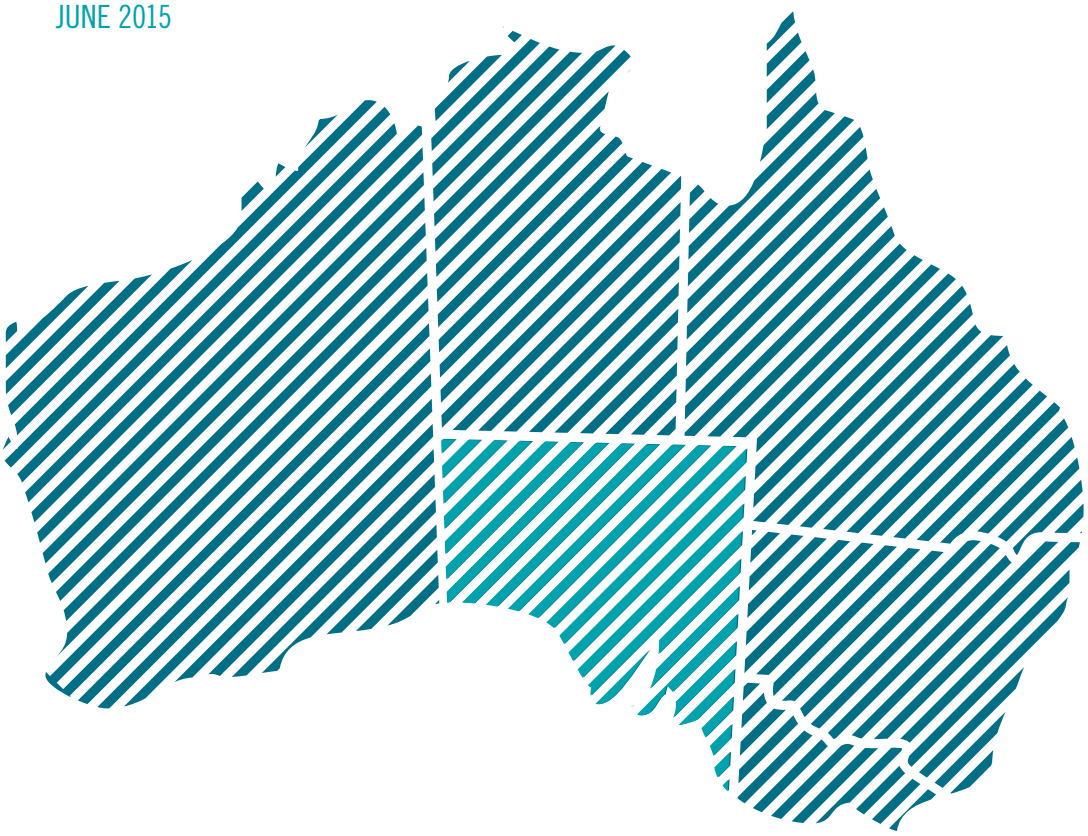
CONSERVATION COUNCIL OF SOUTH AUSTRALIA
JUNE 2015



100% RENEWABLE ELECTRICITY FOR SOUTH AUSTRALIA

There is an energy revolution underway, and our state faces some big choices. We are leading the world in renewable energy and have a real chance to get to 100% renewables in 15 years. However our government has established a Royal Commission to investigate increasing our role in the nuclear fuel cycle.

Do we want to continue our clean energy transformation or be diverted into nuclear energy, with the high costs and risks it entails?

THE RISE OF RENEWABLES.

Forget all you thought you knew about renewable energy.

In the last three years, the pace of change has been breathtaking and what was once true is no longer:

- Renewables are too expensive without big subsidies **WRONG**
- We need 'baseload' power stations **WRONG**
- Renewables are not reliable enough **WRONG**
- A modern economy can't rely on 100% renewable energy **WRONG**

The energy revolution is on and South Australia has a real choice.

We are already one of the world leaders in clean, green energy. In the last decade or so, SA's proportion of renewable electricity has gone from almost nothing to a staggering 39%. Our performance is up there with the leading countries around the world such as Denmark. At times, we produce more energy from renewables than any other source.

And the next step is even more exciting: to be 100% powered by renewable energy in just 15 years.

Possible? Absolutely!

SA households have embraced rooftop solar with open arms – over one quarter of us have it. Every renewable energy target and expectation has been beaten time and time again.

The shift to a reliable electricity system with 100% renewables in SA is not only feasible, but also affordable.

As the amount of renewable energy in our energy grid increases, it brings down the wholesale price of electricity.

This transition also increases the requirement for flexible, 'dispatchable' renewable technologies that complement wind and solar PV. Baseload power stations such as coal and nuclear become redundant.

We simply won't need dirty coal-fired power stations, and we won't need to build any nuclear power plants.

In fact, compared with nuclear power, renewable energy is more reliable, much less dangerous, less expensive, emits less life-cycle CO2, offers a wider range of environmental, health and employment benefits, and can be implemented much more rapidly.

SA can lead the world in switching to 100% renewables, and we don't need to wait for leadership from the Federal Government.

We can do it ourselves.

Conservation Council SA

100% RENEWABLE ELECTRICITY FOR SOUTH AUSTRALIA

IN THE LAST DECADE SA'S PROPORTION OF RENEWABLE ENERGY HAS GONE FROM ALMOST NOTHING TO A STAGGERING 39%.

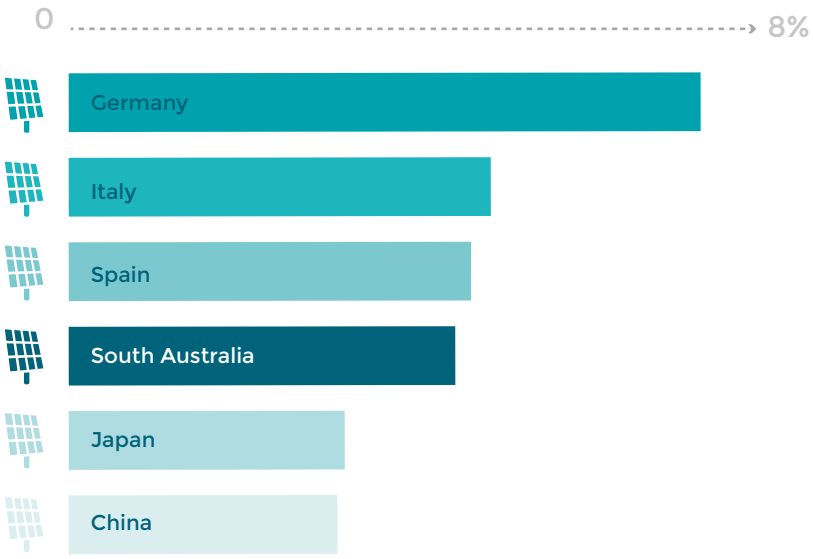
SA LEADING THE WAY.

South Australia (SA) is the leading Australian state and one of the leading places in the world in terms of the proportion of solar and wind energy supplying the state's annual electricity consumption.

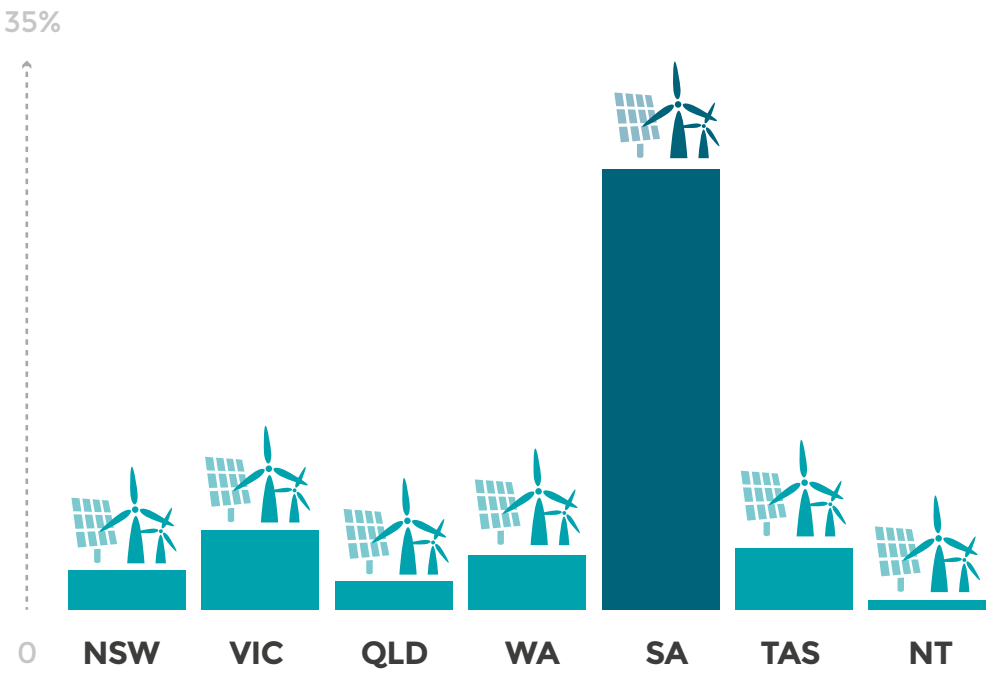
With its excellent wind and solar resources and its already high penetrations of wind energy into the grid and solar photovoltaics (PV) onto its residential rooftops, SA has a realistic opportunity to become the first Australian state to reach 100% renewable electricity (without traditional hydro-electric power).

A recent study by Dr Mark Diesendorf, Deputy Director of the Institute of Environmental Studies at the University of NSW, examined scenarios where the future electricity mix of South Australia (SA) could be predominantly or entirely based on renewable energy by 2030.

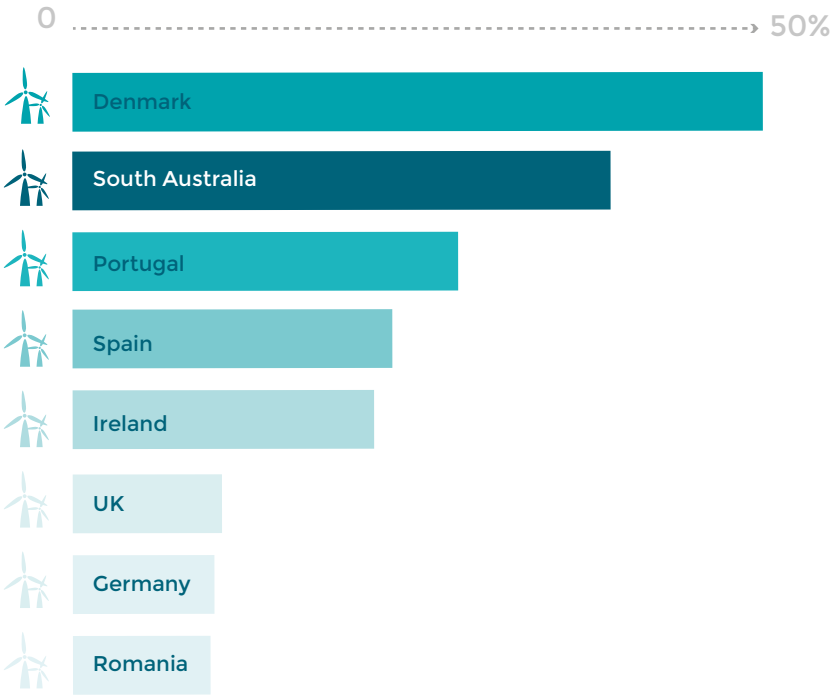
This paper summarises its key findings.



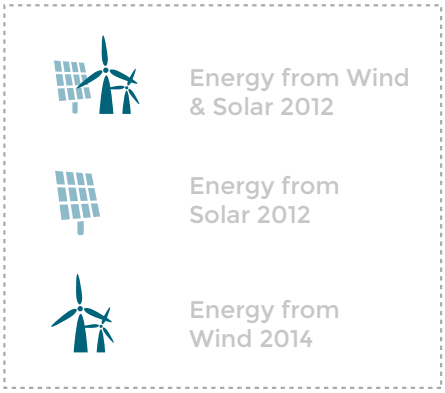
Energy Information (US Government) & Bureau of Resources and Energy Economics (Australian Government)



Bureau of Resources and Energy Economics (Australian Government)



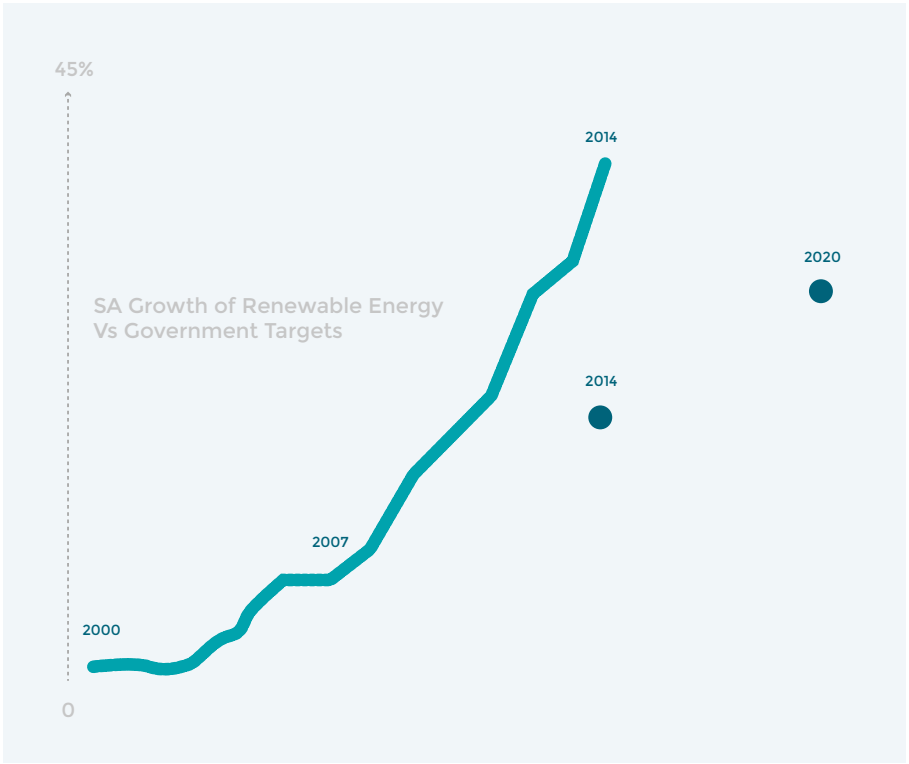
Earth Policy Institute & SA Government



BENEFITS

The benefits of transitioning to an electricity future that is predominantly or entirely based on renewable energy are both environmental and economic. It would reduce SA's greenhouse gas emissions substantially. It would also reduce air pollution and associated respiratory diseases. South Australia could export renewable electricity to the eastern states and possibly, in the long term, overseas.

To undertake this transition SA could create a wide range of new jobs for manufacturing components of wind turbines, concentrated solar thermal (CST) power stations and electric vehicles; engineering jobs for installation and grid connection of clean power stations; and technical and sales jobs for the installation of rooftop solar PV. Large-scale renewable energy reduces the price of wholesale grid electricity. Consumers who install rooftop solar PV reduce their electricity bills.



SA Government

ECONOMICS

The capital costs and the cost of energy from solar photovoltaic (PV) panels have declined dramatically over the past decade and continue to decline as the result of market growth, technological improvements and experience in installation. Rooftop solar PV is now economically competitive with retail prices of grid electricity in most of Australia. As only a few medium-scale solar power stations have recently been installed on the ground in Australia, costs are still quite high, although they are also quickly declining.

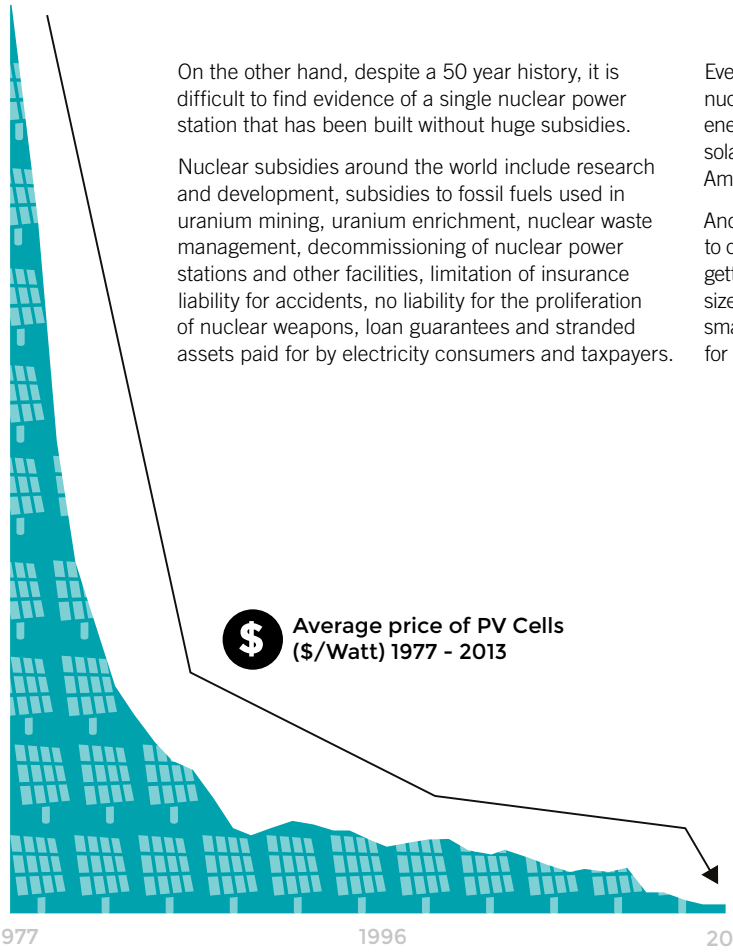
Renewable energy subsidies, although initially high in Europe and Australia, are being reduced to low levels or being removed completely as the technologies mature and markets grow.

On the other hand, despite a 50 year history, it is difficult to find evidence of a single nuclear power station that has been built without huge subsidies.

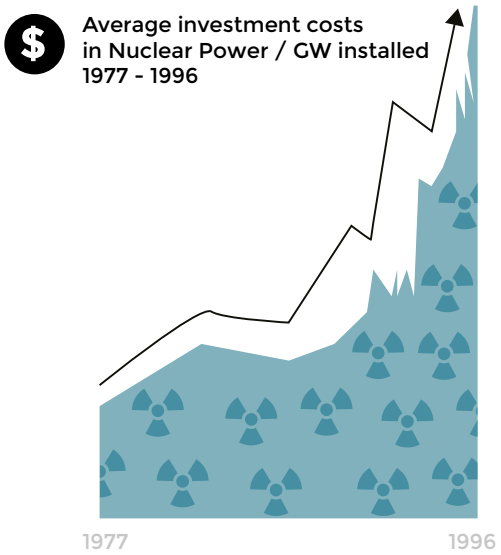
Nuclear subsidies around the world include research and development, subsidies to fossil fuels used in uranium mining, uranium enrichment, nuclear waste management, decommissioning of nuclear power stations and other facilities, limitation of insurance liability for accidents, no liability for the proliferation of nuclear weapons, loan guarantees and stranded assets paid for by electricity consumers and taxpayers.

Even without allowing for the value of subsidies, the price range of nuclear energy is about double the price range of on-shore wind energy and is greater than the cost of solar energy from large-scale solar PV power stations in sunny regions of the USA and South America.

And while the year on year trend is for the costs of renewable energy to continue to fall, the trend for nuclear power is the opposite – it's getting more expensive over time, not less. Furthermore, a standard-sized nuclear power station would be too big to fit into the SA grid and small reactors are not commercially available. It's simply not an option for our state based on cost, size and need.



Bloomberg New Energy Finance



Arnulf Grubler (2010)

MODELLING 100% RENEWABLES.

Recent peer-reviewed studies by a UNSW research group[1] used detailed computer modelling to determine the feasibility of a 100% renewable electricity grid for Australia.

The group took years of real time data and matched it with detailed weather results and then ran hourly simulations to test different renewable energy penetration options. The studies used very conservative assumptions for technology costs (ie, higher costs for renewables and lower costs for fossil fuels than current trajectories suggest).Even with these assumptions, the studies found that 100% renewable energy would be economically competitive with:

- **a new 'efficient' fossil fuelled supply system** with a carbon price of at least $50/tonne CO2 OR if current fossil fuels subsidies were transferred temporarily to renewables
- **a new all-gas scenario** if wholesale gas prices in the NEM region are equal or close to current prices in Queensland (which have been dragged up by high export prices)
- **new coal or gas with carbon capture & storage** almost everywhere, except possibly in southern Victoria.

With less conservative cost projections, 100% renewable energy may already be competitive with new fossil fuel mixes.

The UNSW team have also carried out the same modelling focusing specifically on South Australia's electricity supply and found that the system could be operated reliably with 100% renewable energy.

They have found that a 100% renewable option of SA is reliable, affordable, possible within 15 years, and hugely beneficial for our state.

RELIABILITY

Countries and states with high proportions of renewable energy have found that the electricity supply system can operate reliably with at least 40% average generation from variable sources such as solar and wind. With appropriate transmission connections to neighbouring countries or states, this can increase to 100%. SA itself has already demonstrated that it can operate reliably and stably for hours when the contribution of variable renewables reaches two-thirds of demand.

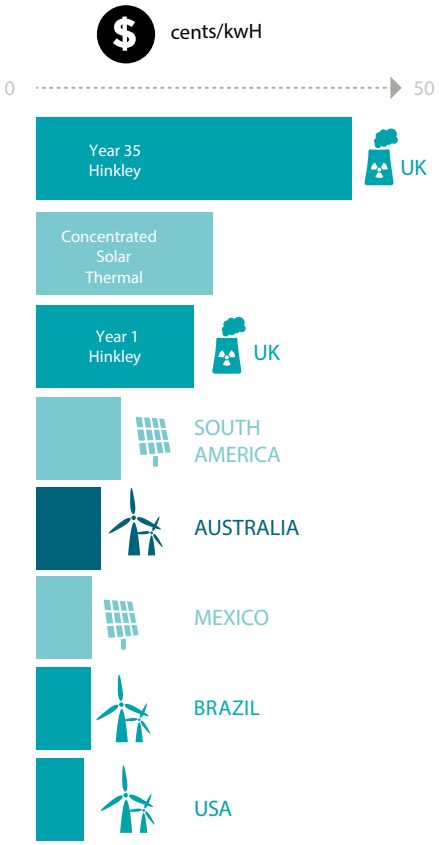
This practical experience is supported by detailed computer simulations from many countries including Australia, which show that 80–100% annual electricity generation from renewables is feasible and reliable. Reliability is achieved by:

- a mix of variable RE (e.g. wind and solar PV) and flexible, dispatchable RE sources (e.g. concentrated solar thermal (CST) with energy storage, biofuelled gas turbines and hydro with dams);
- geographic dispersion of RE power stations assisted by one or two new major transmission links;
- demand management assisted by 'smart' meters and 'smart' switches in a 'smart' grid.

There is no need for any baseload power stations, such as coal or nuclear. The inflexibility of coal and nuclear makes them poor partners for high proportions of variable renewables. This is one of several reasons why France is planning to decrease its nuclear contribution to total annual electricity generation.

Although nuclear power generally has a much higher capacity factor (annual average power output divided by rated power) than wind and solar PV, it has reliability challenges resulting from extreme weather and severe accidents

[1] Elliston et al. 2012; 2013; 2014



Dr Mark Diesendorf (2015)

HOW COULD THE SA GOVERNMENT MAKE IT HAPPEN?

State government policies recommended for achieving the benefits of a renewably-powered future include:

- strong targets for greenhouse gas reductions and for large-scale renewable electricity for 2020, 2025 and 2030
- a state-based large-scale renewable energy target (RET) with tradeable certificates akin to the national RET that has been reduced by the federal government. This could have separate targets for wind, solar PV and CST with thermal storage, to achieve the optimal energy mix. *OR*
- SA could have various RETs as described but instead of tradable certificates, use the successful ACT approach of reverse auctions for each RE technology together with feed-in tariffs or contracts for difference for the winning bids.
- mandated fair feed-in tariffs for rooftop solar PV. Electricity retailers typically charge 25–35 c/kWh for electricity, but pay only 0–8 c/kWh for electricity from small scale renewables. Feed-in tariffs could vary to reflect supply and demand to encourage the use of batteries for evening peaks in demand.
- fair prices for retail electricity, which should also vary to reflect supply and demand.
- a fast transition to a 'smart' grid, where customers have 'smart' meters and switches that permit both customers and electricity retailers to switch off particular circuits for short periods, depending on supply and demand in the grid, governed by the contract between supplier and consumer. This would be necessary to facilitate fair pricing and feed-in tariffs.
- policies to encourage investment in flexible, fast-response, peak-load power plant that is operated intermittently for short periods of time when there is insufficient wind and sun (for example, a capacity payment available only to this kind of plant).
- a high-voltage, high-capacity, transmission line linking Port Augusta via Broken Hill to the eastern electricity grid in NSW. This would feed the principal load centres in NSW with excess wind power from SA, solar and wind power from western NSW and possibly in the long term hot rock geothermal power from central Australia. The transmission line could be funded jointly by the SA, NSW and federal governments.

CONCLUSION.

THE TRANSITION TO A RELIABLE ELECTRICITY SUPPLY-DEMAND SYSTEM WITH 100% RENEWABLES IN SA IS FEASIBLE AND AFFORDABLE.

As the contribution of renewable energy increases, it reduces the wholesale price of electricity and increases the requirement for flexible, dispatchable technologies to complement wind and solar PV, removing base-load power stations, that is, coal or nuclear, as options in SA's electricity mix.

Compared with scenarios involving nuclear power, the renewable energy scenarios explored by the UNSW team are reliable, much less dangerous, less expensive, emit less life-cycle CO2, offer a wider range of environmental, health and employment benefits, and can be implemented much more rapidly. A nuclear power station (600 MW or more) would be too big for the SA grid system and would need a huge amount of back-up. Yet small modular reactors are not commercially mature.

Considering all its shortcomings, nuclear is too expensive, too inflexible, too dangerous, too CO2-intensive, too slow a technology to introduce and too big for South Australia.

Instead, South Australia is poised to transition rapidly and safely to a 100% renewable energy future.

RENEWABLE ENERGY MYTHS.

MYTH: RENEWABLE ENERGY IS TOO VARIABLE OR 'INTERMITTENT' TO RELIABLY MAKE THE MAJOR CONTRIBUTION TO ELECTRICITY SUPPLY

Hourly computer simulations, spanning 1–32 years of data on electricity supply and demand, show that 80–100% renewable energy can supply electricity just as reliably as conventional power stations. Reliability is achieved by having a mix of variable renewables (eg, wind and solar photovoltaics (PV)) and flexible, dispatchable renewables (eg, hydro with large dams, gas turbines burning renewable gases and liquids, and CST with thermal storage). Geographic dispersion of renewable energy generators and reductions in demand peaks in 'smart' grids further increase reliability. As of mid-2014, about 30 simulation studies have been published for different countries and regions and most use commercially available renewable energy technologies.

MYTH: BASE-LOAD POWER STATIONS ARE NECESSARY AND RENEWABLE ENERGY CANNOT PROVIDE THEM

Base-load power stations, such as coal or nuclear, are unnecessary for supplying base-load demand reliably. This is shown by both hourly computer simulations of electricity supply from 100% renewable energy and practical experience with high penetrations of wind power into electricity grids. In a 100% renewable electricity system, reliability is achieved by the means explained in the previous refutation.

MYTH: COAL-FIRED POWER STATIONS MUST BE OPERATED CONTINUOUSLY AS BACK-UP FOR VARIABLE RENEWABLE ENERGY SYSTEMS

Again, both practical experience and computer simulations bust this myth. In South Australia, where 33% of annual electricity is generated from wind, one of the two coal-fired power stations has been shut down and the other is now only operated for half the year. No additional gas-fired power stations have been installed. Computer simulations confirm that base-load power stations, such as coal and nuclear, are too inflexible to be partners with large amounts of variable renewable energy. The necessary partners are flexible, peak-load power stations, which can be entirely renewable.

MYTH: RENEWABLE ENERGY IS TOO EXPENSIVE

Once true, but now no longer. In many countries rooftop solar PV has become economically competitive with retail electricity prices and in a few locations large solar PV power stations are already becoming competitive in the wholesale market. On-shore wind is competing with new conventional power stations in the wholesale market in several countries. Both solar PV and wind are continuing to become cheaper, while coal and nuclear power stations are becoming more expensive.

MYTH: RENEWABLE ENERGY RECEIVES HUGE SUBSIDIES

Subsidies to renewable energy have been decreased to the point where they are generally much smaller than the direct economic subsidies to the production and use of fossil fuels and to nuclear energy. In addition, fossil and nuclear energies receive huge indirect subsidies resulting from the failure to include in their prices their huge environmental and health costs and risks.

MYTH: RENEWABLE ENERGY IS NOT READY TO REPLACE FOSSIL FUELS

A sufficient variety of commercially available renewable energy technologies are ready to replace fossil-fuelled electricity in Australia and many other countries. Of course renewable energy has to be scaled up, however this can be done much more quickly than for fossil and nuclear power stations, because wind and solar technologies are mass-produced in factories and the installation is very rapid. For urban transport, cycling, walking, improved mass transit and vehicles fuelled by renewable electricity can replace most fossil-fuelled vehicles. For long-distance rural road and air transport, renewable energy still needs further development: 2nd and 3rd generation biofuels may be the solution.




MYTH: RENEWABLE ENERGY IS TOO DIFFUSE TO RUN AN INDUSTRIAL SOCIETY

There is ample marginal land on the planet, together with rooftops, to provide all the solar energy required, while wind farms are compatible with almost all forms of agriculture and occupy only 1–2% of the land they span. While not all countries are equally blessed with renewable energy resources, trade in renewable energy by transmission lines and by transporting renewable hydrogen in LNG tankers could supply disadvantaged regions. After all, fossil fuels and uranium are traded internationally.

MYTH: ENERGY PAYBACK PERIODS (IN ENERGY UNITS, NOT MONEY) FOR RENEWABLE ENERGY SYSTEMS ARE COMPARABLE WITH THEIR LIFETIMES

This was once true in the early uses of solar PV in satellites. Nowadays energy paybacks for solar PV modules are typically 0.5–1.8 years and for wind turbines 0.25–0.75 years, depending on location and technology type. The lifetimes of these technologies are about 25 years each. For comparison, energy payback periods for nuclear energy are 6.5–14 years, depending on whether high- or low-grade uranium ore is mined and milled.

MYTH: DANISH ELECTRICITY PRICES ARE AMONG THE HIGHEST IN EUROPE, BECAUSE OF THE HIGH USE OF RENEWABLE ENERGY IN DENMARK

Danish electricity prices are among the highest in Europe, because the tax on electricity is very high in Denmark. This tax goes into consolidated revenue; it does not specifically subsidise renewable energy. When European electricity prices without taxes are compared, Denmark's is in the lowest quartile.

MYTH: THE DOUBLING OF RETAIL ELECTRICITY PRICES IN AUSTRALIA IN RECENT YEARS IS PRIMARILY THE RESULT OF THE CARBON PRICE AND THE RENEWABLE ENERGY TARGET

By far the biggest contribution to the increase in electricity prices in Australian states comes from the costs of upgrading the distribution system (poles and wires) resulting primarily from increasing demand for air conditioning and new suburbs. In 2013–14 the distribution network was responsible for the major part of average retail electricity price, the carbon price 9% and the Renewable Energy Target about 2%. However, the latter would be offset by the reduction in wholesale electricity price from wind farms, ***if*** it were passed on to retail customers.

MYTH: INFRASOUND (SOUND THAT IS TOO LOW IN FREQUENCY TO BE HEARD BY THE HUMAN EAR) FROM WIND TURBINES CAUSES A WIDE RANGE OF ILL HEALTH SYMPTOMS

Despite numerous studies, there is no scientific evidence to support this claim. Evidence against it is that infrasound from air conditioners, motor vehicles travelling on roads and waves breaking at a beach is generally much greater than infrasound from a wind turbine. Furthermore, a randomised, controlled, double-blind trial shows that people cannot distinguish between infrasound and sham infrasound (silence) and that illnesses attributed wrongly to infrasound can be psychologically induced.

NUCLEAR ENERGY MYTHS.

MYTH: THERE IS A RENAISSANCE IN NUCLEAR ENERGY.

Annual global nuclear electricity generation peaked at 2660 TWh in 2006 and dropped to 2359 TWh in 2013. In percentage terms, nuclear energy's share of global electricity generation has dropped from its historic peak of 17.6% in 1996 to 10.8% in 2013. Reductions in nuclear capacity are expected over the next decade and beyond as Germany closes nuclear and France reduces its nuclear fleet. Retirements are expected from other countries too, since the world nuclear fleet is ageing, with 44% having operated for 30 years or more.

Optus Evolve has been designed to be modular and easy to understand. The greater simplicity and reliability of the new Optus network means the company can deliver on its service level agreements. The network is delivered as Ethernet, eliminating clunky serial interfaces and forklift upgrades. It is also application-aware so Optus can deliver intelligent performance management and reporting which means that you can have confidence your applications will perform the way you want them to.

MYTH: BASE-LOAD POWER STATIONS ARE NECESSARY, SO THE ONLY CHOICE IS BETWEEN COAL AND NUCLEAR.

As explained in Section 3.1 and Appendix 1 of this submission, electricity supply systems based on 100% renewable energy can be designed to be reliable, even when the energy mix has the major contribution from variable sources such as wind and solar PV. This is shown by both hourly computer simulations of electricity supply from 100% renewable energy and practical experience with high penetrations of wind power into electricity grids.

MYTH: NUCLEAR ENERGY COULD FILL IN THE ALLEGED GAP IN CLEAN ENERGY SUPPLY UNTIL RENEWABLE ENERGY IS READY.

Nuclear power stations are a very slow technology to construct, taking typically in the USA 9–10 years plus planning years. In Australia even the nuclear industry admits that it would take 15 years to plan and build the first nuclear power station and to this should be added the time required to convince the public. On the other hand, large wind and solar power stations can be planned and built in 2–3 years. There is no gap in clean energy supply—only the political will to embrace renewable energy is lacking in some countries with powerful vested interests in fossil fuels or nuclear energy.

MYTH: NUCLEAR WEAPONS CANNOT BE MADE FROM REACTOR GRADE PLUTONIUM (THE TYPE OF PLUTONIUM MADE IN A CIVIL NUCLEAR POWER STATION).

This claim has been refuted by a leading nuclear bomb designer (Dr Theodore Taylor), a Commissioner of the US Nuclear Regulatory Commission (Dr Victor Gilinsky) and the US Department of Energy. Indeed the USA has tested nuclear bombs that use reactor grade plutonium.

MYTH: FOURTH GENERATION NUCLEAR REACTORS – FAST BREEDER, INTEGRAL FAST OR THORIUM – ARE EITHER COMMERCIALLY AVAILABLE OR WILL BE VERY SOON

None is commercially available. The fast breeder has been stuck at the demonstration stage of maturity for decades. The integral fast reactor was only built as a pilot plant in the USA. Thorium has been researched for 40 years as a potential nuclear fuel, but the commercialisation of thorium reactors still looks expensive and distant.

MYTH: NUCLEAR WEAPONS CANNOT BE MADE FROM THE THORIUM FUEL CYCLE

Nuclear reactors are fuelled on fissile elements, i.e. those whose atomic nuclei can be split. If the fuel is fissile, it can be split either in a controlled way in a reactor or in an uncontrolled chain reaction in a bomb. Since thorium is not fissile, it has to be converted into a fissile element, uranium-233, by bombarding it with neutrons. The USA and India have exploded nuclear bombs with uranium-233 as the explosive.

MYTH: NUCLEAR WEAPONS CANNOT BE MADE FROM THE INTEGRAL FAST REACTOR.

The integral fast reactor is a hypothetical reactor whose spent fuel would be separated on-site, using an experimental process called pyroprocessing, into medium-life fission products and long-life transuranic (aka actinide) elements including plutonium-239, a nuclear weapons explosive. In theory the transuranics could be fed back into the reactor and 'burned' up, without separating the plutonium. But in practice the plutonium could be extracted from the other transuranics by chemical reprocessing and used in nuclear weapons. This extraction would be easier and safer from the spent fuel of an integral fast reactor than from a conventional reactor, because the highly radioactive fission products would have already been separated by pyroprocessing.



MYTH: ONLY 30-64 PEOPLE DIED AS THE RESULT OF THE CHERNOBYL DISASTER.

This misleading statement refers only to the relatively small number of short-term deaths from acute radiation syndrome and ignores the major contribution to deaths and disabilities, namely long-term induced cancers. Estimates of cancers by reputable authorities range from 16,000 to 93,000.

MYTH: NUCLEAR POWER EMITS NO OR NEGLIGIBLE GREENHOUSE GAS EMISSIONS.

This misleading statement ignores life-cycle CO2 emissions which are already greater than those of wind power and are expected to increase substantially over the next few decades as high-grade uranium ore is used up and low-grade ore has to be mined and milled using fossil fuel (diesel).

MYTH: NUCLEAR POWER STATIONS HAVE CAPACITY FACTORS (ANNUAL AVERAGE POWER DIVIDED BY RATED POWER) OF AROUND 90%.

Although this misleading statement is correct for the operation of US nuclear power stations in recent years, it omits to mention that lifetime average capacity factors are much lower. It has taken much expensive maintenance over several decades to lift the performance to current levels. Global average capacity factors in 2013 were about 72%. It is unlikely that the new generation of reactors (Generation III and III+), with their teething problems, could achieve high capacity factors in their early years of operation.

MYTH: THE QUANTITY OF NUCLEAR WASTES IS TINY COMPARED WITH THAT OF COAL WASTES.

This misleading statement is based on comparing all coal wastes with the volume of high-level nuclear wastes only, while ignoring the much larger volume of low-level nuclear wastes, e.g. Olympic Dam uranium and copper mine has a waste mountain of about 150 million tonnes blowing in the wind.

MYTH: NUCLEAR ENERGY IS CHEAPER THAN WIND AND SOLAR PV.

On-shore wind energy is already half the price nuclear energy; utility scale solar PV power stations are just starting to become competitive with nuclear power in a few regions of the world. Fourth generation nuclear reactors, which are being presented by enthusiasts as the future hope of the nuclear industry, are more complex and hence likely to be even more expensive than the current third generation that are under construction.

In the last decade or so, SA's proportion of renewable energy has gone from almost nothing to a staggering 39%.

Our performance is up there with the leading countries around the world. At times, we produce more energy from renewables than any other source.

Conservation Council SA

CCSA JUNE 2015