



Department
of Energy &
Climate Change

Smart Metering Early Learning Project: Synthesis report - Annexes

Research conducted for DECC by the Environmental Change Institute, Oxford, the University of
Ulster, and the Tavistock Institute

March 2015

Environmental Change Institute



Campaigning for Warm Homes

This report was produced by Sarah Darby (Oxford), Christine Liddell (Ulster), Dione Hills and David Drabble (Tavistock Institute).

Paul Wallace of NEA advised the project and contributed invaluable assistance with the planning and conduct of the Northern Ireland installer focus groups.

We gratefully acknowledge the support of NIE, British Gas and e.on, who arranged for us to conduct focus groups with smart meter installers, and we thank the installers for their thoughtful contributions, offering fresh insights into what happens around the time of smart meter installation and during the installation visit itself.

© Crown copyright 2015

URN 15D/084

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence.

To view this licence, visit www.nationalarchives.gov.uk/doc/open-government-licence/ or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk.

Any enquiries regarding this publication should be sent to us at smartmetering@decc.gsi.gov.uk **Error! Bookmark not defined..**

Contents

Annex A: Methods and sources	5
Annex B: Literature review	4
Annex C: Lessons from the public health sector.....	64
Annex D: Summary of GB smart meter installer focus groups.....	71
Annex E: DECC Smart Meter Workshop, December 2013.....	103
Annex F: Theory of change maps.....	106

Annex A: Methods and sources

The Early Learning Synthesis was designed to bring prior research and theory together with current research data, in order to build a comprehensive picture of customer engagement with smart meters and their role in energy saving, and to inform the next stages of the programme. The synthesis brought together

- Findings from the Smart Metering Early Learning Project (ELP), including:
 - Consumer survey and qualitative research: a survey of 4,000 households, half with and half without smart meters, and follow up in-depth interviews with selected respondents.
 - Qualitative research with prepayment customers
 - Energy Consumption Analysis for matched samples of smart metered and legacy metered customers (different sample to the survey).
- Research literature on metering and energy use feedback in relation to customer benefits and behaviour changes (Annex B).
- A short review of lessons from the public health behaviour change programmes (Annex C).
- Focus groups of smart meter installers from two GB energy retailers (Annex D), and two installation teams from Northern Ireland Electricity.
- An expert workshop with academics, practitioners and policymakers to develop theory-of-change maps and examine how smart metering might be adopted by different householder segments (Annex E).

This Annex describes the approach and methods used to bring together this material, in a synthesis broadly founded on ‘theory based’ evaluation and review strategies.

The synthesis approach

The framework used to combine these sources of data was informed by three theory-based evaluation and review methods:

- Theory-of-change (ToC)
- Realist synthesis

- Realist evaluation

Theory of change mapping

Theory of change mapping involves identifying anticipated causal pathways through which an intervention leads to a set of outcomes, and the articulation of the assumptions (underlying theories) of how the hoped-for change will come about¹. Elements of this approach are now widely used for the planning of programmes and projects, and for designing appropriate evaluation strategies, with theory of change maps used to help in generating hypotheses, and in the identification of research methodologies to be used in gathering data on programme processes and outcomes.

Initial work on drawing up a theory of change map for the implementation of smart meters was undertaken by the review team, drawing on a review of the literature, consultation with the DECC team responsible for the Smart Metering Early Learning Project, and input from Professor Elliot Stern, an advisor to the project. At this stage three levels were identified in the implementation of smart meters:

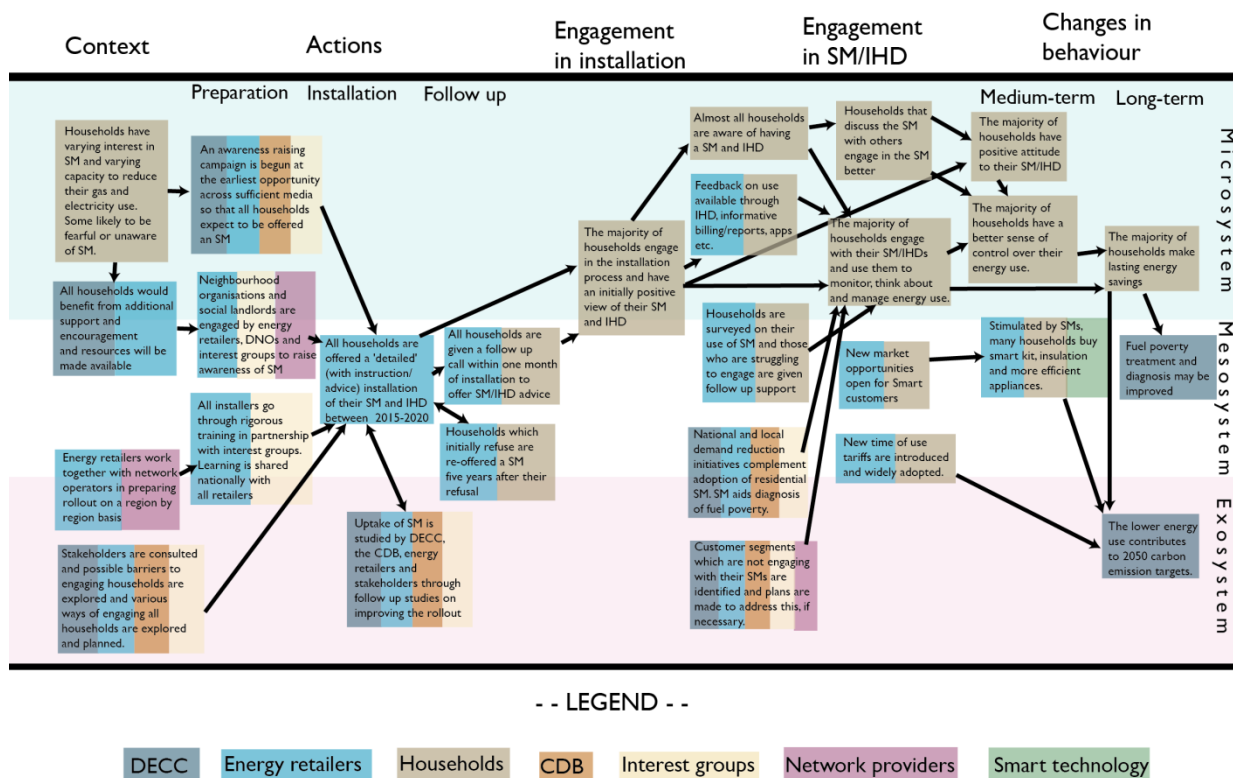
- the ‘household’ level, focusing on the individual ‘customer journey’²
- the ‘delivery’ level, which involves organisations in a direct relationship or communication between the customer and another party, such as the energy retailer, the installer, the housing provider or Smart Energy GB (formerly Central Delivery Body); and
- the ‘wider’ system, where no direct relationship is necessarily involved. Examples of ‘wider’ influences are the regulator Ofgem, the government, and meter manufacturers.

The map overleaf shows an example of a ToC map, where the three levels are described as micro- (or household level), meso- (or delivery level) and exo- (or wider) systems.

¹ Literature on the development and current use of theory of change can be found at <https://www.theoryofchange.org/what-is-theory-of-change/#2>

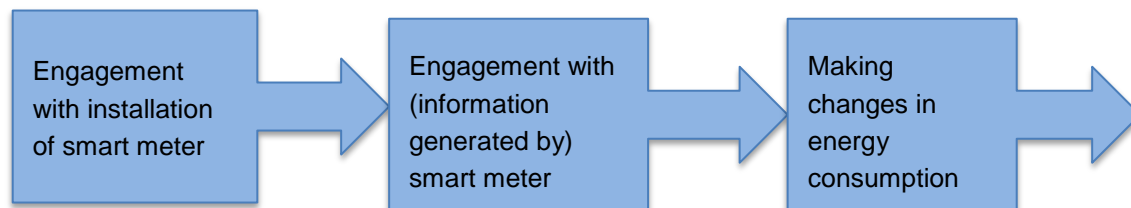
² This paper is primarily concerned with smart meters as a means of changing (reducing) household energy consumption. Neither engagement with meter installation or with the information generated by smart meters is necessary for energy providers to use smart meters for other purposes (e.g. allow for distributed generation, enable demand reduction and demand response). However, these other purposes will require consumers to accept the installation of smart meters.

Full supported rollout

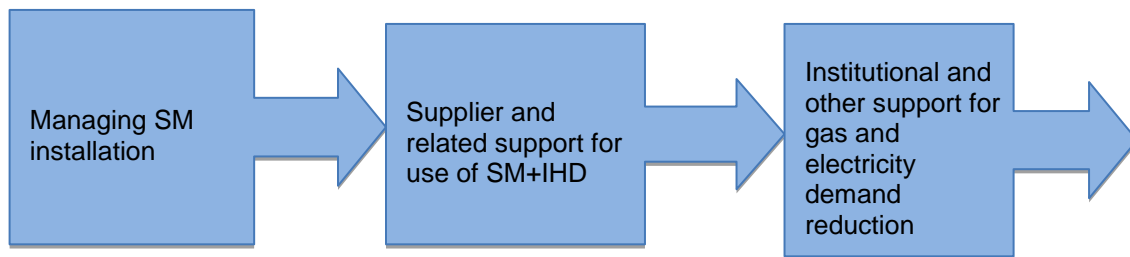


Expert workshop

Further work on developing theory of change maps for the household level took place during a workshop in December 2013 with experts in the field of household energy behaviour and smart metering (see Annex E for attendees). This helped to identify three key 'transition points' in relation to customer response to smart meters:



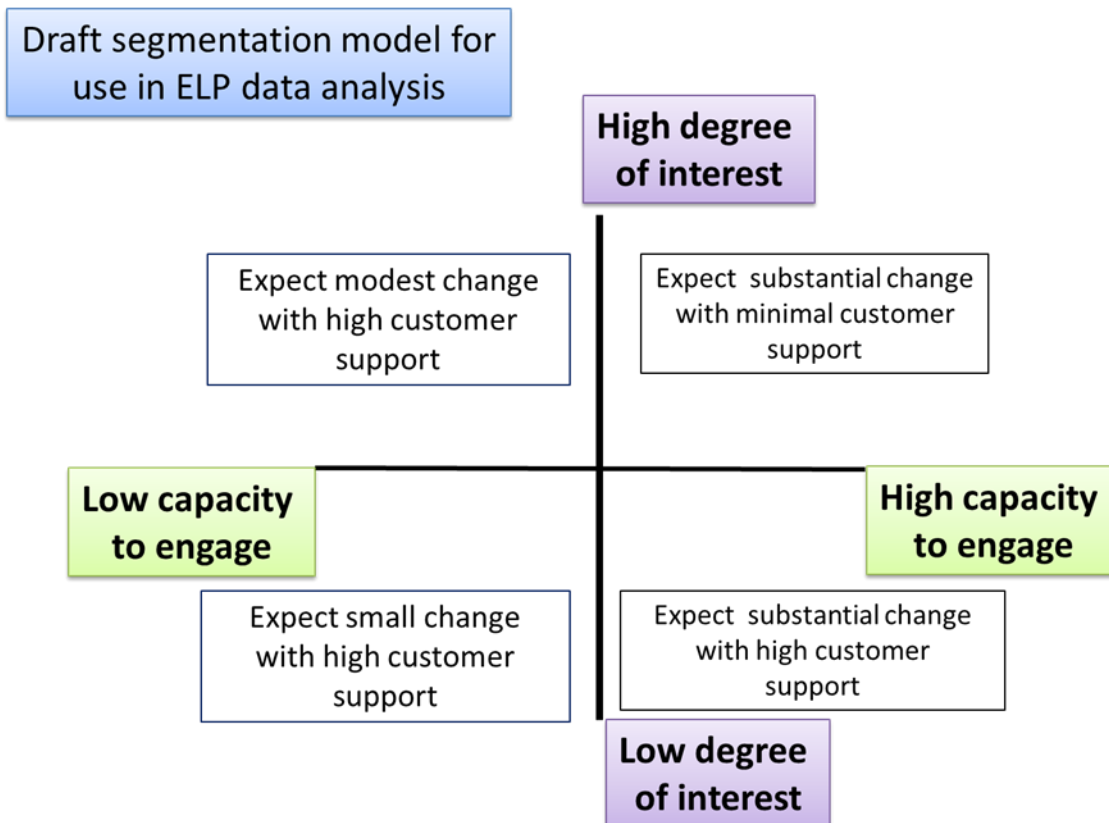
The logic of the ToC mapping suggests that in order to achieve change in energy use attributable to smart meter adoption, the two early 'transition points' will have to be navigated. Although focusing on the household level, the workshop also helped identify the implications, at each transition point, for other actors operating at the delivery level:



More specifically, it had implications for:



The workshop explored how different subsets of the customer population might respond, and what kind of support might be required at each transition point. Two key elements of ‘customer’ dimension were considered: *receptivity* to smart meters (arising from an interest in reducing energy bills, environmental concerns or in technology more generally); and *capacity* to engage with the smart meters and make changes to their energy consumption.



Although the focus of the workshop was on developing specific theory of change maps for different population segments, following the workshop these were developed into theory of change maps indicating different ‘forward looking scenarios’, outlining how different processes would serve to engage customers with different levels of interest and/or capacity to change. (The idea of formal segmentation was put to one side later in the project, although the value of differentiated approaches to customers was upheld in the conclusions.)

Realist evaluation

Like theory of change evaluation, the realist approach, developed by Pawson and Tilley in 1997³, was designed to support the evaluation of complex programmes and projects. It does this through seeking to articulate, and test, the central ‘mechanisms of change’ through which programmes will generate their anticipated outcomes. It also explores how these mechanisms may differ, under different sets of circumstances, or for different subgroups of the population affected. Rather than starting from the usual evaluation question of ‘Does this intervention work?’ it asks the question ‘*What works, for whom,*

³ Pawson R and Tilley N (1997) *Realistic evaluation*. Sage, London

under what circumstances?’ This enables the researcher to pose, and then test, a set of alternative hypotheses about how change might take place, for different groups, in different sets of circumstances. For the current synthesis, the realist approach was used to elaborate a set of questions concerning customer behaviour at each of the ‘transition points’ identified by the theory of change mapping i.e.

- **What** works: i.e. the characteristics of **the interventions**, including the installation process, the smart meter itself and the information generated
- For **whom**: i.e. the characteristics of **recipients** of smart meters and their households
- Under **what circumstances**: factors which might influence engagement and change.

More specifically, we identified a set of questions for each transition point, related to its implications for both the household level and delivery level (the role of organisations directly involved in the implementation of smart meters, or supporting households in the use of these).

Transition Point	Household questions	level	Delivery level questions	Where is this answered?
Questions for TP one: engagement in installation of smart meters	<i>How and to what extent engagement in the installation process influence subsequent engagement in using the smart meters and the information they generate?</i>		<i>What actions of energy companies, CDB, DECC and third party organisations would help maximise engagement in the installation of smart meters?</i>	Chapter 4
Questions for TP two: engagement with information generated by smart meters	<i>To what extent do customers engage with the information provided by smart meters and in-home displays in a way that encourages reduced energy consumption?</i>		<i>How can delivery-level support achieve widespread and effective customer use of smart meters and IHDs?</i>	Chapter 5

Questions for TP three: making changes in energy use as a result of having a smart meter	To what extent do customers make changes in their electricity and gas consumption, in the short and longer term, as a result of having a smart meter?	How and to what extent are additional support and information required in order for 'smart' customers to make changes to their energy consumption?	Chapter 6
--	---	--	-----------

These questions have helped to structure both the review of literature, and our engagement with new data emerging from the Early Learning Project and other fresh sources.

Realist synthesis

Realist synthesis is a method for synthesising evidence that builds on the principles of realist evaluation. Rather than comparing evidence related to similar *interventions* (like most systematic reviews), it compares evidence related to similar *mechanisms* of change, on the assumption that it is these that are central to the impact of a particular intervention with any given population group, or set of circumstances.

The present synthesis used as an overarching framework guided by the realist synthesis steps outlined in an ESRC paper by Pawson et al. (2004)⁴. This highlights the fact that a review of this kind is generally highly iterative: an initial set of questions and process might be set out in the initial scoping phase, and is regularly revisited as new learning comes to light from the literature and the review progresses.

Key steps in a realist synthesis

1. Define the scope of the review
2. Search and appraise the evidence
3. Extract and synthesise findings
4. Draw conclusions

⁴ Pawson R, Greenhalgh T, Harvey G and Walshe K (2004) Realist synthesis: an introduction. ESRC research methods programme, 2/2004. <http://www.ccsr.ac.uk/methods/publications/documents/RMPmethods2.pdf>

The literature offers three broad potential mechanisms or processes at work in household responses to smart meters during the ‘customer journey’. That is, it gives some guidance on answering ‘how’ questions about smart metering, in addition to setting out what is known about outcomes. These are set out in the table below.

Processes at work	Relevant theory includes...
Energy users’ response to feedback on their energy consumption, with variable but measurable impacts on their energy use and their understanding of energy use	Affordance theory, experiential learning, theory of planned behaviour, personal development theory and behavioural economics
Households’ adoption and adaptation of new technology into their lives with variable but identifiable impacts on their energy use.	Socio-technical systems, diffusion of innovation
Learning and sense-making over time: the development of formal knowledge and practical know-how through formal/official channels and informal social networks.	Practice theory, social learning, actor-network theory

Research literature based on affordance theory, experiential learning, planned behaviour and behavioural economics is particularly useful in relation to energy users’ response to feedback and their adoption and adaptation of new technology. The literature on socio-technical systems and diffusion of innovation is valuable in relation to adoption and adaptation of new technology, and literature on practice theory, social learning and actor-networks is particularly relevant to energy users’ learning and sense-making over time. The Early Learning Project survey and follow-up interviews, along with the installer focus groups, provided material of relevance to all three areas.

Step One: Defining the scope of the review

In the Pawson et al. paper, the scoping stage involves

- Identifying the question
- Clarifying the purposes of the review
- Finding and articulating the programme theories

The initial **question** posed by the review, ‘How can smart metering assist householders in reducing electricity and gas demand?’, was, as noted earlier, elaborated following the theory of change mapping workshop, and as lessons emerged from the literature review, the focus groups with installers, and Early Learning Project consumer survey. Changes in the wider context, such as the early work of Smart Energy GB (originally known as the Central Delivery Body) have also brought out new questions, for example, about the value of having a general advertising campaign to provide information to the public about smart meters.

The overarching purposes of the review were identified during an initial scoping phase, through the specification put together by DECC, which summarised the purpose as providing:

- An analysis of progress to date in delivering consumer benefits from smart metering, especially in relation to energy saving
- Identification of where further steps are likely to be effective in increasing benefits
- A consistent and systematic means of designing evaluation that can be used for the national smart meter roll-out.
- Consideration of the potential for unintended consequences, and ways of containing or adapting to these.

A note on theoretical sources

Finding and articulating theories in this process of synthesis has involved two key elements: the work on developing *theory of change* maps for the programme (see above), and also early work during the literature review on articulating a range of *academic theories* which might provide insight into customer responses to smart meters, and how smart meters might contribute to changes in energy related behaviour.

The term ‘theory’ is therefore used in two different ways in the present report. In ‘theory of change’ mapping, the concept of ‘theory’ refers to ‘espoused theory’⁵ or mental models used in the design of the policy and programme, which could also be described as the ‘underlying assumptions’ that shaped its design. Sometimes referred to as

⁵ Argyris C, Schön DA (1978) *Organizational Learning: a Theory of Action Perspective*. Reading, Mass.: Addison-Wesley.

'programme theory' the term 'policy design' has been used in the main report to describe this level of theory, to distinguish it from academic theory. Academic theories refer to more formalised sets of propositions that have been used to explain and structure academic investigations into phenomena.

The material brought into the synthesis was originally gathered, analysed and presented using a range of academic theories concerning household energy use and public engagement: the main ones are listed below. They reflect the variety and scope of higher-order concepts that could be brought to bear on consumer engagement with smart meters in industrialised countries. These provide a number of different ways of understanding the processes, or mechanisms, underpinning observed patterns of behaviour, and as such, can also be used to generate alternative hypotheses for testing against data relating to this behaviour.

Household level

Affordance theory: meter specification and design – what it enables users to do – is related to effectiveness.

Theory of planned behaviour: action is related to attitudes, intentions, subjective and social norms, and perceived control. 'Proximal' factors (near at hand) are the most powerful.

Classical microeconomics: indicates that energy saving will result from consumers responding to financial incentives

Behavioural economics: takes into account non-economically-rational nature of many decisions.

Experiential learning theory: assumes that people experiment with technologies and activities, learning as they go

Personal development theory: indicates that benefits come from combined effects of infrastructure, norms, education, personal experience and technologies

Delivery level

Practice theory: proposes that outcomes depend on dynamics between technology, meanings, rules and routines

Social learning, communities of practice: indicates that people learn in company with others in many contexts, sharing knowledge and experience

Diffusion of innovations theory: proposes that innovations spread in relation to their characteristics, communication channels, time and the nature of social systems

Actor-network theory: assumes that outcomes will depend on relationships between human and non-human actors at many levels

Socio-technical systems (STS) theory: highlights the role of knowledge and social processes in energy systems

Wider system

Large technical systems theory: system is the unit of enquiry; systems evolve in phases.

The theoretical constructs incorporated into the synthesis reflect the variety and scope of higher-order concepts that have been brought to bear on consumer engagement with smart meters in industrialised countries. Whilst a list such as this one may seem somewhat overwhelming, realist synthesis offers an organisational framework that can create greater synergy between these diverse approaches to an inherently complex area of study. In so doing, it can also create more fruitful and all-encompassing hypotheses.⁶

⁶ This is not an attempt to mix incompatible approaches, but to use them selectively and consciously with a view to what they can bring to bear on problem identification and resolution. (See Shove E (2011) On

Step Two: Search and appraisal of evidence

As has already been noted, the synthesis is not a pure ‘systematic review’, but one that sought to bring together past research evidence and current data. Each of the evidence sources is described briefly below:

The literature review

This began with a review of material that had already been collected by the synthesis team for other purposes⁷, which was then supplemented by additional searches, particularly as new questions and hypotheses emerged.

A central consideration was to include research that represented a wide range of theoretical and disciplinary perspectives, and the literature review included:

- earlier reviews relating to feedback on residential energy use (undertaken between 2000 and 2011);
- papers from academic journals and conferences covering residential energy use, technology adoption, environmental psychology, and sociological and educational aspects of energy use;
- ‘grey’ literature, covering similar territory and with an emphasis on implementation. This includes some DECC policy papers and EC Directives, as background.

The evidence was appraised by the review team in terms of rigour of the research, theoretical background, and the extent to which it involved trials and experiments carried out in ‘ecological’ or real-life conditions. Small-scale studies were also included, for the light they shed on processes and emergent effects.

A report on the main literature review can be found at Annex B, with additional material relating to public health interventions at Annex C

Incorporating data from the Smart Metering Early Learning Project

The Early Learning Project incorporated three related elements:

the difference between chalk and cheese – a response to Whitmarsh et al’s comments on ‘Beyond the ABC: climate change policy and theories of social change’. *Environment and Planning A* **42** (6), 262-264)

⁷ Including Darby S (2006) *The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays*. Environmental Change Institute, University of Oxford; Darby S (2010) *Literature review for the Energy Demand Research Project*. Ofgem (Office of Gas and Electricity Markets), London; ; Darby, SJ and McKenna, E (2012) Social implications of residential demand response in cool temperate climates. *Energy Policy* **49**, 759-769; Liddell, Christine and McKenzine, Paul (2013) *Area-based targeting of fuel poverty - an empirical evaluation*. OFMdFMNI. University of Ulster; Liddell, C, Morris, Chris, McKenzie, Paul and Rae, Gordon (2012) *Measuring and monitoring fuel poverty in the UK: National and regional perspectives*. Energy Policy, 49. pp. 27-32

1) Consumer research: This research has involved a national in-home quantitative survey (within Great Britain) with 2,037 domestic smart meter customers and a matched sample of 1,979 legacy (traditional) meter customers. The smart meter customers surveyed had all had at least one smart meter installed between April 2011 and February 2013.⁸ Analysis of the survey data provided evidence on the consumer experience pre, during and post installation, as well as consumer behaviour change, benefits and concerns. The survey and analysis design also allowed for comparisons between smart and legacy meter consumers which provided evidence of the impact of smart meters on various outcomes.

Follow-up in-depth interviews were also conducted with 79 survey respondents who had received a smart meter and IHD. The aim of these follow up interviews was to explore consumer experiences in greater depth, and to help explain survey findings.

The full report on the survey and qualitative follow-up is published separately by Ipsos MORI.

2) Prepayment research: This research focussed specifically on smart meter enabled pre-payment. A total of 90 in depth interviews were carried out with customers who had already switched to smart pre-payment, legacy prepayment customers and legacy credit customers. The research aimed to explore the experiences of those who had already switched to smart pre-payment, the experiences of current legacy pre-payment customers, and the likely information and support needs for customers switching to smart prepayment in the future.

This project was undertaken by the research agency Creative Research. The sample for the smart prepayment customers was provided by an energy supplier installing smart prepayment meters.

3) Energy Consumption Analysis: This analysis compared annual energy consumption levels between a group who received a smart-type meter during 2011 and a control group who did not. In total, over 10,000 households were included in the analysis. The extent to which energy consumption within the treatment group fell in the year following installation compared to the year prior to installation by more than that of the control group in the same period was calculated. This provided an estimate of the impact of the installation of smart-type meters on energy consumption during this period.

Focus groups with installers

⁸ The survey provides information on respondents' *perceptions of change* in their energy practices and bills; early quantitative findings come from the Energy Consumption Analysis, carried out with households who had new meters installed in 2011, using a year's data.

Focus groups of smart meter installers from two major GB energy retailers and Northern Ireland Electricity (Annexes D and E). The GB retailers have both been involved in the Foundation Stage rollout since 2011. Each is installing smart meters in one of a variety of ways:

- responding to a direct request from the customer;
- informing selected customers about smart meters, and supplying one at the customer's request (active agreement);
- informing selected customers about smart meters, making a specific offer of one, and supplying one if the answer was yes;
- offering a smart meter to replace a legacy meter, as part of routine replacement.

The companies differed in the degree to which they adopted each of these possible pathways.

We noted some differences in institutional culture and practices between the three suppliers. However, the main reason for conducting the focus groups was to gain some understanding of what happens during smart meter installation, from the people who represent the supplier and who, briefly, spend time in the homes of a wide variety of customers. We were also keen to know about the training that they received and about the knowledge, skills and manner they saw as important in order for installers to carry out their work effectively.

Step three: extract and synthesise results

The process of extracting and synthesising the results of the review has largely clustered around two activities:

- The generation of hypotheses
- Contributing to some additional 'pathway' analysis of ELP data

Generating and testing hypotheses

The theory of change, early results from the literature review and the focus groups with installers helped in revising the evaluation questions, and also in identifying a set of hypotheses related to each of the transition points in the customer journey. The overarching hypothesis for each of these was:

- Transition point 1: Installation. Active engagement with the installation of smart meters is required if consumers are to engage with the information generated by the meters in such a way that they subsequently make changes to their energy use.
- Transition point 2: Information. Active engagement with the information generated by smart meters can lead to customers setting off on pathways

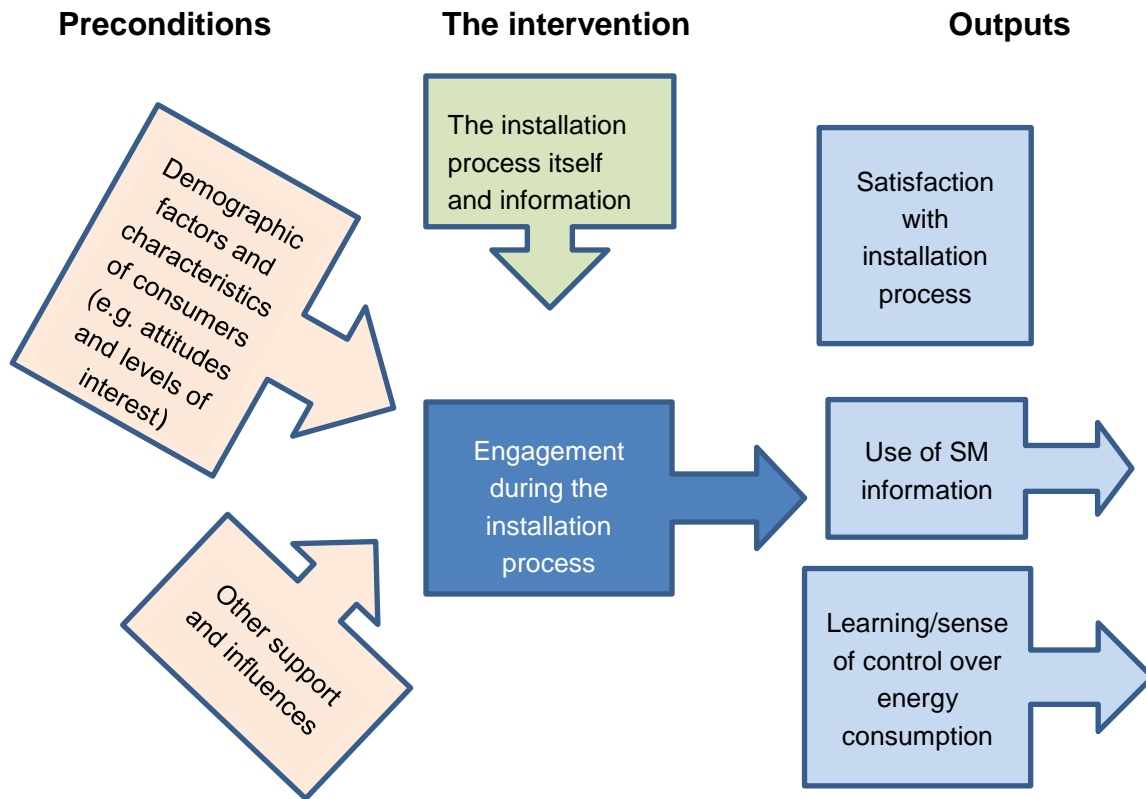
(including learning, feeling in greater control of their energy consumption, changing the way they use energy, and adapting their homes) that lead – directly or indirectly – to an actual and/or perceived⁹ reduction in energy consumption.

- Transition point 3: Energy consumption. Changes in energy consumption (whether actual or perceived) can only be attributed to the installation of the smart meter if customers report that they are actively engaged in using the information provided by the smart meter.

However, these were broken down further into more specific hypotheses relating to the preconditions, customer characteristics, the nature of the intervention, and likely outcomes at each stage.

As an example, the main hypothesis relating to transition point one was that engagement with the *installation* of smart meters is required if householders are to engage with the meter-generated information in such a way that they will be more able to make changes in their energy use. A diagram of what happens around the first transition point is shown in the figure below:

⁹ As there are no figures for metered energy use to accompany the ELP survey, perceptions and reported actions are the best indicator of change available. Other evidence records measured changes in usage.



Sub-hypotheses related to each set of these elements were then developed, against which data from the ELP consumer survey and follow-up interviews could be mapped. Examples are listed in the table below, along with the main sources of data to which we turned for each.

Hypotheses related to smart meter installation – examples from the early stages

	ELP survey	ELP interviews	Other sources of data
Preconditions			
Personal characteristics are likely to be related to customer interest and engagement in installation.	household characteristics; pre-installation interest in smart technology	Attitudinal/knowledge characteristics	NEA and University of Ulster reports on smart meter installation and adoption; installer focus groups
Input from friends, neighbours and third party organisations may influence decision to have a smart meter installed.		Material on social contacts and influences.	NEA, UU, focus groups, academic literature on social networks and social learning.
The intervention			
Information sent out prior to installation may affect the customer's experience of installation and the questions they would like answers to.	Survey material on information received before installation, and its usefulness.	Material on how the information was received.	Some information sheets from the energy suppliers; other grey lit; installer focus groups

This process was carried out for each of the three transition points.

The delivery level

The GB rollout is unusual internationally in that

- installation is led by energy retailers, not DNOs
- with overall demand reduction via improved feedback is a specific element in the business case, consumer engagement is a central part of the programme, and the rollout has been designed to this end, e.g. with specification for IHDs and installer training.

- the actions and decisions of delivery level actors are thus very significant in influencing programme outcomes, and the table below summarises four major functions that are likely to rely heavily on delivery level actors.

At this level, we encounter a number of hypotheses that are difficult to test as yet, but which will need to be tested over the coming years. For example, a roll-out based primarily on customer willingness to adopt smart meters would differ from a simple replacement of end-of life meters by new ones. And, because of the emphasis on customer involvement along with the location of most meters within the home, the role of Smart Energy GB, retailers and third parties in preparing the way for smart metering is likely to be significant. At present, there are assumptions that suppliers will plan their roll-outs in order to minimise costs; it is expected that they will aim to optimise customer acquisition and retention as well as using smart metering as a platform to increase the range of products and services they provide. Some co-ordination may occur for technical reasons, e.g. in large blocks of flats where many meters need to be installed in the same place and where metering communications may need individual architecture solutions. Reflecting the supplier-led nature of the GB rollout, there will be uncertainty over individual supplier strategies relating to their timing profile of installations, such as replacing existing prepayment meters (PPMs). All suppliers and industry are however expected to be able to offer basic smart services by the beginning of the main installation stage.

There is also an implicit hypothesis that delivery level actors such as local authorities, energy advisors, and social landlords will have a role to play in supporting engagement with technology, the use of smart meter information, and options for reducing gas and electricity demand. For this, we have rather more supporting evidence in the form of research into energy advice, feedback, efficiency and low-carbon living programmes.

Summary of potential delivery level actors and functions

	Customer service and protection	Information	Shaping utility-customer relationship	Supporting rollout to improve prospect of energy savings and other customer benefits
Smart Energy GB		√	√	√
Data Communications Company	√	√		
Energy retailers	√	√	√	
Network operators	√	√		

Meter installers	√	√	√	
Local authorities and housing associations		√		√
Energy advisors, NGOs and other third parties offering energy services		√	√	√

Discussions with DECC helped to elaborate some more specific hypotheses concerning the operation of agencies at the delivery level. These broadly clustered against transition points one and two – i.e. related to the installation and use of smart meters:

Some hypotheses concerning the role of the delivery level in smart meter rollout

Supporting engagement in installation	Supporting the use of information generated by smart meters
a) If smart meters are presented as compulsory/ data privacy is breached/ there are poor quality installations and anticipated benefits fail to materialise, then there will be resistance and rejection.	b) Smart metering can be considered a "platform" social innovation that will develop in a variety of ways, similar to mobile phones. Some of these may be unexpected (emergent properties), and may or may not lead to reductions in energy use.
c) Speed and extent of uptake will be affected by perceived benefits to different customer groups, derived from different sources.	d) An increasing range of consumer applications over time will increase the speed and range of innovation diffusion.
e) Targeting specific consumer segments (e.g. prepayment customers, those with electric heating) will affect the 'map' of installations and also the social learning that takes place.	
f) Despite the "platform" nature of smart metering and the likelihood that suppliers will present different offers to different types of customers, it is possible to communicate smart metering as a single concept, e.g. using branding and messaging to lead consumers to be disposed to accept it.	

<p>g) There will be a 'natural' timeframe for adoption, depending on where people lie on the spectrum between early adopters and resisters, which may take longer than the planned five-year roll-out.</p>	
--	--

Step four: draw conclusions

Conclusions from the above stages were drawn together in a report that is structured around the three key transition points in the 'customer journey' identified in the theory of change mapping exercise.

Annex B: Literature review

Scope and approach of the review

This review was carried out in support of the Smart Metering Early Learning Synthesis, commissioned by DECC. The synthesis brings together material from

- research into residential energy use;
- studies of smart meter roll-outs and energy feedback programmes;
- the most recent studies relating to smart meter roll-out in the UK (these include evidence from the Smart Metering Early Learning Project consumer Survey and qualitative research),¹⁰ and material from focus groups with meter installers in Great Britain and Northern Ireland;¹¹
- responses to new technologies and public engagement programmes.¹²

The review is primarily concerned with the first and second of these, as they go some way towards answering questions about the nature of residential energy use and what might be achieved through better energy feedback in the short and long term. It offers guidance on how introducing smart meters might assist householders in managing their energy use, how outcomes might vary between households, and what circumstances favour particular outcomes.

The primary question addressed is

How can smart metering assist householders in reducing electricity and gas demand?

In order to answer the primary question in the main report, we broke it down into three sets of evaluation questions, each related to a 'transition point' in the process of residential smart meter adoption, as described in Chapter 3 of the main report and in Annex A:

- engagement with the installation of the smart meter (SM) and accompanying in-home display (IHD),
- engagement with the SM + IHD, and the information provided by them,
- making changes in daily routines and one-off decisions (e.g. concerning retrofits and appliance purchases) that lead to changes in energy consumption.

¹⁰ Published by DECC at the same time as this report

¹¹ See Annex D.

¹² See Annex C for some lessons from the public health sector.

In order to achieve the final outcome – changes in energy use – the two earlier transition points will have to be successfully navigated or completed.

In order to understand what is going on during these transition points, and what the possibilities might be, it is important to understand something of (a) the nature of residential energy use and possibilities for change, (b) the background to the GB smart meter roll-out, (c) the evidence on householder engagement with feedback on consumption and with smart meter-enabled information, and (d) the theories that are used to explain why things are as they are, and how change might happen.

It may seem odd to set the summary of applicable theories towards the end of the review, but this is offered primarily as a pointer to possible future research approaches. It also serves to point to the wide range of practical issues that can be described and analysed through different theoretical lenses, and that have in some cases contributed to the development of the theories themselves.

A ‘realist’ approach

In carrying out the Smart Metering Early Learning Synthesis, we aimed to develop an iterative process of evidence-gathering and theory-building to guide programme design for smart meter roll-out and its evaluation, along ‘realist’ lines (Pawson et al., 2004). This literature review, as part of the synthesis, offers an account of some of the principal findings on energy demand in homes, technology adoption and responses to feedback. It also outlines some of the theories used to explain observed outcomes, and indicates which are likely to be most fruitful when carrying out further research.

The material comes from the research literature, experimental trials, process and outcome evaluations, surveys, government documents, interviews and opinion polls: a mix of peer-reviewed academic writing and ‘grey’ literature. The items were chosen primarily from a database¹³ of literature on residential energy use, energy feedback, demand response, social learning about energy, consumer engagement¹⁴, and socio-technical innovation in energy systems. These were supplemented by items in the peer-reviewed and grey literature that came to light during the synthesis project, through searches triggered by specific questions or recommendation from colleagues.

Given the complexity of the innovations and processes involved in rolling out smart meters (let alone developing smart grids), and given the time constraints for this project,

¹³ at the Environmental Change Institute, University of Oxford

¹⁴ The DECC Smart Metering Implementation Programme Consumer Engagement Strategy aims to

- build consumer support for roll-out, by increasing confidence in the benefits of smart meters and by providing reassurance on areas of consumer concern;
- facilitate the realisation of consumer benefits, by building acceptance of the installation of smart meters and by helping consumers to use smart metering to manage their energy consumption; and
- ensure that vulnerable, low income and pre-payment consumers can benefit from the roll-out.

an exhaustive review was not possible. Even had it been, such a review might have offered a misleading sense of completeness, at a time when the aim is to draw provisional conclusions and to open up further lines of inquiry. The review is probably best understood as an informed selection from the research and grey literature, offering pointers towards sources of evidence and hypotheses for the future.

The choice of literature was influenced by the topic and perceived quality of a given study or report – a judgement on the rigour and nature of the research, and the extent to which it involved trials and experiments carried out in ‘ecological’ or real-life conditions.

When selecting quantitative studies, scale is obviously a factor worth considering, but some very small-scale studies are also included for the light they shed on processes and consequences, particularly unexpected or unwanted outcomes.

One further note; a review can only be truly ‘realist’ when the literature is structured in such a way as to make it possible to identify details of context/circumstances, mechanisms and outcomes. It has not been possible to do this for many of the studies. For example, outcomes of a smart-meter or feedback intervention are often documented in terms of averages, rather than the characteristics of most interest to a realist review; or they may provide sparse detail on context, or on *how* a given programme or trial was designed to operate. It is therefore best to see this work as ‘realist-informed’ or ‘realist-influenced’. It makes no claim to be a full realist review.

1. Residential energy use

Disciplinary background

A description or analysis of energy use depends on where the chronicler or analyst stands, and what tools they have at their disposal. The concept of energy can be interpreted in several ways, for example as a physical phenomenon, a social need, a strategic or ecological resource, or a commodity (Sheldrick and Macgill, 1988). The concept of energy *use* is also open to interpretation, depending on the standpoint of the analyst. Wilson and Dowlatabadi (2007) offer one of the most comprehensive overviews of decision-making models in relation to energy use, in which they identify four disciplinary perspectives:

- Economics
- Technology adoption theory and attitude-based decision-making, where segmentation is important
- Social and environmental psychology
- Sociology.¹⁵

¹⁵ Darby (2010) also sets out four models for understanding energy use (day-to-day, rather than specifically in relation to decision-making). These are based on economics, psychology, sociology and education – the latter being most significant in terms of emergent change over the medium to long term.

These perspectives are noted as introduction to what follows, and also as a caution: associated with differing modes of thinking, they cannot be randomly combined. For example, there can be mismatches between energy efficiency or demand reduction programmes with an emphasis on adaptive engagement with customers who display a wide range of patterns of energy use, and typical programme-accounting language, where financial considerations and ‘average’, more-or-less homogeneous energy uses are dominant.¹⁶

It is important to be clear about what a particular discipline and approach can offer, and to set out the assumptions behind a plan or an interpretation explicitly. For example, the assumptions being made about what consumers are (‘construction of the consumer’), and how they go about the business of day-to-day living and decision-making. Different models can then be used in generating different problem definitions for sustainability research and policy, as well as in attempting to address those problems.¹⁷ There is more on the question of applicable theories in Section 4 of this review.

The research literature on residential energy use

The literature on residential energy use demonstrates that energy consumption patterns reflect patterns of daily life – indeed, they are patterns of daily life.¹⁸ Energy use is not an action or practice in itself – we do not normally set out to burn gas or use electricity for its own sake. Rather, electricity or fuel consumption are among the measurable outcomes when people heat or cool buildings, or perform the many activities woven into daily life.

The literature on social and behavioural aspects of energy use and technology adoption covers a range of issues affecting the scale and pattern of demand, including household composition, tenure and occupancy, daily routines and spending decisions. These all help to explain why similar numbers of people in identical households can consume electricity in quantities varying by a factor of three or more. Specific issues relevant to this synthesis include:

- The meaning of ‘home’ to the householder – for example, is it a ‘nest’ for sleeping, eating and storage, a workshop where things are made, mended, maintained and experimented with, or a place for entertainment and display?¹⁹
- Involvement / experience in design, adoption and use of new technologies. These would include renewable microgeneration, heat pumps, and electric vehicles.²⁰

¹⁶ Lutzenhiser et al. (2009)

¹⁷ Shove (2011), p.264

¹⁸ e.g. Shove E (2009) Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A* **42** (6), 262-264; Gram-Hanssen K (2013) Efficient technologies or user behaviour, which is the more important when reducing households’ energy consumption? *Energy Efficiency* **6**, 447-457

¹⁹ Aune (2007)

²⁰ Ornetzeder and Rohrer (2006); Caird and Roy (2007)

- Views on the importance of privacy, transparency, anonymity, choice, and sharing of data²¹, and on trust in utilities and other institutions²².
- Interest in, and use of, feedback and advice on energy consumption.²³

These considerations indicate several pathways to customer engagement with new technology and programmes, while offering a caution against ‘techno-optimist’ approaches in which it is assumed that simply installing new equipment in a home will produce a desired outcome. We can hypothesise that the impact of a new technology such as a smart meter will be affected by the nature of that technology, how it is introduced, the knowledge and expectations of those who adopt it, the nature of their daily lives, and their ‘infrastructures of demand’ (buildings, heating systems, appliances). The broader research literature on technology adoption can also show that introducing new technology into a household is a socio-technical process involving trust, confidence, skills, and communication in addition to new equipment.²⁴

Sociotechnical systems and middle-level actors

While there can be divergent approaches to describing and analysing residential energy use, there is substantial agreement that energy systems are social as well as technical in nature²⁵, and that most changes within these systems have both social and technical implications. For example, the business models of energy suppliers evolve as ‘hub and spoke’ centralised systems give way to networks of more distributed supply.²⁶ The nature of demand is shifting, with changes in end-uses, appliance efficiency, and patterns of daily living. The growth in ICT-related consumption and the electrification of heating and transport are significant developments, along with the debate about appropriate policy responses to rising fuel prices, the state of British buildings, the suffering caused by fuel poverty, and the role of energy retailers. Smart metering, by incorporating ICT further into energy systems and influencing the practices of supply and demand, adds another layer of complexity to what is already a complex sociotechnical regime and a complex policy environment.

It follows that questions framed purely in economic or psychological terms, for example in relation to demand elasticity, or responses to new pieces of hardware (meters, real-time displays, solar PV) and software (informative bills, new tariffs) may not reflect the complexity of what is going on in energy systems. Over recent years there have been some useful developments. For example, behavioural economics has made some novel

²¹ McKenna et al. (2012)

²² Wolsink (2011)

²³ Darby (2003 and 2006 b); Biggart and Lutzenhiser (2007)

²⁴ For example, in relation to internet adoption, see [Lu J](#), [Chun-Sheng Yu](#), [Chang Liu](#), [James E. Yao](#), (2003) "Technology acceptance model for wireless Internet", *Internet Research*, **13** (3), 206 - 222

²⁵ Hughes (1983)

²⁶ The Edison Institute produced a striking account of the changing situation in the USA: see <http://www.eei.org/ourissues/finance/Documents/disruptivechallenges.pdf>

contributions to the literature on billing, payment and feedback²⁷, while some economic studies of demand response acknowledge synergies between technology, tariffs and feedback programmes²⁸, showing that tariff policies are more effective when combined with feedback, primarily for demand response but also for overall demand reduction. The idea of social learning has taken hold in relation to technology adoption, resource management and demand reduction.²⁹

The complexity of energy systems, especially on the demand side, has led to an increased interest in middle-level actors, the people most involved in implementation of public programmes and in market activity.³⁰ Examples are local authorities, energy service companies, housing associations, estate agents, appliance manufacturers and NGOs.

Scope for change in household energy use

Part of the rationale behind the GB smart meter roll-out, briefly stated, is that a lack of accurate and timely information on energy use may prevent customers from reducing their consumption.³¹ If so, it is reasonable to expect that energy savings can be assisted by improved information, even if not caused directly by it.

In the short term, the potential for energy savings relates to the extent to which daily patterns of living are open to negotiation and change within the household. There have been various attempts to calculate this. A factor analysis of selected variables from the 2005 US Residential Energy Consumption Survey (RECS) identified five 'lifestyle' factors reflecting social and behavioural patterns associated with air-conditioning, laundry, computer usage, climate zone, and TV use. Multiple regression analysis using these factors was then able to account for approximately 40% of variance in electricity consumption, with income, surprisingly, contributing only about 1% of unique variance.³²

An earlier household-level model of over 1600 Californian households ascribed roughly a quarter of variance in electricity use to physical factors such as climate and building fabric; just over a third to 'social' or demographic variables such as income, tenure, occupancy and ethnicity. The remaining 40% was impossible to attribute to any single factor.³³

²⁷ E.g. Allcott (2011); Brutscher (2011)

²⁸ Faruqui et al., in several papers for Brattle; Jessoe and Rapson (2012). The latter highlight the significance of the IHD in 'overcoming inattention' and facilitating learning through experience.

²⁹ Ornetzeder and Rohrer (2006); Blackmore (2007); Verbong et al. (2013)

³⁰ e.g. Janda and Parag (2013)

³¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277941/2013-12-06-RPC13-DECC-1944_-_Smart_meter_roll-out.pdf

³² Sanquist et al. (2012)

³³ Lutzenhiser and Bender (2008)

Both these studies used datasets in which air-conditioning was a major variable, but this is rarely the case in Europe. Analysis of data from over 50,000 Danish households, combined with in-depth qualitative research, found occupancy to be the most significant variable in explaining differences in electricity use, with income and floor area (closely related) coming second and third. But these three, together, only accounted for 30-40% of the variability observed in three different types of housing. Age, education, gender and ethnicity influenced usage very little, except insofar as there were children in the home, or had been. The authors concluded that 'actual behaviour cannot be understood in a simple rational model where a wish to save energy actually leads to changed behaviour. For instance, in most families lighting gets much more attention than washing ... even though [they] have been told how their total consumption has been distributed... daily habits in many cases are changed only very slowly in spite of information and campaigns'. The authors also point out that 'energy is used for purposes that in a social sense are very different to each other. Tumble dryers and computers both use electricity though the social explanations for using them, and thus their correlation with background variables, may be very different'.³⁴

In the longer term, the potential for changes in demand is greater than might be thought from a study of end-use alone, because *infrastructures* of demand themselves change over time: the buildings, vehicles and appliances through which we channel fuel and electricity, and the ways in which we control and coordinate these.

It is important to distinguish between 'energy saving', 'low usage' and 'low demand', as the dynamics of each are different.³⁵ For example, usage is related to averages and trends over time, while demand has particular meanings in relation to power rating, capacity, heat load and timing (particularly in relation to peak demand). The concept of savings is more related to specific motivations and abilities than the concept of low usage, which has more to do with broad lifestyle choices, competences, economic imperatives, and infrastructures of demand.

It follows that we can expect the scope for changes in energy use to vary considerably depending on which end-uses are under consideration, not least because some are seen as more negotiable/flexible than others. But more importantly, we can expect the potential for change to vary greatly between the occupants of different premises with different equipment, holding different views on how they wish to live and commanding different resources (physical, cognitive, social and financial) with which to do this. Among all these factors, the question arises as to how much impact we might expect from a new variable – improved feedback in connection with the introduction of smart meters.

³⁴ Gram-Hanssen et al. (2004) p.2

³⁵ Klopfer and Wallenborn (2012)

2. Operational and policy context for smart metering in Great Britain

Smart meters are designed to operate in specific national or regional contexts³⁶, but are always part of programmes to extend the use of ICT in energy infrastructure, whether that is in the high-voltage transmission system, or at the level of the individual end-user. They can be specified, introduced and supported with the aim of improving feedback to customers on their energy usage, as is the case in Great Britain, where the functional specification for smart meters includes the ability to communicate with in-home displays, and to provide automated meter reading for accurate (i.e., not estimated) bills. During the Foundation stage of roll-out, all customers are offered an in-home display (IHD) along with the smart meter, and meter installers have been trained to explain how to use the IHDs in order to view electricity usage in near-real-time, and gas usage at hourly intervals.

The DECC impact analysis for smart meter roll-out estimates that this arrangement can lead to savings of 2.8% for all electricity customers, with 2% for gas credit and 0.5% for gas prepayment customers.³⁷ This is slightly less than the estimates for Ireland (3% for electricity) and the Netherlands (3.8% for electricity and 4% for gas)³⁸.

The functional specification for GB smart meters is summarised in Figure 1. The chief functions of interest are the possibility of easier switching between tariffs (including prepayment /credit); measurement of own-generation and export of electricity, and measurement of consumption at regular intervals. This last function means that they can be used in conjunction with time-of-use pricing, in order to encourage customers to use electricity less at peak times, or when supply is inadequate to meet demand.

³⁶ Marvin, Chappells and Guy (1999); Darby (2010)

³⁷ Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB). IA No: DECC0009 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/78666/IA-Feb.pdf

³⁸ For Dutch customers with an in-home display (IHD), the figures are 6.4% for electricity and 5.1% for gas. However, only 20% of the population are assumed to take up the offer of an IHD; the remainder are assigned 3.2% and 3.7% savings respectively, resulting from improved 'indirect' feedback from accurate bills and statements, etc.

High level functionality		Electricity	Gas
A	Remote provision of accurate reads/information for defined time periods - delivery of information to customers, suppliers and other designated market organisation	✓	✓
B	Two way communications to the meter system - communications between the meter and energy supplier or other designated market organisation - upload and download data through a link to the wider area network, transfer data at defined periods, remote configuration and diagnostics, software and firmware changes	✓	✓
C	Home area network based on open standards and protocols - provide "real time" information to an in-home display - enable other devices to link to the meter system	✓	✓
D	Support for a range of time of use tariffs - multiple registers within the meter for billing purposes	✓	✓
E	Load management capability to deliver demand side management - ability to remotely control electricity load for more sophisticated control of devices in the home	✓	
F	Remote disablement and enablement of supply - that will support remote switching between credit and pre-pay	✓	✓
G	Exported electricity measurement - Measure net export	✓	
H	Capacity to communicate with a measurement device within a microgenerator - receive, store, communicate total generation for billing	✓	

Figure 1: high-level functional specification for GB smart meters for residential and small business use.

The meter specification is however only one element of the complex roll-out process, which involves coordination between suppliers, customers, meter operators, data managers, the Data Communications Company, data and communications service providers, Smart Energy GB, and the energy regulator Ofgem (among others).

Reality-testing of policy intent: smart meter trials in northern Europe

The Energy Demand Research Project, 2007-2010

The main test of DECC policy intent for residential smart metering in GB to date has been the EDRP set of trials. The stated primary aim of the trials was to investigate customer responses to smart meters and to the associated in-home displays (IHDs), accurate bills, financial incentives to save energy, general advice tips and (to a lesser extent) time-of-use tariffs. Information was delivered to customers via various media: bills, clip-on electricity display monitors, smart-meter-connected IHDs, web and TV interfaces.

The trials were conducted by EdF Energy, e.on, Scottish Power and Scottish and Southern. Bringing together the findings from four large sets of trials was taxing, as each set was carried out by a different supplier with a different experimental design and sampling conditions. However, it was possible to draw some general conclusions and

the final report on the trials concluded that the policy expectation of low-level savings was upheld (Raw and Ross, 2011). A combination of smart meters and IHDs gave energy savings of ~ 3% for both gas and electricity. For electricity, savings with a smart meter plus display were 2-4% higher than those with a smart meter only. This makes sense, in the light of what we know from previous feedback trials: the near-real-time information on a display is most immediately relevant to a person who is switching electrical appliances on and off throughout the day.

Some more detailed EDRP findings are discussed later in this review. However, the following summary points are worth noting here, as part of the context for what follows:

- with two sub-trial exceptions (involving simple clip-on electricity displays), there was no significant reduction in energy consumption when an intervention did *not* include a smart meter. This conflicts with a number of studies indicating that 'non-smart' displays do have an impact on consumption.³⁹ However, in the EDRP, it seems that reductions were associated with one or more of the following:
 - the experience of installation;
 - any additional advice or support offered in relation to smart meter installation;
 - more accurate billing enabled by the smart meter;
 - the display of smart meter data on an IHD.
- In the absence of a smart meter, energy efficiency tips, historic billing feedback⁴⁰, self-reading of meters and financial incentives had no significant impact. This is broadly in line with the research literature, apart from the finding on historic billing feedback which conflicts with findings from the classic studies on informative billing carried out in the 1990s in Norway.⁴¹
- Web- and TV-based feedback was not associated with any reductions in consumption. This is consistent with findings elsewhere showing weak, zero or apparently perverse effects⁴²
- Savings were generally persistent where the trial was long enough to test this (1yr +), especially with interventions including displays and smart meters
- Installation was not as straightforward as had been assumed, either technically or in terms of gaining access to households. The main technical difficulties arose in getting the meters to communicate with the supplier, and data management.

³⁹ E.g. van Houwelingen and van Raaij (1989); Henryson et al. (2000); Mountain (2006, 2007, 2012)

⁴⁰ That is, feedback showing usage over the same billing period in a previous year, or over a period of 13 months or more.

⁴¹ Wilhite and Ling (1995); Wilhite (1997)

⁴² Abrahamse et al. (2007); Pyrko (2011)

- The final report concluded (p6) that ‘advice should be provided as a fundamental requirement, and historic feedback can be useful, but the details of delivery, and combination with other interventions (e.g. smart meters and real-time feedback), are critical.’

These two themes, details of delivery and potential synergies, are significant considerations when evaluating the Foundation stage of smart meter roll-out.

Irish smart meter and DSM trials

The Irish smart meter trials were carried out by the Commission for Energy Regulation between 2009-10, with the primary purpose of assessing any impact of smart metering on electricity and gas consumption, to inform the cost-benefit analysis for a national roll-out. All participants (approximately 5,000 electricity and 1900 gas customers) had smart meters, along with ‘demand-side management (DSM) stimuli’: a bi-monthly bill with detailed energy statement, a monthly bill with statement, a bimonthly bill, statement and IHD, and a bimonthly bill, statement, IHD and time-of-use tariff. The trials were therefore primarily a test of the DSM stimuli. They gave rise to

- average electricity savings of 2.5% overall and 9% peak (electricity) achieved by a ‘combination of technology, price signal and customer engagement’. These rose to 3.2% and 11.3% for customers with the combination of bimonthly bill with statement and IHD.
- 2.9% gas savings on average from DSM stimuli, with similar outcomes from bimonthly bills, detailed statements, in-home display and seasonal tariffs.
- Homes with children recorded lower gas savings (1.3% on average) than those without (6.4%).
- 74% of participants reported increased awareness of gas usage, and 87% reported some change in how they used gas, as a result of the trial. The corresponding figures for electricity were 54% and 82%. There was little or no evidence of increased knowledge of *how* to reduce usage, but the trial was not designed to supply that.
- Participants underestimated their achievement of electricity savings, with 41% believing they had made some overall savings (although 59% had done so, from meter data) and only 22% thinking they had reduced peak usage (63%).
- In the gas trial, participants tended to overestimate the savings they had achieved.
- Given the mis-estimations of savings, the figures on perceptions of how helpful the feedback was should be read with caution. However, 62% of the gas trial participants reported that their IHD had helped them to save gas. Corresponding figures for electricity trial participants were 84% and 79%, with 91% stating that the IHD had helped them with peak reduction. Written feedback and information were also found to be useful. For example, in the electricity trial, energy usage

statements were rated as very effective in helping to reduce usage by 51% of electricity trial participants, and as effective by 28%; fridge magnets were found useful by 75%, and stickers by 63%.

- 75% were still using the IHD at the end of the gas smart meter trial, and 71% in the electricity trial.
- It appeared that the impact of the IHD was sustained over the (12-month) period of the electricity trial, and that it was most relevant during periods of higher usage.
- Customers were not price-sensitive with TOU tariffs, responding simply to whether the cost at a given time was higher or lower, rather than to the size of differentials.

Smart meter and feedback trials in the Netherlands

The Dutch Parliament in 2011 agreed to start installing smart electricity and gas meters for households and small businesses. The cost-benefit analysis by KEMA (now DNV-GL) estimated that the smart meter, in combination with indirect feedback through bi-monthly energy usage and home energy reports from suppliers, would result in an average reduction in household energy consumption of 3.2% for electricity and 3.7% for gas. In combination with more sophisticated real-time feedback, savings of 6.4% for electricity and 5.1% for gas were assumed to be possible.

A preliminary quantitative and qualitative analysis of the impact of smart meter installation was undertaken. After a year, this showed savings of 0.9% gas (significant at 95% level), and 0.6% electricity (not significant at 95% level), in households that had smart meters plus early versions of bimonthly 'home energy reports', compared with a control group. The report on the trials⁴³ points out, though, that the experimental group did not actually have the *intended* home energy report, with a comparison to costs during the same billing period in the previous year. Neither had suppliers promoted the home energy report, and many customers had not noticed it, especially those who were referred to the company website. Reports that arrived in the mail were more likely to be associated with reduced consumption. Therefore 'a conclusive [quantitative] evaluation cannot yet be made' (p5).

In relation to direct feedback, via displays, the report concluded that 'smart metering in combination with direct feedback ... can lead to a considerable household energy reduction... pilot research ...with a real-time energy management app for smart phones amongst home-owners, showed average savings of 3% for electricity and 4% for gas. Another trial... testing the consumption change effects of a real-time in-home energy dashboard⁴⁴ amongst households in the low [income] rental segment, delivered average savings of 5.6% for electricity and 6.9% for gas. Whether households with smart meters

⁴³ Van Elburg (2014)

⁴⁴ Considered similar to the IHDs in use in the UK.

and direct feedback interventions will be able to actually meet the average savings potentials of 6.4% for electricity and 5.1% for gas as mentioned in the national cost-benefit analysis, deserves a cautious answer of ‘yes, on condition that...’ (pp5-6).

A range of feedback modes is seen as important because different forms of feedback are complementary, with direct feedback offering the best prospects for ‘quick win’ low- or no-cost changes in usage, while indirect feedback (as in home energy reports) is more likely to encourage investment in efficiency measures. Also, ‘opt-in websites and apps should not be considered as the up-to-date substitute for in-home displays, but rather as a complementary option’ (p8).

As with the EDRP trial findings, we see the significance of programme detail. The report comments that the feedback medium needs to match user preferences. So, for example, it is stated that real-time web services on PC, tablet and smartphone could help reduce energy demand, but are more likely to do so with technically-minded customers who are already looking to reduce their energy consumption. However, less committed and /or less technically-minded customers are likely to experience such systems as too complex or demanding, and prefer simple, visually appealing in-home displays. The report sees the IHD as a necessary first step to activate interest and engagement for older people, and those with low levels of numeracy and computer literacy, and recommends that a broad range of feedback systems be made available for when large-scale roll-out begins. This is necessary in light of the trend towards sophisticated home management systems, which are seen as more commercially viable but offer little to many households, especially the less skilled and privileged.

Small-scale qualitative studies of smart metering in vulnerable households

Suppliers have an obligation to fund Smart Energy GB, set up in 2013 and specifically tasked with assisting vulnerable, low income and pre-payment consumers to realise the benefits of smart metering systems while continuing to maintain an adequate level of warmth and meet their other energy needs.⁴⁵

The policy design assumes that Smart Energy GB will develop appropriate advisory materials for suppliers and others to use as part of the support for the installation. It also appears to assume that some of the impact will be felt prior to installation (through awareness-building), and some afterwards (e.g. assisting vulnerable customers to realise benefits from smart metering). All suppliers hold Priority Service Registers of vulnerable customers, although not all vulnerable customers will be on these registers (and this is therefore not a comprehensive means of dealing with their needs). There would seem to be a strong case for additional support to vulnerable customers: preparing installers, arranging for translation if necessary, checking that carers or other companions will be available if necessary, and following up the installation visit.

The voluntary nature of the roll-out is significant. NEA/Consumer Focus qualitative research with a mix of vulnerable and non-vulnerable householders found that those with a supplier where most customers ‘opted in’ to smart metering (rather than simply

⁴⁵ <http://www.eua.org.uk/sites/default/files/3%20lawrenceslade.pdf>

accepting a smart meter on a replacement basis) appeared more likely to mention multiple benefits than those whose smart meters were supplied more on a replacement basis. The benefits mentioned most often were being able to monitor electricity usage and not having any more estimated bills.⁴⁶

NEA, Consumer Focus (now Citizens Advice) and Age UK argues for a need for third party support around the time of installation for several groups of vulnerable customers including those with low levels of literacy and numeracy, those in rented accommodation, particularly if this is in the private sector, and older people.

DECC has published research exploring access to smart meter benefits for blind and partially sighted householders, which recommends that the most appropriate approach would be to combine a specially-designed IHD that could be used along with other accessible web- or smartphone-based applications: multiple information channels.⁴⁷

In a small-scale trial of smart meters with specially-designed displays in Northern Ireland, the value of personal contact and tangible reminders of the visit was clear. Customers appreciated a welcome pack and home visit, especially the energy audit and Standby Off plug. However, it is worth noting that the 'How to Use HenRE' [the IHD] manual was used only occasionally, and none of the 56 participants in the trial visited the website for further information. The trial also demonstrated that there were low income consumers with little if any opportunity to make savings, with baseline consumption so far below the average for their demographic that it bordered on risk. For the sake of their health, these people needed to use more energy, not less, and/or (ideally) to live in better-insulated homes.⁴⁸

3. Householder engagement with energy feedback

Since about the turn of the century, the utilities and some of their supplier industries have shown a growing interest in the literature on feedback and responses to pricing. In particular, the timing of electricity usage has become more significant in the pursuit of greater system efficiency, and ICT offers the prospect of much more sophisticated communication and control. In place of the old 'predict and provide' model, where it is taken for granted that demand will grow and capacity will expand to satisfy it, we have an emerging model in which demand is balanced with available resources in near-real-time. Improving the feedback loops is essential for this. For our purposes, the feedback

⁴⁶NEA and Consumer Focus (2012) Smart for all – Understanding consumer vulnerability during the experience of smart meter installation. Report for DECC.
<http://www.consumerfocus.org.uk/publications/smart-for-all-understanding-consumer-vulnerability-during-the-experience-of-smart-meter-installation>.

⁴⁷ SQW (2013) Study on access to smart meter benefits for blind and partially sighted consumers.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/175653/access_to_smart_meter_benefits_for_bps_consumers.pdf

⁴⁸ Liddell (2012) Smart Meters, Smart People. University of Ulster.
<http://eprints.ulster.ac.uk/25443/1/SMARTerMetersExReportWEB-7Jan13.pdf>

loop of most interest is that between supplier and end-user, mediated through timely, clear and accurate information on consumption (and, for the prosumer, on own-generation).

The role of feedback displays, informative bills, and other forms of consumption feedback is well-worked-over by now, and discussed in more detail below. In summary, there is plenty of evidence (a) that improved feedback is typically associated with durable single-figure-percentage savings and (b) that the size of the effect varies substantially according to the type and quality of feedback, and the context in which it is used.⁴⁹

This variability in effect size is usually attributed, reasonably enough, to the many variables that affect energy use: the infrastructure of demand (housing, appliances, vehicles etc); energy users' demographic status, knowledge, values and relationships.⁵⁰ If energy use is itself so complex, then its responses to energy feedback are also likely to be highly variable. However, it is worth pointing to one rather simple conclusion from the most widely-cited review of feedback from a psychological standpoint: that 'a feedback intervention provided for a familiar task, containing cues that support learning, attracting attention to feedback-standard discrepancies *at the task level*... and *void of cues to the meta-task level* (cues that direct attention to the self) is likely to yield impressive gains in performance.' Put another way, 'Feedback intervention effectiveness decreases as attention moves up the hierarchy closer to the self and away from the task'.⁵¹

Research findings derived from studies of 'M-learning' offer relatively new but fruitful insights into the potential of IHDs and related wireless devices for facilitating user engagement with smart meter data. Researchers in m-learning have focused on how people learn, rather than on teaching and knowledge transfer.^{52, 53} They are also concerned with understanding learning within the constraints and opportunities of small screen size, rich media choice (audio, video, text messaging, etc.), and ease of update, all of which are issues which translate readily into harnessing IHD capabilities more effectively. Whilst perhaps of greatest value to providing new services for children and younger people, studies have also illustrated the readiness with which older people can master m-learning, provided appropriate content and early support are made available.⁵⁴

⁴⁹ See Ehrhardt-Martinez et al, (2010), Darby (2010a) and VaasaETT (2011) for recent examples.

⁵⁰ E.g. Gram-Hanssen (2010)

⁵¹ Kluger and DeNisi (1996), pp254 and 278

⁵² E.g. Teall, Wang, Callaghan and Ng (2014)

⁵³ O'Donnell (2014)

⁵⁴ Santos, Balestrini, Righi, Blat and Hernández-Leo (2013)

Active and passive – a note

One of the earliest reviews of research into energy and behaviour identifies two contrasting theoretical frameworks, ‘behavioural’ and ‘cognitive’, for analysing responses to feedback.⁵⁵ In the former, feedback was interpreted as having a *motivating* function for energy users who have previously been somewhat inactive. In cognitive schemes, though, people were seen primarily as information processors who *make sense of the world around them*. The authors concluded that ‘behavioural’ approaches tend to have short-term effects only, while ‘system learning’ can be the basis for more durable change. This 35-year old review is still a useful point of reference for more recent work on feedback, and it is instructive to check feedback studies, and research into smart technology adoption, on the basis of how active they assume consumers to be.^{56,57}

The main question addressed in this review, ‘*How can smart metering assist householders in reducing electricity and gas demand?*’ indicates the relative positions of the technology (assistive, informative) and the people who use it (sense-making and with varying degrees of ability and willingness to make changes).

The question is broken down into a short series of subquestions: How does smart metering ‘work’ for customers? What elements of display design lend themselves most to adoption and continued use? Does smart metering affect the sources of information and guidance customers turn to?

How does smart metering ‘work’ for customers?

In addressing this question, we are looking at the ways in which householders interact or engage with their smart meters and with the feedback they enable, through in-home displays (IHDs) and other channels such as accurate, informative bills and statements, and (often more detailed) online data. It is this interaction that ‘works’.

Part of the rationale behind the GB smart meter roll-out is that a lack of accurate and timely information on energy use may prevent customers from reducing their consumption.⁵⁸ By implication, improving the information also improves the prospects for reduction.

There is evidence of a range of energy savings from offering residential customers improved feedback (from 0 to over 20% in exceptional cases), varying according to

⁵⁵ Ellis and Gaskell (1978)

⁵⁶ Although the terms ‘active’ and ‘passive’ need watching: for example, a recent study of home energy management systems characterises use of an IHD as ‘passive’, while automated control of appliances is ‘active’. Pelenur and Cruickshank (2013)

⁵⁷ Nyborg and Røpke (2013); Hargreaves and Wilson (2013)

⁵⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277941/2013-12-06-RPC13-DECC-1944_-_Smart_meter_roll-out.pdf

- relatively fixed factors such as climate, housing type, modes of space – or water-heating, the presence or absence of air-conditioning, demographics⁵⁹;
- the extent to which a single form of feedback is combined with other modes of information and interaction, such as advice or time-of-use tariffs⁶⁰;
- the nature of interactions with technology, individuals and organisations⁶¹;
- customer priorities and practices, which can also be characterised in terms of perception and lifestyle.

The second, third and fourth of these come under the general heading of ‘consumer engagement’, a significant element of the GB smart metering strategy. *Note that all three only make sense if we see feedback as part of a process of interactive learning*: it is not simply a matter of providing information, but of people integrating it into their existing practical know-how and abstract knowledge.

For heating, the obvious primary concern relates to the state of the building and the heating system.⁶² There may be gains from the more careful use of heating controls, and from improving the design of these controls, but these are likely to be less significant than the potential from improving the state of the building itself. Space heating typically accounts for 50-60% of delivered energy to a home, with water heating accounting for a further 25%.⁶³ There is scope for improved feedback on heating consumption having an effect through two main pathways: prompting and supporting short-term changes in behaviour (switching on and off, use of timers and thermostats); and raising awareness of the need for better insulation and ventilation.

For cold appliances, permanently switched on, appliance efficiency rather than any changes in usage will be the prime consideration; for the rest, modes and patterns of use are likely to be at least as significant as technical efficiency, and probably more so. In this residual group of lights and appliances, real-time information is likely to have the greatest effect. For the rest, improved historic and comparative⁶⁴ feedback through bills and statements is likely to be more significant.

Much of the research literature still deals with relatively short-term effects from feedback (up to a year), but longer-term datasets are starting to appear that show persistent impact when comparing customers with and without access to improved feedback.⁶⁵

⁵⁹ See the range of econometric studies in various parts of Canada by Dean Mountain

⁶⁰ VaasaETT (2011); Faruqi et al. (2010); Darby (2006b) for a constructivist explanation of why this might be.

⁶¹ E.g. Roberts and Redgrove (2011)

⁶² as we move towards zero-carbon housing, it is worth noting that if the building is of high enough quality, there is no longer any need for a heating system – the ‘passive house’ concept.

⁶³ DECC (2008), Energy Trends

⁶⁴ See OPower statistics for a demonstration of this

⁶⁵ The best-known is the OPower dataset, now stretching over upwards of five years; others are referenced in Ehrhardt-Martinez et al. (2010), Darby (2010a), and VaasaETT (2011)

This is consistent with an interpretation of feedback usage as a form of social learning over time.

What elements of IHD design lend themselves most to adoption and continued use?

Several researchers have noted the importance of attractive design in influencing whether a display is kept in a prominent position in the home and used regularly.⁶⁶ This relates to functionality as well as aesthetics. One study notes that

*When considering the influence of design on the effectiveness of Home Energy Management Systems and prevention of non-use, it is important not only to focus on the physical appearance. Associated elements such as type of feedback, the architecture, the interface, the interaction between users and product, and the context in which it is used need to be included...while feedback is approached by social scientists as strictly a behavioural intervention, it is ...intertwined in the design of HEMS.*⁶⁷

Design test results tend to be commercially confidential, but the continued evolution of energy display designs indicates that such testing is still under way. We can get an idea of process and priorities from a report on a 'lay' exercise with five focus groups that met twice to design their own ideal energy displays in 2009, and who came up with a minimum specification for an interactive display. They concluded that it should present a default screen with a clear analogue indicator of current consumption rate, along with figures showing the current rate of usage as rate of spend in £/day, and cumulative daily spend in £. Customers could turn to other screens for further information if necessary. For a single-screen, non-interactive display, this information could be supplemented by the current rate of consumption in kW. During the period between design sessions, when the participants tried out various designs in their homes, they found that the displays motivated actions categorised as:

- turn it off
- use it less
- use it more carefully
- improve its performance
- replace it / use an alternative.⁶⁸

A more recent British study notes 'mobile, familiar, intuitive, visible' as desirable attributes in 'smart home' technologies generally,⁶⁹ and the trend in design seems to have been in this direction. These studies can usefully be read with affordance theory in mind.⁷⁰

⁶⁶ E.g. Hargreaves et al. (2010)

⁶⁷ van Dam et al. (2010), p.461

⁶⁸ Anderson and White (2009)

⁶⁹ Hargreaves and Wilson (2013)

⁷⁰ Norman (1999)

One of the most thorough academic studies of smart energy management design-in-use concludes that displays should not be developed as standalone interventions, but be incorporated into a broader change strategy that uses information and guidance from a range of sources.⁷¹ As smart meter data can be used to develop more informative bills and home energy reports, these are obvious candidates for inclusion in such broader strategies.

The EDRP final report⁷² notes that different market sectors have different preferences for design and display features, giving priority variously to saving money, environmental benefit, acquiring and manipulating data, and the appearance and functionality of the new gadget itself. The authors suggest that 'it may be critical for installers to have a small set of options for how to present a device to different households.'

In the e.on trial (one of the four large trials that made up the EDRP), where customers with smart meters were supplied with a more advanced display than those without, the evaluators note that *'differences in survey response are consistent with the analysis of consumption data, the real-time display (RTD) being more likely to be used, and rated as more useful, in the smart meter groups than in the non-smart meter groups. Since the groups differed in both the type of RTD and the context of other interventions, the reasons for the differences in response cannot be stated with certainty. However, the differences in the RTDs themselves are the more likely explanation.'*⁷³

The e.on trial survey also provided evidence relating to optimum design of electricity displays, indicating the importance of cost data and simple graphics. In contrast, CO₂ emissions and the usage alarm were not widely used or highly rated. High ratings were given to the thermometer function of the clip-on RTD (given to non-smart-metered customers), which may have been helpful when interpreting advice about room temperatures.

The Customer-Led Network Revolution (CLNR) project⁷⁴ reports that, among their interviewees with smart meters and IHDs, the two *'are understood to be the same thing, or at least two parts of a whole. All households who have taken part in our study have both a smart meter and an IHD and for the vast majority the IHD is the smart meter – it is the means through which they are provided with information, and it looks 'smart' because of its digital display, its real time information and the way it physically resembles other devices which are associated with domestic ICT devices (smart phones, portable consoles)'*. The interviewees found their smart meters with IHDs easy to use, with very few concerns about privacy or health. The researchers detected a sense of 'civic engagement' with the idea of having a role in keeping the lights on and decarbonisation. The CLNR participants used their IHDs in at least three distinct ways: to manage the household economy, to provide oversight on what their families were

⁷¹ Van Dam, SS (2013) Smart energy management for households. PhD thesis, Technical University of Delft. <http://abe.tudelft.nl/index.php/faculty-architecture/article/view/614>

⁷² Raw and Ross (2011)

⁷³ *ibid.*, p142

⁷⁴ funded by the UK Low Carbon Network Fund

doing, and to challenge themselves to save energy. The most commonly used feature of the display was the ‘traffic lights’ that told users whether their electricity use was low, medium or high. Negative comments fell mostly into two categories; that the accuracy of the displays was not trusted, and that it could be hard to engage other members of the household with them.⁷⁵

In summary, there is useful guidance in the research and grey literature as to IHD design features that are most helpful to householders: attractive design, simple, intuitive interfaces with clear information on cost and consumption, and the potential to ‘dig deeper’ and to link with other sources of information and guidance. The research findings also signal that the IHD/RTD is best seen as part of a wider engagement strategy; and they indicate that many people can benefit from some guidance in how best to use them – a topic that is taken up in the consideration of the installer’s role, below and in the main report.

Non-IHD feedback

Non-IHD feedback falls mainly into the categories of written reports, statements or informative bills, text messaging, and web-based feedback via a computer or other online device.⁷⁶

There are only a few trials that show the effect of informative billing in isolation from other factors. The highest recorded savings were achieved in Norway: 10% over controls when quarterly bills based on an annual meter reading were replaced first by accurate bills every two months, and then, after a year, by historic feedback – a comparison with the same period during the previous year. Including advice on energy efficiency with the bill added nothing to the savings (this contrasts with findings from several other sources), and the authors concluded that the main single stimulus to conserve had come from increased billing frequency.⁷⁷ It appeared that people knew what they needed to do in order to save energy, and that the improved, more frequent bill prompted them to do it and then, later, validated their actions by showing the reduced usage. A follow-up study, on a larger scale (2000 participants) in which customers phoned in their meter readings every month, gave comparable savings: 8% over controls, three years after the end of the trial.⁷⁸ It seems that the durable and relatively high impact from frequent, accurate bills in Norway was primarily due to their supplying a ‘missing link’: customers were already motivated to save and were then given something crucial for knowledge and understanding that they had lacked previously, plus a regular prompt to act.

However, this high level of savings from more frequent and accurate billing has not been replicated. A review of energy information programmes in the Nordic countries

⁷⁵ Bulkeley et al. (2013)

⁷⁶ The EDRP trials also included an attempt to provide feedback information via the TV, which proved far more difficult than expected and was unproductive. See Raw and Ross (2011)

⁷⁷ Wilhite and Ling (1995)

⁷⁸ Wilhite (1997) and pers. comm.

found savings of 0 - 4% (though not *only* from enhanced bills; other forms of information were included). It concluded that the longer the duration of a trial and the more information available to the customer, the more persistent the effects were likely to be.⁷⁹

The accessibility of billing and similar energy information is clearly a factor in its effectiveness. Recent qualitative work confirms the inadequacy of the 'information deficit' model in which the energy user passively soaks up information, showing how effectiveness is related to interlinked factors: trustworthiness and expertise of the source, contextualised information and ease of understanding. The authors identified a need for policy to support more 'personalised' approaches, allowing tailored information to be shared and made sense of.⁸⁰

A variant on the informative bill is the home energy report that uses billing data but is sent out separately, by an organisation that works for, but is separate from, the utility. The best known example of this is OPower, who report independently evaluated savings of between 1.5-3.5% against longer-term datasets.⁸¹ Participation rates are high (the programme is opt-out, and the cost to customers very low), with around 85% of customers showing some sort of response to the reports. OPower claim increased participation in energy efficiency programmes, as well as direct response to the reports.

Other studies of the impact of written feedback give a range of savings from 0 to 13%, but the high figures are associated with small-scale experiments of short duration, and usually involve combined interventions, not just improved billing/written feedback. For example, Midden et al (1983) found savings of 13% and 7% in comparison with controls, for electricity and gas respectively, in 69 apartments which were given weekly written information on usage in kWh, % increase or reduction on individual's baseline, cost implications, and graphs of consumption to date. The apartment residents were also given advice at the start of the experiment, and some were given financial incentives to reduce - this was a high-intensity intervention. Interviews after the experiment showed that three responses were most effective, though not necessarily easy to implement: heating to a lower temperature, turning the heating down an hour before bedtime, and having a smaller number of lights on.

Feedback from utility websites appears to be effective (in terms of engagement and subsequent action) mostly for people who have already been engaged by skilful marketing and good relationships with the supplier. Such successes are rare. A 2010 review for Ofgem offers examples.⁸² Since that time, the indications are that customers rarely use web-based feedback from utility sites, or even from third-party sources: for example, the Google PowerMeter was short-lived. Such information appears to be most effective as a *complement* to other, more accessible feedback. It is, of course, not universally available. Ofcom reported in 2011 that there were 'considerable differences

⁷⁹ Henryson et al. (2000)

⁸⁰ Simcock et al. (2014)

⁸¹ The best-known is the OPower dataset, now stretching over upwards of five years; others are referenced in ACEEE (2010), Darby (2010a), and VaasaETT (2011)

⁸² Darby (2010a)

in internet access by socio-economic group and by age, with 41% of those aged 65+ having internet access at home, and 60% of those in DE households, compared to 79% overall'.⁸³ In 2013, the Office of National Statistics reported 83% of GB households as having internet access. They did not offer a breakdown by social group but gave a similar figure to Ofcom's for single pensioners (40% access), and about three-quarters of single adults aged 16-64. This compared with almost full access for the remainder of the population.⁸⁴

The Vaasa Energy Think Tank report on best practice in ICT as an influence on energy efficiency comments that

*There is a lot of debate in the field of smart meter enabled energy efficiency and demand response about which forms of feedback work best, but what this research ...has shown, is that multiple feedback channels work best ... different feedback channels have different purposes...typically, successful programmes put many of the above forms of feedback together in one programme...*⁸⁵

Studies of informative billing and home energy reports offer a consistent account of customer satisfaction with the improved information.⁸⁶ As smart metering offers a way of improving the accuracy and detail of these reports, the assumption is that billing and reports based on smart data are likely to be appreciated by customers, provided the information is well-presented. Evidence from the USA, Netherlands and Austria supports this.⁸⁷

Text messaging has been tried on occasion. In the Irish smart meter trials, text messages sent to the IHD were reported as effective for those who recalled receiving the message, but this was only 15% of recipients. There has been some effective use of phone and/or text message alerts in dynamic electricity pricing trials, to inform participants about forthcoming high prices.⁸⁸ In the recent 'Smart Communities' project in Kingston upon Thames, weekly emails were used to prompt participants to continue with their use of energy displays, and to help generate the sense of being part of a group.⁸⁹

⁸³ <http://stakeholders.ofcom.org.uk/binaries/research/media-literacy/media-use-attitudes/adults-media-use-2012.pdf>

⁸⁴ http://www.ons.gov.uk/ons/dcp171778_322713.pdf

⁸⁵ Lewis, Dromacque, Brennan, Stromback and Kennedy (2012)

⁸⁶ e.g. Wilhite H (1997) *Experiences with the implementation of an informative energy bill in Norway*. Ressurskonsult A/S report 750; data from OPower, and from take-up of home energy reports (specially if paper-based) in the Dutch smart meter trials.

⁸⁷ As in the footnote above; also Schleich J, Klobasa M, Golz S and Brunner M (2013). For further material on non-IHD feedback, see Annex B; there is also a summary of several of the main points in Darby (2010a)

⁸⁸ E.g. Isaacson et al. (2006); more recently, in the 'Low Carbon London' initiative, funded by the Low Carbon Networks Fund and led by UKPN.

⁸⁹ Burchell et al. (2014)

As yet, we have very little evidence on the effectiveness of mobile phone apps as feedback devices. In the report on the Netherlands smart meter trials, there is reference to a phone app trial, leading to savings of 3% for electricity and 4% for gas among 500 participants after 12 months, but the detailed conditions for the trial and for the savings calculation are not known. The report comments that ‘the more advanced applications, on online media, may stand a better chance of succeeding with users who are already motivated, tech-oriented and media-savvy, and will be able to use the *added* value [our emphasis] from using a PC, tablet or smartphone. Those with less motivation and/or technical affinity often find these too complex or demanding for user use, and prefer a simple monitor at a fixed location in the house, visible to all members of the household. Interface design *and* household interaction play an important role in changing consumption routines.⁹⁰

It is worth stressing that *an app on a mobile phone or similar device is not equivalent to an IHD with ambient feedback in the home*, and indeed the thinking behind proposed apps often seems to have more to do with remote controls than with feedback. As indicated above, the impact of a mode of feedback relates to several factors, including design, location, situations in which it can be used, possibilities for interaction and synergies with other forms of information. So it is not possible to extrapolate from findings with one mode of feedback to another. Apps for smartphones and similar devices will need careful monitoring and evaluation over time and with a range of users before we can draw useful conclusions about their effectiveness.

Complementary information and advice

Energy suppliers are an obvious source of information and advice, not least because they have access to some crucial customer information and are responsible for meter installation.⁹¹ This puts them in a strong position to offer support, and the EDRP trials show how customers will seek information and advice from them. The final EDRP report notes that e.on experienced an average of 30 additional minutes of call centre contact for each customer having a meter exchange. This indicates a substantial need for support from the supplier, even if most of that occurs immediately around the time of installation (as was the case for e.on). Detailed information on queries to a dedicated customer service helpline at Scottish and Southern Electric (SSE) during their smart meter trials showed that they covered a wide range of concerns, including requests for detailed energy advice. The EDRP trial findings in general support the setting up of dedicated advice lines for smart metered customers, with staff trained in domestic energy efficiency and tariffs, as well as smart meter-specific issues.

An ability to refer customers to appropriate local sources of help is also important, given the value of in-home advice in many situations. There is a difference between providing general information to the public – for example, raising awareness of what a smart

⁹⁰ Van Elburg (2013) Energy Savings Monitor Smart Meter report. Translated from the Dutch for DECC

⁹¹ Just under a third of customers surveyed for Wave 3 of the DECC smart meter tracking cited their energy company as somewhere they would go to for information about smart meters and displays; see also Boardman and Darby (2000)

meter is and what it can do, or publicising arrangements for data privacy – and offering detailed guidance on how to go about reducing energy demand in a particular home occupied by a particular set of people. In-person energy advice in relation to questions raised by the householder is normally more effective than written ‘advice’ without the possibility of interaction⁹².

Self-disconnections happen frequently among a small but concerning minority of vulnerable customers on prepayment meters; the issues have been recently analysed in New Zealand⁹³, and many findings are applicable to the UK. Self-disconnection patterns (particularly when these are frequent, usually take place at the same time of day, and occur more often in colder weather) are signals of energy being unaffordable, and therefore of vulnerability. Prepayment meter customers would seem to be candidates for additional advice and support.

Engagement with the meter installer during the installation visit

We have some research findings from the EDRP trials that indicate the significance of installation visits in terms of customer engagement with smart metering and/or feedback displays. The final report⁹⁴ notes (p129) that *‘the EDRP trials did not set out to test installation effects but they arise through different approaches to recruitment and installation. The installation procedure, for example, ranged from trying to minimise any impression that the work was anything other than “business as usual” or promoting minimal interaction between installer and householder, to training installers to demonstrate the installed technology to householders.’*

There was minimal interaction between installation teams and customers in the EdF trial, where customers were simply given a booklet. The conclusion is that *‘there is scope for RTDs [real-time display – that is, a non-smart-meter-connected display] to have greater impact, simply by ensuring that more households who receive one retain a greater awareness of its existence and actually make use of it. This would come partly from using well designed devices and partly through the installation/ delivery and support processes that are put in place.’* (p137)

In the Scottish Power trial, where installation was carried out in a very low-key way, the evaluators comment that *‘although the smart meter technology was being tested, the experience of installation and understanding of the meter were not. At no point did the energy consumption of the groups with RTDs differ significantly from the groups without RTDs.’*

Scottish and Southern Energy customers were given an explanation of how their smart meter worked at installation, and *‘were generally satisfied with the explanation provided ...68% were very or somewhat satisfied in groups that did not also have an RTD but this*

⁹² New Perspectives and Energy Inform (2004)

⁹³ O’Sullivan et al. (2013)

⁹⁴ Raw and Ross (2011)

rose to 81% and 83% for credit and prepayment customers respectively with an RTD... Householders generally reported more positive changes in attitudes and awareness in the groups that received smart meters, particularly if they also had an RTD' (p112). Some SSE customers only received an RTD, with no smart meter, and had to install it themselves: 'Of those who had installed the RTD, 17% of those who had received the RTD thought it complicated, or thought the instructions were not clear. This further reduces the potential of the RTD to affect consumption and emphasises the benefit of RTDs being fitted and explained by an installer.' (p112)

Summarising, the EDRP evaluators state (p169) that *'The relevant feature of the customers' experience of the smart meter installation cannot be stated with certainty but there was a clear difference between E.ON and SSE, which set out to explain to customers what they were receiving, and Scottish Power, which ran the trial as a blind trial (every effort was made to prevent customers knowing they had a smart meter, by presenting it as a routine meter replacement). While smart- and non-smart conditions could not be compared in the EDF trial, the survey data showed that (a) customers expected, and could have benefited from, more engagement and instruction during installation of equipment and (b) some respondents were happy to benefit from no more meter readers or estimated bills and nothing else.'*

A recent e.on/AgeUK survey of elderly smart meter users found that one in five had some difficulty in understanding their display, although all felt that the installer had given a clear explanation.⁹⁵ This suggests that, for some customers at least, follow-up guidance can also be useful.

Differential outcomes from smart metering

As emphasised in the literature on residential energy use, energy outcomes are the product of an innumerable set of variables; and introducing a new form of metering adds yet another. So it is realistic to expect variable outcomes, and also some surprises. The information we have from feedback and smart metering trials (rather limited, because they tend to focus on *average* outcomes) confirms this. For example, high-income dual-fuel households benefited most from the smart meter and feedback interventions in the e.on EDRP trial, possibly reflecting a greater capacity for savings (though also the tendency for participants to 'regress towards the mean' from their relatively high baseline consumption). More surprisingly, the SSE trial found that smart prepayment electricity customers made similar savings to those of smart-metered credit customers.

The main single reason why we might expect variable outcomes in terms of electricity and gas consumption relates to a household's capacity for energy saving without jeopardising their welfare. From what we know of residential energy use, this will have something to do with the state of their housing, and the extent to which they can make changes in housing, heating systems or appliances: are they owners or tenants? It will

⁹⁵ E.on and Age UK (2013), Smart meter satisfaction research

also be affected by their ability and willingness to invest in efficiency measures, and their ability to access and use new knowledge, alone or through social connections.

35% of the GB population are now estimated to rent their homes, and 60% of those aged 25-34.⁹⁶ This limits their options for making changes to their dwelling and major appliances and, given that they are likely to move house relatively often – particularly those in the private rented sector – they may have relatively limited local knowledge (for example, about how to access services) and social networks.

Technical knowledge could be said to influence willingness to engage with the IHD (as shown in the Early Learning Project research) and it is likely that people with a good working knowledge of their home, and especially those with DIY experience, are more able and more likely to make efficiency improvements than those without this sort of knowledge.⁹⁷

The research literature throws up varying evidence on the capacity of different households to achieve savings following advice and/or improved feedback. Energy advice programmes, especially those that are client-led and involve personal contact between adviser and householder, can lead to significant savings in low-income households⁹⁸, and an evaluation of GB advice programmes in 2004 concluded that those on lower incomes tended to save more than those on higher.⁹⁹ The Netherlands smart meter trials, too, found indications of greater savings for less affluent groups. But it is unclear how widely applicable these findings are, and how dependent on the intensity and quality of advice available.

Some in-home variability can be expected: for example, a Danish study that found teenagers to be the family members most interested in feedback¹⁰⁰. This indicates some potential for informal learning within households.

A report for the European Consumers' Bureau, based on the findings from six large-scale European trials, concludes that, from the point of view of energy-saving potential, the two groups with enough consumption and capability, and enough motivation, to be worth supplying with smart meters are those who are high-consuming, motivated and capable, and those with average consumption who are also motivated and capable; therefore smart meters should be deployed on a voluntary basis or by targeting 'extravagant' customers, which could have the indirect effect of introducing a social norm (that smart meters are desirable).¹⁰¹

⁹⁶ Creative Research (published in parallel with this), report for DECC on prepayment and smart metering.

⁹⁷ Aune M (2007) Energy comes home. *Energy Policy* **35**, 5457-5465; Darby S (2006b) op.cit.

⁹⁸ Darby S (2003) *Making sense of energy advice*. Proceedings, European Council for an Energy-Efficient Economy. Paper 6,157

⁹⁹ New Perspectives and Energy Inform (2004) Savings from behavioural changes following energy advice: report on a survey

¹⁰⁰ Grønhøj and Thøgersen (2011)

¹⁰¹ Klopfert and Wallenborn (2012).

A modified version of this approach was advocated following a field trial of electric smart meters in Linz, where smart metering produced 4.5% savings on average, and was found to be most effective for the 30th-70th percentiles in terms of prior consumption. Above and below this, feedback appeared to have no effect. The authors contrast this finding with the German energy law which stipulates that smart meters should only be mandatory for households using more than 6MWh per year of electricity.¹⁰²

The Irish gas smart meter customer behaviour trial findings, published in 2011, conclude that *'participants with the highest and lowest education and social grade education are least likely to reduce usage. This may reflect motivation (among those with AB social grade) and communication (among those with lower social grades C2 and DE). While efforts were made in the communications strategy to be inclusive, the [trial] results may reflect more fundamental barriers to engagement among those with lower levels of educational achievement.'*¹⁰³

From these examples, there would seem to be the potential for households in all income groups to make some energy and/or cost savings arising from smart metering. However, vulnerable customers are likely to need greater support and guidance than others.¹⁰⁴ For those at the bottom of the income scale and in the deepest fuel poverty, whose main problems relate to housing quality and income, it is unrealistic to expect smart metering alone to make a substantial difference to consumption, even if it is able to offer some noticeable benefits.¹⁰⁵

4. Theories relevant to smart metering roll-out and householder engagement

Hypotheses as to how smart meters might benefit different energy users could stem from a range of theories relating to both feedback *and* to consumer engagement in relation to energy use and technologies. We have selected some of these below.

Some of these theories offer fairly clear mechanisms for change; some are more dynamic than others; some have broader scope, taking into account cumulative / layering effects (e.g. different modes of feedback + advice + community benefit from smart grid-type arrangements). And some take more account of the dynamics of system development, e.g. how changes in utility regulation might alter tariffs and incentives to loadshift; how the electrification of heating and transport could alter load profiles locally and nationally.

When first considering the issues raised by consumer engagement with smart metering, it became clear that several types of engagement occur, including

¹⁰² Schleich et al. (2013)

¹⁰³ [http://www.cer.ie/docs/000340/cer11180\(ai\).pdf](http://www.cer.ie/docs/000340/cer11180(ai).pdf), p64

¹⁰⁴ This can pay dividends, as shown during the introduction of keypad meters to low-income customers in Northern Ireland. Savings were of the order of 10% when the customers were also offered in-home advice.

¹⁰⁵ Boardman (2012)

- Engagement with *technology* designed to particular specifications (smart meter, in-home display)
- Engagement with the *meter installer* during the installation visit
- Engagement with the *billing system* – is it clear and does it provide actionable information?
- Engagement with *other members of the household*; shared use of the meter and display, negotiation of practices
- Engagement *beyond the household, informally* – social learning, knowledge transfer
- Engagement with *formal bodies and support services beyond the household*, e.g. advice programmes, energy efficiency installers, energy retailers, network operators, housing associations. More remotely, with Smart Energy GB and the regulator, Ofgem.
- Engagement with *initiatives and incentives* to adapt energy-using practices, e.g. new tariffs, adoption of energy efficiency measures or low-carbon technology, demand response programmes or similar.
- Engagement with the *concepts* of smart metering and smart grids, and with national or local energy debates, as well as with the *business case, processes and anticipated outcomes* currently underpinning GB's smart meter roll-out.

Once we do this, we can see a degree of 'layering', from micro-level interactions to engagement with whole systems, from artefacts to ideas.

In this section, we identify and briefly discuss a range of academic theories which are likely to contribute some insight into customer responses to smart meters. These theories have been used to explain and structure investigations into phenomena that have a bearing on everyday domestic practices (especially in relation to gas and electricity use), energy infrastructures and utilities, and engagement with technology and public programmes.

This is an introduction to some theoretical possibilities, no more, as a guide to further work.

The main theories identified as applicable to this exercise are listed in Figure 2 below, grouped according to level of operation: the household, the 'delivery level' of organisations in some sort of contact with the household, and the 'wider system' level of governance, design and regulation. They indicate the variety and scope of higher-order concepts that could be brought to bear on consumer engagement with smart meters in

industrialised countries. They also provide several ways of understanding the processes underpinning observed actions and outcomes related to smart metering and feedback, and can be used to generate hypotheses for testing during roll-out and evaluation.

Household level

Affordance theory: meter specification and design – what it enables users to do – is related to effectiveness.

Theory of planned behaviour: action is related to attitudes, intentions, subjective and social norms, and perceived control. 'Proximal' factors (near at hand) are the most powerful.

Classical microeconomics: indicates that energy saving will result from consumers responding to financial incentives

Behavioural economics: takes into account non-economically-rational nature of many decisions.

Experiential learning theory: assumes that people experiment with technologies and activities, learning as they go

Personal development theory: indicates that benefits come from combined effects of infrastructure, norms, education, personal experience and technologies

Delivery level

Practice theory: proposes that outcomes depend on dynamics between technology, meanings, rules and routines

Social learning, communities of practice: indicates that people learn in company with others in many contexts, sharing knowledge and experience

Diffusion of innovations theory: proposes that innovations spread in relation to their characteristics, communication channels, time and the nature of social systems

Actor-network theory: assumes that outcomes will depend on relationships between human and non-human actors at many levels

Socio-technical systems (STS) theory: highlights the role of knowledge and social processes in energy systems

Wider system

Large technical systems theory: system is the unit of enquiry; systems evolve in phases.

Multi-level perspectives, energy transformation: smart meter is a niche product, within a sociotechnical regime, itself within a social, physical and political 'landscape'.

Figure 2: Some theories applicable to adoption of new technology and user engagement

Engagement and participation

There is not much theory that comes directly under the heading of 'engagement', but a good deal under 'participation'. As shown in Arnstein's ladder of citizen participation¹⁰⁶, this can range from manipulation, through consultation and partnership, to full citizen control. Most of the participation literature deals with non-energy programmes and interventions, but we can still draw on it selectively for material applicable to technology adoption and adaptation, and to the development of socio-technical systems and service provision. There is also some applicable innovation theory (for engagement with new technologies).

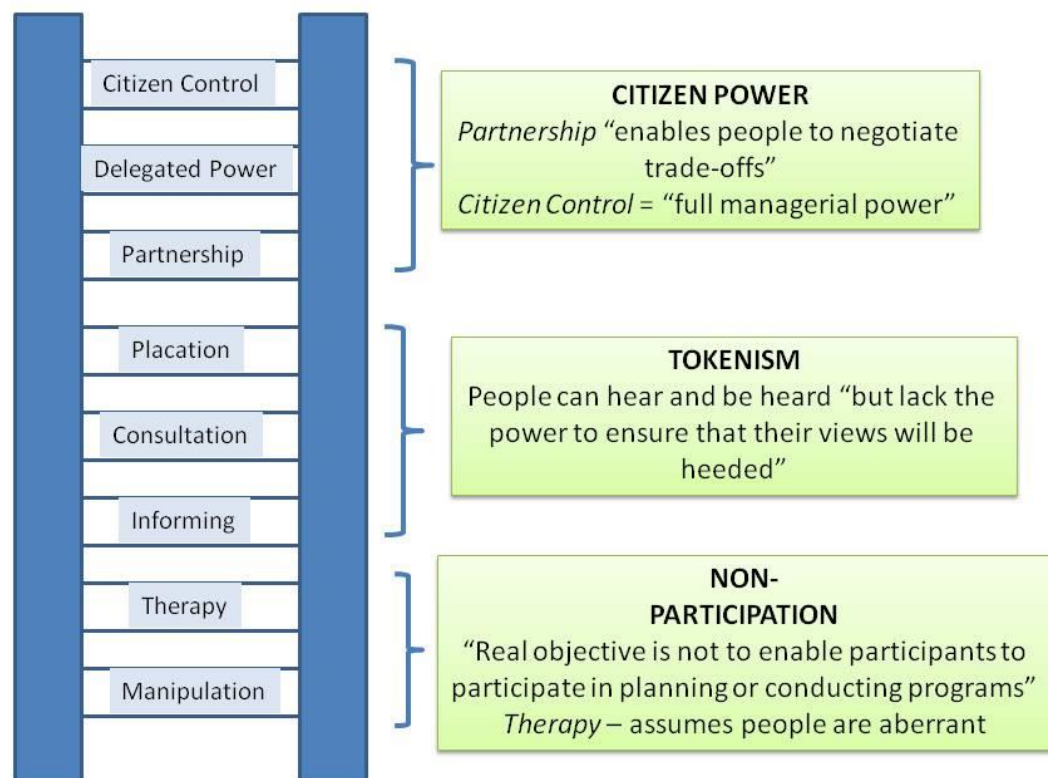


Figure 3: Arnstein's 'Ladder of Citizen Participation' (1969)

Note that some theories which apply primarily at the household level could be 'nested' within higher-level and more system-based theories. This nesting approach can

¹⁰⁶ Arnstein (1969)

incorporate stakeholders at all levels from individuals, through households, to neighbourhoods and trusted support agents (see Figure 4). This type of model can fit with frameworks such as ‘Energy Cultures’¹⁰⁷, which propose that consumers be guided loosely towards macro-level goals (low carbon, demand reduction), while finding ways that work best for them. Such an integration of scales could be useful when assessing possible energy futures: an example is offered in the recent UK Energy Research Centre scenario exercise, where the degree and quality of public engagement in smart grid development significantly influences outcomes.¹⁰⁸

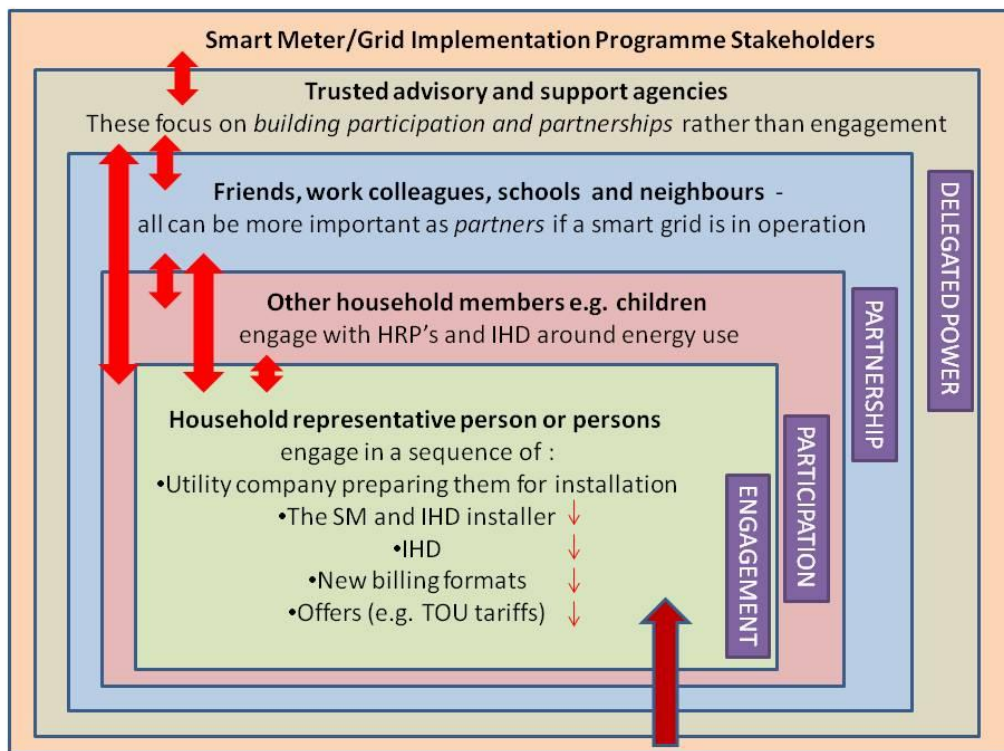


Figure 4: a nested model of consumer engagement/participation

However, not all theories sit well together. In particular, there are strong differences between some of the more individualistic theoretical positions – primarily psychological and economic – and the more social and relational ones.

Wilson and Chatterton (2011) offer four criteria or dimensions to guide policymakers in their choice of theories or models: the actors, scopes, durability and domains of a

¹⁰⁷ Stephenson et al. (2010)

¹⁰⁸ Balta-Ozkan et al. (2014)

particular behaviour.¹⁰⁹ As noted earlier, a range of models is valuable in that it enlarges the problem definitions and hypotheses to draw upon when addressing complex issues.¹¹⁰ It also offers a range of possible indicators or metrics for use when evaluating a programme. While different models cannot be combined, it is possible to select one for a given purpose – for example, analysing how people go about the business of decision-making when choosing a heating system.

Theories should in any event be used with a degree of flexibility when applied to complex phenomena: like the processes they attempt to account for, they are in development. It is worth remembering that:

*‘... inefficient trials usually precede efficient practice and therefore at that [trial] stage the presentation of theory may be positively harmful... [we need to see theory] as something which is worked on by a group of people and which they use in criticising and harmonising their joint activity’.*¹¹¹

References

Note: not all these references are used in the literature review. Some were added to the main report later in the project, and are included here for completeness.

Abrahamse W, Steg L, Vleck C and Rothengatter T (2007) The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology* 27, 265-276

AECOM (2011) Energy Demand Research Project: final analysis. Raw G and Ross D, AECOM, London. p.4

Allcott, H (2011) Social norms and energy conservation. *Journal of Public Economics* 95, 1082-1095

Anderson W and White V (2009) Exploring consumer preferences for home energy display functionality. Report for the EST from the Centre for Sustainable Energy, Bristol

Arnstein SR (1969) A ladder of citizen participation. *Journal of the American Institute of Planners*, July 1969, 215-224

Aune M (2007) Energy comes home. *Energy Policy* 35, 5457-5465.

Balta-Ozkan N, Watson T, Connor P, Axon C, Whitmarsh L, Davidson R, Spence A, Baker P, Xenias D, Cipcigan L and Taylor G (2014) *Scenarios for the development of smart grids in the UK – synthesis report*. Report UKERC/RR/ES/2014/002. UK Energy Research Centre, London

Banks N (1998) Cultural values and the adoption of energy efficient technologies. Unpublished DPhil thesis, University of Oxford

Banks, N (2000) Socio-technical networks and the sad case of the condensing boiler. *Proceedings, Energy efficiency in household appliances and lighting*, Naples, eds. Bertoldi, Ricci and de Almeida.

Biggart, NW and Lutzenhiser L (2007) Economic sociology and the social problem of energy

¹⁰⁹ The scheme is set out in detail in Chatterton and Wilson (2014)

¹¹⁰ Shove E (2011) On the difference between chalk and cheese – a response to Whitmarsh et al's comments on 'Beyond the ABC: climate change policy and theories of social change'. *Environment and Planning A* 42 (6), 262-264

¹¹¹ Hodgkin (1976), p4

- inefficiency. *American Behavioural Scientist* (2007) **50** (8), 1070-1087
- Blackmore C (2007) What kinds of knowledge, knowing and learning are required for addressing resource dilemmas? A theoretical overview. *Environmental Science and Policy* **10** (6), 512–525
- Boardman, B and Darby, S (2000) Effective Advice: energy efficiency and the disadvantaged. *Environmental Change Institute, University of Oxford, UK*
- Boardman, B (2012) [Fuel poverty synthesis: Lessons learnt, actions needed](#). *Energy Policy*, 49: 143-148
- Boardman, B. and Darby, S. (2000) Effective Advice: energy efficiency and the disadvantaged. *Environmental Change Institute, University of Oxford, UK*
- Bronfenbrenner U and Crouter A (1983) The evolution of environmental models in development research. In PH Mussen (ed) *Handbook of child psychology vol. 1: History, theory and methods*. 4th edition, pp357-414. New York, Wiley
- Brutscher, P-B (2011) Payment Matters? - an Exploratory Study into the Pre-Payment Electricity Metering. Cambridge Working Paper in Economics 1124, <http://www.dspace.cam.ac.uk/handle/1810/241889>
- Buchanan K, Russo R and Anderson B (2014) Feeding back about eco-feedback: how do consumers use and respond to energy monitors? *Energy Policy* **73**, 138-146
- Burchell K, Rettie R and Roberts T (2014) *Working together to save energy? Report of the Smart Communities project*. Kingston University
- Burke L et al (2011) Self monitoring in weight loss, a systematic review of the literature. *J Am Diet Assoc*, Jan 2011;111(1) 92-102
- Caird S and Roy R (2008) User-centred improvements to energy efficiency projects and renewable energy systems: research on household adoption and use. *International Journal of Innovation Management*, special issue on user-centred innovation
- CER (2011) Electricity and gas smart metering customer behaviour trials (CBT) findings reports.
- Chatterton T and Wilson C (2014) The 'Four Dimensions of Behaviour' framework: a tool for characterising behaviours to help design better interventions. *Transportation Planning and Technology* **37** (1), 38–61. <http://dx.doi.org/10.1080/03081060.2013.850257>
- Darby S (2003) *Making sense of energy advice*. Proceedings, European Council for an Energy-Efficient Economy. Paper 6,157
- Darby S (2006a) *The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays*. Environmental Change Institute, University of Oxford
- Darby S (2006b) Social learning and public policy: lessons from an energy-conscious village. *Energy Policy* **34**, 2929-2940
- Darby S (2009) *Implementing Article 13 of the Energy Services Directive and defining the purpose of new metering infrastructures*. Proceedings, European Council for an Energy-Efficient Economy summer study, paper 2262
- Darby S (2010a) *Literature review for the Energy Demand Research Project*. Ofgem (Office of Gas and Electricity Markets), London. <http://www.ofgem.gov.uk/Sustainability/EDRP/Documents1/SD%20Ofgem%20literature%20review%20FINAL%20081210.pdf>
- Darby S (2010b) Smart metering: what potential for householder engagement? *Building Research and Information* **38** (5), 442-457

- DECC (2011) Smart Metering Implementation Programme response to prospectus consultation. Functional Requirements Catalogue.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42737/1480-design-requirement-annex.pdf
- DECC (2012) Smart Metering Implementation Programme. Government response to the consultation on the Consumer Engagement Strategy.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43042/7224-gov-resp-sm-consumer-engagement.pdf
- Department of Health (2011) *Changing behaviour, improving outcomes: a new social marketing strategy for public health*
- Ehrhardt-Martinez, K., Donnelly, K.A., and Laitner, J.A. (2010) *Advanced metering initiatives and residential feedback programs: a meta-review for household electricity-saving opportunities*. American Council for an Energy-Efficient Economy, Washington DC
<http://www.aceee.org/sites/default/files/publications/researchreports/e105.pdf>
- Ellis P and Gaskell G (1978) *A review of social research on the individual energy consumer*. Report, London School of Economics Dept of Social Psychology.
- Faruqui A, Sergici S and Sharif A (2010) The impact of informational feedback on energy consumption - a survey of the experimental evidence. *Energy* **35** (4), 1598-1608
- Faruqui A, Sergici S and Akaba L (2013) Dynamic pricing of electricity for residential customers: the evidence from Michigan. *Energy Efficiency* **6**, 571-584
- Fischer C (2008) Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency* **1**, 79-104
- Freeman J, Lessiter J and Beattie E (2007) Digital Television Switchover and disabled, older, isolated and low income consumers. Report for Ofcom. Goldsmiths, University of London.
- Gram-Hanssen K, Kofod C and Naervig-Petersen K (2004) Different everyday lives: different patterns of electricity use. Proceedings, ACEEE Summer Study
- Gram-Hanssen K (2010) Residential heat comfort practices: understanding users. *Building Research and Information* **38** (2), 175-186
- Gram-Hanssen K (2013) Efficient technologies or user behaviour, which is the more important when reducing households' energy consumption? *Energy Efficiency* **6**, 447-457
- Grønhøj A and Thøgersen J (2011) Feedback on household electricity consumption: learning and social influence processes. *International Journal of Consumer Studies*, **35** (2), 138-145
<http://onlinelibrary.wiley.com/doi/10.1111/j.1470-6431.2010.00967.x/full>
- Hamilton J and Killip G (2009) Demonstration, inspiration ... replication? Assessing the impact and limits of social learning from Eco-Homes Open Days in the UK. Proceedings, ECEEE, paper 4074
- Hargreaves T, Nye M and Burgess J (2010) Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy* **38** (10), 6111-6119
- Hargreaves T, Nye M and Burgess J (2013) Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy* **52**, 126-134
- Hargreaves T and Wilson C (2013) Who uses smart home technologies? Representations of users by the smart home industry. Proceedings, ECEEE, Paper 6-241-13, pp 1769-1780
- Henryson J, Hakansson T and Pyrko J (2000) Energy efficiency in buildings through information - Swedish perspective. *Energy Policy* **28** (3), 169-180

- Hinton E (2010) *Review of the literature relating to comfort practices and socio-technical systems*. Environment, Politics and Development Working Paper Series 35, Department of Geography, Kings College London
- Hodgkin RA (1976) *Born curious. New perspectives in educational theory*. John Wiley and Sons Ltd, London
- Hughes TP (1983) *Networks of Power: electrification in western society, 1880-1930*. Johns Hopkins University Press, Baltimore.
- Isaacson, M, Kotewa, L, Star, A and Ozog, M (2006) *Changing how people think about energy*. Proceedings, American Council for an Energy-Efficient Economy summer study, paper 7-127
- Janda KB and Parag Y (2013) A middle-out approach for improving energy performance in buildings. *Building Research and Information* **41** (1), 39-50
- Jensen OM (2005) Consumer inertia to energy saving. Proceedings, ECEEE summer study, 1327-1334
- Jessoe K and Rapson D (2012) Knowledge is (less) power: experimental evidence from residential energy use. Working paper 18344, National Bureau of Economic Research, Cambridge, Mass.
- Klopfert F and Wallenborn G (2012) Empowering consumers through smart metering. Report for BEUC
- Kluger AN and DeNisi A (1996) The effects of feedback interventions on performance: a historical review, a meta-analysis and a preliminary feedback intervention theory. *Psychological Bulletin* **119** (2) 254-284
- Lave J (1993) The practice of learning. In Chaiklin S and Lave J (eds) *Understanding practice: perspectives on activity and context*. CUP, Cambridge
- Leighty W and Meier A (2011) Accelerated electricity conservation in Juneau, Alaska: a study of household activities that reduced demand 25%. *Energy Policy* **39** (5), 2299-2309
- Lewis PE, Dromacque C, Brennan S, Stromback J and Kennedy D (2012) *Empower Demand 2: energy efficiency through information and communication technology: best practice examples and guidance*. VaasaETT.report for ESMIG.
http://esmig.eu/sites/default/files/final_empower_2_demand_report_final_distr2.pdf
- Liddell C (2012) Smart Meters, Smart People. University of Ulster.
<http://eprints.ulster.ac.uk/25443/1/SMARTerMetersExReportWEB-7Jan13.pdf>
- Lu J, Chun-Sheng Yu, Chang Liu, James E. Yao (2003) Technology acceptance model for wireless Internet. *Internet Research* **13** (3), 206 – 222
- Lutzenhiser L, Cesafsky L, Chappells H, Gossard M, Moezzi M, Moran D, Peters J, Spahic M, Stern P, Simmons E and Wilhite H (2009) *Behavioral Assumptions Underlying California Residential Sector Energy Efficiency Programs*. Report for California Institute for Energy and Environment.
http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/pdfs/ba_ee_res_wp.pdf
- Lutzenhiser L and Bender S (2008) *The 'average American' unmasked: social structure and differences in household energy use and carbon emissions*. Proceedings, ACEEE Summer Study, paper 7552
- Marvin, S., Chappells, H. and Guy, S. (1999) Pathways of smart metering development: shaping environmental innovation. *Computers, Environment and Urban Systems* **23**, 109-126
- McKenna E, Richardson I and Thomson M (2012) Smart meter data: Balancing consumer privacy concerns with legitimate applications. *Energy Policy* (2012) **41**, 807-814
- Mountain D (2006) The impact of real-time feedback on residential electricity consumption: the Hydro One pilot. Summary at

<http://www.reduceenergy.com/PDF/Summary%20Results%20Hydro%20One%20Pilot%20-%20Real-Time%20Feedback.pdf>

Mountain D (2007) Real-time feedback and residential electricity consumption: British Columbia and Newfoundland and Labrador Pilots. Summary at <http://216.130.184.244/blueline/exec-summary.pdf>

Mountain D (2012) *Alberta Real-Time Electricity Consumption Monitoring Study* <http://www.albertatechfutures.ca/LinkClick.aspx?fileticket=w1Z1IM-2ius%3D&tabid=825>

Navigator (2012) Smart Meters: research into public attitudes. DECC, May 2012

NEA and Consumer Focus (2012) Smart for all – Understanding consumer vulnerability during the experience of smart meter installation. Report for DECC.

<http://www.consumerfocus.org.uk/publications/smart-for-all-understanding-consumer-vulnerability-during-the-experience-of-smart-meter-installation>.

New Perspectives and Energy Inform (2004) *Savings from behavioural changes following energy advice: report on a survey*. New Perspectives for the HECA Forum Ipswich

Norman DA (1999) Affordance, conventions and design. *Interactions* **6** (3), 38-43

Nyborg S and Røpke I (2013) Constructing users in the smart grid - insights from the Danish eFlex project. *Energy Efficiency* **6** (4), 655-670

Ofgem (2014) Smart Metering Installation Code of Practice (SMICoP) <https://www.ofgem.gov.uk/ofgem-publications/57316/smartmeteringinstallationcodeofpractice.pdf>

O'Donnell, A (2014) Using M-learning as a Means to Promote Self-direction and Engagement in Apprenticeship Theoretical Lessons. *Irish Journal of Academic Practice* **3** (1), Article 6. <http://arrow.dit.ie/ijap/vol3/iss1/6>

Ornetzeder M and Rohrer H (2006) User-led innovations and participation processes: lessons from sustainable energy technologies. *Energy Policy* **34**, 138-150

O'Sullivan K, Howden-Chapman P, Fougere GM, Hales S and Stanley J (2013) Empowered? Examining self-disconnection in a postal survey of electricity prepayment meter consumers in New Zealand. *Energy Policy* **52**, 277-287

Owen G and Ward J (2007) Smart meters in Great Britain: the next steps? Paper 6: case studies. Sustainability First, London

Palm J (2010) The public–private divide in household behavior: How far into home can energy guidance reach? *Energy Policy* **38**, 2858-2864

Pawson R and Tilley N (1997) *Realistic evaluation*. Sage, London

Pawson R, Greenhalgh T, Harvey G and Walshe K (2004) Realist synthesis: an introduction. ESRC research methods programme, 2/2004.

<http://www.ccsr.ac.uk/methods/publications/documents/RMPmethods2.pdf>

Pelenur MJ and Cruickshank HJ (2013) Investigating the link between well-being and energy use: an explorative case study between passive and active domestic energy management systems. *Building and Environment* **65**, 26-34

Pyrko J (2011) *Am I as smart as my smart meter is? - Swedish experience of statistics feedback to households*. Proceedings, ECEEE summer study, paper 8-014, pp1837-1841.

Pyrko J (2013) *Energy saving targets - tested in households in the Swedish largest electricity saving experiment*. Proceedings, ECEEE summer study, paper 8-381-13, pp2349 - 2354

- Raw G and Ross D (2011) Energy Demand Research Project: Final Analysis. Report by AECOM for Ofgem. <https://www.ofgem.gov.uk/ofgem-publications/59105/energy-demand-research-project-final-analysis.pdf>
- Roberts S and Redgrove Z (2011) The smart metering programme: a consumer review. Report by the Centre for Sustainable Energy for 'Which?' magazine. http://www.cse.org.uk/downloads/file/The_smart_metering_programme_a_consumer_review_for_Which_f inal_0112.pdf
- Santos P, Balestrini M, Righi V, Blat J, Hernández-Leo D (2013) Not Interested in ICT? A Case Study to Explore How a Meaningful m-Learning Activity Fosters Engagement among Older Users' Lecture Notes . *Computer Science* **8095**, 328-342
- Sanquist T, Orr H, Shui B, Bittner AC (2012) Lifestyle factors in US residential electricity consumption. *Energy Policy* **42**, 354-364
- Schleich J, Klobasa M, Golz S and Brunner M (2013) Effects of feedback on residential electricity demand—Findings from a field trial in Austria. *Energy Policy* **61**, 1097-1106.
- SEE Action (2012) *Evaluation, measurement and verification (EM&V) of residential behavior-based energy efficiency programs: issues and recommendations*. State and Local Energy Efficiency Action Network. DOE/EE-0734,
- Seligman C, Darley JM and Becker LJ (1978) Behavioural approaches to residential energy conservation. *Energy and Buildings* **1** (3), 325-337
- Shove E (2009) Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A* **42** (6), 262-264
- Shove E (2011) On the difference between chalk and cheese – a response to Whitmarsh et al's comments on 'Beyond the ABC: climate change policy and theories of social change'. *Environment and Planning A* **42** (6), 262-264
- Simcock N, MacGregor S, Catney P, Dobson A, Ormerod M, Robinson Z, Ross S Royston S and Hall S-M (2014) Factors influencing perceptions of domestic energy information: Content, source and process. *Energy Policy* **65**, 455-464
- SQW (2013) Study on access to smart meter benefits for blind and partially sighted consumers. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/175653/access_to_smart_meter_benefits_for_bps_consumers.pdf
- Stephenson J, Barton B, Carrington G, Gnoth D, Lawson R and Thorsnes P (2010) Energy cultures: a framework for understanding energy behaviours. *Energy Policy* **38**, 6120-6129
- Stern P. and Aronson E., eds (1984) *Energy use: the human dimension*. Report for the National Research Council, WH Freeman and Co., USA
- Teall E, Wang M, Callaghan V and Ng JWP (2014) An exposition of current mobile learning design guidelines and frameworks. *International Journal of E-Learning*, **13** (1) 79-99
- VaasaETT (2011) *Empower Demand. The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison*. (Lead authors Strömbäck, K, Dromacque, C, and Yassin, MH). Report for the European Smart Metering Industry Group. Vaasa Energy Think Tank, Helsinki
- van Dam SS, Bakker CA, van Hal JDM (2010) Home energy monitors: impact over the medium-term. *Building Research and Information* **38** (5), 458-469
- van Dam, SS (2013) Smart energy management for households. PhD thesis, Technical University of Delft. <http://abe.tudelft.nl/index.php/faculty-architecture/article/view/614>

- van Elburg, H. (2014) *Dutch Energy Savings Monitor for the Smart Meter*. Report for Rijksdienst voor Ondernemend Nederland.
- van Houwelingen JH and van Raaij WF(1989) The effect of goal-setting and daily electronic feedback on in-home energy use. *Journal of Consumer Research* **16**, 98-105
- Verbong G, Beemsterboer S and Sengers F (2013) Smart grids or smart users? Involving users in developing a low carbon electricity economy. *Energy Policy* **52**, 117-125
- Whitmarsh L (2009) Behavioural responses to climate change: asymmetry of intentions and impacts. *Journal of Environmental Psychology* **29** (1), 13-23
- Wilhite H and Ling R (1995) Measured energy savings from a more informative energy bill. *Energy and Buildings* **22**, 145-155
- Wilhite H (1997) *Experiences with the implementation of an informative energy bill in Norway*. Ressurskonsult A/S report 750
- Wilson C and Chatterton T (2011) Multiple models to inform climate change policy: A pragmatic response to the 'beyond the ABC' debate. *Environment and Planning A* **43** (12), 2781-2787. ISSN 0308-518X
- Wilson C and Dowlatabadi H (2007) Models of decision making and residential energy use. *Annual Review of Environment and Resources* **32**, 169-203.
- Wolsink, M (2011) The research agenda on social acceptance of distributed generation in smart grids: renewable as common pool resources. *Renewable and sustainable energy reviews* **16**: 822-835

Annex C: Lessons from the public health sector

The team undertaking the Early Learning Project Synthesis was asked to consider any significant theory, evidence or learning that could be drawn from other sectors which could contribute to understanding the smart meter early installation experience and its implications for the future.

Public health is a field in which there is one of the largest bodies of theory and evidence related to interventions designed to bring about individual and social change. Because of the close relationship between public health and clinical medicine, there has always been a strong tradition of research in this field, with 'evidence based public health' (EBPH) emerging over the last 10-20 years ago parallel to 'evidence based medicine' (EBM) developments taking place. The field has benefited from the existence of several international (e.g. the Campbell Collaboration and World Health Organisation) and national (e.g. National Institute of Clinical Excellence) bodies that are regularly collating and synthesising the evidence of effective practice, and translating this into guidance for policy makers and practitioners.

Given the size of this body of evidence, it is not possible, here, to do more than give a brief indication of areas of theory and research in the public health field that might contribute to an understanding of the adoption and use of smart meters. Four areas are of particular relevance:

- General learning from the public health field related to behaviour change interventions
- Use of public information campaigns
- Use of feedback mechanisms
- Whole system approaches

General learning about behaviour change interventions

The most impactful early work in the field of public health (mid 19th century) were structural interventions designed to remove the main causes of infection and harm (e.g. improved sanitation and water supplies), later followed by clinical interventions: mass inoculation and the introduction of more effective drug treatments. However, alongside

this there has also been a long tradition of seeking to persuade the public to stop engaging in activities (e.g. drinking to excess) that were damaging to their health.

The focus on behaviour change received much stronger emphasis in the mid 20th century with the realisation that, while improved sanitation and mass vaccination had dramatically reduced the incidence of many killer diseases, key factors in leading causes of premature death such as heart disease and cancer lay in the life style of individuals. This led to the emergence of the new professional disciplines of health education or health promotion. 'Health education is any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes' (World Health Organisation definition).

The development of new disciplines, with associated academic interest, led to a rapid expansion of theory, knowledge and evidence related to how the factors influencing behaviour, and how these might be changed. A wide range of different types of interventions have been tried (with or without accompanying research) including most of those included in the recent the recent House of Lords Scientific Committee Review¹¹² of behaviour change interventions (the examples given by this report in the list below relate both to public health and energy saving measures):

- Fiscal measures directed at the individual: fiscal disincentives (taxation of cigarettes) and fiscal incentives (tax breaks on purchase of bicycles)
- Non-regulatory and non-fiscal measures
 - Non-fiscal incentives and disincentives (e.g. time off work to volunteer)
 - Persuasion (e.g. marketing campaigns)
 - Choice architecture (nudges)
 - Provision of information (leaflets and labels e.g. showing carbon usage on household appliances)
 - Changes to the physical environment (e.g. traffic calming measures)
 - Changes to the default policy (e.g. requiring people to opt out of organ cloning)
 - Use of social norms and salience (e.g. providing information about average energy usage)

Many of the examples given in the House of Lords report were drawn from the public health sector, including one of two major 'case studies' provided to illustrate points from across the report: a review of different interventions used to reduce the prevalence of obesity. The other case study is drawn from the environmental sector: interventions to reduce car use in order to limit CO₂ emissions. The report makes a distinction between the two in terms of the former being principally concerned with benefiting the individual (though reducing burdens on the health service must also be a concern), while the

¹¹² House of Lords Science and Technology Select Committee (2013) Behaviour change. 2nd Report of Session 2010–12

second involves preventing harm to society at large, now and in the future. However, it could be argued that the introduction of smart meters aims to benefit both individuals (through potential savings in energy costs) and society at large (e.g. reduction in energy consumption and thereby CO₂ emissions).

Theories related to behaviour change in the health education field come from a number of different disciplines, some of which are focused on individual behaviour change, and some related to change in at a system level (and thus, the context in which individual behaviour takes place). Theories related to individual change include ¹¹³

- Health Belief Model
- Theory of Reasoned Action
- Transtheoretical (stages of change) Model
- Social Learning Theory

There is a considerable body of research supporting (and sometimes challenging) these theories¹¹⁴. Several of the theories seek to articulate different stages individuals go through prior to making long lasting changes in their behaviour. For example, the transtheoretical model of behaviour change (TTM) ¹¹⁵ suggests that there are five key stages through which individuals will pass, or cycle between, over time:



The idea of a number of different steps or stages through which individual pass, and that different ‘interventions’ may be relevant at different stages is also reflected in the ‘customer journey’ concept used in the smart meter synthesis report. This also has

¹¹³ These are taken from <http://www.healthpromotionagency.org.uk/healthpromotion/health/section5.htm>

¹¹⁴ See for example: Bury et al., *A Review of the use of the Health Belief Model (HBM), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Trans-Theoretical Model (TTM) to study and predict health related behaviour change.*
<http://www.nice.org.uk/guidance/ph6/resources/behaviour-change-taylor-et-al-models-review2>

¹¹⁵ Prochaska, JO; Butterworth, S; Redding, CA; Burden, V; Perrin, N; Leo, M; Flaherty-Robb, M; Prochaska, JM. (2008) [Initial efficacy of MI, TTM tailoring and HRI's with multiple behaviors for employee health promotion.](#) *Preventative Medicine* **46** (3):226–31.

parallels in the different experience of smart meters, arising from different levels of prior interest and knowledge, difference capacities to change: i.e. that different interventions might be received differently according to different levels of 'readiness for change.

Public information campaigns

Public information campaigns have been a major aspect of public health interventions, and a great deal of learning has taken place on how to use these effectively, learning which might usefully be drawn on in the design of any public information campaigns that might be used to encourage the public to adopt, and use, smart meters.

In the public health sector, such campaigns have been used with varying success. (For examples of the different levels of change brought about by various public health campaigns, see Box 1 in the Health Development Agency briefing on public health campaigns¹¹⁶). Some work has taken place in understanding the theories and assumptions about the 'Mechanisms of Change' that underpin such campaigns¹¹⁷ which may be relevance to the use of public information campaigns used to promote smart meters.

Key findings from the evidence of different campaigns were drawn together by the Health Development Agency in preparation for its 2004 guidance¹¹⁸. These are summarised in relation to research into anti-smoking campaigns in the 1990s, points which continue to have considerable relevance to publicity campaigns in other sectors:

- Campaigns need to contain a variety of messages – 'threatening' and 'supportive' styles of delivery can complement each other
- Anti-smoking advertising has to compete in a crowded media marketplace – a hook is needed to engage the emotions of the target audience
- Emotions can be engaged using humour, fear, sympathy or aspiration
- TV advertising, in particular, is better at jolting smokers than delivering encouraging or supportive messages
- Smokers want help and encouragement to quit
- Advertising should not tell people what they should do
- Smokers are motivated by knowing that they are not alone, and that support and help are available – they need reminding of the benefits of not smoking
- Content and style of delivery are of equal importance – smokers can accept unpalatable messages if the context is encouraging and supportive.

¹¹⁶ Health Development Agency (2004): the effectiveness of public health campaigns HAD briefing no 2

¹¹⁷ [Alcalay R](#) (1983) The impact of mass communication campaigns in the health field. *Social Science and Medicine* **17** (2),87-94

¹¹⁸ Health Development Agency (2004) *The effectiveness of public health campaigns*. HAD briefing no. 2

However, the relatively low rate of population change (compared to the relatively high cost) resulting from mass media campaigns has encouraged the public health field to adopt more sophisticated social marketing approaches¹¹⁹. This involves in depth research into what might effectively motivate different subsections of the community to change, targeting these subsections with tailored messages via the media that most frequently used by that particular subgroup.

Feedback mechanisms

One of the key elements of smart meters is that these provide immediate and regular feedback on energy use on the assumption that this will motivate users to make changes in their energy consumption. In the public health field, the equivalent can be seen in the home use of scales (weight control), pedometers (in campaigns designed to increase exercise), use of blood pressure monitors for people with high blood pressure or at risk of Coronary Heart Disease, and providing people with diabetes with the means to monitor their blood glucose levels. On the whole, evidence suggests that the home use of feedback mechanisms of this kind can be effective¹²⁰, although with variable levels of result (depending in part on the commitment and motivation of the individuals using them as well as the nature of the condition for which they are being used)¹²¹. Research indicates that feedback mechanisms may in some circumstances bring about only limited, or short term, levels of change¹²².

Like public information campaigns, one of the broad messages arising from the research is that feedback mechanisms work best when used in combination with other factors: that they need to be supported by the provision of good information, regular input from a health professional, and/or peer support mechanisms.

Whole system change

This title is a bit of a 'catch all' for the understanding, within the public health sector, that in it is rare to be able to find one intervention that can, on its own, can bring about large scale and long lasting change. In addition to any specific interventions targeted at behaviour change, changes may also be required in the organisations and agencies interacting with the target group. Whole system change may involve work with whole

¹¹⁹ Department of Health (2011) *Changing behaviour, improving outcomes: a new social marketing strategy for public health*

¹²⁰ E.g. see Macintosh B et al, (2010) Efficacy of self-monitoring of blood glucose in patients with type 2 diabetes mellitus managed without insulin: a systematic review and meta-analysis. *Open Medicine* 4 (27), June 2004

¹²¹ Burke L et al (2011): self monitoring in weight loss, a systematic review of the literature. *Journal of the American Dietetic Association*, Jan 2011:111(1) 92-102

¹²² [Uhlig K, Patel K, Ip S, Kitsios GD, Balk EM](#) (2013) Self-measured blood pressure monitoring in the management of hypertension: a systematic review and meta-analysis. [Annals of Internal Medicine](#). 159 (3):185-94

communities via targeted work with groups or organisations working at a community level as well as work with individual organisations, or specific professional groups.

One of the challenges this presents is that generating high quality of evidence of effectiveness for complex, multifaceted interventions, is far from easy. This has led to a number of useful debates concerning the relative strengths of different research methods for capturing change at a whole system level¹²³ which may also be of interest to those considering the best research methods to use in assessing the impact and benefits of smart meters, going forward.

In spite of a lack of evidence of effectiveness that conforms to the highest 'gold standards', there is a growing acceptance that effective partnership working, interventions at a community level, and clarification of the roles of the organisations delivering services are required when seeking to implement long term and large scale change. This is reflected in several of the recent sets of guidance issued by NICE in relation to public health interventions, a large part of which focus on the role of the key agencies involved, rather than the effectiveness of individual interventions. The following comes from the recent general guidance on behaviour change interventions, and many of the points made may also have considerable relevance to work in the field of smart meters¹²⁴:

'Policy makers, commissioners, service providers, practitioners and others whose work impacts on, or who wish to change, people's health-related behaviour should work in partnership with individuals, communities, organisations and populations to plan interventions and programmes to change health-related behaviour. The plan should:

- be based on a needs assessment or knowledge of the target audience
- take account of the circumstances in which people live, especially the socioeconomic and cultural context
- aim to develop – and build on – people's strengths or 'assets' (that is, their skills, talents and capacity)
- set out how the target population, community or group will be involved in the development, evaluation and implementation of the intervention or programme
- specify the theoretical link between the intervention or programme and its outcome
- set out which specific behaviours are to be targeted (for example, increasing levels of physical activity) and why
- clearly justify any models that have been used to design and deliver an intervention or programme

¹²³ See for example: Nutbeam D (1998) Evaluating health promotion - progress, problems and solutions. *Health Promotion International* **13**(1) 27-44 or Wimbush E & Watson J (2000) An evaluation framework for health promotion: theory, quality and effectiveness. *Evaluation* **6**(3) 301-21

¹²⁴ NICE (2014) *Behaviour change, individual approaches*.
<http://www.nice.org.uk/guidance/PH49/chapter/1-Recommendations>

- assess potential barriers to change (for example, lack of access to affordable opportunities for physical activity, domestic responsibilities, or lack of information or resources) and how these might be addressed
- set out which interventions or programmes will be delivered and for how long
- describe the content of each intervention or programme set out, which processes and outcomes (at individual, community or population level) will be measured, and how to include provision for evaluation. It should also prioritise interventions and programmes that:
 - are based on the best available evidence of efficacy and cost effectiveness
 - can be tailored to tackle the individual beliefs, attitudes, intentions, skills and knowledge associated with the target behaviours
 - are developed in collaboration with the target population, community or group and take account of lay wisdom about barriers and change (where possible)
 - are consistent with other local or national interventions and programmes (where they are based on the best available evidence)
 - use key life stages or times when people are more likely to be open to change (such as pregnancy, starting or leaving school and entering or leaving the workforce)
 - include provision for evaluation.
- Stop investing in interventions or programmes if there is good evidence to suggest they are not effective.
- Where there is poor or no evidence of effectiveness (or the evidence is mixed) ensure that interventions and programmes are properly evaluated whenever they are used.
- Help to develop social approval for health-enhancing behaviours, in local communities and whole populations.

Conclusions

There are a number of lessons to be learned from the public health field which can potentially be applied to understanding the best approach to introducing smart meters to the public, and in supporting the public in using these to make lasting changes in their energy use.

Many of these point to the importance of adopting a carefully targeted approach, which take into account the different motivations and lifestyles of different sections of the population. Other findings point to the importance of taking a multi-strand or system - based approach, when seeking large scale and long term change, with specific interventions targeted at individual change supported by a range of changes in the organisations and agencies whose activities impact on the target groups in which change is sought. These findings parallel those which have emerged from the smart meter synthesis.

Annex D: Summary of GB smart meter installer focus groups

Background: smart meter installation during the Foundation Stage and the development of the SMICoP

The Smart Metering Installer Code of Practice (SMICoP) came into force in June 2013. It specifies standards in relation to customer-facing aspects of smart meter installation. It is the work of Energy UK, DECC and Ofgem. The Code covers electricity and gas smart metering in homes and small businesses. The aim is for a positive customer experience of installation, customer protection, and programme benefits, including long-term behavioural change.

Sections of the SMICoP¹²⁵ deal specifically with customer engagement before and during the meter installation, and also with the period between the installation visit until the customer receives the first bill using smart meter data, or the first vend for prepayment customers. The Code also addresses the training of installers, requiring them to have training and accreditation from a National Skills Academy for Power (NASP)-accredited provider, or equivalent training and accreditation (S2.6.2).

The NASP level 1 award in promoting energy efficiency to potential customers involves a seven-hour course, after which the installers are expected to understand the reasons for energy efficiency measures, how customer behaviour affects consumption, which energy efficiency initiatives and products are relevant to customers, and how to communicate effectively with customers.¹²⁶

The focus groups

Two focus groups were held in Birmingham on November 28th 2013 involving smart meter installers from two GB energy suppliers.

The aim was to capture the experiences of smart meter installers in relation to customer service and support domain: how did they approach the work of installation, how long does it take, what training did they have, what sort of questions were they asked, and

¹²⁵ http://www.britishgas.co.uk/content/dam/british-gas/documents/Smart_Metering_Installation_Code_of_Practice.pdf

¹²⁶ See http://www.skillsfirst.co.uk/Downloads/Tutor_Handbook_for_Level_1_Green_Deal_SEE_1_PEE1.pdf for the tutor handbook.

how did customers react to the process? Also, to help indicate how utilities might build up a body of experience and knowledge about good practice, and how expectations and practices might evolve over time. The questions and contributions therefore cover some of the same ground as the SMICoP.

The discussions each lasted around two hours and were facilitated by Sarah Darby from the Environmental Change Institute, University of Oxford, and Christine Liddell of the University of Ulster. Audio recordings were made, with the consent of all concerned, and summary transcripts contain the bulk of the conversations. The material is grouped under these themes:

1. Safety
2. Installer skills and training
3. Contract staff
4. Engagement and potential energy savings. Advising customers at installation, and supplementary information
5. Preparation for roll-out, back-up and follow-up / potential role of Smart Energy GB
6. Customer interfaces: IHDs, websites and apps
7. Customer awareness, concerns and questions
8. Vulnerable customers
9. Prepayment customers
10. Technical, system and management issues

The main messages are summarised below. The contributions are not identified as being from one or the other group, as agreed with the two supplier companies involved, and the transcript does not identify any individuals. The quotations therefore represent comments and considerations that are generally applicable to the business of smart meter roll-out and customer engagement.

Many of the passages quoted here from the transcripts are conversations with contributions from two or more participants, and these are shown in separate paragraphs, in italic. The questions or comments from one of the facilitators are in standard script, prefaced by 'F'.

1. Safety

Safety is an absolute priority:

That's what ... I personally think about most of, making sure the customers are safe and that I have done my job properly so that they are not in harm's way at all.

... Before switching the gas on when installing the meter, you're actually responsible for every appliance. You have to visually inspect and test every

appliance in the house. Sometimes customers aren't happy but a lot of the times they are.

The installation itself has to be safe, and it is an opportunity to check that the home is safe, for example from carbon monoxide or even a major gas leak:

Once I saw this black substance around the boiler and I asked if anyone's been ill or had headaches. The man said his daughter had been sick and her bedroom was above that. They were really grateful that you've spotted it.

...we get these old Victorian houses where the pipes go underneath the floorboards and you've got like a massive cavity and they've got vents in the house to stop the wood from rotting. So if you've got a gas leak ... they could live there 20 or 30 years and not even realise.

One participant talked about how it was company practice to go through a mental check for a couple of minutes after each job:

...then you think about it, like the technical side of it and the safety side of it and you make sure of everything in your head, you can visually see if ... everything is right and all the safety checks have been done.

Safety issues require concentration. So when an installer commented on how they appreciated the new dimension to the job that came with customer engagement:

...there's nothing worse than just going in and meter fix, move on, meter fix, move on, you just like that engagement as well...

... a colleague commented

At the right time! Because it can be a distraction, because we are working with gas and electrics and ... if you've got a 'connector' [a conversational customer] who wants to talk your ear off whilst you're playing around with mains electrics... it can be a bit of a problem.

You become very good at multi-tasking very quickly, don't you?

Yeah, exactly.

Very occasionally, the need to disconnect during installation could lead to a customer refusing a smart meter:

...you tell them that you're going to disconnect some of their gas because of the safety issue, they will say 'OK, I don't want it, get out'... if you get a late appointment and they want to cook the dinner or something and you're going to have to turn the gas off.

2. Installer skills and training

Both companies had specific training programmes for their engineers who would be installing smart meters, with a combination of classes and mentoring over a period of up

to six months. The installers in one of the groups talked about their training in relation to customer engagement:

There was a lot of behavioural training, isn't it?

Yea, we had two weeks of that alone in the academy.

[Interviewer] Can you describe what you mean by that?

Teaching you how to try and say the right words to customers, to sell them, not to sell them things... to...

...Get them engaged

... It did seem at times excessive compared to the practical side of the job that you needed, I mean I know it's a big part of the job.

There was some of it that was quite useful in terms of knowing how to adapt to different styles of people and just looking into how different people react and how you can react with them, you know rather than making a mess of things throughout a conversation.

I think they called it flexing, didn't they?

What sort of character type they had, so if they were like a very sort of 'computer straightforward bam bam bam', how you would adapt your style to deal with that customer if they were like a pretty switched on, open and honest person...or quiet person, how you would adapt when going into their house...

Yeah, we learnt about controllers and things like that

Reflectors, Creators, Controllers...

I can't remember what the other one was, it was green anyway

Connector

F: Did that help you at all?... There must be something that's keeping those at the front of your minds?

It's quite useful when you initially meet a customer and start speaking to them, you kind of slightly analyse them and think 'what kind of person am I dealing with here, do they want to absorb all the information I've got to give or do they want it short and sweet and want me to get on and do the job' ... If they are bombarding you with questions you can throw the answers back at them or if they are a bit more of an analytic person, if they're a bit of a controller they're going to say 'there's your meter, go and fit it now' and stuff like that.

Yeah, that's it.

There was some selection of installers who were seen as good communicators, prior to training for smart installations:

I think a lot of us were like that already when we got that training ...I thought that these things they were telling me to do like adjust yourself to different people's

personalities, I thought that I sort of do that anyway...because of how long you do the job ... you see different people day in, day out ...

What we do as well is look at the breakdown of people who have been employed during that period, they all fitted into the 'connectors' and a lot of the customer service side, the majority of people tended to be 'connectors' as opposed to engineers when we did some analysis ...that was a positive for us.

F: So you had to analyse yourselves...

... The man in the mirror, as they say.

F: And which do you find are the easiest people to explain the whole thing to and feel you walk away feeling they've got it?

Well I would say 'controllers' are the easiest type because they like to have it short and sweet and as you say bam bam bam, they love to learn the basics and nothing more, however it's not the most... how do I say it...

Comfortable

No, it doesn't really fuss me, but I mean the most helpful way is to try and get the smart agenda across, we strive to give as much information as we possibly can, whether they want that or not, it's up to them.

When asked about the qualities or person specification needed for smart meter installers, there was an implicit contrast between the idea that communication skills could be taught (as acknowledged in the account of the training courses) and the sense that they were something people were, or were not, born with. The conversation in one of the groups went as follows:

Technical people skills.

Obviously great people skills, communication skills, because that is a big part of the job.

I think definitely people skills.

Technique is something that can definitely be taught to an extent at the very least, but people skills, you can't really teach that, you can't take someone off the street and say 'OK, you go in and try and help this person and be as nice and sincere as you can be'. Some just can't do it, simple as that.

You definitely have to have that about you... the technical side can be learned, it can be taught... it's not the most technical job going, but if you've not got the people skills then you wouldn't succeed in the job really.

You need patience...

... the meter [customers] haven't purchased and a lot of people are like 'and I should care because?' ... I think because they aren't purchasing it, there is always that battle... I think that is why you need people who are 'people' people to sort of smooth that journey across and get that smart message and the energy message across.

The other group discussed their experience of training in relation to going into the household and adapting to a variety of situations, also pointing out the need to assess what sort of customer they are dealing with, and adapt to them:

F: In terms of what you're doing around the house... Is that a part of a training scheme, that you've all been on?

Yeah ... Smart Customer Experience I think it was called, and it was about two or three days.

Meter Learning Journey or something like that.

...There was lots and lots of training. It's very customer focused, so you really are trying to think from customers' point of view, and what the customers have asked for...

I think the companies are customer focused as well.

They know that we're the only interaction between the energy company, and they want us to be a sort of energy partner. So, they want you to do a small pitch before you go into the property and explain what you're going to do. Obviously install the meters, tell them how long you're going to be there, and you explain the SED (the in-home display). They don't just want you to give the instructions. You've got to spend the time. Different people have different ways to do it. One idea is that we give them the booklet, they can read through it and by the time you finish the job, they've got all the questions. It's easier when you've got someone asking you questions rather than you just sitting there. The customer experience side of it is that you have spent as long as you need to spend to make it clear ...

You're not going to go to a property and say that you haven't got the time and you've got the manual and the video for them. The next person might ask you every question you've ever been asked.

I think they're putting it down to three different types of customers with regards to their engagement to how you pitch it. So, you've got the ones that when you go in, they know more about it than you and it gets embarrassing 'cause of the thought of questions they're gonna ask you, go right over your head. So, you just let them speak. And then you've got people who are interested in but not very good with technology, and you've got the ones who are really interested in technology but have no engagement, no time free... and you get the phobic ones, who don't want to talk to you...

F: Could I come back to the training that you've done. Would that have been customer related training rather than a technical side? Was that outsourced or do you have in-house people that do it?

In-house people, yeah.

F: Is it for all installers, or are you a picked bunch who have special training?

No, there's more. We all have the ability to speak to customers anyway. It's our job to go out every day and speak to different people... All that is a part of making the customers feel a lot more comfortable, let them know exactly the purpose, why we're there, let them know how long we're going to be disruption-wise.

It's constantly everyone mentoring each other...If you're struggling on the job, there's always someone that will help.

...Every five years we have to be re-tested... we're very heavily audited.

F: Is there a test on the customer interaction?

When you're getting audited, they actually come out with you. Part of it is if the engineer is showing the customer their ID, are they being polite, where you are parking your van. You know if you're doing quite well when the customer makes you a cup of tea.

...We've had people that have made mistakes and they'll be re-trained...if you fail [an audit] then the amount of audits goes up that they have to complete on you...If you fail they'll go back to your last 10 jobs and they'll inspect those as well to make sure you haven't been making the same mistake.

Training was also mentioned in terms of general customer services:

We've got technicians and they will have the training that they need in terms of the customer side... and then we've got the Smart Centre of Excellence call centres... and we will send all of the people that are on the phones doing the appointments, they go through a two week training course as well. It will be similar in terms of understanding what a smart meter is, the benefits of it, how to sell it over the phone, customer guide and a whole two week programme with the guys on the phones...

F: Do the call centre people train along with you?

No, they don't train with us.¹²⁷

We go into the call centres to see what types of calls they're getting.

So we can see the pressures of each side.

That's part of the induction. As part of the 2-week course, everyone who works in a call centre has to go out and see what it's like.

We also get called for team briefings every month or so, where you'll sit round and see how things are going in the company and they'll also bring up any issues...

There is always refreshers [training] and there's plenty of people around if you need help.

¹²⁷ This was the case for both groups.

Asked whether they would be involved themselves in training installers for the future, the answer from one group was

Yeah, we all have. Now we will need less meter readers but a lot more engineers, because I don't think people realise just how many houses need doing.

I don't see it kicking off in 2015.

F: Because?

Because of the team problems.

3. Contract staff

The issue of whether installations are carried out in-house or outsourced arose in both groups, unprompted, and it is significant in terms of training and auditing, and in terms of the conditions under which installers work, e.g. the amount of time they are allowed for each job. Installers in one group complained of having to rectify poor-quality work carried out by contractors:

...we're going in there, we're doing everything properly now...re-bracketing, re-wiring, and it's taking a lot longer, but when the customer sees the finished article, they're impressed and that's a good feedback.

The other group commented on how their company had brought all metering in-house when the smart metering programme began:

F: what sort of a difference do you think bringing it in-house has made?

I think it's got a lot of us and the [company] brand and engineers in the homes and that makes a difference... and people feel comfortable to see us around.

4. Engagement and potential energy savings. Advising customers at installation, and supplementary information

Installers have to walk into a huge range of domestic situations and try to set up some sort of positive engagement with the householders. As indicated above, their training does something to prepare them with communication skills over and above what they already bring to their job, but giving advice can still be quite a challenge, given the short time available in unfamiliar surroundings. This section covers the business of advising customers, and also the type of conversations that can occur during installation.

Engagement was seen as an integral part of the job, and something that several of the installers said they took satisfaction from:

...if you've had a day where... you can tell people have got a lot from that then it's rewarding whereas... if they haven't, it doesn't feel as good, because at the end of the day everyone's got their own patterns...when you're going through the job and explaining it is nice for people to listen and you know they've got something

from it rather than them just... if they're not that bothered, do you know what I mean?

The IHD is usually the central talking-point, and is invaluable in demonstrating real-time electricity usage at installation. One installer emphasised how important it was that customers were able to learn directly from the display and from what was going on their own home, as opposed to being told disembodied facts – and that he himself could tailor advice in response to what he saw around him:

... that display ... it's not so much telling them, you can tell them facts and stuff like that and they do appreciate that, but I don't think they take it in as much as ...when you're saying about putting the kettle on and showing them, when they can see you, that is something completely different... But obviously when we are in people's houses, you look around when you're doing the job and sort of suss out what they've got... energy efficient light bulbs or whatever and you can ... gauge what sort of level they are ... towards the end when you're...explaining the display and stuff you can say to them, you know, I've noticed you've got this or you haven't got this and you just give them tips and that sort of thing.

Another described in more detail how the IHD was used as the basis for advice:

Most showers have now about eleven and a half kilowatts. That's three or four kettles every time you get into the shower. You explain to people that when you're there for half an hour, would you put three or four kettles on for half an hour at the time? No... No... That's exactly what you're doing in the shower. So, they even change their habits ... they'll spend five minutes in the shower instead half an hour, so they automatically save a fortune by doing that. With these devices you can actually show, you can put the shower on and it'll show how much it's costing you.

F: Is that something that you do...?

We show them the device, and then we'll show them how it works. We ask them to put the kettle on for two reasons: to make a cup of tea, and to show them how it works. You show them and it shoots up straight away. You tell them: 'That is how much it's costing you an hour to put the kettle on. Now, if you put enough water for a cup of tea, it'll be on for a third of the amount of time and that will cut off two thirds off the cost'.

When it came to discussing whether customers might make savings, the installers recognised the range of possibilities, and the need to be careful about raising unrealistic expectations:

The question that we always get is 'well, is this going to make my bills cheaper or dearer?

F: What do you say to them?

Depends how much you use! No, the positive way we say that is, 'the one thing is, you're not going to get a shock after 3 months, where as previously you're

going for 3 months and all of a sudden you get a bill and you're like 'Oh my goodness' and it does give you a better awareness.' [Goes on to explain how he uses his own IHD to check on how the electric shower is being used] *...and so we always say to [customers] 'you've got greater awareness', and that has been one of the biggest positives for us.*

...F: When you leave, roughly what percentage of people do you think will save money?

The people who get the most engaged with it to be honest, as a percentage it is kind of hard to say... I think it literally is about us raising awareness, the more awareness you raise, the more people that will do it because obviously everyone, and I don't care who you are, wants to save money. It's just whether people want to put the effort in to do that.

... Eventually it will just be a normal behaviour, like older people for example might not be able to come to grips with it now but the younger generation who are just brought up with it, it will eventually be just normal to do it. So it is good when you just look into the future in that way, but ... as I say it's hit and miss, but some people just are genuinely not interested in the bills... other people know to the exact penny what they spend, it just depends on the person.

So how do you think we change their habits then...what sort of percentage would say 'right, I am now going to change my habits of using my energy because of the smart meter?'

Quite a few of them, because when you go through it with them they are like, especially when you tell them that just leaving a plug socket or something on standby loses them energy, they're like, 'oh I never even realised that' and quite often you can almost see to some extent that it might cause arguments between couples because, like... hang on when you are using your hair straighteners you are using probably the most amount of electricity at a time, it's not your husband with his PlayStation on, it's you with your hair straighteners.

From the installers' viewpoint, some element of change in customers' habits was a realistic expectation on average, and some of them saw the IHD as part of a bigger picture.

F: So when you walk away from a job about how often do you think, yeah, they seem to pretty much get it and they'll probably...use their display and think about their energy more and they're a bit more aware and there is some change happening, and about what proportion do you think 'hmm not sure'?

60-70% roughly are going to be like that about change.

Yeah.

F: So they've engaged to some extent?

For how long, though?

I suppose if you can get one customer to save £1 a month you have been successful to some extent haven't you?

Yeah.

I suppose the proof is in the pudding, once they see that they have saved some money once, why are they not going to do it again?

Yeah, it would be stupid not to.

But ...I think if we knew about more technology and as it's changing all the time, if we have that information we would brighten people's eyes as to what is going on and what's happening out there, what they can do. Because it's not just about that display unit – it's about ...what else you can do, you know ground source heating and solar panels and these kind of things.

There are particular issues relating to gas that tend to be sidelined in discussions of smart metering and IHDs, and these were explored in one of the groups:

F: You're talking very much about electricity and savings on electricity bills but do you get to talk about gas related savings?

... you have a room temperature displaying at the top of the monitor. So all you can do is to advise the customer. If it's 22°C, that's a perfect room temperature, you don't need to turn your thermostat down...I don't want to advise a customer to turn the heating off, because that's what it's there for.

There are some customers who ask why their neighbours down the road pay £100 less. You try to explain that: 'well, you've got an old Victorian house with high ceilings; the radiators have to work harder to heat those rooms, comparing to the new estate down the road'.

And the boiler is not as energy efficient.

We ask if they had their loft insulated. A lot of them keep the original windows, so they would be better off with double glazing.

The difference is that with the electric you can actually see how many kilowatts that appliance is costing you. With gas we can't see that and on top of that you don't know how efficient the appliance is either. The appliances could be extremely expensive and you wouldn't even know.

The [display] doesn't know whether you've got cavity wall or loft insulation, it doesn't know whether you've got PVC or how energy efficient your boiler or how old it is.

The engineer does. So when we're there, we can advise them.

There are leaflets we can leave them about cavity walls.

Solar saver, boiler care and water pumps.

There are limits to the advice that an installer can offer. For example, when asked whether they ever set a budget for a customer before leaving a home, the discussion in one group went

We've been told not to.

There's reasons for setting up a budget for a customer. I've been on emergency callouts to people who have worried about this budget before. If you don't set the budget... Say, for example, if you were to turn off ... it resets to factory settings. So, if the customer was to set their budget to whatever they say and set their direct debit or something along them lines, and then it was to go off, and then the meter was to come back on again, it would revert back to the settings, but it would actually keep the history that it's made, if that makes sense. So, say if it was seventy pounds, cause that's what the customer had used, the device went off, they had set their budget to a hundred pounds, device went off and came back on, it reversed back to thirty four pound, the alarm comes on automatically, and then they phone up and say: The alarm is going off. What's going on with this device? Then I have to reset the budget for them...

I've definitely been told not to, because that job I went to, the old lady, the budget had been set to a direct debit but depending on what time of year it is, the direct debit will stay the same, and in the winter time we do use more gas, and she's gone over her budget. So, if we start setting budgets and that happens, and it increases the customer's debt, we are responsible for it.

A colleague had also had problems with the budget function, arguing:

The last thing you want to do is scare the customer. If some people are setting budgets and leaving the alarm system on and it starts going off, an elderly customer is going to panic.

The only way the alarm will go off... is if you set a budget that is lower than the national average. That is literally impossible to achieve.

I went to that job with that woman. The budget had been set and the alarm was going off, so she literally sat there for a few days with no heating on.

At least until factory settings and designs changed, it seemed wise to avoid the budget function:

All I can tell them is to look at the monitor. I say to them, if you check every night at the same time, before you go to bed, how much you've used for that day, so it'll work out they're using one pound fifty a day. Do it for two weeks and work out

their average, then they can set their budget to say one pound forty, and the idea is to try and keep to a one pound forty. They do that then the bill is gonna reduce.

5. Preparation for roll-out, back-up and follow-up / potential role of Smart Energy GB

The installers recognised the role played by others who paved the way for their own work and who offered back-up and follow-up services. There was specific, unprompted, mention of the Central Delivery Body (now Smart Energy GB):

There's an agency called the Central Delivery Body and that's government run. My manager is on the board of it and what they're working towards is that by 2015 what the national advertising campaign is going to look like. Because at the moment ...the ... suppliers are getting nervous about how they're going to advertise. So, we're working very closely with the CDB to understand what it is that our customers are telling us now, during this learning period. Then from the messaging point of view we can make sure there is no fears and that there will be an independent knowledge hub. That's what the government is quite keen on, an independent advice that customers can get their answers from as we know that there is the trust issue there.

Such a role was seen as having some protective value:

In America when PG&E did [smart meter installation] all those years ago down the west coast there was no customer communication, there was nothing to say why they were doing it. Then they had the hottest summer and everyone thought their bills went up because of the smart meter. They should have done it from a customer point of view originally, where people are seeing the benefits.

The installers discussed the question of customer wishes, and potential customer refusal of a smart meter:

At the moment the approach we're taking is all opt-in. All of the marketing that we do, all the communications is all based on the customer's choice. When we start going into [full scale] roll-out this is where there's a sort of grey area from the government point of view. What they say is 'best endeavours', but they haven't quantified what best endeavours are. We're going to go for 97% of our base. If there are customers who are absolutely adamant about not having one, we know about them already, we have a list. We will put them on the "Don't ever talk to them" type of list.

Hopefully we can get it right, we will be able to turn the bad press around and show that it does work and you can save.

The focus groups were carried out a few months after adverts about smart metering during the summer of 2013, and these were seen as having been useful in raising awareness and building knowledge. So was word of mouth, as increasing numbers of people knew someone who had a smart meter:

F: Any surprises in the way your customers are reacting?

They are more aware.

F: More than you would have expected?

Well yeah, I actually found when they did that smart advert that overnight people were slightly more aware, obviously still not to a point where we would like it to be because there are still blanks and everything like that, but I get asked a lot more questions now about how things work, how they can potentially save money, than I did probably a year ago.

F: Do you think that's because of the advert or because of the price?

A bit of both, the advert would have helped though, because obviously they are putting all of these advantages into people's heads, its coming through their telly, it's the easiest way of promoting, then as you say, the price as well, people need to save, especially in poorer households these days.

It's natural growth as well, like, because people are having it installed, I have had it numerous times where someone would say 'oh my brothers had these smart meters installed' if I am just going to them to put normal meters in. Or 'when can I get these?'

Yeah, they ask you don't they, 'is that a smart meter you're putting in?' you say No and they're like 'well why not?'

Just word of mouth in itself is naturally arousing people's attention.

I don't know if the terminology they use on the radio and TV is different to... they never seem to refer to it as smart meters, it's not 'get your new smart meter fitted', they refer to it as something else and it almost confuses me, I'm listening to it and thinking 'is that what I'm fitting? What they're talking about... I can't remember what they say but it's smart something.

Once installation was under way, the technical support and help desk/call centre were seen as an integral part of the service.

They always say your best tool is your phone. If you've got a problem, you ring somebody.

You don't just wing it because you're going to cause problems.

Video and online information could be a useful supplement to the installer visit, not least because it supplies some material on which to base a conversation:

I'd say if you've done the job most people just stand there and listen and don't ask you any questions... but you know that they're not understanding a word that you say unless you can get them to interact with you, which is why this YouTube channel now is good, so they can watch that.

DVD¹²⁸ is the best option, I think because while you're changing the gas meter they could be watching the DVD and then ask you any questions once it's finished, to save time. Not everyone has Internet access.

... I was talking to someone yesterday about the readings, and I said I'll explain it to you but a lot of it will go over your head if I go in depth. So I suggest they watch the YouTube video.

That's one of the reasons why we re-did the website. The first time I looked at the website I thought it was not customer-friendly and that was the thing we wanted. One of the biggest demands in our centres was after the installation visit, customers were ringing and asking to remind them things again and if you're spending 15 minutes on the phone going through the [display], you're not booking appointments, so we had to change it. There's somewhere you can go on our website, they've got all the questions there and all the answers.

Another installer mentioned that his team had a 2-minute video on their work tablet that could be shown to the customer at installation. Both companies give their customers leaflets to introduce them to their new meters and displays.

As noted below, a customer is very unlikely to pick up all they need to know about their IHD and smart meter at the installation visit. One installer saw a need to have some continuing support:

¹²⁸ At the time of the focus groups, the DVD was still an unrealised idea.

I think the one place we currently miss out on with these in-home displays is after we've left, because when we are there, normally they'll be, so far today, it's something like 11 pence [spend on electricity during the visit] so people just literally roll their eyes at it... in the coming days and the coming weeks, you can have a look at what you've actually used, and obviously we're not there to try and support that. I'm not too sure if there is anything in the office to support that but... if they had a dedicated team it wouldn't half help, because, from my own experience, I do use mine quite a lot, especially now that the winter is coming, my heating has gone through the roof. So I'm having to try different things every day and having that figure there in front of me is really helping me trying to work it out, but... when we are at an actual property, because we are only there two hours, the amount of money that you can see on the display isn't a lot, so a lot of people just go 'whatever'.

An installer from the other company similarly commented that

You can't really gauge how many people are going to benefit from the time in there [at installation]... if there is a follow up a couple of weeks later to see how they were getting on with the display, that's when you realise if it's worked and how much money they are saving.

Occasionally there is a follow-up visit, but only in cases where there are complications with an installation; and any checking on progress is incidental rather than planned:

...I do a lot of complex gas work so sometimes I go back to a property if someone has already done the electrics, set up the display. I might go back a couple of weeks later to do the gas meter... and most of the time I do see that they've still got the displays out and they are still using them.

6. Customer interfaces: IHDs, websites and apps

The discussion on customer interfaces largely centred on the in-home displays, as these are the main point of interest for most customers. Installers are required to offer an IHD to all smart meter customers and, if it is accepted, to set it up in an appropriate place, in such a way as to meet the needs of the household. They are also required to demonstrate the 'smart metering system' to the customer, which includes the IHD in almost all cases.¹²⁹

¹²⁹ Smart Metering Installation Code of Practice, June 2014

The installers identified some design issues that cropped up with some of their customers. One concerned the relative merits of simple and complex features, especially when even the apparent simplicity of a 'traffic lights' feature could be deceptive because the traffic lights could be used in different modes:

Problem with the traffic lights on that one is that there is three different modes ... I've been to customer that's turned off all the heating because she was petrified cause the traffic light was on red, but she'd have it in one mode, so it was going red because she'd gone over her budget for that day. But she thought, she was told by the engineer that red meant to be using a lot of energy, so she turned everything off and she wasn't using it....

F: When you say what mode it was in, do you mean gas or electricity?

No, you've got three modes. You've got Cumulative, Instant and Predictive. They can predict how much energy you will use, but the thing is that didn't really work. Cause you've got summer/winter. So you might have it in the winter and it'll work out how much you've used in the winter, it'll show you what you can use during summer. But you won't have the heating on, you won't have this, that or the other, so...

If you've got it in the Instant mode, the traffic lights work as: green is good, amber is medium usage and red is high usage... As soon as you swap the mode to the Cumulative, it shows the customer what they've used throughout the day. You can change it to the week or the month. Then ...[for Predictive] it's green if you're under budget, amber if you're close to it and red if you've gone over. So you could've only gone over by 10 pence your budget for that day but you're still gonna get a red flashing light...

I think keeping it simple is the best thing... Because you have the traffic lights, and they walk out the door, and it shows it's in the red, they think what they've got on, so they go around the house...

I agree with the simpleness but ... you should also have the option for the complicated, because the novelty does wear off on these meters relatively fast for most of our customers. But ...if you're just bored one day yourself and if you're to pick it up and read through the book and have a mess with it there's something to do with it. But if it was too simple, you just look at it, no there's nothing to do there, and carry on. That's why I like the fact that the customer could go back to it ... and you've still got that interest, because there's something else to do with it.

The traffic light settings for Instant mode were also queried:

I'd change ... the green, amber and red. I'd bring the kilowatt ratings down on them because I don't think 2.1kW you should still be in green... I think we should just go on kW rating.

Opinions varied over the value of the Predictive mode figurative display function, which predicts according to patterns 'learned' over a period of 10 weeks:

It's good for families with kids.

I don't think it really is in this country, cause you can't really predict it cause of the summer/ winter. If you're using so much over the winter and then it works out how much you've used, you can't be accurate, cause in the summer you're not gonna use that much energy, you're not gonna have the heating on every day.

Coming to your tenth week, you're changing to autumn and things like that, and you change your patterns.

You're not gonna have your lights as long. You're not gonna use tumble dryers, cause...you'll leave your washing hanging outside.

F: I was thinking if you've got the electric heating and the weather changes too...?

Well, I like the predictive... What everyone is talking about predictive is ten weeks of memory getting built up and then they're trying to guess how much it's costing you. I agree that part of predictive isn't for me either, but when you click on our predictive mode, there's the date that comes up on the top and it'll say the first of every month or say weekly or daily, there's an option, 'cause we have a time period also on the monitor. And that date you can actually go back in time. Obviously, you have to add on your standing charge now, 'cause that's how everyone's going. So, if you're a bit concerned that your direct debit is going to go up the following year and had a smart fitted for a year, you can actually add the twelve together, do a division of twelve and you'll find your gross average minus standing charges the following year and you can also check it in kilowatts [sic]. So, if you were to compare tariffs for the year...you'd be able to see how many kilowatts you've used and compare tariffs monthly as well. So you can go on switching websites and say how many kilowatts do you use a month, you can find that out through a predictive mode.

It is as complicated as you want to make it, really.

You can watch the [IHD] on YouTube channel. They've put up a three minute video on it, which is worth watching, cause it goes through everything there.

There seemed to be broad agreement that the most useful metric for the IHD was cost, followed by kW and kWh, with the very occasional exception:

I have never met anybody who has preferred CO₂ or kilowatts over pounds.

I have, actually...I met one person who had loads of solar panels and who is really interested in green stuff and he was all about CO₂. I was a little bit out of my depth at times because he was saying things that went straight over my head.

I think you need pounds AND kilowatts, because prices fluctuate and if ... they are trying to compare month on month they can't do it without kilowatts readings.

Some of the installers had found it difficult to explain the IHD to others until they had some experience of it themselves, and had time to absorb the range of possibilities. This lends support to the notion that customers too are unlikely to learn all about what an IHD can do for them within a few hours:

When we done the training course we went out there blind to it. We didn't have a clue and we had to complain, and they brought us back in and gave us some more training, and then [they] also asked the guys who were doing the [display] trials to come up with an idea to train the next engineers. So we said all the problems that we was getting. I learnt it better from reading the manual than I did from sitting there in the classroom because you got too in-depth with things sometimes.

...We try to explain in the simple terms... give them the basics. If they want to go more in-depth, what you say is, there's a book.

There was a balance to be struck between meeting individual needs in IHD design and having something that almost everyone could use:

...that monitor that you're leaving in that house is not necessarily only for that customer. That customer might move and that monitor should really stay there so the next person that's come into that house, even if it is an elderly person that lived there and you've given them the most basic one, the next person might be a tech head ... There needs to be a benchmark with what's acceptable to everyone. You've got to think generally, not specifically.

You've got to cater to the customer that's there. You can't think about who's going to be moving in 10 years.

I get that. What I'm saying is we need a benchmark. We need to say what's acceptable and what's not.

It was noted that (provided they can first find out what is possible), people will find their own level to some extent, selecting the functions that are most useful:

[The display] can be really complicated, if that's how people want to use it, but a lot of people just ... glance at it to check that everything is normal, so they get to know what's normal for them. 'Cause everyone is using their energy differently.

People have busy lives, and they haven't got the time to thoroughly look at it every day.

Installers in both companies noted that the IHD designs were still evolving, which they broadly welcomed, seeing a shift to more attractive designs, though not necessarily more user-friendly for older customers:

When we were fitting the old style the lads were saying that people were moaning because they had seen the one on the TV advert and said I want that one. 'I want the one that looks like a sat-nav, not the one that looks like a house brick' (laughs).

F: Which was the old style?

... It was like a portrait box with 4 lights at the bottom, blue, green, amber and red and that's when some of the elderly people, when they see the red, they just saw the red as a warning rather than red as using a lot of energy...

F: So the new one is more sophisticated, it does more?

Yeah , it's like a smart phone really

...It's a little bit problematic if I'm honest, in terms of pressing all the buttons, because it's a little bit small and touch-screen.

... With young people ... they have a certain level of capability with computers allowing them to work the ... touch screen ok, but I mean people who are older, I fitted one yesterday, she was 92, and for her, she hasn't even got Internet so for her going from not knowing anything about computers to having a touch screen one put in front of her, it's not going to be natural for her to work with that sort of technology. I think as far as that goes there should be a couple of different ones maybe.

Websites have already been mentioned as useful sources of backup information. There was support in one group for smartphone apps, as part of developing different options for different generations of customers; websites were also seen as part of the provision of complementary information:

I think the app is the future, to be honest with you.

Yeah.

Of course it is.

Because otherwise you've got your phone in one hand and your display in the other when it would just be much easier to just have your phone in one hand.

And the phone would be a lot more...

Unless you're talking to a dinosaur ...who would rather have the display, it's just different people isn't it?

And what I think is good as well is when you've got your [supplier] account, I think that is good as well, it's the same sort of thing, you can look at, you can log in online and just see how much you have been using. It's not like the same as the display but it goes along with it. I think that's quite good, they should do more things like that as well, more stuff over e-mail as well.

7. Customer awareness, concerns and questions

Some customer awareness issues and concerns have already been touched on, in sections 4-6: for example, the various traffic light messages, predictive mode and budgeting functions on IHDs. In this section, we look at customer questions in general.

F: You've mentioned that sometimes you have people firing questions at you. Are there some questions that you get most commonly?

I get a lot of questions about the energy display. Obviously, we go there and try to encourage people to save energy, and a lot of them would ask how much is it costing to work?

They say: How can you help me save money? That's what everyone wants to know and they want an answer within two minutes. The only way they can save money is by having the monitor going on instant mode, seeing how much it's actually costing them, and then unplug the appliance or seeing how much it's using sitting on standby and doing something about it... Without the monitor you don't know what to do, you don't know where to start; you don't know how many

kilowatts your house is using. Once you have the monitor, you can act on reducing your bills.

... At schools now they're encouraging children to be aware of the energy usage. So if, you've got children, they tend to be switched on about it and it's good to get them involved as well.

I'd say that 80% of the customers I go to purely want the meter fitted because they don't want the meter reader going into the house, and they don't want the estimated billing. They haven't called me because they want the smart display.

Two concerns likely to contribute to smart meter refusal were touched on: confusion with prepayment metering and concern about loss of privacy or intrusive directions as to how to go about daily life:

A lot of people ask about the payments on smart meters, because there used to be prepayment meters and they were called 'prepayment smart'. So they could be losing people that way. There's a bad name with pre-payment meters. You also get the conspiracy theory people, who think that we're watching them and we want to know when they're out of the house. We tell them that all we're getting is the reading, and what they see on their monitor is not what we see.

Recently, there was a customer who was convinced there was a camera in the meter watching him.

There's a lot of bad press with smart meters in other countries. America, Austria... With some people you do get this conspiracy theory...

F: About what proportion of households would have those concerns?

A very, very small percentage, much less than 1%.

You can easily turn these people around. You can explain that they're not like the pre-payment meters and you can make sure they know what smart metering actually is.

... Once you explain to them what the meter does, what the purpose is, the in-house display and everything else they'll benefit from it quite happily.

... I believe everyone lives how they live in their house, this is what I say to every customer. I can't tell any customer to turn their appliances off, when they're in their house. It's when they leave the house, that's when they make savings or not.

The installers reported little in the way of major concerns.

I felt it was a picky type of person who would have actually liked it [a smart meter]. At the start there wasn't many people going towards it but now there are loads of people going towards it. Loads of different people have it, from young people to old people to anyone.

I've found that from when we first started... the awareness has gone up tenfold already, but we've still got a 'blank', especially with the elderly customers, they think we are there to just fit a meter, they don't have any understanding of what they're getting.

...the typical thing we hear from customers – 'How does it work'? People are excited to see what happens. They don't really know much about it and physically want to know what is happening and what it's displaying. Not all of them.

... A lot of people would ask about the aesthetics of the new meter, how it looks and the size in comparison with the old meter.

There were some concerns about changes to billing:

F: If you have a smart meter, do you get a different sort of bill ... does it change?

... we actually said, if you want a smart meter in the transit we were doing [i.e., a particular trial], you would then have to go on monthly billing. They would often turn around and say 'No, I don't want to go onto monthly billing, but I will have a smart meter' ... that was a turn off...

Is that because they get lower amounts in the summer and then big bills in the winter?

I think for a lot of them it was ... people think of Christmas coming up and that's going to be when their biggest bills will be coming up...

F: But that is what they have to have now if they go on to smart meters?

Not necessarily, I think there is a bit of room for negotiation there.

There was sometimes a measure of suspicion as to supplier motives in offering efficiency advice, which is countered to some extent by reference to supplier obligations:

F: Do customers ever say to you, 'You guys are trying to sell me electricity, why are you advising me to use less?'

I have had a couple of people ask me that where they're like, 'well shouldn't you be trying to get me to spend more?', but it's not about trying to get them to spend more, because in theory, if they spend less... it benefits us somehow.

Yes it's something like, we've got like a certain target to reach by a certain date, whereby if our customers don't reduce their bills by a certain amount we get fined so much.

It's eco efficiency as well, isn't it?

Yeah, we've got an obligation to bring down people's CO₂ emissions, with the loft insulation and things like that.

There was also a need to be aware of sensitivities about energy affordability and customer-utility mistrust:

... obviously the cost is up, since ... I started, people are a lot more touchy in those two years ... so in a way, you have to be a little bit more aware of how you are saying things because they will go 'it's not my fault, it's your company pushing up the prices'.

Yeah. 'You're trying to get me to save money, so don't put my bills up'.

Exactly.

You do get customers who just see you as negative no matter what.

Yeah.

Like if I've got [name] to come up and give me a part that I've not got, the customer will say, 'oh this is why my bills are so high, nice new vans, both in uniform', some people just see it as negative.

... I think a lot of it now, we are having to be a lot more honest as well because it's a bit of an easier conversation to have now because you can say to people 'we know energy is going to go up, fact, we know it's going to go up so all we can do is to help you save money by giving you energy advice so hopefully one might negate the other as it were... So that helps us with our energy advice because if it goes up by 10% you can save 8% energy, you are only going up by 2%.

8. Vulnerable customers

The need for special consideration for elderly customers when designing and explaining IHDs and smart metering was raised earlier; in addition, elderly customers were identified as more likely to refuse an IHD, especially if it was seen as over-complicated:

F: Could I ask when you put in a meter, how often - or is it always - that you leave some kind of in-house display?

Every domestic. Not commercial, but every domestic.

... We were told ... because the government say... how much it is... and the whole idea is for them to have them.

Unless they opt out of it?

F: And do many people opt out?

Not domestic.

Quite a few vulnerable people, probably the elderly. They're just happy that they don't have some stranger knocking on their door, so they come to read your meter. They're happy with that. The in-house display, it is a bit slow and hard to explain how it works.

The first ones that were fit in, the units were so simple to use, I mean, there's still somebody now who'd get confused, there was only few buttons, but they all love the fact that they could still take the meter reading. Cause even though you tell them that it's getting sent back to the tech manager, they still want to do their readings in their books. And they brought out the new, [display], and someone's done the trial with them to get the feedback, and the customer doesn't like it cause he can't get the reading out of it, it was never used.

One installer mentioned additional service that was available from his company for vulnerable customers:

If it's a vulnerable customer, we would actually set up a carbon monoxide detector and we do it for nothing... Also, a lot of heat from the radiator goes into the wall and you lose it. There are reflectors that actually bounce that heat back to the room. The customers can't believe we do anything like that.

40% of heat you'd save through the radiator reflectors against the wall. Plus if ...we find an unsafe situation with the boiler, we would leave an electric heater just so they know we're sorry about this and we do care about them.

There was some advance notice of vulnerable customers if they were on the Priority Services Register:

... it says on the additional notes things like customers over 65, disabled, in a wheelchair anything that could have been passed down so you know that and you have to ring them prior to getting to the door.

The main things we have to watch are things like oxygen machines...If you're pulling the fuse in the electricity. A lot of them have alarm monitors which alert the office or hospital if disconnected so you get alarm bells and phones going.

F: Do you have a special routine to follow when you're working in a PSR home?

That's more done upfront before the installation so if we have a specific vulnerable customer journey when the appointment's being booked, we offer vulnerable customers what we call a smart support coordinator and then that person in the call centre will follow that customer the full way through the journey. So they'll be in touch with that customer or their third party carer once the technicians do the call on the day, and then we'll follow up.

F: How much later typically would they phone?

They normally phone about an hour after we leave.

They don't do as much work with vulnerable people now as we used to. We were doing a lot of work with Age UK.

F: Would there be any further follow up after that?

No, not unless the customer has asked for it or the third party carer might call us, but no not usually.

Language was less of a difficulty when communicating with non-native English speakers than might be supposed, though the installers acknowledged that they might not ever encounter people with no knowledge of English:

F: Do you have any language difficulties possibly with newly arrived and have rang up or perhaps a landlord has decided he or she might want pre-payment?

Yes. There is a bit of a barrier.

We're supposed to be given a card but I've never been given one.

Now there's a different influx. There is a lot of eastern Europeans so there is still that barrier.

If there is that language problem anyway the landlord will be there. You can ask for him to be there so he can explain.

Or there's a relative.

A lot of the time the school kids speak English. So the children will actually interpret and tell the parents what's going on.

I don't like to do those jobs, to be honest, because if you get any of those problems on the gas side you don't know the questions, and if you've got to disconnect then they don't have a clue if they've been disconnected. We're supposed to be getting cards in so many languages, and there is a number.

... A translating number.

People with real language difficulties wouldn't get in touch with you to ask questions.

Installers from the other company stated that some of their team members spoke some of the ethnic minority languages in their area, and that there was also an arrangement whereby

There is also a language line, isn't there? Where you sort of..

Speak to a translator.

And basically you have a three way conversation with the customer, yourself and then someone that can speak that language.

I've personally never used that, because 9/10 there is someone who is in the house that can speak, if not fluent, decent English.

A lot of it is visual as well, you can show them visually.

F: ... but you can sometimes see from the name on a customer's sheet that, I mean does that affect at all which installer is sent in?

...No, because how they're chosen, there's a system called 'The Optimiser'... All it does is it looks at skills and where this person is geographically, does this person have the skills to do that job and so it is based on skills ...

...So it's not about the authenticity of language, it is purely about: this is the job, they're due for a Smart, who's in the area that is capable of fitting smart meters and whether or not they can get there in time and then put that person onto it?

9. Prepayment customers

At the time of the focus groups, neither of the suppliers was installing smart meters in prepayment mode.

When we are going round and changing someone from a credit meter to a prepayment meter, that's then a fresh meter that then might not be changed to a smart meter...

I think we've got some while to go with the smart meter, I don't think we are hitting anywhere near where we can help the most. When Smart comes in and eventually supports a prepay model where you've got ... some of the ... people we've got on our customer records, and you're going in and giving the option to save money, that is going to be where we can be our most helpful with these things.... When we hit prepay, that's going to be where we really start making savings and encouraging people to do this.

10. Technical, system and management issues

While the main purpose of the focus groups was to discuss customer engagement, in line with the Smart Metering Early Learning Synthesis generally, the conversation threw up many technical and organisational issues that affect the day to day work of installers.

The provisional nature of functional and technical specifications was mentioned, as instances of the changing environment in which the installers worked:

F: There's still SMETS 2 to come and compliance with that, you've still got that hurdle.

There was a distant manufacturing hurdle...a big percentage of our customers have Economy 7, and this particular manufacturer didn't have it in their meter...

F: So it is quite fast unfolding...

Yeah, it has been for the last three, four years.

That's a way forward, you just get to grips with it ... and then you go backwards and you start all your team and the problems start again.

It's also the cost of things. If the government says we could, for example charge the customer so much for the installation of the smart meters, we have to do it

within the cost ... So we need to find the right device at the right price for when we're ready to roll it out.

I found as well that when we go out and fit these and then the system drops down, we can't do the install. We could've been in that customer's house for over an hour and then we're told we've got to cut the damage and come back here. But [the supplier] are good, in that sense, they'll compensate customers for the time that they've lost. It's a bit of embarrassment but it's not our fault, the system has dropped down. We never used to get that with the old toy, as long as you done the signal checks everything would go through it. If you didn't it could from the office and would go through later.

It can be a bit of a nightmare, can't it?

There were some views on the technical and social aspects of roll-out logistics:

At the moment a lot of it is voluntary, it's not a proper roll-out. It's more to do with customers wanting it. So one customer could be in [name of place] and one in [name of place] on the same day, so you've got quite a bit of travel. So, when the national roll-out comes in, hopefully they'll do area by area, postcode by postcode.

When it does [come to] roll-out, the other energy companies will see what we've gone through.

...They've realized there had been signal problems, but that's why they're sending us out there, usually remote places. Once we identify the areas, hopefully they will set up something with mobile phone companies...

F: Have you had any problems installing with signals in the high rise? You talked about the hard ones being rural, but I was thinking probably the high rise ones too.

... in a lot of high rise the meters are downstairs, so if you're three floor up it may be hard to pick up a signal. The idea is that it's supposed to work the whole way around the property.

Around 40m I think it is.

In some new apartments... the meter rooms are downstairs in the garage whereas the flats are five floors up so ... unless they put some sort of little booster in the middle they're not going to get it.

Other physical and technical difficulties crop up, often in particular types of housing:

F: How many [installs] are difficult technically?

You mean to actually just fit?

F: To get the kit in, yes.

You'd probably get about 5% where you would struggle, maybe space-wise.

Normally most jobs you can do, you can do the pipe work, cable jobs stuff like that, there's only about 5%, probably less than that you can do, probably 2% or 3%

I find it depends on area, I find that in certain parts... you'll find a lot of them are at the back of kitchen cupboards and...

Yeah, you know when the postcode comes up; you're like 'Oh, they're going to be awkward because they're always in the same stupid place'. Whereas if you get ... a new area, it's all meter boxes outside and you're not going to go far wrong.

There are various different problems, you know, space requirement is one, the meter and the equipment is quite big at times for certain places and there's going to be, 'can you technically do it?' Signal? Do we have the reception for it to be able to bind into our back end systems?

Yea and like interference as well from appliances nearby, or if it's at the back of a kitchen cupboard, or sometimes you'll find that they won't bind up.

... a lot of new builds now ... will give you a very small space to fit your meters because they know we have small meters. But I know for a fact that we are never going to get smarts in there... not because it's the meter, it's because of the size of the smart equipment... you get the actual meter itself... you have something called a comms hub, which is basically the brains of everything, that sits separate from that...

The amount of time allowed for installation was identified as a significant organisational/regulatory issue. This relates not only to the range of technical difficulties, but to the time available for talking with customers:

F: So what's the sort of variability as to how long you're in the house, what's the shortest and the longest you would be in the house?

Hour

Average about two hours

Two and half hours sometimes if it's very difficult and problematic

Four hours the other day

Ok, I've never had one like that ...

Yeah, so an hour and a half or two, three hours

The actual job time is 1¾ hours for a dual smart, that what they give us, but I reckon if it goes smoothly, I reckon you're in and out in 1 ¼ hour, that's with no issues, you know, fitting issues and that sort of thing.

... If you're in a ball park, it's about two hours for a dual meter, roughly... if you were to take an average.

No I reckon a bit quicker than that, I reckon an hour and a half average

If it's nice and straightforward.

*I would say it sometimes depends on the individual as well doesn't it?
[agreement]*

F: In what way does it depend on that?

Some people are just quicker than others with tools

Yeah, with like organisation and everything

Someone who is less experienced is always going to take longer than someone who is more experienced.

Not just that, I think it's customer interaction as well, some people will just go in there and get the job done whereas some people will just sit there and have the second cup of tea, have a quick chat...

Timing became a particular issue on 'rest days' for employees of this company, as

...if you want to work your day off they'll send you eight jobs and they'll pay you per job, and the idea is to try and do as many as you can.

F: But if you are on a normal day and you set aside 1 ¾ hour, two hours or so, about how much of that time do you think would be spent talking to the customer?

More than when you're on rest day work...

F: But how much time do you think you would be having a conversation, do you think?

I think about 10-15 minutes' talking, about ... display, energy advice. I reckon 10-15 minutes.

... As a rule, yeah, obviously it can go longer depending on whether they are interested or not.

They'll be talking to you as you're doing it as well, which kind of adds to it, doesn't it?

Annex E: DECC Smart Meter Workshop, December 2013

Location: 1 Victoria Street Conference Centre

Project Aims

- to draw together empirical findings from the Early Learning Project consumer survey of customers taking part in the current early smart meter roll-out, along with evidence from the research literature and from fresh qualitative research;
- to develop a theoretical underpinning relating to programme delivery and changes in energy use, using realist methods;
- to offer conclusions on
 - a. observed processes leading to energy saving, for different groups, under the consumer engagement approaches used in early smart meter installations
 - b. the relative importance of different types of engagement activities which could be carried out in future, to offer customer benefits especially in relation to energy saving.

Workshop Aims

To share initial thoughts from the Synthesis project, and invite participants to contribute to the development of theoretical and evidence-based models of how the introduction of smart meters may bring about energy savings for households, how outcomes between different groups of customers may vary, and what circumstances favour particular outcomes. The participants will review and map a draft set of theories of change for consumer engagement in relation to smart metering, presented by the project team, and then propose how best to develop them over the remainder of the project. In other words, to invite participants to contribute towards establishing a picture of 'what works for whom, in what circumstances' that will enhance planning for the future implementation of smart meters. Your guidance on potential data sources, theoretical perspectives and practical considerations will be valuable here.

Workshop programme

10.30 – 11.00	Coffee/tea
11.00 - 11.10	Introductions: Michael Harrison, DECC
11.10 - 11.20	Overview of workshop : Dione Hills, Tavistock Institute
11.20 - 11.45	Overview of synthesis project and lessons emerging from the literature review: Sarah Darby, University of Oxford
11.45 - 11.50	Initial thoughts arising from focus groups with smart meter installers: Christine Liddell, University of Ulster
11.50 - 12.10	The Early Learning Project consumer survey: design, what it might tell us: Antonia Dickman, Ipsos Mori
12.10 – 12.30	Theory of change mapping: preparation for the afternoon session
12.30 – 13.15	Lunch
13.15 – 14.15	Work in small groups on the development of theory of change maps for different smart meter customer 'clusters' (Dione Hills to facilitate)
14.15 – 15.00	Feedback from small groups and discussion (Dione Hills to facilitate)
15.00 - 15.30	Short reflection from everyone on the day, and possible next steps in synthesis project (Demelza Birch to chair)

Workshop participants

DECC

Demelza Birch	Smart Meters Benefits and Evaluation team
Michael Harrison	Smart Meters Benefits and Evaluation team
Sarah Mussell	Smart Meters Benefits and Evaluation team
Matthew Baumann	Central Evaluation team
Siobhan Campbell	Central Evaluation team
Pau Castells	Smart Meters Economics team

Synthesis project team

Sarah Darby	Environmental Change Institute, University of Oxford
Christine Liddell	School of Psychology, University of Ulster

Dione Hills	Tavistock Institute of Human Relations
David Drabble	Tavistock Institute of Human Relations

Contributors

Antonia Dickman	Ipsos Mori
Derek Lickorish	Fuel Poverty Advisory group
Charlie Wilson	School of Environmental Sciences, University of East Anglia
Megan McMichael	UCL Energy Institute
Gary Raw	UCL Energy Institute
Kevin Burchell	Kingston Business School, Kingston University
Gareth Powells	Department of Geography, University of Durham
Zoe McLeod	Consumer Futures
Bart Schoonbaert	Ofgem
Tim Chatterton	University of the West of England
Lucinda Watts	Central Delivery Body

Annex F: Theory of change maps

Theory of change mapping involves identifying anticipated causal pathways through which an intervention leads to a set of outcomes, and the articulation of the assumptions (underlying theories) of how the hoped-for change will come about. Theory of change maps are used to help in generating hypotheses, and in the identification of research methodologies to be used in gathering data on programme processes and outcomes. Below are some theory of change maps produced during the project for the purpose of mapping possible scenarios during roll-out, the logic of the roll-out and causal pathways, and the hypotheses which underlay the government actions. Five scenarios were explored in detail and are outlined here. Note that these maps are not intended to be definitive: they were drawn up as tools to assist in thinking through what might happen, and how.

1. Full supported roll-out

This scenario considered the possibility of a **smart meter roll-out that was supported as much as reasonably possible** by all parties in a generic way. This implied strong training of installers, collaboration between partners, a 'detailed install' for all households, and continuous evaluation of the process. It was assumed to achieve the most positive outcomes of any scenario. Support at critical points throughout the pathway would ensure that changes in energy behaviour would be more significant and longer lasting.

2. Full roll-out with support for vulnerable customers

Under this scenario we considered the impact of all services agreeing to focus the roll-out on customers in fuel poverty, with a more basic roll-out procedure for other customers. This implied early identification of observable proxies, clustering the installers with the best communication skills for vulnerable customers, tailored information for these households: in effect, a parallel installation process. Good outcomes for all customers.

3. Full roll-out with support for microgeneration

This scenario was developed in order to consider what the **highest level of response could be** by focussing on the segment with the most capacity and interest to reduce their energy consumption: current and prospective microgenerators who could monitor both consumption and production through their smart meter. This scenario assumed the highest level of pre-installation collaboration, including identification of those most likely to reduce energy consumption, an offer for simultaneous installation of smart meters and microgeneration technology at a special discount, additional training for some installers in smart technologies, and special installation arrangements for customers with microgeneration. These actions, together with continuous marketing for microgeneration and national demand reduction initiatives, would promote reduction in the UK's carbon footprint.

4. Full basic roll-out

This scenario assumed more limited resources than 1-3, with a roll-out to all British households at a similar intensity to non-vulnerable customers in scenario 2. Training would be more light touch, the awareness raising campaign would be shorter, installation time allocations would be short, fewer households would engage with their smart meters and, due to lack of support through the pathway, the overall impact of smart meters across Great Britain would be much lower.

5. Partial basic roll-out

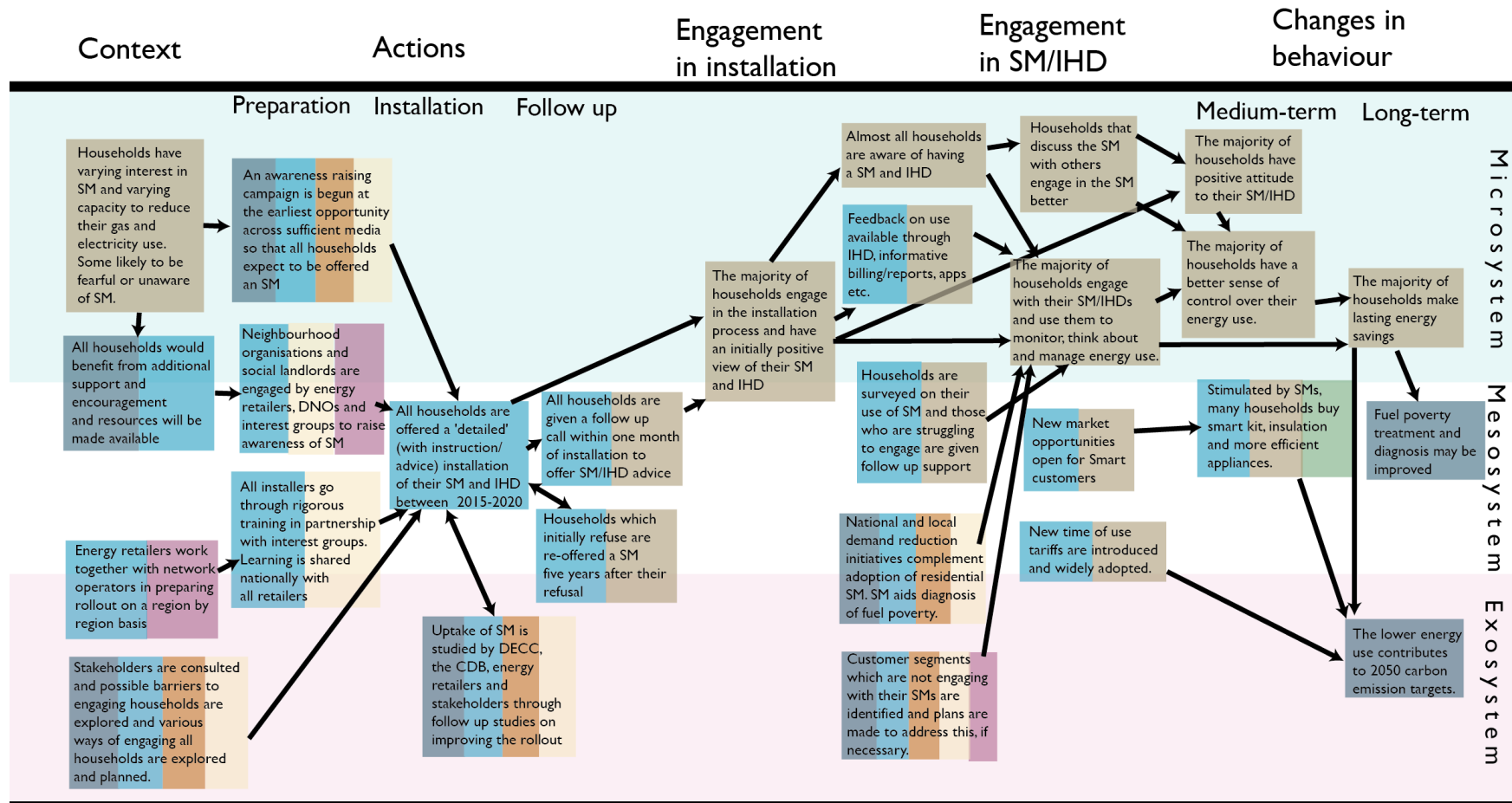
This was the most pessimistic scenario that assumed little buy-in to the scheme from half the energy retailers, less trust of energy retailers, and very low impact. Assuming poor national coordination, half the retailers would not offer an IHD to their customers, resulting in less engagement in energy use among these households, and fewer spin-off benefits from the development of smart appliances and applications. Retailers offering IHDs would be likely to receive some benefits in gaining customers and higher levels of trust.

Micro, meso and exo-levels of activity

These terms refer to activity at

- the household level, at which the 'customer journey' takes place;
- the delivery level: organisations with a direct relationship with households as part of the smart meter roll-out, for example, suppliers, Smart Energy GB (formerly the Central Delivery Body or CDB), housing providers, local authorities, NGOs;
- the wider system level: no direct relationship with households is necessarily involved, for example, DECC, DNOs, Ofgem, meter manufacturers.

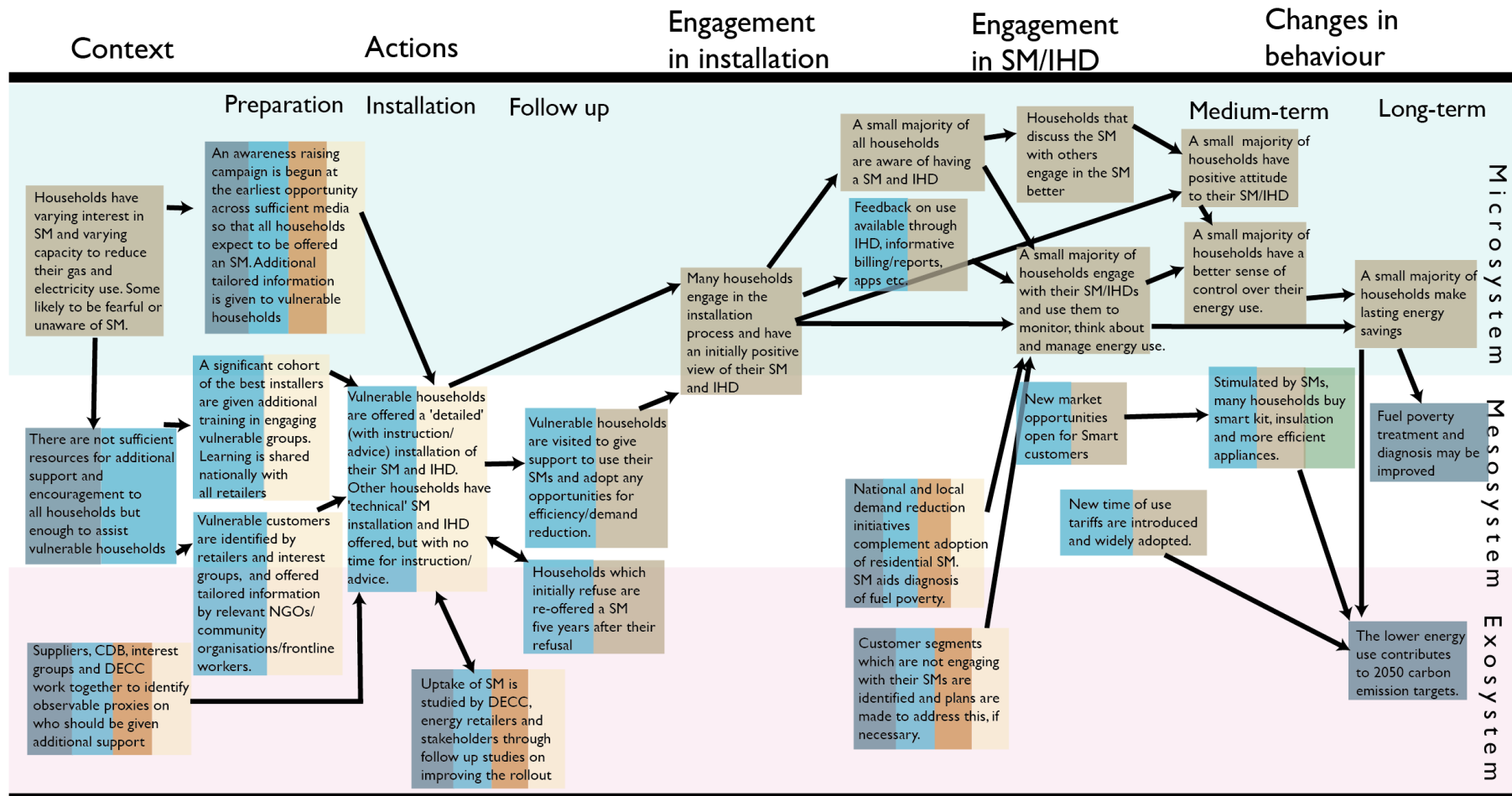
Full supported rollout



-- LEGEND --

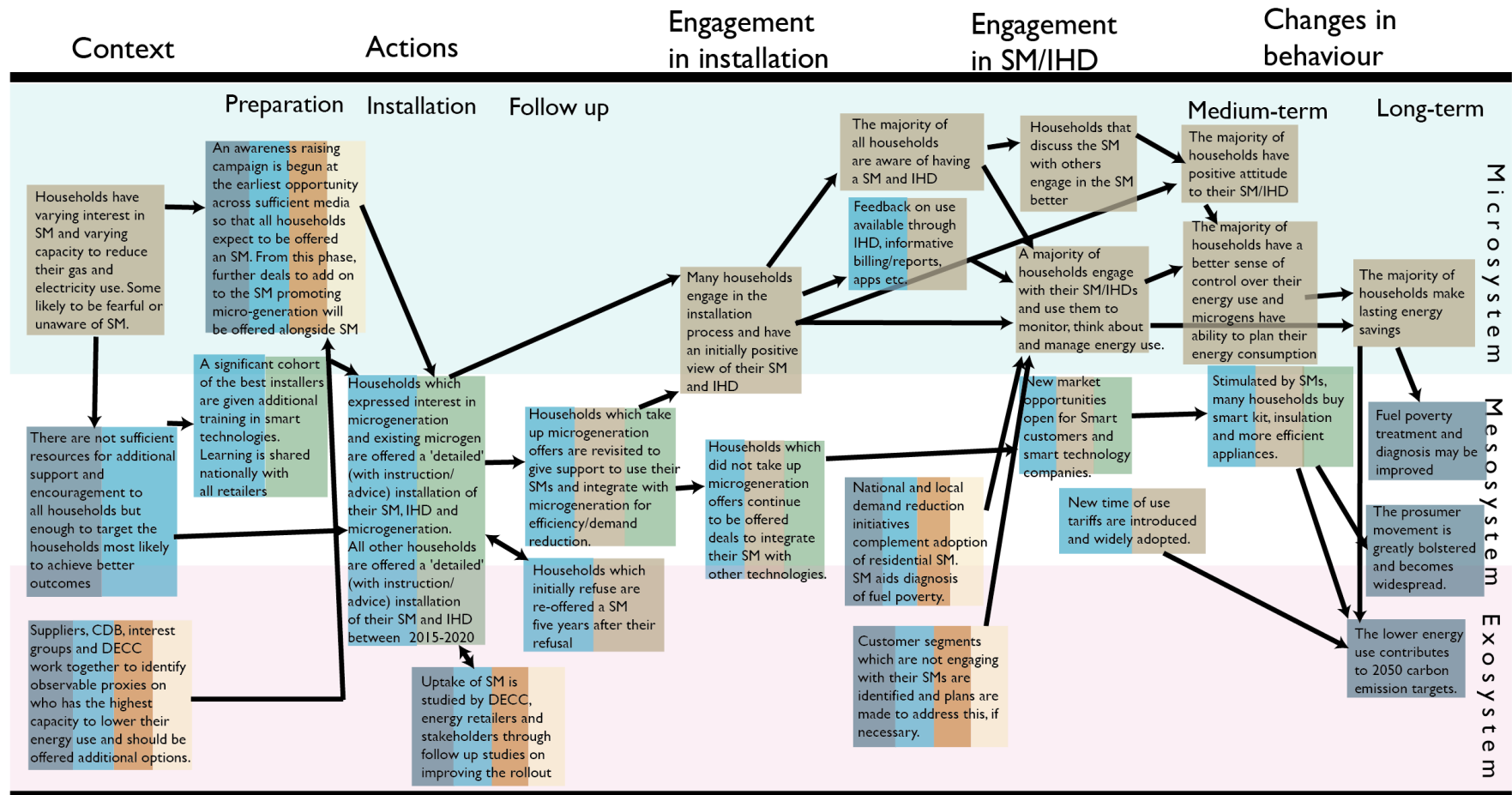
DECC Energy retailers Households CDB Interest groups Network providers Smart technology

Full rollout with support for vulnerable customers



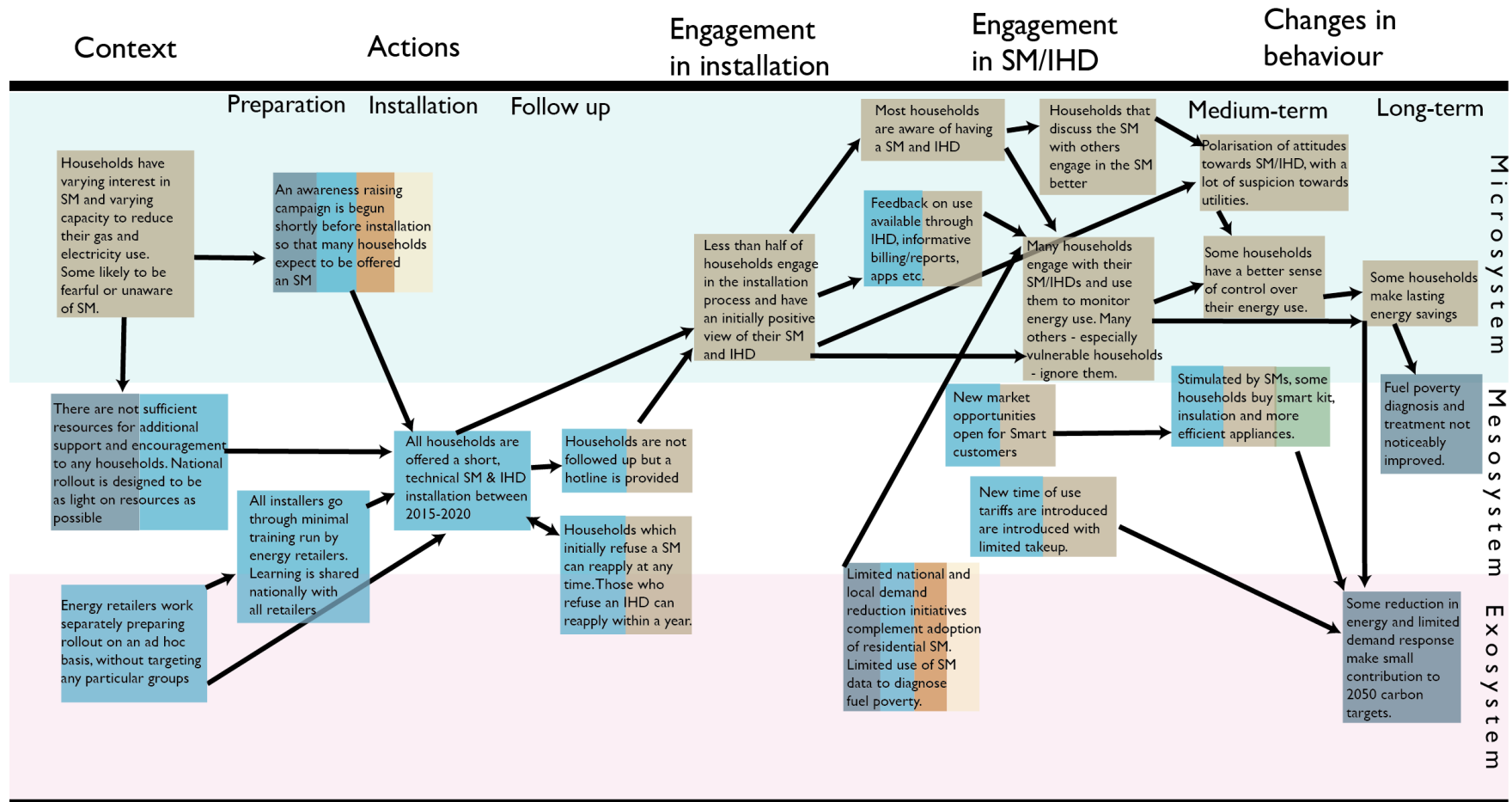
- - LEGEND - -

Full rollout with support for microgeneration



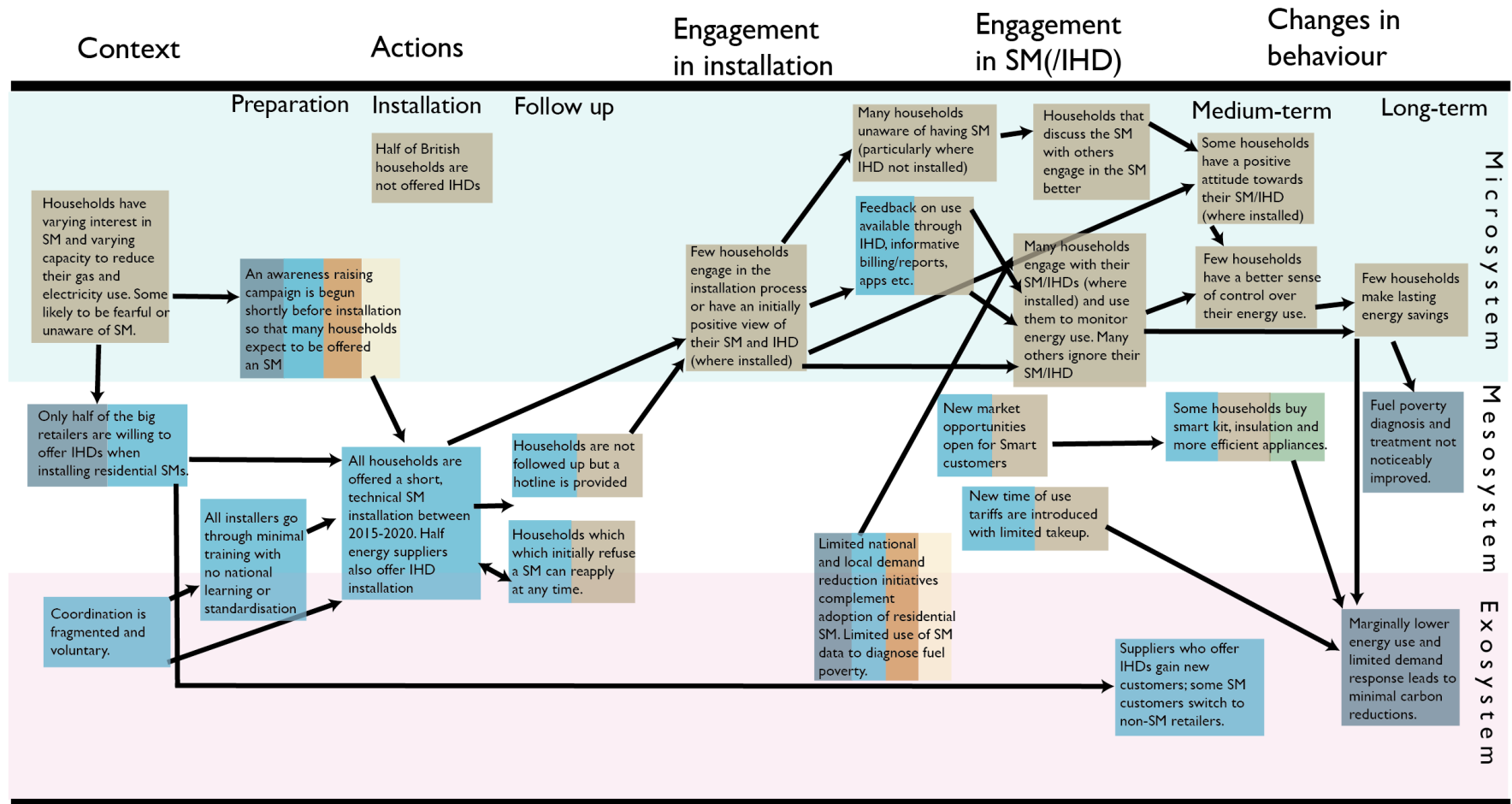
-- LEGEND --

Full basic rollout



-- LEGEND --

Partial basic rollout



-- LEGEND --

DECC Energy retailers Households CDB Interest groups Network providers Smart technology

