Julian Lawrence response to Post 2025 Market Design Issues Paper

It occurs to me that renewables behave very differently in markets to fossil generators.

Renewables are:-

- almost zero marginal cost
- are use or lose
- there is more tomorrow (they are renewable)

These three properties lead to considerably different market behaviour than fossil (which has the cost of digging out of the ground and can be stored in a pile in front of the generator or left in the ground). Not the least is that they can, and do, always underbid fossil. Which, I suspect, is what led directly to the perceived need for market intervention and the creation of the energy security board.

The three properties create an imperative to maximise utilisation. An imperative to operate as long as the sun shines and the wind blows. At present we have a mixed generator fleet, the competition which results with 100% renewables will be considerably different to that between renewables and fossil.

There is an economic inevitability about 100% renewables (with storage), they are cheaper to build, and cheaper to operate. From a consumer perspective the perpetual downward pressure on prices available with near zero marginal cost, appropriate market design, and competition is attractive. Australia has the resources.

I'd respectfully suggest that we have a need for both market design for transition and market design for 100% renewables.

Network Operation

We operate the network now in the same way we have for the last 100 years. The operating paradigm is to match supply to demand, in real time. The generators follow the total intermittent variable demand through peaks and troughs.

This leads to a vocabulary including "base load generation", "dispatchable power", "firming", "storage", etc.. We also see "intermittent and variable" generation perceived as a liability. Words that belong to the language of network management, not the physics of electricity.

If we continue to operate in the same way with large percentages of renewables we will meet the rather pleasant problem of disposing of excess energy which is free to generate.

In conventional supply chain management the network is currently operated as a "pull" system.

The recent rule change that allows some demand to bid into the market to reduce their demand and have it equated to increased supply is a very small hint of what may be.

Inventory

Most supply chains include inventory. It decouples supply and demand. And so we find the initial response to variable intermittent renewables is to add storage. Storage is the bucket, inventory is what is stored in the bucket. Most supply chains have a master production schedule which includes supply, demand, and inventory. The AEMO master production schedule has historically not included inventory. It didn't have to. Dare I suggest that the future version of the Pelican Point problem of not being able to generate when required may be pumped storage which is empty. AEMO currently consider storage to be both supply and demand (with "time contracts" held outside the master production schedule).

My prediction is that AEMO will modify their master production schedule and develop practices to manage inventory.

Inventory currently has a role in reliability and security of all supply chains except electrical energy. Simply by design. Surprisingly (to me), in the last AEMC reliability review there was no mention of the effect of storage or inventory on reliability and security. Despite the (then) pending approval of Snowy 2.0 and the presence of batteries (eg SA) and other pumped storage (eg Snowy and Wivenhoe).

The introduction of electrical energy inventory into the electricity network was both unnecessary (coal can be stored next to the power station) and not economically viable due to storage losses. Perversely, in a mixed generator fleet, it is fossil that is stored not renewables (have to think about that), and emissions are increased above what they would otherwise be. The outcome of Snowy 2.0 gaining from arbitrage with a mixed generator fleet will be increased emissions.

With 100% renewables the effect of zero marginal cost flows through storage and subsequent processes in a way unachievable with fossil. Similarly zero emissions. Like zero GST would, it doesn't compound through each operation.

Perhaps interesting from a market design perspective is to consider the effect that London Metal Exchange inventories have on Aluminium and Copper prices. Simplistically, increase inventory, prices fall, decrease inventory, prices rise. Electrical energy inventory will rise and fall an order of magnitude more rapidly, but the principle is relevant.

Perhaps also interesting to consider is the potential for the owner of storage to sell storage to the owner of energy to be stored (tolling storage). Like self-storage. Part of market design, it is quite likely that trading electrical energy will appear. A market for electrical energy.

I imagine that we may introduce a market for "safety stock". A common concept in inventory management. Given that Snowy 2.0 will have up to 7 days inventory (limited by how fast it can be re-generated) we may choose to pay Snowy 2.0 to keep the storage as full as possible, as insurance.

Power and Energy

A different way of saying the same thing. Currently we manage the network by managing Power (MW), instantaneously. In the future we will have to also manage Energy (MWh), over time, the stuff we store.

I believe that not only presents a significant change for network operation, but also a significant change for market design.

Push or Pull

With the presence of inventory, in the long term supply always equals demand. In the short term supply may exceed demand (push) or demand may exceed supply (pull). In reality most supply chains can operate in either mode, and frequently do. Its just a way of looking at operations.

The hydrogen strategic study (chief scientist, also precipitated by COAG Energy Council) asks the question of integration of hydrogen into the electricity network.

In simple terms, that could entail an operating paradigm which, in sequence:-

- operates all generators at 100% utilisation
- satisfies conventional demand
- fills inventory
- uses excess for hydrogen production

Patently there are many variations on this, not the least being the use of stored hydrogen to re-generate when inventory is empty and the wind hasn't blown for an extended period. An additional form of insurance. The traded price of energy inventory would rise after a couple of days.

The addition of electric vehicles, supplied from batteries or hydrogen fuel cells, becomes part of the same operating paradigm. Hot water is a form of storage.

I mention hydrogen generation as, although it is currently expensive, it has the rather nice property of 100% turndown ratio. Indeed, it is marketed as capable of network balancing and frequency control. It can operate as a variable intermittent demand to mirror the variable intermittent supply of renewables. In the above scenario that would be when inventory is full or generation exceeds pumping capacity.

If it isn't hydrogen production something else will be developed. Desalination is one prospect. Large scale pumping for irrigation another. Hydrogen production includes the prospect of direct export. I believe Tokyo Olympics will be powered by hydrogen.

To help definition, push or pull are related to "make to stock" or "make to order" in supply chains. The concepts, and the dichotomy, are not to be taken literally.

The imperative to operate, the push, that renewables introduce may impact the business case for Snowy 2.0. Potentially, the existing arbitrage between off-peak and peak may disappear. It will depend on how we re-design the market. There is potentially a conflict of interest within government.

Capacity Utilisation and Bottlenecks

The current operating paradigm results in unutilised generating capacity during demand troughs. Average generator utilisation is about 80%. It is a challenge for any market design to pay for unutilised capacity. I suspect current design is inadequate in that respect, the high peak prices may not be sufficient to pay for poor utilisation during off-peak.

In any supply chain there is a bottleneck. One bottleneck when viewed at the appropriate level. The electricity network, and market, is designed around demand being the bottleneck. A pull system.

It is conceivable that by introducing hydrogen production renewables generation, supply, could be the bottleneck (by design), operated at 100% of available capacity. A push system.

The existing network has grown around demand being the bottleneck, which is probably economically sound as the marginal cost of generation is the cost of digging coal out of the ground. The downside is that coal fired power stations are not really designed to be flexible – it takes time to heat steam.

With zero marginal cost generation from renewables there is no additional cost of fully utilising the available raw materials (wind and sun). It is potentially economic to produce hydrogen from energy which is essentially free. An interesting challenge for market design.

To be clear, the iron ore mines have grown through progressively investing in their bottleneck. A small investmestment in increasing throughput through a bottleneck increases throughput through the whole operation. They are capital intensive, a small increase in total $ cost can mean a large increase in tonnes. To reduce $/tonne increase tonnes. To extrapolate, increase MWh to reduce electricity $/MWh.

Slightly off-topic, the impact of zero marginal cost electricity, in a network operated as push, has the potential to relieve a bottleneck in energy productivity caused by carbon. A profound impact on economic growth. It would be a shame if the electricity market were redesigned in a way which didn't allow such an impact to occur.

<u>Forecasting</u>

Network operation relies on forecasting demand. A common practice with most supply chains. The introduction of variable intermittent renewables has made forecasting demand more difficult as rooftop solar is behind the meter and appears as reduced demand. It has also added the difficult task of forecasting renewables generation.

In a push system with inventory the application of forecasting changes.

<u>Lead Time</u>

The lead time for renewables is shorter than for a fossil generator. The modular nature means that generation can commence before all generators are in place. At the extreme roof top solar has a lead time of a few weeks.

This changes market dynamics.

Snowy 2.0 has a timeline which will deliver storage, renewables generation and transmission line upgrade at the same time. Storage is the critical path.

Mobile Phones

The first mobile phone plans were expensive. Expensive monthly charge plus expensive calls. I now pay $30 / month for unlimited local and international calls plus some internet. 30 years ago I used to pay $30 / month (in absolute $) for a fixed line, and extra for calls.

I look forward to further cost reductions as phone calls are remarkably similar to renewables. The cost of an extra phone call to the telco is about zero. Their imperative is to fully utilise the network to maximise revenue.

The bottleneck is demand. The way demand is increased is to reduce the price to hopefully increase revenue, at zero additional cost to the network operator. Ultimately network congestion will occur or more capacity will be added. And so the cycle continues.

I mention this because a bottleneck is not only physical. In the case of mobile phones the bottleneck may be perceived as product pricing. A not unusual logical outcome of zero marginal cost. I mention it so that the market design doesn't introduce, or isn't defined by, an unintended bottleneck. Which of course implies knowing where the bottleneck is, or is desired to be.

Interestingly, even without renewables, the electricity network (and market) has contrived to increase electricity prices, and reduce demand. This has been achieved by generator capacity being momentarily the bottleneck at peak demand. Perhaps understandable with a non-zero marginal cost and variable intermittent demand. The expected competition to generate hasn't (yet) eventuated. Nevertheless, a somewhat bizarre and undesirable vicious cycle which seems to have added to the conclusion that market intervention is good and the market requires redesign.

Marginal Cost Recovery vs Full Cost Recovery Markets

While zero marginal cost has an attraction to me as a consumer I have to recognise that the market must ultimately provide for full cost recovery.

Not surprisingly this is difficult to achieve in market design.

Redundant Technical Requirements

Occasionally I see discussed the concept of technology neutral management and development of the network (in all aspects). My reason for describing the above is that our operation of the network is implicitly founded on fossil technology.

In the language of systems design such barriers to change are termed redundant technical requirements.

Such requirements are currently evident in pretty much all aspects of the network, from rules to policy.

I write because I feel those constraints may colour future market design.

It would be a great pity if the market were designed around "pull" without recognising that "push" may (and in my humble opinion probably will) also occur. In the current scheme it already has for short periods.

The National Electricity Guarantee, the Big Stick legislation, and potential guarantees for fossil generators, are examples of system design at too low a level of abstraction. They are interventions in the market rather than systemic market redesign. I understand why they may be perceived as useful in the short term, but in the long term their one-time effect wears off. Redesign is my preference. They lend a lie to the very existence of the market which rapidly becomes an over regulated sham.

It is quite conceivable that at some time in the future we may find ourselves paying for guarantees to a generator that even then is uneconomic to operate. Cheaper to operate renewables and pay the stranded generator to not operate.

Paradigm change is a difficult process, its not just that the constraints exist on paper its the effect they have on mental models and thought processes. The redundant technical requirements reinforce the existing paradigms.

<u>Chicken or Egg</u>

Should market design define how the network is operated. Or should network operation define how the market is designed.

Certainly I detect some friction between current market design and current operating paradigm (a deliberate understatement!).

I suspect the current market design represents an unintended redundant technical requirement.

Since its rarely possible to change the laws of physics to meet a market design I'd respectfully suggest that an appropriate methodology for market design begins with the limits, and opportunities, of network operation.

I write it as chicken or egg as its difficult to decide which comes first. But its difficult to imagine a chicken without an egg, and similarly difficult to imagine an egg without a chicken.

System design is commonly an iterative process.

Since the concepts outlined above have not yet arisen through other projects under the auspices of the COAG Energy Council I offer them before the next iteration of the Beyond 2025 project rather than the more difficult task of introducing them after alternatives for market design have been proposed in the next step.

<u>Optimisation</u>

It is doubtful that any market design can lead to an optimised supply chain. The risk is rather that the extent of a sub-optimal outcome is exacerbated by poor design.

Put another way. The current market failure is a failure from the perspective of the consumer. The generating companies may be quite happy with the result.

Perhaps a question for COAG Energy Council is “is the network pull or push?”. The answer will be both, but as a precursor to good systems design it is a critical question – by definition a question which if not resolved now will lead to poor system design.

I am not proposing a switch from pull to push, just asking for a system (market and operation in this context) design to allow for both. Technology agnostic at this level.

Perhaps a roadmap through the transition to 100% renewables rather than a single market change.

Climate Change

It appears to me that the urgency to address climate change will increase. While the aim to have an orderly exit from coal generation may be perceived as desirable now I believe that may well change.

Utilising market design to create order when the cost of renewables is reducing, the cost of fossil is stable or increasing, and markets are typically chaotic would seem to be a redundant technical requirement that artificially constrains outcomes. In short, the unwelcome truth is that coal fired generation cannot compete with renewables plus storage and climate change will demand a transition to renewables. Simple economics has created an additional imperative for change.

We are witnessing the largest infrastructure project in our history, with all the benefits to the economy that implies.

It would be a mistake for the market redesign project to ignore potential change in policy. A not unusual problem for systems designs.

Just transition is outside the remit of market redesign and this submission. It is however a necessary but not sufficient requirement for change and the removal of a perceived barrier to a more free electricity market.

The End

The above is aimed at describing some of the factors to be considered in market redesign that I felt were not adequately explored in the issues paper and which may not otherwise be included in alternatives.

I accept that there is no such thing as a free market, and market design is a poorly developed discipline. But I do believe the market should be more free than it is.

Who Am I

I’m a retired systems thinker who, several years ago, wondered why Splityard Creek (Qld 500MW, 5000MWh pumped storage) is capable of smoothing supply to a constant but is unutilised. My industrial experience (mostly unrelated to electricity) and private research over several years has led me to the above submission.

Julian Lawrence