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SUSTAINABILITY OF ENERGY SUPPLY AND RESOURCES IN NSW

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Committee on Environment and Planning

Sustainability of energy supply and resources in NSW

Recommendation

New England and the Southern Tablelands (around Goulburn) should be declared to be Renewable Energy Zones (REZ), the latter in conjunction with the ACT Government.

The Government should facilitate rapid upgrade of transmission from these REZ to Sydney to unlock further large-scale private investment (and job generation) in solar, wind and pumped hydro in NSW.

Renewables dominate new generation capacity deployment

Solar photovoltaics (PV) and wind are being installed at far higher rates than other technologies as illustrated in Figure 1.

In Australia, PV and wind constitute nearly 100% of net new deployment.

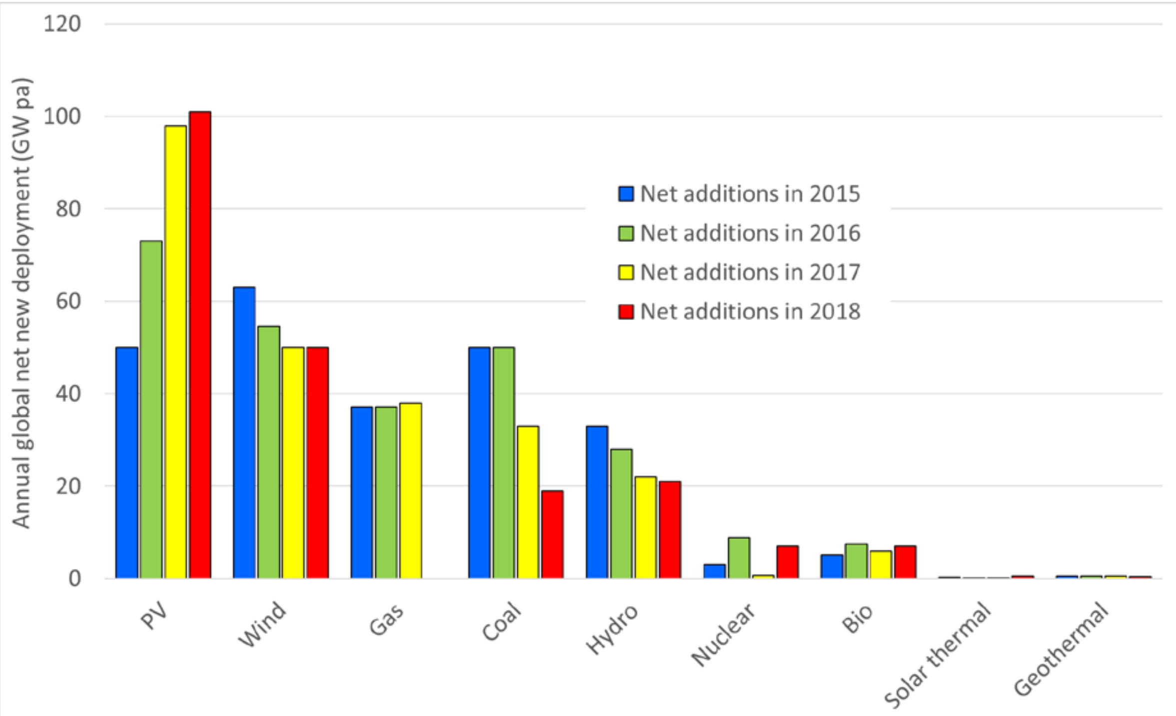

Fig. 1. Global net new capacity additions 2015-18 illustrating the dominance of PV [1-7]

The dominance of PV and wind is because it is much lower cost than other generation technologies, including nuclear, coal and gas.

The huge gap in annual net new deployment rates between PV and wind on the one hand and all other energy technologies on the other means that PV and wind are likely to dominate future energy markets because of economies of scale (amongst other advantages).

RAPID RENEWABLE ENERGY DEPLOYMENT IN AUSTRALIA

Australia is experiencing a remarkable renewable energy transition that has global significance. Over the three years 2018-20, Australia will install 16 Gigawatts (GW) of solar PV and wind. For perspective, average and peak demand in the National Electricity Market is 24 and 36 GW respectively.

This equates to 200-250 Watts per person per year compared with about 50 Watts per person per year for the European Union, Japan, China and the USA (Fig. 2). This renewable energy pipeline is fast enough to reach 50% renewable electricity in 2024 and 100% in 2032.

Developments in Australia have global significance because they demonstrate that rapid deployment of variable PV and wind is feasible in an isolated electricity market in an industrialized nation.

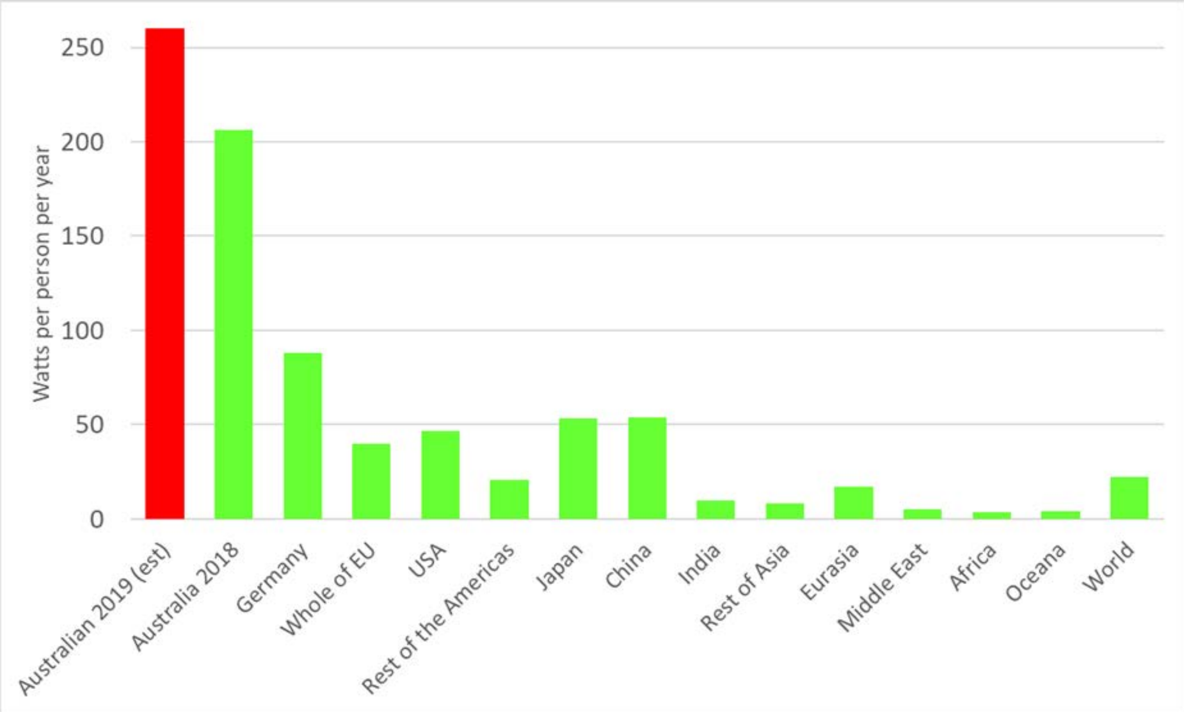

Fig. 2. Annual per capita renewables deployment rate for countries and regions. Data for Australia (2018 and 2019) is from [8] and data for other countries/regions (2018) is from [1].

The price of electricity from large-scale PV and windfarms in Australia is currently $45-55 per MWh and falling. This is below the cost of electricity from existing gas-fired power stations and is also below the cost of new-build gas and coal power stations. The cost of electricity from PV and wind is already similar to the cost of fuelling and maintaining much of the black coal fleet. Premature retirement of many existing black coal power stations is likely during the 2020s, enlarging the market for PV and wind.

The rise of electric vehicles (pushing out oil) and electric heat pumps (pushing gas out of water and space heating markets) will increase demand for PV and wind (by 50% if all land transport is converted to electricity and all low temperature heating is provided by to heat pumps). Renewable electrification can reduce greenhouse gas emissions by more than half during the 2020s by displacing much of the coal, oil and gas.

Greenhouse gas emissions in the Australian electricity sector are declining rapidly as wind and PV displace coal generation. Future increases in emissions outside the electricity system are likely to be smaller than decreases within the electricity sector, leading to an expected overall decrease in emissions. If wind and PV deployment rates remain at current levels, then this decrease would be fast enough to reach Australia's entire Paris greenhouse emissions reduction target in the late-2020s.

Pumped hydro energy storage

A global study by the authors found 616,000 potentially feasible off-river PHES sites with storage potential of about 23 million Gigawatt-hours (GWh) [9]. This is 100 times more than needed to support a global 100% renewable electricity system.

ANU identified 3,000 good pumped hydro sites in Australia, mostly off-river (Figure 3). This is 300 times more than needed to support a 100% renewable electricity system.

Each identified site comprises an upper and lower reservoir pair plus a hypothetical tunnel route between the reservoirs (Fig. 4). Detailed zoomable maps for all of the reservoirs are available, together with spreadsheets containing data such as latitude, longitude, altitude, head, slope, water volume, water area, rock volume, dam wall length, water/rock ratio, energy storage potential and approximate relative cost (classes A-E) [9].

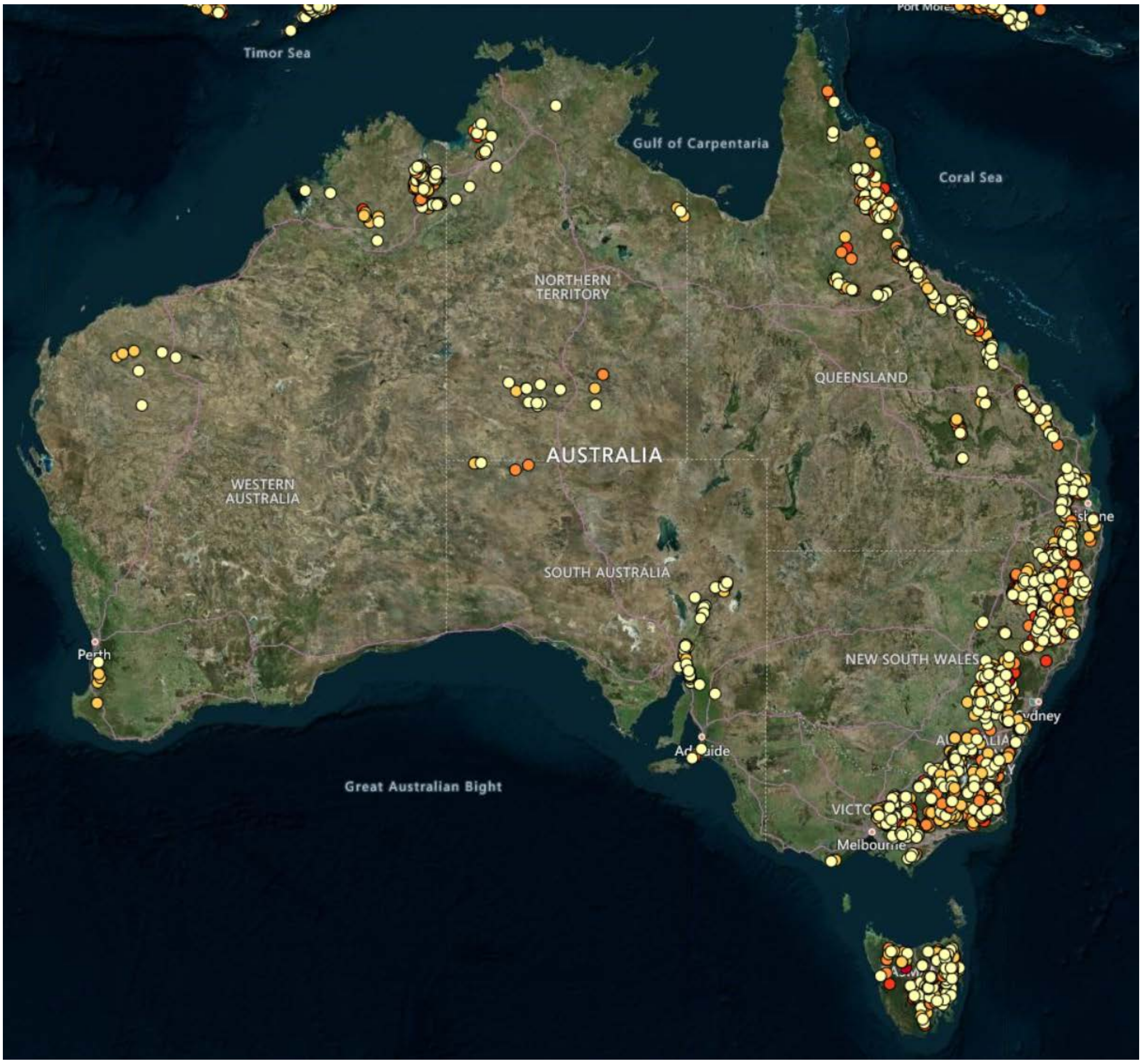

Figure 3: 3,000 good pumped hydro sites in Australia. See reference [9] for detailed zoomable maps and information.

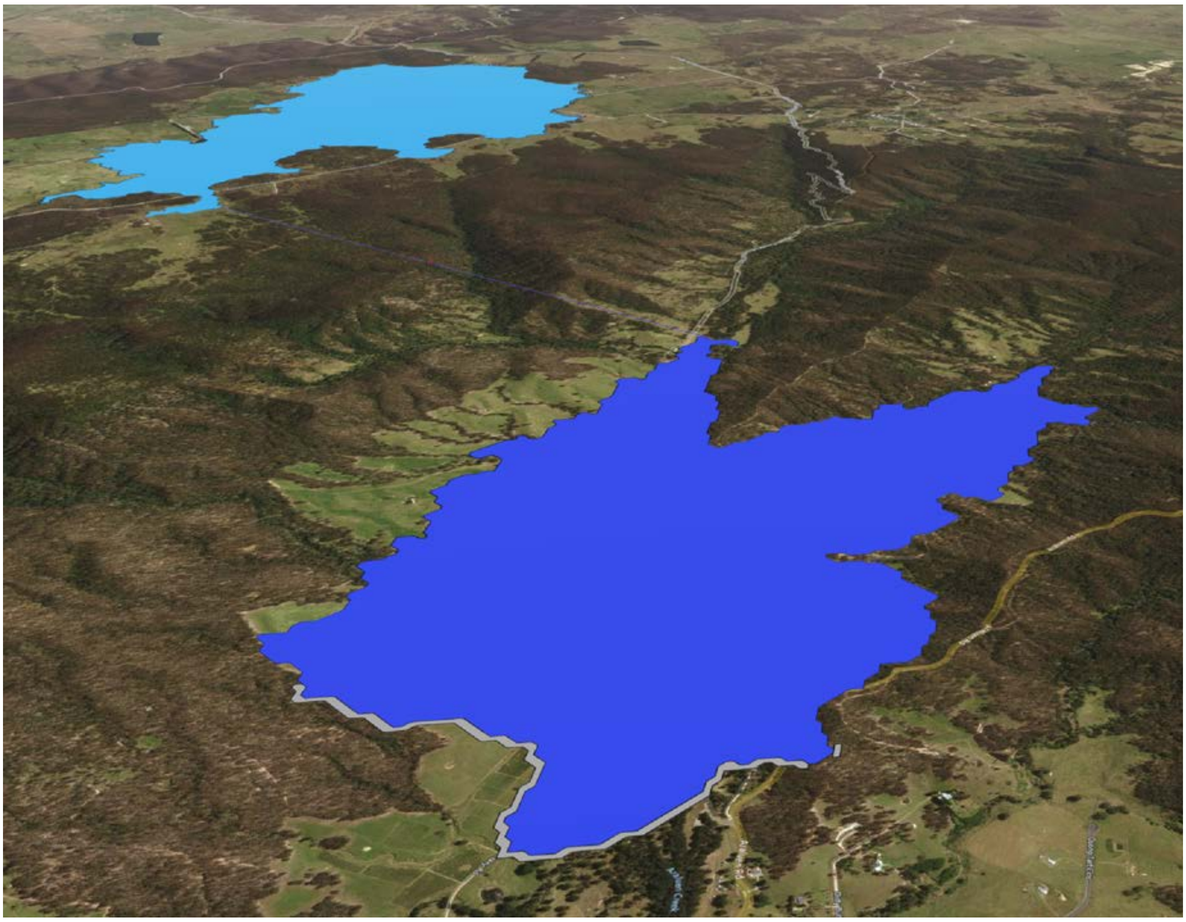

Fig. 4. 3D visualization of a Class A 150 Gigawatt-hour off-river pumped hydro site in Araluen (NSW) [12]. Image credit: Data61 hosting and Bing Map background.

Stabilising the grid with large amounts of PV and wind

Energy balancing for a 50-100% renewable grid is straightforward using off-the-shelf techniques that are already widely used. These techniques comprise energy storage, demand management, and strong interconnection over large areas using high voltage transmission lines. Occasional spillage of energy on sunny/windy days when storages are full is cheaper than providing unlimited storage to avoid spillage. Deployment of both wind and solar can reduced the required storage capacity compared with equivalent capacity in either alone, because wind and solar availability are often counter-correlated.

The cost of hourly balancing of the Australian National Electricity Market for 100% renewables has been estimated at about $25/per Megawatt-hour (MWh) [13]. This comprises additional storage and transmission and includes the cost of occasional spillage of electricity. The amount of storage required was determined to be about 500 Gigawatt-hours (GWh) of storage energy and 20 GW of storage power [13]. For comparison, Snowy 2.0 is 350 GWh of storage energy and 2 GW of storage power.

In response to rapid deployment of PV and wind, about a dozen new pumped hydro energy storage systems are being considered in Australia, including about 2.5 GW that is approved or is under construction. Some (like Snowy 2.0) utilize existing reservoirs and others are located away from any significant river, for example [10-12].

Pumped hydro offers system inertia, rapid start (20-200 seconds) and black start capability, which helps to overcome the void left for such services when coal and gas power stations retire.

Continental-scale transmission smooths out the effect of local weather and demand, and greatly reduces the required storage [13]. State-of-the-art high voltage direct current (HVDC) systems transmit 12 Gigawatts (GW) of electricity over 3,000 kilometers at voltages of 1.1 megavolts, and with losses of around 10%.

Continued development of storage and transmission is critical to continuation of the large Australian PV and wind pipeline.

Renewable Energy Zones

A Renewable Energy Zone (REZ) is a region with good wind, solar and pumped hydro opportunities.

New England and the Southern Tablelands (around Goulburn) are excellent candidates for REZ, the latter in conjunction with the ACT Government.

The advantage of grouping PV, wind and pumped hydro deployment in several REZ is that a single high-capacity powerline can be constructed to transmit power from the REZ to a city.

Preferably the powerline is an upgrade of an existing powerline to reduce social and environmental push-back.

REZ is a means to overcome the paralysis in deployment of new transmission to service new PV and wind farms, caused by very slow approval processes under existing rules. The failure of COAG to meet and change these rules is a major impediment to continued deployment of PV and wind.

Employment implications

All windfarms, solar farms, pumped hydro systems and high voltage transmission is being built in regional areas. Construction, maintenance and renewal (after 30 years) will bring thousands of long-term jobs to regional areas.

Short CV:

Andrew Blakers is Professor of Engineering at the Australian National University. He is a Fellow of the Academy of Technological Sciences & Engineering, the Institute of Energy and the Institute of Physics. He has published approximately 300 papers and patents. His research interests are in the areas of silicon photovoltaic solar cells and renewable energy systems. He was a leader and first author of the team that developed PERC silicon solar cell technology, which currently has 50% of the worldwide solar market and cumulative module sales of around $50 billion (mid-2019). He also has interest in sustainable energy policy and is engaged in detailed analysis of energy systems with high (50-100%) penetration by wind and photovoltaics with support from pumped hydro energy storage (for which he and colleagues won the 2018 Eureka Prize for Environmental Research).

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