PAGE NAV
1
2-3
4-5
6-7
8-9
10-11
12-13
14-15
16-17
18-19
20-21
22-23
24-25
26-27
28-29
30-31
32-33
34-35
36-37
38-39
44-41
42-43
44-43
44-45
46-47
48-49
50-51
52

Clean local electricity for Braidwood and villages

Geoff Davies is switched on

It may be possible to generate and store clean, reliable, local electricity for Braidwood that is also cheaper than grid electricity. The technology and costs seem favourable, with the main challenge now being to get the power through a maze of poles, wires, politics, bureaucracy and commercial agreements and into our homes.

Clean electricity generation is now feasible and popular, using solar photovoltaic (PV) panels and wind turbines. The main limitation has been a lack of economical storage. Two storage options are now becoming feasible: batteries and off-river pumped hydro.

First though, a disclaimer. The author is not an accountant or financier, nor an engineer qualified in any of the specialties discussed here. He is a physicist. This has been a scoping exercise to see if more expert evaluation would be justified. The estimates are rough, but the results seem clear enough for the idea to be worth pursuing.

Sun, wind, and efficient use

Solar electricity would require a small 'solar farm' of PV panels, which could be placed in a suitable local paddock. It would only occupy perhaps a couple of hectares, and a combination of panels and grazing may be feasible.

Wind-generated power is also becoming available. Rather than dealing with the complications of setting up and running dedicated wind turbines, the easiest way to access wind-generated electricity might be through a contract with a nearby wind farm, as is done by the ACT.

It is good to combine wind and solar, because the wind still blows at night and on cloudy days. There are times in Braidwood when cloud persists for several days and the wind input would cover some of the solar shortfall, thus reducing storage needs.

Rooftop PV panels within the town might also be integrated into a local system, at the owners' discretion. This is a little more complicated because the household would also want to use some of the power. A smart 'micro-grid' can, in principle, collect surplus current from local households and smooth loads. The feasibility and functioning of a micro-grid would need expert evaluation.

Often overlooked is the potential to reduce the amount of electricity we need. This can also be an excellent investment. One option is to retrofit houses to be more solar passive, with better insulation and more sunlight entering and warming the house. This usually makes the house more comfortable and light as well. Another opportunity is to replace old appliances with modern, more efficient appliances.

If the town were to invest in a total energy system then it could make sense to put part of that investment into improving the energy efficiency of homes, so less electricity generation and storage would be required. This could be done through low-interest loans to householders, possibly with grants to those in need. It is possible that, with better household efficiency, the sum of a reduced electricity bill plus a loan repayment is no more than the householder's previous bill. Once the loan is payed off the householder has the enduring benefit of smaller bills.

Such a scheme could be win-win-win. The householder is more comfortable for less cost, the community pays less for its electricity system, and Mother Earth says thank you for not over heating her.

Storage

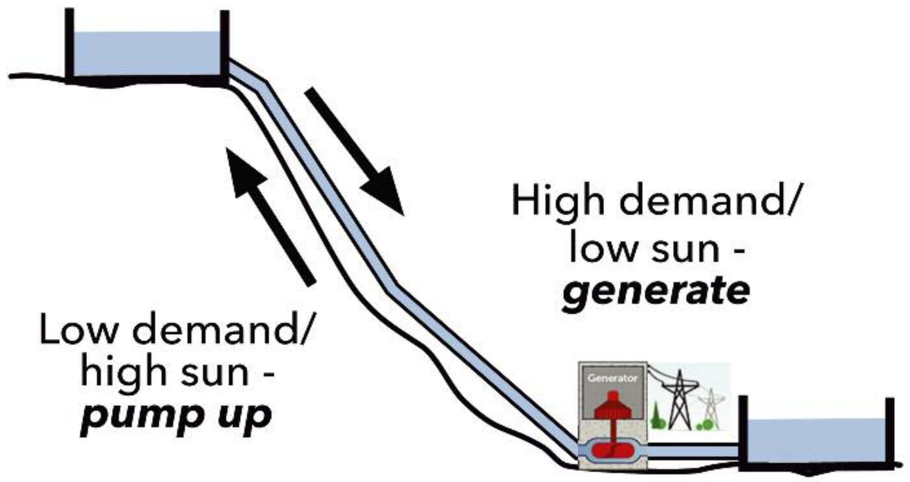
Batteries are becoming more popular. They can store a few hours' power and so can smooth some daily fluctuation, but reliable supply over days or a week is still a concern. A national "smart" electricity grid could help by passing power between communities and regions, but the existing grid is not well adapted and its upgrade does not seem imminent.

Battery packs are now available scaled from households up to the large, grid-connected array built for South Australia by Elon Musk. Their big advantage is they can already be bought 'off the shelf'. Disadvantages are limited storage, still significant cost, and toxic and/or scarce materials.

A local storage system that could store power for longer periods could thus make a big difference. A promising new development is small-scale, off-river pumped hydro storage. This would use two small reservoirs at different elevations that are connected by a pipe.

> When power is abundant, water is pumped from the lower to the higher reservoir. When power is needed the water is run back down through a turbine and into the lower reservoir.

All the technologies involved with pumped hydro are mature and there would be few toxic materials. Modern reversible pump/generator turbines can do the whole job, and can be switched from pumping to generating or back in less than a minute.



Two key features of this option are that it does not require a lot of water and it does not have the complications of big irrigation dams, which disrupt rivers and have to be engineered to survive floods. Once the reservoirs are filled the water recycles between them, and only a small top-up supply is needed to replace evaporation and other losses.

The surprise is that it seems quite feasible to store enough water to supply electricity to the community for a week. The reservoirs would not be large, about 100 Ml (megalitres) each. For comparison, the town water storage dam on Mt Gillamatong holds 80 Ml. For illustration, a storage 7 m deep covering an area 100 m x 150 m (1.5 hectares) would have a capacity of 105,000 cubic metres or 105 Ml.

The system depends on the two reservoirs being at different elevations, and the greater the difference the better. A few hundred metres seems to be ideal. The Araluen escarpment could thus be an excellent location, with a nearly 500 metre drop from the plateau into the valley.

With properly sized pipes connecting the reservoirs the process is about 80% efficient. In other words you only recover 80% of the energy it takes to pump water to the top reservoir. Since the cost of generating electricity is now low, this is not a problem. You gain more by having the electricity available when it is needed than you lose by having to store it.

Local electricity needs

Braidwood's population is around 1500, with the villages bringing it to near 2000. These would comprise around 700 households. Allowing for businesses would bring the total to the equivalent of around 1000 households. Obviously this is a rough preliminary estimate.

Average household electricity use in the region, and nationally, is about 20 kWh per day (kilowatt hours per day). 1000 households using 20 kWh/day comes to 20 MWh/day (megawatt hours per day). Much of this would be used in the peak evening time, at a peak rate of around 2 MW.

Solar panels produce for only part of a day, amounting on average to the equivalent of four hours at full capacity. Thus we would need a farm with 5 MW capacity to get 20 MWh/day (5 MW times 4 hours per day).

Much of that power would be generated in the middle of the day when it was less needed, so the excess would be used to pump water to the upper reservoir. It would then be recovered later as evening demand peaks.

Costs

Costs of PV systems have been falling steadily. Current estimates are around $2 per PV watt capacity, or in other words $10 million for 5 MW capacity, according to Professor Andrew Blakers at the ANU.

For pumped hydro, Blakers indicates a cost of $1 million per MW capacity. However this is for medium-scale systems rather larger than our small system. If we assume a 50% margin to allow for the smaller size we get $1.5 million per MW capacity. For peak capacity of 2 MW the total is $3 million.

For comparison, batteries cost about $200 per day per MWh capacity (averaged over the approximate 10 year life of the batteries), according to Blakers and others. To store, say, 6 hours' power, a quarter of average daily usage, requires 5 MWh at $1000/day or $3.65 million up front.

Thus battery storage costs are roughly comparable to pumped hydro costs, but the pumped hydro gives far greater storage capacity — a week versus 6 hours. Battery lifetimes are a few years, whereas the pumped hydro components should last for decades, with maintenance. Battery storage could be quickly available, but in the medium term pumped hydro would seem to be much better value.

So taking PV plus pumped hydro, we have $10 million for the PV and $3 million for the pumped hydro, for a total of $13 million capital cost of the main infrastructure. There may be additional costs, for example to upgrade transmission lines, transformers and so on, so let's make the total $15 million. (Contracting for some wind power would reduce the required PV capacity, and thus the capital costs, by perhaps one quarter, replaced by usage charges.)

A capital cost of, say, $15 million spread over 20 years for 1 MW average supply would amount to around 8.5¢/kWh of electricity. The plausibility of this estimate is supported by numbers from Blakers in November 2015, who cited full production costs for PV to be about 12 cents/kWh and for wind about 8 cents/kWh, and both are declining. Taking the higher number, that comes to $2.40 per day or $876 per year per household. Allowing for storage costs, on those numbers it seems plausible the total cost of a Braidwood system would be no more than about $1200 per household per year.

This compares with current average retail costs of about $2800 per household per year. (Retail costs include about $600 connection fee plus 30c or more per kWh. For average household use of 20 kWh per day the usage charge comes to $2190 per year. The money currently paid to retailers by the Braidwood community would amount to around $2.8 million per year, which would pay for the capital cost of a local system in a bit over 5 years.)

Thus, allowing for financing costs, maintenance and running costs and uncertainties, it seems plausible the cost of local, clean power would be rather less than power from the grid.

Remaining questions

All of these possibilities require expert evaluation. The biggest unknown may be the difficulty and cost of getting the electricity through poles and wires and into homes. Charges can be high for access to the grid, and there are stringent requirements on generators so as not to disrupt the smooth supply of electricity. A flexible storage system would ease the latter concerns.

A key question might be whether to try to go completely off the grid. This could avoid the prospect of rising grid costs and difficult politics but would require local ownership of a local grid, and high reliability of supply. It would also preclude contracting for a wind-power component of the local supply. An intermediate option would be to go 'behind the meter', which would mean having a single main connection and meter for the town, thus allowing for some wind contribution and for having the grid supply as a backup.

If you're interested in following the progress, email paul@artplan.com.au