPA and the power company, was reassessed by public health physicians who were DEA members, prior to the launch of the community campaign in 2010. The data, as well as the correspondence from the SA government disputing the claims (largely on the grounds of confounding factors such as smoking) can be seen in the report of DEA's presentation to the South Australian Parliament⁵⁹. In fact, the lung cancer rate in Port Augusta was nearly double that compared to other towns and respiratory illnesses in children were the highest in the state. Our re-analysis could not reconcile the government's claims. This information was presented at the community meeting in October 2011.

In retrospect, the most important lesson was to keep health at the centre of the community campaign, for the community recognised its own ill health. Admittedly there were two important allies, the smoke stack and the Mayor, the late Joy Baluch. The former sat approximately 3km from the edge of the town. The latter 'a solar Warrior' sat in the centre of town, where the pollution could be smelled, and where she terrified most visiting ministers from opposing her view.⁶⁰ She campaigned incessantly from the Council office till her death in 2013. Her emotional drive came from the death of her husband from lung cancer: he was a non-smoker and a worker in the power station, and from the illness of her child who had severe asthma.

The health message was delivered by frequent journeys of 311km to Port Augusta by the DEA team of clinical doctors and medical students from Adelaide. Members of key community groups were briefed: the Council CEO, unions, small businesses and local community groups. DEA sought and obtained support from RACGP, AMA(SA) and AFPHM, which was important to demonstrate medical solidarity to the government, but probably had little impact otherwise.

A range of educational material was used by DEA over the five years. Examples include a Coal and Health Fact Sheet⁶¹ to illustrate the specific illnesses and costs of coal combustion, as well as fact sheets on Renewable Energy and Health⁶² and on the preferred alternative to coal power, Concentrated Solar Thermal⁶³.

As part of our recognition of the urgency for transition, four medical experts from Doctors for the Environment Australia wrote a peer reviewed article *The mining and burning of coal: effects on health and the environment*⁶⁴ published in the Medical Journal of Australia. It was published to coincide with the launch of the campaign and was used in briefings to state and federal members of parliament (PDF 1 of the Report⁶⁵).

Despite medical briefings to state and federal members of parliament, little government interest and commitment was shown in the issue and a request (30.8.2011) to meet with Premier to present the health case and solar thermal solution received the response (on 6.10.2011) that a meeting could not be arranged. Only in 2016 was there belated action to attract CST development. DEA members met with the SA Minister of Health in 2012, just prior to his retirement. Amazingly, despite many attempts, DEA never managed to see the subsequent state Minister for Health to request his support. However, in May 2012, DEA held a very successful medical-expert briefing at Parliament House, which highlighted the massive health costs of coal and gas pollution⁶⁶. DEA gave a further health presentation to a parliamentary enquiry into CST in 2013.

In South Australia, government Ministers were dismissive of health problems in Port Augusta, the standard response given to us at meetings was that smoking was the problem. In retrospect, it seems likely that failure to acknowledge the problem was influenced by possible concern over licences to pollute given to the power generator by previous governments and subsequent failures to monitor pollution and health appropriately.

We were also interested to find that governments tended to deny any role for themselves in facilitating the transition and, in a meeting with the state minister of energy to ask for support, it was stated that this was the role of the market and not government; we were unprepared for the philosophy of market primacy having infiltrated a Labor government so completely. DEA then made a submission to the Clean Energy Finance Corporation⁶⁷ for funding for a Port Augusta transition on health grounds; we have no evidence that this received government support.

2. Air pollution in Port Augusta

DEA undertook a detailed analysis of air quality data from EPA SA records for 2005-2011⁶⁸. We contended that the community was exposed to excessive amounts of pollution. It was our view that the methodology of recording pollution was flawed and the exposures may have been greater than the recorded results.

There is nothing more important than protecting the health of the community and we are therefore critical of the following information which became evident in our studies.

Much of the recording of emissions was allocated to the generator itself⁶⁹, presumably as a cost saving measure. We think that this was an abrogation of duty of health care by the government. As a result it seems that measurements were not uploaded to EPA sites to be easily available for scrutiny by government and health professionals. DEA had the services of a DEA member who was familiar with the system; some data could not be found despite extensive searching and other data was obtained only with difficulty. Yet this was a time when Port Augusta Council had expressed concerns about cancer and pollution, as documented in their correspondence with the state government.⁷⁰

In making these comments, we indicate that we received courteous assistance from the EPA and we recognise there may have been restraints imposed upon them.

In conclusion, we find it difficult to accept the lack of government endeavour to rescue Port Augusta from its ill-health burden; it failed to show urgency in adopting an alternative form of power generation when it became available.

3. The viable solution, concentrated solar thermal energy (CST)

The proposal for establishing a CST power plant was a vital part of the engagement with the community. The presentation to the community by Mark Ogge, in October 2011, was a comprehensive plan for alternative power and jobs.⁷¹ It outlined how coal plants could be transitioned to CST power generation without the loss of jobs and with an increased manufacturing capacity for South Australia. The community then had a vision for the future, supported it, and its worry about jobs never came to the fore.

In 2013, a Select Committee of the South Australian Parliament investigated the merits of CST power generation in Port Augusta. DEA presented the health imperative. The report stated "*The Committee*

considers the health of the Port Augusta community to be a very significant factor in support of BZE's Repowering Port Augusta proposal." The report left open the possibility of CST but did not go so far as to recommend a speedy path to implementation. Our media release reflected our disappointment when the committee wound up.⁷²

At the time of writing this submission it is a great disappointment to health experts and, no doubt, to the citizens of Port Augusta who wished for a healthy technologically-driven future, that the state government is considering another polluting source of energy, gas, to replace energy needs rather moving to solar thermal energy.

Conclusions and recommendations

The events detailed in this report on Port Augusta closures illustrate the failure of governments around Australia to consider and plan for a transition away from the use of fossil fuels dictated by the urgent need to address both climate change and pollution. This urgency has been evident for a decade from consideration of climate change science. It is an indictment that closures are imminent in regions like the Latrobe with minimal government plans for transition and, as was the case in SA, the plans for the future have been developed by community organisations, for example, *Life after Coal*; from Environment Victoria.¹⁶

It is evident that the recurrent political changes in national renewable energy targets, had a delaying effect as criticised this week by the International Energy Authority.⁷³ These political changes have been deleterious to effective progress, even in Port Augusta where a plan was available in 2011.

Indeed our report indicates a likely widespread failure of governments to consider transition and prepare plans to address health costs of pollution as part of problem, and to protect the health of communities near power stations during the remaining lives of these stations.

Recommendations

These are based on our experience with Port Augusta 2011-2016

1. Detailed planning for community employment and development in relation to every coal-fired power station in Australia be implemented immediately.
2. Renewable energy should be the development of choice for these communities.

3. The need for transition should include information on expected improvement in community health.
4. The degree of pollution and its danger to local communities should be a major factor in deciding priority for closure and in advising community and workers of the need for closure.
5. Air quality data monitoring in relation to all power stations should be subject to independent review, be transparent, immediately available and conducted by the state Environmental Protection Authority and not the operator.

References

1

http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Coal_fired_power_stations

2 <http://theconversation.com/factcheck-have-eight-of-australias-12-most-emission-intensive-power-stations-closed-in-the-last-five-years-65036>.

3 <http://www.singletonargus.com.au/story/3356121/redbank-power-station-sold/>

4 <http://www.theaustralian.com.au/business/business-spectator/another-coal-power-station-bites-the-dust/news-story/cf5ee66178aa4cd6972f10272b49d5c0>

5 <http://www.hrf.com.au/resources/publications/economic-indicators>

6 Hunter Research Foundation, Upper Hunter Economic indicators June 2016

7 Small Area Labour Markets, SALM, data

8 http://ratchaustralia.com/collinsville/about_collinsville.html

9 Courier Mail, December 26, 2015

10 http://www.abc.net.au/news/2016-02-02/ratch-australia-collinsville-solar-project-could-begin-this-year/7132424#.WBXSQnm0_aQ.mailto

11

<http://www.committeeforgippsland.com.au/docs/7108%20Committee%20for%20Gippsland%20-%202016%20Booklet.pdf>

12 Measuring Poverty and Inequality from Highly Aggregated Small Area Data: The Changing Fortunes of Latrobe Valley Households Jill Wright, Rebecca Valenzuela and Duangkamon Chotikapanich February 2015 Monash Business School, Department of Economics.

https://business.monash.edu/_data/assets/pdf_file/0011/339347/measuring_poverty_and_inequality_from_highly_aggregated_small_area_data_the_changing_fortunes_of_latrobe_valley_households.pdf

13 The Latrobe Valley, Victim of Industrial Restructuring, Birrell, B, 2001. Centre for Population and Urban Research, Monash University

<http://www.aph.gov.au/DocumentStore.ashx?id=378f4515-63e8-4af4-9e4a-910de9a3fbdf>

14 <https://www.parliament.nsw.gov.au/researchpapers/Documents/the-hunter-region-an-economic-profile/Newcastle%20and%20the%20Hunter%20GG%202.pdf>

15 <https://www.theguardian.com/world/2014/feb/11/victoria-looks-newcastle-clues-post-toyota-future>

16 <http://environmentvictoria.org.au/newsroom/report/life-after-coal>

17 <http://www.nytimes.com/2012/02/03/opinion/rochesters-survival-lessons.html>

18 <http://www.bbc.com/news/uk-wales-27920610> and

<http://environmentvictoria.org.au/newsroom/report/life-after-coal>

19

http://environmentvictoria.org.au/sites/default/files/Life%20After%20Coal_Pathways%20to%20a%20Just%20and%20Sustainable%20Transition%20for%20the%20Latrobe%20Valley%20-%20Executive%20Summary.pdf

20

<http://www.committeeforgippsland.com.au/docs/7108%20Committee%20for%20Gippsland%20-%202016%20Booklet.pdf>

21 Paris Agreement, Page 1,

http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

22 Paris Agreement, Article 2, page 3

http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

23 http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

<http://theconversation.com/we-have-almost-certainly-blown-the-1-5-degree-global-warming-target-63720>

24 Paris Agreement Article 4, page 4

http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

-
- ²⁵ Paris Agreement Article 3, page 3
http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
- ²⁶ https://en.wikipedia.org/wiki/List_of_countries_by_greenhouse_gas_emissions
- ²⁷ <http://www.smh.com.au/federal-politics/political-news/australias-carbon-emissions-jump-in-2015--20151225-glv017.html>
- ²⁸
<http://www.climatecouncil.org.au/uploads/a904b54ce67740c4b4ee2753134154b0.pdf>
- ²⁹ <http://www.commondreams.org/news/2016/04/20/climate-change-has-all-destroyed-great-barrier-reef-study-confirms>
- ³⁰ <http://time.com/4184898/global-warming-oceans-hot/>
- ³¹ <http://iopscience.iop.org/article/10.1088/1748-9326/11/5/054011>
- ³² Paris Agreement Article 4, part 3, page 4
http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
- ³³ Paris Agreement, Page 2
http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
- ³⁴ [http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(15\)60901-1.pdf](http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(15)60901-1.pdf)
- ³⁵ Paris Agreement, Article 10, page 14
http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
- ³⁶ Paris Agreement Article 10, page 15
http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf
- ³⁷ ANSTO work from Richmond
<http://www.ansto.gov.au/AboutANSTO/MediaCentre/News/ACS049674>
- ³⁸ The hidden costs of electricity: Externalities of power generation in Australia. A report by the Australian Academy of Technological Sciences and Engineering. 2009.
- ³⁹ National Pollutant Inventory www.npi.gov.au
- ⁴⁰ www.aemo.com.au
- ⁴¹ Load based licensing: www.epa.nsw.gov.au/licensing/lbl/lblicences.htm
- ⁴² Australia's Emissions Project, 2014-15. Australian Government, Department of the Environment
- ⁴³ National Electricity Market Update, data to March 2016. The Australia Institute
- ⁴⁴ Melbourne Energy Institute: Winds of change McConnel & Sandiford
- ⁴⁵ Melbourne Energy Institute: Pumped hydro energy storage-making better use of wind
- ⁴⁶ RenewEconomy 16/9/2016: Solar vs Gas: Why South Australia needs to seize the future
- ⁴⁷ World Resources Institute: A Close Look at Fugitive Methane Emissions from Natural Gas
- ⁴⁸ Melbourne Energy Institute: A review of current and future methane emissions from Australian unconventional oil and gas production.
- ⁴⁹ PLOS one: Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania
- ⁵⁰ Unconventional Gas and Oil Drilling is Associated with Increased Hospital Utilization Rates
- ⁵¹ <http://costing.irena.org/technologyt-costs/power-generation.aspx>
- ⁵² International energy Agency: Renewable Energy Medium Term Market Report 2016
- ⁵³ Australia's Emissions Project, 2014-15. Australian Government, Department of the Environment.
- ⁵⁴ ZCA2020 Stationary Energy Plan, Beyond Zero Emissions and the University of Melbourne, 2010.
- ⁵⁵ <https://croakey.org/how-a-prescription-for-solar-thermal-treatment-changed-the-health-fortunes-of-a-whole-town/>
- ⁵⁶ <http://www.cleansa.org/>
- ⁵⁷ <https://www.greenleft.org.au/content/support-solar-power-grows-port-augusta>

58 <https://repowerportaugusta.org/>

59

[http://www.dea.org.au/news/article/illness and pollution at port augusta dea speaks at the parliament of south](http://www.dea.org.au/news/article/illness_and_pollution_at_port_augusta_dea_speaks_at_the_parliament_of_south)

60 <http://reneweconomy.com.au/solar-warrior-port-augusta-mayor-joy-baluch-dies-age-80-57352/>

61 [http://dea.org.au/images/general/The human health tolls of coal fact sheet 06-15.pdf](http://dea.org.au/images/general/The_human_health_tolls_of_coal_fact_sheet_06-15.pdf)

62 [http://dea.org.au/images/general/Renewable Energy fact sheet 04-15.pdf](http://dea.org.au/images/general/Renewable_Energy_fact_sheet_04-15.pdf)

63 [http://dea.org.au/images/general/CST Fact Sheet 09-14.pdf](http://dea.org.au/images/general/CST_Fact_Sheet_09-14.pdf)

64 <https://www.mja.com.au/journal/2011/195/6/mining-and-burning-coal-effects-health-and-environment>

65

[http://www.dea.org.au/news/article/illness and pollution at port augusta dea speaks at the parliament of south](http://www.dea.org.au/news/article/illness_and_pollution_at_port_augusta_dea_speaks_at_the_parliament_of_south)

66 <http://dea.org.au/resources/submissions/solar-thermal-power-generation-at-port-augusta-sa-parliamentary-inquiry>

67

[http://dea.org.au/images/uploads/submissions/Clean Energy Finance Corporation Submission 12-11.pdf](http://dea.org.au/images/uploads/submissions/Clean_Energy_Finance_Corporation_Submission_12-11.pdf)

68 [http://dea.org.au/images/general/DEA Particle Assessment Report Final.pdf](http://dea.org.au/images/general/DEA_Particle_Assessment_Report_Final.pdf)

69 see 4.2

[http://dea.org.au/images/general/DEA Particle Assessment Report Final.pdf](http://dea.org.au/images/general/DEA_Particle_Assessment_Report_Final.pdf)

70 [http://dea.org.au/images/general/Official correspondence Port Augusta.pdf](http://dea.org.au/images/general/Official_correspondence_Port_Augusta.pdf)

71 [http://media.bze.org.au/Repowering PortAugusta.pdf](http://media.bze.org.au/Repowering_PortAugusta.pdf)

72 <http://www.dea.org.au/news/article/repowering-port-augusta-in-limbo>

73 <http://reneweconomy.com.au/iea-raises-concerns-about-australias-renewable-energy-policy-2021/>