Implementing a national electricity guarantee: Challenges and new market approaches

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The National Electricity Guarantee (NEG) is an attempt to use the long-run generation contract hedge market, which exchanges risk between generators, retailers and large electricity users, to enforce a lower bound on the amount of "dispatchable" generation in use in the National Electricity Market (NEM) at all times, and reduce wholesale market prices. Electricity retailers will be required to meet a reliability benchmark, and a separate low emissions benchmark.

There are four significant drawbacks with this plan:

1. **Generators do not directly control the dispatch level system-wide, so they cannot directly control reliability levels (or emissions intensity).** Generator dispatch is done through the NEM Dispatch Engine (NEMDE), which relies of bids from all generators to construct a merit order, and selects the cheapest set of generators to satisfy demand, subject to the technical envelope determined by AEMO. The only way for generators to ensure their contracted dispatchable machines are indeed dispatched is to bid very low, possibly even below their short-run costs. The price of their contracts will have to reflect the risk of this degree of bid shading being necessary, This may distort the wholesale spot market to the point where the prices it generates do not represent short-run costs of the marginal generator.

2. **Constructing "dispatchability contracts" that address these issues will be a costly and time-consuming process, potentially increasing costs to end users of electricity.** Contract markets for energy are opaque, and there is no reason to expect new dispatchability contracts to be any different. Markets drive efficiency through transparent price discovery, which allows producers and consumers to allocate resources to their best ends. Without transparent pricing, a contract market-based solution cannot be as efficient as a transparent one. Uncertainty begets risk management, which introduces a source of additional costs to generators, retailers and, ultimately, end users of electricity. This may occur even if spot market prices are reduced.

3. **Enforcing greater amounts of "dispatchability" may not improve the reliability of the NEM.** As reliability is only loosely defined, it can relate to a power system's ability to respond to changes over different timescales. For the most common rates and magnitudes of change seen in the NEM, AEMO's procedures are currently adequate. However, challenges are being seen at two particular timescales. First, the fastest time-scale considered in an electricity grid are its sub-second (or transient) response to large shocks, such as generator or transmission line failures. This is the timescale over which *inertia* and *fast frequency response* play a major role in system control. AEMO and AEMC have work packages devoted to addressing this highly technical concern, so it will not be considered in the remainder of this submission. Second, the slowest timescales managed by AEMO are changes in dispatch levels every 5 to 30 minutes. This corresponds to the timescale over which renewable generation, and particularly wind, can vary considerably, thereby introducing uncertainty. It is also the timescale at which conventional generator ramping constraints apply, which limit the rate at which they can change their power output, thereby limiting the ability of the system as a whole to respond to variable generation. However, scheduling more coal- or gas-fired steam turbines to be online during times of high variability may not remedy this variability, even though they are "dispatchable," because they are slow-ramping generators.

4. **Non-generator technologies, such as demand response, can provide fast ramping reliability services.** The reliability concern that arises at a time of high renewables generation variability is that not enough ramping capacity is available to balance generation and load. Battery and pumped hydro

storage, and in particular, **demand response**, supplied by flexible industrial, commercial and residential loads and distributed energy resources, can provide these ramping services. However, there is currently no direct way for these resources to integrate with the NEMDE. Instead, they are largely consigned to participating in only the existing FCAS markets, with highly strategic bidding into the energy market.

A suggested approach: Power system operation using a market-based system, under the agency of the NEM, has worked relatively efficiently for two decades in Australia. However, changes in generation and technology mix, and competing political and environmental concerns, have understandably given rise to new operating conditions that need addressing with new market mechanisms.

In light of this, we suggest consideration of **two new ancillary services** with supporting markets, **short-run generation capacity** and **short-run load capacity** services, to be defined by AEMC and administered by AEMO. These services represent a **direct market-based solution** to electricity system dispatchability or ramping requirements, which can be constructed and integrated with existing NEMDE procedures as follows:

- Define the required capacity technically and precisely, in terms of power systems control service requirements and relevant connection and registration codes,
- Verify or validate the technologies that can provide the required services,
- Ask for bids* to provide the services from the plant or resource owners, and
- Co-optimise their use in the NEM as part of existing NEMDE processes.

Indeed, this is the approach that has been successfully used to co-optimise the supply of energy and frequency control ancillary services in the NEM for many years.

*However, in order for short run capacity to be efficiently integrated into the NEMDE, a particular form of bid is required. One approach is to, over the dispatch horizon, bid apacity by specifying a *total energy constraint* (i.e. energy in storage), minimum and maximum *power constraints*, *ramping constraints*, a list of *available dispatch intervals*, all at a single specified *price*. The bid would *not* allow for incremental price bands. Such a form of bid can be converted into a set of bidder optimality conditions that may be efficiently integrated within the existing NEMDE (using a standard bilevel-to-MILP reformulation), and thereby used to minimise system costs during dispatch. This would allow energy-constrained resources, such as storage devices and plant with limited bands of flexible operation, to directly participate in the NEM, rather than having to carefully and strategically bid into existing energy and FCAS markets.

Final note: it is important that these services are classified as *ancillary services*, so that the potential value of load side technologies may be exploited by resource owners and ancillary service aggregators. Under current AEMO rules, ancillary services do not have to pass through retailers to be bid into the NEM. If the ramping services are constrained to be bid by retailers, they may have a perverse incentive to suppress load-side options in favour of supplying the services with their own resources (or at least may be seen to have such an incentive), which is a form of market manipulation by withholding supply.

A partial list of recent academic publications supporting this perspective on flexible capacity and ramping services, generator efficiency and renewable generation capacity firming is listed below [1-5], and copies are available on request.

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[1] S Riaz, H Marzooghi, G Verbič, AC Chapman, DJ Hill, "Generic Demand Model Considering the Impact of Prosumers for Future Grid Scenario Analysis," *IEEE Transactions on Smart Grid*, in press.

[2] AS Ahmadyar, S Riaz, G Verbič, AC Chapman, DJ Hill, "A Framework for Assessing Renewable Integration Limits with Respect to Frequency Performance," *IEEE Transactions on Power Systems*, in press.

[3] KR Khalilpour, AM Vassallo and AC Chapman, "Does battery storage lead to lower GHG emissions?" *The Electricity Journal*, 30 (10), 1–7, 2017.

[4] M Pantos, S Riaz, AC Chapman and G Verbič, "Capacity Firming of Intermittent Generation by Dispersed Energy Storage," *Australasian Universities Power Engineering Conference*, Melbourne, December 2017.

[5] S Riaz, AC Chapman, G Verbič, "Evaluation of concentrated solar-thermal generation for provision of power system flexibility," Power Systems Computation Conference (PSCC), 2016.