Wind and solar power need storage



The New Zealand government, along with many others in the Western world, has committed to “net zero” emissions of carbon by 2050. They seem to believe that wind and [solar power](https://www.telegraph.co.uk/solar-power/) can achieve this. This belief has led many governments to promote and heavily subsidise wind and solar. New Zealand promotes them but does not offer direct subsidies.

These plans have a single, fatal flaw: they are reliant on the pipe-dream that there is some low cost large scale technology that will store surplus electricity.

In the real world a wind farm’s output often drops below 10 per cent of its installed capacity for days at a time. Solar power disappears completely every night and drops by 50 per cent or more during cloudy days. About 3000 megawatts (MW) of wind and solar capacity is needed to generate as much energy as a 1000 MW geothermal power station: and in fact, as we shall see, we will still need conventional power stations or low cost energy storage once large scale wind and solar are online.

The governments of countries with a considerable amount of wind and solar generation seem to believe that they can simply continue to build more until [net zero](https://www.telegraph.co.uk/net-zero/) is achieved. The reality is that many of them have kept the lights on only by using existing fossil fired stations as backup for periods of low wind and sun. This brings with it a new operating regime where stations that were designed to operate steadily and continuously have to follow unpredictable fluctuations in wind and solar power. As a result operating and maintenance costs have increased and many stations have been forced to shut down. While New Zealand does have considerable hydropower it is now virtually fully committed propping up existing wind farms.

Overseas it's already common to see efficient base load combined-cycle gas turbines replaced by open-cycle ones because they can be throttled up and down easily to back up the rapidly changing output of wind and solar farms. But open-cycle gas turbines burn about twice as much gas as combined cycle gas turbines. Switching to high-emissions generating plant as part of an effort to reduce emissions is, frankly, madness!

Many countries now survive because their power systems are supported by major [inter-connectors](https://www.telegraph.co.uk/business/2021/09/11/power-struggle-europe-uk-grid-struggles-keep-lights/) to adjacent regions that have surplus power available but this is not sustainable in the long term. Under net-zero plans, all nations will need to generate many times more electricity than they now can to meet the increasing electrical demand from electric cars and electric heating and the shutdown of many coal and gas fired stations. Quite soon adjacent regions will be unable to provide the backup power needed; emissions from open cycle gas turbines (or new coal power plants, as in the case of Germany at the moment) will become unacceptable; more existing base load stations will be forced to shut down by unpredictable fluctuations in renewables; more and more wind and solar power will have to be expensively dumped when the sun is shining and the wind is blowing.

Power prices will soar, making most things more expensive, and there will be frequent blackouts.

Given that the CEO of Transpower has warned us of the risk of blackouts this year, when the lakes are full, it seems to be inevitable that if it was a dry year, we would be in serious trouble. Quite obviously, the electricity market is unable to ensure an economic and reliable supply. The Electricity Authority has some explaining to do!

Building even more renewables capacity will not help: even ten times the nominally-necessary “capacity” could never do the job on a cold, windless evening when the lakes are low and wind farms are generating less than 5 - 10% of full output.

Low cost, large scale energy storage, sufficient to keep the lights on for several days at a minimum, would solve the problem.

What are the options?

First we need to consider the scale of the problem. Relatively simple calculations show that over the course of a year California would need over 200 megawatt-hours (MWh) of storage per installed MW of wind and solar power. Germany could probably manage with 150 MWh per MW. Could this be provided by batteries?

The current cost of battery storage is about US$600,000 per MWh. For every MW of wind or solar power in California, $120 million would need to be spent on storage. In Germany it would be $90 million. Wind farms cost about $1.5 million per MW so the cost of battery storage would be an astronomical 80 times greater than the cost of the wind farm! A major additional constraint would be that batteries are simply not available in the quantities needed. Not enough lithium and cobalt and other rare minerals are being mined at the moment. If prices get high enough supply will expand, but prices are already ridiculously, unfeasibly high.

Some countries are gambling on hydro pumped storage. Here the idea is to use electricity to pump water uphill into a high reservoir using surplus renewables on sunny, windy days: then let it flow back down through generating turbines as in a normal hydropower plant when it’s dark and windless. New Zealand's Onslow scheme is designed to eliminate the need to burn coal and gas during dry hydropower years, not to back up wind and solar.

Many pumped storage systems have been built in China, Japan and United States but they have storage sufficient for only 6 to 10 hours operation. This is tiny compared with the several days storage that is needed to back up wind and solar power through sunless calm periods. Much larger lakes at the top and bottom of the scheme are needed. There are very few locations where two large lakes can be formed with one located 400-700 m above the other and separated by less than 5-10 km horizontally. Such a location must also have an adequate supply of make-up water to cope with evaporation losses from the two lakes. Another problem is that at least 25 per cent of the energy is lost while pumping and then generating.

Hydro pumped storage will seldom be a feasible option.

Carbon capture and storage (CCS) for fossil fuel stations is also touted as way of avoiding the problems of wind and solar power. But this is not a technology, just a case of wishful thinking. In spite of many years of work and enormous amounts of money spent, nobody has yet devised a technology that can provide large scale, low cost CCS. Even if capture worked and didn't consume much of the energy generated, storing the carbon dioxide is a huge problem because three tonnes of carbon dioxide are produced for every tonne of coal burned.

Hydrogen is another technology which is often suggested for energy storage: but its problems are legion. At the moment hydrogen is made using natural gas (so-called [“blue” hydrogen](https://www.telegraph.co.uk/business/2021/08/25/boris-right-britain-has-beautiful-competitive-advantage-blue/?WT.mc_id=tmgoff_psc_ppc_dsa_catchall&gclid=CjwKCAjw3ueiBhBmEiwA4BhspBlPhkI_Zzz2X6SIORtBB0lon0kkHPYnsJ4h-5K4RruE2ZKgyhX5KBoCd-cQAvD_BwE)). This is not an option for New Zealand because the government have stopped gas exploration. In countries with sufficient gas it will have to stop in a net-zero world as the process emits large amounts of carbon dioxxide: you would be better off burning the natural gas. Proper emissions-free “green” hydrogen is made from water using huge amounts of electrical energy, 60 per cent of which is lost in the process. Storing and handling the hydrogen is extremely difficult because hydrogen is a very small molecule and it leaks through almost anything. At best this means that a lot of your stored hydrogen will be gone by the time you want to use it: at worst it means devastating fires and explosions. The extremely low density of hydrogen also means that huge volumes of it would have to be stored and it would often have to be stored and handled cryogenically, creating even more losses, costs and risks.

The conclusion is simple. Barring some sort of miracle, there is no possibility that a suitable storage technology will be developed in the needed time frame. The present policies of forcing wind and solar into the market and hoping for a miracle have been memorably and correctly likened to “jumping out of an aeroplane without a parachute and hoping that the parachute will be invented, delivered and strapped on in mid air in time to save you before you hit the ground.”

Wind and solar need to be backed up by some other means of power generation. If that backup is provided by open-cycle gas or worse, coal, net zero will never be achieved: nor anything very close to it.

There is one technology that can provide a cheap and reliable supply of low-emissions electricity: nuclear power. Interest in nuclear power is increasing as more and more people realise that it is safe and reliable. If regulators and the public could be persuaded that modern stations are inherently safe and that low levels of nuclear radiation are not dangerous, nuclear power could provide all the low cost, low emissions electricity the world needs for hundreds or thousands of years.

But if we had 100 per cent nuclear backup for solar and wind, we wouldn't need the wind and solar plants at all!

Wind and solar are, in fact, completely pointless.

*Bryan Leyland MSc, DistFEngNZ, FIMechE, FIEE(rtd) is a power systems engineer with more than 60 years experience on projects around the world*