Attention: Rebecca Knights,
Director of Energy Policy and Projects,
South Australian Government

Dear Ms Knights

Australian Solar Council, Energy Storage Council submission on South Australian Energy Security Target

I am writing on behalf of the Australian Solar Council and Energy Storage Council – peak national bodies for the solar and energy storage industries - to comment on the South Australian Government's draft Energy Security Target.

The Australian Solar Council and Energy Storage Council welcome the South Australian Government's strong commitment to renewable energy and action on climate change. South Australia is a world leader in the uptake of residential, commercial and industrial-scale solar and storage.

The South Australian Government's commitment to "Australia's largest battery" – 100 megawatts of storage – has the potential to unleash massive investment in energy storage, with over 90 companies submitting proposals.

Unfortunately, the South Australian Government has missed the mark in designing its draft Energy Security Target. The draft target has the potential to undermine some of the Government's excellent work on energy storage and we would urge the South Australian Government to look at this issue again.

The Australian Solar Council and Energy Storage Council share the concerns expressed by energy storage companies, energy experts and environment groups that the draft Energy Security Target could exclude battery storage and could make solar farms with storage ineligible to receive credits.

We agree with Giles Parkinson of *RenewEconomy* that this move "could have serious implications for wind and solar farm developers and owners in [South Australia], given the restrictions it is likely to impose on output as the State seeks to limit the amount of 'non-dispatchable' generation."

"Accredited generators" are defined as being those that can provide "real inertia" and "fault current". Battery storage provides synthetic inertia and should be able to claim credits under the Energy Security Target.

As the leading energy storage company, AES, has noted: "Battery storage and inverters enhance the outcome of grid frequency disturbances by filling the inertia and governor gap of synchronous generators and replicate the performance of synchronous generators in Low

Voltage Ride Through scenarios. These characteristics improve overall grid stability and reliability. (emphasis added)".

I have attached a paper from AES on *AES Battery Backed Inverter Grid Frequency and Voltage Response* for your consideration.

The Australian Solar Council and Energy Storage Council also endorses the concerns raised by the Australian Conservation Foundation, the Conservation Council of South Australia, GetUp and Solar Citizens that "key design elements of the Electricity Security Target appear to be based on inaccurate information. The idea that for energy security, 50% of South Australia's electricity generation must ultimately come from "on demand" sources that have inertia, does not reflect either practical experience of system operation, research or technology advances...The stringent requirements that exclude new technology solutions to 2030 and beyond will curtail innovation in the state and are *not* needed to ensure electricity system security."

The Australian Solar Council and Energy Storage Council notes that the leading solar thermal company, SolarReserve, (a member of the Australian Solar Council and Energy Storage Council) has argued that "the legislation as currently drafted does not distinguish the time of day or time of year that energy security certificates (ESCs) are created. Without such definition, the State risks a perverse situation whereby incumbent electricity "gentailers" could generate electricity at times of low demand to extinguish their EST obligations, but withhold generation at times of high demand and low wind production to maximise revenue from increases wholesale price periods."

We urge the South Australian Government to look at opportunities for time of day pricing, including time of day multipliers, which are utilised in California.

Energy Storage Council, Australian Solar Council

The Australian Solar Council and Energy Storage Council are peak national bodies for the solar and energy storage industries. They are partner organisations, with a shared Management Board and Secretariat.

The Australian Solar Council has more than 1000 members, including solar PV and solar thermal manufacturers, distributors and installers, as well as researchers and consultants. The Australian Solar Council's members are actively involved in the residential, commercial and large-scale solar industries.

The Energy Storage Council has around 150 members, including manufacturers, distributors and installers. It covers all aspects of residential and large-scale energy storage, including battery storage, pumped hydro and solar thermal.

You can find more information at www.solar.org.au and www.energstorage.org.au

Please contact me on 0400 102 396 should you wish to discuss this matter further.

Yours sincerely

John Grimes
Chief Executive
Australian Solar Council, Energy Storage Council

26 May 2017

AES Battery Backed Inverter Grid Frequency and Voltage Response

Introduction

AES has developed an intelligent and modular energy storage system that includes bidirectional inverters as part of the power controls system. These are designed to be used used in a variety of power system scenarios.

The AES energy storage product meets both European and US requirements for frequency response and Low Voltage Ride Through (LVRT). Furthermore, as discussed in this paper, inverter based systems provide some added advantages for grid stability relative to traditional sources of thermal generation.

Speed of Response to Frequency Excursions

A traditional synchronous turbine-generator design, whether steam driven, reciprocating engine driven, or gas-fired has mechanical inertia because of the mass of the generator rotors or drive shaft, generator, and exciter.

When generation is lost elsewhere on the grid, the grid frequency falls initially in a linear slope according to the summation of mechanical inertia of all the synchronous generators on the grid (See Figure 1.A). The falling grid frequency slows down the synchronous generator shaft rotation. This linear change in shaft rotational speed is proportional to a cubic change in power required to turn the generator shaft. The lower grid frequency angular velocity is "easier" for the turbine to produce so each synchronous generator on the grid temporarily produces more electrical power from the same mechanical power being delivered to its turbine (Figure 1.B). This additional power is not sustained and will drop quickly to a point where the mechanical power provided to each synchronous generator catches back up to the electrical power with respect to any grid load reduction due to the lower grid frequency

Individually, a synchronous generator will provide an inertial frequency response based on its own characteristics. The larger the machine, the flatter the slope will be, generally aiding in grid stability until the governor response begins.

Inertial response has the advantages of being available and immediate. The disadvantage of inertial response is that it is not controllable or tunable as needed by the power system operator.

If reserve mechanical capability is available, the synchronous generator can also begin to respond in approximately 3-10 seconds (Figure 1.C) with a governor response (more steam, more fuel, etc.) to help stabilize the grid frequency (Figure 1.D).

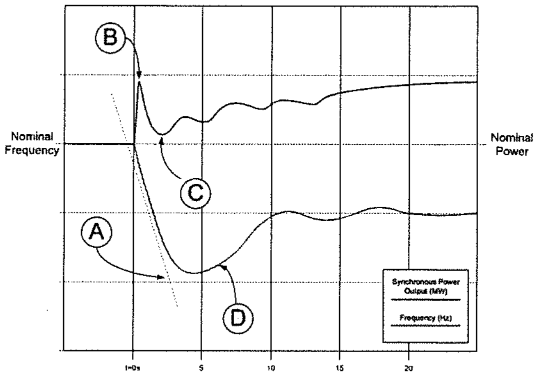

Figure 1: Synchronous Generator Disturbance Response

The synchronous generator governor response can operate faster than load shedding to stabilize grid frequency. However the governor response is relatively slow compared to the inertial response (3-10 seconds after the grid disturbance initiates), it must be tuned to work correctly, and the generator must be capable of increased output if it is to aid in the grid governor response.

Inertial and governor response in combination leave a power "gap" in the recovery period between the immediate inertial response and full governor response (if available) to contribute frequency and power correction.

Inverters, like the excitation systems of traditional generators, are constantly sensing the connected grid with a Phase Locked Loop control system and make adjustments to the output frequency accordingly. Commercial IGBT based inverters, like those used in the AES Energy Storage system, have already demonstrated grid interconnect capability, complying with European and North American frequency response requirements (e.g. BDEW: Technical Guideline "Generating plants connected to the medium voltage network", and NERC PRC-024-1 Attachment 1). While battery and inverter combinations cannot provide mechanical inertia, the inverter's programmed automatic controls can respond within 50 ms (2.5 cycles in 50 Hz nominal electrical systems; 3 cycles in 60 Hz nominal electrical systems).

This time is approximately broken down as follows:

- < 1 cycle to sense frequency
- 20-30 ms to fine tune the Phase-Locked Loop
- 15-20 ms for active power regulator settling

Figure 2 illustrates the response of an IGBT inverter system to the same event illustrated in Figure 1 (Note: inverter response overlaid on Figure 1; magnitude not to scale). When operating at nominal dispatched power level (Figure 2.E) The inverter can sense the grid frequency drop, and respond, after 50 ms, with a power increase (Figure 2.F) that is based on desired parameters and not limited by physical machine design. This "synthetic inertia" is of particular importance between dissipation of the inertial response and the generator governor response.

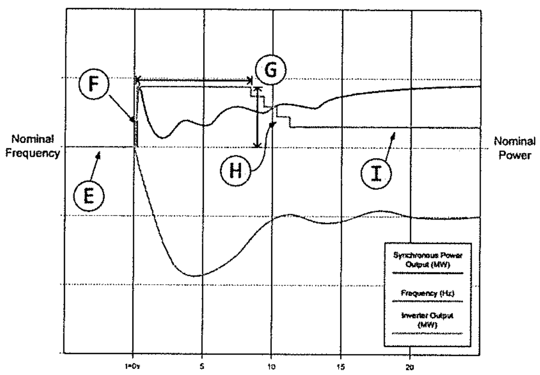

Figure 2: Inverter Grid Disturbance Response

This power increase may continue according to battery capacity (Figure 2.G) until the inverter senses a positive frequency rate of change. Once frequency recovery is sensed, the inverter output power ramps down in as many discrete steps as is practical or desired (Figure 2.H) and eventually settles at the new dispatched power (Figure 2.I).

Additionally, the inverters used by AES have an "overrate capability" (not shown) where, for a finite period of time, the inverter will provide an additional 10% of power output above its nameplate rating in response to frequency excursions in cases where its nominal output was already 100% in the moment before the excursion.

This "overrate" capability is a distinct difference from the governor response of a synchronous generator, where a sustained increase in power output may only be achieved if the machine has the mechanical capability.

System Support During a Transmission Fault

Support of the transmission system during a grid fault is another important attribute of connected generation. During the fault clearing time, typically 100 to 150 ms depending on the location of the fault and the nearest protective elements, generators on the grid are expected to ride through the fault. During the fault period, generators must be able to accommodate increased reactive power, phase imbalances, and frequency fluctuations.

Interconnected grids have established standards for LVRT capabilities for grid fault conditions. While the curve shapes vary from region to region, the typical requirement is for generators to stay connected at any voltage level for up to 150 ms, then various steps or a linear curve upward to 90% of nominal. The inverter portion of the AES Energy Storage System is configurable to meet European and North American standards for voltage ride through, such as the examples provided below.

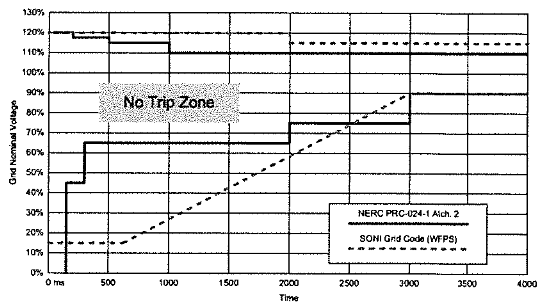

Figure 3: LVRT Grid Connection Requirements

Conclusion

Battery storage and inverters enhance the outcome of grid frequency disturbances by filling the inertia and governor gap of synchronous generators and replicate the performance of synchronous generators in LVRT scenarios. These characteristics improve overall grid stability and reliability.