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What changes to capacity market design are required to assist in achieving carbon neutrality and to effectively prioritise renewable energy generation in a multi-source or hybrid procurement?

Right now, up to 75% of the electricity flowing on the Ireland and Northern Ireland electricity grid at any point in time can come from variable non-synchronous renewable sources. The Ireland and Northern Ireland power system is the first in the world to reach this level, overcoming major technical challenges associated with integrating electricity from wind farms, solar farms and interconnectors that link it with other countries. We are working towards 95% by 2030 in order to achieve Government renewable energy targets. This will be achieved through the delivery of the Shaping Our Electricity Future programme of work[1].

Ireland and Northern Ireland have a Capacity Market based on centralised auctions of reliability options. Capacity providers including conventional thermal, hydro, interconnectors, batteries, wind, solar all compete alongside each other to provide reliable capacity to the power system. The approach taken in Ireland and Northern Ireland is to design the market for energy, capacity and system services around the needs of the power system, which in the case of a Capacity Market is reliability, rather than basing the design on any one technology required to meet those needs.

Capacity providers apply to qualify for Capacity Auctions and EirGrid and SONI apply marginal de-rating factors to each technology class to convert the capacity of the unit into 'reliable capacity' or de-rated capacity. So, at the beginning of the process, we have a set of heterogeneous technologies with very different levels of reliability, at the end we have a set of units all providing the same homogenous product, which is de-rated capacity. This enables wind to compete with interconnectors to compete with conventional thermal units etc. on a level playing field, where the contribution each unit makes to reliability is captured and remunerated accordingly.

De-rating factors are calculated by the System Operators based on the change in Loss of Load Expectation from a marginal increase in the capacity of unit. The main determinants of derating factors for a particular unit are: forced outage rate, scheduled outage rates, size, daily and annual energy limits. Wind and solar are represented using historical output profiles (matched to the demand profile for the relevant year).

Figure 1 illustrates the relationship between technology class which is characterized primarily based on outage statistics, size and the resultant de-rating factor. As can be seen, size has a significant impact on the contribution to reliability of unit. This is size

[1] For more details see "Stability Analysis on the Power System of Ireland and Northern Ireland for Operation with 75% Inverter-Based Resources" C4 PS3 11016, IBRAHIM et al. C4 Poster Session on Wednesday.

of these units relative to a peak of approx. 7 GW. As units increase in size, the failure of these units results in greater loss of load expectations and reduced reliability.

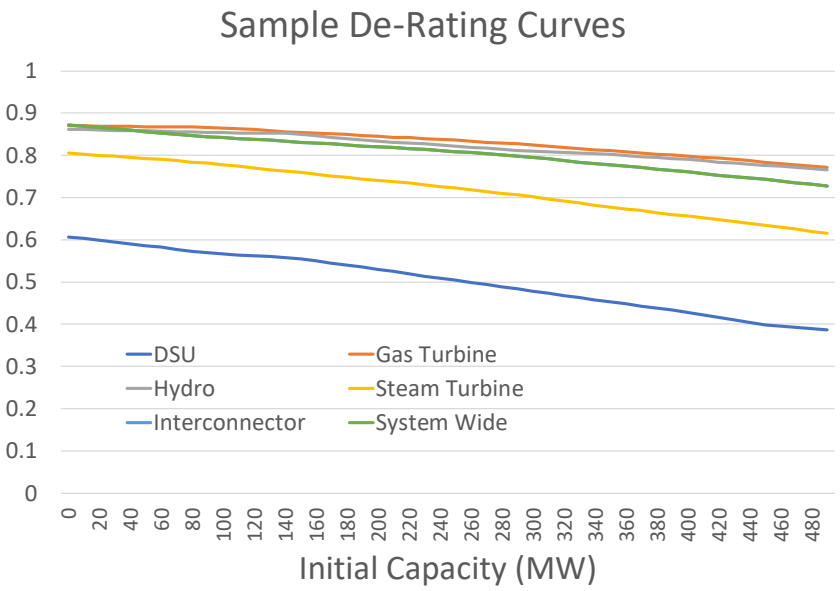

Figure 1 - Sample De-Rating Curves from Ireland and Northern Ireland

Wind is a highly variable resource and unlike hydro, solar and tidal, it does not conform to any daily or seasonal patterns. It does, however, blow a reasonably constant amount annually. The challenge of decarbonizing the power grid in Ireland and Northern Ireland is to ensure that controllable resources capable of meeting the demand are available when wind and solar output is low.

By using marginal de-rating factors that reflect the loss of load probability of the portfolio against a net demand profile, the capacity market values each unit in accordance with its ability to mitigate periods of high net demand.

Based on the dynamic price signals from the balancing market, as demand is incentivised to move to periods higher wind and solar output, the value of wind and solar in providing reliable generation will increase as the correlation of these resources with demand increases. In this regard, we can envisage a highly reliable power system based on renewable resources. The challenge is how to move the demand to periods of high wind and solar – demand response, storage and interconnection offer a balance of low carbon options.

In Ireland and Northern Ireland, we are seeing significant increases in the levels of these resources and the marginal value of each resource is updated based on latest penetrations of each technology class. As amounts of a particular resource increase, there can be a decrease in its marginal contribution to reliability. This provides a signal to the market that there is sufficient levels of a particular type of technology in terms of its contribution to reliability.

Is this the role of capacity markets?

It certainly is. Capacity markets form part of the revenue stream for renewables insofar as they contribute to reliability (which will increase as demand moves towards low variable cost renewables). Of equal importance is that capacity markets are

needed to provide for the capacity that is needed to meet the net demand – in a longer term zero carbon world this is demand response, storage, interconnection and flexible hydrogen / biogas fired turbines.

Figure 2 shows the outcome of the most recent Capacity Auction for 2025/2026, where we can see the proportion of different technology classes that were successful.

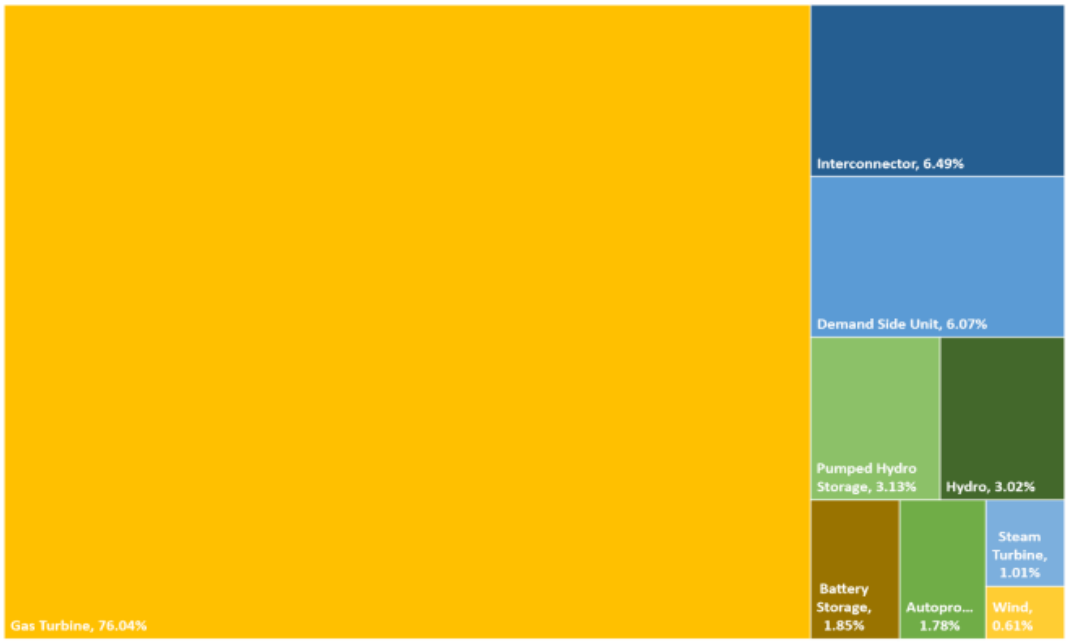

Figure 2 - 2025/2026 T-4 Final Capacity Auction Results

Is there a possibility of using a double-sided auction in the capacity market where multiple buyers and multiple sellers bid simultaneously? What is the possible market design in such a case including price discovery?

In Ireland and Northern Ireland, a double-sided auction is used; however, the demand curve is based on TSOs forecast demand and is set by the Regulatory Authorities i.e. the amount that demand wants to buy is set using a regulated process. See Figure 3 for an illustration of the regulated demand curve and the submitted offers by capacity providers.

In terms of price discovery, the Ireland and Northern Ireland approach to capacity markets enables greater price discovery in respect of generator units. It does not, however, give any insight into the value that end users place on reliability. Instead, this is estimated in terms of the Value of Lost Load by the Regulatory Authorities.

It is conceivable, even desirable, that retail market suppliers and large energy users could bid for capacity in a capacity auction. This would enable end users to communicate in their bids the security standard that they need. Having a market with sufficiently refined pricing mechanisms such that reduced reliability is reflected in the energy price, would be a highly complex undertaking.

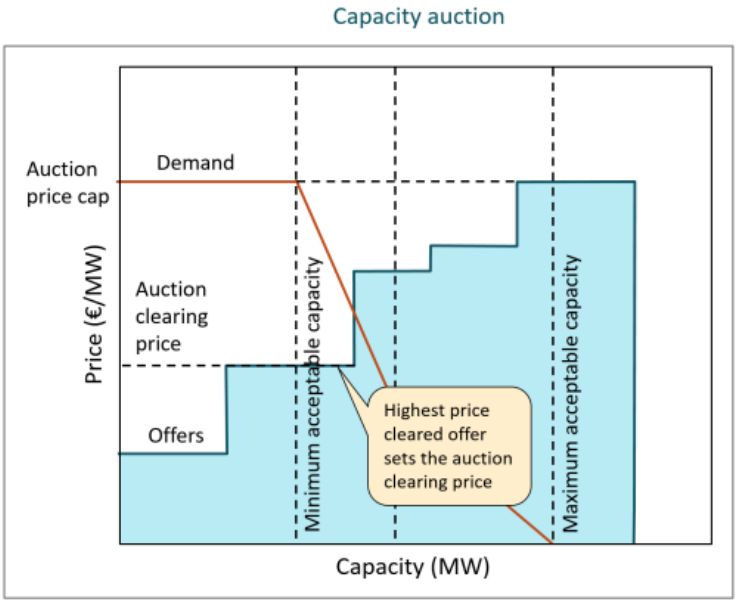

Figure 3 - Capacity Auction Supply and Demand Curves

In Ireland in particular, there is a significant increase in demand forecasted due to the connection of data centres as can be seen in Figure 4 from the published [Generation Capacity Statement 2021-2030]. Balancing the needs of all sectors of society as we transition to a zero-carbon economy is complex and enabling these sectors to bid for a level of reliability may offer a means of striking the right balance.

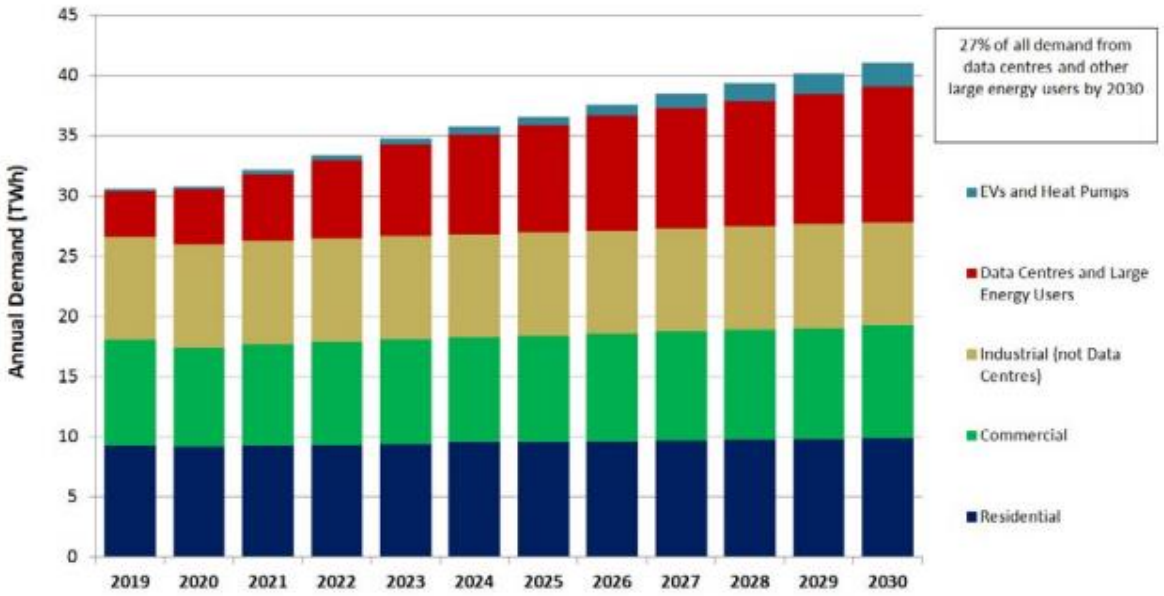

Figure 4 - For the Ireland Median Demand scenario, this illustrates the approximate split into different sectors. EirGrid estimate that 27% of total demand will come from data centres and large energy users by 2030.

As customers consider different ways of meeting their energy needs from roof top solar to sustainable energy communities, it will be important to ensure that the reliability of the grid, which is delivered by significant amounts of infrastructure, is appropriately valued. This will ensure efficient planning and investment in the coming years and decades as we decarbonise our economies. Allowing end customers to bid for capacity (kW) as well as energy (kWh) would allow them to express the value that they place on the reliability provide by the grid.