SIF Discovery Close Down Report Document

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Project Progress

Project Title

CrowdFlex: Discovery

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Lead Funding Licensee

NG ESO - National Grid ESO

Project Start Date

April 2022

Project Duration

2 Months

Nominated Project Contact(s)

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Project Summary

CrowdFlex aims to establish residential flexibility as a reliable energy and grid management resource, establishing it alongside business as usual solutions such as network reinforcement or new thermal capacity, using system operational principles to develop a new digital service. CrowdFlex builds on a significant first phase, https://smarter.energynetworks.org/projects/nia2_ngeso001/, which sized the market opportunity and the viability of consumer response.

Problem Being Solved

- Predicting the current and future needs for domestic energy provision for heat, power, and transport, and how flexibility can reprofile these to support the power system. Building on CrowdFlex:NIA (which focused on residential loads and EV demand), this Project will also explore residential heat. CrowdFlex:Trial will assess how the impact of EV charging, heat pumps, and other emerging low carbon technologies on customers electricity bills can be reduced when consumers participate in domestic flexibility.
- Coordinating energy transmission, distribution, and system operation. CrowdFlex partners represent stakeholders across the power system. CrowdFlex aims to develop commercial frameworks to allow the ESO and DNOs to coordinate their needs and transmit them to consumers via effective tariffs.
- Planning future policy, regulatory conditions, and market designs to support whole system approaches. CrowdFlex will identify the market design of flexibility services that coordinate the needs of the ESO and DNOs, while lowering consumers' energy bills. CrowdFlex will align demand to variable renewable energy generation, reducing stress on the transmission and distribution networks.
- Maximising efficiency in large-scale network and system investments by taking a whole systems view across generation and demand side changes linked to decarbonisation. Domestic flexibility will improve the efficiency of existing investments, deferring or avoiding investment in new network and generation capacity. These savings can be transmitted to consumers, reducing energy bills.

Summary Key Findings

Meeting the aims of the SIF Innovation Challenge

We found ESO & DNOs aligned for a reliable domestic flexibility service to participate in technology agnostic markets. Stakeholders wanted to transmit to customers, incentives which coordinate to alleviate whole system challenges. They wish CrowdFlex to leverage learning via ENA Open Networks Project for “whole system” service stacking and improve coordination between networks and other system participants. Simple customer-facing incentives will reduce complexity, bureaucracy, and barriers to entry for domestic flexibility.

Categorization of response actions via PAS-Routine and PAS-Response will help reduce duplication when testing assets in a trial and commercial deployment.
Discovery has shown how CrowdFlex can support whole system transformation by:
- Improving baseline data to streamline reserve requirements and balancing actions,
- Inform FES/DFES modelling on ToU tariff-based response,
- Clarify role in Network Options Assessments and future Capacity Market
- Exploring grid-responsive heating for congestion and constraint alleviation
- Identify and respond to consumer preferences to inform future market designs, which optimise across networks and infrastructures.

Evolution of the perception of the problem/opportunity

We found that flexibility will initially be required to express domestic flexibility as a firm capacity. This loses value through derating but will bring assets to market rapidly, without regulatory revision. CrowdFlex will create a novel service, procuring capacity on a probabilistic basis, to unlock more whole system value.
We delineated between “Routine” and “Response” dispatch, and how these have distinct system value.
Stakeholders wanted Crowdflex to limit Constraint costs, and Distribution congestion from heating and indicated better demand baselining has significant value.

Network’s role to realise future opportunities

There is a need to develop consumer incentive signals that reflect whole-system challenges. DSOs wish to understand how to accommodate domestic flexibility while avoiding sub-optimal investment at DSO level.
Improved visibility of demand forecasting will improve network planning decisions. Flexibility will improve utilization of network and system operators’ existing and future assets, delivering value to all network customers.

Innovative, novel, risky aspects of the work

Generating Response-type actions to support networks during stress events is very challenging and novel, but have significant system value.
Expressing flexibility as a stochastic resource is highly innovative, requires a coordinated approach to deliver value, and therefore is risky.Linking dispatchable demand to reducing constraint costs is needed but has significant unknowns technically and commercially.

User needs

Scope boundaries

CrowdFlex will exclude generating assets ensuring results will be statistically significant.
Trials will build upon the behavioural segmentation identified in Discovery, encouraging greater participation in domestic flexibility.
Discovery confirmed the two-pronged approach to service delivery, generating early value in domestic flexibility while maturing a more innovative approach to procurement.
The trial experiments will correspond to the service categorization that were identified (Response and Routine).
Aligning with other projects, responding to DSO needs, CrowdFlex Alpha will include a Heat Road Map, including a demand turn up service to reduce VRE based Constraints and heating based DN congestion.

User Journey & Needs

We plan on early and regular communication with customers to maintain engagement, educate and o optimize the user journey. Input from Citizens Advice has tested assumptions against the needs of consumers, taking learnings from previous research, and incorporated into Alpha.
Ohme and Octopus are aggregators of small-scale assets and will lead the development of any demand and flexibility forecasting and consumer segmentation modelling.
We clarified system user (ESO/DSO) needs for confidence in flex provision, and to solve system challenges. The project will develop incentives that reflect this, and the trial will provide statistically significant results.
We have conducted interviews with National Grid ESO, SSEN, and WPD to capture their vision for utilizing domestic flexibility. These operators are project partners and will continue to be engaged throughout CrowdFlex. CrowdFlex also engaged with BEIS/Ofgem to consider any regulatory/policy barriers which might need removing.

Minimising the burden on your future users

Ohme’s charging optimization software improves the user experience, connecting with ToU tariffs, NGESO, and EV OEM APIs to automate charging schedules to deliver consumers’ EV charging requirements whilst minimizing the burden on the consumer, their costs, or CO2 emissions. CrowdFlex has identified that domestic assets could maximise the benefits to consumers by stacking services. By utilizing a commercial model where domestic assets are aggregated by an aggregator, they optimize the stacking of flexibility services, minimizing the burden on the consumer, while increasing their revenue.

As consumers uptake of more LCTs, CrowdFlex can reduce their impact on the system. Similarly, as more VRE is brought onto the system, CrowdFlex can increase the penetration of VRE, reducing redispatch and peaking gas turbines on the system, CrowdFlex offers a source of balancing and other flexibility services for NGESO & DNOs at less cost than BAU, with cost savings passed back to customers.

Impacts and benefits

Discovery has confirmed strong appetite from ESO/DNOs for domestic flexibility to play an active role in energy markets and services. The introduction of such a large resource of flexibility could greatly reduce the operational costs of the ESO (namely constraints, reserve and energy balancing, which amounted to £2B in 2021 (£72 per household) and strategic capacity and network investments. CrowdFlex distinguished market appetite for both “Routine” type actions to make energy markets more efficient (supported by ToU tariffs) and “Response” actions to support system operation and network and system planning. It identified the value of a reliable consumption baseline to reduce reserve and balancing costs.

We identified that shifting demand out of peak times via ToU tariffs is already factored into the deliverability of Net-Zero policies, and CrowdFlex will be critical vehicle for delivery. The need to mitigate VRE constraints/redispatch costs will be essential to the affordability of net-zero policy.

Discovery confirmed:

- The current energy markets and services that CrowdFlex should target.
- Trial parameters required to test and mature services under Routine and Reserve categories.
- A behavioural based segmentation to improve the uptake of domestic flexibility.
- A novel methodology for forecasting domestic demand and flexibility
- A pathway to introducing exploitation of stochastic flexibility services.
- A commercial framework for domestic flexibility to address system challenges
- A high-level specification for future work in Alpha and in a future trial.

The only notable scope variation is that Alpha will include a Heat Roadmap to align with other projects exploring heat flexibility.

CrowdFlex has shown the capability to reprofile daily demand, supporting VRES uptake and lowering emissions from domestic demand. Additionally, Discovery has identified the opportunity to manage network constraints and reduce balancing costs. Benefits can flow to all electricity users.

Based on Element analysis of the value of domestic flexibility, households could generate up to £137 per year in savings. Assuming CrowdFlex becomes BAU, flexibility could be worth £1.25B p.a. across GB. This far outweighs the estimated £10-15M trial to establish a domestic flexibility resource. This includes £3.8B of avoided DN reinforcement and £1.8B of avoided transmission network reinforcement investments. This equates to 4.6MtCO2eq/year of avoided CO2 emissions, assuming peak demand is met with additional OCGTs. If initially 100,000 customers begin participating in domestic flexibility in 2024, growing out to 2050, The potential IRR of CrowdFlex is 318%.

Risks, Issues and Constraints

Potential constraints

Discovery confirmed capability of residential assets to address challenges across the power system, excluding a few services (Dynamic Containment/Moderation on basis of latency).

It may be challenging to forecast the availability of domestic assets far enough in advance to be accepted into the Capacity Market or the NOA process.

There is a need to establish an agreed baseline as a reference for flexible actions. A federated approach to data and agreed methods may need to be developed to achieve this while following GDPR.

Monetising the full value of this stochastic resource will be challenging initially, but the twin track approach delivers early value while maturing the full value.

Barriers to innovation

Discovery has indicated near term ESO/DNOs require firm capacity to be declared, which likely derates flex assets relative to their expected potential. Alpha will work with stakeholders to determine enhanced system value should market participants use a stochastic approach to express capacity. Such a procurement process would need regulatory approval. Entering domestic assets into current flexibility services may also present potential barriers, such as metering requirements. To integrate domestic flexibility into the current marketplace, these will have to be overcome.

Discovery has indicated that there would be value in sharing probabilistic demand forecasts with ESO for system operation and reserve setting. A mechanism and incentive to facilitate this data sharing would need to be established for BAU operations.

Working within/Removing these constraints

CrowdFlex:Alpha will have parallel focus areas. One will confirm the current services which domestic assets can meet the technical criteria to participate. The second will develop methods to declare and value stochastic assets. We will engage with the SO/DNOs to explain the benefits of stochastic flexibility offerings and understand the barriers for implementing such a service. This approach improves confidence in the services and revenues available to domestic flexibility in the near term, ensuring it can be rolled out rapidly, while laying out a long-term pathway to introduce a stochastic approach to flexibility, which would provide system savings for all stakeholders.

To facilitate sharing probabilistic demand forecasts, ESO SMEs will be engaged to ensure the model scope is fit to meet their needs and trial designs are appropriate. CrowdFlex will work with the Virtual Energy System program to develop a Common Framework approach to enable interoperable and secure data sharing as an enduring approach.

Working in the open

Talking publicly

CrowdFlex had presented publicly at SIF launch webinar and at SIF Show and Tells and VirtualES webinars. We have a project page covering scope, partners, and benefits on the public ESO website and are drawing up comms plan to share outcomes (on ENA smarter networks portal).

Challenge and external input

CrowdFlex invited input in presentations/meetings with:
- BEIS Digital Twin Steering Group for possible modelling approaches and data interfaces,
- Ofgem ESO Incentives Monitoring meeting for consumer engagement approaches,
- Citizens Advice meeting for user journeys/needs,
- BEIS/Ofgem meeting for policy/regulatory/innovation interactions and areas of interest for investigation.

The project team held interviews with a range of stakeholders in ESO, SSEN, and WPD to present CrowdFlex's learnings/proposals and seek input, feedback, and recommendations of further resources/initiatives.

Shared learning

CrowdFlex produced shared learning plans with BiTraDER, Equinox, Domestic Reserve Scarcity. This includes inviting named contact to SIF show and tell, and 1-1 follow up. Sharing findings on range of services and incentive and statistical modelling approaches will accelerate industry development. We leveraged prior innovation projects such as Sustain-H, CLNR, LCL, CVEI.

CrowdFlex also had deep engagement with:
- Equinox as CrowdFlex project partner (1-1 calls to share learning on scope/alignment, opportunities for future collaboration to avoid duplication, shared expertise for planning trial technical aspects and possible additional expert partners for consortium).
- DRS as partner (cross-attendance at project meetings, they shared project design/implementation/operational learnings, they shared initial project data findings).
- SIF Flexible Heat SPEN project (1-1 call to share learning on scope/alignment, opportunities for future collaboration to avoid duplication).

Building relationships

CrowdFlex began discussions with other suppliers (Utilita, British gas) and modellers (Imperial College) as possible future collaborators and to share past project learnings. As part of our discussions with Equinox, they have directed us to other organisations which might be needed in Beta for a large-scale consumer trial.

How has it been?

Our approach has achieved high visibility of CrowdFlex (Both Discovery and the previous CrowdFlex:NIA), making discussions efficient and effective. Engaging with similar projects through shared learning plans has enabled us to ensure that CrowdFlex completes independent, innovative work, not overlapping with other funded projects. This is most relevant for Equinox, undertaking a trial to investigate flexibility available from HPs. CrowdFlex:Alpha will develop a heat roadmap so that any heat trial is coordinated with Equinox.

Costs and value for money

Fund spending

CrowdFlex has done out what it set to do in the Discovery Phase and all the costs incurred were as budgeted. All project partners spent 100% of their costs and there are no significant variations to explain. Funds were spent as follows; all are labour costs:
- Element Energy – conducting interviews with ESO/DSO SMEs on current/future flex service needs, technology capabilities and commercial services, writing up interviews and summarising findings, developing high-level approaches to trailing flex services, writing up findings in T1/2/4/5 report, attending project progress meetings.
- ESO – providing expertise during SME interviews and via email, providing integration with VirtualES and use case inputs, general project management, reviewing deliverables, conducting project progress meetings.
- WPD – providing expertise during SME interviews and via email, reviewing deliverables, attending project progress meetings.
- SSEN – all in kind, but same inputs as WPD.
- Octopus – conducting interviews with ESO/DSO SMEs on current modelling approaches, writing up interviews and summarising findings, developing high-level approaches to statistical modelling of demand and flexibility, developing initial use cases and data needs for VirtualES integration, writing up findings in T3 report, attending project progress meetings.
- Ohme – developing customer segmentation approaches and consumer journeys, conducting meetings for feedback, undertaking clustering data analysis, writing up findings for T2 report, attending project progress meetings.

Value for money

Since these are activities that are not core to ESO's day to day activities, in the absence of SIF funding, we would consider other routes for innovation funding. If all such routes were exhausted or not sufficient, ESO would be unable to take the leading role in making this idea a reality. If domestic flexibility could be integrated into the SO/DNOs BAU approach then regardless of whether participation is via existing services or a new stochastic service, domestic flexibility could provide significant savings in balancing, reserve, capacity and network investment costs that in the absence of domestic flexibility would be passed on to the consumer via their energy bills. Further, we note our updated CBA indicates domestic flexibility could generate system savings of £1.25Bn/yr across GB. This is

significantly greater than Discovery cost £0.5M and trial (£10-15M).

Special conditions

Condition 3: required CrowdFlex to present to Ofgem a summary of how CrowdFlex, BiTRADER and EQUINOX differ, a resource plan, and a plan for sharing learnings across all three, before CrowdFlex began.
- CrowdFlex produced a summary of how it differs from BiTraDER, Equinox, and Domestic Reserve Scarcity, a resource plan, and a plan for sharing learnings across the projects.
- This has already impacted the direction of CrowdFlex, with the extent that heat trial investigation is to be tackled by a Heat Roadmap to be developed in Alpha.
Condition 4: required CrowdFlex to engage with other funded projects that have explored the integration of demand side flexibility in markets and present to Ofgem for regulatory approval a plan to access these types of assets and approaches under BAU market arrangements.
- CrowdFlex engaged with multiple relevant projects, through literature reviews and 1-1 meetings. These projects include: Sustain-H; Customer-Led Network Revolution (CLNR); Low Carbon London, Consumers (LCL); Vehicles and Energy Integration (CVEI); Equinox; BiTraDER; Domestic Reserve Scarcity trial; and SIF Flexible Heat SPEN.
- As a foundation, CrowdFlex should develop statistical techniques to predict portfolio capacity. These will need to balance the desire to offer markets firm capacity, and the temporal/geographic limits given the nature of the resource.
- Initially, these techniques should conform to the needs of existing markets, where the aggregator collapses the PDF of portfolio capacity to a single value, offered to the market as a firm capacity.
o While this is sub-optimal (as the aggregator has to derate the asset base to ensure declared performance) nevertheless the approach does not require any alteration to business-as-usual market arrangements.
o This has the advantage of bringing domestic flexibility services to market, without regulatory revision.
- In parallel, CrowdFlex should work with ESO to identify if greater system value can be unlocked by providing a probability density function of portfolio flexibility capacity, rather than a single value.
o This could reduce operating reserve requirements (over £0.5Bn spent in 2021) while avoiding the need for the aggregator to derate the portfolio. As a key innovation action, Alpha will work with stakeholders to determine potentially unlocked system value should market participants use probabilities to express capacity.
o If a new stochastic domestic flexibility service was designed, it would need regulatory approval. Therefore, engagement with policy and regulation stakeholders should be maintained in alpha.

Documents uploaded where applicable

Yes