BUILDING ELECTRICITY NETWORKS UNDER DEMAND UNCERTAINTY

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EXEC SUMMARY

More investment in network infrastructure will no doubt be required to provide for the increase in demand on any path to Net Zero; however, flexibility solutions may help defer, or obviate entirely, the need for some of this investment

Among the many firsts of 2020, three of the four Future Energy Scenarios (FES 2020) produced this year by National Grid, the UK's electricity system operator (NGESO), are compliant with the Net Zero target. These scenarios represent a range of credible ways to decarbonise the energy system in order to meet the government's target, enshrined in law in 2019, to bring all greenhouse gas emissions to Net Zero by 2050[1].

In addition to producing more electricity from low carbon and renewable energy sources (RES), all the scenarios envisage that the path towards Net Zero will require significant electrification of the transport system as electric vehicles replace their traditional, fossil-fuel-powered alternatives. In relation to the heat sector, FES 2020 envisages a number of decarbonisation pathways, involving a choice between hydrogen, bio-fuels or electrification to replace natural gas boilers presently used for most heating purposes. Total electricity demand is thus projected to increase in each scenario, but on different trajectories. By 2050 the level of demand will differ markedly, depending predominantly on the degree of electrification and how hydrogen is produced[2].

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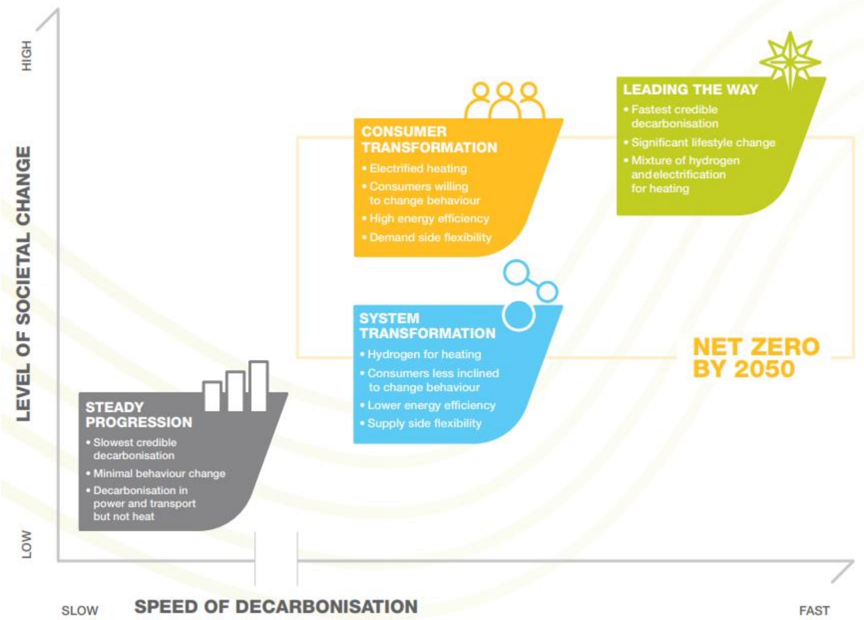
[1] The new target is more ambitious than the previous one, which aimed for a reduction by 2050 of at least 80% from 1990 emission levels and had been legally binding since the Climate Change Bill became law in November 2008.

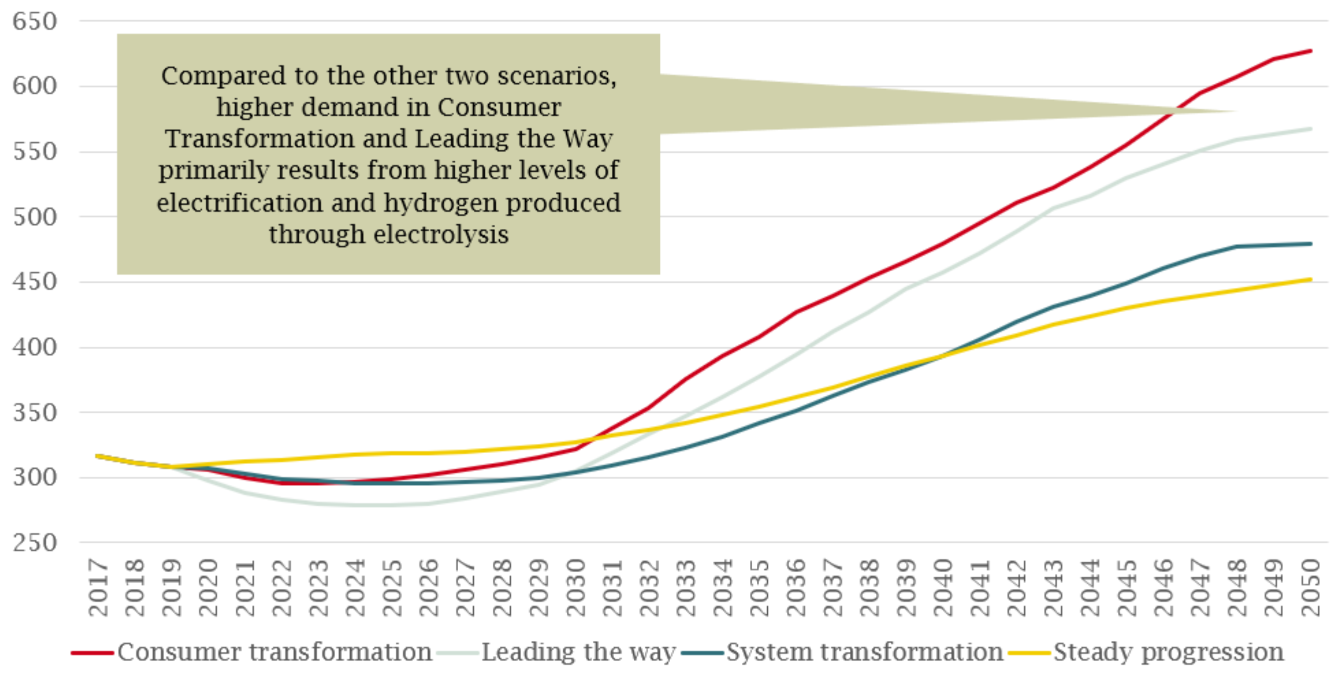
[2] Hydrogen can be produced through electrolysis, creating a source of electricity demand, or through methane reforming with a large requirement for natural gas with carbon capture storage.

FIGURE 1 FES 2020 SCENARIOS



Source: https://www.nationalgrideso.com/document/173821/download

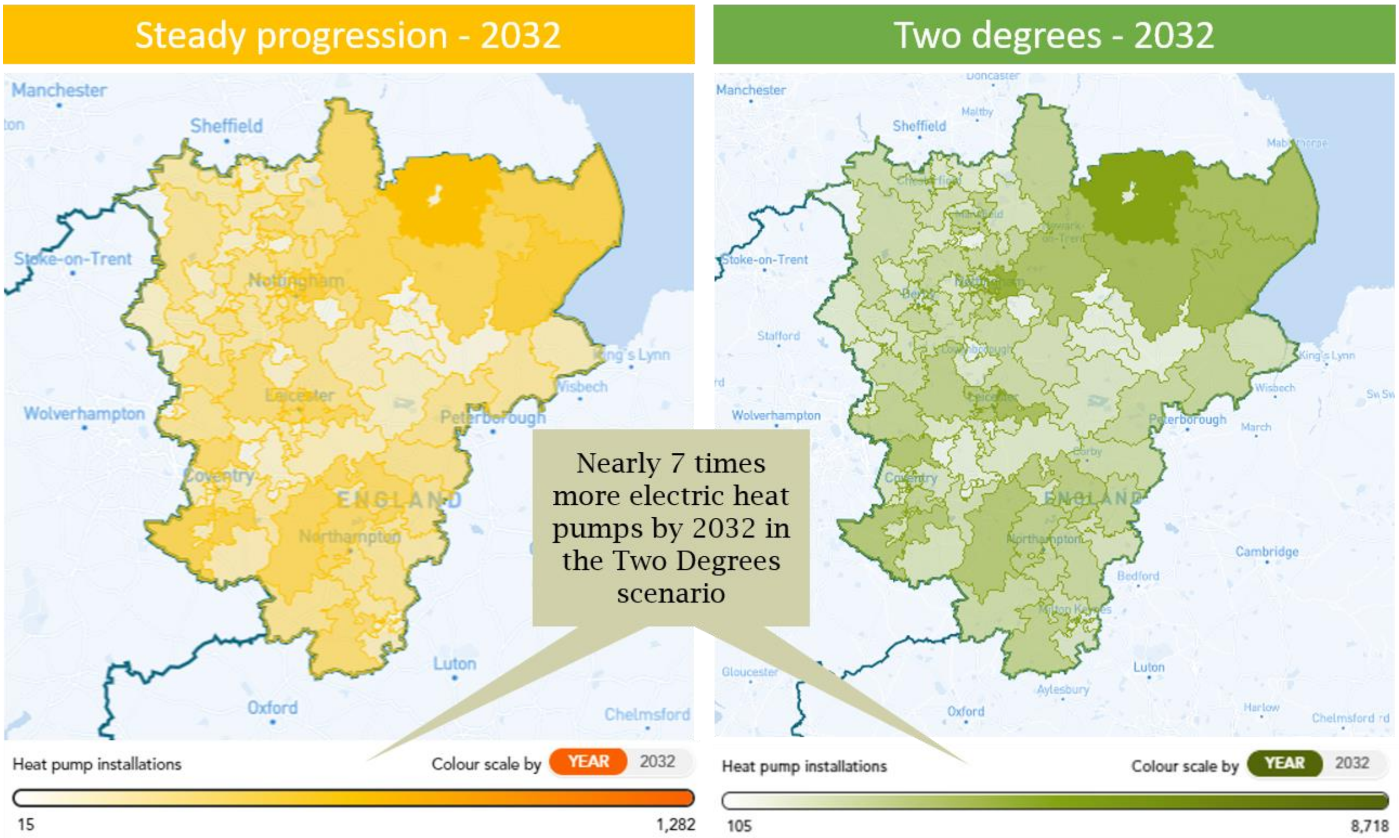
FIGURE 2 TOTAL ELECTRICITY DEMAND (TWH) IN FES 2020 SCENARIOS



Source: National Grid FES 2020. Available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

Forecasting what levels of demand will materialise at specific points on the network is even more challenging than running the exercise for the system as a whole. That is because of the uncertainty associated with whether and when consumers in different parts of the country will take up electric vehicles or replace their fossil-fuel-fired boilers with electric alternatives for heating their homes. Efforts undertaken last year to translate NGESO's FES into so-called Distribution FES (D-FES) show considerable variation between scenarios in the uptake of electricity-intensive devices and, consequently, in the levels of electricity demand that can be expected at specific points of the distribution system.

FIGURE 3 FORECAST OF ELECTRIC HEAT PUMP UPTAKE AT THE DISTRIBUTION LEVEL IN THE EAST MIDLANDS UNDER TWO FES 2019 SCENARIOS



Source: https://www.westernpower.co.uk/distribution-future-energy-scenarios-application

WHAT THIS IMPLIES FOR THE ENERGY SYSTEM

Irrespective of which FES 2020 scenario materializes, it is clear that the path toward Net Zero will entail large volumes of low-carbon generation producing varying levels of electricity depending on the time of day or the weather, increasing the intermittency of the power supply. Consumption levels and patterns, too, will change significantly as households choose to generate their own power or take up electricity-intensive yet flexible technologies, such as electric vehicles or heat pumps. This means greater potential for congestion on networks built to accommodate established production and consumption patterns.

These developments will be occurring against a background of increasing digitalisation, which will enable different types of distributed generation, dispatchable loads, electric vehicles and energy storage to become active participants in the market as “flexibility” resources. Through the emergence of aggregators and specialised markets, network operators are increasingly able to buy flexibility from both local sources of demand and electricity producers; in return for a payment, the flexibility provider offers to modify either demand or supply to help address an anticipated mismatch[3].

[3] In 2018, Britain’s six distribution network operators (DNOs) entered into the Flexibility First Commitment co-ordinated by the Energy Networks Association (ENA), pledging to assess smart flexibility service markets when reviewing requirements for significant new

Traditionally, Britain's six distribution network operators (DNOs) would build the distribution network to meet exogenous consumer demand for electricity generated upstream. More investment in network infrastructure (new pylons, transformers and substations) was the key to avoiding congestion and no doubt will still be required in significant amounts to provide for the increase in demand on any path to Net Zero. But flexibility resources may help DNOs resolve congestion and either defer the cost of extending or reinforcing the network or obviate the need entirely. Instead of building new infrastructure which may turn out not to be needed, DNOs can pay a flexibility resource to help relieve local congestion. For example, if there are too many people charging their electric vehicles at peak time, operators can pay them to charge during off-peak periods rather than investing in new network equipment.

BUILD OR FLEX?

In this new world, DNOs need to decide whether to use a flexibility resource or network reinforcement to tackle congestion. Which offers better value? One approach is to take the cost of asset reinforcement as the baseline and compare it with the alternative of deferring the new investment and using flexibility in the interim. This recently emerged as a "common evaluation methodology" under the Energy Networks Association's (ENA's) Open Networks Project[4].

Under this approach, the value attached to flexibility is derived primarily from the so-called time value of postponing a large expense today to some point in the future. Even if this assessment is conducted across a number of different demand growth scenarios, the underlying assumption is that the network investment will take place; if not now, then at some point. Crucially, the methodology does not include the option for the network operator to use flexibility and then decide to scrap the investment because, for example, new forecasts suggest weaker demand than anticipated. This may happen because EV charging in the area in question is going to be less clustered than in the initial scenario, or uptake of EVs and heat pumps will be a lot slower, or another source of local demand (e.g. a factory) has shut down.

Put another way, this approach does not attribute any value to the fact that using flexibility allows network operators to wait and see until it can be known with greater certainty whether an expensive, long-lived network investment is required at all. Network operators may therefore end up utilising less flexibility than what would be optimal.

To take this wait-and-see value into account requires a more complex analysis involving additional information. In conjunction with SSE Networks, Frontier Economics has built a model that does just that[5]. It is based on the type of analysis that is used to value any option because flexibility provides an option to choose whether or not to invest in the future based on the (better) information available then.

SO WHICH APPROACH IS BETTER?

In a textbook sense, an option-based analysis is a better representation of the real world. But using it is complex and requires the input of a lot of data. For example, the model needs possible scenarios for the

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electricity network infrastructure. Since then, flexibility has been procured by different DNOs through competitive tenders, bilateral procurement and recourse to flexibility market platforms like Piclo Flex.
https://www.energynetworks.org/electricity/futures/flexibility-in-great-britain.html

[4] In October 2019, members of the Energy Networks Association (ENA) committed to developing a common evaluation methodology (CEM) and a CEM Cost Benefit Assessment tool under the Open Networks Project. Both were published in July 2020, and the expectation is that all DNOs will use them from April 2021 for the remainder of RIIO ED1 and beyond. Available at: https://www.energynetworks.org/assets/files/ENA%20Common%20Evaluation%20Methodology-publishedpdf.pdf

[5] SSEN announces a new cost-effective approach to delivering a smart, low-carbon energy system. 16 July 2020. Available at: http://news.ssen.co.uk/news/all-articles/2020/july/ssen-announces-a-new-cost-effective-approach-to-delivering-a-smart,-low-carbon-energy-system/

development of generation and load, probabilities of their happening as seen today, how information today may change views/forecasts tomorrow, etc.

The value of any option derives from the degree of uncertainty. Flexibility as an option for network operators is no different. If there is not much uncertainty, it is likely that the two approaches will produce similar outputs. And if the investment is not very large, the time taken to populate the more complex approach may outweigh the benefit of improved decision making. Finally, other factors (such as replacing ageing network assets) may be important enough to have a determining influence on the final decision. So in some situations, sticking to a less complete but simpler analysis may be the right answer.

But in other cases, the stakes will be high given the significant uncertainty in the level and trajectory of demand growth we describe above. In these situations, thoroughly modelling uncertainty and thinking through what can be gained by "waiting and seeing" will need to be an essential part of the network operators' toolkit.

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