WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Multi Asset Demand Execution (MADE)

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Prepared by:	Matt Watson	04/10/2019
Reviewed by:	Steve Pinkerton-Clark	10/10/2019
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Glossary

Term	Definition
BAU	Business as usual
BEIS	Department for Business, Energy and Industrial Strategy
CCC	Committee on Climate Change
DNO	Distribution Network Operator
DSO	Distribution System Operator
DUoS	Distribution Use of System
EV	Electric Vehicle
GB	Great Britain
HHP	Hybrid Heat Pump
HP	Heat Pump
HV	High Voltage
IPR	Intellectual Property Register
LCT	Low Carbon Technologies
LRE	Load Related Expenditure
LV	Low Voltage
MADE	Multi Asset Demand Execution
NIA	Network Innovation Allowance
NPV	Net Present Value
PAT	Public Attitudes Tracker
PV	Photovoltaic
V2G	Vehicle to Grid
WeSIM	Whole-electricity Scenario Investment Model
WPD	Western Power Distribution

1 Executive Summary

The Multi Asset Demand Execution (MADE) project is funded through Ofgem's Network Innovation Allowance (NIA). MADE was registered in March 2019 and will be complete by October 2020.

The MADE project investigates the network, consumer and broader energy system implications of high volume deployments of the combination of:

- Domestic Electric Vehicle (EV) charging;
- Hybrid heating systems (domestic gas boiler and air-source heat pump) or Heat Pump (HP) heating systems; and
- Solar photovoltaic (PV) generation and storage.

The research objective is to better understand the feasibility of managing and aggregating multiple Low Carbon Technology (LCT) assets affordably through the use of advanced algorithms to unlock value from energy markets.

MADE is a £1.6m project, delivered by PassivSystems with a five home technology trial in based in South Wales and the South West.

This report details progress of the project, focusing on the last six months, March 2019 to September 2019.

1.1 Business Case

Previous Distribution Network Operator (DNO) trials[1] have highlighted the significant potential value of flexibility from LCT loads (My Electric Avenue highlighted up to £2.2bn of reinforcement avoidance by 2050 and Freedom highlighted £300 million of reinforcement deferral in South Wales alone by 2050). This trial will evaluate the potential interactions between the various value streams to understand the total savings possible.

Based on a future homeowner that has a conventional heat pump and a conventional EV charger, PassivSystems estimate that one LV (Low Voltage) feeder (at a cost of approximately £40k) would be required for every four homes, a cost of £9,279 per home.

As shown in the trials mentioned above, this cost can be reduced significantly though the use of inherent asset flexibility (smart EV charging & hybrid heating systems). By utilising this flexibility, PassivSystems estimate that one feeder would be required for every 14 homes, at a cost of 2,900 per home.

An integrated optimised approach with supplemented PV and storage (the MADE method) could produce significant savings, PassivSystems estimates that one feeder would be

[1] For Example Electric Nation (http://www.westernpower.co.uk/projects/electric-nation), Sola Bristol (https://www.westernpower.co.uk/projects/sola-bristol), Freedom (https://www.westernpower.co.uk/projects/freedom) & My Electric Avenue (www.myelectricavenue.info).

required for every 39 homes, at a cost of £1,531 per home. This would help reduce network reinforcements, in addition, a hybrid solution can also respond to constraint signals and prevent Distribution Use of System (DUoS) charges.

Financial benefit = base cost – method cost.
Financial benefit = £2,900 - 1,531 = £ 1,369 per household.

Whilst the speed of deployment will vary on a regional basis, the deployment of LCTs is expected to grow significantly across GB. As such the learning will be replicable across all GB.

To achieve the optimised control of LCTs, new hardware and software is required. With economies of scale, the hardware cost to roll out an automated multiple asset control that will integrate with the majority of LCTs will be £100. In addition, an annual service fee of £30 - £50 will maintain and continually optimise to market conditions. This equates to a Net Present Value (NPV) of approx. £500 - 756 over a 25 year lifetime.   However these costs will provide significant additional benefits beyond DNO reinforcement avoidance which should help cover a significant portion of the costs.

1.2 Project Progress

This is the first progress report. It covers progress from initial registration in March 2019 to the end of October 2019.

This reporting period has focussed on the trial design and modelling aspects of the project. This is detailed in section 2.2, and includes

- The design of the trial use cases;
- The design of the trial control strategies;
- The assessment of data sets for Electric Nation, Freedom and Sola Bristol;
- The assessment of the in-home value of the MADE concept;
- The modelling of the associated impact on a local network;
- The impact of the MADE concept on the wider distribution network and the whole electricity system;
- The development of potential business models for the deployment of the MADE concept; and
- A survey of customer views on the MADE concept.

With the modelling complete, the trial has now entered the recruitment phase to install the equipment for the technical trial.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The MADE Project Review Group meets on a bi-annual basis. The role of the Project Review Group is to:

- Ensure the project is aligned with organisational strategy;

- Ensure the project makes good use of assets;
- Assist with resolving strategic level issues and risks;
- Approve or reject changes to the project with a high impact on timelines and budget;
- Assess project progress and report on project to senior management and higher authorities;
- Provide advice and guidance on business issues facing the project;
- Use influence and authority to assist the project in achieving its outcomes;
- Review and approve final project deliverables; and
- Perform reviews at agreed stage boundaries.

1.3.2 Project Resource

Using existing relationships from the Freedom project, we have formed a project team led by PassivSystems to deliver the MADE project. This includes, Wales and West Utilities, Imperial College, Everoze and Delta EE.

The project partners are all experts in their field and are managed by PassivSystems. Everoze, Imperial College London and Delta EE act as subcontractors to PassivSystems, whilst Wales and West Utilities act as an advisor.

PassivSystems - Project management, home energy management system, PV optimisation and demand aggregation modelling.

Wales & West Utilities - Gas distribution network requirements, measurement and modelling.

Everoze – micro-economic energy modelling, commercial modelling.

Imperial College – Data analysis and a whole-system assessment on the future GB electricity systems.

Delta-ee – Customer research and Business Modelling.

1.4 Procurement

During this reporting period, contracts were placed with PassivSystems for the delivery of the project. PassivSystems have in turn placed contracts with the partners acting as subcontractors.

1.5 Project Risks

A proactive role in ensuring effective risk management for MADE is taken. This ensures that processes have been put in place to review whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, reporting of significant changes that will affect risk priorities and deliver assurance of the effectiveness of control.

Contained within Section 7.1 of this report are the current top risks associated with successfully delivering MADE as captured in our Risk Register, Section 7.2 provides an update on the most prominent risks identified at the project bid phase. There are currently 24 live project risks.

1.6 Project Learning and Dissemination

Project lessons learned and what worked well are captured throughout the project lifecycle. These are captured through a series of on-going reviews with stakeholders and project team members, and will be shared in lessons learned workshops at the end of the project. These are reported in Section 5 of this report.
The key dissemination activity held in this reporting period was the interim results webinar held on the September 24th. 100 people attended the presentation which discussed the project progress to date. This focussed on the results of the modelling. A brief question and answer session was held following it with follow up provided to attendees on unanswered questions. A recording of the webinar as well as the full interim report and the partner reports are also available here.

2 Project Manager's Report

2.1 Project Background

Following the publication of the Committee on Climate Change (CCC) report promoting hybrid heating systems as a "low regret" option, we need to consider the network implications of CCC's call for ten million hybrid heating system installations across GB by 2035. Many of these installations will be in homes that have also adopted EVs. Understanding the interplay between these two primary drivers of electrification is essential to plan future network developments. The third factor that the project will explore is the impact of domestic solar PV and storage installations on these. During the same timescale as hybrids and EVs are being adopted, solar PV costs will fall to a level that makes subsidy free installation an economic reality for homes that wish to save on the cost of their grid supplied electricity.

Several innovation trials have highlighted the possibilities for individual LCTs to provide flexibility: EV - Electric Nation[2], HP - Freedom[3], PV and Storage - Sola Bristol[4]. However, each of these investigations has looked at a single technology type in isolation. Currently we do not have sufficient understandings on how such systems may interact and whether the flexibility is complementary, optimal, or counter-acting.

The research objective is to better understand the feasibility of managing and aggregating multiple energy assets (EV, hybrid heating system and solar PV) affordably through the use of advanced algorithms to unlock value from energy markets. Through customer research we will also evaluate consumer trust in new technology that is taking greater levels of EV charging, heating system control, and design appropriate user interfaces and information systems to help drive adoption.

Based on the lessons learned from previous NIA trials MADE will carry out micro-economic and system-level analysis to extrapolate previous trial findings in order to:

- Build a microeconomic model for domestic multi-asset, multi-vector flexibility for GB today, this will: Identify the most attractive customer types; Identify the high potential service stacks; Quantify the value (£); Include a particular focus on Distribution System Operator (DSO) services.

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[2] The Electric Nation project aimed to enable DNOs to identify which parts of their network are likely to be affected by EV uptake, and whether EV demand control services are a cost effective solution to avoiding or deferring reinforcement on vulnerable parts of their networks. The project has deployed Smart Chargers to understand how and when people charge their EV's, and has trialled solutions such as smart charging and Time of Use tariffs. The results from these trials were used to develop a network assessment tool to predict where plug-in electric vehicle uptake may cause network problems.

[3] FREEDOM, in partnership with Wales and West Utilities installed 75 hybrid heat pumps within domestic properties in South Wales. The hybrid heat pumps used electricity when there was sufficient capacity on the system to do so and switched to gas at the point the capacity on the electricity system had been reached. This project demonstrated the value of a hybrid solution to avoid the need to reinforce the electricity network whilst supporting a significant decarbonisation.

[4] The Sola Bristol installed 2kW of battery storage in domestic lofts alongside PV solar panels. The PV panels were directly connected to the battery to store excess solar energy. Five commercial buildings were also tested. The project highlighted the

- Understand how the combined operation of residential solar PV generation, heat pump systems and smart EV charging may provide benefits to the consumer;
- Assess the whole-energy system benefits (including network infrastructure) and carbon benefits of large-scale deployment of the MADE concept;
- Consider conflicts and synergies between local community and national level objectives, in the context of the flexibility enabled by the MADE concept.
- Estimate consumer benefits of the MADE concept and inform the design of the market framework that would enable consumer to access the revenues that reflect the benefits delivered.

A five home technology trial in South Wales and the South West will be used to validate the modelled learning.

The proposed project runs for 19 months and has been broken down into six work packages.

Work Package 1: Project Management
PassivSystems will complete the project management for the duration of the project to deliver the system design, development and technical feasibility installation. The project management will use PassivSystems' project management processes and will oversee the flow of development work through PassivSystems' agile Kanban processes.

Work Package 2: Problem definition, approach and trial design
The project delivers the consolidation of existing information across partners, development of the customer, DNO, local network and national network proposition, a documented set of use cases, establishing data protection and data management protocols.

Work Package 3: Modelling: Consumer, Micro-Economic, Local and National GB Network
PassivSystems will produce a high level control strategy, simulate the MADE concept (desktop exercise) and collaborate with Imperial College and Everoze to model the local network, national network and the microeconomics. All partners will apply advanced big-data techniques to analyse and quantify the success of different approaches, considering demographic parameters, consumer flexibility, different loading conditions, different generation periods, time of application of different prices etc. The system-wide benefits of a large-scale rollout of the MADE concept, considering both local and national level infrastructure will be assessed. This will be enabled by advanced modelling approaches developed by Imperial College, that identify system solutions that deliver secure and cost-efficient energy supply while respecting national decarbonisation targets.

Work Package 4: ASHP/EV/PV Control & Aggregation Solution
PassivSystems will design and develop its smart control to enable optimisation (by cost or carbon) of the EV charge point, the electric heating asset and the rooftop PV generation. The will include the PassivEnergy platform that aggregates demand across households and enables the demand flexibility to be traded with energy markets including the DSO. PassivSystems will develop its existing aggregation platform to ensure each vehicle has enough charge for the next trip (based on consumer preferences) before calculating how much remaining capacity to sell to grid and/or support domestic heating (via heat pump,

hybrid heating system, or hot water tank immersion). The controls will also manage the heat and transport assets and maximise the self-consumption of rooftop solar PV through a coordinated control strategy.

Work Package 5: Technology Feasibility Trial (maximum of five homes)
PassivSystems will deliver a five home technology trial; the field trial will test the technology deliverables and gather data on consumer EV charge and energy system outcomes.

Work Package 6: Technology, Customer and Network Analysis – Dissemination
The project partners will deliver an interim and final report on consumer, energy system and business model outcomes. PassivSystems will be responsible for sharing the findings of MADE publically during and after the project is complete.

2.2 Project Progress

2.2.1 Work Package 1: Project Management

Progress within this reporting period

This work package runs for the duration of the project and looks to ensure the project is running smoothly and is progressing adequately. This also looks to track and manage risks to ensure successful delivery. Key elements of this are mentioned in Sections 3 to 7.
During the reporting period the first project review group was held, this provided an overview of the project progress to the Project Sponsor (The Network Strategy Manager) and the Innovation Team Manager. This focussed on the modelling work and the key assumptions used and outputs being delivered.
Within this reporting period, a number of deliverables were we delayed due to resource constraints. However these have now been resolved with no impact on the project budget or overall timescales. Lessons have been learnt from prevent similar issues arising again in the project.

Next steps

This work package will continue for the duration of the project.

2.2.2 Work Package 2: Problem definition, approach and trial design

Progress within this reporting period

This work package has now been concluded with the trial design now complete. PassivSystems have developed an initial design for the field trial and the use cases that will be explored over winter 2019-2020 using the deployed physical assets. The general approach is to explore in-home factors for the multi-asset multi-vector scenario, rather than factors that affect multiple homes, as a small scale field trial is unlikely to provide definitive answers to the latter.

Phase 1: Baseline operation

For the first part of the field trial, assets will operate somewhat independently and this will provide baseline data for later comparison.

- **Flat electricity tariff**. We expect that participants will initially be on a flat electricity tariff that provides no incentives to shift electricity from peak times. Operation is expected to illustrate how demand coincides in the early evening.

- **High fossil fuel price**. The hybrid heat pump (HHP) controls will be configured with a high price for the fossil fuel boiler to reflect the future scenario of substantial decarbonisation (so that as high as possible a proportion of the heat demand is provided by the heat pump). Against this pricing, hybrid heat pump operation will be optimised by the system to minimise running costs for the user and maximise heat pump efficiency.

- **Solar optimisation.** The heat pump will be optimised to utilise available solar generation (and recognise that it is free) but will not otherwise be coordinated with the battery. An alternative baseline scenario we might consider is no solar awareness for the heat pump (i.e. it assumes electricity it consumes is a fixed price).

- **Simple automatic battery control.** The batteries will be controlled by Sonnen's internal "automatic" control algorithm which charges the battery when there is net household production (i.e. excess PV generation that would have been exported) and discharges when there is net consumption. The battery will thus react to heat pump operation, and in effect the heat pump will have priority on the solar generation.

- **Default EV charger behaviour.** The EV charger will be used "out of the box" however the consumer decides, and the consequences will be monitored.

Monitored data will be collected from this phase and analysed to produce conclusions as to likely load profiles in the baseline scenario. These results will be compared with modelling, and further modelling work used to extrapolate these results to the country as a whole (i.e. used to refine previous models).

Phase 2: National-scale grid drivers

The next step is to construct a scenario where assets in the home react to national-scale grid drivers (but assets within the home are largely uncoordinated with each other). This will explore the impact of "selfish algorithms" where multiple assets take advantage of cheap electricity prices (for example) causing stress on the local distribution network.

- **Variable ToU electricity tariff**. We propose that all participants are placed on a simulation of the Octopus Agile tariff as this is the most advanced tariff in the market today and most representative of future price variations (as prices are determined by the day-ahead electricity wholesale market).

- **Export tariff.** If possible we will suggest that participants sign up to the "Outgoing Octopus" tariff which pays a variable rate for electricity exported to the grid. We believe that export tariffs are going to become more widespread with the Smart Export Guarantee coming in from 2020.

- **Hybrid heat pump optimisation.** Heat pump operation will be optimised against the variable rate tariff, so that heat will be stored in the fabric of the house during low tariff periods, and perhaps the fossil fuel boiler will be used during high tariff periods; the strategy will be determined by optimisation calculation.

- **Simple battery control.** On top of the "automatic" behaviour, we will inject commands to charge if the grid import price is below a certain threshold or discharge when the export price is below a threshold.
- **Immersion control.** We will inject simple commands to turn on the immersion heater if the grid import price is below an appropriate threshold such that it is the cheapest way of producing hot water.
- **Electric vehicle charge control**. The occupiers will be encouraged to set up rules on their smart charger to take advantage of the ToU tariff in a relatively simple way.

We hope to demonstrate from analysis of the monitored data some of the consequences of cheap rate electricity causing simultaneous asset activity which results in higher grid stresses than the baseline case.

Phase 3: In-home asset coordination

PassivSystems will develop algorithms which coordinate assets within the home to make best advantage of the variable availability of cheap electricity, the different storage potential of the assets, and the various patterns of consumption needed by the occupiers. These will calculate the best strategy for the householder in terms of minimising running costs against the variable tariffs. The battery will be put into "manual" mode in circumstances when the algorithm determines that it can do better than the default "automatic" mode.

The purpose of this phase will be to find out how the patterns of asset operation change when they move from uncoordinated to coordinated control within the home, and whether this makes the impact on the local grid bigger or smaller.

Phase 4: Local grid interventions

In this final phase we will identify some key grid problems (for example, times of peak load) and will design some interventions that demonstrate that an inter-home coordination system could mitigate some of the problems. This could for example involve pushing down to the control algorithms a whole-house maximum power constraint which is applied across the set of flexible assets, and might for example result in more pre-heating by the heat pump and a transition to gas heating at the time that the EV is plugged in and the sun has gone down. This application of the control is expected to take place towards the end of the trial, around March 2020.

Next steps

This work package is now complete.

2.2.3 Work Package 3: Modelling: Consumer, Micro-Economic, Local and National GB Network

Progress within this reporting period

The bulk of this work package was carried out in this reporting period. This collated in the Interim Report, with all the detailed learning reports also finalised. These can be found here and are summarised below.

Analysis of existing datasets

PassivSystems have carried out analysis of the data from three previous major projects:

- The Electric Nation project which looked at smart charging of electric vehicles;
- The Sola Bristol project which looked at integrating battery storage with PV panels;
- The FREEDOM project which looked at hybrid heat pumps.

These projects investigated in isolation the individual LCT assets that the MADE project is combining together, so the starting point of the MADE modelling exercise was to understand the conclusions from each of these projects and analyse their datasets to get insight into the MADE scenarios.

The concluded that previous NIA projects provide a useful data source for information on individual LCTs which may be installed within a home. In particular, the FREEDOM project has enabled PassivSystems to develop an annual forecasting tool, enabling the gas and electricity demands of a hybrid heating system to be modelled, in order to provide heat pump demand profiles for use in the MADE modelling. Through the FREEDOM project, knowledge has been gained on consumer acceptance of hybrid heating system operation, and therefore what demand management interventions may be acceptable to consumers. This will help to shape the MADE control strategy.

In addition to this, Electric Nation results demonstrate that there is scope for demand management of EV charging and that time of use incentives can be effective in influencing charging habits. The project also demonstrates that mass uptake of time of use tariffs can lead to further complications surrounding demand on the network, suggesting that coordinated control between households may be required to manage these consequences. Electric Nation has also provided insight into domestic consumer EV charging use, which has been used to develop the EV charging profiles used for the MADE modelling.

However, whilst these projects provide useful insight into the operation of LCT's in isolation, no previous projects have addressed operation of all the energy assets considered under the MADE project in combination.

Domestic Level Techno-Economic Modelling

Everoze have undertaken techno-economic modelling to evaluate the feasibility and benefits of multi-asset co-ordinated delivery of flexibility at a domestic property level. This section provides a very brief summary of this modelling work, extracted from Everoze's Modelling Results report where more detail can be found.

The estimated value accrued is shown in Figure 2-1. Modelled benefits or 'value' from providing flexibility are calculated as the savings in electricity costs and revenues from ancillary services, less any cost of additional electricity imports. This does exclude asset capital or operating costs and so 'value' as used in this report does not imply life-cycle value. It should also be noted that DSO services are highly geographic. As such the revenues shown below will not be available in all areas. Additionally, as increased volumes of flexibility enter the market, we would expect to see negative pressure on the available DNO value.

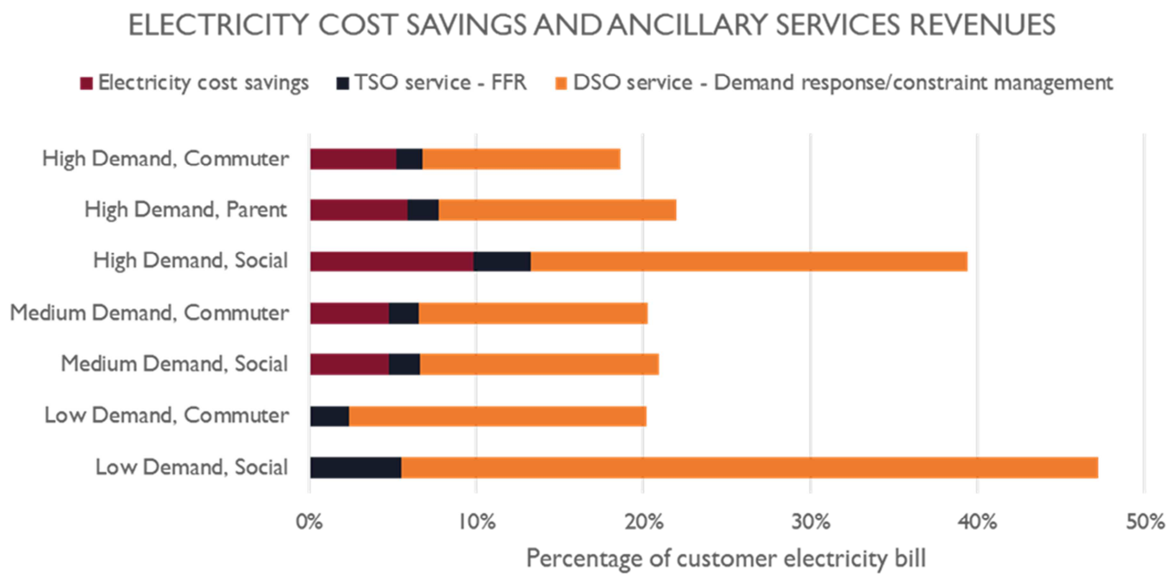

Figure 2-1: Estimated Flex Values for the considered property types/EV use cases

Key findings from the modelling regarding electricity cost savings are as follows:

- **There is good value from EV smart charging:** Savings from EV smart charging is a key component of the electricity cost savings part of the overall value stack. The EV transport pattern and utilisation level, more specifically, arrival and plug-in times close to evening peak periods, have a high degree of sensitivity on cost savings that can be achieved from smart charging.

- **Value from peak shifting is secondary to smart charging:** Based on current wholesale cost profiles and network charges, savings from peak shifting are secondary to savings achieved from EV smart charging for customer types with high EV utilisation.

- **Low demand/EV utilisation customer types are only attractive for DSO services:** The value opportunity from peak shifting and smart charging is low for customer types with low demand and low EV utilisation levels, and the value stack is heavily reliant on DSO services. For such customer types, if DSO service opportunities are not available, then there is little benefit from co- ordinated FLEX at the household level. Moreover, if the EV is available for most of the time during the evening peak period, then with the EV by itself performing peak-shifting, an ESS would not be needed for such Low Demand consumer types (unless DSO services are available and pursued).

Key findings from the modelling regarding ancillary services are as follows:

- **DSO services form a key part of the value stack**, but are subject to large variance in value depending on the local network constraints and service need. WPD's SECURE service offers better value over the year compared to the DYNAMIC service; although the latter has a higher utilisation tariff, the likelihood of utilisation is lower. The right kind of DSO service opportunities appropriate for the domestic portfolio would need to be pursued. If otherwise, revenues from DSO services are not attractive.

- **Maximise DSO service opportunities:** A household or a portfolio being able to offer a higher volume with co-ordinated and combined flexibility from the suite of energy storage and EV available would be able to maximise value.

- **Firm Frequency Response is not an attractive value proposition: Firm Frequency Response** is a very small portion of the value stack, and so may not be worth pursuing given metering, testing and associated administration costs.

In summary, coordinated domestic flexibility is a notable value opportunity, with possible savings of up to £250 p.a. per household under best conditions. Additionally, Domestic flexibility offers material peak load shifting potential for the DSO.

PassivSystems domestic level modelling

PassivSystems have carried out an internal programme of modelling to explore the interrelations between the low carbon assets. The approach is broadly similar to Everoze's Domestic-Level Modelling but is more closely tied with PassivSystems models that will be used in the field trial. We were also keen to understand the more detailed relationships between the assets and explore directly some of the elements of coordinated control that are going to be tested live in the field trial.

Figure 2-2 and Figure 2-3 show the modelled baseline demand profile for an example winter and summer day, respectively. It should be noted that, in these figures, 'Heat Power' refers to the electrical power consumed by the heat pump.

The following was observed through analysis of the baseline profile:

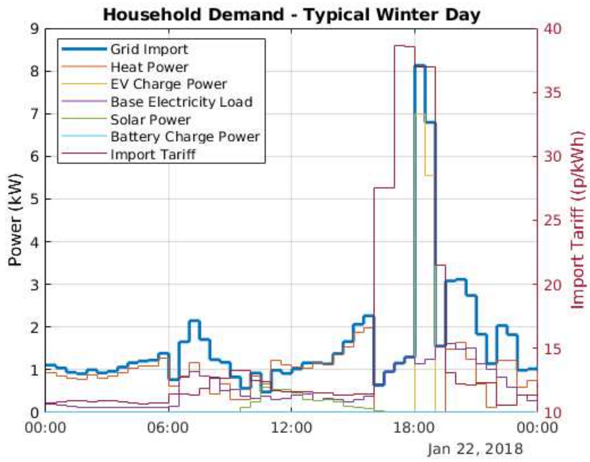

Figure 2-2: Baseline profile, typical winter day

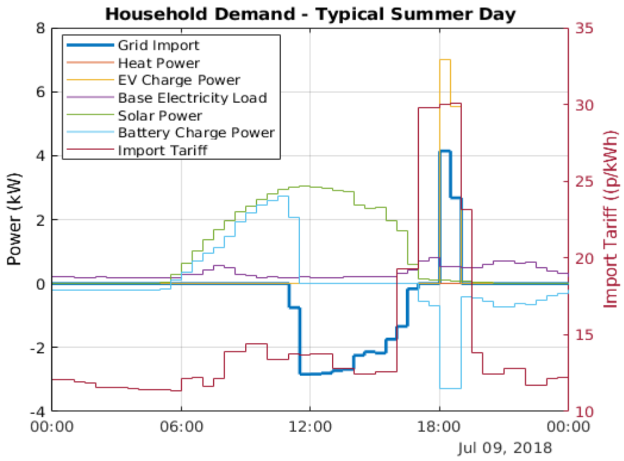

Figure 2-2: Baseline profile, typical summer day

- Due to the nature of the EV Commuter use profile, without smart charging EV charging is likely to fall during times of increased electricity import costs, corresponding to times where there is high demand on the network. This timing, coupled with the high EV charges rates, mean that this is both expensive for the consumer and likely to lead to potential network problems.
- EV charging is a significant load compared to other household loads; EV charge power can reach up to 7kW, whilst heat pump power is constrained to 2kW, battery charge power is constrained to 3.3kW and base household electricity consumption has a maximum of 1.8kW over the year. This suggests that simply shifting the EV charging to a different time or postponing the operation of other energy assets within the home whilst the EV is charging is not likely to be a sufficient solution to mitigate potential network overloads if high EV uptake occurs. Instead, one possible solution includes inter-home coordination, where the EV load of one household could be compensated by the delaying of EV charging or switching to gas boiler use in multiple other households. Alternatively, another potential solution includes a constraint on EV charge rates. Reducing the EV charge rate would potentially make it possible to compensate for the EV charging load through intra-home coordination of assets, since the loads would be more comparable.
- Due to low solar generation coupled with the assumed simplistic domestic battery charging behaviour (charging when there is excess solar generation, discharging when there is excess household consumption), the battery is used very little over the winter.

The following can be observed from implementation of the three optimisation methods outlined above:

- Optimisation Method 1: Delayed EV charging - It can be observed that the EV charging moves entirely away from the import tariff peak, which leads to a reduction in associated import costs of approximately £180 over the year. However a small increase in peak daily electricity demand during winter is observed. This can be explained by the fact that since the household heating demand is met by the boiler during the import tariff peak and outside of this peak it is met by the heat pump, shifting the EV charging outside of this time led to the heat pump and EV charger operating simultaneously. This is unlikely to be an issue on a house by house basis, but may present problems at feeder level if this effect occurs in multiple homes.

- Optimisation Method 2: Switching from heat pump to gas boiler - It can be seen that there is little effect on annual cost to the consumer, with an increase of £13 across the year in the optimisation case. This is largely due to the fact that EV charging commonly takes place during times when the import tariff is expensive, and thus the gas boiler is used instead of the heat pump during this time anyway, coupled with the fact that EV charging is typical quite short (less than two hours) in the modelled scenario. However, this method of optimisation could be used in conjunction with Optimisation Method 1, to enable the cost saving benefits of shifting EV charging away from times of peak import tariff, whilst preventing the increase in winter peak import loads.
- Optimisation Method 3: Constraining EV Charge Power - It can be observed that this optimisation method notably reduces the homes demand peaks. This allows for the coordination of assets also has a much bigger role to play as the relative power consumption levels of the EV, battery and heat pump are more comparable.

Local Network Modelling

Delta-EE's primary modelling focus has been to draw on the outputs from the household level modelling and simulate the impact of the LV network to understand the level of constraint. This modelling uses outputs from the domestic level modelling conducted by Everoze. A model has been created which uses the electricity demand and export profiles to create a demand profile at the feeder level. The model calculates demand diversity across the total number of households on a feeder based on the total number of customers, and the proportion of customers with the new technologies installed (representing the market penetration).

The feeder is assumed to have been sized based on the After Diversity Maximum Demand (ADMD) of a feeder consisting of the average UK home (that has no solar PV, heat pump or EV). This allows for the feeder limit to be calculated, and hence the number of occurrences where demand exceeds this limit.

Figure 2-4 shows the model flow chart for the local network modelling, including required inputs and outputs.

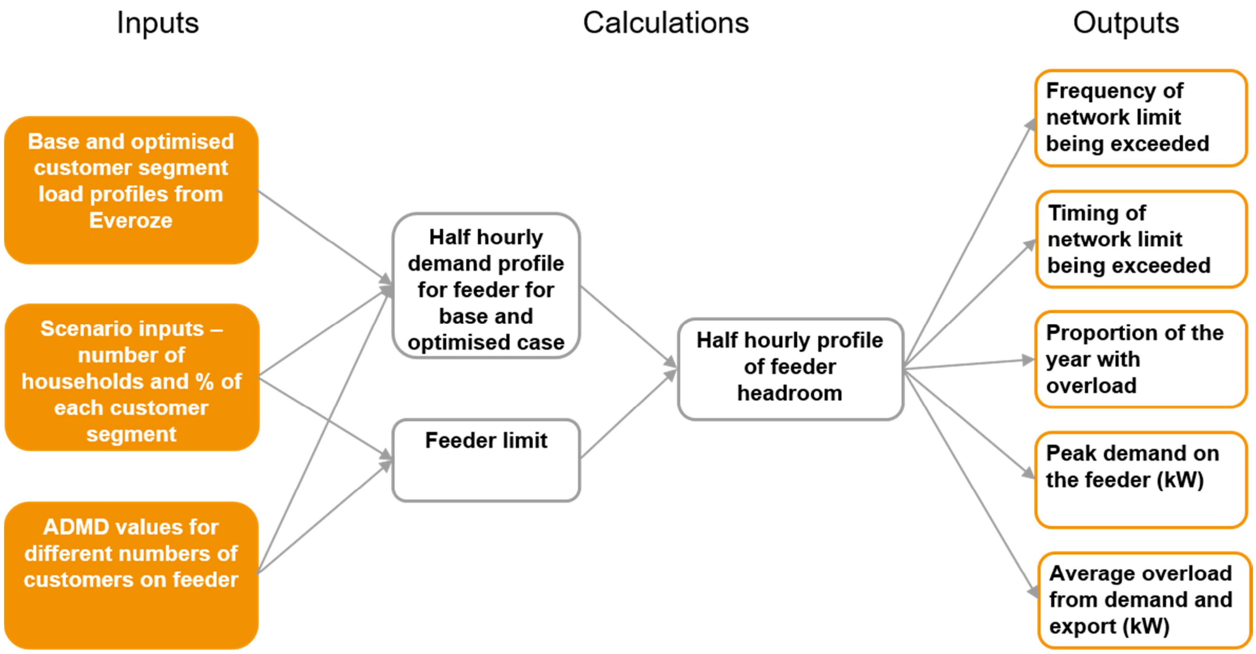

Figure 2-3: Local network modelling flow chart

The following key conclusions can be drawn from the local network modelling results:

- Network constraints could be significant by the mid-2030s without optimisation of demand.
- Optimisation of household energy demand in many cases reduces the load on the network. At technology penetration levels of less than 50%, optimisation at the household level to existing price signals reduces occurrences of feeders being overloaded. Beyond this point, price signals will need to be altered to incentivise behaviour that reduces the aggregated loads on feeders. For example, price signals will need to be structured in order to incentivise.
- Staggering EV charging to avoid automated responses causing night time peaks in demand.
- Flattening load profiles to increase network utilisation.
- Feeder capacity can vary significantly and exact effects are likely to be location specific. This has a large impact on the occurrences and extent of network limits being exceeded and should be investigated further.
- The largest load is caused by EV charging. Effective EV smart charging strategies will therefore be key to reducing the likelihood of overloading the network.
- Further research should be done to better assess the impact of diversity in demand on these results, and to assess a broader range of ADMD conditions based on real network data.

Whole-System Modelling

Imperial used their Whole-electricity System Investment Model (WeSIM) and Load Related Expenditure (LRE) model to determine the whole-system benefits of the MADE concept. This section provides a summary of this modelling work, extracted from Imperial's MADE Project interim report. The whole-system benefits of MADE concept have been assessed for two scenarios for the GB power system from the CCC, Baseline and High Uptake, and for three time horizons: 2025, 2030 and 2035

The system benefits of a large-scale deployment of MADE concept across the considered scenarios are shown in Figure 2-5. Cost savings are reported as annual values, consisting of annual operating costs and annualised investment costs for different asset types. The results suggest that the flexibility delivered via MADE solutions can achieve overall system gross benefits in the order of billions of pounds per year. It should be noted that these benefits do not consider the costs of coordinated control system implementation, as such these values present the best case view of the benefits. Further details on these costs will be developed as part of the trial.

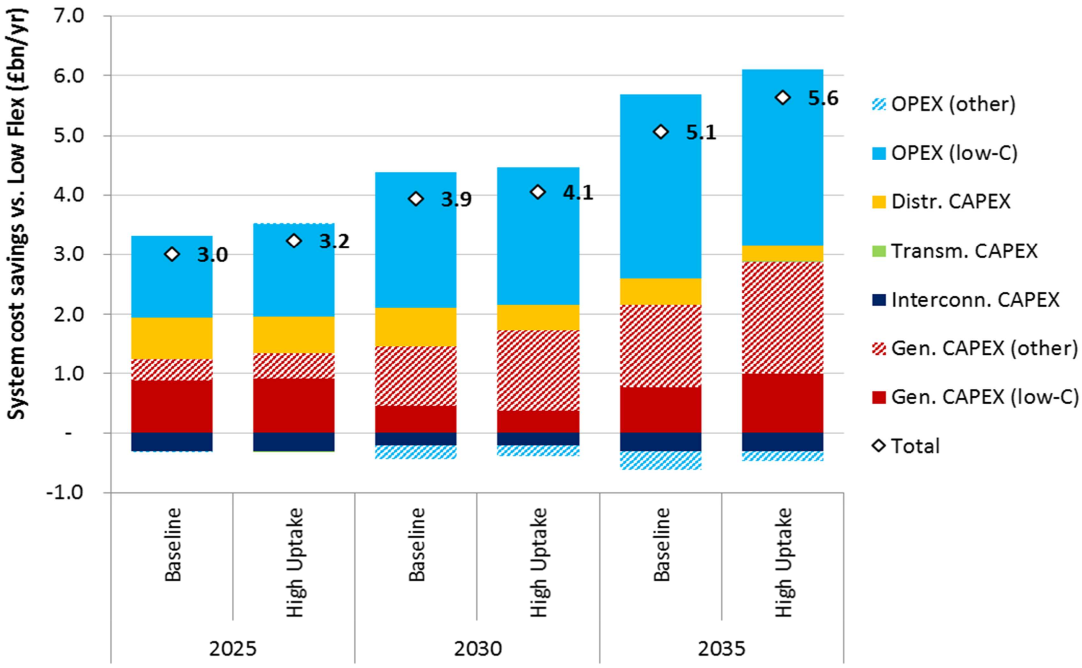

Figure 2-4: System cost savings driven by MADE concept across scenarios

Significant distribution network reinforcements could be needed to accommodate rapid uptake of EVs and HHPs. Its effect could increase the total cumulative expenditure on distribution networks by up to £50bn by 2035 (or £1.8 billion per year in annualised terms). According to an earlier analysis by Imperial College.

Utilising distributed flexibility, in particular using smart resources such as EVs and HHPs, could mitigate the impact of electrification of heat and transport on distribution network reinforcement cost. In order to assess the GB distribution network reinforcement requirements driven by heat and transport electrification and the related impact of distributed flexibility, we have run the scenarios considered earlier in our detailed distribution network model (LRE), in order to investigate the implications of high EV and HHP uptake on necessary network upgrades across different voltage levels, asset types and DNO areas.

Figure 6 shows the effect of MADE-enabled flexibility on annualised GB network reinforcement cost for the scenarios analysed in this report. Cost savings in Figure 2-6 are broken down according to asset types, voltage levels and reinforcement drivers. It should be noted that the counterfactual to these savings is a significant increase in DNO reinforcement cost (mentioned above) rather than current levels of DNO reinforcement spend.

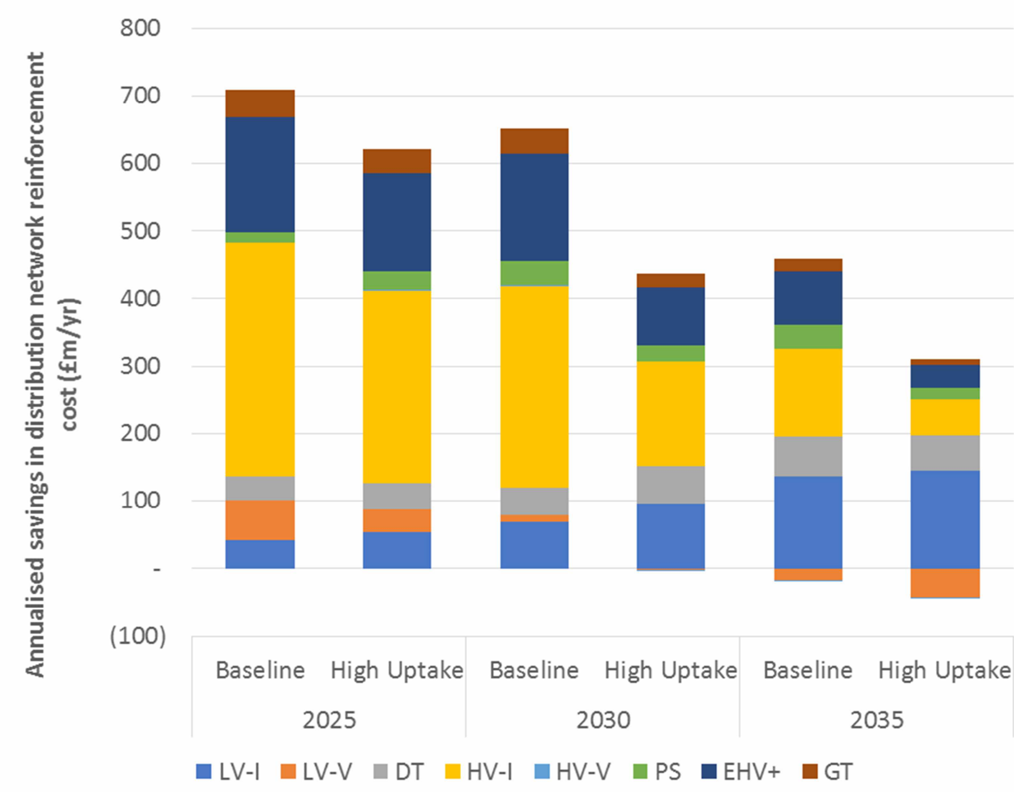

Figure 2-5 Breakdown of annualised savings in network reinforcement cost driven by MADE concept across voltage levels and asset types

The results show the significant distribution network benefits of distributed flexibility and the spread across the voltage levels. Reinforcement cost savings diminish when looking further into the future, which results from a very high penetration of EVs and HHPs assumed in that time horizon, so that energy requirements become more prominent than power requirements. Nevertheless, the potential savings are still substantial even at high penetrations, and are combined with an increased potential for whole-system savings.

Customer engagement

As part of the MADE project, Delta-EE carried out customer research with 750 UK car owners. This exclusively commissioned customer research was carried out in order to better understand current views around EV ownership (and usage patterns) as well as third party control of EV charging. The research was carried out via an online survey during May 2019, with a panel of UK adults that is close to representative of the broader UK population. The panel contained 52 respondents that own a fully electric vehicle, 57 that own a plug-in hybrid vehicle, 67 that own a hybrid (can't be plugged in) and 150 respondents that own solar PV.

Depending on the technologies owned, survey respondents were directed to answer different sets of questions. The maximum number of questions answered by any respondent was 38.

The key findings from this survey were as follows:

1. **EV charging**

The most popular place of charging is at home. Most current EV owners charge their EVs less than two hours per session. If forced to allow third party control of their EV charging for the purposes of Vehicle to Grid (V2G), EV owners are willing to let their batteries discharged to a minimum level of 30%. EV owners are mostly very positive about the idea of having an app to help them control their charging

2. **Third party control**

There was a lot of concern around third party control of charging and heating systems across all groups. If third-party management of assets is to be accepted, people still want to feel as if they are ultimately in control at all times and that the third party is helping them save money.

3. **EV and solar PV owners are higher income and more engaged**

One of the apparent trends in the results is that the EV and solar PV owners tend to be between the ages of 25-49, are more engaged with switching their energy supplier, tend to have higher incomes (over £64k household income /year) and own their own homes. They also tend to live in detached homes. This makes sense as detached homes are more likely to have their own driveway (for EV charging) and more roof space, for putting solar PV panels. The majority also are interested in installing a battery system. When asked about their attitude towards the environment they tend to think they are doing as much as they can to be environmentally friendly.

4. **Those with electric heating are more engaged**

Of the survey respondents, 22% said electric heating was their main source of heating. A higher proportion of those with electric heating (including heat pumps) had a low emission vehicle, particularly a fully electric car. Those with electric heating also switched suppliers more often than any other group.

5. **The laggards**

There was a group of respondents, about 10% of the total, that tended to be older (>50), drive petrol cars and not own solar PV. They were not as interested in being green and do not regularly switch energy suppliers. They also had little awareness of heat pumps or smart appliances or heating controls.

6. Comparing the results of this customer research to other sources

It is apparent that the online survey sample is not a truly representative sample given how much more aware of heat pump technologies the respondents were than compared to the Department for Business, Energy and Industrial Strategy (BEIS) Public Attitudes Tracker (PAT) (47% awareness versus 25% awareness in BEIS PAT).

Another discrepancy can be found in the number of respondents that actively switch their energy supplier. Data from Ofgem and BEIS indicates that ~15 - 20% of homeowners switched their energy supplier in the last year, whereas the survey results indicate that 43% switched their energy supplier in the last year. This is likely an artefact of the nature of an online survey, where the respondents are likely to be more informed and tech savvy.

Business models

The energy landscape is rapidly evolving and moving from the traditional centralised model (central power generation) to one that is decentralised, more customer centric and lower carbon. This transition is seeing a lot more value being moved downstream and this is resulting in new ways for domestic customers to access these value streams.

As part of the MADE project, Delta-EE have identified customer propositions for business models which could be developed following a large scale deployment trial. These propositions are built upon a well-used framework for developing business models and customer propositions, and build on insight taken from studying similar business models. The propositions identified by Delta-EE are summarised below in Table 2-1.

Table 2-1 Summary table of customer proposition options

	Option 1: All inclusive	Option 2: Buying enhanced control	Option 3: Minimising peak demand
Technologies included	Heat pump, Gas boiler, EV, Solar PV, Battery storage, Smart controller hub.	Smart controller hub plus any combination of Heat pump, Gas boiler, EV, Solar PV, Battery storage.	Heat pump, Gas boiler, EV, Smart controller hub.
Purchase / ownership of tech	Leased at no upfront cost to customer.	Bought upfront by customer (or through finance arranged by customer).	Bought upfront by customer (or through finance arranged by customer).
Energy supply	Included within monthly fee.	Bought separately by customer.	Included but paid per unit energy used.

Contract	Monthly fee covers lease of technology, energy supply, MS&I. Approx. 5 years (could offer choice).	No monthly fee, no minimum contract length.	No monthly fee, no minimum contract length.
Customer value streams	Monthly fee which is an acceptable price to customer, easier budgeting, peace of mind.	Energy bills are reduced by smart control hub. Credit paid back from any DR revenue.	Cheap flat rate energy price (not being exposed to TOU variation).
Company value streams	Minimising cost of electricity through self-consumption and buying at cheap times (company keeps costs savings), selling electricity to grid at peak times.	Sale of smart controller hub DR revenue from selling electricity back to grid at times of high demand.	Minimising peak power draw over home (no current value in this in UK), Minimising cost of heating and charging EV via dynamic TOU signals, DR Revenue - turning down demand.
Risks	Low for the customer, except for perception of entering a contract. Main risks taken on by company.	Low if the customer was seeking to buy these technologies already (but long payback period if all tech bought).	Low if the customer was seeking to buy these technologies already.
Target customer	Customers who seek low carbon heating and personal transport.	Customers who own or would like low carbon heating and personal transport.	Customers who are looking to buy low carbon heating and personal transport.
Most suitable provider	Energy Service Provider (could be energy supplier, manufacturer or other).	Controls company.	Energy supplier, DNO.

In addition to understanding potential future business models, Delta-EE have also considered a proposition for participants if a large scale deployment trial was to take place, aiming to test how its suite of technologies interact and can access flexibility value streams as they emerge or increase in the future

The assumed fixed aspects of the trial:

- All households which have all technologies: hybrid heating system (heat pump and boiler), EV and charger, solar PV and battery, control hub;
- Households will pay for or already own heat pump, boiler, solar PV and battery Household will be provided with EV, charger and control hub;
- Trial length will be two years; and
- No further relationship or contract is intended to be offered after two year trial.

The options for a trial proposition are limited by the requirements on which technologies must be included, and that the customer must pay for them. The main variation between different options are whether energy supply is included, and how the customer is financially incentivised to participate. A summary of the identified potential trial proposition options can be seen below in Table 2-2.

Table 2-2: Summary table of trial proposition options

<table>
<tr><th></th><th>Option 1: fixed monthly cost</th><th>Option 2: low price energy tariff</th><th>Option 3: credit payment</th><th>Option 4: social housing</th></tr>
<tr><td>Technologies included*</td><td colspan="4">Heat pump and battery storage (paid for by customer),
Gas boiler and Solar PV (assumed customer already owns)
EV (leased to customer for free), Smart controller hub (assume given for free)</td></tr>
<tr><td>Purchase of tech*</td><td colspan="3">Bought upfront by customer</td><td>Bought by social housing provider through grant funding</td></tr>
<tr><td>Energy supply</td><td>Included: within fixed monthly fee</td><td>Included: paid per unit used</td><td>Bought separately by customer</td><td>Bought separately by customer</td></tr>
<tr><td>Contract</td><td colspan="4">Length of trial (2 years)
Guarantees include: sufficient level of comfort delivered, sufficient mileage in car when required</td></tr>
<tr><td>Customer value streams</td><td>Low fixed monthly price for energy (based on level of existing usage or similar)
MS&I included
Lease of EV for free</td><td>Low price tariff for energy
Lower energy demand (due to increased self consumption)
MS&I included
Lease of EV for free</td><td>Monthly or periodic credit payment for being involved in the project
Lower energy demand (due to increased self consumption)
MS&I included
Lease of EV for free</td><td>Monthly or periodic credit payment for being involved in the project
Lower energy demand (due to increased self consumption)
MS&I included
Lease of EV for free</td></tr>
</table>

Company value streams	Experiments demonstrate value of: optimising dynamic TOU, self-consumption of PV, selling electricity back to grid via DR.			
Risks	Financial benefit to customer is unlikely to cover capital cost of technologies Value streams cease to exist after trial			
Target customer	Wealthy / high income households who are attracted by all-electric home or minimising environmental impact			
Partners needed	Energy supplier, provider of EVs	Energy supplier, provider of EVs	Provider of EVs only	Provider of EVs, social housing provider

Next steps

This work package is now complete.

2.2.4 Work Package 4: ASHP/EV/PV Control & Aggregation Solution

Progress within this reporting period

The project will utilise PasivSystems's existing energy management platform, with the addition of new components for integration with assets that are new for this project. A logical view of the system architecture is shown below in Figures 2-7 & 2-8.

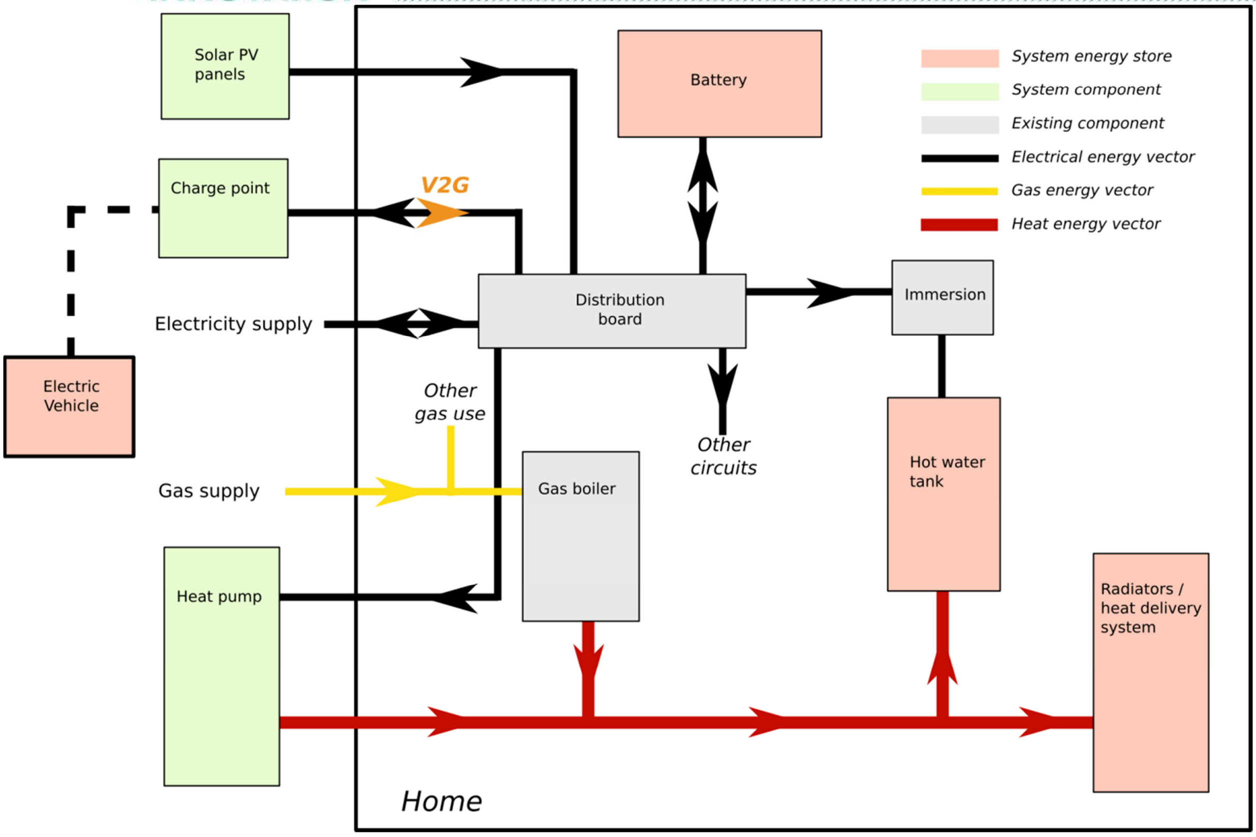

Figure 2-6: MADE system components

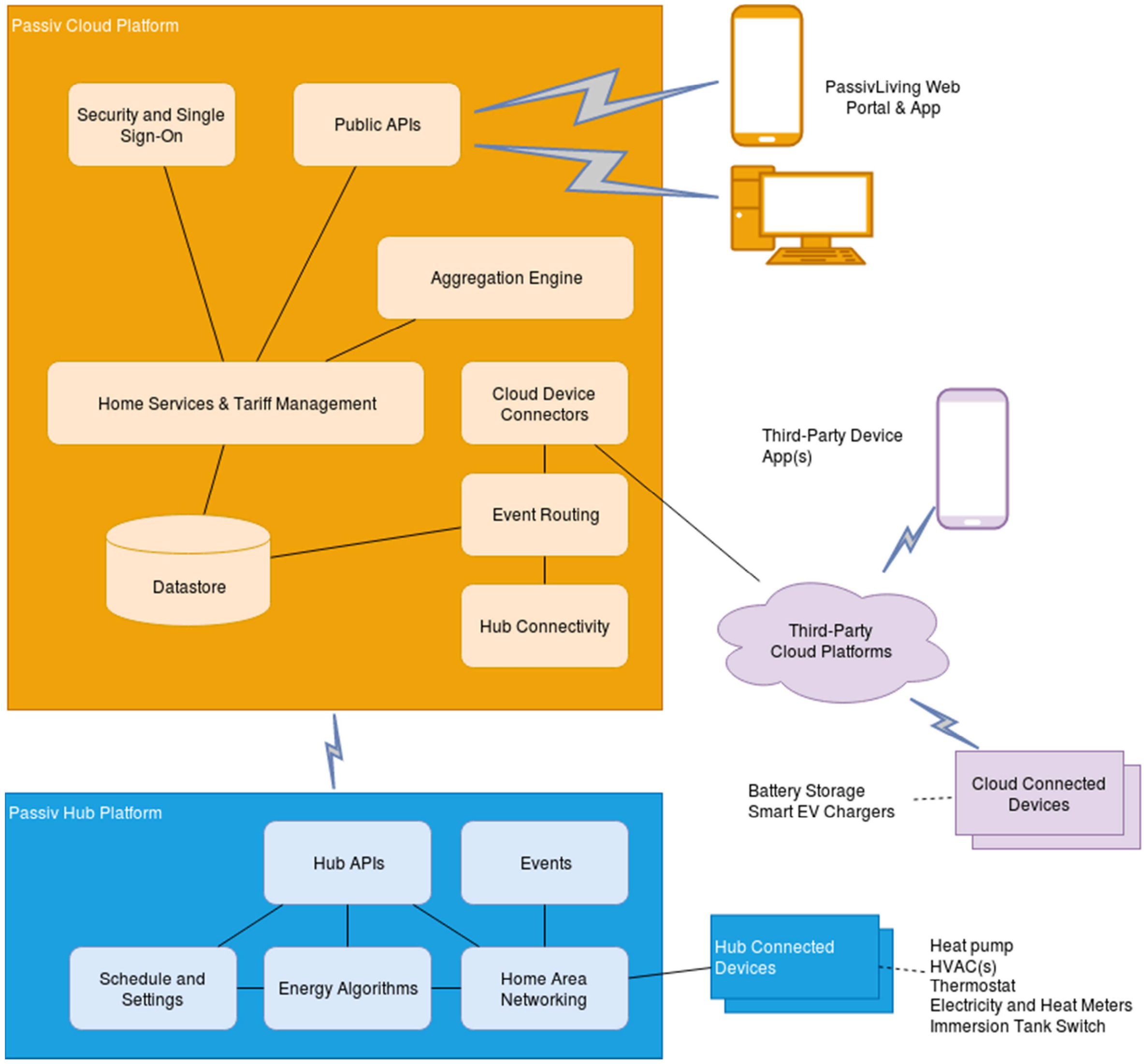

Figure 2-7: MADE system architecture

PassivSystems have developed an initial design for the field trial and the use cases that will be explored over winter 2019-2020 using the deployed physical assets. The general approach is to explore in-home factors for the multi-asset multi-vector scenario, rather than factors that affect multiple homes, as a small scale field trial is unlikely to provide definitive answers to the latter.

- **Phase 1: Baseline operation:** For the first part of the field trial, assets will operate somewhat independently and this will provide baseline data for later comparison.

  Monitored data will be collected from this phase and analysed to produce conclusions as to likely load profiles in the baseline scenario. These results will be compared with modelling, and further modelling work used to extrapolate these results to the country as a whole (i.e. used to refine previous models).

- **Phase 2: National-scale grid drivers:** The next step is to construct a scenario where assets in the home react to national-scale grid drivers (but assets within the home are largely uncoordinated with each other). This will explore the impact of "selfish algorithms" where multiple assets take advantage of cheap electricity prices (for example) causing stress on the local distribution network.

We hope to demonstrate from analysis of the monitored data some of the consequences of cheap rate electricity causing simultaneous asset activity which results in higher grid stresses than the baseline case.

- **Phase 3: In-home asset coordination:** PassivSystems will develop algorithms which coordinate assets within the home to make best advantage of the variable availability of cheap electricity, the different storage potential of the assets, and the various patterns of consumption needed by the occupiers. These will calculate the best strategy for the householder in terms of minimising running costs against the variable tariffs.

  The purpose of this phase will be to find out how the patterns of asset operation change when they move from uncoordinated to coordinated control within the home, and whether this makes the impact on the local grid bigger or smaller.

- **Phase 4: Local grid interventions:** In this final phase we will identify some key grid problems (for example, times of peak load) and will design some interventions that demonstrate that a inter-home coordination system could mitigate some of the problems. This could for example involve pushing down to the control algorithms a whole-house maximum power constraint which is applied across the set of flexible assets, and might for example result in more pre-heating by the heat pump and a transition to gas heating at the time that the EV is plugged in and the sun has gone down.

Next steps

The control systems will be developed through the next reporting period. This will deliver ever more complex control of customer assets.

2.2.5 Work Package 5: Technology Feasibility Trial (maximum of five homes)

Progress within this reporting period

This phase started towards the end of the reporting phase. This is aimed at recruiting and installing equipment in dive homes to help deliver the trial.

To date surveys have been completed in the all five trial participant homes. Hardware has been procured and is ready for the installations.

Next steps

The bulk of the work in the next reporting period will be within this work package.
This will include the installation of all the technology as well as the start of the actual trial.

2.2.6 Work Package 6: Technology, Customer and Network Analysis – Dissemination

Progress within this reporting period

The main work carried out in this reporting period was the creation of the interim report. This is now available here. A webinar was also held on September 24th to share the results to a wide group of stakeholders.

Next steps

We will continue to share the interim results over the next reporting period. We do not expect significant new learning to be shared within this period as we will still be collecting data from the trial. We expect this to pick up in the subsequent work package.

3 Progress against Budget

Spend Area	Budget (£)	Expected Spend to Date (£)	Actual Spend to Date (£)	Variance to expected (£)	Variance to expected %
Combined FNT Project & Programme Management	£81,221	£22,320*	£21,323	£997	4%
PassivSystems costs	£1,357,000	£857,110	£857,111	-£1.00	0%
Contingency	£116,825	£0	£0	£0.00	0%
TOTAL	**£1,555,046**	**£879,430**	**£878,434**	£996	0%

* This value has been re-baselined following lower than expected resource usage in the initial stages of the project.

4 Progress towards Success Criteria

Objectives	Status
Use the ability of managing multiple energy assets (EVs, hybrid heating systems and solar PV) to switch between gas and electric load to provide fuel arbitrage and highly flexible demand response services.	**In progress:** This will be tested in the trial.
Demonstrate the potential consumer, network, carbon and energy system benefits of large-scale deployment of in-home multi-energy assets with an aggregated demand response control system.	**In progress:** Initial modelling has shown the value. This must be validated in through the trial.
Gain insights into the means of balancing the interests of the consumer, supplier, and network operators when seeking to derive value from the demand flexibility.	**In progress:** Initial modelling has given an initial view. This must be validated in through the trial.

Success Criteria	Status
A detailed understanding of technical feasibility of asset coordination (supported by a report and operational data).	**In progress:** Initial modelling has given an initial view. This must be validated in through the trial.
A detailed customer proposition for the MADE concept.	**Complete:** the business modelling work has highlighted the potential propositions for customers.
A detailed understanding of the customer benefits of the MADE concept (supported by a report and operational data).	**In progress:** Initial modelling has given an initial view. This must be validated in through the trial.
A detailed understanding of the impact of coordinated asset control on the distribution network (supported by a report and operational data).	**In progress:** Initial modelling has given an initial view. This must be validated in through the trial.
A detailed understanding of the whole system benefits of coordinated asset control on the distribution network (supported by a report).	**In progress:** Initial modelling has given an initial view. This must be validated in through the trial.
Dissemination of key results, findings and learning to policy makers, regulators, network operators and suppliers.	**In progress:** First webinar held. More dissemination to follow.

5 Learning Outcomes

Within the project to date we have created the following learning:

- Estimated charging times and durations from the Electric Nation data;
- Learning on the potential value of the MADE concept and an in home level (Everoze modelling). This shows the importance of avoided energy costs and DSO services when available. This also highlighted the limited value of FFR;
- The coordination of three basic optimisation strategies can unlock a significant chunk of the potential value (PassivSystem's report);
- Optimisation of in-home assets can flatten load profiles and reduce the impact on the network, however there is a risk of secondary peaks being created (Delta-EE modelling);
- There is very significant value to the wider electricity system should the MADE concept be rolled out. This is due to avoided generation Capex and Opex as well as avoided DNO reinforcement costs (Imperial Modelling);
- There is significant DNO reinforcement cost that could be avoided through coordinated control. This is spread across the voltage levels;
- There are a number of business models that can be used to highlight the benefits of the MADE concept. These are based on all-inclusive fees, selling enhanced control or minimising peak demand (Delta-EE assessment); and
- There is work to be done to convince participants to allow third party control of assets (Delta-EE customer engagement).

All the learning is detailed in the interim report and the associated detailed reports

6 Intellectual Property Rights

A complete list of all background IPR from all project partners has been compiled. The IP register is reviewed on a quarterly basis.

IPR	Category	Owner
Passiv platform	Enabling Relevant Background	PassivSystems
Passiv control strategy report exclusive to MADE (heat and storage)	Enabling Relevant Background	PassivSystems
Passiv control strategy (EV + multi)	Enabling Relevant Background	PassivSystems
Heat pump storage forecasting tool	Relevant Background	PassivSystems
Battery storage forecasting tool	Relevant Foreground	PassivSystems
Delta EE feeder level monitoring report	Relevant Foreground	Delta EE
Delta EE business model report	Relevant Foreground	Delta EE
Delta EE customer survey results	Relevant Foreground	Delta EE
Imperial whole system value report	Relevant Foreground	Imperial College London
Passiv Systems modelling report	Relevant Foreground	PassivSystems
Project Interim report	Relevant Foreground	PassivSystems
Everoze report	Relevant Foreground	Everoze

7 Risk Management

Our risk management objectives are to:

- Ensure that risk management is clearly and consistently integrated into the project management activities and evidenced through the project documentation;
- Comply with WPDs risk management processes and any governance requirements as specified by Ofgem; and
- Anticipate and respond to changing project requirements.

These objectives will be achieved by:

- ✓ Defining the roles, responsibilities and reporting lines within the Project Delivery Team for risk management;
- ✓ Including risk management issues when writing reports and considering decisions;
- ✓ Maintaining a risk register;
- ✓ Communicating risks and ensuring suitable training and supervision is provided;
- ✓ Preparing mitigation action plans;
- ✓ Preparing contingency action plans; and
- ✓ Monitoring and updating of risks and the risk controls.

7.1 Current Risks

The MADE risk register is a live document and is updated regularly. There are currently 24 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In

Customers interfere with controls	Moderate	A well-defined engagement plan. This will include clear instructions on what should and should not be adjusted.	Risk has increased due to proximity

we give details of our top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Table 7-1: Top five current risks (by rating)

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
Load shifting causing low charge EV/discomfort/overheating/confusion	Major	Detailed testing as part of design	Testing is underway. Risk has increased due to proximity
Unknown capabilities and functionality of EVs, charge points and PV invertors resulting in not being able have the desired control functionality. If the functionality does not meet the product specification could result in not being able to design automated control.	Major	Testing, detailed specification and communication	Risk has increased due to proximity
Unable to recruit 5 trial homes in time to hit the critical heating season.	Major	A well-defined engagement plan.	A customer engagement plan has been completed
On-boarding of customers is more arduous than expected	Major	Adequate budget and support for on boarding	Risk is relevant as we enter the recruitment phase
Customers interfere with controls	Moderate	A well-defined engagement plan. This will include clear instructions on what should and should not be adjusted.	Risk has increased due to proximity

Figure 7-1: Graphical view of Risk Register
1 provides a snapshot of the risk register, detailed graphically, to provide an on-going understanding of the projects' risks.

Figure 7-1: Graphical view of Risk Register

Likelihood = Probability x Proximity						
	Certain/Imminent (21-25)	0	0	0	0	0
	More likely to occur than not/Likely to be near future (16-20)	0	0	0	0	0
	50/50 chance of occuring/ Mid to short term (11-15)	0	0	2	0	0
	Less likely to occur/Mid to long term (6-10)	0	7	9	2	0
	Very unlikely to occur/Far in the future (1-5)	0	0	1	3	0
		1. Insignificant changes, re-planning may be required	2. Small Delay, small increased cost but absorbable	3. Delay, increased cost in excess of tolerance	4. Substantial Delay, key deliverables not met, significant increase in time/cost	5. Inability to deliver, business case/objective not viable
		Impact				

	Minor	Moderate	Major	Severe	
Legend	8	12	4	0	**No of instances**
Total	24				No of live risks

Figure 7-2 provides an overview of the risks by category, minor, moderate, major and severe. This information is used to understand the complete risk level of the project.

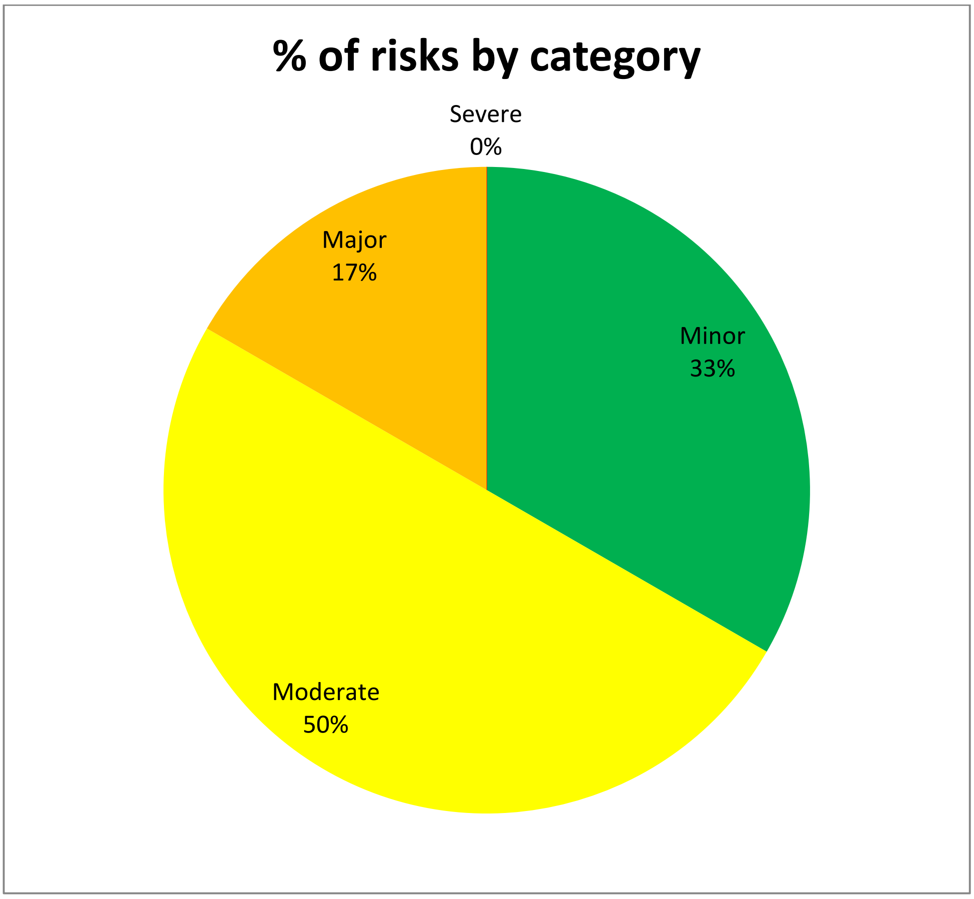

Figure 7-2: Percentage of Risk by category

7.2 Update for risks previously identified

Descriptions of the most significant risks, identified as part of the project registration are provided in **Error! Reference source not found.**2 with updates on their current risk status.

Table 7-2: Risks identified in the previous progress report

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
Project Data from other projects is unavailable at the required times or with sufficient quality	Major	Closed	Early investigation of data	Closed
Load shifting causing low charge EV/discomfort/overheating/confusion	Moderate	Major	Detailed testing as part of design	Testing is underway. Risk has increased due to proximity
Delayed start impact on project timescales	Moderate	Closed	Project governance and regular communications	Closed
Unknown capabilities and functionality of EVs, charge points and PV invertors resulting in not being able have the desired control functionality	Moderate	Major	Testing, detailed specification and communication	Risk has increased due to proximity
Customers interfere with controls	Moderate	Minor.	A well-defined engagement plan. This will include clear instructions on what should and should not be adjusted.	Risk has increased due to proximity

8 Consistency with Project Registration Document

The scale, cost and timeframe of the project has remained consistent with the registration document, a copy of which can be found here.

9 Accuracy Assurance Statement

This report has been prepared by the MADE Project Manager (Matt Watson), reviewed and approved by the Innovation Team Manager (Jon Berry).

All efforts have been made to ensure that the information contained within this report is accurate. WPD confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.