It is fast becoming apparent that we must reduce our greenhouse gas emissions and move urgently to carbon-neutral economies to mitigate climate change. But we have become so dependent on energy on demand, energy to power trains, industry, hospitals, even our flat whites, that we have made it a technically challenging task.

Power generation is Australia's biggest atmospheric polluter, emitting some 25 megatonnes (Mt = one million tonnes) of CO_2 annually, some 30 percent of our total greenhouse gas emissions.

In WA, natural gas provides about 55 percent of our electricity. Natural gas is the simplest hydrocarbon, consisting of one carbon (C) and four hydrogen (H) atoms (CH_4). When burned it gives one CO_2 molecule for every two H_2O molecules.

Gas fired power plants can run 24/7 and modern, gas turbine power plants can reach full capacity from a cold start in about 20 minutes. They can be turned off almost in an instant.

Heavier hydrocarbons – LPG, petrol, diesel, fuel oil – emit progressively a higher percentage of CO_2.

Coal is not a hydrocarbon. It is essentially carbon, with elements such as sulphur, iron, mercury, arsenic and lead, also water and ash. On burning it emits CO_2 (about double the amount per unit of power that gas does), nitrous oxide (a greenhouse gas almost 300 times worse than CO_2), other compounds and leaves a residue of heavy metals and ash.

Coal fired power stations are built to run 24/7. They can run at reduced output, but this is inefficient and regular changes in power generated materially reduce the life of the plant. From cold, it takes six and more hours for a coal fired power plant to reach full capacity. As well, the WA Collie coal mines extract and pollute one Sydney Harbour of water each decade.

The Sun as a fuel emits nothing, however here, in the SW, solar panels are about 21% efficient, though for certain periods (cloud cover) they may produce no or very little power for days. Wind power has a greater range of efficiency, but similarly is unreliable. Battery storage offers a degree of supply stability, but once used, depends on being recharged. Hydro storage, water pumped up the Darling Scarp, is deserving of positive attention, as is hydrogen technology.

Western Australia has little potential for hydro power, and for a range of environmental reasons, including CO_2 emissions, I would dismiss biomass, sustainable or not, as a viable alternative source of energy. And I won't enter the nuclear debate!

Theoretically, a 500 Mw gas or coal fired power station can generate 500 x 24 = 12,000 megawatt hours/day (Mwh/d), whereas a solar powered 500 Mw station under ideal conditions (no clouds), and using a figure of 5 hours (equivalent) sunshine a day (which could be increased in the tropics using tracking arrays), could generate up to 2500 Mwh/d. Yet this, whether to the grid or for recharging batteries, cannot be done reliably, and indeed for periods of many days may not generate any meaningful power. Obviously, installing say five times as much generative capacity won't solve the problem, as all generators would be down simultaneously. Dependent on location, wind may be better.

Wind and solar power generation is analogous to having your 100 Kw car parked in the garage most of the time; it's still a 100 Kw car, but it's not producing any power. Clearly, these alternatively powered stations need a fast, reliable back-up. As much as we want to rid ourselves of fossil fuels, right now and perhaps for many years, gas-fired on/off power is the only viable option, though this too needs to be phased out. Arguably, the best way to achieve this is to have this facility government owned, ie not profit driven, but with the aim of complimenting renewables and assisting the transition to carbon-free power generation. We could have and should have shut down Collie and replaced it with gas decades ago, and the longer we now procrastinate, the more coal we will burn.

The sums don't make switching to carbon-free alternatives easy. Rather than simply looking at replacing (large) fossil fuelled power stations with alternatives (each Mw of installed solar would require possibly more than two hectares of land), and while small, community centred alternative installations are making valuable inroads, I believe the emphasis needs to be on the very small, and the very, very big.

Small. Stand-alone and community shared rooftop photovoltaics and battery storage are already having an impact, but importantly industry needs to accept and plan for strong growth of these scattered 'virtual power stations.'

These small systems, as well as niche projects such as small scale (5Mw to 50Mw) solar and/or wind, and possibly wave energy and biogas (dairy and other compostable waste) are not only environmentally friendly, but would very likely be financially rewarding, as well giving communities greater energy independence.

Large. 35 percent of Australia is classified as desert, much of it in WA, and with climate change and current land management, these sun-drenched areas are expanding. They have the potential to house solar and wind power stations on a massive scale, and interestingly these could greatly assist in rejuvenating the environment of these regions (https://www.smithsonianmag.com/smart-news/wind-and-solar-farms-could-bring-rains-down-africa-180970254/). Early November 2018 the Palen project was announced. This is 500 Mw of solar located in the Californian desert, covering 1270 Ha (>2.5ha/Mw) at the cost of about $US1 billion.

The technical challenges we have bridled ourselves with are not insurmountable. Per capita, in terms of renewable carbon free energy resources, Australia is arguably the richest of nations, and given the political will, we have the opportunity, not simply to 'go alternative', but to lead the world.