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Seven Electricity Market Fixes to Help the NEM Face Modernity

A Personal View from Hugh Bannister; Chairman and CEO of IES

The National Electricity Market was conceived and designed around twenty years ago. At the time, it was a small miracle of both technical and institutional innovation. Like Ford's model T, it's been tweaked in many ways since then but under the hood it remains much as it always has been. It is badly in need of an update to deal with the world as it will soon become.

The challenges are known – the rise of distributed generation and storage, the impact of government policy on renewables and emissions, customer incentives created by skyrocketing retail electricity tariffs and the challenges all this poses for established networks, generation, retailers and customers. AEMC and AEMO are busy peering into this uncertain future and contemplating responses.

The NEM has been built around idea of large, dedicated players offering to buy and sell into a wholesale market through formal spot auctions and related contracting. These arrangements support a controlled and orderly centralised dispatch process designed to meet cost and security criteria. But the new world looks like being far more distributed and, on the surface, far less controllable. This raises a host of new or technical and security challenges.

There are two broad responses to this change in circumstances. One response is to ensure, by regulation or by default, that most of these new technologies end up being controlled by existing network monopolies or other large entities such as dominant retailers. This outcome would be driven by an argument that efficiency and security are best served by such control rather than small operators "doing their own thing".

The other model is to ensure that any party following suitable guidelines can buy and sell most, if not all, of the energy and other technical services required by the NEM, without first achieving the blessing and support of dominant entities. This is the pro-competitive option that the AEMC seems to endorse in its recent Electrical Energy Storage Discussion Paper and with its development priorities more broadly. However, the AEMC doesn't offer much insight into how a competitive outcome can be achieved in practice.

This article contends that most of the services required by the NEM, including technical services and those dealing with network constraints, can and should be priced, independently of any bidding process where feasible. In this way, and with regulatory support, competition can be promoted throughout the NEM, including in the provision of network support services.

Here is my top seven list of NEM upgrade tasks, in no particular order.

1 Update NEMDE

The Issue

The National Electricity Market Dispatch Engine (NEMDE) was conceived as a linear programing optimisation problem in around 1995 and successfully implemented, running on a PC rather than a mainframe, at market start in 1998. That technology was certainly state-of the art at the time.

Since then, computing power has increased a thousand-fold and the reliability, performance and scope of optimisation algorithms has improved to a similar degree. Conservatism in the upgrade of such a central piece of technology is understandable and desirable, but it's time to start researching and prototyping the engine we will need ten years hence. Here's my take; this is pretty technical stuff so those not so inclined can jump to the next section.

Proposed Solution

- Implement a non-linear solver. There are many aspects electricity systems that are fundamentally non-linear and some do not lend themselves well to linear approximations.
- The NEMDE should model all significant network elements internally. This was barely possible 20 years ago but is possible now with modern interior point solvers. One could and would retain regional pricing, so why do this? See the following.
- With non-linear capability, losses could be more easily and accurately modelled, whether using AC power flow or a DC approximation.
    - One useful rule change would be to use dynamic loss factors from the new NEMDE to replace current fixed loss factors, even if regional pricing is retained. This would have significant commercial implications only where it should; where flows are highly variable or tidal, such as around remote wind farms. The current approach to losses is ad hoc.
    - Another specific benefit of non-linear loss modelling is that the annoying appearance of so called non-physical losses when prices are negative would be avoided, greatly simplifying this element of the NEMDE.
- With an internal network model, many contingency constraints, especially thermal ones, could be generated automatically and transparently. At present, constraints are developed off line for a range of different system conditions, mapped to the NEM's regional model and wheeled in as needed.
    - If such constraints are generated internally in real time, they could also be tuned to better reflect current system conditions, allowing the network to be run at greater capacity while remaining secure.
- An AC power flow model could be implemented. This would:
    - reduce the need for much external manipulation to fit a DC approximation;
    - price reactive power (for voltage control) which could be useful, although setting up a market in reactive power may be more challenging because voltage control is very localised; and
    - greatly improve the accuracy and robustness of 5 minute and longer pre-dispatch, as key information for modelling realistic security constraints would be available from the internal network model.
- Consider the Judicious use of integer variables to deal with fast start inflexibility profiles and the no-go bands of Basslink.

Degree of Difficulty

A new NEMDE along these lines will take a considerable time to develop and test, including an extended period running in parallel with the current system. That could be five years or more from start to finish. That's why investigations should start sooner rather than later.

Some may argue that a system that is working should be left very much alone, as appears to be current AEMO policy. Certainly, a change is not to be undertaken lightly. But our Model T NEMDE will likely restrict options to evolve the market as the industry itself evolves. If this is to be the innovation century we need to make a start.

2 Fix the 5 minute pricing problem

The Issue

Physical energy as well as contracts are traded at the half hour level in the NEM, convenient for commercial contracting. An early NEM innovation was to go to 5 minute dispatch, where an operating schedule and market clearing prices are actually determined each 5 minutes, in advance of operations. This minimises the requirement for system operator intervention within the half hour – a Good Thing. However, 5 minute dispatch delivers 5 minute prices, which must then be converted to half-hourly prices for settlement. This is currently done by taking a simple arithmetic average of the 5 minute prices within each half hour, even though 5 minute prices may, and often do, spike for only one or two 5 minute intervals within that half hour.

The well-known problem here is that this approach dilutes and distorts the real price signals required for good market operation. It encourages parties to maximise output for the reminder of the half hour after an incident, even when the need is past, straining frequency control services to compensate. Looking forward, small storages would find it more difficult to respond to whole half hours than to the shorter and sharper high price bursts that are the more typical reality.

Proposed Solution

There are several variations of a quite simple solution to this problem, involving use of SCADA (i.e. real time measurements). In essence, a new 5 minute ramping service could be created. Smart meters at customer premises could be programmed to measure net energy at the 5 minute level, to be uploaded to and processed by an aggregator for settlement purposes. All this would need to be auditable.

Degree of Difficulty

Technically, the proposed solution should be straightforward for large, centrally dispatched players and, with a little more development, for customer-level responders. In the past, incumbent participants complained that such changes would be very costly for their own systems. Incumbent indifference to the problem persists. The challenge for the regulator is to give sufficient weight to the participants who are not yet present in the NEM in numbers and aggregated size.

3 Introduce a two-way 4 second FCAS market

The Issue

Frequency Control Ancillary Services (FCAS) in the NEM are procured through eight different services; raise and lower services at three timescales for contingency and another raise and lower set for regulation. Participants can offer into these markets for enablement and payment.

One interesting innovation which IES proposed when these markets were introduced in the early 2000s is called “Causer Pays”. This system uses 4 second SCADA measurements to allocate costs to participants according to their contribution to the need for regulation. Causer Pays has helped drive the cost of regulation down.

This system has worked well for larger participants but is not suitable for small ones, who cannot in practice make offers into current FCAS markets. The AEMC recognises that storages and other small scale options can usefully provide these services. Further, there will be an increasing need for them as the inertia of the system declines with growing renewable penetration. But the mechanism to achieve this is unclear.

Proposed Solution

The original proposal was to extend Causer Pays to a two-way market in regulation (not just to allocate costs), and also, potentially, to measure, charge and reward for cause and correction in a similar way for contingency FCAS as well. The idea was dropped because, at the time, it was probably seen as unnecessary to go this "extra mile".

A two-way 4 second market would open up FCAS provision to all players. Smart metering could be programmed to calculate the relevant performance measures locally for later uploading and settlement. The pricing incentives in such a market would remove any need for central management of small scale options to provide these services.

Degree of Difficulty

Conceptually and technically, the development of this facility would not be unduly difficult. Some prototyping and tuning would be required, along with the development of smart metering logic and processing facilities. A bigger challenge is the regulatory one of getting such a concept past incumbent participants, who seem quite satisfied with the status quo.

4 Follow through with Contingency FCAS Causer Pays

The Issue

The current FCAS markets are integrated with the energy market to ensure that their dispatch is co-ordinated and efficient. While the cost of regulation is allocated reasonably well through the causer pays mechanism, the costs of contingency services are smeared between all generators for raise services and all loads for lower services.

There is a simple and robust mechanism that could be implemented within NEMDE to optimise the requirement for contingency services and to allocating these costs much more efficiently between participants, including networks, but NEMMCO (predecessor to AEMO) decided against it. The price for this failure is that the current FCAS dispatch costs are higher than they need to be and that, worse, new conventional and renewable plant are designed and located largely indifferent to the FCAS costs they will impose.

Proposed Solution

The allocation of the costs of all ancillary services in the NEM, including FCAS, should be revisited, especially in light of the evolving nature of the system. The requirement needs to be co-optimised with the energy market by NEMDE at dispatch time and cost allocation needs to be much more rigorous, based on NRMDE calaulations.

The proposal in this article to consider re-vamping NEMDE into an AC load flow model and to implement a two-way 4 second FCAS market are relevant to this issue.

Degree of Difficulty

There is much technical homework to be done but pushing changes such as this through the regulatory process is likely to be the biggest hurdle. There will be winners and losers from such a change.

5 Price distribution network constraints dynamically

The Issue

One of the assumptions that we make in the Australian Electricity market (and in most others that I am familiar with) is that real time pricing stops at the distributor's gate. Everything inside that gate, including relief of distribution network constraints when and where it might be sensible to do so, is done through regulation or under the control of regulated entities.

Distribution networks do need to invest in green-field developments and to replace old and unreliable equipment. Potentially, they also need to upgrade existing facilities to meet the growing demand from urban infill. In this latter case there are potential alternatives; alternatives such as batteries and some level of load management that, in the foreseeable future, could become economically viable on a large scale. How can these alternatives be marshalled? One way is to let the network operate manage them and this will likely happen to some degree, but this is not a competitive approach.

Proposed Solution

Another way is to price emerging distribution network constraints dynamically. How can this be done?

- Suppose critical sub-station data were to be metered and published in real time, just as we do now for a wide range of NEM data. Such data are already available on request to the distribution business, but only a year after the event which is not useful for control.
- Suppose also that some responsible party implements a pricing algorithm based on the margin between the real time load on the substation asset and a rating that would trigger a decision to expand the asset. The smaller the (real time) margin the higher the price.
- That price, regarded as an increment to the wholesale price, could incentivise some automated demand response, using batteries, load shedding or both.
- If the payments for this service begin to exceed the threshold that would support investment to expand the asset, that expansion should proceed, but not otherwise.

Degree of Difficulty

The above is a bare bones outline only. But constructing a technical and regulatory framework that would work to relieve network constraints as they occur, without requiring active participation or approval by a distributor or large retailer, is entirely achievable. The first task is a research activity to define and model how this would work, and to review the technical and economic issues around it.

6 Update planning models

The Issue

System modelling is widely by all parties to the NEM, generators, retailers, transmission owners, traders, market operators and many others. IES is developer and supporter of one such tool, PROPHET.

These models are built around the idea of a set of controllable generators being dispatched efficiently to meet a given load. Increasingly, those who need to understand network needs and business opportunities in the NEM must deal with the impact of growth in renewables, weather sensitive loads and of course emerging storage technologies. While we can produce

projections of these things (which include regional and technology variability), they are pre and post-model adjustments. Integrating emerging technologies into the system wide model is an area in need of further investigation.

Proposed Solution

Needed is a tool that can explicitly model generation and loads that do not have tidy controllable behaviour, which show wide regional variation and yet computable correlations between them. Further, the tool needs to recognise that all these operate within a potentially constrained network. We'd like to get a good handle on projecting reserve needs and network flows under different growth scenarios of these non-controllable elements. We might want to look for locations where increments to reserve plant and network capability may be required. We may also want to do some screening level optimisation around these things.

Degree of Difficulty

This task is quite hard, but we at IES are working on such a tool and have a prototype in the works. It will not replace our current simulation models, but will do a lot of preliminary scenario screening prior to more detailed analysis with traditional tools. Interested parties should contact IES and we'll see if there's enough current interest to justify an early workshop on the matter. Earlier committers get the best deals!

7 Harmonise regulatory policy

The Issue

An economist visiting from another planet, touching down in the land of Oz and surveying the energy policy landscape, might well wonder whether she had arrived in a topsy-turvy wonderland. Sure, there are differences between parties on climate policy, tax policy and fiscal policy generally, but the current policy mix serves nothing particularly well. Consider this:

- We had a carbon tax that could raise significant revenue (as free permits fall way) as well as contain emissions growth. We scrap it in favour of a scheme that costs revenue and leaves major emitters free to emit, even though there is a common objective on all sides of politics to reduce emissions. We are now searching for unpleasant revenue raising alternatives such as GST hikes to fund Direct Action and to substitute for lost revenue, including lost carbon tax revenue, of the order of billions each year.
- While the campaign to turn the public against a carbon tax was successful, the campaign against the renewable sector was not. The public seems to like the renewables idea. The result? A renewables scheme that forces in wind power at a rate that hurts existing and otherwise viable thermal plant. If not an objective of the scheme, this is certainly an understood consequence. The problems?
    - The wrong type of plant is under pressure to close. Absent a carbon price, the oldest and heaviest emitters are running now at high output.
    - Further, the system is becoming less flexible than it will need to be to accommodate increasing levels of intermittent power.
    - Looking forward, the revival of large scale renewable investment has been muted thus far even though the legislated target has been settled. With the industry now dominated by three large, vertically integrated, coal plant

owning entities, it may remain muted indefinitely. A large cloud of policy-induced uncertainty still overhangs the industry.

- While our political attention was focussed on carbon taxes that made up less than 10% of domestic retail electricity costs, massive distribution network cost increases, many times the economic cost of the carbon tax, slipped under our collective radar. Those costs are now sunk and must be paid for. We cannot abolish them with a vote in the parliament; they will be with us for many years to come.
- It seems that everyone in the industry, including the AER, knows that network and retail tariffs are set to evolve, beginning July 2017, to undermine the case for small scale PV and storage by increasing the unavoidable fixed charges in tariffs. Nobody seems to have told the general public about this. In time, this trend may well erupt into a major customer revolt, with much political pain to be shared around. As I write this, I notice that a recent Chairman of AEMO, Tom Parry, has also made precisely this point, among others.

Proposed Solution

Our current dysfunctional policy settings are the result of a series of smoke and mirrors exercises, emanating from all sides of politics. Here's my take on a more balanced, middle-of-the-road approach.

- Set a viable objective for climate change response. Saving the planet doesn't cut it in my book; we in Australia are too small to count. Being a good global citizen to contribute our fair share might make more sense. A more concrete and defensible objective to is to promote an orderly re-orientation of the electricity sector to face a carbon-constrained world. We should also plan and research more to deal with distributed technologies that will likely arrive whether we are climate sceptics or not. Fancy carbon trading and copping out with cheap international permits don't help much with that objective.
- Consistent with that objective, and the objective of helping to fix our revenue problem (irrespective of any spending problem), revive a modest carbon tax. What is modest? Probably a bit less than what it was, but not much less. Trading of permits can wait until the rest of the world gets there. Hey, I know this is dreaming…
- To avoid putting the whole burden of adjustment solely onto electricity prices, energy efficiency policies and the large scale renewable energy target (LRET) should continue.
    - If history had turned out otherwise and the carbon tax had been left intact, perhaps at a reduced rate, some modest winding back of the LRET would have been desirable and politically possible. This policy mix would be less troublesome for the system and existing players and would deliver a very similar emissions outcome.
- If some of the above comes to pass, one might think about winding back the small scale renewable scheme. Why?
    - A modest carbon tax (still dreaming) would be a partial alternative.
    - The small-scale renewable sector is largely driven by retail prices, which are dominated by network costs that are higher than LRMC at the moment. Along with PV cost reductions, this gives the sector opportunities even if the current small-scale subsidy were to be wound down.

- Subsidising small scale renewables may prompt networks to discourage them by seeking tariff adjustments such as higher fixed charges. It makes no sense for these two policies to be pulling in opposite directions.

- Resource the AEMC, AER and AEMO to support stronger regulation, market innovation and renewal well ahead of need.
  - AEMC and AEMO should be tasked to support pro-active development of pricing and other options to accommodate new technologies efficiently. If innovation is the new buzzword, public sector entities are just as critical as private ones.
  - Consider implementing simple, robust regulatory rules, rather than procedures requiring case-by case analysis that can be easily gamed. Regulated entities will always know more than the regulator.
- COAG should be far more pro-active that it is in setting the reform and market development objectives.

Degree of Difficulty

This is a hard one. Any sense of bipartisanship on electricity sector policy was busted five years ago. It's difficult to see a more balanced policy mix emerging any time soon; all the more reason to work to ensure that new, distributed technologies support rather than hinder efficient operation and stability of the NEM. Innovation is the buzzword of the day and it's needed here.

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