Submission

STORAGE

It is very clear in South Australia that energy storage is needed quickly in its supply network that features a high renewable energy penetration (approx. 41% in 2014/2015). Almost all of this is intermittent, or variable renewable energy (VRE), consisting of photovoltaic (PV) and wind power, (which now has in the order of 1500 installed MW capacity). PV I believe has in the order of 700 MW installed in SA. The energy storage is needed to cover periods where the sun can't provide solar energy and the wind is absent or minimal. Of the 1500 MW installed capacity for wind it is relatively common to see the total output below 50 MW, though usually not for extensive periods (>8 hours) from my casual observations. I would think AEMO would have accurate data on that.

The experience and progress of the electricity supply network in SA is vital for the rest of Australia that needs to follow with increasing renewables penetration. All of Australia, indeed all of the globe has to tread this path, to well beyond 50% renewable energy (ie ultimately to net zero emissions from energy sector) so it is very important to get this right. SA is the forward scout in Australia in this endeavour, and should be commended for it. It has taken some fire and suffered some casualties so far on this path – that should serve to make this path safer for others. I lament the political bludgeon that the circumstances of renewable energy and SA's role in it has been turned into.

Storage adds to network resilience chiefly by balancing the gaps between supply and demand, and addressing the intermittency problem of traditional VRE.

The most common storage types proposed are :

- batteries, of various types, to be associated with domestic, commercial or utility scale installations
- thermal storage, such as molten salt storage associated with concentrating solar thermal (CST) generating plants. Other storage mediums are possible, eg graphite block storage as currently being deployed by the Australian company Solastor, but the vast majority of existing proven facilities use molten salt (a mixture of Potassium and Sodium nitrates).
- Pumped hydro facilities, known as Pumped Hydro Energy storage (PHES) with a variant referred to as Short Term Off River Energy Storage (STORES).
- Flywheels and compressed air storage are other options but do not seem to have made any significant penetration globally, and I will refer from now only to the 3 types above.

There is currently very little of any of these in SA, and in Australia generally, apart from the pumped Hydro Tumut 3 facility and Shoalhaven (both NSW) and Wivenhoe (Qld) with something like a total 1350 MW capacity between all 3 I believe. A fourth facility is being planned at Kidston in QLD.

Whilst I have personally chosen to advocate for CST with storage, I do not doubt that all three have value and should all feature in the future energy mix. It is not too clear what proportions offer the best return from the point of view of security/reliability, affordability and lowest possible emissions – the energy trilemma, to borrow a term from the Review into Network Security led by Dr. Alan Finkel.

Batteries

Batteries are I believe the most expensive of the storage types mentioned, sure their cost has/is falling quite sharply but it is not clear if they will become less expensive than the other two types. Their penetration will grow in any case due to individual actions, and potentially commercial and utility use. Typically, as I understand it their discharge capability is relatively short term, they do not lend themselves as well to bulk load shifting. In order to enhance the stability of the grid, all such battery systems would need to be integrated to some extent by the grid control system or else their behaviour is likely to result in unpredictable changes in load demanded from the system. There is potential for Australia to set itself up to manufacture our own renewable energy batteries, and I

would like to see that happen. It will come with a cost penalty I am sure, it will be offset by the economic value to Australia of those jobs, but I suspect that will not fully recompense the cost gap between make our own or overseas supply.

Concentrating Solar Thermal with Storage

As mentioned I have personally chosen to pursue CST with storage as one of the solutions to the energy trilemma, in a fair part as it is a proven technology, and would work well in my region in South Australia (Port Augusta), and its benefits to the network resilience are considerable. CST so far has not been able to establish itself at utility scale in Australia, but I note its deployment has and is planned to further grow in many countries around the world with good solar irradiance.

The benefits of CST in regard to storage is that it is capable of large scale energy storage, eg the CST plant proposed for Port Augusta by Solar Reserve, features 110 MW capacity with 8 hours storage via molten salts. That means it can provide up to 880 MWh of electricity, per day, in addition to providing power at 110 MW during sunshine hours. Of course that capability is reduced due to cloud and overcast conditions, the total annual predicted production from that specific proposed plant is 480,000 MWh. In summer periods, the plant would be capable of supplying power for continuous 24 hour periods, though not at the full 110 MW capacity for that time. Of course the output from CST plants with storage can deliver many required output profiles within the envelope of heat energy available in collected hot salt tank (continually augmented when sun available) and the restrictions in turbogenerator turndown and stop/start capability. Turbines associated with CST plants are typically designed to be nimble with short stop start times and high turndown rations (in comparison to a typical coal fired facility).

It should be understood that a network of such CST plants would allow offset scheduling of despatch from individual storage repositories, and that will help provide a continuous energy supply as needed. The same is true for the other forms of storage.

Naturally the nature of CST plants means that they will always add capacity to the electricity supply system, whereas the other two types covered can be added independently purely to provide storage, in which case they are a net user of power. At this point in time with the recent closure of Northern Power Station (average annual output over its life 3,500 GWh) and the imminent closure of Hazelwood, adding additional capacity in the near future is I believe prudent.

The main limitation for a CST plant is likely to occur in winter, with shorter days, greater prevalence for overcast conditions.

Pumped Hydro Storage

My knowledge on pumped hydro systems and its potential is limited so I will make only minor comment on this technology. It does seem to have considerable potential for Australia, including SA but I don't think the Upper Spencer Gulf region specifically. The implementation costs are claimed to be attractive (I have seen a figure of $1000 per installed kWh, not including additional VRE to charge the system and provide a net energy capacity increase. I cannot verify those figures. The rapid stop/start of the associated turbines combined with other features that characteristic offers to network resilience are all positive and desirable characteristics.

I understand there is work going on by the Melbourne University, the ANU, and now the Network Security Review led by Dr. Alan Finkel, so I believe a good quality of information will emerge from that work.

OTHER RESILIENCE ISSUES

There are of course other resilience (and therefore security and reliability) issues apart from just covering intermittency of VRE and balancing demand to supply. The ability to control grid voltage and frequency is vital,

and maintaining supply when system disturbances occur from events like tripping of one or more large generating sources, islanding during separation events if interconnectors trip, and black start capability, essentially the attributes known as FCAS (Frequency control and Ancillary Services, and SRAS (System Restart and Ancillary Services).

Voltage/ frequency control has traditionally relied on the electrical inertia of the large rotating masses of the turbogenerator units. The RE technologies of CST and pumped hydro will maintain those capabilities as they too have such turbogenerators too, albeit on a smaller individual unit size. As I understand it PV, wind and any associated storage via batteries is unable to provide that capability without incorporation of things like synchronous condensers, though I concede my knowledge in this area has gaps.

Possibly battery systems may offer network resilience advantages via potentially very fast responses in some circumstances, providing they have capability built into their hardware and control, but I have no specific knowledge in that field.

Having more distributed energy supply points in itself adds to network resilience as there are just simply more available points of supply and greater likelihood that points of supply will be unaffected by poles and wires issues.

To that end battery systems can aid individual and commercial consumers to maintain supply in the event of a power failure, though at cost of adding the necessary hardware to their VRE (typically PV) and battery systems.

Definitely for CST, and possibly for pumped hydro the characteristic of having mid-size generating units typically in the order of 110-150 MW for CST means that system disturbance from any one unit or even station if consisting of multi-units tripping or otherwise being available is less compared to the larger typical units found in coal (or nuclear) dominated networks.

The grid will exist for a long time, if not always, even if totally off grid trends develop, or mini-grids, and in particular CST with storage and pumped hydro enhance the resilience, security and reliability of the energy supply system.

OTHER ISSUES

For me and I am sure many others the jobs inherent in different technologies is very important, and must be considered as part of the affordability evaluation of any technology or specific project.

I have already mentioned I would like to see Australia participate in renewable energy battery storage industry, and by that I mean manufacture form raw materials to a large extent, not assemble sub-components manufactured overseas. As I said, that will no doubt be at some direct cost penalty, and without data I cannot comment on how that stacks up.

I do know that CST with storage does typically incorporate a good number and range of jobs throughout the construction, operation and maintenance phases of their life cycle. In the case of the specific CST/storage plant proposed now to the SA Government to be built near Port Augusta that is in the order of 4000 direct, indirect and induced jobs during construction (on site personnel u to 1000 at construction peak) and around 50 ongoing for the minimum 25 year life of the plant. In the case of that specific proposal, an investment of $650 million is involved with up to 60% is expecte3d ot be expended in South Australia.

In many if not all technology cases a 5 - 8 year or so rolling forecast and commitments to reasonably specific technology types will help to give constructors and more importantly financiers the confidence that will result in lower build costs, and also maximise Australian jobs by deep participation in the facility construction and component supply chains. Those jobs must be part of the calculations in the affordability considerations. There is, particularly with CST and storage potential to maximise Australian

job participation if multi plant commitments are made, as was announced in China last year, and as is planned for Saudi Arabia to name just a few countries that have made such enabling commitments.

I do not know comparable figures from pumped hydro options, but I suspect it would be less equalised to a per delivered MWh basis.

Consideration of other factors is needed too, like impact on the environment, visual impacts, social acceptance, equity of benefits (eg equal access to benefits of domestic/commercial PV and battery systems) regardless of wealth, and residential situation. End of life considerations and cost also need considerations, and overall sustainability and ecological impact of the technology concerned. All I can really say on this area at this point is that CST with storage appears to offer a very palatable result in these areas.

GOVERNMENT MEASURES TO HASTEN ROLLOUT

A start to adding concentrating solar thermal with storage to the energy mix is tantalisingly close. If the SA government selects CST for its energy provider from its current tender, it will only take already identified Federal support to get that first utility scale plant built. This could be locked in as close as June 2017. I cannot see a downside to doing that. Do it.

The Federal Government can I am sure provide other avenues that can expand that capability beyond a single CST plant, or in the event the SA Government turns its back on our region, use those avenues to facilitate that first utility scale CST plant with large scale storage.

One dilemma that needs to be addressed lies with financing these more expensive types of renewable energy, as that seems to entail financiers wanting to see certainty of return on their investments, via guaranteed use of the power generated from these facilities for a long term – eg 20-25 years via PPA's. Maybe there are other instruments to provide that certainty of return. This situation seems to be prohibitive towards rollout of the types of RE with storage that are most needed. Other avenues to incentivise desirable types of RE construction with storage need to be set up, it can't just rely on State/Fed government's own power use to provide the certainty of long term power offtake – and there is a measure of reluctance from government to do that as it is.

Battery technology appears set to roll out to some degree already without direct support, and there has been some government action to incentivise that too.

Obviously ARENA, CEFC and CEIF are avenues for some support for all the types of systems discussed here, but I would suggest batteries are the area where the least support is needed, purely as it is/will appear anyway, and can be provided in vary small increments.

At this stage with pumped hydro I think it prudent to let the current work associated with that technology going on by the Melbourne University, the ANU, and now the Network Security Review led by Dr. Alan Finkel to be completed before taking any step to assist that technology.

I am happy for this submission to be placed on the Internet, with contact / address details omitted.

Yours faithfully,

Gary Rowbottom,