IEA HPP Annex 42: Heat Pumps in Smart Grids

Task 3: Demonstration Projects

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This report is Task 3 of 4, and reviews the UK demonstration projects:

Task 1: This consists of a UK market overview and an analysis of the smart-ready capabilities of heat pumps on the UK market – and expected to come to the UK market

Task 2: This report summarises the major UK modelling studies which have investigated issues linked to the use of heat pumps for load shifting. This report assesses the extent to which these modelling studies have sufficiently addressed DECC's core questions in relation to this project – and identifies areas of further work which would support DECC's core questions.

Task 3 (this report): This report summarises the major UK demonstration projects involving heat pumps in load shifting. It assesses the extent to which DECC's core questions are being tested and identifies areas of further work.

Task 4: The aim of this report is to summarise the assessments of modelling and demonstration projects in Tasks 2 and 3, and make recommendations on where the evidence gaps are which warrant further work in order to fully answer DECC's core questions.

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1. Executive Summary

We have assessed three demonstration projects in the UK which trial (to variable extents) the impact of heat pumps on the grid, and the ways in which heat pumps can be used to shift demand. These are the only UK projects which include heat pumps to any significant extent.

There are very few currently running demonstration projects in the UK which tackle DECC's key questions

- **The Customer Led Network Revolution (CLNR) project** is the most advanced and relevant to DECC – it is driven by a need to shift demand away from peaks in order to manage grid congestion, and it includes 348 heat pumps – of which 17 are being directly controlled. One focus is on developing the optimum mechanisms for controlling individual heat pumps in response to grid congestion.
- **The NEDO Smart Community Manchester project** is not yet off the ground but has the potential to offer some very valuable data to DECC, as it will be the largest trial of smart heat pumps in the UK. Its main focus is on understanding business models for aggregation of large numbers of heat pumps and using them as a flexible load.
- **The Low Carbon London (LCL) project** represents the largest UK study to analyse customer response to Time of Use Tariffs, which offers valuable insight, but the project does not include heat pumps in any form of influence or control – data collected on heat pumps will only add to the understanding of base case operation, not to peak shifting potential.
- Some of the other Low Carbon Network Fund projects will provide some insight to DECC's questions, but primarily at a network level. The exception is the **Northern Isles New Energy Solutions** (NINES) project, where insight into the use of 'smart' electric storage heaters could have some parallels for heat pumps.
- Exploring **projects outside the UK** – of which there are many – will provide significant additional insight to DECC. Much of this learning may come from other Annex partners. Projects of particular interest in tackling DECC's questions include a suite of projects in Denmark, Smart Electric Lyon in France, and powermatching city in the Netherlands.

Identifying gaps where new research – or extensions to existing projects – may be valuable

In Task 4 of this set of reports we have carried out a gap analysis to identify where further work is required through modelling or demonstration projects to better answer DECC's core questions. Below we summarize the main evidence gaps we have identified based only on the demonstration projects, building on the "modelling gaps" identified in Task 2.

DEMONSTRATION PROJECT GAP 1: Testing of more alternative mechanisms for control / influence of heat pump operating times

This will provide better understanding to DECC of how much flexibility could be technically and cost-effectively provided by heat pumps. Direct control mechanisms are being well-tested in CLNR – and are planned to be tested in NEDO, but we see space for further investigation particularly around price influence:

- **Test a greater range of Time of Use (ToU) tariff rates** to investigate those which encourage the greatest behavioural change. ToU tariffs included in both CLNR and LCL are not designed around the heat pump – there is scope for further investigation of different tariff structures to identify those which can promote behavioural change.
- **Explore HP automated response to flexible / ToU tariffs** rather than only manual – based on experience from outside the UK, automated response is likely to yield greater flexibility and potentially greater customer value (because it can respond more dynamically). There are different approaches which could be tested within "automated

response", e.g. it could be enabled by the heat pump itself (e.g. the approach from NIBE in Sweden), or it could be enabled using Home Energy Management Systems designed to connect to heat pump control systems (e.g. the approach by There Corporation in

DEMONSTRATION PROJECT GAP 2: Further develop understanding of the factors which influence how much heat pump flexibility can be captured, and ways to

Finland).

A critical issue when using heat pumps to provide demand side flexibility is how to optimise the operating patterns of the heat pump, storage, heat distribution system and any other energy source in such a way as to enable interruption of the normal heat pump operating pattern for a period (for peak shifting) whilst maintaining thermal comfort. A wide variety of factors affect this possibility to interrupt heat pump operation, including end-use patterns, building characteristics and outside weather conditions. These factors can all have a significant impact on heat pump system dynamics (affecting e.g. response times), and need to be well understood in order to draw conclusions as to how much heat pump flexibility could be captured. We highlight some specific areas where new or additional work could add value:

- **Further analysis and data collection to better understand the impact of building type and characteristics on heat pump flexibility.** There is little available field test data which has analysed in detail the impact of the building type (including e.g. insulation levels, age, size, thermal mass) on available heat pump flexibility, with a view to modelling the flexibility potential across the UK building stock. CLNR is the only currently running project which is controlling the operating times of heat pumps as a peak shifting mechanism. The data from this will provide valuable insight when comparing the response characteristics in different homes, but it is based on only 19 buildings. The NEDO project – if it takes off as planned – should include a larger number of buildings. It will be valuable to DECC if the analysis of data from these projects attempts to develop a detailed understanding of heat pump flexibility in different building types – and ultimately if this can be translated into a detailed UK building stock model.
- **Explore the use of weather forecast data to better optimise heat pump operation**. Outside weather conditions have a strong impact on heat pump performance, and therefore on the whole system operating patterns and flexibility potential. While most demonstration projects do monitor basic outdoor temperatures, there has been little focus to date on incorporating weather forecast data – particularly at a local level – to use as inputs to plan the future operating patterns (e.g. the HP control knows it will be very cold tomorrow so can pro-actively fill the storage tank). Where there are planned HP ramp down periods to allow for peak shifting, this kind of pro-active optimisation is even more critical in order to maintain end-user comfort. There is scope for a study which investigates how weather forecast data could be used to inform control strategies. There may be some learnings to draw from international projects (e.g. in Denmark), which are investigating this issue.
- **Explore further the options for integration of heat pumps with different volumes and types of storage, and understanding potential storage volumes in the building stock.** Storage is an integral part of most heat pump demonstration projects which are attempting to shift heat pump operating times – because storage can de-couple heat pump operating times from required heating times. However, there are alternative ways to design the storage / heat pump interaction, and different volumes of storage can be used – all of which affect the way this can provide flexibility. Storage is generally included in projects such as CLNR as one type and one system set-up. Further trials

testing different set-ups – particularly with integrated systems, and different storage volumes – would add value to DECC. Further, to translate this field data to across the building stock will require better understanding than currently exists of the available space for storage in different building types (down to the scale of e.g. cupboard sizes where storage tanks may fit).

- **Test the use of hybrids (heat pump combined with a boiler or other 2nd energy source) for peak shifting.** A hybrid system which combines a heat pump with e.g. a gas boiler, has strong market potential in the UK for several reasons[1], but one of the strongest long-term arguments is that hybrids have a lower impact on the distribution grid than a pure electric heat pump. The potential exists to switch away from electricity to gas at peak times as a way of maintaining end-user thermal comfort (rather than necessarily relying on large volumes of storage). Given the generally small size of UK homes and the trend towards combi boilers (see Task 1 Market Report), hybrids may be a more feasible way of achieving flexibility in many homes. Hybrids on the market do not yet have the capability to "smartly" shift between heat sources, but it would not be technically difficult to do this according to manufacturers. UK trials addressing the use of hybrids for peak shifting would provide valuable insight to DECC (it is possible hybrids will be included in NEDO project but the details of how they will be controlled is not yet known).

DEMONSTRATION PROJECT GAP 3: Focus on the customer – understanding what motivates them to provide flexibility.

The end-user is a critical piece in the puzzle to enable demand side flexibility from heat pumps. On-going demonstration projects will provide valuable insight into customer response once heat pumps are installed e.g. heat pump demand profiles, the influence of factors such as random behaviour, the availability of customer over-ride and response to existing simple tariff structures (although based on a relatively small number of homes). There is scope for further work to investigate ways to better encourage customers to take part in trials (and ultimately commercial roll-outs), and gain buy-in to the projects goals – this is a common challenge in smart heat pump projects both in the UK and in Europe. Two areas not fully addressed in existing projects which could be a valuable focus are below:

- **Explore business models which capture new value streams from 'smart' heat pumps, and use it to reduce upfront cost, reduce customer risk, or provide savings.** There is scope to carry out further work to test different ways of sharing value with the customer. Examples include alternative customer propositions which remove the risk of poor performance / high energy costs and the upfront cost from the customer – two critical challenges to the growth of the heat pump market – in exchange for shifting HP operating times (e.g. ESCo type models as currently tested by Insero Energy in Denmark with 'smart' heat pumps); or testing ways to allow the customer to capture the value from flexible tariffs (see activity in Sweden).
- **Explore other ways to engage customers** – a major challenge in all projects – including European projects – has been gaining customer buy-in to projects, and engaging them in order to ultimately increase the potential for behavioural change. This may come through investigating more financial benefits as described above, but there is room for focus on "softer" factors. For example, what are the best ways of communicating flexible tariffs to customers? LCL is using a simple traffic lights system combined with an In Home Display to communicate the ToU rates – but as yet this has not been linked to heat pump demand. There is scope to test further such options with heat pumps, potentially including the use of Home Energy Management Systems.

[1] E.g. Delta-ee Heat Pump Research Service report, Hybrid Heat Pumps, April 2013

2. High level summary of demonstration projects

TABLE 1: SUMMARY TABLE OF UK DEMONSTRATION PROJECTS

	Customer Led Network Revolution	NEDO Smart Community Manchester	Low Carbon London
Is the study already collecting data?	since winter 2013		since 2012
Do the study aims try to tackle DECC's core questions?			
Understanding the value of HPs for peak shifting			HPs only monitored
Understanding control / influence methods			
Understanding customer response			ToU tariffs
Understanding building response			
The demonstration project: How robust / scalable is it?			
Inclusion of HPs (high / medium / low #s)	450 HPs monitored	600 HPs monitored	18 HPs monitored
Inclusion of HPs being controlled / influenced (#s)	19 HPs controlled	600 HPs controlled	No HPs controlled
Range of heat pump types controlled	Only 1 type	At least 2 types, varying system configurations	
Range of building types & occupancy patterns where HPs installed	(though limited range of homes with *controlled* HP)	potentially large # of existing Homes with HP	
Range of mechanisms tested for capturing HP flexibility (e.g. storage, modulation, hybrid)	Only on-off cycling with storage, but potential to use modulating in the future	TBC, likely to test modulation & on/off; with & without storage; hybrids	
Range of control / influence mechanisms tested	Testing direct control & ToU tariffs	Direct control tested, unclear if ToU tested as well.	Different tariff structures tested but not for HPs
Need for further work?			
Will the data provided provide some insight to all of DECC's questions?	The research questions are well-aligned to provide *some* insight to all key question	based on planned outcomes – but v early stages	no shifting of HP demand being tested
Could new analysis of the existing data answer DECC's questions?	e.g. understanding flexibility potential from different types of building	**?** – too early to say	
Key recommendations: Gaps	▸ Test revised ToU tariff rates – design more around the HP ▸ Automated response to flexible tariffs ▸ Investigate business models to reduce the upfront cost	▸ Testing flexibility potential through influencing e.g. with ToU tariffs ▸ Focus on the customer proposition or value to customer within business model analysis	▸ Attempt to control / influence operating times of HPs as well as collecting monitoring data

KEY: WHAT DOES THE RATING MEAN?

Rating	Description	Rating	Description
	Issue addressed, and in a robust way		Plan to address issue fully – but project not yet running so risk this could change
	Issue addressed, but only on limited scale		Plan to address issue partially – but project not yet running so risk this could change
	Not addressed at all		

3. Detailed review of UK demonstration projects

The following projects have been identified in the UK:

- Customer Led Network Revolution
- NEDO Smart Community Manchester
- Low Carbon London

3.1. Information collected in 'ideal' demonstration project

Here we will describe within the template the type and level of information which would be necessary from an 'ideal' demonstration project to provide real and meaningful conclusions for DECC (based on their key aims in IEA Annex 42). This 'ideal' project will then be used as a basis for identifying the 'gaps' in the assessed demonstration projects.

TABLE 2: IDEAL DEMONSTRATION PROJECT

Overall project info	
Project aim	There is a range of demonstration project aims which would be relevant to DECC in the context of the research under IEA HPP Annex 42. Ultimately, DECC need to gather learnings from demonstration projects which test the use of heat pump systems for peak shifting. Key topics investigated could include: - Testing technological methods for capturing heat pump flexibility - Testing ways to control / influence heat pump operating times - Testing the influence of building thermal properties on flexibility achieved - Testing the influence of customer behaviour on flexibility achieved - Testing business models and market mechanisms for creating flexibility
Scope – indicates robustness of testing / how scale-able the results are	
Project scale	Ultimately a demonstration project covering a large number of homes and heat pump installations will enable greater scaling up of the results to draw conclusions on DECC's core questions at a wider scale. However, a smaller project which covers a wider range of building and/or installation types could be as valuable – or more

	valuable – in answering DECC's core questions.
Geographical coverage	The coverage will indicate the extent to which conclusions can be drawn across the country (e.g. if it is focused on the south of England, conclusions drawn for the north of Scotland should be adapted).
Range of building types	For the greatest scalability of results, a wide range of building types should be included e.g. old, new, variable thermal demand and insulation levels, variable occupancy patterns.
What technologies?	In order to draw conclusions about the use of heat pumps for peak shifting, a sufficient number of heat pumps should be included. For greatest scalability of results, inclusion of a range of heat pump types would be an advantage.
Customer engagement	Experience from 'smart heat pump' trials across Europe indicates that recruiting and engaging customers in such trials can be challenging. We will explore the methods employed to engage customers in the project - for example, financial benefits, provision of information, alternative business models (e.g. ESCos)
What is it specifically testing in relation to heat pumps	
Extent and method of control / influence of HP	DECC would like to understand how well heat pumps can be used for peak shifting using a range of control / influence methods - from influence through different types of price signals (e.g. ToU tariffs, hourly pricing, peak pricing) to direct control; and from automated response to manual response. Therefore demonstration projects should address as many of these options as possible.
Time resolution of control	The time resolution of control / influence signals is important in determining the way in which this method can be used specifically to shift operation away from peak times (DECC's core question). For example: - **day ahead** signals (means the HP operation can be shifted away from known peaks which can be predicted at least a day ahead – for example, a known 4-6pm peak in demand) - **intra-day** signals (means the HP operation can be shifted in response to less predictable grid challenges such as decreased wind generation or localised climate characteristics) - **minute by minute** signals (means the HP operation can be shifted in response to short-term issues e.g. to 'fine tune' demand so that the grid voltage is not overloaded)
HP requirements (how "smart-ready" are they / should they be)	The requirements for the heat pump are important in identifying how easily repeatable the conclusion from the study are (i.e. are they off-the-shelf heat pump systems or bespoke designs?), and what learnings can be drawn (i.e. what are the necessary capabilities of a smart-ready heat pump to be used in peak shifting?). Characteristics to investigate include: - Communication capability (1 way / 2 way) - Communication protocol used - Level of intelligence in HP - Speed of response - Length of on/off cycle period - Include buffer / storage? - Inverter-driven to enable modulation?

Need storage?	Storage can be an integral element of a heat pump system which can provide peak shifting capacity. Understanding whether it is a necessary element in this study – and the volume of storage required – is important to understand the level of flexibility which may be enabled.
Methods being used/tested for getting flexibility – technology & system	Heat pump on/off cycling combined with thermal storage through hot water tanks is typically the major mechanism employed to gain heat pump flexibility in existing smart heat pump projects across Europe. However, there are a range of possibilities which could be investigated, all of which could offer some demand side flexibility, and some of which could reduce the impact of this on end-user comfort. It is important to understand the use of all such mechanisms for peak shifting, as the standard storage solution may not be possible in many UK buildings (e.g. due to space restrictions). Mechanisms to be investigated include: - HP on/off cycling - HP ramp-down to x% (modulation) - Hybrid system which can switch heat sources (i.e. switch to gas instead of switching off) - Pre-heat algorithm - Thermal storage (incl novel storage technologies) - Use of building thermal mass
Details of testing procedures	
Time resolution of sampling	The time resolution should be sufficient to reveal the subtleties of heat pump response - at least minute by minute would be ideal.
Monitoring equipment	Sufficient parameters should be monitored in order to answer DECC's questions. For example, electricity import (e.g. to HP, immersion heater, circulating pump…), heat output (from HP, thermal store and rads), water temperature in storage tank (at several positions in the tank if possible), inside room temperatures and outside temperatures.
Results aimed for / available	
Flexibility	An ideal demonstration project would be aiming to identify how far demand can be shifted
Customer response	An 'ideal' demonstration project will address questions such as: - Can behavioural change be created? - How do customers respond to 3rd party control? - What are the best ways to get customer engagement?
Challenges which have emerged	It is important to highlight challenges such as - Any problems which have arisen during the project - Technology issues - Customer issues - If heat pump part of project has been scaled back, why – what were the specific challenges for heat pumps??
How has the data been analysed	Is there room for further analysis of existing data?
Next Steps & Gap Analysis	
Planned Next steps for	It is important to understand any planned next steps for the project in order to assess the "gaps" e.g. commercial roll out, 2nd phase of

project	trial, trial on more homes etc?
Exploring scope for further work	In an 'ideal' demonstration project, all of DECC's core questions would be addressed either based on completed or planned work. Where we expect further work to be necessary to answer DECC's questions, we will highlight the extent to which this is the case. For example: - Where there were insufficient data points to capture system dynamics, additional testing / monitoring may be necessary on existing installs (e.g. for another heating season, or with higher temporal resolution) to more clearly answer DECC's questions - Where the sample size is too small to draw representative conclusions, it may be necessary to carry out the same testing / monitoring on a larger number of buildings to better answer DECC's questionsWhere the main research questions did not reflect DECC's questions, new analysis on existing project data could tackle DECC's questions - Where the main research questions did not reflect DECC's questions, it may be necessary to set up a new phase of the project with a set of new tests and monitoring (e.g. to test the use of modulation rather than only on/off)
Gaps / recommendations	What further work would add value to answer DECC's core questions?

3.2. New Energy Development Organization (NEDO): Smart Community Demonstration Project, Greater Manchester & Wigan

TABLE 3: NEDO SMART COMMUNITY MANCHESTER PROJECT

Overall project info	
Wider context	NEDO's Smart Community Project in the Greater Manchester Region is part of a wider range of "smart community" demonstration projects funded by NEDO across the world (e.g. including projects in Spain, France and Indonesia).
Participants – identification & motivations	Participants includes firstly NEDO (the main funder): - **New Energy Development Organization (NEDO)**: NEDO is the main funder of the project. NEDO's aim is to support Japanese companies in demonstrating their abilities and creating new business around the world, by promoting research and development as well as the dissemination of industrial, energy and environmental technologies. And secondly the members of the consortium for the Smart Communities Project in Greater Manchester: - **Hitachi** Smart Cities Energy Group: Hitachi's role in the project is to develop the ICT infrastructure required to smart control the installed heat pumps. - **Daikin**: Daikin is providing the heat pump equipment for the project and will assure the balance between efficient control of the systems and the requirements of the smart control platform. - **Mizuho**: The Mizuho Corporate Bank's branch Mizuho Info & Research is responsible for the developing the business models based on trading the smart controlled capacity of the heat pumps on the energy markets. - **DECC** is also involved in the project. A memorandum of understanding regarding the project has been signed on March the 12th 2014 between DECC, the Department for Business Innovation & Skills, the Greater Manchester Combined Authority and NEDO.
Funding	The project is funded by the New Energy Development Organization (NEDO) with a total sum of approximately £22.2 million
Timing	A pre-project phase started in mid-2013, with the kick-off of a feasibility study. This study was concluded by December 2013 and has since then been analysed by NEDO. The go ahead for the project was given in the middle of March 2014, so that the actual project phase can be expected to start in April. The project will then run for 3 years, until end of March 2017. The heat pump installation will start from April 2014 onwards. The aggregation system will only be implemented at a later stage, since it has yet to be developed. The data from installations that have been installed and running before the aggregation system was put in place will serve as a control group for the impact of the aggregation system on the running patterns.
Project overall driver	The projects overall driver is business focused. The aim is to demonstrate that business models based on the aggregation of small distributed demands can be developed and successfully

	implemented.

Project aim	The overall aim of the project is to demonstrate energy load-balancing through the control of residential heat pumps and establish business models in the electricity demand aggregation market.
	
	The specific aims of the project are threefold:
	- **Heat Pump Technology**
	  - What is the optimal technical solution for a given location?
	  - What drives and hinders consumer adoption of heat pumps?
	  - What capabilities are required in the value chain?
	- **ICT Solution**
	  - How should the ICT system be designed to fulfil the requirements of the Demand Response (DR) market and consumers?
	  - What solutions are needed to ensure reliable and secure communications?
	  - What monitoring devices are best suited?
	- **Business Model and Commercial Viability**
	  - What is the value of heat pump demand response in the UK market? What scale is needed?
	  - What incentives can be offered to improve take-up?
	  - Is regulatory change needed to enable this business model?

Scope – indicates robustness of testing / how scale-able the results are	
Project scale	The project's aim is to install 600 air/water and hybrid heat pumps in social housing in the Greater Manchester area. The Registered Social Landlords (RSLs) involved in the project have already been contacted and have been participating in the feasibility study, so that it currently seems likely that this target will be met.
Geographical coverage	Greater Manchester Region
Range of building types	Mainly existing social housing, largely refurbished buildings with an energy rating of B. There will be a mix of houses with and without storage tanks, as well as a mix of different insulation levels. This will provide a good opportunity to determine how these variables affect the demand response opportunity offered by heat pumps.
What technologies?	Air/water heat pumps and hybrid heat pumps (HP integrated with gas boiler).
Customer engagement	The customers in the buildings equipped with a heat pump will have the opportunity to opt out of the trial. The approach on how to convince them to opt in is not yet clear, as the project implementation has not started yet.
What is it specifically testing in relation to heat pumps	
Extent and method of control / influence of HP	It is most likely that the DR aggregation platform will control the installed heat pumps directly, but as the project hasn't started yet and the ICT platform is still to be developed, this is still subject to change. It is part of the project's aim to determine whether the heat pump manufacturer has to grant the ICT platform direct control capabilities or whether the control strategy and decisions remain within the HPs controller.

	The exact communication channels between the heat pumps and the DR aggregation platform has yet to be determined. It is likely that the openADR standard is going to be implemented.
Time resolution of control	Real-time (minute by minute) control is ideally required, since it provides the most flexibility in terms of markets the DR platform can participate in.
HP requirements (how smart are they / should they be)	This is yet to be determined (see “Extent of control / influence of HP”.
Need storage?	In houses meeting the space requirements hot water tanks will be installed.
Methods being used/tested for getting flexibility – technology & system	This is yet to be determined. From our discussion with the project coordinator, technically available options may include lifting the temperature of the storage tank, lifting / reducing the room temperature. Completely stopping the units as well as modulating their output (thus extending the response time) are likely options that are going to be tested.
Details of testing procedures	
Time resolution of sampling	This is yet to be determined. A real time control of the HPs is wanted, but the solution which is finally going to be implemented is depending on the type of information that will be received from the DR markets.
Monitoring equipment	Full details are not yet available, but the project will monitor the electrical consumption and heat output of the heat pumps, as well as the room temperatures.
Results aimed for / available	
Flexibility	The project aims to demonstrate that the aggregation of many small (residential) heat pump loads can create demand side flexibility at a scale which is potentially sufficient to enable participation in the energy markets.
Customer response	TBC
Challenges which have emerged	N/A
How has the data been analysed	N/A
Next Steps & Gap Analysis	
Planned Next steps for project	Currently the project is still on hold, until the funding from NEDO has been granted. Once the project goes live (expected for April 2014), the installation of the heat pump systems as well as the development of the ICT platform are going to start. At the current stage the next steps which are going to be taken after the project’s conclusion are not yet clearly defined, but if viable business models can be developed during the project’s lifetime and there are no non-economic barriers to their implementation (e.g. regulatory barriers), the developed solutions might be commercialised.
Exploring scope for further work	The future results of the NEDO project have the potential to contribute answers to most of DECC’s key questions. However, it should be noted that it is very early in the project timeline, and plans

	may yet change. Based on the current plans, we outline how NEDO will contribute to DECC's core questions: - It plans to **explore several different options for the heat pump and the heating system** (hybrid, a/w, with and without storage tanks) and how these affect the demand side flexibility that can be provided by the individual heat pump system designs. - It is expected that **several different control strategies** (on/off, modulation, fuel switching, etc.) are going to be tested throughout the project and across the different technologies installed. - The project will most likely rely upon a centralised direct control through the ICT platform. It will therefore provide insight into **direct control of many heat pumps via a central ICT system and how customers are reacting to this type of direct control**. It is not clear yet if any other forms of control/influence (e.g. time-of-use tariffs) will be tested in the project. - The project aims to cover **a range of different housing sizes, ages and insulation levels**. It should therefore be possible to gain good insight on how the building response impacts the flexibility of the heat pump in a particular building type. - The project plans to investigate **how end-user characteristics affect the flexibility that can be provided by the installed heat pumps** e.g. occupant demographics, family structure and lifestyle patterns The project will have to get further underway before conclusions can be drawn about extensions to this work which will add value.
Gaps & additional data which project partners would ideally like	We do see some research questions which have not been considered in detail so far in the planning of the project – though it is possible these may emerge as the project runs on: - Investigating the **flexibility potential through influencing operating times with price signals e.g. ToU tariffs** (a potentially cheaper and simpler mechanism than direct control, which is already being investigated) - Investigating the **optimum integration between heat pumps and storage**, and testing different system options – it is not clear how well this will be addressed based on the current plans. - The ICT platform that is to be developed will most likely take into account local weather data in order to determine the most appropriate control strategy. However, **it is not yet clear whether this includes weather forecast data** for planning heat pump control strategies in advance – this would be a valuable addition to the project as it supports optimisation of heat pump control strategies. - **Focus on the customer:** There is a strong focus on business models, but little planned research at this point to understand the value of DR with heat pumps to the end-customer – and also little emphasis on understanding customer behaviour and response.

3.3. Low Carbon London

TABLE 4: LOW CARBON LONDON PROJECT

Overall project info	
Wider context	The Low Carbon London (LCL) project is one of a suite of projects funded by the Low Carbon Network Fund, administered by Ofgem. The aim of this fund is to "kick-start the radical change that the electricity networks need to make the low-carbon energy sector a reality" through projects which "help all DNOs understand what they need to do to provide security of supply at value for money as Great Britain moves to a low carbon economy". LCL is one of five individual projects under the LCNF which are led by UK Power Networks.
Participants – identification & motivations	The LCL project's consortium includes a total of 12 partners, with key partners including: - **UK Power Networks (DNO):** UK Power Networks is the lead partner of the LCL project. UK Power Networks role is to supervise and co-ordinate all of the trials which form the LCL project. The prime movers for UK Power Networks to establish this project are to understand the impacts of future technologies which are going to be rolled out in their grid area, how they might affect the security of supply, and what can be done in order to mitigate any negative impacts these technologies might have. - **EDF Energy (energy supplier):** EDF Energy's role is on the one hand to supply an important part of the infrastructure that is required for the project, the smart meters. On the other hand, EDF Energy is also responsible for the trialling of Time-Of-Use (TOU) tariffs and acts as an aggregator in the Demand Side Response (DSR) part of the project. - **National Grid (TSO):** As the UK's transmission system operator (TSO), National Grid is involved in the DSR part of the LCL project. Its aim is to better understand how DSR solutions can be used to balance supply and demand on the transmission network level. - **Enernoc; Flexitricity (aggregators):** Participating in the DSR part of the LCL project. - **CGI:** Provide IT infrastructure required for storing and analysing the data received from the smart meters which have been rolled-out to EDF Energy customers during the project. - **Siemens:** Capturing and processing the data and information from all of the trials. - **Smarter Grid Solutions:** Supplying the active network management tools for the decentralised energy trial.
Funding	The total funding of the project amounts to £28.3 million. The bulk of the financing is provided by the LCNF (£21.7 million). The project partners contribute £6.6 million to the project costs.
Timing	The project started in January 2011 and will end in December 2014. The final project reports are expected for the middle of the year.

Project overall driver	The LCL project is distribution network driven. It is mainly driven by the need to understand how new technologies like EVs and heat pumps will affect the Greater London power distribution network in the future and the need to understand how these potential challenges can be met in the future.
Project aim	The project has 2 main aims: - Understanding the demand patterns of new demand side technologies like heat pumps and EVs and how they impact the grid and its power quality. - Trial different approaches of how to mitigate the impacts of these technologies and identifying the best mix of solutions that will help UK Power Networks to adjust their network to the increasing challenges facing the Greater London power grid. Furthermore the project is trying to establish how commercial solutions and innovative technology systems and IT solutions can be used to support the trials, mainly related to the contracting of DR loads in the DR part of the project.
Scope	
Project scale	**Limited - with regards to heat pumps, the project only covers 18 installations.** The demand patterns of these installations are monitored, as well as their impact on the power quality on the low voltage grid. Several **cooling loads in industrial and commercial applications** are included in the DR part of the project. Another part of the project is also investigating the **impact of time-of-use tariffs** on the power grid. The data produced by this specific part of the project will deliver some insight on the general response of customers to time-of-use tariffs. The results of this test should be helpful to build DECC's general understanding of how customers react to this type of tariffs.
Geographical coverage	Greater London Area.
Range of building types	Mainly offices and industrial applications.
What technologies?	18 heat pumps are being monitored; several cooling loads participate in the DR side of the project.
Customer engagement	The ToU tariff trial of the LCL project has a strong customer focus. It will provide insight on the engagement of customers with ToU tariffs, but only for customers without heat pumps. The lessons learned from the trial will therefore only be of limited use for understanding the potential response of heat pump owners to such offerings.
What is it specifically testing in relation to heat pumps	
Extent of control / influence of HP	No control or influence is exerted on the heat pumps involved in the project. They are monitored only.
Mechanisms of control/influence	N/A
Time resolution of control	N/A

HP requirements (how smart are they / should they be)	N/A
Need storage?	N/A
Methods being used/tested for getting flexibility – technology & system	N/A
Details of testing procedures	
Time resolution of sampling	N/A
Monitoring equipment	N/A
Results aimed for / available	
Flexibility	N/A
Customer response	Given the fact that the project partners were not able to convince a sufficient number of heat pump owners to have their system participate in the experimentation, we conclude that the customer response to the offer of the project partners was in its majority negative. It is unclear though, how this offer was designed, so that no conclusions about the specific problems that led to the refusal to participate can be drawn.
Challenges which have emerged	The main heat pump related challenge for the project was to identify enough heat pumps to participate in the trial. Of the few installations that could be located in the relevant geographical area of the project, only a few owners were willing to have their systems monitored, let alone being controlled. It was therefore decided to reduce the scope of the heat pump part of the project from a full trial of smart heat pumps to the monitoring.
How has the data been analysed	The data from the heat pump monitoring will be analysed in order to establish (a) a better understanding of operation patterns of heat pumps, and (b) to analyse their impact on the power quality. Depending on the focus that the report writers will have, there might be further room to analyse the produced data e.g. for correlations between demand patterns and building age, the quality of the installation or the occupation of the building.
Next Steps & Gap Analysis	
Planned Next steps for project	N/A

Exploring scope for further work	The Low Carbon London project is expected to only partly answer a very limited number of DECC's key questions: • Through the monitoring exercise the project will provide more evidence on the potential impacts of heat pumps on the distribution network. • Through the ToU tariff trial the project will enhance the knowledge about customer's reactions to flexible time-of-use tariffs, but this will not include customers who own a heat pump. The trial also only covers manual response to the ToU tariffs, not an automated response. Given the small role that heat pumps played in the LCL project, there is scope for further work to be carried out on all of DECC's key questions.
Gaps & recommendations	The major gap is that no heat pumps are being controlled / influenced, so the outcomes are of limited value to the current DECC core questions. New work to tackle specific heat pump questions should ideally be located outside a densely populated urban area, where the potential for heat pump uptake is higher.

3.4. Customer Led Network Revolution

TABLE 5: CUSTOMER LED NETWORK REVOLUTION

Overall project info	
Wider context	CLNR is one of a suite of projects funded by the Low Carbon Network Fund, administered by Ofgem. The aim of this fund is to "kick-start the radical change that the electricity networks need to make the low-carbon energy sector a reality" through projects which "help all DNOs understand what they need to do to provide security of supply at value for money as Great Britain moves to a low carbon economy".
Participants – identification & motivations	• **British Gas - Energy Retailer**: Main interest is in testing new customer propositions and understanding customer behaviour, to inform ways to grow customer 'stickiness' • **Northern Power Grid – Distribution Network Operator**: Main interest is testing ways to manage future grid congestion • **Daikin, Mitsubishi and Neura – Heat Pump Manufacturers**: Main interest is increased heat pump sales and – for some – to identify key 'smart' requirements and gain learning experience • **Others** – primarily consultancies and academia including EA Technology, Newcastle University and Durham University.
Funding	£27 million from Ofgem (Low Carbon Network Fund), £54 million in total
Timing	The project has been running since 2011, and will continue for at least the next year. • **2011-2013:** Installing monitoring equipment, recruiting trial customers, begin monitoring (heat pumps cells 1 and 2), test customer flexibility (through TOU tariffs) • **2013-14:** Controlling and monitoring HP (& other) systems (due to complete in March 2014), testing network flexibility, identifying the optimum solution to maximise flexibility and benefit the customer
Project overall driver	Investigating ways to manage congestion on the distribution grid – in order to minimise grid upgrade costs in the future.
Project aim	CLNR has two parallel aims: • Test the impact of new technologies on the grid: EVs, solar PV, heat pumps • Test consumer behaviour and how far it is possible to shift or manage loads (focusing on peak period between 4pm and 8pm) Specifically in relation to heat pumps, CLNR aims to test • The system set up – including technologies, control systems and communication channels - which enable direct control or influence of heat pump operating times (i.e. integrating smart meters, allowing end-users to access ToU tariffs, sending direct control signals to heat pumps, optimum design for smart-ready heat pumps and storage) • The demand side flexibility which heat pumps can provide

	through different methods of control/influence, and with different levels of thermal storage.
Scope – indicates robustness of testing / how scale-able the results are	
Project scale	The whole project covers 14,000 homes & businesses. The heat pump cells of the project are restricted to residential buildings – plans to include 600 but currently with almost 350.
Geographical coverage	Focused on the North East and Yorkshire, including rural areas plus cities of Durham, Leeds, Newcastle & Sheffield.
Range of building types	The homes with heat pumps included are all existing buildings - retrofit installs, mostly replacing oil or electric storage heaters. The buildings represent a relatively wide variety of home types, from 1950s council houses to old farm houses. No homes had underfloor heating and all had radiators running at flow temperatures of at least 45°C. The buildings are fairly representative of the age and type of homes making up a large portion of the UK building stock – however, the majority of radiators in UK homes run with a higher flow temperature, and 85% of homes are existing gas properties. Taking these two factors into account, the outcomes of CLNR can not immediately be rolled out across the whole building stock.
What technologies?	**Heat pumps are a core part of the project** – the aim was for 600 to be included (as of December 2013 there were almost 350). The majority of the heat pumps are Mitsubishi and Daikin air/water heat pumps, and 18 are Neura “smart-ready” heat pumps (‘Nano’ model, air/water). Electric vehicles, PV and ‘smart’ appliances are also included in the trial.
Ways to engage customers	**Testing ways to enable and encourage customer flexibility, and testing customer propositions is a key part of the CLNR project**. For example, Time of Use tariffs are being tested to assess how much behavioural change can be encouraged, and for the ‘direct control’ heat pumps, a discount on the upfront cost of the heat pump has been provided to participants (the Neura HP has cost end-users a third of the standard price, because of additional DECC funding).
What is it specifically testing in relation to heat pumps	
Extent and method of control / influence of HP	CLNR aims to use heat pumps within four cells to test different levels of influence / control: - Flat tariff (i.e. no influence of operating times, only monitoring to inform ‘base-case’) - A 3-rate Time of Use tariff (testing extent to which HP operating times are shifted via manual response to tariffs) - A Restricted Hours’ tariff (testing effect of restrictions on operation 4-6pm) - Direct Control (automated response to utility control signals) The original plan was to monitor 400 heat pumps on the flat tariff,

	100 on the ToU tariff and 50 on each of Restricted Hours and Direct Control. Due to difficulties recruiting customers, the numbers to date are lower than this (as of Dec 2013 the numbers were respectively 311 on Flat, 19 on ToU, 1 on Restricted Hours, 17 on Direct Control). In practice, based on results so far, **the 3-rate ToU tariff has proven insufficient to significantly encourage end-users to shift the operating times for their heat pumps at expensive times**. The tariff is not designed around the heat pump, basically giving a very high rate at peak times and a very low rate for the remainder of the time. In practice, if a user makes no changes at all, he/she still receives an overall lower electricity rate than before (there is more to be gained through shifting the operating times of e.g. the washing machine). Therefore, revisions to the tariff structure could be beneficial in order to better quantify the influence of ToU tariffs on potential HP flexibility through manual response. Further, investigations into automated response to ToU tariffs (e.g. through connecting a HEM) may enable greater flexibility. **The Direct Control cell is of most interest to DECC to answer its current questions**. The set-up is as follows: - Northerpowergrid (the DNO) simulates a 'flexibility request' - British Gas (supplier) sends this request to the heat pumps in homes (the signal is received via a smart meter) - The request asks "how much heat is available", and the heat pump can determine whether it has enough available to switch off for a period - There is a customer over-ride option - Currently the system is not automated, so British Gas calls every customer before any switch off may occur to tell them. In the long-term this process should be automated.
Time resolution of control	Testing both day-ahead and intra-day signals (<1 hour) – higher time resolution preferred. Ultimately, for any commercial roll out, the DNO wants to manage grid congestion in real time, responding to peaks as they happen – so wants high resolution fast response. Sending demand reduction requests up to a day in advance (day-ahead signals) requires more complex planning, which is not currently on the Agenda.
HP requirements (how smart are they / should they be)	The HPs in the Direct Control cell should be able to respond to signals delivered from the DNO central control to the local control platform. The heat pump itself identifies how much flexibility is available, & the external controller defined the control algorithm - **Communication capability:** 2-way (for those being controlled), HP need to communicate how much heat it has available. - **Communication protocol:** internet-based - **Speed of response:** Ultimately, faster response times (<1 hour) preferred. The Neura HPs can communicate on a minute by minute basis. - **Length of control period required:** 15 minutes to 2 hours at peak times - **Integration with storage:** The HP control system is adapted to communicate with 4 temperature sensors in stratified storage tanks.

Need storage?	Storage must be included (300L tank)
Methods being used/tested for getting flexibility – technology & system	Primarily on/off cycling is being tested, although there is the potential for working with modulation (this is to be confirmed with CLNR, but in research directly with Inasol, Neura's UK branch, they told us that Neura HPs were not yet able to modulate down, so within CLNR the HPs have only been designed for on/off cycling).
Details of testing procedures	
Time resolution of sampling	All parameters measured every 2 minutes, except the smart meter which measures energy import every 10 minutes. This should be sufficient to capture subtleties of the heat pump operation.
Monitoring equipment	- Smart meter: Measures energy import - Heat Meters: Measure heat output from thermal store to radiators and hot water outlets, and from heat pump to thermal store - Temperature sensors: Measure water temperature at top and middle of thermal store - Electricity meters: Measure Immersion heater power consumption and heat pump electrical power consumption - Circulating pump status: Records whether the pump is on or off - Room temperature sensors: Record temperature in 3 rooms - External temperature sensor: Records outside temperature
Results aimed for / available	
Flexibility	It is too early in the monitoring of controlled / influenced heat pumps to quantify, but indications are that **it is possible to shift heat pump demand away from the peak period through direct control**. **ToU tariffs with heat pumps have not encouraged flexibility through behavioural change.** However, **ToU tariffs have encouraged shifting of *other* demands – especially where combined with an In Home Display for more effective communication**. Analysis by Durham University has indicated that "day-to-day routines such as showering, domestic chores and cooking are being adapted in response to the tariffs".
Customer response	**Upfront cost still a challenge to customers:** Customers get significant price reduction on the upfront cost of the Neura HP, paying about a third of standard price – but the upfront cost is still seen as a significant outlay for customers, and it has been challenging to recruit customers. **Engaging customers may be easier if the value (cost-savings) created from the controlled smart-ready heat pumps was more clear:** Customers on the ToU tariff do get cheaper electricity rates, and test cells with smart appliances indicates some savings are possible from shifting operating times, but the additional value which could come to customers through shifting (or allowing the shifting of) the operating times of their heat pumps is as yet not very clear in the CLNR project (or indeed in other projects across Europe). **Heating is not a discretionary energy need so it is more difficult to encourage customers to change the operating times of the heat pump:** It has been difficult to drive behavioural change in the ToU tariff cell – firstly the 3-rate tariff does not sufficiently incentivise consumers to change the heat pump run times, but there has been

	more success with shifting operating times of other (more discretionary) appliances such as washing machines.
Challenges which have emerged	**Recruiting customers:** - Due to the upfront cost of the HP discussed above - Because of the technology set-up which meant customers had to have a smart meter installed and be a British Gas customer – it proved difficult to find enough such customers **Physical fit** of the new heat pumps into existing homes – the Neura heat pump is large in size, and the storage tank (of 300-500L) adds significant additional space requirements. **Variable quality of broadband in some buildings** – means HP connectivity not always guaranteed – which is a challenge for data flow through communication channels **Technology readiness:** The Neura heat pumps were described as more of a "prototype" product than a final product, which meant installation was not as straight forward as anticipated.
How has the data been analysed	The monitoring of the Direct Control and ToU heat pump cells has only begun in winter 2013/14, so analysis is still at relatively early stages. Data analysis is being carried out by Durham University, and there will be scope for further analysis and new research questions to be addressed to answer DECC's core questions. Current research questions are: 1. **Better understanding current and possible future load and generation characteristics** e.g. developing load profiles and generation profiles for 1000s of customers, better understanding the drivers which will change these in the transition to a low carbon future, and specifically understanding the impact of heat pumps on these profiles. 2. **To what extent are customers flexible** in their load and generation, and what is the cost of this flexibility? Exploring alternative customer propositions which will encourage or enable changing load profiles (e.g. through shifting heat pump operating times). 3. **To what extent is the network flexible** and what is the cost of this flexibility? Exploring alternatives to investing in grid reinforcement – including demand side 'smart' solutions such as heat pumps. For example, the impact of a cluster of heat pumps on the grid is being tested near a substation in Hexham. 4. **What is the optimum solution to resolve network constraints** driven by the transition to a low carbon economy? Using modelling and simulation to add value to the demonstration project results investigated in Tasks 1, 2 and 3, and assess the interaction between customer flexibility and network flexibility, and the role for each. 5. **What are the most effective means to deliver optimal solutions** between customer, supplier and distribution network operator? How to translate the findings from a demonstration project to a commercial roll-out.

Next Steps & Gap Analysis	
Planned Next steps for project	The immediate next step is the beginning of data collection on controlled 'smart' heat pumps (from early 2014), & the publication of analysis of 'social impact', exploring customer behaviour & response. The project does not have immediate commercial value, but commercial roll-out is possible in the long-term.
Exploring scope for further work on this project	The main research questions from the project identified above do tackle DECC's key questions. The CLNR project – once it is complete – will provide the first valuable insight from any UK demonstration project which can begin to tackle DECC's core questions. **CLNR establishes a strong evidence base to understand 'normal' HP operation and load profiles** (through the monitored test cells). It then **provides insight into ways to capture flexibility through a variety of mechanism** (i.e. from 'influencing' end-user behaviour to 'direct control' of heat pumps). There is scope for further work building on this: - Monitoring is still underway and, due to delays in installing monitoring equipment, has not yet been for one complete heating season. For robust data, **monitoring for at least a second heating season would be valuable**. - Given the fact that only 17 heat pumps were included in the Direct Control cell**, it would be valuable to carry out the same testing / monitoring on a larger number and wider range of buildings** to more robustly draw conclusions to answer DECC's questions (is there scope to try this in homes with existing 70°C radiators, or even retrofitting in existing gas homes? In these cases greater interventions are likely to be necessary e.g. changing radiators, which would shift the economics of the project) - Once Neura heat pumps are available in the UK which can modulate, this could enable **testing of modulation as well as on/off cycling** as a mechanism for creating heat pump flexibility. - One element of DECC's core questions relates to **understanding the impact of the building characteristics on the HP flexibility available**. It is unclear at this stage whether the CLNR data will be analysed in such a way as to indicate differences in flexibility potential in different types of buildings – this could be an area where additional data analysis could be valuable.
Gaps & recommendations	- **Explore revised ToU tariff rates** which more strongly encourage behavioural change – particularly regarding the operation of heat pumps - **Consider exploring automated response to ToU tariffs** as well as manual response. From Delta-ee's wider research on European smart HP projects, automated response is likely to both provide greater flexibility, and enable greater end-user cost savings - the end-user does not have to take any action except for set their level of acceptable comfort. - **Explore business models to reduce the upfront cost to the customer** and reduce risk – engaging customers has been a particular challenge in CLNR, to a large extent

	because of the high upfront cost of the HP (even with a significant discount). This point may be partially explored within the project's research question 5, but we believe there is value in exploring models where, for example, the heat pump is owned by the utility or an ESCo – this model is being tested in the UK for micro-CHP by iPower and Flow for example, and for 'smart' heat pumps in Denmark by Insero Energy.

3.5. Energy Technologies Institute (ETI) Smart Systems and Heat Project

Following discussions between Delta-ee and the ETI, the ETI indicated that currently under the Smart Systems and Heat Project, as well as in other ETI work, DECC's core questions are not currently being directly tackled. However, the ETI does see heat pumps as an important part of its future work, and provided an official statement regarding their views and possible future work which will be relevant to DECC's core questions:

"The ETI considers electric heating (including heat pumps, hybrid gas/electric heat pumps and resistive radiators) to be one of the key routes to low carbon heating.

The ETI does not believe it will be affordable to design an electricity supply system containing the rapid response or peak supply characteristics of the current gas system. Some level of demand control and heat storage in buildings will be critical components. The use of electricity to power district heat energy centres and the use of hybrid gas/electric heat pumps implies a coupling of heat, gas and electricity vectors in future demand control systems.

The ETI sees the options for demand control to be on a scale from no demand side response and capacity surplus in the physical assets (akin to the current gas system) - through to a tightly integrated control system and a capacity deficit (with the control system being critical to avoid overload). The former is likely to lead to excess costs in over-engineering the physical assets; the latter is likely to lead to excess costs for over-engineering the ICT systems. **A key challenge for the ETI Smart Systems and Heat (SSH) programme is to determine the optimal balance and then determine the route to an economic implementation at mass-scale**.

The ETI SSH programme is at an early stage. The aim is to create future-proof and economic local heating solutions for the UK. **It is anticipated that dynamic simulation of the integrated energy system will be required to evaluate the options, followed by real world experimentation within the next few years**."

3.6. Other projects without a heat pump focus but which may add insight to some of DECC's key questions

Capacity to Customers (C_2C): DNO-led project testing demand response with non-domestic customers on the high voltage network

Electricity North West's Low Carbon Network Fund (LCNF) C_2C programme is trialling demand response on its high voltage network (10% of the whole distribution network), with non-domestic customers. Demand response is expected to be dispatched in a post-fault scenario, when restoring supply following a power cut. The trials run until December 2014. Due to the nature of this programme, customers must make themselves available 24/7, as the power cut would generally be unforeseen and interruption to supply would occur instantaneously. There is also qualitative research to understand both domestic and industrial and commercial customer reactions to C_2C and to help formulate effective communication plans to customers affected.

Learnings for DECC: Provides some insight into the technical provision of instantaneous flexibility in response to unforeseen network issues; insight into domestic customer reactions to the concept of 3rd party control.

Flexible Approaches for Low Carbon Optimised Networks (FALCON): DNO-led trial and modelling project testing alternatives to distribution grid reinforcement, including demand response

Western Power Distribution's program, FALCON, is running demand response trials in the Milton Keynes area from November to March 2013/14 and 2015/16, coinciding with the Triad season. Western Power is testing six alternatives to reinforcement, one of which is demand response, to develop a Scenario Investment Model that will help DNOs across the UK to better prepare for peak demand situations in the future.

Learnings for DECC: Project at early stages but will provide insight on network response to distribution grid congestion.

Thames Valley Visions: DNO-led commercial & industrial demand response

The Thames Valley Visions project (LCNF-funded) led by Scottish & Southern Energy (SSE) is using automated demand response (ADR) systems in the Bracknell area during winter months between 4pm and 6pm. The ADR turns down equipment at commercial and industrial facilities across the trial area during peak times to help Scottish & Southern Energy defer costly investment in new capacity for that network and keep consumer bills down (including the domestic sector).

Learnings for DECC: Although the demand response is focused on commercial/industrial, there is a focus on community engagement including with domestic customers - the success rate of achieving customer buy-in to the concept will provide valuable learning (as this has proved challenging in most smart HP projects).

Northern Isles New Energy Solutions (NINES): Smart storage heaters

NINES, is being developed by SSE in association with a range of local stakeholders, including Shetland Islands Council, Hjaltland Housing Association and Shetland Heat Energy and Power. It aims to support Shetland’s sustainable energy future by developing and managing the electricity distribution network more effectively to allow renewable energy to play a bigger part in meeting Shetland’s energy needs

Key aspects of the project of relevance to DECC include replacing old inefficient storage and water heaters in 1,000 homes with modern 'smart' storage heaters which help to balance the electricity network, and deploying new technology on the network that will allow more small scale renewable generators to connect to the network.

Learnings for DECC: Although not including heat pumps, the outcomes of NINES could be highly relevant for DECC, particularly in two areas: developing understanding residential customer demand patterns and customer response; and gaining technical learnings about implementation of the ‘smart’ storage heaters, many of which will be transferrable to heat pumps combined with storage.

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