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nationalgrid

Frequency Sensitive Electric Vehicle and Heat Pump Power Consumption

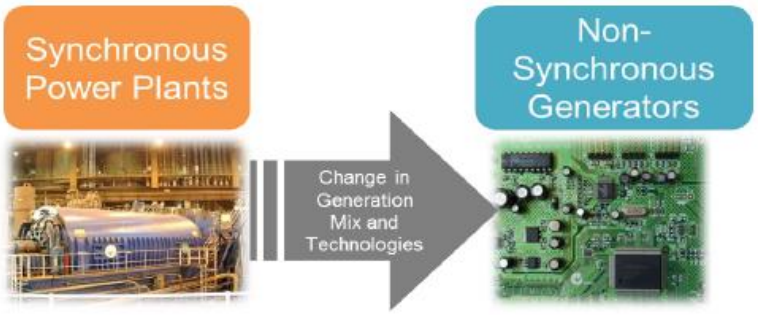
Network Innovation Allowance (NIA) project

National Grid commissioned this Network Innovation Allowance (NIA) project to assess the potential for electric vehicles and heat pumps to contribute to frequency response. The study analyses the potential of these technologies to **contribute to National Grid's frequency response needs**, identifies key **technical and operational challenges** facing this kind of service, reviews potential **commercial models and proposes next steps** for the development of heat pump and electric vehicle frequency response services. The analysis has been supported through interviews with key industry stakeholders including equipment manufacturers, suppliers, aggregators and DNOs.

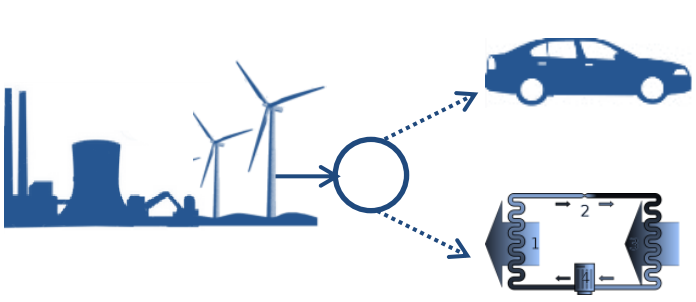
BACKGROUND

National Grid's System Operability Framework (SOF) showed that managing the frequency of the electricity system within statutory limits will become increasingly challenging in the future.

This is driven by the projected reduction in system inertia as renewable forms of energy generation replace conventional synchronous generation. With lower system inertia the impact of an unexpected event, such as a large power plant suddenly coming offline, has a greater impact on system frequency.



This means new approaches are needed to manage system frequency.



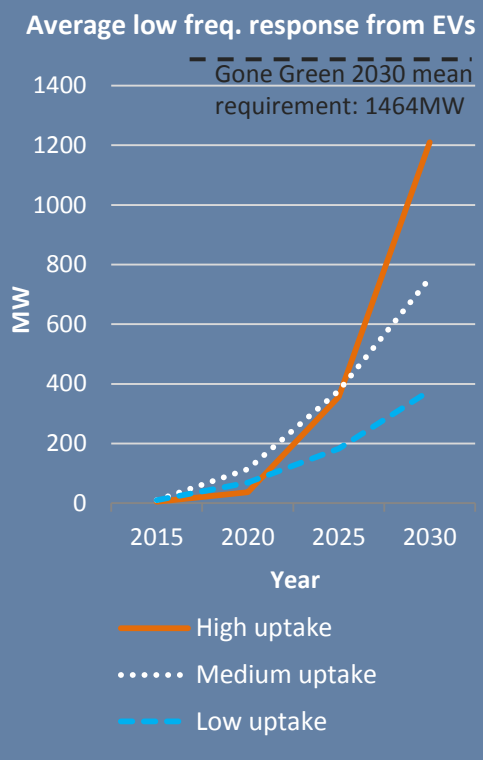
At the same time, electricity demand is projected to increase as heating and transport become electrified, with significant roll-out of electric vehicles and heat pumps. These technologies will also change the daily demand profile and, without adequate measures, could pose further challenges for balancing the system. However with the right framework, they may also provide new opportunities.

New low carbon electricity loads could be utilised to provide flexibility for system management.

KEY FINDINGS: POTENTIAL

The analysis shows a **significant system potential for both electric vehicles and heat pumps** to contribute to frequency response. By 2030 large scale deployment of these technologies combined could provide an annual average of **80% of National Grid's projected frequency response requirement and could represent ~£100 million of annual revenues to be shared between suppliers, aggregators and consumers.** The large number of assets involved leads to dilution of value per customer, and deployment will need to be supported by very efficient commercial models or mandating. Whilst there are no fundamental technical barriers to providing frequency response, **further technical development is required for both technologies to be able to practically deliver this service**.

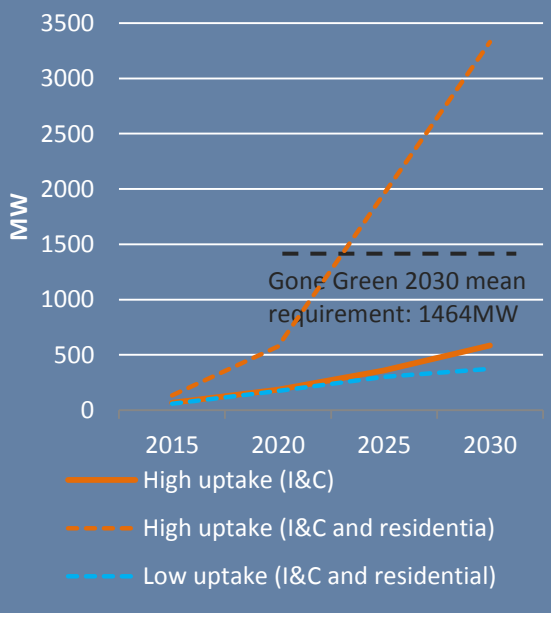
Electric Vehicles



- Potential for frequency response via interrupted charging, as cars are typically plugged in for 8 hours a day but need only 3 hours for charging.
- Batteries and management systems are in principle able to respond with high response speed and accuracy, potentially providing more effective frequency management.
- Charge points not currently designed with all of the required components. They could be redesigned, and the estimated additional hardware cost is ~£10 per unit.
- Currently no standardised protocol for communication between charge points and aggregator management systems.
- A smart charging strategy – rather than start charging as soon as the vehicle is plugged in – allows more sustained levels of available capacity, especially over the night.
- Diluted value at individual EV level, at net annual benefit of ~£25 per EV, requires efficient commercial models.

Heat Pumps

- Significant potential for frequency response from heat pumps with thermal storage. This is very sensitive to the availability of thermal storage such as a hot water tank or sufficient thermal inertia in the dwelling fabric.
- Flexibility from heat pumps has high seasonal and diurnal variation. The night period, when National Grid requirements are highest, has a low availability of heat pump flexibility.
- Not all heat pumps can meet the ramp-up speed requirements for frequency response, and ramp-down may be limited for control and safety. Manufacturers require a driver to address these in subsequent design iterations.
- Diluted value at an individual HP level, at net annual benefits of ~£50 for residential and ~£200 for commercial heat pump owners, requires efficient commercial models.



HOW WOULD IT WORK?

Electric Vehicles (EVs)

Battery charging can be slowed or interrupted without significant adverse effects.

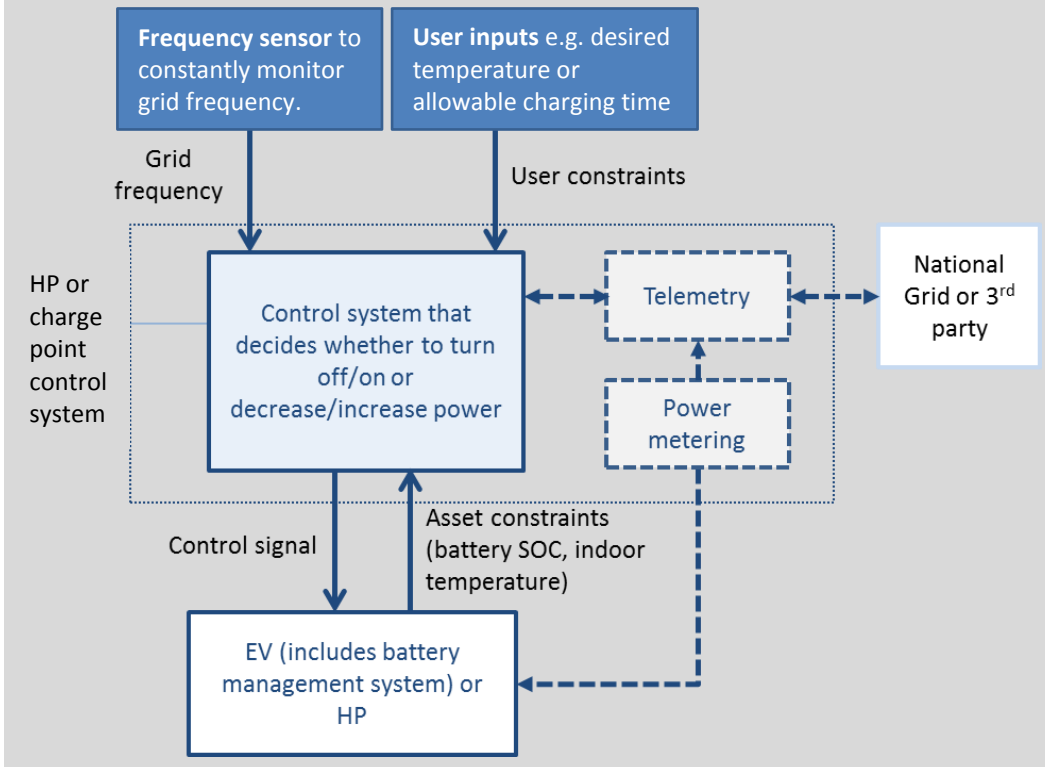
Deployment of a frequency response service would require further investments in metering and communications. Standardisation of communications is key to allow the different parties involved to share data effectively.

Heat Pumps (HPs)

Heat pump ramping rates likely to be the main design concern in using this technology for dynamic frequency response.

Heat pump controls and home energy management systems are usually not developed with required metering, telemetry and communications capability. A clear driver is required to encourage manufacturers to develop this.

Components and data flows for frequency response by EVs and HPs



Transmission grid impact

At a large scale, correlated responses from similar demand assets could lead to system frequency oscillations. This can be addressed through adequate and adjustable control characteristics (including deadband levels, hysteresis, switching devices in and out of frequency sensitive mode).

Verification and metering

The metering resolution and the communications bandwidth required to verify the amount of response provided are key issues for the industry to agree on.

Billing and settlement

Currently electricity suppliers would lack visibility of their customers' frequency response contracts, which could put them at a risk of increased imbalance costs.

Clustering

At the distribution level, clustered uptake may cause issues in already-strained areas. These may require increased communication and interaction between DNOs and the SO.

UNLOCKING THE POTENTIAL

Key barriers

- Diluted value at individual asset level limits incentives for participants to engage with this opportunity
- No current mechanism to utilise the speed and accuracy advantage over incumbent providers
- Lack of confidence and clear framework around demand-side frequency response means the market is not currently incentivising "frequency response ready" capabilities to be rolled out
- Potential impact on local networks and supplier balancing & settlement

Next steps

Strategic agenda & business case

A complex business opportunity such as this one requires the market to have confidence in long term value during early development stages. Options to facilitate this consist of:

- Including frequency response provision by large portfolios of kW-scale assets in strategic planning
- Helping to overcome technical barriers by supporting demonstration projects
- Providing clarity on technical and contractual service requirements

Enabling deployment

In the medium term, the development of this service can be supported by:

- Bilateral contracts with novel commercial models or less stringent technical requirements would allow room for the industry to converge on the most suitable configurations
- Collaboration with DNOs, aggregators and suppliers to provide visibility of impact on local networks and supplier imbalance

Market access

When this industry matures, there will be a more diverse range of response providers. Effective use of these opportunities may be supported by developing services that:

- Accommodate specific characteristics of different providers
- Utilise higher and more accurate responsive, and provide equitable remuneration for performance

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The dissemination event for this Network Innovation Allowance (NIA) project will be held on 22/09/15.

About Element Energy

Element Energy is a specialist energy consultancy working across a wide range of low carbon energy sectors, including smart electricity and gas networks, energy storage, carbon capture, renewable energy generation, built environment and low carbon vehicles.