Dealing with fluctuations in supply and demand in a zero-carbon grid

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The Problem

- To hit net-zero carbon emissions by 2050 we can expect our reliance on renewable energy to increase considerably. Renewable energy can be intermittent and so cannot be relied upon for on-demand energy.

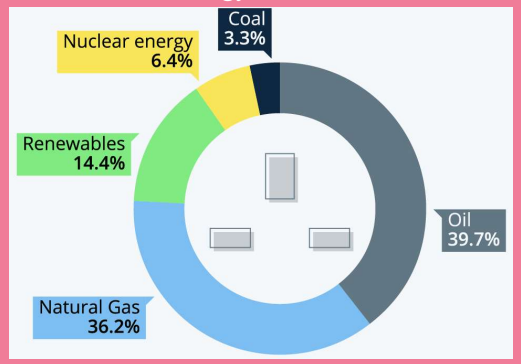

Figure 1: UK's energy mix 2019 (primary consumption in the UK by fuel type)[1] Source: Statista.com

- Demand for energy varies across hours, days, weeks and months. These fluctuations create peaks and slumps. Currently, fluctuations are dealt with by adjusting oil and gas power plant outputs, since these are on-demand and can react quickly to changes in demand.
- To successfully take the national grid carbon neutral, we must implement protocols capable of balancing supply and demand to avoid deficits and excesses.

A Carbon-Zero Solution for 2050

- Using 'smart chargers' means electric vehicle batteries can act as an energy storage system for the grid. Smart charging integrates vehicle batteries into the national grid system and enables batteries to switch between drawing power from the grid and supplying power to the grid.[2] In this way, Electric vehicles can respond to fluctuations in supply and demand in order to balance the status of the grid. These chargers would schedule a full-charge time, ensuring users can still use their vehicles when needed.
- For example, when there is an excess in power supply, cars can charge as usual. However, when there is a deficit in power supply, due to compromised renewable energy production or a peak in energy demand, the car batteries can 'invert' and provide the grid with an auxiliary power supply (possibly for a profit).
- Assuming the average electric vehicle has a capacity of approximately 40kWh[3] and that by 2050 there will be approximately 35 million electric vehicles in Britain[4]: Maximum $Energy\ available = 1.4TWh$
- Typically, charging an electric vehicle draws approximately 2kW power[2]: Maximum power available $= 70GW$.

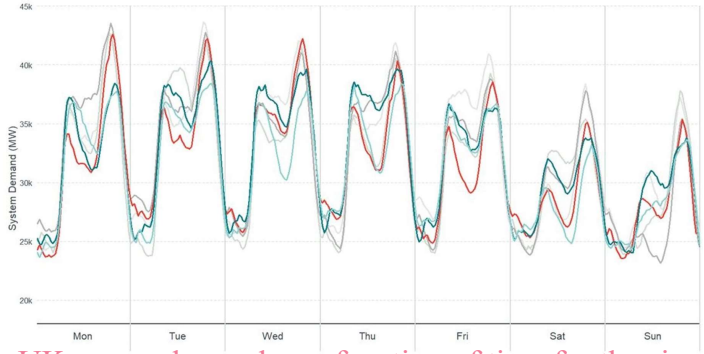

Figure 2: UK power demand as a function of time for the six weeks between 04 March and 11 April[5] Source: frontier-economics.com

- Such a protocol would be capable of balancing a 10GW power deficit lasting 10 hours by drawing power from 5 million vehicles using the equivalent of one full-charge from 2.5 million vehicles.
- A more sophisticated protocol would be able to distribute demand, for example, as 1/3 full-charge from 7.5 million vehicles that are low priority for a full-charge, instead of draining a full-charge from 2.5 million vehicles as in the first example.

Conclusion

- By 2050 excesses and deficits between supply and demand in the national grid will need to be tackled without relying on fossil fuel power stations.
- 'Smart charging' can help balance the national grid by using electricity stored in electric vehicle batteries as an auxiliary power supply to the grid..
- Despite this, we cannot reasonably expect to solve intermittence in renewable energy supply across days by smart charging alone. However, it can play a key role in a larger system to tackle the issue of fluctuations in supply and demand in a zero-carbon grid.

References

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