Insight Paper

Wind in the Australian and Great British energy markets

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CORNWALL INSIGHT

CREATING CLARITY

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Content

Executive summary

A wind turbine is the same piece of engineering no matter where on earth it is located, yet assuming largely similar natural wind resources, the variety of risks and value wind turbines create is very much driven by the market characteristics in which they operate. As a pre-eminent energy research, consulting and market intelligence business that operates in Australia and Great Britain (GB), we have analysed how the outlook for wind in each market is being shaped by market design and infrastructure as well as network realities. Here we share some of our findings.

On balance, whilst both markets will see growth, and both have their challenges, the characteristics of the GB market means it will see greater growth. But there are good opportunities in Australia if challenges of system rules, resilience, and unpredictable market value drivers are addressed and can be navigated.

The outlook for Great Britain:

- GB is a mature wind market with well-progressed investments in system resilience and balancing services to accommodate ever-growing proportions of the generation mix coming from wind
- High volumes of wind growth to come will create substantial levels of power price cannibalisation
- Given that capacity markets dampen flexibility signals, delivering flexible load to accommodate wind is likely to rely on building effective new balancing service solutions
- There is a disparity between the prospects for offshore and onshore wind. The lack of price stabilisation available to onshore wind farms, now locked out of subsidies, is likely to mean that volumes of onshore deployment will reduce, with offshore wind continuing to grow at an extraordinary rate under fixed-price Contracts for Difference (CfD)

Australia by contrast:

- Is a less mature wind market, but with high levels of recent growth as a result of subsidies
- Whilst federal wind support schemes roll-off, state-level policy programmes could see the continued growth of onshore wind capacity in selected regions where the wind resource is attractive
- Wind will impact power prices but will have the most profound impact when combined with solar and interconnection issues in selected regions
- There is the possibility of better flexibility signals in an energy-only market like Australia, which could help bring through solutions to manage wind variability. Although how the market rules evolve over the coming years will be key to the realisation of this
- There is a major unpredictable long-term risk for wind in Australia that simply does not exist in GB in the form of the application of Marginal Loss Factors (MLFs). Unless and until developers and investors can find a way to better model and forecast MLFs, based on integrated system planning tools, the prospects for wind development in Australia will always be uncertain.

Cornwall Insight has offices in the UK and Australia with the experts, tools and experience to help address these issues, including how to quantify and forecast merchant power prices and (in the case of Australia) the impacts of MLFs

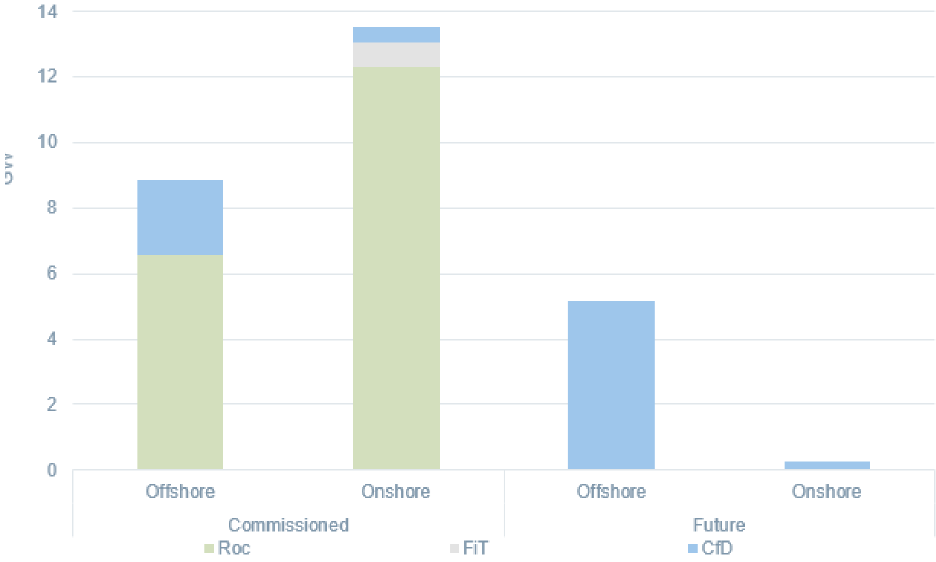
Today's landscape

Due to a near two-decade commitment to subsidy and policy support that has sought to exploit Britain's exceptional natural wind resource, the penetration of wind in the energy mix in GB is much greater than in Australia.

By 2018, operational wind capacity totalled c22.1GW in GB, representing 18% of the total generation. This operational capacity has been brought forward under a range of different schemes including the Renewables Obligation (RO) which has delivered 18.7GWs of wind since 2001, the Contract for Difference (CfD) which has delivered 2.7GWs of wind since 2014, and the Feed-in tariff (FiT) for sub 5MW wind which has delivered 695MWs.

On balance, whilst both markets will see growth, and both have their challenges, the characteristics of the GB market means it will see greater growth. But there are good opportunities in Australia if challenges of system rules, resilience, and unpredictable market value drivers are addressed.

Figure 1: Commissioned and awarded GB wind projects



Source: Cornwall Insight

The distribution of wind farms across Britain is surprisingly even, despite the best onshore wind resource being available in the north. For example, most wind capacity is found throughout England (~9.7GW) and Scotland (~8.8GW), representing 45% and 41% of total capacity respectively. This distribution reflects the recent growth of offshore wind in mostly English waters, the generosity of non-auctioned/ uncompetitive subsidy schemes like the RO and the FiT delivering returns that worked for even average load factor onshore wind projects, as well as physical challenges with exploiting higher load factor wind resource in the north, such as network capacity and planning policy.

The FiT and RO are now closed, and onshore wind has been unable to avail of CfDs in the last two allocation rounds.

Offshore wind now accounts for 39% (~8.5GW) of Britain's total wind capacity. This is a growing proportion given the scale of these projects, the end of subsidy schemes for onshore wind, and the continued support for offshore wind under the CfD scheme.

By contrast, wind currently provides 7% of demand in Australia, stemming exclusively from onshore wind, with exploration for the country's first offshore wind farm off the coast of Victoria currently underway. It is solar instead that has been the anchor technology of renewable growth in Australia, again reflecting the abundance of this natural resource across the country.

Subsidy routes for wind generation in Australia have also been less expansive than in GB. The introduction of federal and state subsidies in renewable technologies, coupled with supportive state regulatory environments, have nevertheless led to substantial new wind developments since 2015. The Large-Scale Renewable Energy Target (LRET), Victorian Renewable Energy Target (VRET), as well as the recently introduced Queensland Renewable Energy Target (QRET), have (to varying degrees) incentivised the spread of wind developments across the eastern seaboard of Australia.

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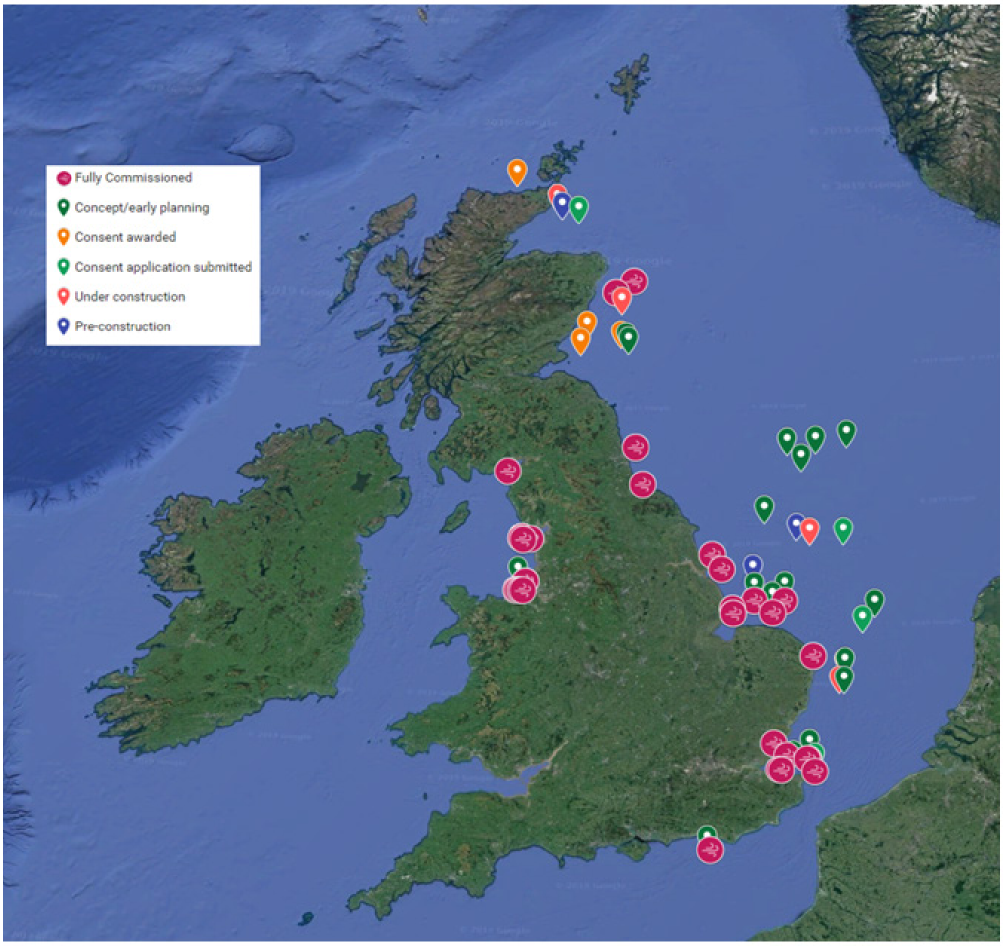
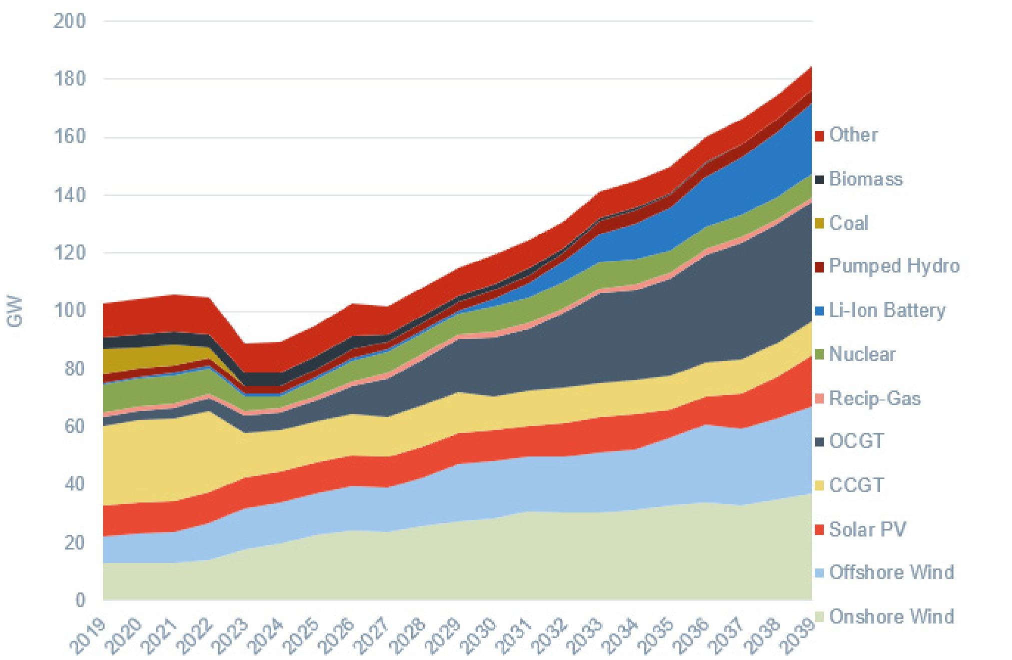
To achieve the new, legally binding decarbonisation goal of “net-zero” it is likely that a further 75GWs of offshore wind alone will need to be delivered by 2050, contributing to 369TWh of variable renewables by 2050.

Figure 2: Location of exsisting and proposed offshore wind farms



Source: Cornwall Insight

Figure 3: Forecast generation mix, Cornwall Insight's 2018 "Two Degrees" model scenario



Source: Cornwall Insight

LRET – how it works

- Implemented through a market for the creation and sale of certificates called large-scale generation certificates (LGCs)
- Power stations accredited in the LRET can create LGCs for electricity generated from that power station's renewable energy sources
- LGCs can then be sold to entities with liabilities under the LRET (mainly electricity retailers) to meet their compliance obligations
- Liable entities are required to buy LGCs from the market and surrender these certificates to the Clean Energy Regulator on an annual basis
- LGCs can also be sold to companies and individuals looking to offset their energy use and emissions voluntarily
- LRET scheme expires in 2030

The LRET has been the predominant overarching scheme across the NEM incentivising renewables development through green certificates. The costs of these certificates were around $80 last year, but have fallen to around $50, with forecasts projecting prices to plummet to around $5 by 2022.

With the federal subsidy (LRET) steeply declining in value (certificates are forecast to plummet to around $5 by 2022 driven by high volume of oncoming solar and wind capacity), many new projects are likely to be more exposed to merchant pricing models; therefore, increasing the impact of price risk on investor returns.

Contrasting a more even geographical spread of wind farms across Britain, the distribution of wind developments in the NEM has largely been in the south of the country, driven by the proximity of good wind resources to transmission infrastructure and consumers. For example, South Australia currently has the highest wind capacity with 1.8 GW of installation while Queensland - up north - has the lowest with c192 MW of installed capacity including the recently commissioned Mount Emerald Wind Farm.

Future growth

Despite the different relative starting points, both markets want to add more wind capacity in future, although again GB wishes to continue to exploit the abundant natural resource of wind with higher growth than Australia.

In GB, to achieve the new, legally binding decarbonisation goal of "net-zero" it is likely that a further 75GWs of offshore wind alone will need to be delivered by 2050, contributing to 369TWh of variable renewables by 2050. The government has already committed to an ambition for offshore wind capacity to be at the 30GW level by 2030.

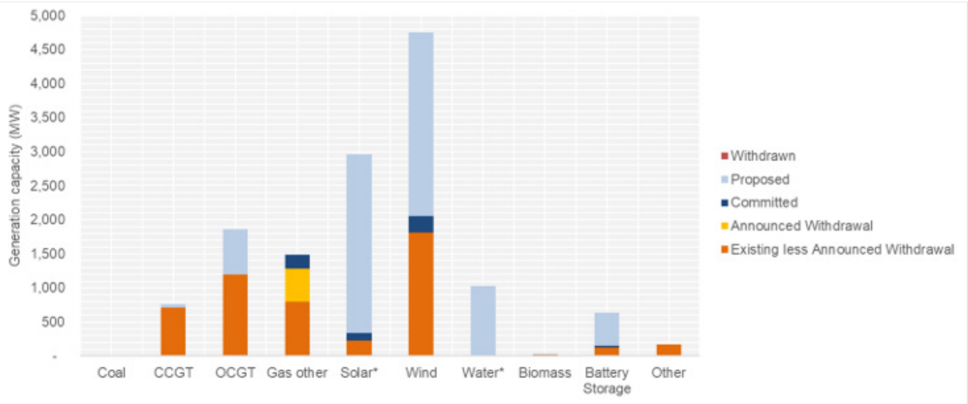
Cornwall Insight's GB power model predicts the evolution of capacity over the next 20 years. We think that under scenarios that are most compatible with the UK's climate ambition, there will be 36.9GWs of onshore wind and 30.2GWs of offshore wind commissioned by 2040.

Australia, by contrast is looking at an impressive, but much more modest growth in wind, with solar instead posing a better exploitable opportunity. Currently, over 24 wind farms with a combined capacity of ~ 6 GW are under construction. This represents around $8 billion of new investments and around 5000 jobs for the Australian economy.

With Australia's ageing coal fleet forecast to retire over the next 10 – 20 years, wind is expected to play a key role (additional ~9 GW in installed capacity by 2040) in replacements, together with storage technologies as identified in the inaugural Integrated System Plan (ISP).

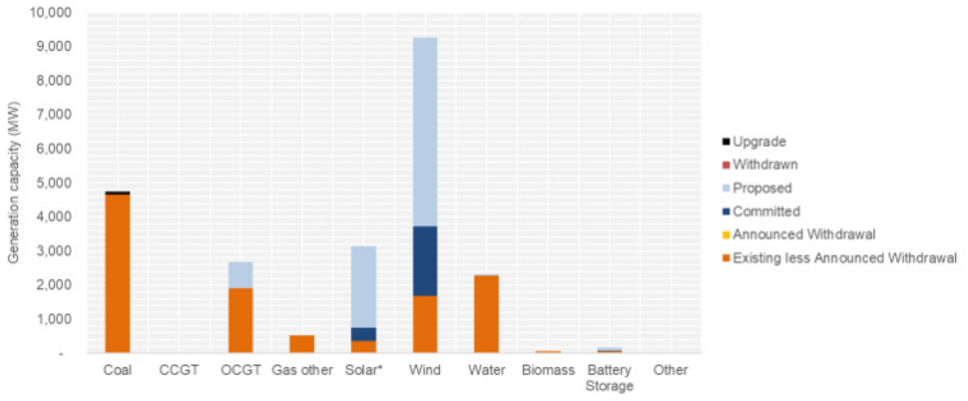
> The distribution of wind developments in the NEM has largely been in the south of the country, driven by the proximity of good wind resources to transmission infrastructure and consumers.

Figure 4: Generation capacity outlook South Australia



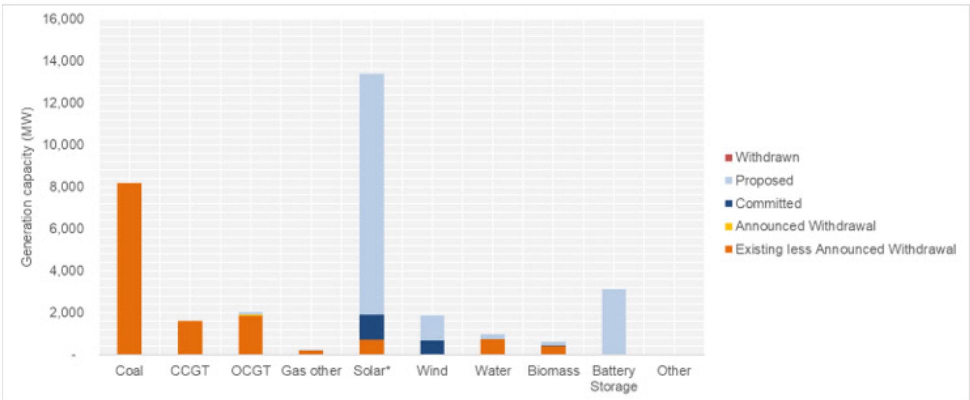
Source: AEMO

Figure 5: Generation capacity outlook Victoria



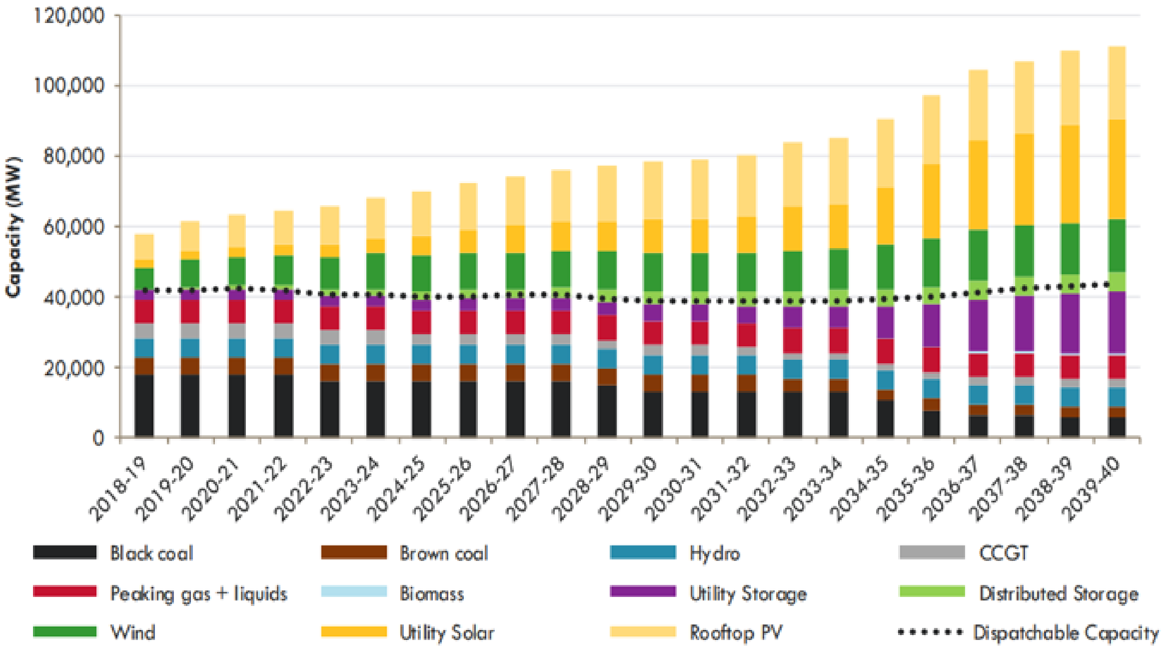
Source: AEMO

Figure 6: Generation capacity outlook Queensland



Source: AEMO

Figure 7: NEM Capacity Outlook - ISP Neutral Scenario



Source: AEMO

Market, regulation and policy factors

An interesting feature in both markets is the impact that growing levels of wind penetration will have on power prices. Price cannibalisation is depressive influence on power prices at times of high intermittent generation output, usually expressed as a percentage of the average power price in a given time period. The cannibalisation effect increases in the future as renewable technologies' share of generation mix rises due to large volumes of correlated, non-dispatchable projects flowing power onto the system simultaneously.

In GB, our analysis shows that wind will experience ever increasing levels of cannibalisation:

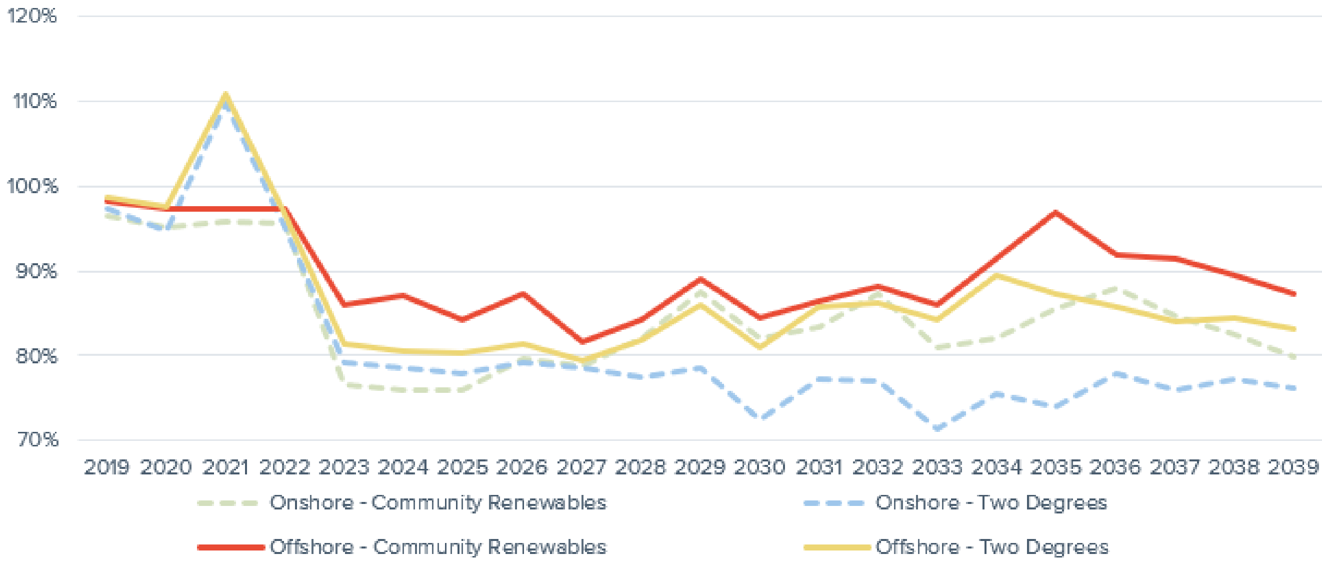
This will create an increasingly challenging investment environment for wind outside of fixed subsidy schemes such as the CfD, unless reductions in technology costs can keep pace with the long-term projected generation-weighted captured price of wind in the GB market.

This is far from a given, as whilst there is undoubtedly going to be a "floor" to the levelized cost of technology, with reducing rates of cost savings as learning rate gains flatten out, there is no such "floor" to power price cannibalisation in the GB market. Without inter-seasonal storage power prices can and will turn negative at times of high wind output and low demand, with greater frequency of these events occurring as wind becomes an increasing share of the generation mix.

The GB market has also seen greater volatility of wholesale power prices as a result of increasing penetration of renewables, and in particular wind.

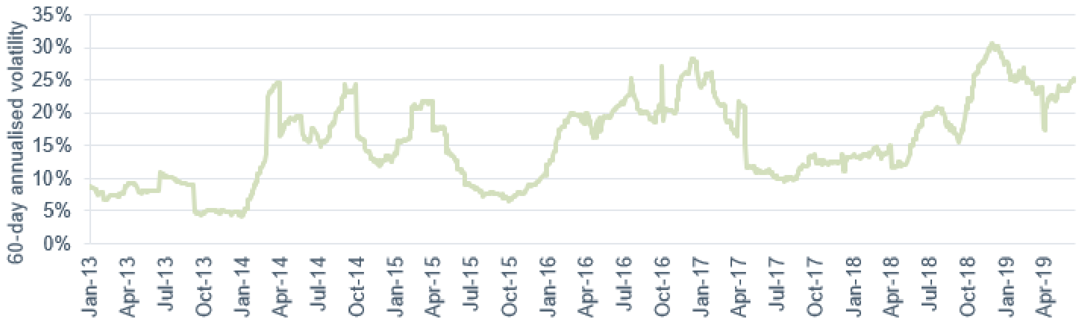
However, the capacity market, which was introduced in GB in 2014 with first payments scheduled in 2018, has dampened the impact of this. As wind drops off the system, in markets without capacity payments then thermal generators would need to capture all their fixed costs of running, when they run, through the power price. This can result in bigger "peaks" in energy-only markets as oppose to those with capacity markets, where thermal generators are able to recover an element or all their fixed costs through a capacity market revenue stream. Whilst the GB capacity market is currently suspended due a State Aid issue with the European Commission, the GB government are continuing to procure and remain confident that it will be reinstated.

Figure 8: GB wind capture prices as a % of baseload power prices



Source: Cornwall Insight

Figure 9: Front-month power contract – 60-day annualised volatility



Source: Cornwall Insight

The GB market also enjoys access to a range of system balancing services, from restorative power, to reserve and frequency services to name but a few. National Grid, the Electricity System Operator (ESO), is now also well-advanced in thinking about how best to reform balancing services in GB to reflect an increasingly wind-dominated system. This includes an examination of new inertia challenges and how best to adapt approaches generally to accommodate increases in the rate of change of frequency. Going one step beyond this, National Grid ESO is now also looking at how to positively leverage characteristics of renewable technologies in balancing service provision too.

National Grid ESO produced the System Needs and Product Strategy (SNaPS) in June 2017 in response to the changing face and needs of the transmission network. It was intended as the first step by National Grid to improve the information it provides on changing transmission balancing needs and use markets to specify how they may be met, through potential new products and services.

The growth of wind capacity in the preceding years had seen system inertia fall. Consensus forecasts show growth in the wind sector along with expectations of a decline in synchronous technologies like coal, gas and nuclear. SNaPS tries to address this future and the challenges it will create.

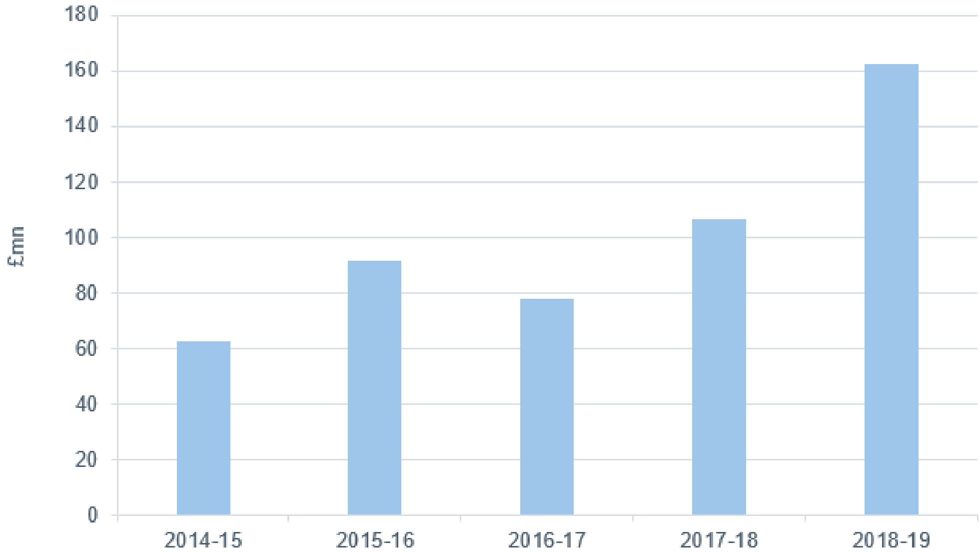
National Grid ESO, therefore is in the process of implementing several changes to the current balancing services market, specifically concerning developments to the frequency response markets, initially with the trialling of the Enhanced

Frequency Response service, along with the development of faster-reacting response products to react more quickly to changes in frequency. SNaPS is also leading to the inclusion of wind assets in frequency response markets, with National Grid ESO's second phase of its Frequency Response auction trail set for September 2019 which will see the testing of new frequency response products with parameters allowing entry for wind assets.

Whilst wind farms are located reasonably far from points of demand in the GB market, and constraint compensation to transmission connected wind projects under the Balancing Mechanism has been a well-publicised issue, there have been considerable efforts made to resolve this through major infrastructure projects such as £1bn development of the Western Link HVDC (2.2GW). This has recently commissioned and will increase flows into England and Wales and will have the effect of reducing constraint compensation.

We are also seeing increased activity from the regional network companies to procure local flexibility services as opposed to investing heavily in network reinforcement as they have traditionally done. This is as part of a deliberate longer-term transition towards becoming Distribution System Operators (DSOs).

Figure 10: Wind constraint costs – financial year 2014-19



Source: National Grid ESO

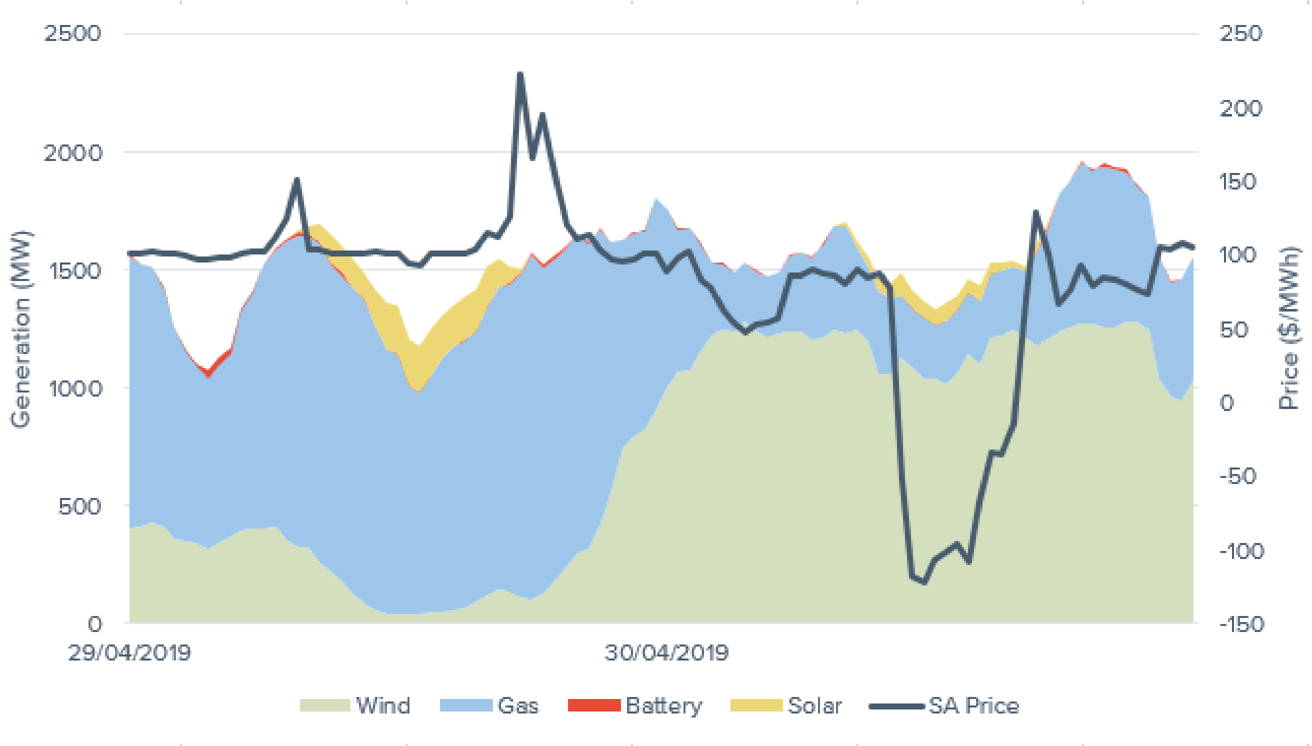
By contrast, given the lower level of deployment of wind on the system in Australia, the level of power price cannibalisation should theoretically be less, but of course, wind is not the only driver of prices on the system. We are already seeing that wind has an impact on power prices regionally in Australia, through negative prices and volatility in South Australia, particularly in periods combined with high levels of solar output and interconnector outages.

The inherent design of the Australian market is also likely to drive greater levels of price volatility than in GB. Energy only markets tend to mean that thermal generators need to capture all their fixed costs of running when they run. When wind and solar dips, and thermal kicks in with moderately strong demand, the price spikes will be bigger than those markets, like GB, where capacity payments allow for recovery of fixed costs. Left to run, this energy-only market design could deliver greater signals for flexible plant.

To some extent, this effect is being seen in certain Australian regions. When wind output is low, gas plants (slow/fast start) are usually left to fill the gap especially in SA (discounting interconnector flows from VIC), resulting in increased volatility.

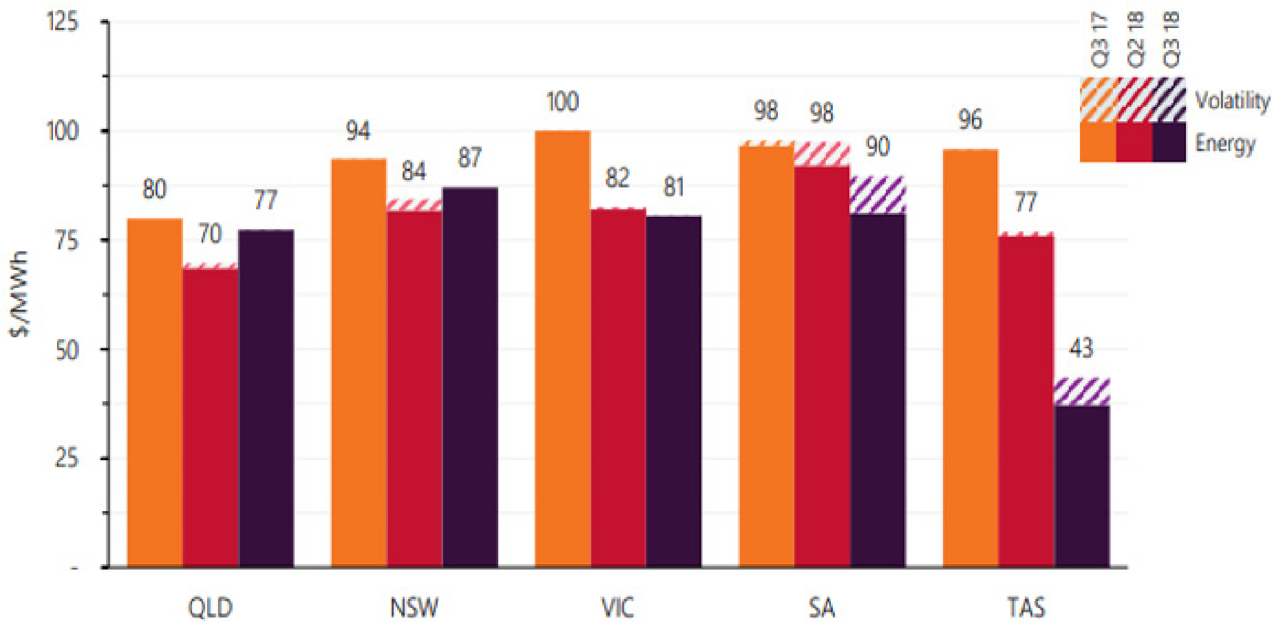
Thermal plants, however, are being kept on the bars even when out-of-the-money for reasons of system security and reliability. There is also a potential ramping issue where sudden drops in wind may not leave enough time for out-of-money thermal generators to ramp up and fill the gap. Over the past two years, AEMO has been directing thermal plants to stay on in certain parts of the network during high wind days (when they are typically out-of-the-money in the energy market) for security reasons. Gas engines are currently playing a big role in these directions. Depending on the combination of gas units online, system strength requirements from the market operator has wind generation in South Australia effectively constrained to 1460 MW, and for some combinations, wind can be constrained to a low of 1000 MW. In rare cases, however, up to 1870 MW of wind can be permitted. Current wind capacity in South Australia is c1800 MW.

Figure 11: Wind output, negative prices and price volatility in South Australia



Source: Cornwall Insight

Figure 12: Average wholesale NEM prices by region



Source: AEMO

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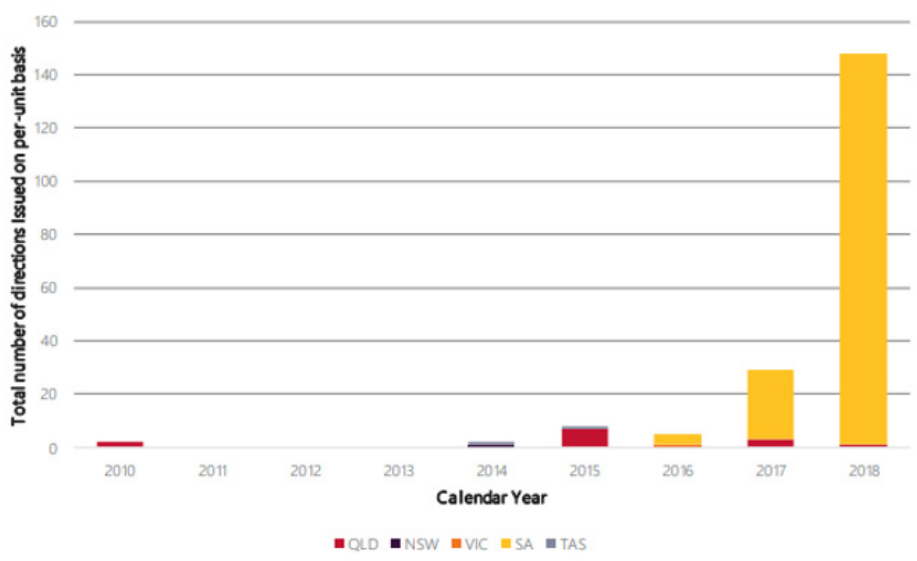
There is also a potential ramping issue where sudden drops in wind may not leave enough time for out-of-money thermal generators to ramp up and fill the gap.

When directions happen, the start costs and operating costs are eventually covered by the market, thereby increasing consumer costs. To support the development of wind and solar with minimal impact on system security, there has been some discussions by relevant Transmission Network Service Providers (TNSPs) to install synchronous condensers in certain parts of the network. In VIC, a 190 MVAr synchronous condenser is currently being installed to stabilise the network and support the largest solar project in the state.

Many wind generators today in certain areas of the NEM (SA and VIC) are also being constrained-off either for security reasons (stability constraint) or congestion (thermal constraint), with this leading to a bigger focus by AEMO on the case for new interconnection in the 2020’s as wind, solar and storage starts to take hold in the period to 2040.

The benefits case is based on reduced costs of ancillary services and constraints, as well as more efficient use of generation and load between price zones, in addition to being a cheaper means to deliver security of supply. The tension though is always how much this will cost, as, under current rules, recovery of transmission costs is covered by the load (customers). To estimate the net benefits to the end user, the regulator carries out the regulatory investment test for transmission (RIT-T) for all new transmission projects.

Figure 13: Total number of directions issued by AEMO in the NEM on a per-unit basis as at 23 September 2018



Source: AEMO

Of relevance here also is the “Co-ordination of Generation and Transmission Investments (CoGaTI)” work that has been recently undertaken by the rule maker, the Australian Energy Market Commission (AEMC). The latest report recommended a comprehensive reform package to better coordinate investment in renewable generation and transmission infrastructure, facilitating transmission and generation in the right place at the right time at an efficient cost. The recommendations complement each other and include:

- directly linking investment decisions by transmission businesses to AEMO’s Integrated System Plan, to streamline regulatory approval processes for these strategic projects
- streamlining the cost-benefit assessment for new transmission by removing duplication from the process
- managing congestion so the cheapest power can get to consumers. This involves implementing phased reforms to change how generators access and use the network, starting with dynamic regional pricing
- allowing generators to pay for transmission infrastructure in exchange for access to it – which means generators can influence and have control over transmission planning decisions, leading to better coordination of generation and transmission investment
- examining how to better align the costs of transmission, especially interconnectors, with those that benefit from the investment
- facilitating renewable energy zones through generators funding of transmission infrastructure
- making it easier for large-scale storage systems to connect to the network by creating a new registration category to support seamless integration.

In contrast to GB, balancing services in Australia are less transparent or segmented. To balance short term swings in system frequency, the Australian NEM has the Frequency Control Ancillary Services (FCAS) market. However, for longer periods of balancing due to system security, directions (as above) are issued when the energy price alone is insufficient to bring the required capacity online. Depending on the nature of the frequency deviation (regulation or contingency), registered participants can participate in each distinct FCAS market for a range of periods (6 seconds to 5 minutes) by bidding to raise or remove capacity to provide the appropriate frequency response. Analogous to the energy market, this market settles on a merit order of cost. The highest cost offer in-the-money will set the marginal price for the given FCAS category. Energy targets of participants are also sometimes reset in a co-optimisation of FCAS and energy markets to reduce overall system costs.

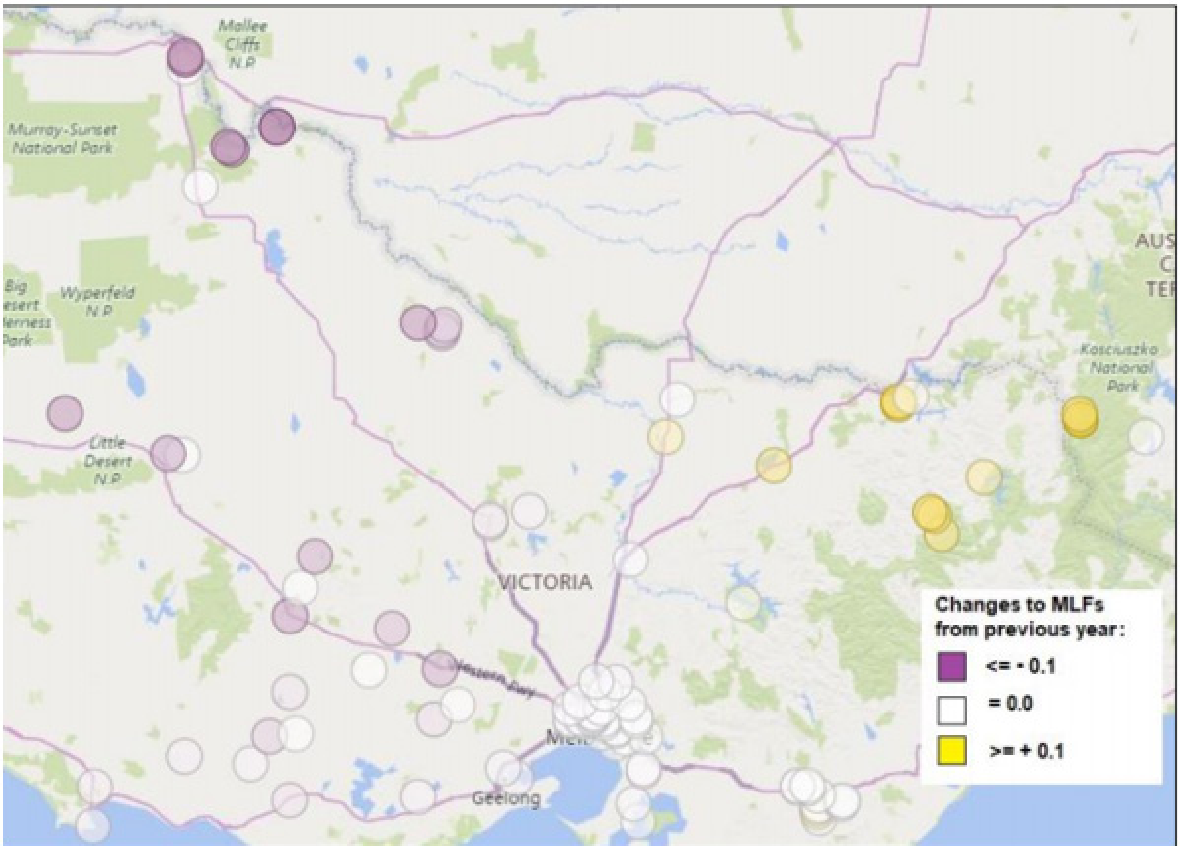
Recently, we have seen industry take the bull by the horns. Co-location of batteries with wind farms are beginning to emerge in wind projects in Australia as a way of wind developers themselves seeking to alleviate the issues. Examples include Lincoln Gap, Hornsdale and Dalyrymple North and plans at Coopers Gap. These tend to be strategically located in parts of the network where there is evident value in placing storage. These developments may have also been further encouraged by the introduction of the “do-no-harm” obligation, which in principle states that no new connection should adversely affect power system security and/or existing registered participants. However, there is also a raft of changes to incentivise baseload/thermal plants to stay on (alleviate stability constraints) as well as send locational signals to investors to incentivise them to locate their projects in less-congested parts of the network.

Probably the biggest issue resulting from the physical characteristics of the network in Australia when compared to GB, relate to losses, which are primarily a factor of the greater distance of travel between generation and consumption in parts of Australia. The hot topic in investment circles in Australia is Marginal loss factors (MLFs).

MLFs allow the calculation of actual power delivered to consumers, and their application changes the revenue from energy supplied for generators, including wind farms that tend to be built close to good wind resource but sometimes at the periphery of the network.

Currently, MLFs are calculated yearly, and a sudden change in these numbers mean an investment that reached final investment decision (FID) today, might have a significant change in projected revenues than assumed at the time of FID. And whilst they are calculated at connection points in each of the five regions and therefore vary, large changes are expected. AEMO themselves highlight that such changes will result from the impacts new technology, a changing generation mix, and rapidly developing areas of high renewable energy penetration.

Figure 14: Changes to 2019-20 MLFs in Victoria from previous year



Source: AEMO

The last update on MLFs saw this risk actualised with some investments losing as much as 22% in their merchant value due to sudden MLF changes.

Being able to predict the impact of MLFs accurately will rely on precisely and comprehensively modelling the energy system and doing so dynamically. This will allow parties to avoid relying on just AEMO annual snapshots, or on imperfect models built by energy analytical firms that short-cut the need to fundamentally model the system in an integrated fashion.

This is no small undertaking, but Cornwall Insight is developing such an approach, utilising skills and expertise that were directly applied for this purpose at AEMO, and aligning this with a broader and deeper, international suite of energy market expertise. We anticipate launching this service in Q1 2020.

Conclusions

On balance, whilst both markets will see growth, and both have their challenges, the characteristics of the GB market means it will see greater growth. But there are good opportunities in Australia if challenges of system rules, resilience, and unpredictable market value drivers are addressed and can be navigated.

The GB wind market has some distinct advantages over its Australian counterpart – no equivalent risk to MLF for investors to deal with, greater network resilience, and system services already beginning to explore the value wind can bring to delivering a smart, low carbon and flexible system. The ambition for offshore wind under the CfD is enormous and will act as a magnet for developers, investors and the supply chain.

But – outside of the CfD – the scale of the deployment of wind will lead to very significant impacts in terms of price cannibalisation. Routes to getting substitute value to allow viable projects to be developed have their limits. Subsidy-free onshore wind is most exposed to these risks.

Australia, by contrast, does have the difficult challenge of MLFs and system operators directing thermal plant in an energy-only market, as well a less resilient network to contend with. Whilst wind is unlikely to directly and materially cannibalise itself, in combination with a high output of solar, and network constraints, there is already some significant impact on power prices from time to time, particularly in South Australia.

How system operators, policy and regulation in general respond to these impacts will significantly shape the prospects for wind deployment in Australia and GB, as will how investors and developers seek to better understand and model power prices and MLFs in Australia in particular.

Our independent and trusted experts are on hand in both markets to assist with how to navigate these issues and overcome these challenges. We would be delighted to hear from you to discuss how we can help in more detail.

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