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Congestion management in the NEM
An individual view

By Hugh Bannister

Congestion management is the topic of the moment at the AEMC. The current AEMC review brings together a range of network irritations that have been festering ever since market start; irritations that the old NECA never really came to grips with. May the sun shine brightly on the AEMC's efforts!

So far, the AEMC has issued a discussion paper and has received over twenty industry submissions, including one from IES. With this in mind, your friendly *Insider* editor has suggested that our readers might be interested in a summary of that submission. This I agreed to do. But while the IES submission was measured, objective and balanced, this piece will instead be forthright, subjective and opinionated! And to give me and other *Insider* contributors this freedom without unduly alarming our readers, we have added a disclaimer to this article and to the whole *Insider* newsletter.

So How Did We Get Here?

History can be a useful way to understand how we got to the present. What follows is hardly a scholarly analysis – more like recollections over a beer or three – but at least from one who was there…

A fundamental decision made early on, now universally followed wherever electricity reform has occurred, is structural separation of the network, and the transmission network in particular, from energy generation and retail. Why was this done? Mainly, to keep the network disinterested in the market; that is, indifferent to price outcomes so that it is not tempted to manipulate them in its own favour. No-one makes a contrary argument these days, but there has been a price to pay; network disinterest in the market can sometimes cause market pain. For this reason, the AER has been trying to inject a little bit of market interest into the networks' reward structures, but not too much.

Far less universal – in fact the NEM is quite unusual in this respect – is the integration of the system operator and the market operator within one organisation – NEMMCO. This was a point of considerable contention in Victoria when VicPool was first set up in 1994, but the decision to go with an integrated operator was later followed in the NEM. I think that was a sound decision. Why? Because only the system operator can know and manage all the network constraints that determine the envelope of secure market operation. Separating these two tasks makes operations difficult and, in some respects, potentially dysfunctional.

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Strangely, this philosophy was not carried through when it came to forward trading. It is history now that the original NEM design included a Short Term Forward Market (STFM) but this element of the design never got up. The argument in favour was that generators needed a basis on which to make day-ahead commitment decisions, that demand-side response would benefit from the ability to lock in a return a little ahead of spot time to facilitate operational planning and that everyone needed a tool to help them manage short term risks..

Why was the STFM stillborn? Some participants and especially the finance industry argued against it – this was a financial market and NEMMCO should not go near it. This argument appears to have swayed the NEMMCO Board, which dropped the concept. This has not been fatal and I for one, originally a supporter of the STFM, must now acknowledge that unit commitment and probably a good deal of load management (although it's hard to be sure) can function perfectly well without it.

But also ditched at the same time was any possibility that NEMMCO might offer forward contracts in network price differences, now known as Financial Transmission Rights or FTRs. Instead, it was decided that inter-regional residues would be auctioned in the hope that someone might construct and trade useful hedge instruments from them. Network operators were also empowered to write "firm access" contracts with participants, which they have never been inclined to do in practice.

Removing NEMMCO from forward trading ensured that NEMMCO would leave the market open to the financial engineers, if they wanted it. And they are certainly happy to have this as a speculative but still profitable business, but that hardly helps contracting over the network. It is hard to escape that what happens to prices over the network is fundamentally NEMMCO's business, so can we be surprised that, absent NEMMCO, no-one has stepped in to take that risk? The AEMC should re-visit this design proposition. This, along with the need for a systematic program of R&D on these issues, is one of the fundamental propositions of this article, so if you need to watch the soccer you can take a break and do that now.

Implicit in the above discussion is another fundamental design decision which I believe was appropriate at the time, but which needs review now. That is that the NEM should be a regional market. To be sure, there were many at the starter's gun who believed you should just wish the network away and have a single energy price. Those with long memories will recall that the NGMC's famous paper trial put paid to that idea – a fine example of more being learned from failure than success. Needless to say, if you want to see others get tangled up with the idea of a single price market and central control of unit commitment, take a look at the design of the Irish electricity market at www.allislandproject.org.

The NEM design never took the final step to a nodal market, for all sorts of complex reasons. One is that a lot of people thought it was too complicated to understand. Some thought it was too complicated to implement (maybe it was at the time, but not anymore). Others thought it would give some generators too

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much market power. A telling factor was that you would need a robust network hedging facility to manage risks, and that was beyond reaching any sort of consensus as we have just discussed.

And so a regional market is what we have and it has worked well enough. But there are quite a few running sores that need a lot of care and maintenance, and how best to deal with them is what the current AEMC review is all about. So let's look at some of them now.

What's Causing the Pain Now?

Although a decision was made to go regional, the market cannot ignore more location-specific issues because they affect the security of the system; running a secure system at all times is an absolute given in the NEM which overrides all other objectives. To allow NEMMCO to manage this, the market engine was given the facility to implement "generic constraints" that can target generation, load and ancillary services at specific network nodes. Further, an attempt was made to minimise their impact on regional price outcomes by putting some "dispatchable" variables as constants, where in fact they were not.

Over time, NEMMCO has found that these arrangements have made it difficult to run a secure system without regular intervention and no doubt dispatch efficiency suffered also. The solution, now agreed and being implemented, is to convert all generic constraints to "Option 4". This nomenclature relates to options discussed in a CRA paper but, in plain language, it means that all constraints will be converted to the way they should have been implemented in the first place, with all dispatchable variables able to be optimised by the market engine at each dispatch interval.

But this fix, while satisfactory to NEMMCO and the market generally, imposes a greater risk for some participants. These have not all been felt yet as NEMMCO is still in the process of converting these constraints to Option 4 form. So the compromise that shows participants a common regional price but leaves them with a volume risk from generic constraints is being placed under more strain.

One of the larger network problems remaining is, as ever, how to contract over the network. Within a region something can be done. Sure, there are risks that will not go away when intra-regional generic constraints bite and it would be good to improve on that. Inter-regionally, it's hard to conclude that supply can be confidently sourced long-term outside a region because adequate hedging is difficult, if not impossible, as no-one is prepared to back network performance with hard cash.

Another set of running sores to think about are the negative residues that arise in the NEM or, more accurately, the real running sore is what NEMMCO has been doing to distort the market in order to manage that perceived risk. Partly, these negative residues are the result of the pricing rules surrounding the regional model; in part they are inherent in the underlying network. Negative residues across some

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pairs of nodes do NOT imply revenue inadequacy over the whole network - on the contrary – a fact which points to a possible solution to that problem.

Finally, there is the problem of what to do when the existing regional boundaries start to look inadequate. The NEM has addressed this problem by providing that, when constraints bind for more than a certain number of hours each year, a new region or regions should be created. However, state governments have argued against actually doing this as differing energy prices between sub-regions in a state might spell political trouble. Networks support the current approach which is that, first, the constraints be managed in dispatch; next that network enhancement be considered and, when all else has been considered, a boundary change be looked at. Needless to say, a boundary change has never happened despite being looked at a few years ago.

The NEM regional model works because the state-oriented regions define viable, nearly self-contained blocks of load and generation. So there is no serious risk issue with this design; only a problem of potential dynamic inefficiency – is generation investment in the best location? With the current regional structure the NEM works, but perhaps not as well as it should.

Now what happens if you consider breaking up the existing regions? Suddenly, you have a whole lot of new price risks introduced by the network. Not only does the NEM lack the facilities to hedge future contracts across these regions, but existing energy contracts suddenly become less useful and perhaps even inoperable. After having dealt with this pain, there is the prospect of further boundary changes in future. Indeed, the vision inherent in the current approach is a gradual evolution toward a more detailed regional and eventually a nodal network model, so a shock to the system at arbitrary intervals determined by a bureaucratic process is expected to be the norm. Now, I have to tell you that this part of the NEM rules has a surreal quality that renders the lack of action on the regional boundary front perfectly understandable.

What is on the Table - and Why?

Because we don't have viable contracting over the network and because nodal pricing has been out of favour in Australia (although the phrase "nodal pricing for generators" can and is spoken out loud, and I will say that also, but later), we seem to be looking at other ways to deal with the network problems that we have. One of them, given some currency by the AEMC (not least because its technical adviser has been advocating it for some time), is called Constraint Support Pricing, or CSP, with corresponding CSCs (Constraint Support Contracts). These are clever things that make sense to those that play with linear programs, and which also apparently appeal to people who don't like the market operator getting involved in operating markets, a concept that I find difficult to understand.

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Incidentally, these concepts are based on what is called flowgate theory in the US. For a delightfully bitchy exchange between Larry Ruff (who advised on the design of the Victorian electricity market prior to the NEM) and a flowgate advocate Professor Shmuel Oren, see: http://www.ksg.harvard.edu/hepg/flowgate/Oren-Ruff%20Email%20Exchange.pdf.

So what is CSP? The idea is that, instead of implementing a centralised nodal pricing and network contracting regime, you can essentially let the participants trade around the mathematical constraints that bind the system. This is an extension of the idea that the shadow price of the (regional) energy balance constraint defines the energy price. If applied across all constraints the outcome is something that delivers the same pricing outcomes as nodal pricing for generators. So this might work fine provided that:

- the exact form of the constraints remains fixed;
- the number of binding constraints remains manageable for trading purposes; and
- the constraints that bind are more or less the same over extended periods of time.

The problem with CSP is that, in practice, none of these assumptions is valid. Ruff has argued that case for the US and our analysis in the IES submission to the AEMC supports the same conclusion for the NEM. NEMMCO makes the same point, in its usual restrained manner, as do other submissions. Further, as the IES submission points out, unless this approach is implemented for ALL constraints, there is a risk of perverse pricing outcomes in particular locations, with resulting distorted and unpredictable incentives.

Much of the AEMC discussion paper asks questions rather than proposes solutions, but CSC and CSP seems to be very much there as a centrepiece. It's being trialled in the Snowy region now and it looks as if it works fine. However, this is simply showing that, on a limited number of constraints, CSC's do provide location pricing signals as would nodal prices. It's difficult to see how the trial could be used to test the issues central to any practical implementation. It's a shame that it looks as if it would seriously miss the mark when applied across the whole of the NEM.

What this Author Thinks May Work Better

So it's easy to throw rocks, but what would I do if someone at AEMC had a rush of blood to the head and asked? It looks to me as if there are only two broad approaches that might reasonably work.

One approach is to more or less stick with what we have now and try to fix the worst aspects. That pretty much means accepting the existing regional structure indefinitely in terms of both boundaries as well as the likely evolution of the pattern of load and generation on a regional basis, with a corresponding (probably large) investment in relieving network constraints.

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The second is to make the jump to nodal pricing, not now but at a planned time in the not-so-distant future. I have some strong caveats to that, which I will outline.

The first caveat is that nodal pricing for loads appears to be such complete anathema to state governments that I would not bother advocating it. So I would support nodal pricing for generators only. This presents its own set of problems and potential anomalies that will need to be identified and worked through, but I think they are both manageable and small compared with the problems we have right now. So in advocating this I am on the same side of the fence as NEMMCO and some other submissions.

The second caveat is that I would not go near any form of nodal pricing without starting from scratch with a regime to support real and robust contracting over the network; not through unworkable CSCs but with FTRs. What does starting from scratch mean? I mean we need to start with the proposition that NEMMCO is not only the appropriate body to manage a market in FTRs, but should also provide the means to make these FTRs firm. We have tried the idea that others might make firm contracts out of the residue stream and it doesn't work, and could never have worked.

So what would an FTR market look like? Here's my design proposition; but I stand ready to adjust it if further research suggests I should!

- There is no pressing need to re-design the NEM market engine. While it can probably be improved in quite a few ways, with some reformulation of constraints to explicitly recognise the location of loads and to get explicit prices for nodes where generators might be built in future, it's adequate to support nodal pricing for generators and a viable FTR regime. Any major improvements to the engine could be regarded as a separate project. Nodal pricing would be implemented essentially by re-interpreting the existing dispatch and pricing solutions. A few elementary considerations suggest that prices for loads should be a load-weighted average of nodal load prices across each region.
- NEMMCO should use the same market engine for FTR trading as it does for dispatch and pre-dispatch runs. Of course, there are lots of design decisions here; what time intervals, how far into the future; how often to trade, what form of auction etc. etc. But the market would clear with this engine. In this way, there is no disjointed boundary between FTR trades and spot trading i.e all the constraints should carry through from one market to the other, unchanged.
- The simplest approach that would meet longer term needs would be to define and support simple swaps between pairs of nodes i.e. a trader would be required to nominate prices for a MW quantity put in at one node and taken out at another. How to account for losses? Allow generators to bid extra into the FTR market (but not loads to take more out, although this rule could be relaxed). Only enough generator energy would be accepted to make up the (anticipated) losses in the system.

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- What about firmness? Let me suggest a bold starting point that I am prepared to retreat from if evidence suggests I should. NEMMCO could offer (nearly) firm contracts up to the "normal" secure operating envelope of the network. "Normal" could allow for planned network outages but, as a starting point, make no allowance for unplanned outages. What would happen if NEMMCO did this? First, the value of the contracts it sells is likely to increase relative to the income it receives form the current non-firm IRR auctions. This may be more than enough in the long term to cover actual payouts at times of forced network outages. Even if it were not, there is the pool of auction proceeds that could legitimately back up the payouts. As a last resort, NEMMCO could reduce payouts across the board to ensure it stays financially whole, as is done in the US PJM market.
- What about negative residues? I might be overlooking something here, but I can't see a major problem if the network as a whole is guaranteed to generate a positive financial residue, which it is. It's only a problem at the moment because of the way the rules are written.
- What about network performance incentives? I have an open mind on this – perhaps some form of "causer pays" could be contemplated but this may be difficult or impossible to implement and generate more flak than it's worth. The concept does not really depend on the networks being fully exposed to market risks, but a little exposure might be useful.
- What about FTR trading liquidity? If NEMMCO implements and financially backs the FTR regime (ultimately backed up by the market as a whole), there would be no liquidity constraint when the FTRs are first auctioned. Liquidity in secondary trading might well be limited, although the central trading facility proposed would certainly support whatever trading the participants want to do. This is an area that would benefit from some interactive gaming.

As an implementation strategy, I believe you could prototype, test and fine tune a robust FTR trading regime based on the existing regional pricing rules. At the same time you could display but not use the corresponding nodal prices. When all is in order, just flick the switch to use the nodal pricing rule and also extend the scope of the FTR contract trading to all nodes, not just regional nodes.

No doubt some form of FTR vesting would be desirable and readily doable.

Some Homework for the NEM

We at IES want to do some of the homework I have set out on the following page, but it must fit in with the regrettable need to make an honest living. So if anyone out there wants to push this along a little faster, just give us a call!

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- What would the pattern of nodal prices look like? With some work, nodal prices can be extracted from the existing NEMDE published market outcomes, with or without Option 4 constraints. At the time of writing, NEMMCO has only partly implemented Option 4 constraints so this fact would need to be accounted for. This is surely fundamental homework if we are serious about this stuff.
- What would have been the past financial outcome of FTR auctions if FTRs had been sold off at various MW levels, including the level of a "normal" network? Of course, you can't predict what people would have paid, but you can do a few scenarios. Again, this is a fair bit of work but essential homework if we are serious.
- How would you operate an FTR auction? What is needed is a simulation that participants can test out and from which they can learn. It could inform the AEMC as well. It would be quite manageable to do a prototype trading system for testing over the internet, based on a simulated FTR market.
- In a nodal pricing for generators regime, in what locations are market power issues likely to arise and how could they be managed?

Looking at this list of things to do, which to me represents essential homework to make an informed decision on the issue at hand, I can only climb again onto my favourite hobbyhorse and ask why the NEM does not somehow support this sort of research on an ongoing basis. Is it really enough to fly by the seat of the pants as much as we do, without doing the basic research, which takes time? Doesn't a multi-billion dollar industry deserve more?

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