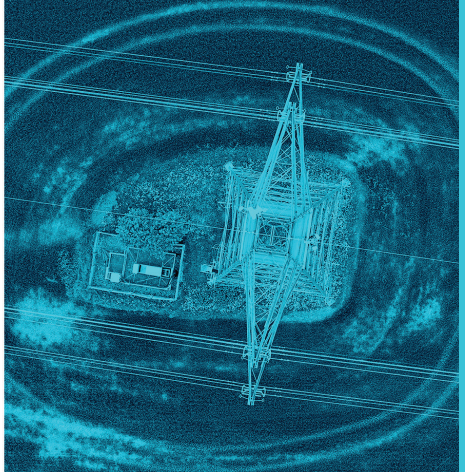


Kevin works in the Utilities Practice within Capita Consulting with particular focus on the Electricity sector. Here he is looking to help clients understand and deal with the issues they face through the huge disruption that is taking place in the sector due to decarbonisation, digitisation and decentralisation.

Kevin Beard
Capita Consulting

Using AI to power electricity networks

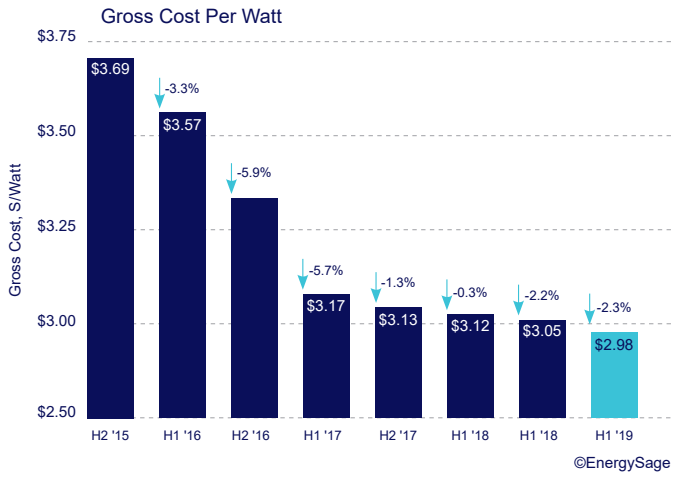
An industry in disruption

The UK electricity industry is facing unprecedented levels of disruption driven primarily from decentralisation, decarbonisation and digitisation. Government policy is also imposing new demands including: the Department for Business, Energy and Industrial Strategy (BEIS) is looking to reduce the UK business energy usage by 20% by 2030, increase the pace of introducing renewable energy as a percentage of total energy supply (currently behind target at 11% against 20%) and reduce overall fossil fuel production (it increased in 2018).

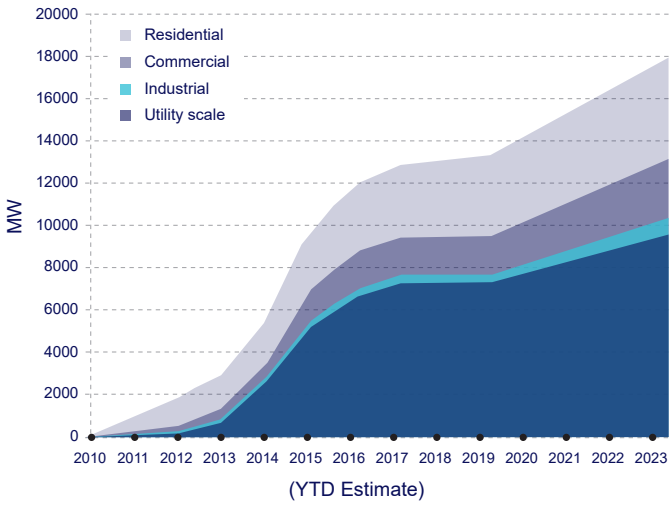
Disruptors include:

- The dramatic reduction in renewable energy infrastructure costs such as solar panels, wind farms and battery storage is leading to huge growth in the sources of energy supply;
- The decision in 2017 by Ofgem to enable consumers to become prosumers and sell their excess electricity back to the grid has accelerated this growth further;

Tracking Solar Price Declines



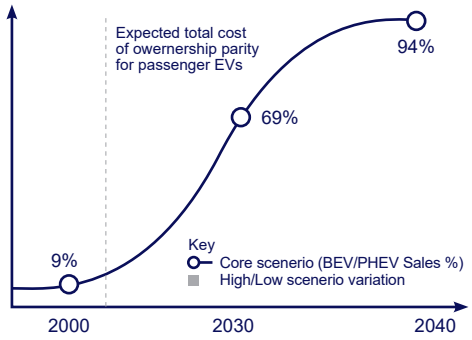
Cumulative installed solar PV capacity - All UK



- As electric vehicle ownership increases not only does this bring increased demand through charging, it also offers huge storage capability for the grid;

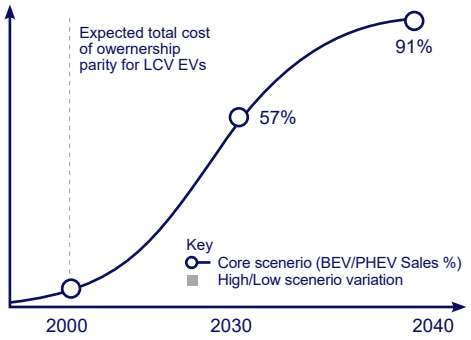
Passenger car

Scenarios for forecast UK passenger EV growth (%Sales)[6]



LCV

Scenarios for forecast UK LCV EV growth (%Sales)[7]



Source: KPMG

- The recent Government announcement that new homes will no longer be built with gas heating will put increased pressure on the electricity networks.

A new approach is needed

These developments are having a fundamental and far reaching impact on the historic, centralised and unidirectional electricity system that has served the country so well for decades. The flow of electricity from huge fossil fuel-based power stations through miles of network to consumers is having to adapt. There are now a multitude of prosumers and energy providers connecting at multiple places in the network, creating a multi-directional requirement, for a multi-source energy profile. This has dramatically increased the complexity of managing demand and supply across the network.

This is further complicated by the increasing unpredictability of UK weather, which directly impacts the generation of renewable energy through solar and wind farms. Similarly, the prevalence of plug-in vehicle and home battery storage adds an extra dimension to balancing supply and demand in the distribution network.

The ‘intelligent’ network

How does the UK energy industry, particularly the Distribution Network Operators (DNO), transform themselves into organisations that can provide a dynamic, self-balancing and reliable supply of electricity to prosumers and businesses alike?

Let’s start by outlining how they are not going to do it. They are not going to follow the traditional approach of investing heavily in expensive new infrastructure and assets. It is simply not cost efficient;

Furthermore, the DNOs can’t simply throw more resources at the problem. In both the operations centre managing the network, and in the field where engineers install, repair and replace broken assets, the challenge is far more complex. The multi-dimensional nature and scale of the problem makes this an unaffordable and impractical route.

The only approach that can solve the problem at a palatable level of investment is to make the network ‘intelligent’. This approach can optimise the utilisation of existing infrastructure and assets whilst also exploiting the proliferation of locally generated and stored energy to add dynamism to the distribution network.

However, this cannot be achieved using the same processes and systems that have been used traditionally. These models are simply not sophisticated enough to cope.

Intelligence through AI and data science

AI and data science will be crucial to all aspects of power networks in the years to come. It will enable preventative maintenance of network assets through the intelligent analysis of alert data and performance monitoring data, ensuring fewer network issues have an impact on consumers

- Optimising the scheduling of field engineers to ensure the right resource with the right skills has the right tools, spares and expertise to resolve asset issues first time every time;
- Supporting the creation of community based energy trading markets through the integration of AI and Blockchain to enable ‘prosumers’ (i.e. solar panel and electric vehicles owners) to trade energy with local consumers, businesses and DSOs;

- Managing the dynamic, hourly ebbs and flows of demand and supply, the changing weather conditions, time of use tariffs (ToU), levels of stored energy across a multitude of devices and then integrating with the models in other organisations in the wider supply chain.

Capita recently undertook a study to explore the forecasting of real and reactive power flows at primary substations, bulk supply points and grid supply points over different time horizons and across a range of network challenges.

As part of this exploratory study the following methods were investigated to quickly identify promising areas worth investigating further:

- Auto-Regressive Integrated Moving Average (ARIMA). A classic statistical modelling approach for building time-series forecasting models;
- Long Short-Term Memory (LSTM) Artificial Neural Networks. A specific type of deep-learning neural network for learning patterns in time-series data;
- Extreme Gradient Boosting (XGBoost). A machine-learning technique based on decision trees that has performed well in recent machine learning and forecasting competitions;

Results were promising:

- In terms of model performance all the techniques were able to meet the performance requirements for the DSO;
- In terms of the range of substation types and generation customers across multiple time horizons, the results highlighted that performance varied by method depending on the time horizon. Inclusion of supplementary data such as weather forecasts suggest a combination of methods outlined above would provide optimum performance;
- In assessing the different techniques, metrics such as training time, tuning time and forecasting time gave an indication of what would be involved to use these techniques at scale. The results revealed potential trade-offs between accuracy and – given the way the underlying methods work – what can be automated, reducing the need to have large teams of data scientists to maintain a large set of forecasting models.

Moving forward

Further studies are underway but results already suggest that the creation of an ‘intelligent’ distribution network is achievable and affordable. Understanding model creation and maintenance will be key in how the DSOs approach network management. The findings suggest that the targeted implementation of specific AI and data science techniques at specific network management and control challenges reap the greatest rewards.

The UK energy industry is facing unprecedented levels of change in the nature of managing power networks and must rapidly adapt in order to cater for a new paradigm. Traditional approaches will not work, and we must look to intelligent network solutions if we’re to create an energy network that can fulfil the needs of the twenty first century.

To find out more go to https://www.capita.com/sectors/utilities/enough to cope.

References

https://www.e3g.org/docs/19_08_19_Centre_AI_coalition_letter_Final.pdf

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