

# Our energy insights

## Forecourts Thoughts: electric vehicle charging; expanding the discussion

1<sup>st</sup> November 2017

This is the third in our Electric Vehicle (EV) Thought Piece series. There are numerous solutions available for EV charging, too numerous to mention in individual short articles. The future will be a mixture of them; a mosaic. National Grid System Operator does not support any one particular solution but it does wish to discuss, through this series and other avenues, the potential impacts on the network of the mass adoption of EVs.

This is a follow-up article to the first EV Thought Piece, *Forecourt Thoughts: Mass fast charging of electric vehicles*, which was published in April 2017. Since then there have been significant announcements concerning EVs; not only in the curtailment of conventional vehicles but also in the need for smart charging.

### What has changed?

There have been a number of major announcements since April 2017, both by governments and vehicle manufacturers. Some governments have shown their intent by phasing out conventional diesel and petrol cars. These include Netherlands, Norway, France, UK, India and China.

In the UK the Secretary of State for Environment, Food and Rural Affairs has said that the Government will end the sale of all new conventional petrol and diesel cars and vans by 2040<sup>1</sup>. In the same press release the Transport Secretary goes on to say that the expectation is for nearly every car and van on UK roads to be zero emission by 2050.

### How do these changes fit with National Grid's Future Energy Scenarios (FES)?

Our scenarios map out four credible pathways that reflect the possible supply and demand of gas and electricity in the future, and the implications of this for the energy industry.

Our report was published before the Government announcement was made, however it aligns well to one of the scenarios we proposed, called 'Two Degrees'.

### What does Two Degrees assume?

- Our modelling for 'Two Degrees' contains a number of assumptions to understand the growth of electric vehicles and their impact on electricity demand. These are:
- 7kW will be the standard rating for domestic chargers.
- All EV sales are pure EVs (PEV) by 2045.
- There will be 25 million PEVs by 2050.
- Shared autonomous vehicle use will grow from today's 0% to 50% by 2050.

<sup>1</sup> <https://www.gov.uk/government/news/plan-for-roadside-no2-concentrations-published>



- 'Time of use' tariffs will be in operation and 85% of the population will take advantage of the differential charging rates. Consumers will be more engaged in how and when they use electricity and move away from charging at peak time.

### What are time of use tariffs?

The Government has laid plans that all homes and small businesses will have installed smart meters by the end of 2020<sup>2</sup>. Smart meters record electricity consumption for every half hour period. Suppliers would therefore be able to set charge rates that reflect the inter- and intra-day variation of electricity wholesale prices. These more cost reflective tariffs are termed time of use tariffs (TOUTs).

The assumption is that electricity charges, if not a flat rate, will be more expensive at peak times (around 18:00 hrs) and less expensive at low usage times (03:00 hrs) – or high generation times (a windy and sunny day).

Different time of use tariffs are already being considered by suppliers/industry. For example, dynamic or static models. A dynamic tariff takes into consideration real time variables, such as the amount of renewable generation expected to be generating over the coming days. The amount of renewable generation available will affect the electricity wholesale price (renewable power is likely to be cheaper) and these price changes could be passed onto consumers.

We believe that engaged consumers will have the means and the desire to react to all these price changes. Their ability to react will be enabled by the use of smart meters and smart appliances.

Static TOUTs whilst having variable tariffs will not be responsive to short term market fluctuations. Much like Economy 7, their different tariffs would be set for long

durations. Such price stability does have its advantages and may be an easier concept for some consumers to grasp.

### What are smart chargers and why are they used?

Within our Two Degrees scenario we assumed that smart chargers for EVs will come as standard in the future.

By smart chargers we mean, at the most fundamental level, a device that is programmable (by apps) and has a two way communication facility with the ability to draw and, potentially, supply a charge to a network.

We envisage that these devices will be able to carry out functions such as:

- Respond to dynamic pricing signals.
- Integration into a domestic electricity system. It will 'understand' all the demands and generation a household is making and make appropriate decisions as which appliance should take precedence to ensure that the most effective use is made of the EVs potential.
- Be capable of turning up and down the demand it draws off the network, in response to signals, in order to support the local and national grid to run efficiently. An example being the trial in My Electric Avenue project<sup>3</sup>.
- Be capable of a two way flow of electricity, so not only demand but also sending it back to the grid if appropriate (or vehicle to grid (V2G) which we will discuss in our next EV Thought Piece).
- Predictive learning of what demand is required. Thereby ensuring the EV battery is used in the most optimal manner for the consumer.
- Ability to tie into applications, such as National Grid's [carbon intensity calculator](#), to estimate the best time to

<sup>2</sup> <https://www.ofgem.gov.uk/gas/retail-market/metering/transition-smart-meters>

<sup>3</sup> <http://myelectricavenue.info/my-electric-avenue-tests-esprit-over-winter>



charge for other environmental and social reasons.

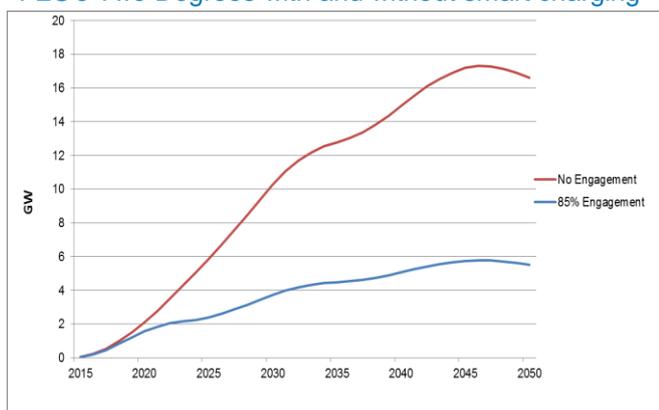
- Override facilities to let consumers opt out of functionalities.

As a bare minimum we firmly believe that smart chargers must be able to facilitate and enable consumers to move away from peak time charging. Smart charging will support more efficient solutions and thereby ultimately reduce the cost of energy to the consumers.

The Government's recently published *Clean Growth Strategy*<sup>4</sup> has indicated "all new charge points sold or installed in the UK to be 'smart' enabled"; once the necessary legislation is passed.

If movement away from peak time charging does not occur then the demand that would be placed upon the electricity networks will be significant. Substantial network reinforcement would be required and also a large amount of generation capacity would have to be built. If smart charging were not to be used we estimate that about 8 GW of extra capacity would be required by 2030 and 11 GW extra by 2050 (see Figure 1), to cover these short peak time demands.

Figure 1 Additional peak demand growth from EVs in FES's Two Degrees with and without smart charging



This would be achievable but it would be, overall, an expensive solution. This could be as much as £8 billion in electricity network costs by 2050<sup>5</sup>, according to the National Infrastructure Commission. But of course any additional cost for new EV requirements

<sup>4</sup>[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/651916/BEIS\\_The\\_Clean\\_Growth\\_online\\_12.10.17.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651916/BEIS_The_Clean_Growth_online_12.10.17.pdf)

<sup>5</sup>[https://www.nic.org.uk/wp-content/uploads/Congestion-Capacity-Carbon\\_-\\_Priorities-for-national-infrastructure.pdf](https://www.nic.org.uk/wp-content/uploads/Congestion-Capacity-Carbon_-_Priorities-for-national-infrastructure.pdf)

will be offset by both the environmental benefits and the reduced costs in the supplying of petrol and diesel.

## Readers' responses to Forecourt Thoughts

This Thought Piece, published in April 2017, was looking at one potential solution, amongst many, to the charging of EVs in a world where most cars are EVs that have high capacity batteries. The article was downloaded over 3,000 times. Some of the readers contacted us directly – continuing the debate, which we always welcome. There were a number of points raised by the readers that we would like to share and clarify. Most can be put into three categories:

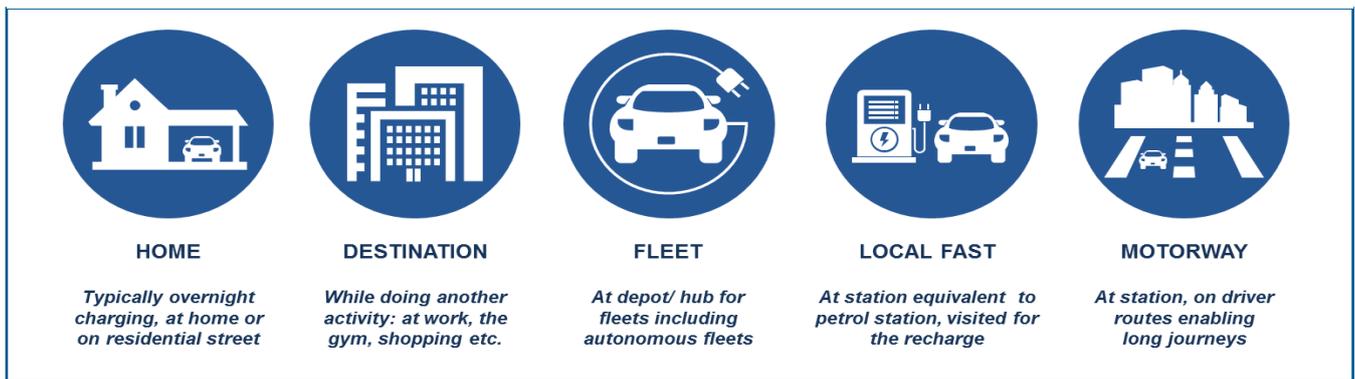
### Home charging is one solution....:

Home charging will be the main solution those whose circumstances can accommodate it. A number of people contacted us to say they had never had any problems with their home charging facilities and it was quite suitable for their needs, as one said "95% of the time". Many who contacted us considered that the ease and convenience of home charging was one of the attractions of EV ownership and anything else, they believed, would stifle EV growth.

Some mentioned that Economy 7 night-time rate was a cheap period to charge EVs. But one pointed out that with the decarbonisation of heating as well as EV charging the night rate period could become very popular and Economy 7's cheap rate could be unsustainable.

A few were in the fortunate position of having solar panels which could supply their vehicles energy requirements. Although whether this was sufficient for them throughout the depths of winter was unclear. What we also did not know in the majority of cases was how many solar panels they had, the efficiency of their cars or how many miles they travel per day.

Figure 2 EV Charging localities



In the last Thought Piece on EVs we mentioned that if an 11 kW charger was used in a home then other high wattage appliances could not be used at the same time without tripping the house fuse. This was based on the presumption that most houses were fitted with single phase electricity supply – and the charger would be single phase. It was pointed out that currently 11 kW chargers and above, are all 3-phase. 7 kW chargers are likely to be the maximum in most single phase households.

Using a 3-phase 11kW charger in a 3-phase fitted house would not cause any issues when using other appliances. However, 3-phase electricity would need to be installed in the house as this is not standard across homes in the UK. It can be fitted into a home but it will incur additional expense and how much it costs will depend on the circumstances that apply to each premises.

### Future infrastructure upgrades:

An interesting insight raised was to do with the electrification of heating. If this was to occur, as part of the decarbonisation of heating, then it might be that local network infrastructure might require upgrading. Therefore any additional EV requirements could be rolled into the same upgrade work within the distribution system.

One suggestion was that all new builds should include at least one 7 kW charging point. At the same time the substations to these new estates should be of the right specifications to meet the potential future demands; that is they should be future proofed.

### Suggested alternative solutions:

A number of alternative solutions to EV charging were proposed. Most are self-explanatory and therefore only bulleted here.

- Battery swapping stations as opposed to refilling stations.
- Charging using lampposts for on-street parking.
- Better public transport to negate the need for so many cars.
- Smart chargers could be operating not only within a household's energy system but also between households on a peer to peer basis.
- One correspondent suggested that there was a huge potential of untapped power with millions of EVs each with 7 kW connections to the grid. (It is most unlikely that all, or even most, EVs would be available at the same time as suggested. However, the topic of V2G is one that we will be discussed in a forthcoming Thought Piece.)

### What broad models might exist for charging vehicles?

There is a mosaic of solutions (Figure 3 and Figure 3) to the charging of a huge number of EVs. We intend to explore individual solutions in this EV Thought Piece series of which Forecourt Thoughts was the first. In essence we believe that there are five broad site types and these are illustrated in Figure 2.

The manner in which any of these types operate will be diverse as different business models are employed by their operators. Which of the above models dominates, if any, will be determined by the needs of EV owners.

Figure 4 A mosaic of solutions; some will be suitable for groups of EVs (as at National Grid)...



Figure 3... and some may not (as sent in by a correspondent).



### In summary

EVs present exciting opportunities for the UK. The energy, automotive and technology sectors, as well as Government and regulators must all work together to achieve clean air quality, carbon reduction, new services, etc. Efficient and innovative ways to integrate EVs into everyone's everyday lives must be found. But whichever ways are found they **should be smart**, convenient and easy to use, and benefit all consumers.

No one knows what the future may hold but we have some ideas that we will explore in future Thought Pieces. So look out for our forthcoming pieces, in this EV series, on Vehicle to Grid and Autonomous Vehicles.

And what we do ask is that you continue to engage with us in order to take the debate forward.

If you have any questions or comments we would like to hear from you.

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