WHITEHELM CAPITAL

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THOUGHT LEADERSHIP:

INFRASTRUCTURE INVESTING IN A DISRUPTED WORLD

Part 2: POWER SYSTEMS

INFRASTRUCTURE INVESTING IN A DISRUPTED WORLD

POWER SYSTEMS

As discussed in the first article in this series, disruption is occurring across the globe and across a wide variety of markets and the infrastructure sector is no different. This article focuses on power systems and how technological, environmental and sociological factors are changing the way the sector works.

From a change in fuel mix as climate change and pollution encourage a move away from fossil fuels, to changes in the way the power system operates in concert, the whole sector is undergoing an enormous transformation, which is affecting infrastructure investments across the energy spectrum.

Coal Fired Generation

In order to comply with the goals agreed under the Paris Climate Agreement, an intense global retirement plan for coal generators will need to be put in place.

Coal continues to dominate global power generation, accounting for around 40% of the total electricity production. OECD countries have seen the generation of electricity from coal sources reduce by 7.5% between 2014 to 2015, closing 2015 at 30% of total generation.

This has been driven by the increase of competitive gas-fired and renewable energy generation, as well as government regulation to encourage investment in cleaner fuel sources.

China and India continue to dominate on coal consumption, and total coal-fired installed capacity is expected to continue to grow. However, the number of planned coal-fired power plants at the beginning of 2017 was 570GW, compared to 1,090GW just a year earlier, with the major driver behind this reduction coming from China. China has put on hold over 300GW of projects, including 55GW of plants under construction. This has been driven by growing environmental concerns.

Globally, existing coal plant owners will continue to face a challenging environment as governments and regulators introduce more stringent requirements, while the cost of cleaner technologies is expected to continue to decline, providing viable, cost-effective alternatives to coal fired generation.

Distributed Generation

Traditionally the power system was a central system, characterised by high entry barriers, a regulated market, high capex intensity and long-term investments. In recent years, technology and environmental awareness have created the need to address the 'energy trilemma', that is the security of supply, sustainability and affordability, in a more efficient way.

Power generation is now distributed in different locations, with consumers drawing and injecting power to the grids, which have become bi-directional and this has significantly increased the stress on grids. This has arisen as consumers may generate some small scale renewable energy such as roof-top solar panels, which when they are generating excess power, they feed this back into the grid. Figure 1 shows a distributed system, where generation from different sources is distributed throughout the community, and generation is located close to final consumption.

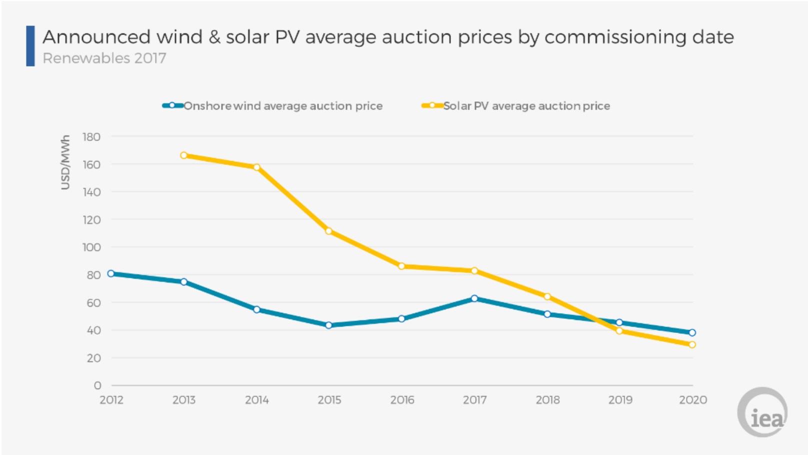
The move towards distributed generation has largely been driven by the development of small scale generation such as solar and on-shore wind. Mass production and enhanced, more efficient technologies have brought traditional renewable generation to the point where the first projects are now being built without any reliance on government subsidies, so called 'grid parity'. Chart 1 illustrates the costs of solar and wind energy over time, where competition has dramatically reduced costs throughout the industry.

Technological improvements have also contributed to optimising energy production. For example, GE Renewables has recently introduced a digital wind farm concept where machine learning and AI technologies can help optimise wind turbines' yields based on historic performance, to choose the ideal location and carry out ongoing data analysis to further optimise performance, potentially boosting a wind farm's energy production by up to 20%.

Figure 1: Depiction of a Distributed Generation System

Source: Global Distributed Generation System Market Research Report 2017

Chart 1: Auction Prices of Onshore Wind and Solar PV



Source: International Energy Agency

There are also other renewable technologies driving distributed generation, such as waste-to-energy plants. Their use has expanded in recent years, especially in northern Europe where there are strict landfill usage regulations, making the utilisation of waste attractive. This is a trend that may expand to other countries, as waste disposal is becoming a greater problem. In January 2018, China began enforcing rules banning the import of 24 grades of solid waste including paper and plastic.

This is due to China's increased efforts to tackle pollution and the growth of their internal market, reducing the demand for imports. Waste-to-energy plants bring the generation of energy closer to where consumption is occurring, reducing transport and distribution losses and reduces barriers to entry due to the reduced capital intensity of such plants.

As these disruptive trends continue, the grid will have more and more strain put onto it and there will be a greater requirement to not only invest in upgrades to the grid, but also a requirement for governments to change the regulation and funding models that enable the grid to be provided to generators, transmission and distribution operators.

Increasing the Systems Flexibility

Demand side response (DSR) refers to initiatives where customers are incentivised to lower or shift their electricity use at peak times. This is particularly important for large energy consumers that may be able to curtail consumption. Taking an active approach with regards to energy consumption can create new cash flows for consumers and at the same time contribute to a more flexible and more efficient system.

The grid always needs to be balanced. Traditionally, whenever there was an increase in demand (especially during peak hours), grid operators asked generators to increase the energy produced. If instead of injecting more energy to the network, the grid operator could reduce demand elsewhere in the system, it would be possible for the associated savings to be shared with those who had reduced demand.

Driven by increasingly available live-data supplied by smart meters, AI software could help to develop more accurate forecasts to assess the reliability of small supply players to balance the grid. In the UK, Google (through its AI start-up DeepMind) is in discussion with National Grid to use artificial intelligence to help balance energy supply and demand, aiming at saving 10% of the UK's energy consumption from optimisation, without the need for any new infrastructure. There are several start-ups using peer-to-peer models to match the consumption of individual customers directly with excess energy generated by small-scale producers such as farmers.

Energy storage has been used in power networks for decades. The most common being hydro power plants and pumped hydro, where energy is stored as potential energy (instead of chemical energy, which is the case for batteries). The operator decides when to release the water and generate electricity.

Pumped hydro plants usually pump water reserves when electricity prices are low (often at night) and release water to produce electricity when prices are high.

As technology advances in the battery sector, battery storage of energy is becoming more commonplace, and able to store larger volumes on energy, which is expected to further impact the power sector as particularly renewable energy sources can be captured when generation is high (i.e. the sun is shining, or the wind is at its strongest), then stored to be sold when demand and therefore prices are highest.

Virtual Power Plants

A virtual power plant (VPP) is a network of decentralised generation assets, flexible power consumers and batteries connected through IT which is governed by a control room. The control room monitors, forecasts and dispatches all the units connected to the network. The aim of the virtual power plant is to integrate all the assets to the existing energy system. Figure 2 shows a representation of a VPP.

Such VPPs could be an important part of future power networks. The IoT and other technologies will enable the creation of a system where consumption is physically located much closer to production and where each prosumer will be able to trade their capacity and flexibility in real time. AI may also contribute by allowing grid balancing to be done automatically. This will result in a cleaner and cheaper system.

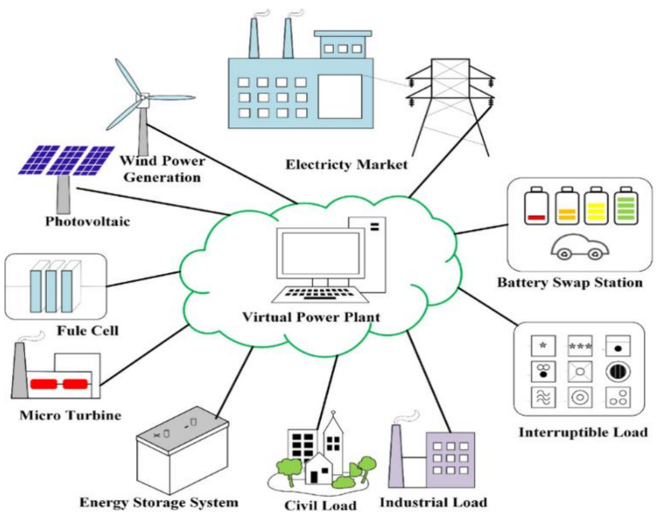
Impact on Networks

The variable nature of renewable energy generation and the demand from electric vehicles are already putting electricity grids under considerable stress and this trend is forecast to continue. During high demand periods where networks are saturated, flexible solutions like DSR, energy storage and virtual power, can help to reduce the stress in the system and use resources in a more efficient manner.

In addition, those users that are generating their own energy (such as rooftop solar), are a potential threat to the grid itself. This is because of the unpredictability of their usage, as well as the fact that they put the current remuneration mechanism at risk, as it relies on a large mass of consumers to share the total costs of the grid. Grid investments have payback periods of several decades. If users go off-line, partially off-line, or pay less due to net-metering arrangements they contribute less, increasing the cost to remaining users.

This increases user burden, and the risk of stranded assets could materially increase the risk of investing in power transmission and distribution assets. Regulators are still debating remuneration schemes that will appropriately incentivise investment and modernisation of the grid to tackle these issues, but future changes may significantly change the business model of existing grid owners.

Figure 2: Depiction of a Virtual Power Plant



Source: Huazhong University of Science and Technology

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