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Optimising VRE plant capacity in Renewable Energy Zones

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Australia's National Electricity Market (NEM) has experienced significant growth in renewable investment commitments over the period 2016-2021. A subset of these new renewables have experienced serious entry frictions, which in turn created a divisive debate over the durability of the NEM's multi-zonal, energy-only market design. Proposals emerged to alter Marginal Loss Factor (MLF) calculations, introduce capacity mechanisms, and shift from multi-zonal prices with MLF multipliers to nodal pricing, to better coordinate generation and transmission investment. However, among the central problems facing the NEM's transitioning plant stock is a lack of VRE network hosting capacity, which will not be resolved by a change of market design.

One NEM-wide policy response with promising prospects for dealing with coal divestment and VRE entry are Renewable Energy Zones (REZ). REZ's are regional areas within the NEM characterised by good wind and solar resources which currently have inadequate (or the absence of) transmission network infrastructure. REZ's are a means by which to develop much needed VRE network hosting capacity at scale, with the underlying intention being to connect multiple parties that would otherwise act independently – thereby avoiding duplication and optimising scarce network resources.

Sub-national governments in each of the NEM's three dominant regions (Queensland, New South Wales, Victoria) have advanced plans to develop REZ. A key question that logically follows is 'who pays' for scale-efficient, but initially under-utilised network capacity? Leaving aside REZ developed as a 'regulated asset' to form part of the shared network and be end-use consumer funded, non-regulated REZs have potential to be developed and underwritten by a transmission planner, VRE generators or government under varying levels of VRE entry uncertainty.

Using an optimisation model comprising 1500MW of transmission network infrastructure, this article examines various definitions of a 'fully subscribed REZ' given the portfolio benefits associated with complementary wind and solar plant in Southern Queensland. We also examine the conditions by which various proponents would sponsor a non-regulated REZ. When 'maximising output' forms the objective function, full subscription is achieved by developing ~3400MW of solar and wind in roughly equal proportions, accepting that some level of curtailment is an economic result. Conversely, full subscription in which the combined cost of the REZ and VRE plant is minimised is achieved at ~1800MW of VRE. If maximising net cashflows forms the objective function, VRE plant development is complicated by the dynamic nature of spot prices. Specifically, in early stages of VRE development solar is preferred but as its market share rises and value of output falls, wind investments dominate holding technology costs constant.

REZ charges flowing to VRE generators are sensitive to utilisation of the transmission infrastructure. The unit cost of REZs falls sharply with its utilisation. Some minimum level of utilisation is therefore critically important. REZ pricing where generators carry the risk of underutilisation is likely to be viable with 1000MW+ of foundation plant commitments. Foundation plant commitments significantly lower than this may face punitive REZ charges relative to the market value of VRE output, and thus pricing where a transmission planner or government carries the risk of underutilisation, becomes important. Consequently, the counterparty most likely to house the risk of transient REZ underutilisation runs counter to the inherent risk appetite of VRE generators, transmission planners and governments, respectively.

Above all, REZ are a means by which to help guide forward market commitments and produce greater coordination between generation and transmission plant investments. The choice of structure for a market REZ, and in particular, who carries the capacity risk, is not only critical in terms of funding, but also the rights given to that participant in exchange for the underwriting the oversized scale-efficient capacity. These rights are likely to factor into decisions around the generation mix of wind and solar resources (and the timing of them), the key question of cost (REZ charges) versus congestion tolerance, and therefore ultimately REZ utilisation and optimisation.

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