Programme Area: Smart Systems and Heat

Project: HEMS ICT Market Study

Title: HEMS ICT Market Study – Market Forecast Supplemental Report

Abstract:

The aim of the project was to characterise the existing market for HEMS and ICT systems and to quantify the market/commercial opportunities for future HEMS and ICT propositions for both consumer and business. This document is a supplemental report and offers a market forecast, this model however is not intended as a final answer but rather provides a flexible forecast tool to inform a forward view of households that could potentially take up any of the 3 Advanced ESCo HEMS propositions set out in the main report. The report was initially published in November 2014. Some details and analysis may be out of date with current thinking.

Context:

The ETI commissioned the HEMS & ICT Market project to undertake an in depth study and assessment of HEMS along with what data, processes and controls and potential additional services enabled via a linked ICT system. The project delivers key insights and findings in terms of potential future offerings and capabilities of these products along with market assessment information. The aim of the project was to characterise the existing market for HEMS and ICT systems and to quantify the market/commercial opportunities for future HEMS and ICT propositions for both consumer and business.

HEMS and ICT – Advanced ESCo Opportunities

GB Market Forecast

26 November 2014

GB Market Forecast

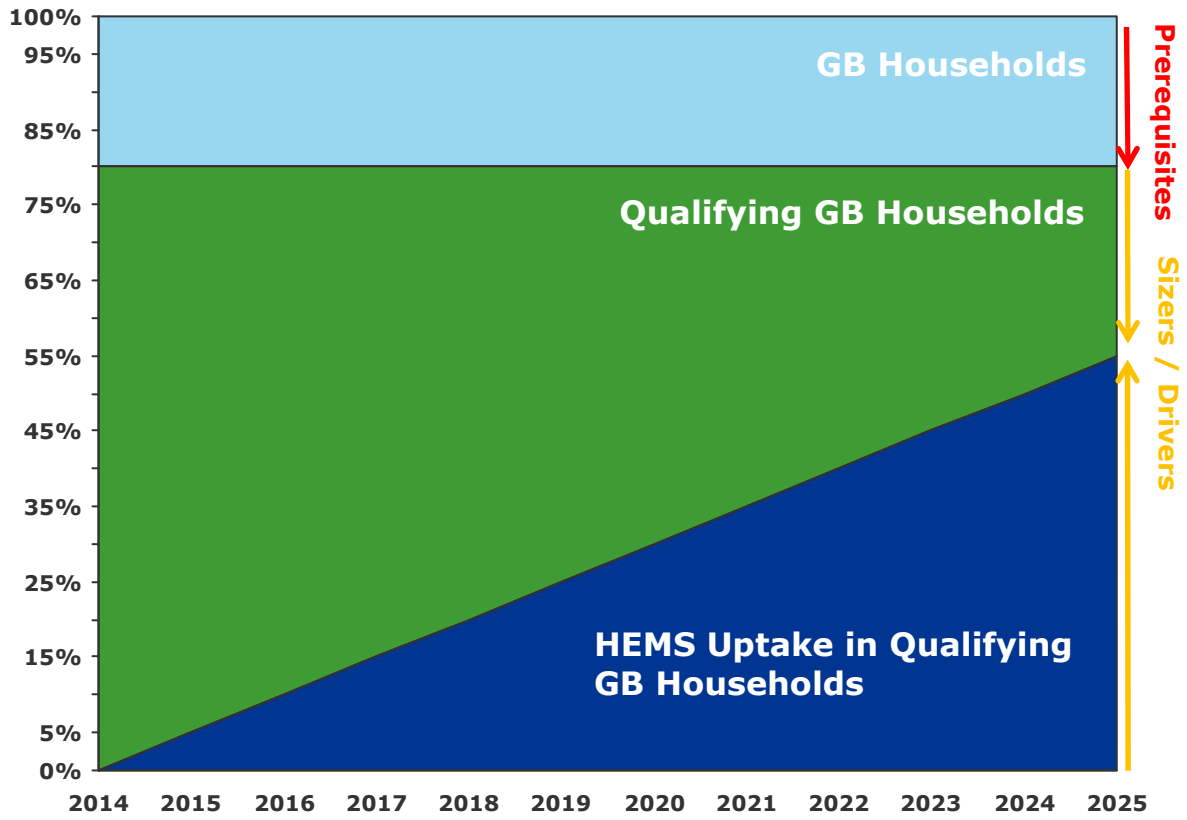
Our August report identified an opportunity for the ETI to lead the Advanced ESCo scenario through 3 key business propositions

ESCOs 'right-size' heating solutions then provide supply contracts with price guarantees	HEMS enable optimised ToU tariffs and DR benefits via local storage	Hybrid heat pump driving arbitrage opportunities in the home
Design and install "right-sized" gas boiler based central heating systems, then carefully manage operational performance for optimum efficiency – combine energy services with supply, to offer ESCO-style price guarantees	**Arbitrage time-of-use tariffs via the use of local energy storage technologies that are managed via the HEMS**	**Arbitrage between gas and power through a hybrid heat pump, to optimise domestic heating efficiency and cost**
Prerequisites: Mains gas heating **Sizers/Drivers:** Gas Boiler replacement (boiler life) HEMS Narrative Market Drivers Dwelling tenure (owned/rented) Dwelling type / Energy Performance Other household characteristics	**Prerequisites:** Smart Meters & ToU Tariffs **Sizers/Drivers:** EV Uptake Heat Pump Uptake Smart Thermal Storage Uptake HEMS Narrative Market Drivers Dwelling tenure (owned/rented) Dwelling type / Energy Performance	**Prerequisites:** Mains gas heating Smart Meters & ToU Tariffs **Sizers/Drivers:** Gas Boiler replacement (boiler life) EV Uptake Heat Pump Uptake HEMS Narrative Market Drivers Dwelling tenure (owned/rented) Dwelling type / Energy Performance

The 3 key ESCo business propositions share many of the same prerequisites and partially overlapping sizers and drivers

Methodology - We forecast the future GB Market for ESCO business propositions by gauging the potential uptake among "qualifying" households

Illustration of modelling approach



Explanation

- Households must meet technology **prerequisites** for the ESCo HEMS business propositions to be feasible (i.e. for households to 'qualify' as a potential HEMS consumer).
- **Sizers** then refer the uptake Willingness reflective of 'fixed' household/dwelling characteristics)
- While **drivers** reflect the uptake willingness based on HEMS Narrative Drivers from the original report, as well as a recent DNV GL Consumer Focus survey on Home Automation attitudes including HEMS

The output from this work will be an estimate of the market size in terms of households that could potentially be interested in taking up these opportunities

ETI HEMS Market Forecast Modelling Tool - Overview

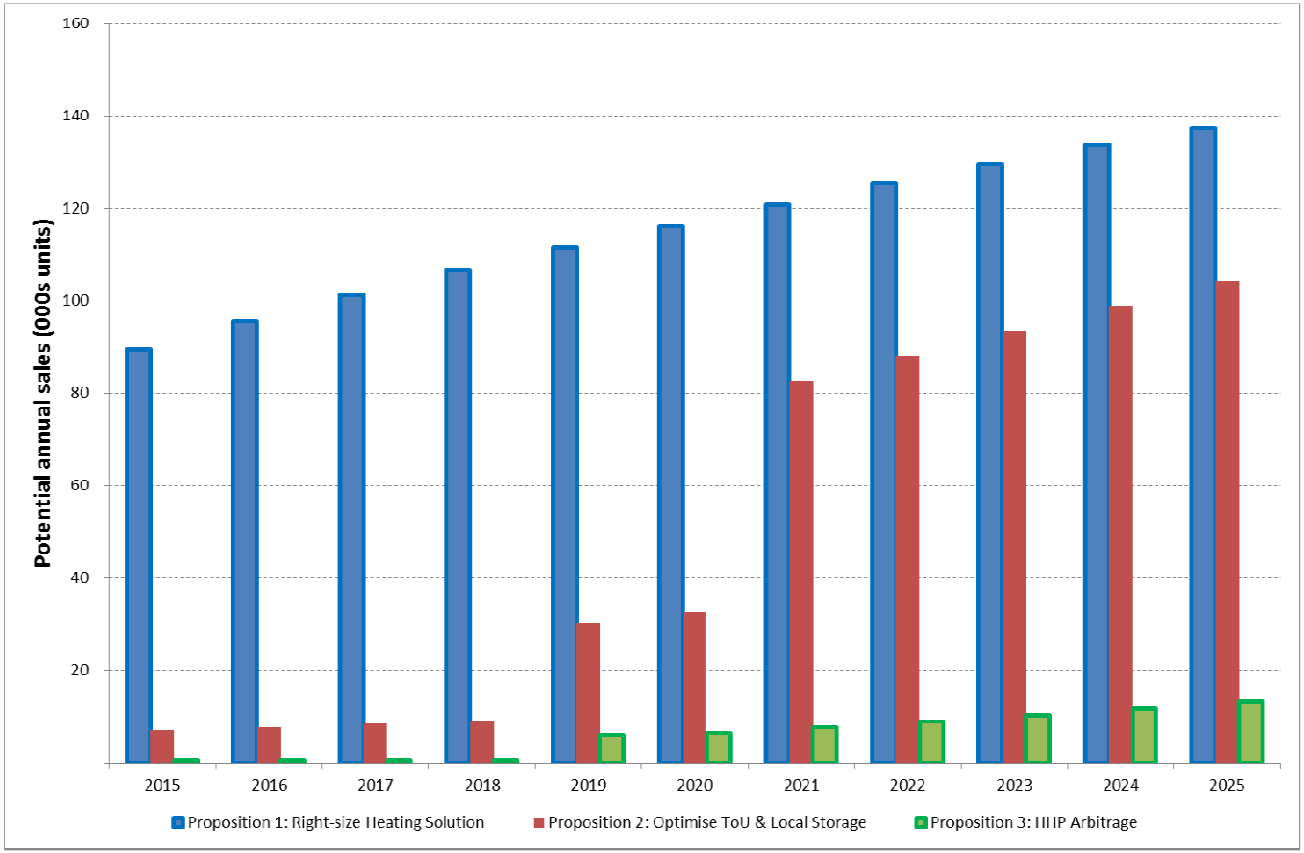
- While we do suggest a market forecast, this model is not intended as a final answer but rather provides the ETI with a flexible tool to inform a forward view of households that could potentially take up any of the 3 Advanced ESCo HEMS propositions. The assumptions made can be supplemented by any future more detailed work that is done by the ETI or elsewhere.

- The modelling tool combines data and analysis from a variety of sources:
  - Government (CENSUS) GB household projection and data on relevant household characteristics;
  - Industry information on the rollout of Smart Meters;
  - Expert consultants' forecasts on the uptake of (smart) technologies (HPs, HHPs, EVs)
  - DNV GL Analysis of HEMS Narrative market drivers from our August 2014 report
  - DNV GL UK Consumer Focus – Home Automation survey

- The Control sheet allows the user to
  - Override assumptions regarding uptake willingness to test alternative views;
  - Select different scenarios for uptake of (smart) technologies like HPs, HHPs and EVs;
    - including bespoke scenarios which the user can define in the 'ETI Scenarios' worksheet to capture new market information becoming available

The modelling tool is intended to allow the ETI to test a variety of scenarios and assumptions that determine the market for different propositions.

ETI HEMS Market Forecast - Results



- The results suggest that the biggest opportunity lies with the right-size heating solution:
  - A comparatively large (ca 90k) market in 2015 based on HH boiler sales (>1M p/a) and rising willingness over time
- Strongest growth is exhibited by the ToU Optimisation proposition:
  - Growth from ca 7k sales in 2015 to >100k in 2025
  - this is mainly reflective of strongly increasing uptake of EVs and HPs from 2019
- The HHP arbitrage opportunity is comparatively modest in growth (0 to 13k in 2025):
  - reflective of slow uptake of HHPs

The way that the propositions have been defined and how the modelling has been structured means that uptake of the relevant heating/EV technology is a primary driver of take up for the HEMS propositions

Appendix – Advanced ESCo opportunities detail

Energy services companies 'right-size' heating solutions then provide supply contracts with price guarantees (1/3)

Design and install "right-sized" gas boiler based central heating systems, then carefully manage operational performance for optimum efficiency – combine energy services with supply, to offer ESCO-style price guarantees

Opportunity summary

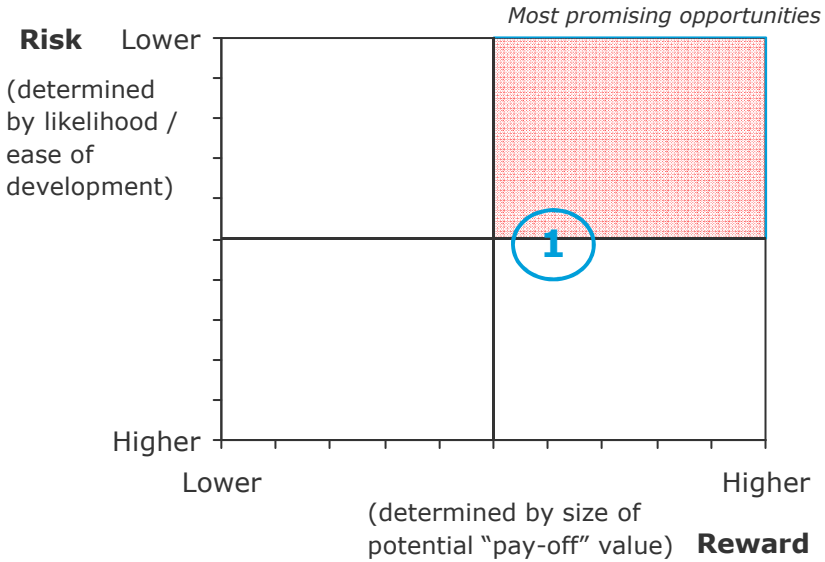
- In this opportunity, a single company (or joint venture) takes an ESCo role making a combined energy services and supply offer to customers where it:
  - Fits right-sized gas boiler systems coupled with advanced HEMS monitoring systems in customer homes;
  - Provides a guaranteed price ceiling to the customer based on the system as designed and installed relying on its ability to manage the customer's energy usage within certain limits without impacting their comfort;
  - Monitors and manages ongoing usage to ensure the proposition remains economically viable;
  - Optimises home energy performance dynamically e.g. by taking account of occupancy data or implementing energy efficiency measures ;
  - Potentially offers remote service management and maintenance.

Gap being addressed

- The gap is the market failure that results from the split between energy supply and the provision of energy services – opportunities to increase efficiency not being taken due to misaligned incentives:
  - Incentive for installers of gas boiler heating systems is to oversize, erring on the side of caution to avoid call-outs later (e.g. on particularly cold days) – leads to under-performance reducing overall heating system efficiency and increasing gas consumption
  - Incentive for energy suppliers is to sell more energy to maximise revenue, therefore benefitting from oversizing of heating systems
- This problem is exacerbated by:
  - Small price increments within boiler price ranges, which make choosing an over-powered unit easier to justify;
  - Widespread policy-led installation of cavity, solid wall and loft insulation, often applied after boiler installation;
  - Energy services companies having no involvement in energy supply (i.e. don't take responsibility for increased gas bills).
- While heating system-led HEMS offered by the likes of Bosch & Viessmann today offer the opportunity to manage correctly designed systems well, ensuring ongoing compliance with performance and comfort, they do not combine this with an energy supply offering.

Energy services companies 'right-size' heating solutions then provide supply contracts with price guarantees (2/3)

Risk & Reward matrix



Value from Opportunity

- Value comes from energy efficiency savings which can be substantial and much of which could be exploited through this type of advanced approach.
- This would be shared between the customer and the ESCo offering the service/supply:
  - Customer benefits from lower energy bills but also the reduced billing uncertainty due to the price guarantee, as well as predictable comfort levels
  - Size of commercial benefit depends on how much of the saving is shared with the customer (dependent on where the guaranteed price is set)

Costs

- High-end heating systems and HEMS systems costs likely to be expensive with initial installation costs higher than with a conventional system, though this is somewhat offset as only incremental costs need to be recovered (assuming the system was due for replacement).
- Likely costs to the supplier will need be fully identified at the design stage, and factored into the proposition.
- System installation cost could be amortised across the life of the supply contract, or, conceivably, recovered via a Green Deal-style loan arrangement.
- Payback needs to be achievable within normal lifetime of a domestic heating system – unclear currently how the cost/benefit case stacks up.

Risks and Barriers

- Potentially risky proposition to develop due to the barriers involved, in particular this is a fundamental change in the energy supply business model requiring commercial innovation but also customer acceptance.
- Likely to require policy support to permit supply contract lock-ins (to provide time for cost recovery), otherwise customers would need to pay more of the upfront cost, which is likely to put off widespread take-up.
  - In its favour, this type of proposition should appeal to policymakers as it creates the supplier business case for energy efficiency, therefore incentivising virtuous behaviour.
- Development of installation supply chain critical; a JV with boiler/HEMS supplier would avoid merchant lock-in.
- Existing suppliers, in particular British Gas may be best placed to take advantage of this opportunity if they show the desire.

Energy services companies 'right-size' heating solutions then provide supply contracts with price guarantees (3/3)

More detail on the opportunity

- The HEMS would be central to exploiting this opportunity through detailed system monitoring to allow total system performance to be managed, and adjustments made either centrally within the boiler, or locally within individual emitters.

- Open windows, zoned occupancy, personal preferences and historical usage data may all trigger room-by-room responses.

- Remote service management and emergency warnings could be triggered in response to carbon monoxide sensors and gas appliance technical data.

- Energy efficiency actions may be instigated based on intelligent assessment of building fabric performance and thermal losses.

Data that the HEMS could measure

- Local room and zone temperatures
- Door and window sensors (inc. open/closed status)
- Wireless TRV data to give emitter temperatures
- Outward and return flow temperatures
- Smart meter half-hourly consumption data
- Room and building occupancy
- Local weather forecast
- Outdoor air and external wall temperature data
- Wind speed data
- Historic usage data and room performance statistics, mapped to past temperature and weather data
- Learned and pre-programmed personal preferences + manual overrides
- (Possibly) cooking equipment data (e.g. programmed heat settings)
- Carbon monoxide sensors
- Gas appliance technical data

HEMS enable optimised Time-of-Use tariffs and DR benefits via local storage (1/3)

Arbitrage time-of-use tariffs via the use of local energy storage technologies that are managed via the HEMS

Opportunity summary

- This opportunity is again focused on an ESCo type proposition, bringing together the supply of energy and the provision of new electricity using devices that have clear demand shifting / storage potential, namely heat pumps and electric vehicles (battery charging), though thermal storage could also be used.

- The ESCo in this case would:
  - Work in partnership with the manufacturers of heat pumps and/or electric vehicles to understand the demand shifting potential from the devices as well as how to shift the energy they use without impacting on their performance and efficiency.
  - Install an advanced HEMS system when the device is purchased as part of a supply package that the ESCo would have with the customer.
  - Provide a discount on overall energy used (or at least energy used in conjunction with the HP/EV) in exchange for agreement to participate in demand shifting controlled remotely via the HEMS according to certain pre-set limits set by the customer.
  - The HEMS would monitor usage, learning about the customer's habits, while also monitoring the market price for energy to optimise when the heat pump is on or when the electric vehicle is charged.

Gap being addressed

- The gap in the market again links to the market inefficiency that results from the split between energy supply and the provision of energy services but in a slightly different way to the "right-sizing" opportunity.

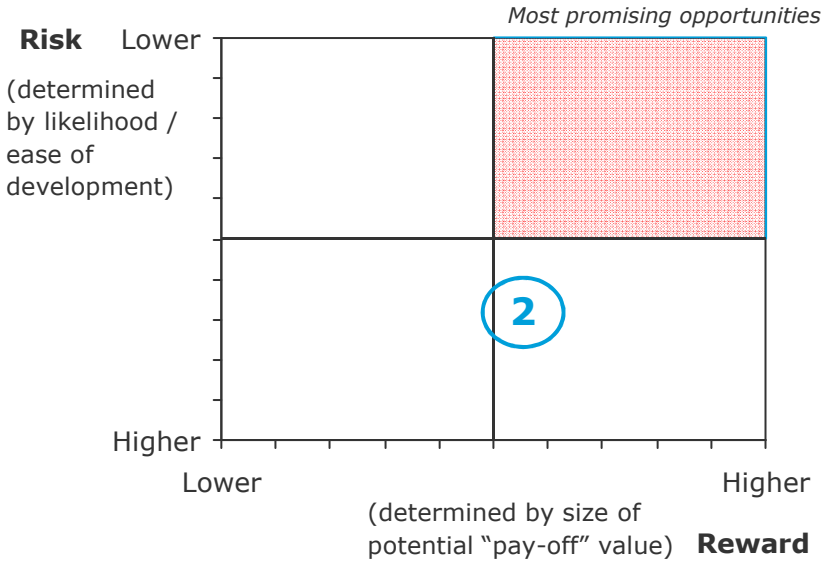
- Here while heat pumps have an inherent energy efficiency benefit (they are simply more efficient than gas boilers), the benefit exploited through the HEMS comes from shifting demand through time-of-use or demand response.

- Opportunities to increase system efficiency, by aligning demand with availability of relatively cheap generation, are not being taken.
  - The manufacturers of the electricity-using devices that show most potential for demand shifting (heat pumps and electric vehicles) are not focused on the benefits that demand shifting could bring.
  - Suppliers of electricity have no incentive to shift demand in the absence of mandatory billing settlement based on actual usage – while they could make the choice to be settled in this way now, none have shown any proactive desire to do so.

- While there are some small suppliers who are exploring the development of their business model around this supply opportunity, they do not have the scale/scope to also consider being involved in the provision of these devices.

HEMS enable optimised Time-of-Use tariffs and DR benefits via local storage (2/3)

Risk & Reward matrix



Value from Opportunity

- Value primarily related to optimising electricity trading, time-shifting the demand for power to ensure the consumer's energy bill is minimised (assuming time-of-use tariffs)
  - Total demand is thus not reduced, but shifted to times of the day when it's cheaper to draw power from the Grid.
- Also potential value from network benefits from demand shifting but this would require an organised structure of aggregation

Costs

- Development and prototyping costs – control strategies with heat pumps and electric vehicles may take a lot of work to understand and optimise.
- For heat pumps:
  - Installation costs likely to be high, perhaps more so than a gas system.
  - Householders need a lot more education and support than they do with gas, as the unit is controlled in a completely different way.
  - As a matter of course, electric heat pumps also come with the requirement to apply energy efficiency measures to plug holes in leaky houses (i.e. avoid a new over-sizing problem).

Risks and Barriers

- Again this type of proposition should appeal to policymakers, but similar risks to opportunity 1 with regard to: the shift in business model requiring commercial innovation and customer acceptance; permission for supply contract lock-ins; existing energy suppliers may be best placed.
- Need to create an installation supply chain from scratch.
- Potential customer resistance to the concept of electric-only heat should not be underestimated.
- Traditional questions around performance of heat pumps at ultra-low temperatures must also be addressed (risk, in extreme weather, that parasitic losses can undermine unit performance).
- Selection of correct heat pump partner is critical – few heat pumps originally designed for the UK market, where the maritime climate demands different performance characteristics.
- Best market for this solution may be larger high-end property given physical footprint (also biggest returns & most sophisticated consumers).

HEMS enable optimised Time-of-Use tariffs and DR benefits via local storage (3/3)

More detail on the opportunity

- With a heat pump, the system effectively uses water as a proxy for power, with heat being drawn from the thermal store in offline mode at times of peak pricing. The cylinder is then recharged when electricity prices have fallen. This approach resembles opportunity 1 by tying up energy supply and service to provide satisfactory levels of comfort at reduced prices.

- With an electric vehicle, the car battery is used to store and release power as required, allowing for both domestic usage and transport needs. Battery charging would be done at periods of vehicle inactivity and low power demand (and hence low cost), allowing time-of-use tariffs to be exploited. In practice, this almost certainly means overnight, owing to charging period duration. It may even be possible to extend current Economy 7 arrangements as a starting point for such tariffs.

- A third variant of the strategy involves use of smart storage heaters, based on thermal bricks of the type used in traditional storage systems. Unlike heat pumps, storage heaters do not exploit the 'free heat' available in the air or ground, so do not provide anywhere near the same levels of efficiency. However, they may have a role to play in certain sectors (e.g. social housing), as the basic technology, though relatively unsophisticated and sub-optimal, is also cheap.

Data that the HEMS could measure

- Closely monitored heat pump-based systems require high levels of local intelligence to manage large amounts of data:
  - Room, zone, emitter / TRV data;
  - Stratified water temperatures within the thermal store;
  - Half hourly smart meter consumption data & related tariff information;
  - Door and window sensors (inc. open and closed status);
  - Outward and return flow temperatures;
  - Room and building occupancy;
  - Local weather forecast;
  - Outdoor air and external wall temperature data;
  - Wind speed data;
  - Historic usage, temperature and weather data;
  - Learned and pre-programmed personal preferences + manual overrides;
  - Historic room and performance data (allows for thermal loss profiles of building fabric);
  - Heat appliance technical data;
  - Day-ahead demand forecast and market information for real-time pricing.

- Less information is required for vehicle battery charging, with the focus being on battery condition and life; vehicle usage and performance data; half-hourly tariff information & day-ahead demand forecasting.

Hybrid heat pump driving arbitrage opportunities in the home (1/3)

Arbitrage between gas and power through a hybrid heat pump, to optimise domestic heating efficiency and cost

Opportunity summary

- This opportunity looks to exploit the specific technical characteristics of hybrid heat pumps to make intelligent choices in real time about which fuel source is used.
- While this may seem similar to Opportunity 2, there is actually a very different type of arbitrage taking place with the possibility of arbitrage between gas and power prices.
- Also provides operational flexibility to optimise system performance in the home. The ability to switch mode depending on the prevailing weather conditions offers the potential for significant efficiency savings:
  - Gas boilers tend to perform better than heat pumps in freezing conditions;
  - Heat pumps make more sense during milder winters.
- Here the ESCo would play a role that crosses over Opportunities 1 & 2:
  - Working in partnership with manufacturers of hybrid heat pumps to understand how they work most effectively (perhaps also becoming a registered installer);
  - Installing an advanced HEMS system with the hybrid heat pump as part of a supply package;
  - Providing a price guarantee to the customer for a given level of comfort;
  - Monitoring and managing customer behaviour and market prices to ensure optimum energy usage.

Gap being addressed

- The gap in this opportunity comes from the market's failure to exploit the value from hybrid heat pumps effectively due to the opportunities for arbitrage and energy efficiency not being combined into one business case.

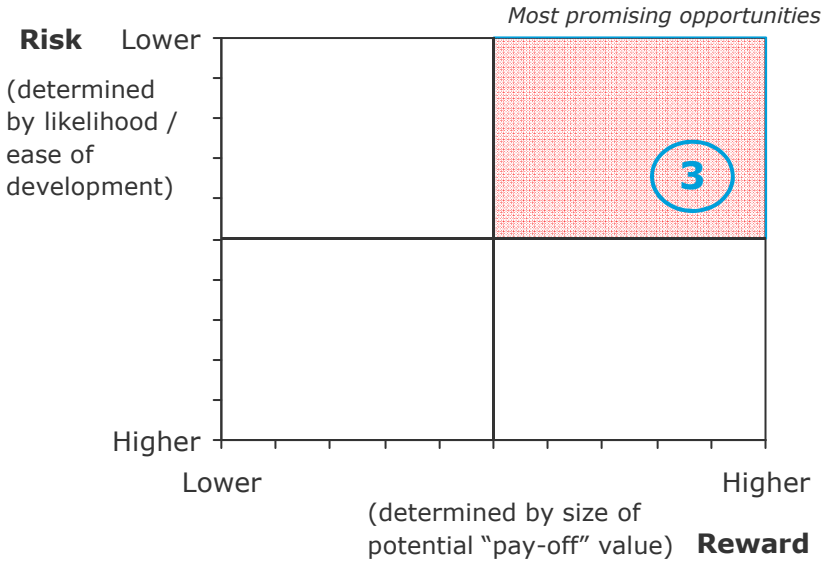
- As with the Opportunities 1 & 2, this requires the roles of energy supplier and equipment provider/manufacturer to be married so that a joined up business case can be developed.

- In addition, within the supply businesses themselves, this requires consideration of gas and electricity prices against each other at a retail level, something they would not normally do.

- As a result opportunities at a domestic level to both operate more efficiently, and to take advantage of relative market priced for energy are not being taken:
  - The manufacturers of hybrid heat pumps are not market experts;
  - Suppliers of electricity are not focused on energy services solutions, have limited incentive to explore arbitrage solutions and are unlikely to make the connection between electricity and gas prices at a retail level.

Hybrid heat pump driving arbitrage opportunities in the home (2/3)

Risk & Reward matrix



Value from Opportunity

- Value comes from both energy efficiency and demand shifting opportunities:
  - Energy efficiency from using the optimum energy source (gas or electricity) depending on weather conditions;
  - Arbitrage between gas & electricity by shifting demand based on their relative prices;
  - Demand shifting based on time-of-use or network requirements (as in opportunity 2) e.g. switching to gas-only mode when the electricity network is stressed.
- As this opportunity combines both arbitrage and efficiency benefits, it may offer greater overall value than the first two.

Costs

- Cost similar to those applying to heat pumps in opportunity 2 in terms of installation, other energy efficiency measures in the home, development and prototyping costs, education and support for householders.
- Primarily the challenge is around developing the optimisation and control strategy
  - This will involve the development of appropriate software and algorithms that can optimise use in complex ways (i.e. balancing up energy efficiency, gas/electric price arbitrage, and network needs).
  - The complexity of control and optimisation is at its most complex in this opportunity given the variety of factors being traded off.

Risks and Barriers

- Similar issues as opportunity 2 around: new business model; supply contract lock-in; existing energy suppliers; customer resistance; and focus on large higher-end properties.
- Selection of correct heat pump partner and solution is even more critical than with electric-only systems as hybrids are a less mature technology and the supply chain will need significant development.
- The development of the business model has a further level of sophistication (and therefore complexity) due to the arbitrage of gas & electricity price, a link which currently does not get made.
- Powerful argument to policy makers around transition advantages:
  - Gas component makes unit a potentially easier sell to customers used to boilers, whilst still moving towards our electrified future.
  - Hybrids offer optionality in an uncertain future, enabling existing gas infrastructure to still play a role and offering security of supply benefits: in extreme weather events as they can switch into gas mode in a power blackout, or switch to power in a gas emergency.

HEMS enable optimised Time-of-Use tariffs and DR benefits via local storage (3/3)

More detail on the opportunity

- This approach thus opens up both trading and energy efficiency opportunities, with the HEM switching the appliance between fuel types according to prevailing weather conditions, time of use tariffs, and pricing and demand response signals (e.g. from DNOs).

- The HEMS used as part of this offer could perhaps be the most complex in terms of intelligence and the different trade-offs that would need to be made as it would need to balance:
  - Optimisation from an energy efficiency standpoint in the home depending on weather conditions

against

  - The relative gas and electricity prices

and

  - The value of providing gas or electricity flexibility to the wider network/system to assist with stress levels

- It may even be possible to offer different modes, depending on user priorities, allowing trading, comfort or efficiency profiles to be set overall, with the HEM deciding on the best way of delivering the required benefit.

Data that the HEMS could measure

- The basic types of information that must be captured and managed by the HEM would likely be similar to opportunity 2 for heat pumps.

- However there would be an additional focus real-time relative market prices.