Importance of Intra-day Forecasts in Renewable Energy Sector to Reduce Imbalance & Congestion Costs in UK Power Grid

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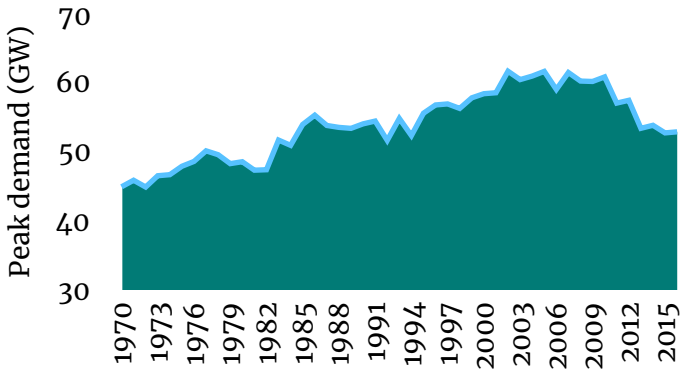
Since 2010 the peak demand in UK power market has declined sharply, a logic follow-up conclusion could be reduced balancing costs and fall in transmission congestion. However, these are not the trends one observes. The overall demand for electricity has fallen, and so has the generation, however, the share of renewable energy, especially from intermittent sources (solar and wind) has increased sharply. The trend of declining demand and generation and increasing solar and wind energy is expected to continue over the next few years, at least. Data suggests that balancing and constraint costs have increased hand-in-hand with the increase in solar and wind energy generation. Short-term forecasting of electricity generation from these sources can significantly reduce the financial burden on National Grid and systemic imbalance in the transmission network.

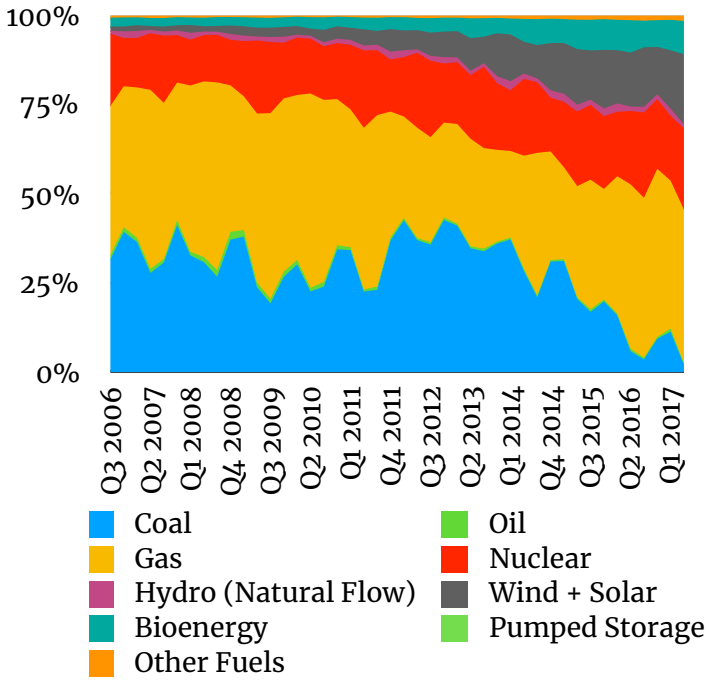
Declining Demand

Between 2010 and 2016, peak demand met has declined by over 13% – from 60.9 GW to 52.9 GW (*BEIS, 2017*). The peak demand met in 2016 was the lowest since 1993. Not only has the peak demand met declined by 8% between 2012 and 2016, the energy mix in the country has also changed significantly. The trend is expected to continue in the next decade.

Graph 1: Peak demand met in United Kingdom – 1970 to 2016



Graph 2: Technology-wise share in UK's power generation mix



Rising share of renewable energy

Coal and gas have been the dominant fuel technologies in UK's power mix for a long time. However, share of coal-based power generation peaked in Q4 2012 at 43% and has been on the decline since. The share of coal-based power dropped to perhaps its lowest-ever level of just 2% in Q2 2017. The share of gas-based power generation has been fluctuating between 54% and 24% between Q3 2006 and Q2 2017. Since the second half of the 2016 the share of gas-based power has increased sharply and in Q2 2017 it stood at 43%, making it the largest contributor in UK's power mix.

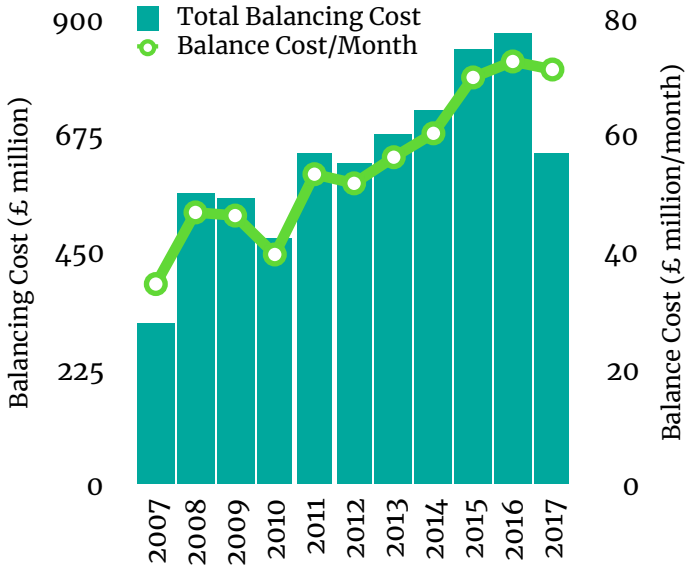
The share of nuclear power has been rather stable and around 20% for several quarters since 2011 to 2017. Intermittent renewable energy technologies – wind and solar – have also seen sharp increase in their contribution to the power mix.

In Q2 2017, the combined share of wind and solar power generation was 20% making them the third-largest supplier of electricity in UK, behind gas and nuclear power. The combined share of solar and wind energy increased significantly between Q2 2013 and Q3 2013, when the share changed from 7% to 12%.

Increasing balancing costs

Despite the substantial decline in power demand balancing costs in UK transmission grid have increased significantly since 2010. The total cost of balancing the grid in 2010 was £476 million which increased to £874 million in 2016 *(National Grid – Monthly Balancing Services Summary)*. The average monthly balancing costs have also increased from £39.7 million in 2010 to £71.5 million in 2017 (till September).

Graph 3: Balancing cost trends in UK



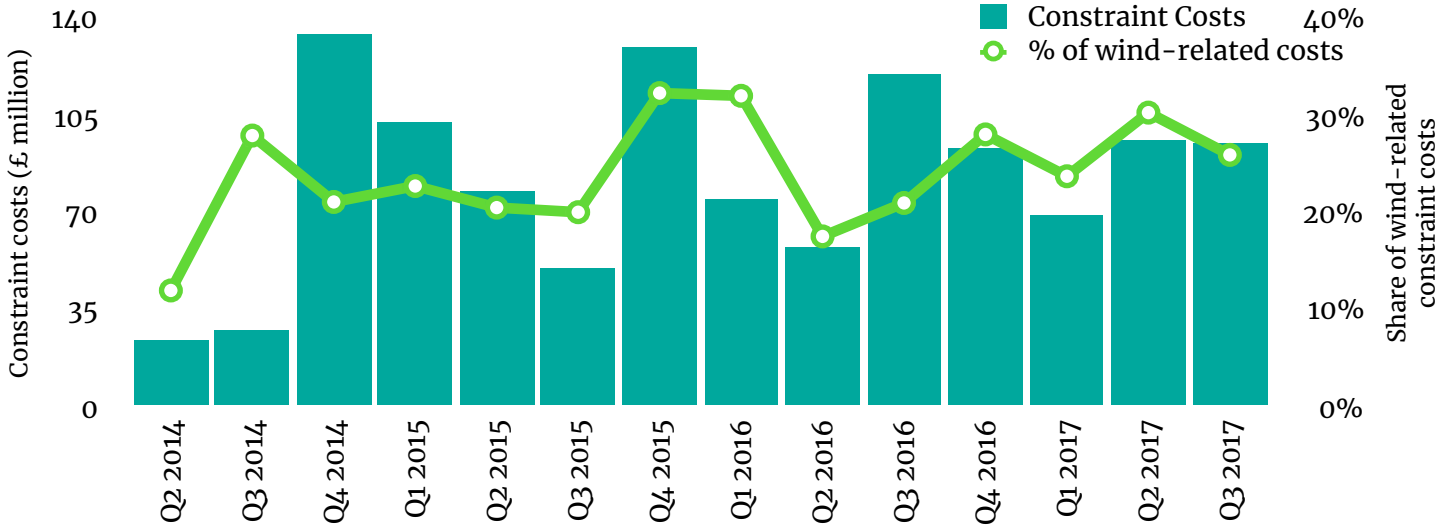
According to the National Audit Office, this increase can be mainly attributed to 'unavailability of some transmission assets due to the major programme of upgrades which is currently underway in Scotland and elsewhere.'

Constraint costs

Price paid by the National Grid to reduce and remove constraints in the transmission grid has also been on the rise and now contributes a much larger share in the overall balancing costs. Even though the balancing costs have increased due to upgrades in the network, the role of sudden rise in the share of solar and wind energy capacity cannot be ignored.

Price paid by the National Grid to reduce and remove grid constraints increased sharply between 2014 and 2017. The average annual constraint cost has increased from £62 million in 2014 to £87 million in 2017. The share of constraint costs related to wind energy has also increased sharply and now hovers around a fourth to a third of the total constraint costs.

Graph 4: Trends in constraint costs and share of wind-related costs



Apart from the increased share of solar and wind energy in UK's total electricity generation, the rapid rise of their share in the grid can also be gauged from the capacity already installed against the 2020 targets, Table 1 *(IEEFA, March 2017)*. Installed solar power capacity in 2016 is estimated to be four times the 2020 target while the 2016 solar power generation is more than four times the 2020 target. Similarly, installed wind energy capacity in 2016 is at 53.4% of the 2020 target while 2016 wind energy generation in 2016 is at 57% of the 2020 target. This leaves substantial room for the growth in the share of solar and wind energy in UK's electricity generation in the coming years.

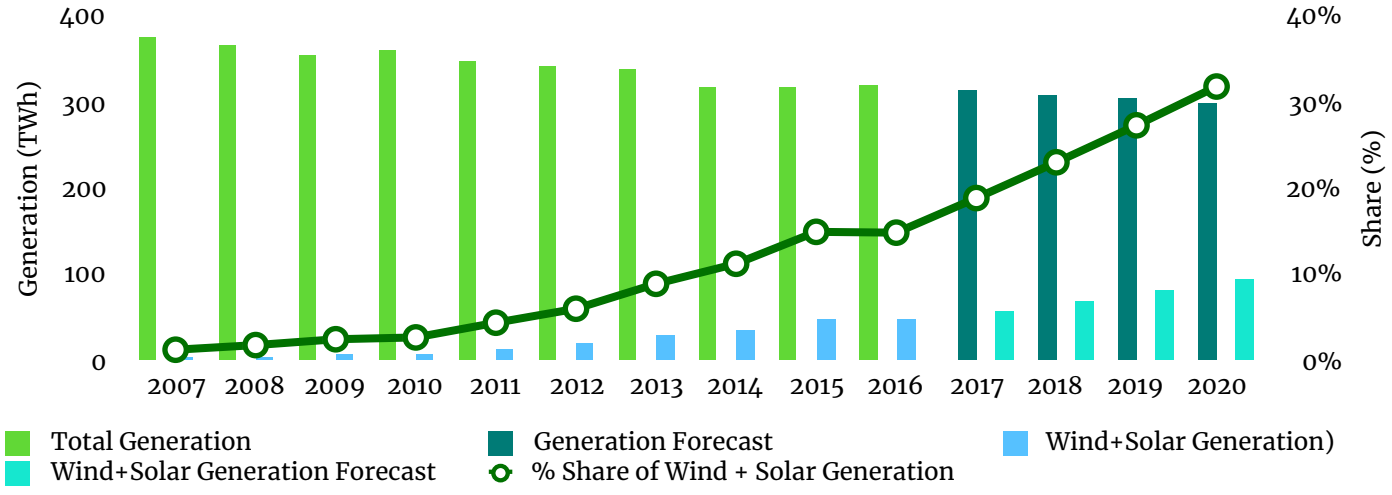
Table 1: Growth potential in U.K. solar and wind energy through 2020

Technology	Installed Capacity (MW)			Generation (TWh)		
	2016 Estimate	2020 Target	Addition Potential	2016 Estimate	2020 Target	Addition Potential
Solar	10,944	2,660	—	10	2	—
Onshore Wind	9,814	14,890	5,076	23	34	11
Offshore Wind	5,094	12,990	7,896	18	44	26
Total Wind	14,908	27,880	12,972	40	78	38

Continued growth in renewable energy expected

Keeping in view the renewable energy targets set by the UK government for 2020 (Table 1), there exists a huge potential for growth in electricity generation from solar and wind energy projects. This, in turn, will further increase the share of intermittent electricity source in the UK grid even as overall generation is expected to fall, inline with weakening demand.

Graph 5: Current and potential share of wind + solar generation in U.K.



Total generation in the U.K. has declined by a CAGR of 1.7% between 2007 and 2016. If this trend continues the total generation could fall to 299 TWh by 2020, from 320 TWh in 2016. In order to meet the wind energy generation target set for 2020 the total solar and wind energy generation will have to increase to 95 TWh by 2020, assuming no increase in solar power generation. This translates into a share of 32% of intermittent power in the generation mix. Even if the generation, driven by a revival in demand, increases to 2007 levels, the share of this intermittent electricity shall be 25%.

The National Audit Office in its briefing to the House of Commons Energy and Climate Change Select Committee on electricity balancing services explains the inherent issues related to renewable energy generation and balancing costs paid by the National Grid.

> *(…) many renewable generation plants receive both the wholesale market price and renewable obligation certificates for each unit of electricity they generate. Renewable generators will therefore want to export as much power into the grid as wind and sun conditions allow. If National Grid curtails their output to meet balancing requirements, generators will seek to recover their costs through their bids into the balancing mechanism.*
>
> *In some cases, National Grid may have few options to resolve a constraint. There may, for example, be few generators (or users available to reduce demand) in the area where action is needed to relieve an excess of generation over demand. In these circumstances, National Grid may need to accept relatively high bids from renewable generators. Curtailing wind power in a constrained location may also incur costs in increasing generation on the other side of the constraint.*

The NAO further notes that incentives for more accurate forecasting of renewable energy generation will help reduce balancing costs and 'help market participants balance their own positions and participate National Grid service requirements.'

Ofgem notes that balancing and constraint costs of around £850,000 per year adds £9 to electricity bills *(August 2016)*. To reduce these costs National Grid has implemented an incentive/penalty program for wind energy projects. Accuracy target for day-ahead forecast for wind energy generation for 2015-2017 is 3.25% and 4.75% in summer and winter, respectively.

Need for renewable energy forecasting services

There is a clear need for increased investment in forecasting renewable energy generation. Current renewable energy prices, which have fallen substantially over the last few years, may not be the true indicators of electricity price. The rapidly falling renewable energy tariffs may not include the cost associated with the integration of large-scale renewable energy into the existing grid. Investment in evolving forecasting techniques would enable regulators and grid operators to provide an additional cushion to the transmission network while overall cost of electricity is reduce through new innovations in forecast and power management techniques.

About Climate Connect Limited: Climate Connect Limited is an energy software solutions provider that works with state-of-the-art Artificial Intelligence and Machine Learning tools. Over 10 GW of assets are currently under active management by the company across the globe covering over 50 generators, traders, utilities and regulators are customers of its products and services. Climate Connect has a team of over 40 software engineers, data scientists, meteorologists and energy analysts working from London, Amsterdam, New Delhi and Pune.

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