Assessing the viability of Energy-Only Markets with 100% Renewables

An Australian National Electricity Market Case Study

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Motivations

Numerous studies have now illustrated the technical potential for electricity systems to derive 80–100% of their energy from renewable energy sources. A key objective of these modeling efforts has been to find renewable mixes that ensure system adequacy by meeting the required reliability criterion for each jurisdiction. Most studies to date have focused on the technical ability of a system to supply reliable electricity; few have directly considered the market implications. As such, these studies typically raise, but do not themselves address, questions regarding the viability of the present market arrangements with 100% renewables.

Efficient wholesale electricity markets should drive preference revealing bidding where generators offer the majority of their power at their short run marginal cost (SRMC). However, most renewables have very low SRMCs, which in a competitive market is likely to lead to an increasing proportion of low priced periods. This has been termed the "Merit Order Effect", and it has been observed in many jurisdictions to date. Combined with concerns around the variable availability of some renewable generation types, this has led to suggestions that energy-only markets may need to be augmented with capacity remuneration mechanisms as their renewable penetration grows.

The analysis presented in this paper aims to explore the issue of system adequacy in a 100% renewables market, meaning the market mechanisms that manage the quantity of installed generating capacity, and the adequacy of this installed capacity to meet anticipated demand. Specifically, we ask whether the mechanisms for system adequacy in energy-only markets are likely to remain sufficient in a 100% renewables system.

Research Performed

The Australian National Electricity Market (NEM) is used as a case study. This energy-only market applies a very high Market Price Cap (MPC) of $13,500/MWh (in 2014-15). Market participants employ hedging mechanisms to manage spot price risk; retailers in the NEM carefully procure a portfolio of derivative contracts to cover the majority of their anticipated customer load, or vertically integrate to supply generation with their own assets. The level of the MPC is the main "lever" by which regulatory bodies can adjust the market to meet the required reliability standard (0.002% unserved energy per annum, measured over the long term). A higher MPC will tend to incentivize greater investment in capacity, even if market participants forecast that the MPC will occur only rarely. For example, all else

being equal, retailers will be more willing to enter into long term contracts to manage the escalating risk if they are exposed to purchasing on the spot market at the higher MPC.

With a move to a high renewable market, and a corresponding reduction in median prices, the proportion of revenue earned during extreme pricing events will likely need to increase significantly in order to maintain a certain reliability standard. This analysis aims to provide an order of magnitude estimate of the amount by which the MPC might need to increase, providing an indication of whether this is likely to be so high that it becomes a prohibitive barrier to the successful operation of an energy-only market with very high levels of renewables.

Historical hourly price data from the NEM was analysed and manipulated to produce a representative price curve for a 100% renewable market. This was done by setting all prices below $300/MWh to zero, implicitly assuming that these periods were representative of competitive market operation, and therefore would experience low prices in a market consisting entirely of low SRMC generation. The price curve was then "stretched" as necessary to bring aggregate revenues to the level required for cost recovery in a 100% renewable system.

CONCLUSIONS AND POLICY IMPLICATIONS

Results suggest that existing energy-only market mechanisms (such as those applied in the NEM) have the potential to operate effectively in a 100% renewables scenario, but success will rely upon two critical factors.

Firstly, an increase in the MPC is likely to be required. Preliminary analysis suggests this may need to increase from the present $13,500/MWh in the NEM to the range $60,000 to $80,000 /MWh. This is a significant increase, but it is not outside the realms of possibility. For example, analysis has indicated that the average marginal value of customer reliability is $95,000/MWh, suggesting that the present MPC is far too low to represent customer preferences. Alternatively, comprehensive demand side participation could allow each customer to select their preferred level of reliability and associated cost, removing the need for an administratively determined MPC.

Secondly, a liquid and well-functioning derivative contracts market will be essential to allow generators and retailers to hedge increased market risks successfully. Such a market is already essential in the NEM, given the high MPC at present. If the MPC is increased, the potential risks of operating in the market will increase, and the contracts market will become even more important to allow generators and retailers to hedge successfully. Therefore, it may be pertinent to make it a priority to increase the level of monitoring and transparency in the contracts market.

Based upon this analysis, at this stage it appears that the introduction of direct capacity remuneration mechanisms in energy-only markets may be premature. Instead of dramatic market reform, an approach of careful monitoring, with a particular focus on promotion of demand side participation and strengthening of the contracts market, appears appropriate at this stage.