Market Integration with Energy-Only Markets and Renewables: Lessons of Experience from Australia

Rabindra Nepal (rabindra.nepal@cdu.edu.au)
School of Business, Charles Darwin University, Darwin, Australia

Tooraj Jamasb (tooraj.jamasb@durham.ac.uk)
Durham University Business School, Durham, United Kingdom

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I. Introduction

The establishment of wholesale electricity markets has been one of the hallmarks of market-oriented electricity sector reforms and restructuring that started in the early 1990s. The standard model of liberalization included establishing wholesale and retail competition, vertical separation of the distinct generation, network, and retail activities and incentive regulation of electricity networks. Later a deepening of competition required fuller physical and financial integration of the separate national or regional electricity markets. For example, creating a common and integrated wholesale market for electricity remains a work in progress that started in the second half of 1990s in the EU while Australia has focused on creating an efficient and integrated National Electricity Market (NEM) since 1998.

This article draws upon from the experiences with market-integration, renewable energy and network regulation from the NEM merging the findings from recent studies in Nepal and Foster (2013); Nepal, Jamasb and Menezes (2014); and Nepal and Foster (2015). We discuss the context within which renewable energy development and market integration can be implemented as complementary policies in energy-only markets, citing Australia as a specific case and with lessons for the EU.. The NEM provides an interesting case study since it is one of the most transparent energy-only wholesale electricity markets and is located in an island economy while it is also poised for greater uptake of renewable energy. The lessons from the NEM can be important for other regions such as the EU, which is predominantly an energy-only market moving towards greater integration of renewables and electricity markets.

Section II of the article provides an overview on the structure and organization of the NEM. Section III presents the facts and underlying reasoning on which the development of renewable energy and electricity market integration can be complementary policy objectives in one of the largest interconnected energy-only markets in the world. Section IV concludes and highlights the broader implications for other energy-only markets especially in the EU.

II. The National Electricity Market (NEM)

The NEM was established in 1998 in response to the overall restructuring of the Australian electricity sector. The NEM is a gross pool arrangement for wholesale electricity trade in Australia and operates a deregulated market in the physically interconnected but separate regions of New South Wales (NSW), Victoria (Vic), Queensland (QLD), the Australian Capital Territory (ACT), South Australia (SA) and Tasmania (TAS). Tasmania joined the NEM in 2005. The exchanges between the electricity generators and consumers take place in a spot market through a centrally coordinated dispatch where the output bids from all generators are aggregated and instantaneously scheduled to meet demand. A dispatch (or spot) price is determined every five minutes and six dispatch prices are averaged every half-hour to determine the spot price for each trading interval in each of the regions of the NEM.

The dispatch price is the energy-only price and does not contain any components for capacity such as 'capacity payments'. The National Electricity Rules (the rules) set a maximum spot price (market price cap) of AUD$13,100/MWh and a minimum spot price (market price floor) of –AUD$1000/MWh for the financial year 2013-2014. The market price cap prevents the wholesale spot prices rising too sharply during extreme peak loads or at times of reduced base load capacity. The negative market floor price allows generators to pay to stay online when the cost of staying online is lower than the cost of shutting down and re-starting their plants. Hence, the minimum spot price guarantees dispatch by bidding at negative prices when a generator is too costly to turn off.

The generation mix in the NEM is dominated by low cost baseload generation. Queensland has installed capacity that amply exceeds the region's peak electricity demand is a net exporter in the NEM. Victoria and Queensland significantly benefit from low cost baseload capacity making them also net exporter of electricity. New South Wales is a net importer of electricity and has limited peaking capacity at times of high demand. NSW mostly relies on local baseload generation. SA relies heavily on electricity imports although new investment in wind power has reduced its import dependency since 2005/06. For example, the registered capacity of wind and solar in South Australia in 2013 was 30% of total capacity while 2,987 MW of wind capacity will be added (equivalent to 61% of the total generation mix) by 2023. TAS is also a net importer of electricity although it became a net exporter in 2011/12 for the first time since its interconnection with the NEM due to greater water availability and installations of new gas fired generation.

The Australian Energy Regulator (AER) determines the maximum revenue (*revenue caps*) that the transmission and distribution companies can recover from the network users in Queensland, Australian Capital Territory (ACT) and Tasmania. Likewise, AER sets the maximum network tariffs that distributors can charge consumers (*price caps*) in New South Wales, Victoria and South Australia. The transmission and distribution networks remain state-owned in Tasmania (TAS), New South Wales, Queensland, and part of the Australian Capital Territory (ACT). Victoria and South Australia have fully privatized electricity generation. Victoria corporatized and privatized its electricity networks between 1995 and

1999 and both the transmission and five distribution networks are now in private ownership. South Australia has privately owned transmission networks while the distribution network is leased to private interests.

There are six operational interconnectors among the five electrically connected states in the NEM. There are two interconnectors operating between (NSW-QLD) and (SA-VIC). However, (VIC-TAS) and (NSW-VIC) are connected by one interconnector. There is no direct interconnection between QLD-SA and NSW-SA. The existing interconnectors largely follow the state boundaries covering a distance of more than 5000 kilometers, running from Port Douglas in Queensland to Port Lincoln in South Australia. Hence, NEM is one of the longest interconnected power systems in the world. Geographical constraints as an island economy have led to the infeasibility of cross-border interconnections to date in the NEM.

III. Market Integration Outcomes

Despite more than 14 years since the establishment of the NEM, wholesale electricity price differences persist across the Australian states. The average daily prices are the lowest in VIC and QLD while SA has the highest average price followed by TAS and NSW. The wholesale price differences between SA and VIC are the lowest among the interconnected states. The persistent differences in wholesale prices can be attributed to the presence of network constraints across the regional interconnectors impeding the wholesale market integration process in the NEM. The Australian Productivity Commission had expressed concerns about under-investment in transmission networks and regional interconnectors. In response, the Australian Energy Regulator (AER), in the past, has recognized the significance of congestion costs in the NEM and has allowed more investments in the transmission network.

Network constraints (congestion) occur due to physical limits to the network's transfer capability. Network congestion can segment the market and increase the wholesale electricity price by displacing low price generation with more expensive generation. Congestion can also lead to market power in the segments of the market. Finally, congestion also promotes inefficient electricity trade flows between the regions as electricity cannot be stored and 'demand and supply' have to be balanced in real-time. The existing network constraints due to underinvestment in interconnectors act as a barrier to the wider and much expected development of renewable resources, such as wind.

The wind resources in Australia are mostly concentrated in the regions with the lowest electricity demand. These include South Australia, Tasmania and Victoria while Queensland and New South Wales exhibit high demand for electricity but with low concentration of wind resources. For example, South Australia can reach a wind penetration (percentage of average generation) of almost 70% followed by Tasmania at 50% while Queensland and New South Wales have wind penetrations of around 1% and 11%, respectively. The lack of adequate interconnection can prevent the development of new wind power in the

resource rich regions and curtailment of existing capacity. The costs in terms of lost revenue to the wind power plants as a result of curtailment are large and hamper meeting the national renewable energy targets.

Furthermore, wind projects are gradually moving to less congested parts of the networks across Queensland and New South Wales but with lower quality wind resources and eventually at higher costs. Expanding interconnectors and increasing export capacity from low demand regions (with high wind potential) to high demand regions is important to reap the security of supply and sustainability benefits from wind generation in the NEM. Improving market integration by increasing the cross-border power flow will also lead to benefits through efficiency gains, both allocative and productive, as well as dynamic efficiency gains because a well interconnected market will facilitate the optimization of investments in both generation and transmission over time across the NEM market.

IV. Conclusions and Policy Implications

The most important factor for market integration is to physically and sufficiently connect the regional electricity systems through transmission grid and interconnectors. The transmission capacity and prices will then determine the volume of trade between the different regions. The EU is striving to create an integrated electricity market in Europe while also aiming to significantly increase the share of its energy from renewables. However, as the EU has identified, the European transmission and distribution networks need to be adapted and extended to facilitate power flows from generation source to end users across borders. Achieving this objective will require substantial investments. The island economies with isolated electricity markets in Northern Ireland and the Republic of Ireland are also aiming to increase electricity integration with the continental electricity markets under the EU 'Target Electricity Model 2014'. In addition, the Republic of Ireland has a target to generate 40% of its electricity from renewables by 2020.

The NEM experience with market integration suggests that harmonization of regulatory and institutional frameworks and electricity market regulations can be coupled with private ownership of assets to improve market integration across energy only markets poised for large intake of renewables in the wholesale trade. The case of NEM suggests that a solid regulatory framework can be a pre-requisite for the necessary infrastructure investments to take place in time for 2020. For example, the AER recognized the significance of congestion costs across the regional interconnectors and allowed higher transmission investments in regulatory decisions in 2009.

The regulatory test for transmission expansion and network planning in the NEM is based on identifying investment options that maximizes the net economic benefits. However, the EU currently has 28 different national regulatory frameworks. A fragmented regulatory system based on uncoordinated national policies can become an obstacle in achieving an internal

electricity market. Achieving an integrated European market is challenging given the lack of adequate interconnections and inconsistency in market design and rules among the member countries while aiming to increase the share of renewable energy.

The Australian experience reveals that the large-scale integration of renewable energy and integrating the regional electricity markets can be complementary and not necessarily conflicting policies under adequate transmission capability in energy-only markets. The EU can improve the number and capacity of interconnections in order to achieve a more resilient energy-only market and to implement the Energy Union, currently uncertain due to inadequate investments in electricity networks. The regulatory framework for the wholesale markets and networks will be important for facilitating trade across the interconnectors and thereby improve market integration among energy-only markets with high share of renewable energy. The EU member states need to better harmonize their regulations and cooperate more to attract economically beneficial investments for achieving the Energy Union.

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