



MARKET DESIGNS FOR A RELIABLE ELECTRICITY GRID

GROWING CONCERNS OVER GRID RELIABILITY AND RESOURCE ADEQUACY

Many electricity grids have moved towards more liberalised, competitive market structures, while also seeing rapid growth in variable renewable energy (VRE) sources such as wind and solar power. This change in grid composition has created challenging market conditions for thermal plant in several regions, due to falling operating hours and wholesale energy prices. Rapid retirement of coal plant in particular, often combined with insufficient investment in new thermal capacity, has led to widespread reassessment of the ability of electricity markets to deliver grids with adequate reliability, resilience, and resource adequacy. In addition to providing dependable back-up capacity to intermittent renewable generation, thermal plant provides key grid services including inertia, frequency control, and reactive power, which can be difficult to obtain from VRE plant. There is therefore growing interest in expanding the role of mechanisms which can compensate plant capabilities beyond the basic delivery of energy, such as capacity, ancillary services, and flexibility.

CAPACITY MECHANISMS PROLIFERATE

Forms of capacity mechanism have been increasingly used to meet concerns over future resource adequacy and falling reserve margins. In particular, the centralised capacity auction model widely used in the USA has recently been adopted in Great Britain and Poland, despite EU concerns over their impact on market harmonisation. Such schemes procure capacity several years in advance, but can be difficult to steer towards specific policy targets. In the PJM grid (USA), aspects of key auction parameters have led to excess capacity procurement, driving significant deployment of combined cycle gas turbine (CCGT) capacity. On the other hand, the GB capacity market has experienced very low clearing prices and unwanted investment in small combustion plant rather than sought-after investment in new CCGT. In Poland, higher gas prices and a relative lack of competition in the market has led to higher clearing prices, helping to drive a wave of new, more efficient coal plant and upgrades to existing plant. Capacity markets are generally beneficial to the viability of existing thermal plant, but questions remain over how they can best address subsidised energy resources and drive capacity with the necessary characteristics for grid reliability.

Decentralised capacity obligations are an alternative option, such as the Retailer Reliability Obligation recently adopted by Australia's National Energy Market (NEM). This requires energy suppliers to demonstrate contracts with adequate firm capacity in the event of forecast periods of scarcity.

ENERGY-ONLY MARKETS CHALLENGING FOR COAL PLANT

Energy-only markets rely on high prices during periods of scarcity to drive investment in new generation. This approach is exemplified by the ERCOT grid (Texas), which employs a 'price adder' to enhance market price signals when available reserves are low. However, growing demand, retiring coal plant, and insufficient investment in new generation have recently pushed reserve margins well below recommended levels. Germany has also adopted an energy-only approach, and currently has adequate capacity, but the country has also introduced several 'out-of-market' reserves of thermal plant as an insurance against

scarcity events and to alleviate regional transmission constraints. Coal plants can struggle to derive added value from such energy-only markets, which are better suited to highly flexible plant able to start up in periods of scarcity.

ANCILLARY SERVICES GET FASTER, BUT NOT ALWAYS MORE VALUABLE

Growing load forecast uncertainty associated with high levels of VRE penetration has been expected to increase the demand and value of many grid services, but in regions such as ERCOT and Germany, the size and cost of grid balancing reserves have often remained static or even fallen. This effect is attributed to parallel improvements in wholesale market design, wider-area procurement, and increased competition from new technologies. For more constrained grids, shortages of inertia and fast frequency control can become a real issue at high VRE capacities. In particular, rapid coal plant retirements in Australia's NEM have resulted in undesirable price spikes for frequency control services, while falling inertia levels are being closely monitored in ERCOT and GB. There is a general trend towards developing faster frequency control services, and greater marketisation of services such as inertia and reactive power. However, these are likely to remain of limited value to thermal plant.

A much greater impact on system costs has been associated with the growth in constraint management operations in some regions, due to the tendency for wind plant to be located far from demand centres. In Germany and GB, such costs can exceed all other grid balancing costs combined, primarily due to the cost of curtailing subsidised generation.

ASIAN MARKETS IN TRANSITION

Many countries are still in the early stages of moving towards more competitive energy markets, and simultaneously undertaking significant VRE expansion programmes. These regions face many of the same challenges in adapting market structures to support thermal plant, often combined with additional challenges of fast-growing demand, capacity shortages, and less developed grid infrastructure.

India has recently taken major steps towards developing more centralised, merit-order based dispatch for inter-state power plants, aimed at reducing unnecessary curtailment of solar power, as well as trialling forms of frequency regulation in coal and hydro plant. Facing similar challenges with the excessive curtailment of wind power in northern provinces, China has introduced a successful market-based incentive for turn-down of coal plants in the region, while also establishing pilot frequency control markets in some provinces.

KEY MESSAGES

- Thermal power plant will retain an important role in providing firm back-up capacity and key grid reliability services;
- Markets are adapting to the needs of evolving grids, but the pace of change can be demanding in areas with very rapid thermal plant retirement;
- Ensuring resource adequacy is challenging and generally requires some form of market intervention – capacity markets help avoid price spikes and scarcity events;
- Grid balancing services are growing in importance, but their value remains limited and highly dependent on evolving markets and grid infrastructure;
- Although gas power is becoming a dominant provider of grid stability and flexibility in several liberalised markets, coal power will continue to play this role in many of the emerging markets of Asia.

The IEA Clean Coal Centre is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Clean Coal Centre do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

Each executive summary is based on a detailed study which is available separately from www.iea-coal.org. This is a summary of the report: Market designs for a electricity reliable grid by Toby Lockwood, CCC/302, ISBN 978-92-9029-625-6, 132 pp, March 2020.