Impact of Transportation Electrification on Distribution System Upgrades

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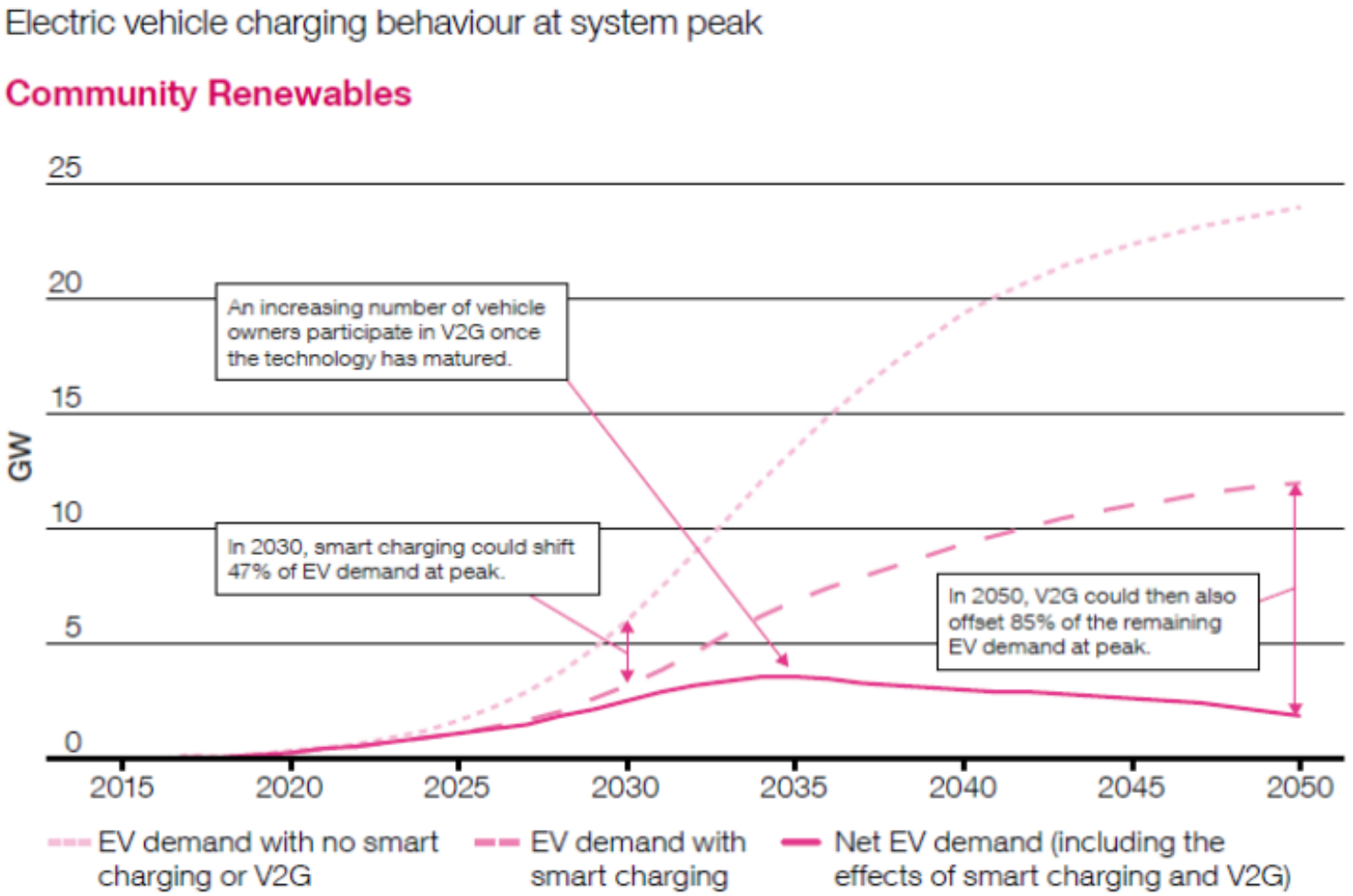
Potential Size of the Challenge

Currently, road transport uses approximately 500 TWh of energy. Although improved efficiencies may reduce this, the shift from petrol and diesel cars could increase electricity demand by 200 TWh. The use of smart charging or vehicle to grid technologies could significantly lower peak demands to be approximately only 8% greater than current peak power draw.

Source:House of Commons briefing doc on Electric Vehicles and Infrastructure



Source: National Grid, Future Energy Scenarios 2019

Potential Size of the Challenge

Infographic from UK Climate Change Committee Briefing document The UK's transition to electric vehicles

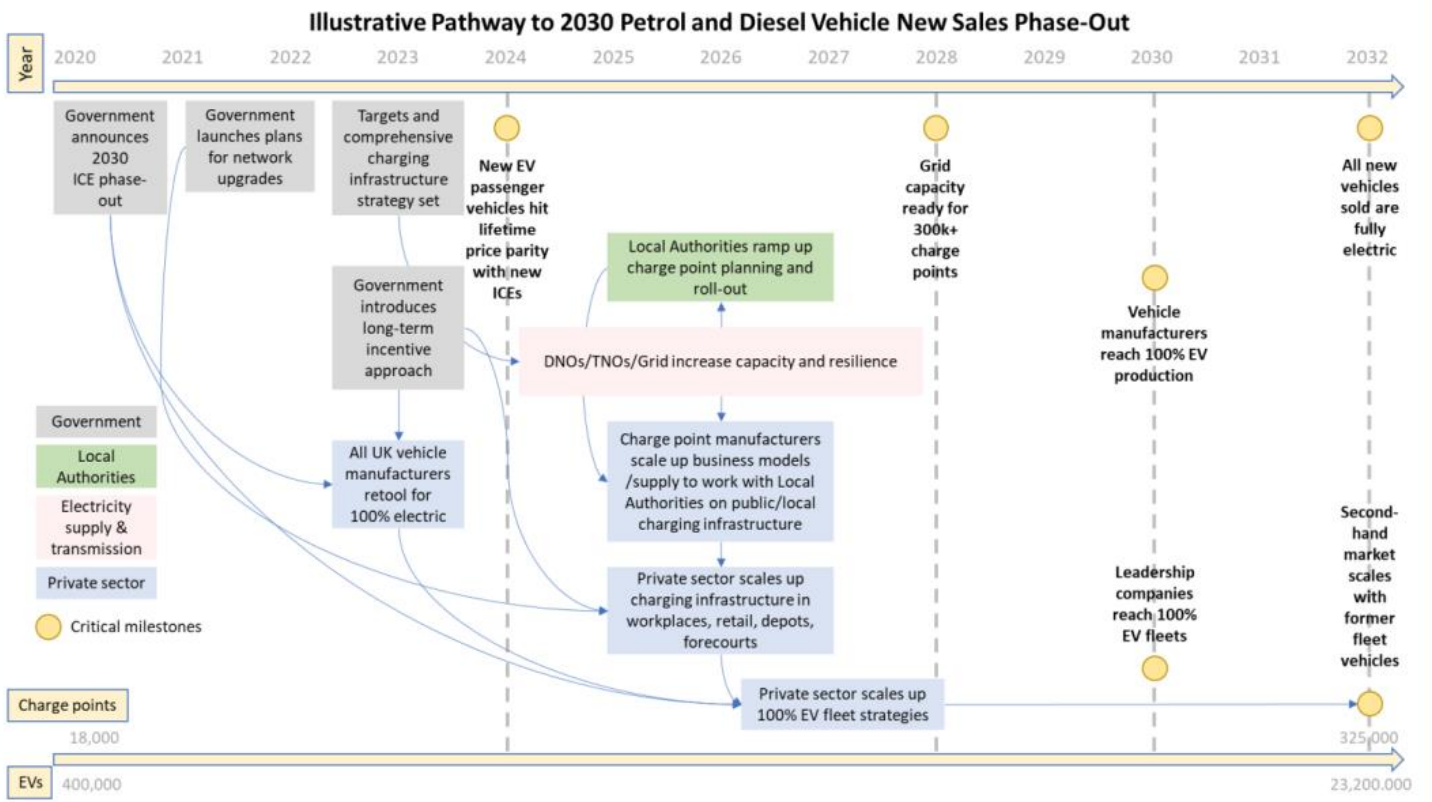
An illustrative pathway to deliver against the UK target to stop sale of non Evs by 2030

Note:

Need for the number of charge points to increase from around 18,000 to 325,000 and the number of Evs to rise from around 400,000 today to 23.2m by 2032

Grid capacity need to be ready for 300,000+ charge points by 2028

Figure 2.1 Infographic showing an illustrative pathway to deliver the 2030 EV transition



Notes: This figure shows an illustrative pathway through which the sales of EVs could be scaled up to meet the Government's planned 2030 phase-out date for new sales of petrol and diesel vehicles and to deliver 100% of all sales being zero-emission by 2032, as required to meet the Sixth Carbon Budget Balanced Net Zero Pathway. Most dates shown within this infographic are illustrative and are not representative of commitments made or recommended approaches. Other pathways may be possible, and there could be opportunities to deliver some phases of the transition sooner.

Source: UK Climate Change Committee Briefing document The UK's transition to electric vehicles

Different issues at different locations

- New Homes
  - Potentially the easiest to address as local networks and service cables can be sized for EV (and use of electric heating) at installation. This can include the use of 3 phase service even if only 1 phase is used initially.
- Existing homes
  - Given the differing design standards used historically, individual assessment will be needed. Via UK Energy Networks Assoiation methodologies are being developed to simplify this assessment process to identify those connections which will need upgrading. Currently 'substandard' service arrangements are upgraded with the costs being socialised across all customers
- On street charging
  - Around 60% of vehicles in UK park on the street. To reduce the amount of street furniture, many local authorities and change point providers prefer upgrading existing street lights to provide a charge point. This will require network upgrade.

Different issues at different locations

- Depot based fleet users
  - It maybe possible to use existing connections where smart charging arrangements can be used, otherwise an upgrade to the network is likely to be required to accommodate. Where these costs are high, it may be economic to have onsite battery storage to reduce the peak consumption at the site.
- Workplace and other off street locations
  - This includes car parks and park and ride sites. Solutions will vary from existing connections being able to accommodate to substantial upgrades on the network being required.
- Motorway/trunk road service areas
  - The need for multiple rapid charge points in the locations will require substantial upgrade of the network to these sites. This has already been recognised by the electricity network companies and the UK regulator (Ofgem) with a program of strategic upgrades planned which include some of the areas where these service areas are located.

Vehicle to Grid impact

- Technology current still in development and limited trials in UK to date
- Initial focus is likely to be on facilitating connection with distribution constraint management being a priority
- Whilst EV battery capacity varies considerably, these are already typically in the range 50 to 100kWh
- Hence, storage potential is plausibly up to 75TWh per million vehicles which is around 25% of UK electricity consumption per annum
- Consideration is already being given to using this storage for balancing services
- Whilst this could be very effective at the GB level, careful management will be needed to avoid creating congestion at the local level

The data challenge

- To date, distribution system planning and generally operation has been based on ‘typical’ behaviour (templates) of different customer types. This would need to include:
  - Location of EV
  - Charging history of EV
  - Driving history of EV
- Work ongoing as to whether these can be established for EVs or whether large scale collection of data will be needed which would include (but have significant issues around data protection):
  - Charge status of EV
  - Journey plans
  - Charging intentions

Connection costs and timescales

Charge Point type and power output	Likely installation location	Typical approximate connection lead-times	Network and Third Party considerations	Approximate connection cost
Slow up to 3kW	Domestic	Immediate	None	None
Slow 3.7kW	Domestic or street side	Immediate in most cases	Usually none	Usually none
Fast 7kW	Domestic or street side	4 to 8 weeks	Likely upgrade to service cable and local mains	Usually none
Fast 22kW	Street side or public charging location	8 to 12 weeks	Streetworks and permissions	£3,500 to £12,000
Rapid 50kW	Public charging location	8 to 12 weeks	Streetworks and permissions	£3,500 to £12,000
Rapid 150kW or multiple rapid chargers	Public charging location	16 weeks	Streetworks, permissions and cost of land for transformer	£70,000 to £120,000

- Whilst these will vary with location this table published in Western Power Distributions Electric Vehicle Strategy 2021 gives an indication for one of the largest distribution companies in the UK.

Potential conflicts within Electricity Industry

- Already seeing tariffs targeted at EV charging
- These are likely to target times of high renewable output and hence a high coincidence of charging may occur
- Distribution networks would favour a diversified charging pattern to avoid stress on local networks
- Whole system analysis is required to understand the best commercial arrangements to balance these conflicts
- Considerable data is needed for this analysis including:
  - Charging behaviour under different tariffs
  - Likely balancing services from EV
  - Cost of distribution upgrades
  - Cost of renewable generation constraint
  - Cost of storage

Summary

- Impact of EVs on distribution networks will be significant
- Solutions will vary from the use of smart technology through to major upgrades to local networks
- Further development in data collection and analytics will be needed to ensure investment is best targeted and timely
- Industry needs to work together to find solutions to the potential conflicts in use cases
- Whilst solutions can be site specific, a series of template solutions will be needed given the speed of change currently planned by the UK Government
- Whilst the general direction of a UK heat strategy is known, publication of a Heat Strategy by the UK Government is yet to be published – substantial electrification/use of heat pumps needs to be considered in upgrading the distribution network