Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Close Down Report Document

Date of Submission

Jul 2022

Project Reference Number

NIA2_NGESO001

Project Progress

Project Title

CrowdFlex

Project Reference Number

NIA2_NGESO001

Funding Licensee(s)

NG ESO - National Grid ESO

Project Start Date

April 2021

Project Duration

1 year and 0 months

Nominated Project Contact(s)

Cian McLeavey-Reville

Scope

While there is limited understanding concerning consumer behaviour, potential size and reliability of flexible response, the project partners believe there is a sizeable amount of flexibility within domestic consumers that is growing exponentially with the rapid growth of EVs. Additional technologies, especially heat pumps and residential batteries, also have inherent flexibility properties, however, these are further away from mass market.

The project will leverage project partners' unique datasets and analysis, based on their customers' participation in dynamic tariffs and use of electric vehicle charging, to provide:

- A quantification of the energy flexibility potential from households (i.e. looking beyond early adopters/sophisticated energy users alone to assess flexibility potential from mass market customers)
- The development of a segmentation methodology for identifying key parameters of domestic flexibility and separating households into discrete cohorts based on this
- An understanding of the cost of incentivising flexibility, allowing comparison against existing contracts

The project will extract and analyse Octopus Energy's and Ohme's data analytic models to provide a statistical analysis of domestic consumption and behaviour in response to dynamic tariffs. Focusing on mainstream low carbon technologies (electric vehicles, electric storage heaters, solar PV), customers will be segmented into cohorts, to study what inherent flexibility exists among them. Particular emphasis and granularity will be given to electric vehicle customer cohorts given the rapidly increasing deployment of this technology and the impact which it may impose on the network. Depth, speed and cost of response will be assessed across

segments.

This project also includes the design of a next-phase trial. The project will provide recommendations for a follow on trial project which would seek to quantify and validate the results of the modelling exercise.

Objectives

- Understand characteristics of flexibility provision from households in different scenarios and different technology types
- Identify distinct segments of household flexibility for use in ESO/DNO/DSO operations
- Recommend key assumptions in the analysis to test in trials

Success Criteria

To provide a segmentation methodology (a characteristic framework for each cohort created with similar profiles of response), related statistics on domestic flexibility and trial design that inform NG and SSEN's understanding of domestic flexibility depth and reliability.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

National Grid Electricity System Operator ("NGESO") has endeavoured to prepare the published report ("Report") in respect of CrowdFlex - NIA2_NGESO001 ("Project") in a manner which is, as far as possible, objective, using information collected and compiled by NGESO and its Project partners ("Publishers"). Any intellectual property rights developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NGESO and the Project partners).

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The project has met and exceeded its aims, objectives and success criteria. The three themes are:

- Determine the characteristics of flexibility
- Deliver a segmentation of household flexibility
- Recommendations for key issues to test in the trial

These are summarised below. A more comprehensive description of the project outcomes is available in the public report: www.nationalgrideso.com/document/230236/download

Flexibility Characteristics

The project analysed data from four tests of residential flexibility. Time of use (ToU) tariffs were used to test enduring response – that is residential flexibility that can be delivered repeatably, every day, over extended periods of time. Two tariff switching experiments were performed (from flat to "Agile" – a Dynamic ToU, and from flat to "Go" – a Static ToU). Also, one-off incentives were used in the "Big Turn-Up" and "Big Turn-Down" trials to test the level of 2-hour response that might be required at system critical times. These comprise four trials in total, with participation (of up to 20,000 customers) making it the largest project of its kind.

Alongside analysis of the trial data, Octopus and Ohme undertook a deep dive into customer participation with flexibility incentives. This produced insights on the year round provision of flexibility and response during negative price events. The deep dive on EVs evaluated how EV driver habits related to plugging in or out, charging times, battery state-of-charge (SoC), and how electricity tariffs can influence flexibility potential.

- For tariff switching, EV owning households reduced peak demand by 18% compared to 7% for non-EV houses
- This level of peak demand reduction was sustained over at least 6 months (the extent of data available)
- One off Big Turn down reduced peak demand by 59% (EV-house) and 41% (non-EV house) for a 2-hour period
- Big Turn up achieved an increase of up to 617% in 2-hour evening peak demand (EV households).
- Overall CrowdFlex demonstrated flexibility potential of national significance, both from enduring tariff changes that routinely reprofiled demand, and from one-off incentives that could support the system at critical times.

Segmentation of residential flexibility

Octopus' customers are more likely to be represented by National Grid ESO's engaged customer (early mover) segments compared to their less engaged (later mover) segments. This is expected given the "opt-in" nature of tariff switching to the Octopus flexible tariffs, and extrapolation of the outcomes to provide a national estimate of flexibility, was cognisant of this. The most important attribute found in the data that determined the level of flexibility response was the presence of an EV. As can be seen above, EV-owning households consistently provided a greater level of response, across both the enduring and the one-off flexibility experiments. This confirmed expectations: previous trials showed that the baseline level of energy consumption was a good indicator of flexibility provision (more consumption = greater flexibility), while other factors like demographics were not a reliable indicator of flex provision. These insights are aligned with CLNR-L243 report, and CVEI trial reports available here:

- TRL Report - Consumers, Vehicles and Energy Integration Project PPR917
- Insight Report: Domestic Baseline Profile - Customer-Led Network Revolution

The exception to the above is that for one-off turn down events, flexibility was similar irrespective of EV ownership. Again, this is expected as many EV owners already have a baseline EV charging profile that is predominantly outside of peak times, and therefore big-turn down response is generated by non-EV discretionary demand (white goods and appliances). The extent to which this turn down might have a demographic aspect, will be studied in future work.

Recommendations for key assumptions to test in trials
The project made recommendations under four headings, summarized below:

Reflect the statistical nature of residential flexibility resource: To fully exploit the potential of this resource, we need to develop tools and techniques that properly reflect its stochastic nature. This includes, baselining techniques, the development of non-deterministic power-system services, and determining how engagement and flex provision varies between segments.

Reliability of flexibility provision: Further work is needed to provide stakeholders with the level of confidence they need to exploit residential flexibility as a "business as usual" grid management option. This includes: understanding what (non EV) assets provide big-turn down, how that load is displaced to other periods, how time of day and season impact the turn down provision, and how electric heating devices perform.

Cost of one-off flexibility provision: CrowdFlex demonstrated the technical potential of one-off interventions, further work is needed to explore the price elasticity of one-off interventions, and the effectiveness of non-financial / information remedies in encouraging flexibility behaviour.

Automation of response: The one-off experiments were all "opt-in", which suggests that automation of response could be much more effective. Future work needs to explore automation, to determine how it can increase engagement, level of response per household, and staggering responses to provide the required flexibility provision at high geographic resolution (primary/secondary substation level)

The project report is available to view here: www.nationalgrideso.com/document/230236/download

Required Modifications to the Planned Approach During the Course of the Project

No significant changes were required to the planned methodology.

Lessons Learnt for Future Projects

As the project analysed pre-existing trial data, risk level was low, there were no significant changes and the planned outcomes were delivered successfully. The process did generate insights that are being carried forward into the design of pre-commercial trials,through the CrowdFlex SIF Discovery project and these include:

- The need to develop statistically reliable baselining processes, in particular to deal with the challenge of the stochastic nature of the asset.
- EV ownership was a primary determinant of flexibility provision, as was expected in the scope. The analysis showed that EV demand can be encouraged to increase demand, however one-off big turn down events look to rely on other assets such as white goods. Future work needs to explore turn down in more detail.
- The analysis indicated that the impact of season on flexibility potential looks to be important, but a bespoke trial will be needed to explore this issue fully.

The project was very effective in demonstrating the technical potential of residential flexibility.

- The analysis undertaken in the project showed that residential flexibility can be encouraged through a number of mechanisms and the aggregated flexibility capacity can be of national significance. For example, the project estimated that turn up could deliver 37GW

of demand turn up, or 6.8GW of demand turn down, by 2030.

- This confirms that this novel asset class has significant latent potential and the sector should continue to be explored to move towards commercially viable sources of reliable residential flexibility.
- The analysis showed that the enduring response to ToU tariffs was strong and sustained, at least over the 6 months of data analysed in the project. Analysing more than one year of ToU tariff data is a goal for future trials.
- The big turn up experiment was shown to be very effective, and heavily reliant on EV demand. Big turn down was less effective, and future work will need to explore how best to incentivize flexibility from non-EV demand.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The main outcomes of the project are the determination of the engagement rate, and the resulting flexibility, arising from each of the four distinct experiments that were part of the customer dataset being analysed.
Engagement rates varied significantly between the experiments. For example, big turn up had 63% participation from smart households, while big turn down had just 2% participation from non-smart households. This indicates there is significant potential to more effectively engage households, particularly for turn down events.

A table summarizing flexibility performance can be seen in the Appendix (figure 1) for each of the four experiments, and segmented by EV ownership. The analysis showed that there is great potential for generating flexibility from EV owning households, especially turning up demand when needed. For turn down of demand, the response is lower, indicating that non-EV loads will be important to provision of flexibility for turn down.

The project was successful in maturing the TRL level from 2 (invention and research/concept formulation) to 4 (bench scale research/lab validation). The project confirmed the latent technical potential for the residential sector to provide flexibility at levels of national significance. Further work is required to:

- develop tools and techniques that reflect the stochastic nature of the asset
- explore the impact of automation; to prove the reliability of the asset class to provide flexibility by evaluating response across seasons and at time of peak system stress
- explore how flexibility can be encouraged from the electric heating sector

A comprehensive project report is available with greater detail on the project outcomes here.

Data Access

Details on how network or consumption data arising in the course of a NIC or NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

Clear ownership of background and foreground IPR is central to the project and the viability of exploiting the outputs of the project by developing commercial flexible incentives to households. The default NIA IPR position has been followed with Foreground IP jointly owned by project participants, and Background IP remaining the property of the contributing party.

All project reports, including the comprehensive final report, are available to access on the Smarter Networks Portal.

Planned Implementation

The results and outcomes of the project will contribute to, and be developed further through the CrowdFlex Discovery SIF project. Future work will include clarifying the commercial models and mechanisms that could encourage flexible behaviour, most notably whether a supplier is exposed to a broad enough set of system challenges (and their costs) such that they could transmit a "Whole System" tariff to customers, whose flexible behaviour would contribute to solving whole system challenges. The alternative is that the DSO and the SO would need to provide these signals via their own commercial models. In the latter case, it may be that the licencees may require some modification of their existing policies and standards, but it is not foreseen at this time.

Other Comments

The Project outcomes and results contain confidential information and intellectual property rights that cannot be disclosed in this Report due to their proprietary nature. Should the viewer of this Report (“Viewer”) require further details this may be provided on a case by case basis following consultation of all Publishers. In the event such further information is provided each and any Publisher that owns such confidential information or intellectual property rights shall be entitled to request the Viewer enter into terms that govern the sharing of such confidential information and/ or intellectual property rights including where appropriate formal licence terms or confidentiality provisions. Dependent upon the nature of such request the Publishers may be entitled to request a fee from the Viewer in respect of such confidential information or intellectual property rights.

Standards Documents

Not applicable