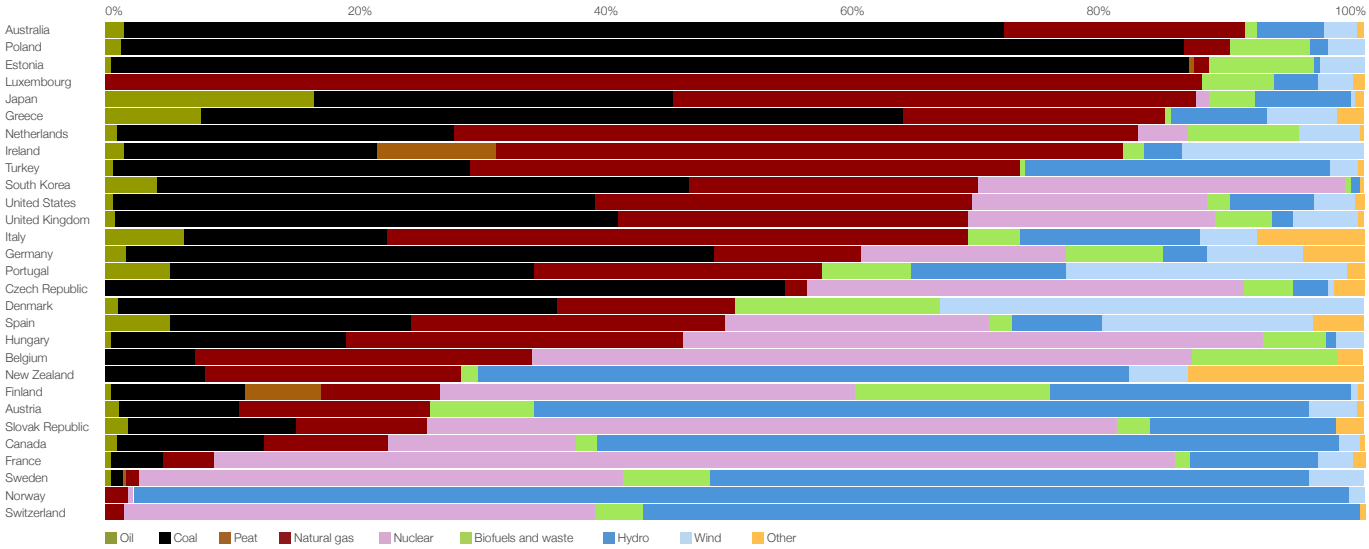
RENEWABLE ENERGY IN AUSTRALIA

How do we really compare?

AUSTRALIAN ENERGY COUNCIL

Increasing electricity generation from renewable energy sources is one of the main strategies to reduce greenhouse emissions from the power sector. Australia has historically had a relatively greenhouse-intense electricity generation industry because of the abundance of its coal and gas resources. We also have a relatively high consumption of electricity per capita, with around one-third of all electricity in Australia used for large, energy-intense industrial processes.

Figure 1: Electricity generation by proportion of energy type by country, 20131



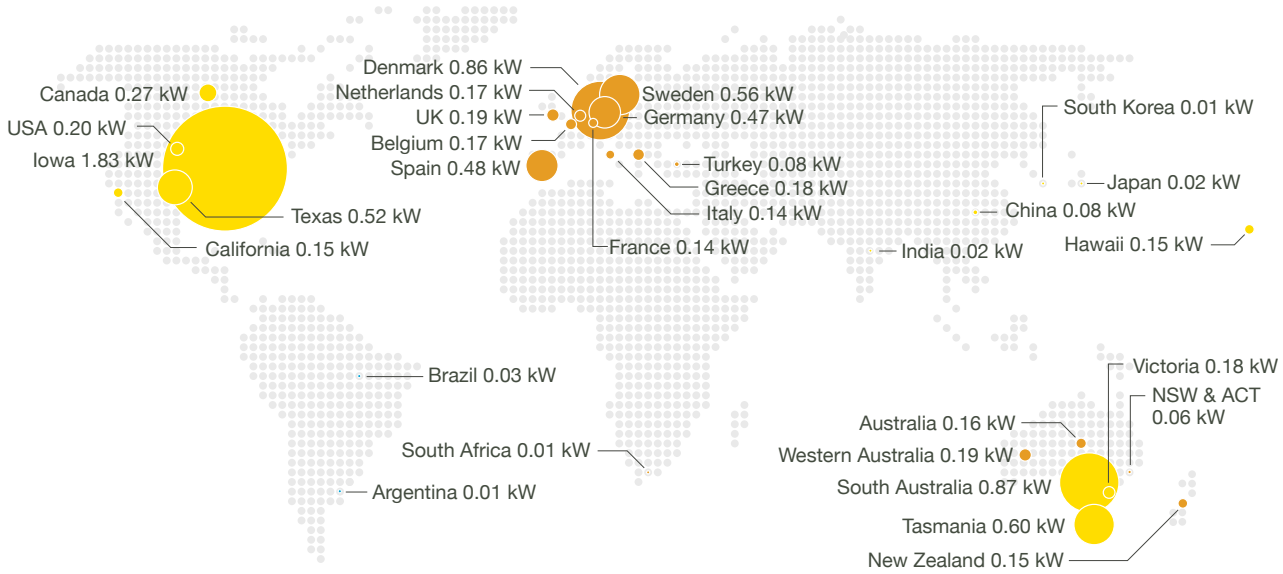
Australia sources around 5-9 per cent of its generation from hydro generation. Most hydro generation around the world was built during the 20th century as an affordable and reliable source of generation. Countries like Norway, Sweden, New Zealand and Canada have been blessed with abundant hydro resources, which gives them a significant head start in reducing greenhouse gas emissions.

Moving beyond these conventional sources of generation, most developed economies have begun increasing the share of generation from new renewable sources, in particular wind and solar energy. **So how does Australia compare?**

Wind

By country, Australia currently ranks 11th in the world for wind generation per capita ahead of countries like China and France. Denmark leads the world, followed by Sweden, Spain and Germany. Australia currently has around 3,800 megawatts (MW) of installed wind capacity.

Figure 2: Per capita wind capacity by country and key US and Australian states/territories, at Dec 2014 (cumulative capacity)[2]



LEADING WIND RANKINGS*		
1st	Iowa	1.83 kW
2nd	South Australia	0.87 kW
3rd	Tasmania	0.60 kW
4th	Texas	0.52 kW

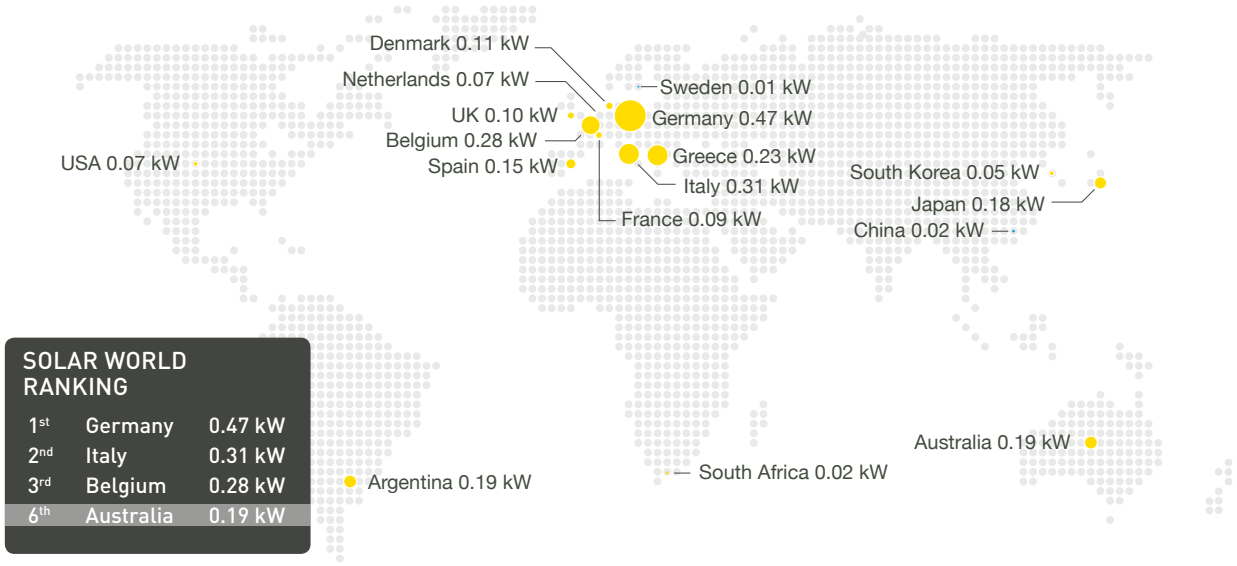
*by jurisdiction

At a jurisdictional level, Australia's wind generation is heavily skewed towards states like South Australia and Tasmania, which have some of the highest per capita wind generation in the world alongside leading US states like Iowa and Texas.

2. Source: World Bank, Global Wind Energy Council (GWEC), EGA

Solar

Figure 3: Solar capacity (kW) per capita by country, at August 20153



By country, Australia ranks 6th in the world for total solar (PV and solar thermal) installed capacity per capita, behind Germany, Italy, Belgium, Greece and Argentina. Australia currently has around 4,500 MW of installed solar capacity.

Figure 4: Penetration rate of solar PV across Australian households

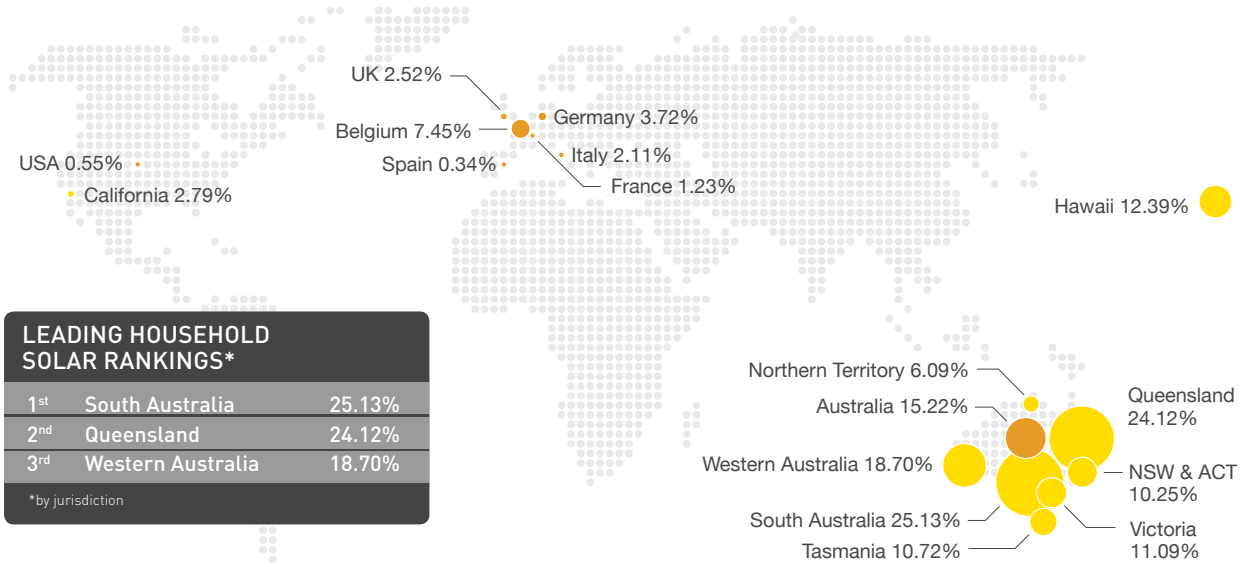
What is significant about Australia's solar capacity is that it is almost entirely located on Australian rooftops. By 2015 more than one in seven Australian households had installed solar photovoltaic (PV). This is a 15 per cent penetration rate across all Australian households. In South Australia and Queensland the household penetration rate is 25 and 24 per cent respectively. Some suburbs in greater Brisbane and Adelaide have recorded household solar PV penetration rates above 50 per cent.

3. Source: World Bank, International Renewable Energy Agency (IRENA), EGA

Household solar

Using data from the Clean Energy Regulator, the US Energy Information Administration and others, we can compare the penetration rates of residential/small-scale solar across various jurisdictions (see Figure 5). Small-scale is defined as less than 100 kW which is the threshold used as part of Australia's Small-scale Renewable Energy Scheme (SRES).4

Figure 5: Small scale solar: Proportion of households with solar PV by country and jurisdiction (US and Australian States/Territories)5



LEADING HOUSEHOLD SOLAR RANKINGS*		
1st	South Australia	25.13%
2nd	Queensland	24.12%
3rd	Western Australia	18.70%

*by jurisdiction

Australia clearly leads the world in the installation of household scale distributed solar PV. Australia has double the residential solar PV penetration rates of the next country (Belgium), and more than three times more rooftop solar PV than Germany and the UK. The three leading jurisdictions in the world for rooftop solar PV are South Australia, Queensland and Western Australia ahead of Hawaii.

Across the US, just 0.5 per cent of households (600,000) have solar PV installed. The US-based Solar Energy Industries Association recently highlighted that America could have 3.3 million households with solar installed by 2020.

By contrast, Australia has few utility-scale solar installations. The recently opened 102 MW solar PV plant at Nyngan is the only large-scale example, although smaller facilities exist around Alice Springs, Western Australia and Queensland. By contrast, California has more than 7.3 GW of large-scale solar capacity out of a total 9.4 GW of installed capacity.7 Spain, and Italy have also developed large amounts of utility-scale solar PV and solar thermal power.

Australia leads the world in the installation of household solar PV.

4. Due to differing data reporting, installations up to 50kW in capacity have been considered in the UK and up to 200 kW in Italy.
5 Sources: Clean Energy Regulator; Energy Information Administration; Atlasole; French Ministry for Ecology, Sustainable Development and Energy; Bundesverband Solarwirtschaft; Spanish Photovoltaic Association (UNEF); Wallonia Energy Commission; Belgian Association for the Promotion of Renewable Energy (APERE); Eurostat; Electricity Gas Australia 2015, UK Department of Energy and Climate Change.
6 Solar Energy Industries Association, 5 May 2015, SEIA Newsletter.
7 Solar Energy Industries Association, Major Solar Projects List. Last accessed 24 August 2015.

How does Australia rank across both technologies?

Total cumulative world wind capacity stood at 369 gigawatts (GW) at the end of 2014, while solar PV surpassed 150GW globally in early 2014. Australia does not feature in the top 10 countries on cumulative capacities for either wind or solar.

When considering combined wind and solar capacity per capita by country, however Australia is currently ranked 8th in the world. The country with the highest capacity of wind and solar is Denmark, followed by Germany, Spain and Sweden. Australia is ranked, on a per capita basis, ahead of the UK and the US.

Figure 6: Wind and solar capacity (kW) per capita at Dec 20148

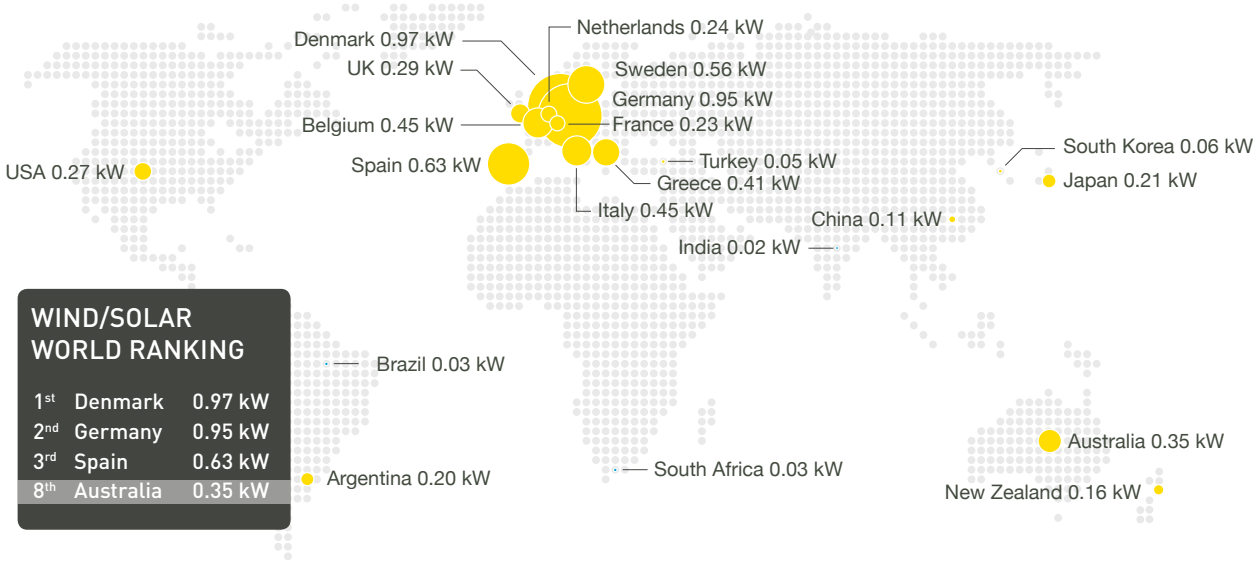
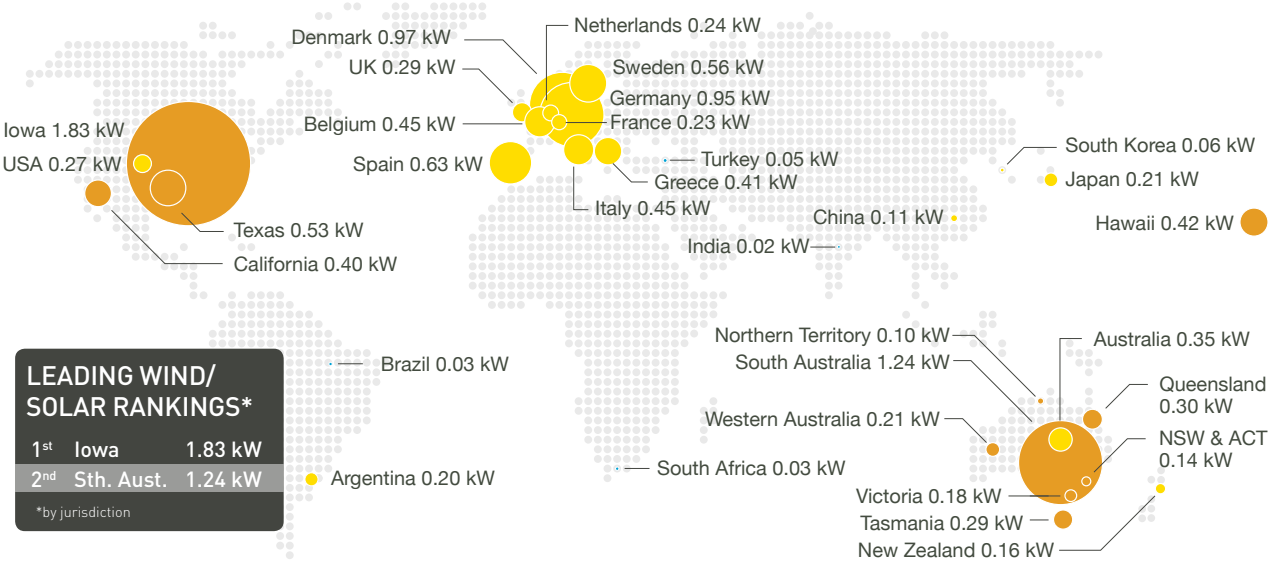


Figure 7: Wind and solar capacity (kW) per capita – including selected US and Australian states and territories - as at Dec 20149



8. Source: World Bank, International Renewable Energy Agency (IRENA), Global Wind Energy Council (GWEC).
9 Source: World Bank, International Renewable Energy Agency (IRENA), Global Wind Energy Council (GWEC), EGA

When looking at a jurisdictional level, Iowa has the highest per capita capacity of wind and solar, with South Australia ranked second in the world. South Australia currently has around 39 per cent of its total generation supplied by wind and solar.

The South Australian renewables experiment is more significant given most other high renewables penetration regions and countries - Iowa, Denmark and Germany – are much more integrated into larger grids with complementary (dispatchable) generation technologies. The South Australian grid is partially constrained, connected to Victoria by two transmission lines which allows it to source a maximum of around 20 per cent of peak load from Victoria.10 By contrast, Denmark has interconnections that allow it to source its entire peak load from other countries.

Around 3 per cent of Australia's total electricity generation comes from solar and around 2 per cent from wind energy.

10. esaa analysis based on Electricity Gas Australia and ElectraNet data

King Island: The future of renewables

Hydro Tasmania is undertaking a project on King Island to test and showcase the impacts of large-scale solar and wind generation.

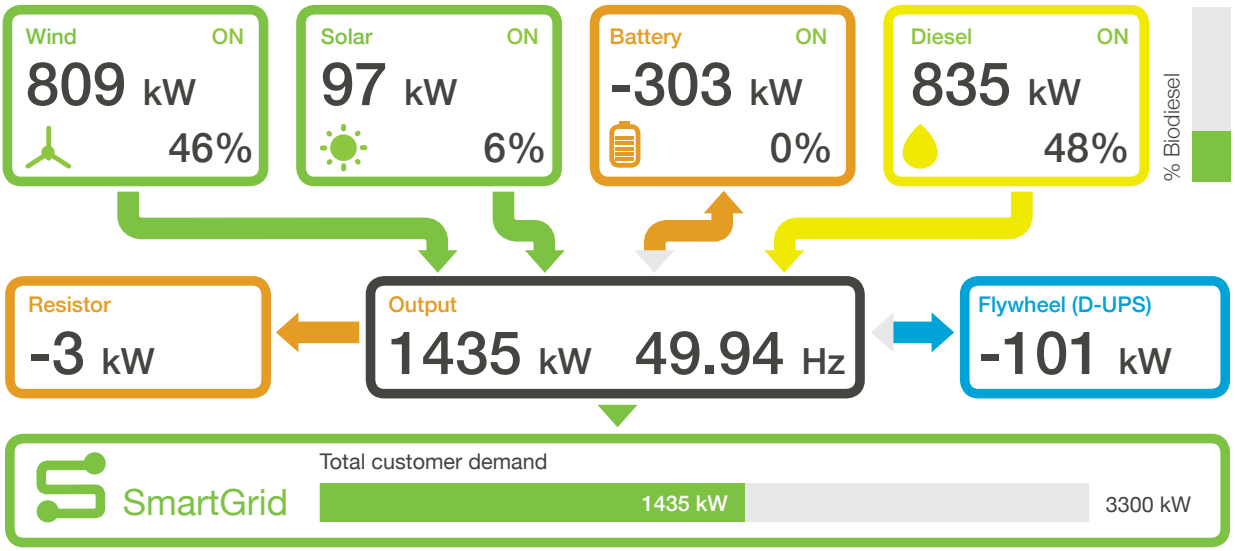
Since 1998 the King Island Renewable Energy Integration Project (KIREIP) has been reducing the island's dependence on diesel for power generation by increasing the use of renewable energy, while maintaining a reliable and stable electricity supply. The ambition of the project is to reduce costs and greenhouse gas emissions in the long-term. It is the only megawatt scale hybrid system able to achieve 100 per cent renewable penetration, or 'diesel-off' operation.

The project is targeting 65 per cent of the annual energy demand from renewable energy sources, with the remaining powered by diesel, although there are plans to replace this with biofuels. In 2014-15 there was a 40 per cent renewable contribution, representing a diesel saving of approximately $2 million per annum.

At times, particularly when it is very windy, the island is already powered by 100 per cent renewable energy. Since early 2014, the system has achieved more than 1000hrs of total 'diesel-off' operation including a single day record of 20 hours. This is among the most advanced integration of grid scale renewable energy in the world.

The project utilises a combination of solar, wind and biodiesel for generation along with enabling technologies such as battery storage, smart grid technology, demand response, flywheels, and a diesel uninterruptible power supply to maximise the possible contribution from renewable energy.

Figure 8: Snapshot of King Island's electricity supply at 11.36am, Friday 4 September



The King Island project has the potential to help other off-grid communities understand how renewable sources and enabling technology can provide reliable renewable generation.

Any questions about the report should be addressed to Panos Priftakis panos.priftakis@energycouncil.com.au.