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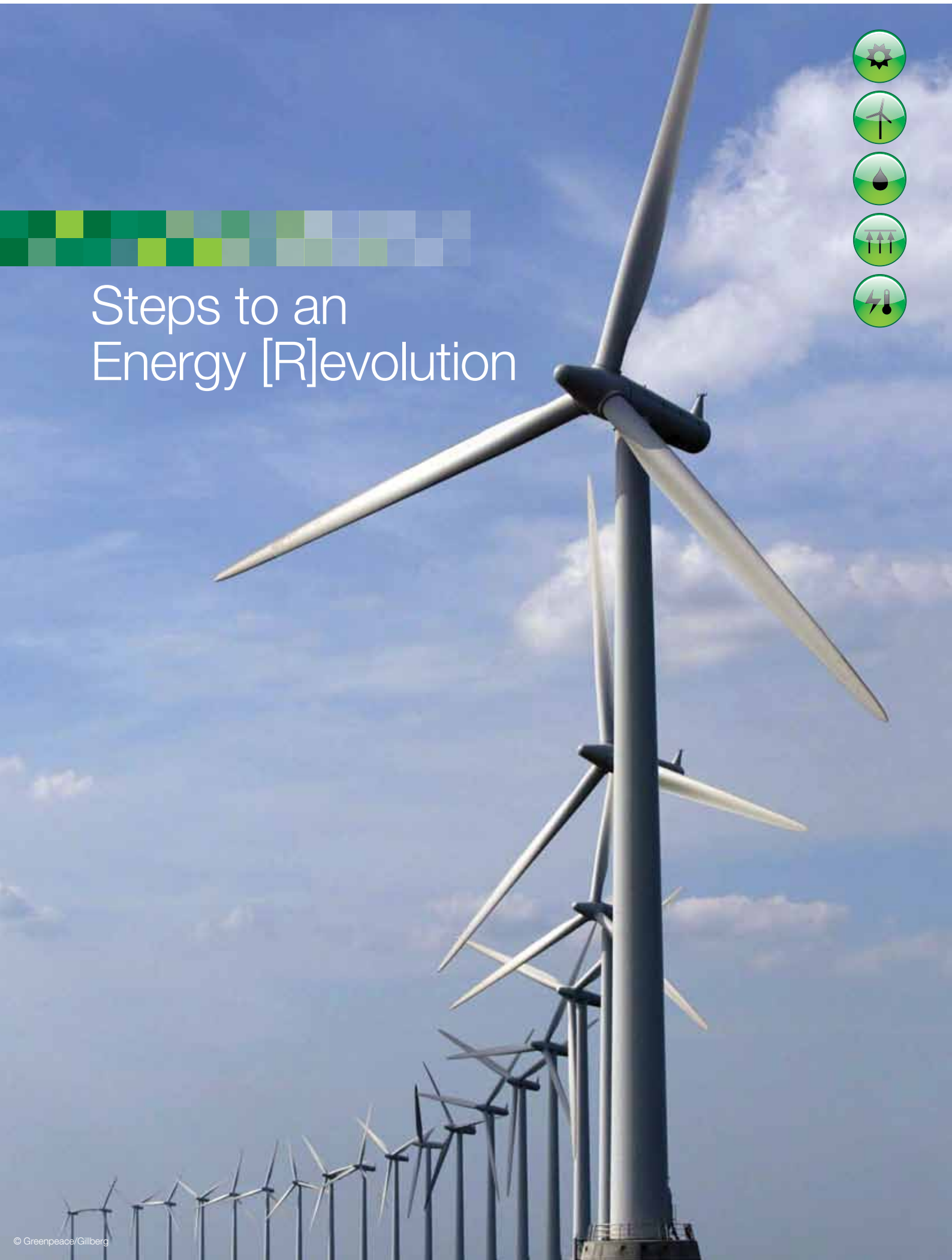
Australia Pacific

Steps to an Energy [R]evolution



The Energy [R]evolution - We have a choice

We have a choice about the kind of world we live in today and what kind of world we leave for our children tomorrow. Greenpeace has a vision of a world where everyone can use clean, safe, affordable, pollution-free energy.

The Energy [R]evolution lays out how this vision can become a reality for Australia. Specifically, how our society and economy can be powered by renewable energy. It would use a fraction of the resources we currently need to sustain our lifestyle, while making massive cuts in greenhouse pollution. It would also leave us with more jobs and cheaper power. By getting involved, Australia can also help other countries join the global Energy [R]evolution, while providing a pollution-free future for ourselves and our children.

Burning coal for electricity is the largest cause of greenhouse pollution in Australia and the world. Our heavy use of coal makes Australia the world's highest per-capita polluter.

Today, a range of proven and commercial technologies offer solutions to coal. Renewable energy is a global industry-in-waiting, ready to stimulate new investment and create millions more jobs than fossil fuels ever could.

We have to make the choice now and we can only make it once. Do we replace our ageing, dirty coal-fired power plants with more of the same? This would lock us into a polluting and increasingly expensive energy source for decades to come. Or do we choose a pollution-free future, roll up our sleeves and get on with the job of building clean power plants, driven by renewable energy?

Ultimately it is a choice about whether our society has the will and commitment to be part of the solution to climate change or give up and succumb to its devastating impacts.

The model

This report answers the question: what could Australia achieve if we were driven by the goal of reducing emissions as much and as fast as possible? What if we were not limited by social and political barriers to replace polluting power with renewables as quickly as possible?

By looking at and modelling different scenarios we can contrast two potential futures. The 'Reference scenario' for this exercise is a very modest plan for reducing greenhouse pollution, based on a federal government model for reducing nationwide emissions by 15% below 2000 levels by 2020. The other is the Energy [R]evolution scenario - named to reflect the urgent need to evolve the way we provide power to all. The Energy [R]evolution scenario provides renewable solutions that respect the natural limits of our environment, phase out dirty energy sources and put the entire energy sector on a truly sustainable basis.

The goal is to deliver the fastest possible reductions in greenhouse pollution and quickly reach a point where all of Australia's new power needs are being met through efficiency improvements and renewable energy. This scenario is limited only by what is technically possible, unconstrained by political reluctance.

The Future

Better energy efficiency – achieving more with less

Being energy efficient means maintaining our standard of living while consuming less electricity. In the power sector, efficiencies can be made at every point along the production chain: from improvements in power plant technology, to reductions in the power lost through transmission, right up to changes in end use. The greatest potential is in the residential and commercial sectors, many of the potential reductions coming from the design of appliances and buildings.

In Australia, using best-practice technology and power management practices would **save us enough power to switch off the ten largest power stations in the country.**[i]

In the Energy [R]evolution scenario, primary energy demand decreases by 17% from 2010 to 2020. This is a critical factor in making the transformation from fossil fuels to renewable energy, and keeping overall costs down.

A great transport sector

The largest proportional changes in demand are possible in the transport sector. Between 2010 and 2024, transport demand would drop by 24% with an Energy [R]evolution. The main factors driving this reduction are increased fuel efficiency and a roll out of hybrid electric and fully electric vehicles, as well as substantial shifts in transport modes.

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What we could achieve

Diverse energy sources

Currently, 90% of Australia's electricity comes from fossil fuels (coal and gas).

Greater diversity in the power sector increases resilience in our power supply. It also reduces the use of coal and gas by using eight different technologies to provide all our power

In the Energy [R]evolution scenario, renewable energy's share of the total generation increases dramatically to 75% by 2024 while coal's share reduces to zero by 2020.

Electricity generation - reference

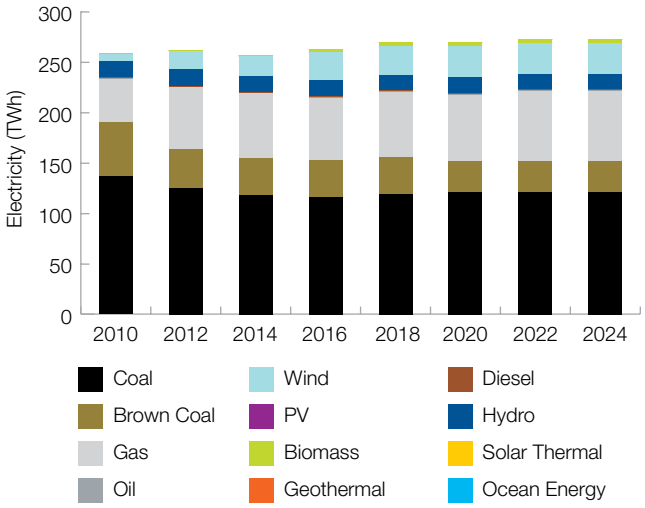


Figure 1: Electricity mix in Australia under the reference scenario

Stable energy costs

The cost of energy under a strong climate action scenario is largely the same as under a weak climate action scenario. Under both scenarios, the total cost to produce power in Australia would increase at first. In the Energy [R]evolution scenario, the cost of Australia's power would peak by 2018 and then begin returning to original levels, while the Reference scenario continues to become more expensive into the future.

The principal driver of an initial cost increase is the flurry to build new power plants and develop the grid to accommodate these. By 2020, under the Energy [R]evolution scenario we would be far less reliant on fossil fuels to supply energy. Having integrated renewable energy plants, most of which run on free sources of energy, costs begin to decline.

Electricity generation - Energy [R]evolution

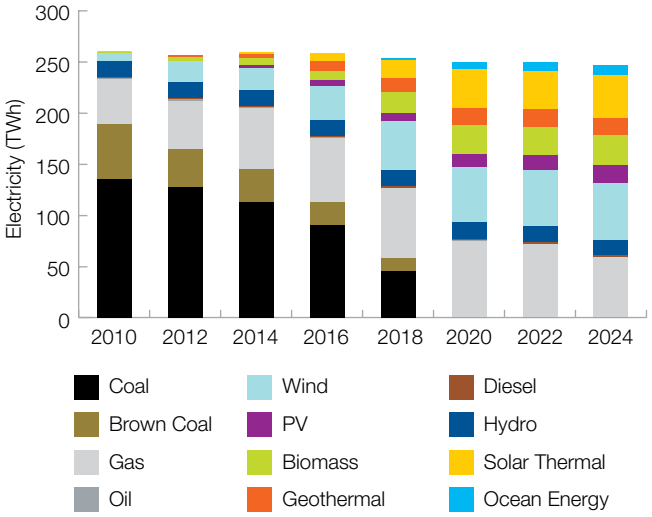


Figure 2: Electricity mix in Australia under the Energy [R]evolution scenario

By making energy efficiency gains and massively increasing renewable power, Australia could be free of coal-fired power by 2020.

Greenhouse pollution halved in 10 years – in line with the demands of climate science

By 2020, the Energy [R]evolution scenario would reduce annual CO_2 emissions in the sector by 185 million tonnes, effectively halving Australia's energy emissions in a decade.

Carbon emissions from energy under Energy [R]evolution

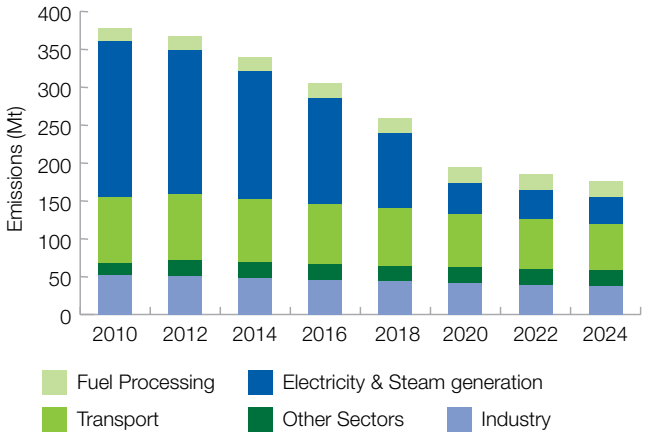


Figure 3. Energy-related CO_2 emissions in the Energy [R]evolution scenario

Mapping out the Energy [R]evolution - making it happen

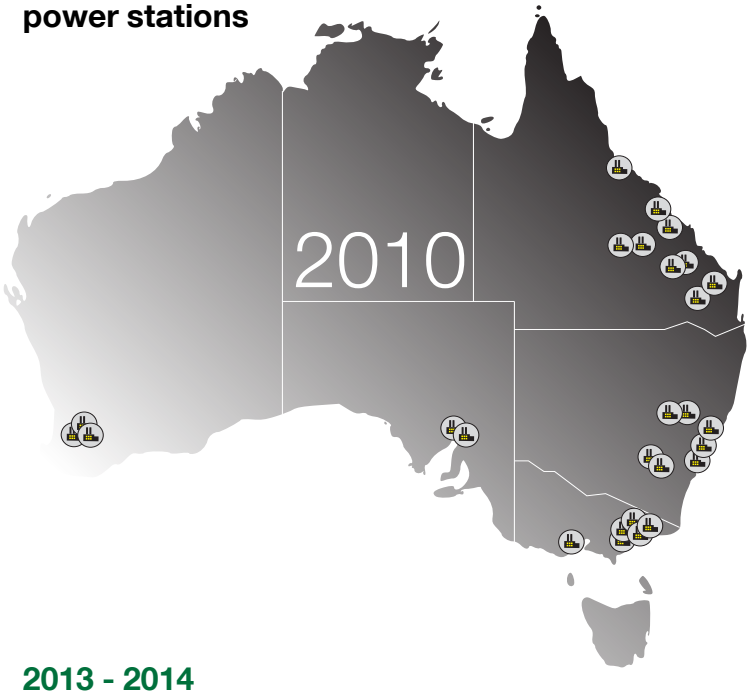
To create an Energy [R]evolution, one by one, coal-fired power stations would be retired and replaced with renewable energy.

Phasing out coal is not only deliberate but essential to meet the Energy [R]evolution's objective of making the fastest possible reductions in greenhouse pollution. However, Australia's coal-fired power stations cannot be switched off overnight. The transition must be well managed and fair to existing coal workers and communities.

The principles behind the phase out of coal-fired power plants are:

- Wherever possible, oldest and dirtiest power stations are closed first.
- Phase out is in line with renewable energy capacity additions.
- Large plants are phased out in stages to avoid abrupt changes to electricity network.

Location of coal power stations



This section describes the changes that would take place as the Energy [R]evolution is rolled out and a complete phase out of coal-fired electricity is achieved by 2020.

2010 – 2012

The big mover in the first two years is wind. By the end of 2012, three gigawatts of wind power projects that stalled due to uncertain government policy in 2009 have been developed, about half of the new capacity in Victoria. Small amounts of PV, geothermal and biomass are also added, helping to back up the new wind power.

The combination of wind's massive growth, assisted by other technologies and immediate efficiency gains, allows the first polluting coal plants to be retired. Swanbank, already scheduled to close in 2012, is the first to go followed by Morwell and Playford B later in the year. While continuing to operate, Hazelwood, Munmorah and Liddell all shut down half of their capacity, as renewable energy begins to take over. The Anglesea coal plant in Victoria also reduces capacity.


© Greenpeace/Redondo

2013 - 2014

The market for new wind power remains stable, adding another three gigawatts from 2012 to 2014. However, several new technologies pick up the pace, including concentrating solar power, which appears first in the NSW and Qld markets supplying around the clock electricity to directly replace coal plants. Solar PV growth also accelerates after 2012, with enough solar panels installed by 2014 to substitute for one coal-fired power station.

Australia's dirtiest power station, Hazelwood, closes in early 2013 after 42 years in operation. Anglesea's remaining units are also permanently closed and Yallourn prepares for eventual closure by cutting output by a third.

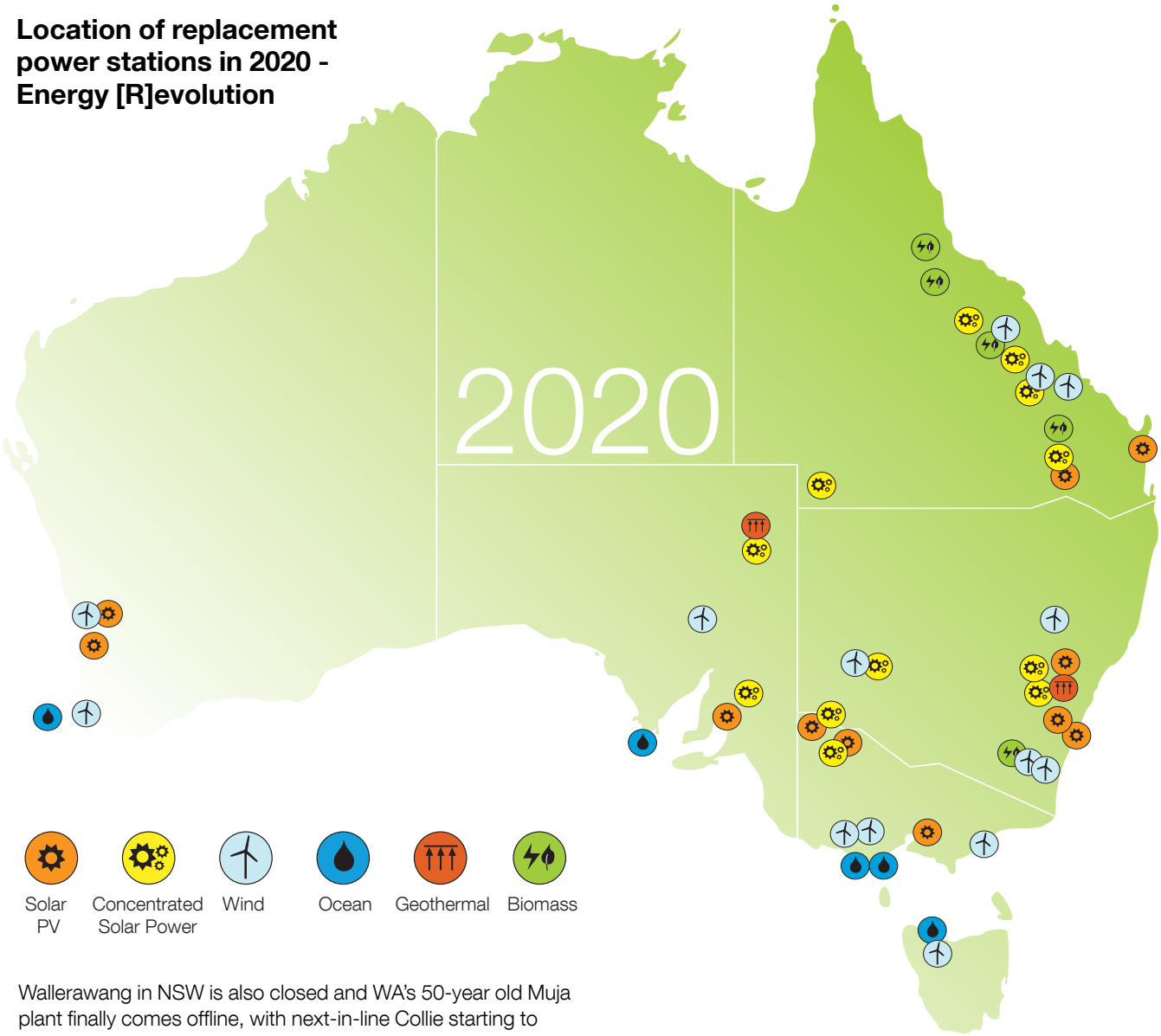
In NSW, wind and Concentrated Solar Power (CSP) combine to replace the remaining units at Liddell and Munmorah, while Vales Point is also retired after 50 years in operation and Redbank comes offline. In Qld, Gladstone power station halves its output, while the Collinsville plant is also taken offline. Muja, Western Australia's oldest power plant also begins to lower its output.

2015 - 2016

Renewables are now making major headway in Australia's power sector. The pace of new wind power quickens with the southern states dominating the market. Ocean energy also makes its first significant appearance, supplying electricity to Vic. Geothermal power continues to expand faster, supplying around-the-clock electricity to SA and the eastern Australian grid. The solar technologies CSP and PV both continue their rapid growth and are directly substituting for retiring coal plant.

SA becomes the first state to have phased out coal-fired electricity entirely, as geothermal and wind power combine to replace Northern power station. Elsewhere, Tarong and Callide power stations in Qld begin to curtail output after Gladstone's phase out is completed.

Location of replacement power stations in 2020 - Energy [R]evolution



Wallerawang in NSW is also closed and WA's 50-year old Muja plant finally comes offline, with next-in-line Collie starting to reduce output. Yallorn is the next Vic power station to come offline in 2015, while Loy Yang A takes the first of its four boilers offline. About three gigawatts of gas steam plant is also retired in this timeframe, after the same amount of more efficient combined heat and power gas plants were installed from 2010 to 2014.

2017 - 2018

These are the two years in which renewable energy technologies move outside of their original geographic bases. Ocean energy expands in Vic but also begins supplying significant power needs for Tas, WA and SA. Large-scale solar projects in SA and north-western Vic help build the region's energy hub that geothermal power initiated. Geothermal becomes a direct contributor to the NSW market, as does sustainable biomass. Wind power capacity continues to expand but reaches a peak in new installations as Australian networks approach the maximum allowable levels of fluctuating power.

There are fewer retiring power stations in this timeframe, as by this stage we are left with several large plants that take time to phase out. Eraring and Stanwell close in 2018, while half of Bayswater's units are also retired. The gradual phase out of Callide and Tarong continues in Queensland with Callide B coming offline in 2017 while Loy Yang A and B in Vic, and Collie in WA also start to turn off units.

2019 - 2020

The widespread deployment of CSP is the main source of around the clock electricity that replaces the remaining 10 coal-fired plants. Over 5 gigawatts of large-scale solar power is put into action, spread evenly throughout the eastern states, with additional projects helping to replace the remaining coal plants in WA. While growth in most technologies tapers, PV and ocean energy continue to expand rapidly. By this stage, enough solar panels have been installed to substitute for five large-scale power plants, while ocean energy is providing enough around-the-clock electricity to replace one large-scale power plant.

By the end of 2020, Australia has replaced all of its coal-fired electricity with renewable power. In 2019, a number of power stations that had been running on reduced capacity are retired once and for all. These include Bayswater, Callide, Tarong, Collie and Loy Yang A. The final coal-fired power stations are all closed in 2020. These are Milmerran, Kogan Creek, Bluewaters, Mount Piper and Loy Yang B.

Mission accomplished

Replacing all of Australia's coal plants with renewable energy may not be the end point of the Energy [R]evolution, but it is a significant accomplishment, eliminating Australia's largest source of greenhouse pollution in a decade. The list below shows when each of Australia's existing power stations are taken fully offline.

Table 1 Final closure dates for Australia's polluting coal fired power plants in the Energy [R]evolution

Year	Name	State	Size (MW)	Commissioned	Lifespan (years)
2012	Swanbank B	QLD	500	1973	39
2012	Playford B	SA	240	1960	52
2012	Morwell	VIC	165	1958	54
2013	Hazelwood	VIC	1600	1971	42
2013	Munmorah	NSW	600	1969	44
2013	Angelsea	VIC	160	1969	44
2014	Collinsville	QLD	180	1998	16
2014	Liddell	NSW	2060	1973	41
2014	Redbank	NSW	150	2001	13
2014	Vales Point B	NSW	1320	1978	36
2015	Gladstone	QLD	1680	1982	33
2015	Yallorn	VIC	1480	1975	40
2016	Wallerwarang C	NSW	1000	1980	36
2016	Northern	SA	540	1985	31
2016	Muja	WA	850	1965	51
2017	Callide B	QLD	700	1989	28
2018	Eraring	NSW	2640	1984	34
2018	Stanwell	QLD	1400	1996	22
2019	Bayswater	NSW	2640	1984	35
2019	Callide C	QLD	900	2001	18
2019	Tarong	QLD	1400	1986	33
2019	Collie	WA	340	2001	18
2019	Loy Yang A	VIC	1000	1987	32
2020	Mount Piper	NSW	1320	1993	27
2020	Loy Yang B	VIC	2120	1996	24
2020	Kogan Creek	QLD	750	2007	13
2020	Millmerran	QLD	850	2002	18
2020	Bluewaters	WA	210	2009	11

2020 - 2024

The job of having phased out the most greenhouse-polluting source of electricity in Australia complete, much of Australia's renewable power industries turn their attention to the export market, helping other countries in our region roll out large-scale renewable energy. All new electricity needs are now being supplied by renewable energy with Solar PV and CSP dominating the domestic market. The phase-out of gas – the second-biggest contributor to power sector emissions – has also begun.

image: Wizard Power is the company commercialising the “Big Dish” solar thermal technology that has been developed at the Australian National University. The prototype has been generating reliable power since 1994.

Jobs [R]evolution

The Energy [R]evolution is great news for job creation

There are about 30,000 people currently employed in Australia's domestic power sector. There are nearly as many people employed in renewable energy as in coal.

A closed power plant, regrettably, does mean the end of some jobs in that area. However, the development of jobs per unit of energy in renewables is very healthy compared to the coal industry as it operates in Australia. Making energy from burning coal is a highly mechanised process, requiring fewer people as time goes on. In the Energy [R]evolution, employment in domestic coal would drop by 11,000 and renewable energy job numbers increase by 54,000.

How the employment figures were calculated

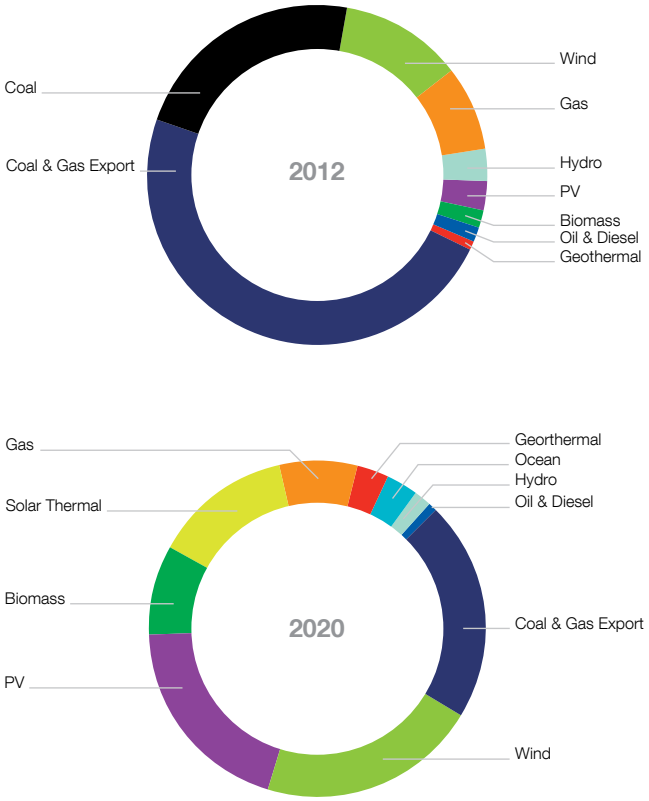
Additional to the technical modelling of the Energy [R]evolution the Institute for Sustainable Futures at the University of Technology, Sydney were asked to undertake an assessment of the effects of these scenarios on direct employment in the electricity and energy export sectors in the years 2012, 2016 and 2020.[ii]

The changes in employment by the type of electricity generating technology are shown in the charts (right).

Jobs created in just one technology, concentrating solar power (solar thermal) are more than enough to make up for the jobs lost in domestic coal generation. CSP jobs grow to more than 12,000 in 2020, roughly equivalent to today's total renewable energy workforce.

The technology to provide the most jobs is wind, with 19,000 employees nationwide in 2020. This is to be expected as it is the technology that has been deployed the most in the Energy [R]evolution. Solar PV is also a major job provider, with 17,900 people working in the sector in 2020. Despite there being much lower installed capacity of PV in the Energy [R]evolution, it creates more jobs per unit installed.

Figure 4. Changes in employment by type of energy (and coal & gas exports) as the Energy [R]evolution scenario rolls out.



Education and Training

Creating a workforce for the 21st Century

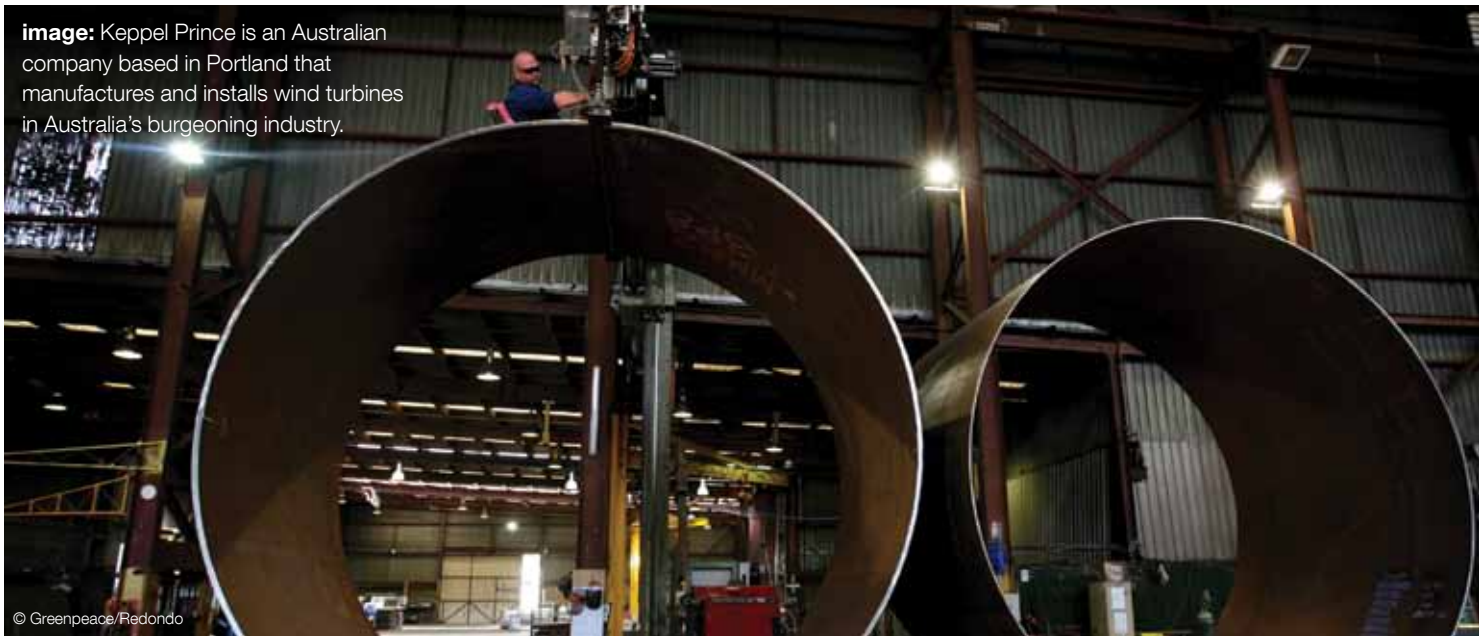


image: Keppel Prince is an Australian company based in Portland that manufactures and installs wind turbines in Australia's burgeoning industry.

The net gain in jobs in the domestic power sector in the Energy [R]evolution would be an average of 5,500 per year from 2012 to 2020. The main options for how these jobs will be filled are:

- Traineeships and apprenticeships
- Tertiary level education
- On the job training
- Redirection from existing jobs
- Appropriately skilled people returning to the workforce
- Redirection from similar jobs

Existing skilled workers

There is some limited potential for redirection of existing energy or manufacturing workers into renewable energy jobs, or to re-employ previous members of the workforce. This approach is significant and it has the potential to boost local economies.

Redirection from similar jobs

For the sake of quality in the workforce, there will be a need to bring experienced energy workers into the expanding renewable energy workforce. Many of the skills in operating and maintaining power stations are transferable and in areas such as the Hunter Valley, where an abundance of renewable alternatives to coal exist, it is common sense to employ as much of the previous workforce as possible in the new power plants.

Providing a just transition

Australia should explore and adopt every possible mechanism to minimise the impact on coal communities of a large-scale shift to renewable energy. Such a major transition may not be seamless, but a raft of realistic measures can provide new, sustainable opportunities in energy and reduce the adverse impacts to communities.

Such a transition would include: a substantial industry re-structuring package created through wide consultation with all stakeholders and a strategy that would include a large component for re-skilling displaced workers, tax incentives to attract manufacturing business to former coalmining communities and a commitment on the part of both State and Federal government to turn former coal mining communities into hubs of renewable energy production and manufacturing.

Manufacturing [R]evolution

Australian manufacturing jobs in particular have been in decline for nearly two decades and the Energy [R]evolution is an opportunity to revitalise the manufacturing sector and its workforce. The Geelong region has been hit hard by declines in manufacturing and is an ideal area to produce power plant equipment for wind, ocean and other renewable energy technologies with a high local and export potential.

Australia's manufacturing base must be scaled up in order to deliver the renewable energy equipment for the Energy [R]evolution, which results in 56 GW of renewable energy power generation installed by 2024.

Not all of the renewable energy equipment will be constructed on-shore. It is assumed that in 2012, 20% of all renewable energy technology components will be manufactured onshore, except for solar PV, of which 15% will be manufactured onshore. By 2020, the proportion for onshore manufacturing is assumed to increase to 30% for solar PV and wind, and 40% for wave, geothermal and concentrating solar power.

It is probable that local manufacturing will tend to specialise in a particular component of the renewable energy technology (e.g. the mirrors for concentrating solar power plants) but for the sake of putting the Energy [R]evolution figures in perspective, it will be assumed here that the locally manufactured proportion of renewable energy will account for complete renewable power generating units.

Building the Energy [R]evolution
Manufacturing for the 21st Century

How much renewable energy does Australia need to make?

The following table shows how much of each renewable energy type needs to be manufactured in Australia to meet the Energy [R]evolution.

Table 2 Renewable energy technologies manufactured in Australia

Renewable energy type	Gigawatts manufactured in Australia in each timeframe						
	2011-12	2013-14	2015-16	2017-18	2019-20	2021-22	2023-24
Wind	0.63	0.70	1.09	1.61	0.69	0.13	0.00
Solar PV	0.01	0.24	0.39	0.39	0.68	0.21	0.47
Biomass	0.01	0.04	0.03	0.40	0.21	0.00	0.02
Geothermal	0.02	0.12	0.20	0.29	0.16	0.00	0.00
CSP	0.00	0.14	0.80	0.92	2.10	0.05	0.23
Ocean	0.00	0.00	0.03	0.22	0.42	0.05	0.17
TOTAL	0.67	1.24	2.54	3.84	4.25	0.44	0.89

At its peak during the Energy [R]evolution, Australia is manufacturing over 2 GW of renewable energy equipment per year. There is a clear need to scale up the local manufacturing capacity to meet this level of production but it is also important to view these figures in the context of the efforts to manufacture renewable energy around the world.

In 2019-2020, Australia is manufacturing solar PV at a rate of 350 MW per year. Between 2006 and 2008, a single solar PV manufacturer increased its production by almost this amount[iii], meaning Australia is attempting to increase its capacity of solar PV over 10 years as one company alone achieved in two. Australian-founded Ausra has a single CSP manufacturing facility in the US, capable pf producing 700 MW of CSP components per year[iv]. It is not until 2019 that Australian local manufacturing reaches this scale.

It is important to remember that many renewable energy power generation components will be similar across different technologies. For example, geothermal, solar thermal and biomass/biogas plants run on steam-fed turbines, creating opportunities to concentrate manufacturing of such commonly used components and create a more stable manufacturing base.

Beyond the Energy [R]evolution

In the first 10 years of the Energy [R]evolution scenario, almost all of the manufacturing capacity is used to facilitate the transition from coal to renewable energy. After 2020 the amount of new renewable energy capacity built in Australia decreases and the manufacturing bases shift to being more export driven.

Infrastructure / grid reform

The Energy [R]evolution is more than a shift in how we produce and use energy. It will require restructuring the power network, to decentralise and diversify supply, bringing power closer to the consumers and making people more aware of where their electricity comes from.

The Energy [R]evolution analysis factors in costs of installing individual projects and demonstrates that network costs are lower for renewable energy than fossil fuels per unit of new installed capacity. The overall network costs would be higher for the Energy [R]evolution only because much more new power capacity would be built than in the reference scenario.

Rather than allow the development of Australia's electricity network to take place on an ad-hoc basis, it would be more beneficial to deliberately restructure the electricity network to unlock Australia's high potential renewable energy areas and connect them to our existing grid.

i Taking the OECD Pacific average of a 53% energy saving potential and applying it to an Australian total generation of 242 TWh.

ii Rutovitz, J., 2009, Analysis of Australian electricity jobs to 2020: methodology. Prepared for Greenpeace Australia by the Institute for Sustainable Futures, University of Technology, Sydney.

iii Suntech increased solar cell production from 160 MW per year to 500 MW per years from 2006 to 2008. Renewable Energy Policy Network for the 21st Century, Renewables Global Status Report 2009 Update. http://www.ren21.net/pdf/RE_GSR_2009_Update.pdf

iv ibid.

image: This solar tower plant, the first commercial solar tower in the world, by Spanish company Solucar, can provide electricity for up to 6,000 homes. Over the next 7 years 9 towers will be built which will increase capacity to approx 180,000 homes.

Steps to an Energy [R]evolution

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Join the Energy [R]evolution

The main barrier to achieving an Energy [R]evolution is the lack of political will and lack of investment. We can choose to power our society with safe, secure, affordable, pollution-free energy. We just need people to help create the political and social impetus for change.

Help us turn the Energy [R]evolution vision into a reality:

- **Tell your political representatives you will vote for someone who takes bold action on climate change.**
- **Add your voice to the public climate change debate - write letters to your local media, comment on blogs or share information via social media.**
- **Live out the change you want to see - make choices as a consumer that promote renewable energy and efficiency.**
- **Stay informed – sign up to receive our email updates. Visit www.greenpeace.org.au/takeaction**
- **Keep your money out of the hands of polluters – tell your bank and super fund not to invest in new coal-fired power. Ask them to invest in the Energy [R]evolution.**
- **Join Greenpeace. We do not accept funding from governments or corporations; instead we rely on the goodwill and generosity of people like you to continue our work. Call 1800 815 151 or visit www.greenpeace.org.au/donate**

For more information about the Energy [R]evolution visit www.greenpeace.org.au/energyrevolution