Smart Grid Implementation: How to engage consumers

Task 23:
The Role of the Demand Side in Delivering Effective Smart Grids

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Task 23 The Role of the Demand Side in Delivering Effective Smart Grids

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Participants

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1 Introduction

Whilst there is considerable focus on the technological aspects of delivering Smart Grids, little is understood of the extent to which consumers are willing and able to embrace new technologies and initiatives that enable their use of energy to be actively managed. There is a real risk that if consumers do not adopt new approaches to the way that they consume electricity, Smart Grids may not be able to achieve their full potential.

Not enough is currently known about how Smart Grid initiatives should be designed in order to make it more likely that consumers are willing and able to actively engage in them. This document represents the first step in filling this gap in knowledge. It describes a 'step-by-step' approach to implementing Smart Grid related initiatives that focuses on the customer perspective.

It provides general guidance, applicable in a range of contexts, on ***how*** Smart Grid initiatives should be designed in order to make them more attractive to consumers. It is ***not*** the intention to provide a detailed description of those Smart Grid related initiatives that are considered to be the most attractive to consumers. Instead, it provides guidance on some of the key criteria to consider when designing Smart Grid initiatives that endeavour to change energy consumption through energy efficiency, load shifting or information sharing.

This document represents the final output of a two-year project *'The Role of the Demand Side in Delivering Effective Smart Grids'*, Task 23 of the IEA Demand Side Management Implementing Agreement[1].

1.1 Who is this guide intended for?

The document is intended to provide guidance to implementers of Smart Grid related activities that require action from consumers, particularly domestic and smaller businesses. It is primarily intended for Energy Suppliers, Distribution Network Operators and System Operators who are the main stakeholders responsible for the development of Smart Grids, and thus stand to directly benefit from the engagement of consumers. However, there are many aspects of the design of Smart Grid initiatives that can be directly influenced by other industry stakeholders. These include:

- Government and Energy Regulators who are responsible for setting policy, legislation and the rules defining the way the energy market operates. There are a number of specific areas where they can directly influence the way Smart Grid initiatives evolve.
- Third-party aggregators, who act as intermediaries between consumers and Smart Grid implementers. They have a pivotal role as facilitators, and co-ordinate between multiple Smart Grid implementers.
- Energy service companies, who help consumers manage their electricity consumption, and can design initiatives specifically to meet the needs of the consumers themselves.

[1] An overview of the IEA DSM Implementing Agreement can be found in Appendix I.

- Technology developers / appliance manufacturers, who develop technical solutions that meet the needs of Smart Grid implementers, third party aggregators, energy service companies and the consumers themselves.

This document focusses specifically on the design of Smart Grid initiatives from the perspective of the consumers themselves. The scope is limited to consumers with Smart Meters, or those likely to have Smart Meters in the near future, i.e. those consumers expected to play an important part in future Smart Grids. This includes:

- Residential consumers; and
- Small commercial, business and local authority consumers, i.e. those that are treated in a similar way to residential consumers (for example have similar metering arrangements, or have similar access to the energy market).

1.2 How this guide should be used

It is suggested that readers start by reviewing the background information in Section 2, followed by the overview of the step-by-step approach described in Section 3. Thereafter, readers can review each of the steps in detail in the order presented (i.e. Sections 4 to 11). Alternatively, readers can focus only on those steps where they consider they require further information and guidance.

Key messages associated with each of the Steps are summarised at end of each Section.

The step-by-step process is supplemented with additional guidance that implementers can use at selected points in the process. This guidance is described in Section 12 ‘Tools to help implementers’.

The further reading section provides a list of useful background information on energy behaviour change and Smart Grid related topics. This list contains sources that are not cited elsewhere in this document, as well as listing the earlier reports relating to this project.

The following diagram provides a high level overview of the contents of the document to help readers navigate their way around more easily.

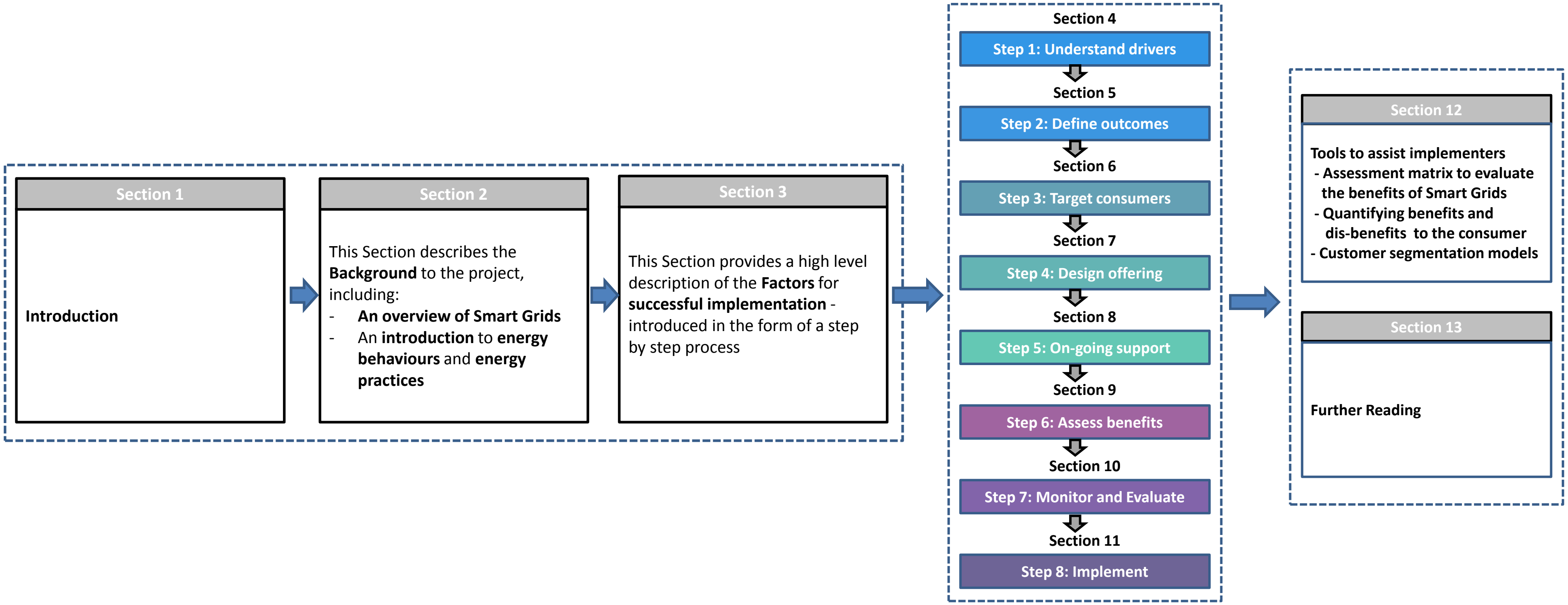


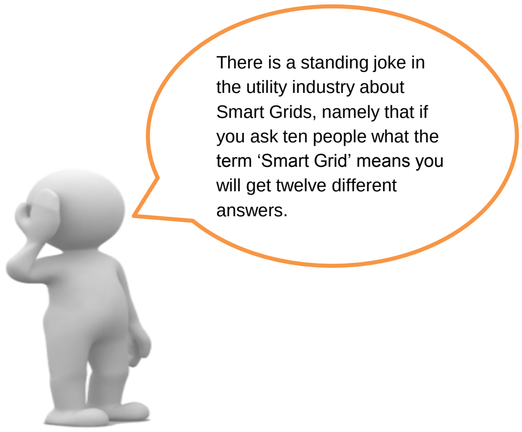
Figure 1.1 Overview of guidance document

2 Background to Smart Grids and Energy Behaviours

This Section provides a high level overview of Smart Grids and introduces the concept of energy behaviours and energy practices.

2.1 Smart Grids – an overview

Smart Grids mean different things to different people; as a result there are many different definitions of Smart Grids in use today. It is not the intention of this guide to add further complexity into this arena by introducing yet another definition into this already crowded space. Yet, it is impractical to prepare a Smart Grid guidance document without including a description of the basic context to which it applies.



Source: Kamphus (2013)[2]

Therefore, this Section provides the reader with a high level description of Smart Grids.

Within the context of this document, the term 'Smart Grid' refers to an electricity system that intelligently integrates the actions of ***all*** users that are connected to the system (generators, consumers and those that do both) in order to efficiently deliver sustainable, economic and secure electricity supplies[3]. This is illustrated in Figure 2.1, and represents a significant change in the way the electricity system has been designed and operated since the first electricity networks were introduced in the mid 1890's.

[2] Quotation by ABB, cited in a presentation by Kamphus, R. (2013) *Distributed generation: will this result in more energy use, more energy efficiency or only additional costs for the network operator?* New ways to achieve energy efficiency in the "polder model". 24th March 2013. Utrecht.
[3] EU, European Technology Platform Smart Grids. (2010) *Strategic Deployment Document for Europe's Electricity Networks of the Future,* April 2010

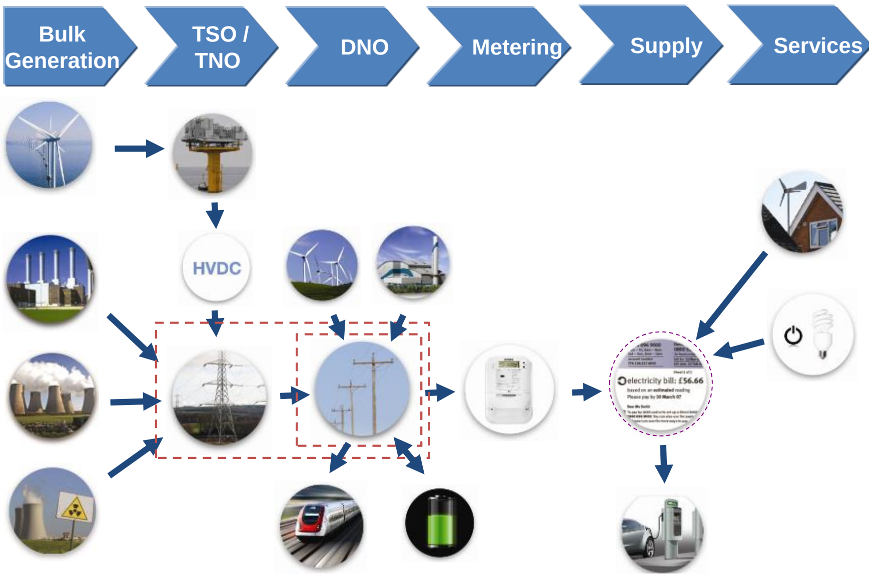
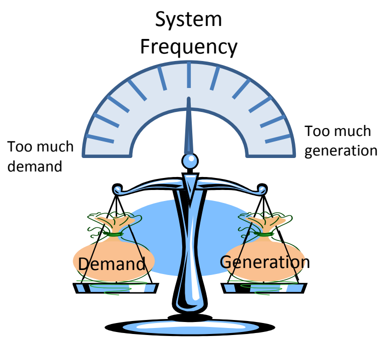


Figure 2.1 The Smart Grid

One of the main differences between the Smart Grids of the future and the electricity grids of today relates to the way the balance between the amount of electricity generated and the amount of electricity consumed is maintained.



In a conventional electricity grid, balancing is principally achieved by varying the output of large generators connected to the transmission system. In a Smart Grid, balancing is achieved using a much wider range of resources. This includes the flexibility of the demand side to adjust its pattern of demand to match availability of generation resources. Such flexibility is becoming ever more necessary, due to the challenges faced by the electricity industry world-wide as it seeks to find ways to reduce carbon dioxide emissions, whilst also maintaining the security and quality of supply.

The move towards the use of renewable sources of electricity generation such as wind, and/or inflexible generation such as nuclear, makes the problem of managing the balance of supply and demand ever more complex.

Furthermore, the decarbonisation of transport and heating through the uptake of electric vehicles and heat pumps can lead to increased demands on already constrained networks.

Smart Grids are now widely regarded as an essential component of ensuring sustainable energy supplies. They enable a co-ordinated approach, whereby energy production and demand are integrated to ensure the optimised use of renewables, whilst also minimising both the use of fossil fuel fired generation and investment in new network infrastructure.

2.2 Understanding Energy Behaviours

The factors that influence the energy consumption within a Smart Grid context are wide ranging and complex. This report specifically considers those factors that relate to the consumer, i.e. how individuals interact with Smart Grids. Specifically, this report examines how to ensure Smart Grids deliver energy efficiency and/or cost savings by enabling or stimulating certain energy behaviours. In order to do so, it is first necessary to define what is meant by energy behaviour. More generally, a 'behaviour' can be understood as any activity or decision described in terms of the following elements:

- the '*actor/decision maker'* who decides/acts/performs the behaviour (in this context this is the consumer);
- a well-defined '*outcome*' or action (i.e. switching off lights, installing a heat pump, keeping a comfortable indoor temperature or washing clothes);
- a '*goal*' or object (in this context, this would be within the home or workplace[4]);
- a point in time or a '*time period'*; and
- a specific '*context*'.

Based on this general concept of 'behaviour', the more specific concept of 'energy behaviour' can be defined as a behaviour that concerned with the energy use of the relevant actor/decision maker. By considering energy behaviour in this way, it is possible to use a behavioural model to help explain the factors that influence the decision maker's choice over whether or not, or how, to perform the behaviour. It is important to stress here that it is ***always*** the individual who makes the decision and performs the behaviour. This approach to energy behaviour is wide, ranging from specific one-off behaviours (such as investment decisions) to habitual daily routines (such as television viewing and washing clothes, often referred to as energy practices).

Task 24 of the IEA DSM Implementing Agreement, entitled '*Closing the loop - Behaviour change in DSM, from theory to policies and practice*' is focussed on creating a better understanding of how behaviour change models can be used by policy makers and practitioners in the context of Demand Side Management. The Task explores how a wide range of models have been used in a number of energy related case studies in different countries. Further information on the outputs of the Task can be found in Section 12.4 of this document.

It is important to note here, that no single model or framework is considered to be ideal. They are considered to be necessary tools to assist decision makers implement policies, and to support practitioners as they implement technologies and initiatives to help achieve an outcome that depends upon behaviour change. Importantly, these models do not attempt to predict an outcome, i.e. how individuals will behave. Rather, they are used to provide a perspective on energy behaviour and the aspects that influence an individual's decision of whether or not to perform a specific behaviour.

A number of models or frameworks of understanding exist and these have been used with varying success in an array of situations. Some focus on individuals, whilst others focus on the individual in his/her social environment. Some focus only on behaviour whilst others also focus on the context impacting that behaviour. Some focus on one-off behaviours whilst

[4] Smaller businesses only within the scope of this document

others focus on habitual behaviours. Where some focus on discrete actions, others focus on a complex inter-related set of actions.

The fundamental academic debate – as indicated above – is whether this choice is best understood by studying characteristics of the decision maker (individualistic approach) or by studying the physical, social and political context within which the decision is made (system approach). Some energy behaviours may be best discussed within the individualistic approach, while others are best understood within the system approach. The starting point for the present Task 23 is that valuable insights can be found within all of these approaches. Therefore, the model shown in Figure 2.2 has been used to provide theoretical guidance for the research leading to the development of this document.

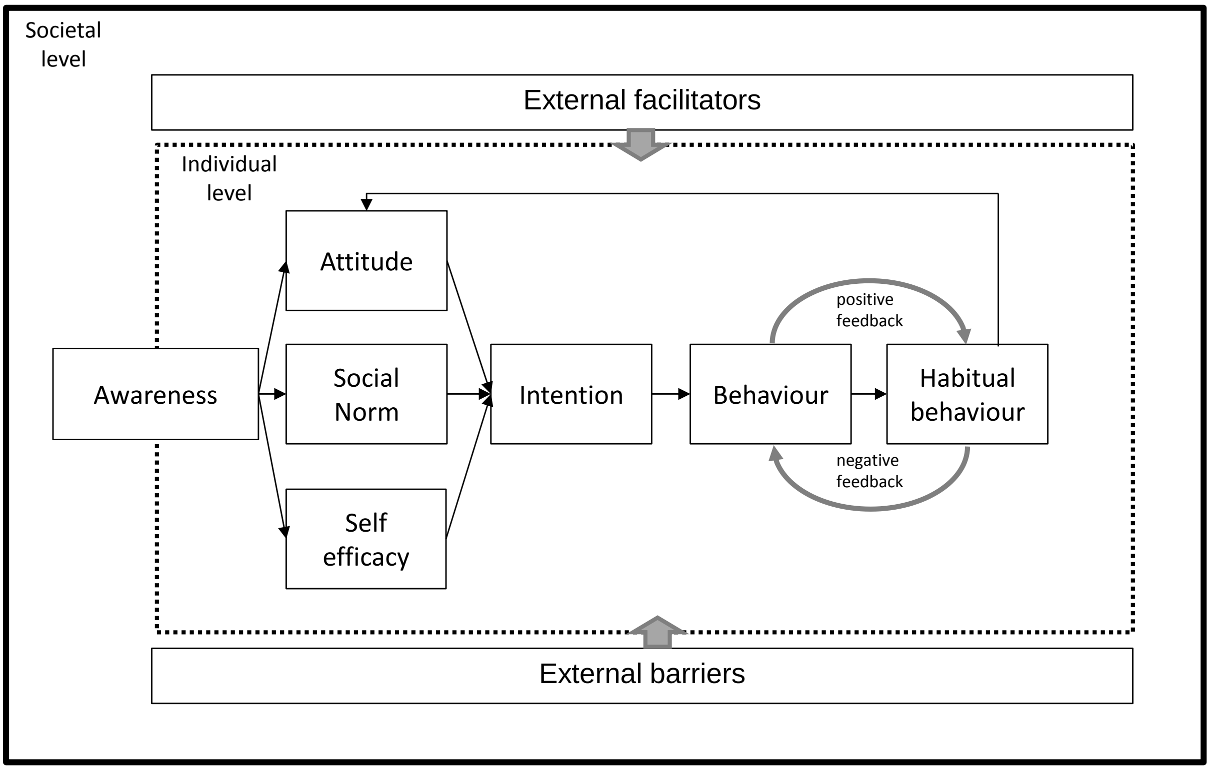


Figure 2.2 Theoretical model of energy behaviour[5,6]

The model shown in Figure 2.2 demonstrates that an individual's behaviour is defined by their own attitudes, their own abilities and the social norms relevant to them. In addition, it is important to also take account of their context and the opportunities or barriers presented to them. Consequently, an initiative that is successful for one group of consumers may not necessarily be effective with another group of consumers in a similar context due to their differing views and beliefs. Likewise, what works for one group of consumers may not work for similar consumers in another context due to the opportunities and barriers that exist. The step-by-step process described in this document considers the societal and individual elements of the model highlighted in Figure 2.2 and how they impact on the design of Smart Grid initiatives.

[5] Fishbein, M., I. Ajzen (2010) *Predicting and changing behavior: the reasoned action approach*. New York: Psychology press.
[6] Egmond, C., R. Bruel (2007) *Nothing is as practical as a good theory. Analysis of theories and a tool for developing interventions to influence energy-related behaviour*. Senter Novem, 16 September 2007

2.3 Getting Smart Grids into the Mainstream

Although individuals display different kinds of behaviour within a given market context, there is often a tendency for individual behaviours to develop over time, i.e. as the market develops. The 'Diffusion of Innovations' model is one theory that seeks to explain how, why and at what rate new ideas and technologies are taken up by individuals.

Many of the technologies and initiatives proposed as part of the Smart Grid are relatively new to consumers. As new technologies/offerings are introduced to the market they are taken up gradually, by different types of consumers at different times. 'Diffusion of Innovations' theory (popularised by Everett Rogers and first published in 1962[7]) seeks to explain how these new initiatives spread through a population.

Different types of adopters will take up the innovation at different rates and the process described above will take a varying amount of time. These different types of adopters were defined by Rogers as:

- Innovators: These are the first individuals to adopt a new technology or innovation. They are keen to try new technology just because it is new and innovative, and are willing to take risks. They can easily imagine the benefits of new technology and are eager to 'give it a try';
- Early Adopters: These are similar to innovators but are more discrete in their adoption choices. They are also considered to be opinion leaders, and they provide an indication of whether an innovation is going to be adopted by others;
- Early Majority: These are the first sizeable segment of the market to adopt an innovation, but they only do so after they have seen it used by innovators or early adopters that they know. They are pragmatists;
- Late Majority: individuals in this category will adopt an innovation after they have seen that the majority of the population has already done so; and
- Laggards: these are the last group to adopt an innovation. They typically have an aversion to change, are suspicious of innovation, and are focussed on 'traditions'.

Rogers showed this diffusion graphically (see below), where the blue bell curve shows the proportion of the market within each of five categories, and the yellow s-curve showing the market share of the innovation increasing over time as each of the different groups adopt the innovation.

[7] Wikipedia (2013) Diffusion of Innovations. [Online]. Available from http://en.wikipedia.org/wiki/Diffusion_of_innovations#Diffusion_of_New_Technology [Accessed: 01 August 2013]

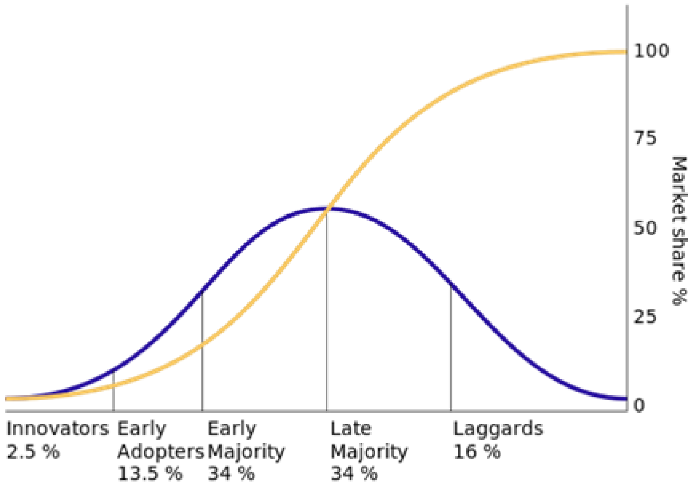


Figure 2.3 Diffusion Curve for New Technologies/ Innovations[8]

Each of the adopter categories has very different requirements and different expectations, and therefore requires different strategies to persuade them to adopt new technologies and innovations.

The status of a specific concept within a given market varies. It can be in its very early stages and only trialled by a few innovators. Alternatively, it may be well established and implemented by the majority of individuals, with only a few (the laggards) excluded. The difference in the rate of implementation of any concept can be influenced by two factors:

- The readiness of the concept (i.e. the technology or initiative itself), represented by the external facilitators and barriers of the behavioural model shown in Figure 2.2.
- The readiness of individuals to accept the technology (i.e. the market readiness level), represented by the individual elements of the behavioural model shown in Figure 2.2, i.e. awareness, attitude, social norms and self-efficacy.

An analysis of the initiative readiness levels (IRLs) and market readiness levels (MRLs) of Smart Grid activities was conducted during the early stages of this project[9]. The results of this analysis are summarised in Figure 2.4. Figure 2.4 shows the IRL and MRL for each of the case studies considered using a scale 1 – 10; with 1 indicating a very low readiness level and 10 the highest readiness level.

The results demonstrate that whilst progress has been made on the development of technologies and initiatives (indicated by a high IRL level), the market is not yet 'ready' to accept them (indicated by a low MRL level)[10].

[8] Based on Rogers, E. (1962) Diffusion of innovations. Free Press, London, NY, USA
[9] IEA DSM. (2013) *Interaction between Consumers and Smart Grid Related Initiatives*, (Task 23 Report for Sub-Task 2), November 2013
[10] IEA DSM. (2013) *Interaction between Consumers and Smart Grid Related Initiatives*, (Task 23 Report for Sub-Task 2), November 2013

This suggests that Smart Grid initiatives are still very much at the innovators/early adopters stage.

The low initiative readiness level reflect the current level of awareness of Smart Grids, attitudes towards different initiatives, the impact of social norms and how easy individuals consider it is to participate (self-efficacy), i.e. the individualistic elements of the behavioural model shown in Figure 2.2.

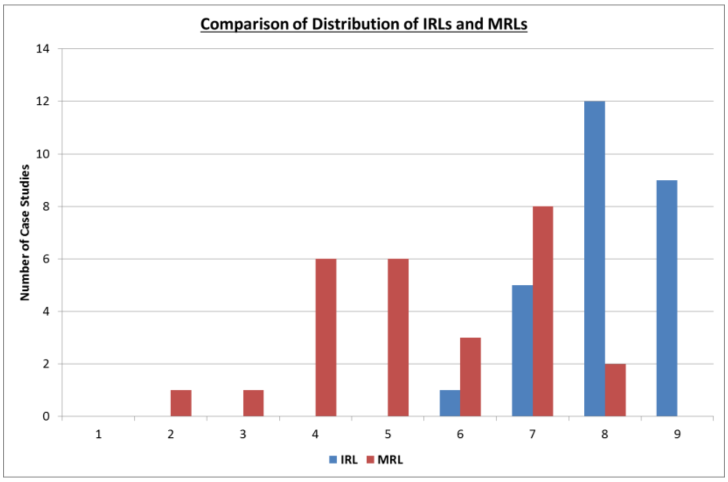


Figure 2.4 Initiative and Market Readiness Levels[11]

The focus of this document is to help implementers and other interested stakeholders design Smart Grid initiatives that are adopted not just by innovators and early adopters, but also by the majority.

Many innovations fail to be taken up on a wide scale because of the chasm that exists between early adopters and the early majority. Where-as innovators and early adopters are willing to try new innovations simply because they are new and innovative, pragmatists require a firm reason for change.

Crossing the chasm is relevant for disruptive technologies that require a behaviour change from individuals. As such, it is considered to be a relevant concept for Smart Grid interventions.

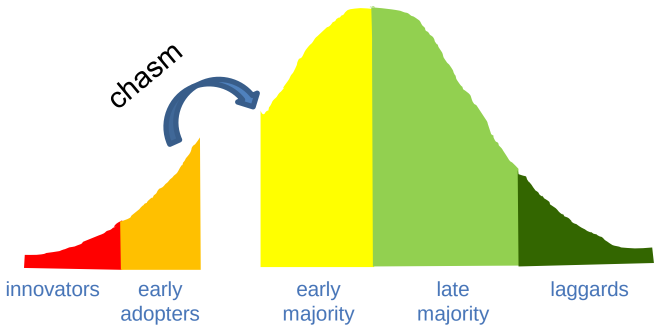


Figure 2.5 Diffusion innovations theory and crossing the chasm

Two factors that are particularly relevant for helping to cross this chasm are:

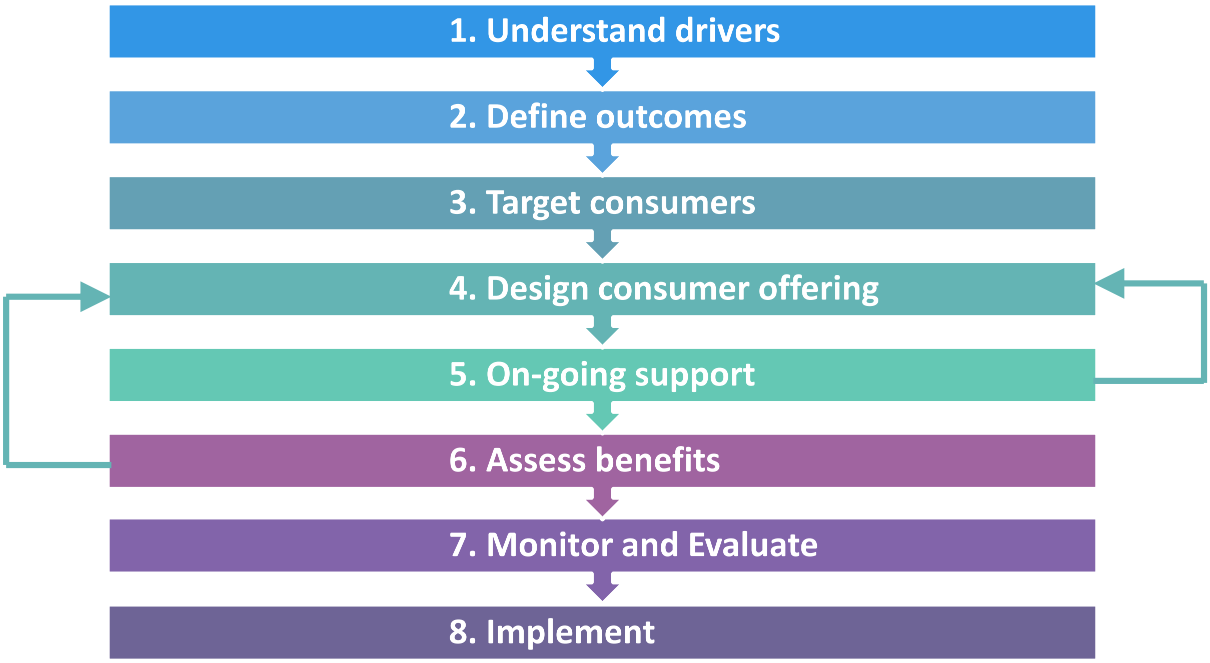
- Design the initiative so that it provides a solution to an existing problem, i.e. focus on the external facilitator/barrier and self-efficacy elements of the behavioural model shown in Figure 2.2; and
- Use community champions to engage the majority, i.e. focus on the social-norm element of the behaviour model shown in Figure 2.2.

These are discussed further in Step 4, which considers how the design of Smart Grid initiatives can influence consumer willingness to 'sign-up'.

[11] See Appendix II for further details of the Initiative Readiness Level (IRL), and Market Readiness Level (MRL)

3 Factors for successful implementation – step-by-step process

There are a number of discrete steps that must be completed in order to ensure the success of Smart Grid initiatives requiring the participation of consumers. These steps are shown below.



If any one of the steps is omitted, there is a risk that the initiative will not deliver benefits to the energy system as a whole and/or will not be adopted by consumers.

A brief description of each of these steps is provided below to provide the reader with a 'bird's eye' view of the overall process. Once the aim of each individual step is understood, the reader has the option of either reviewing each step in detail in the order presented in Sections 4 to 11, or, alternatively, just exploring one or more steps in detail. This may be useful for those implementers who have in-depth knowledge and experience in some areas, but less in others. For example, distribution network operators may have in-depth knowledge of the drivers for Smart Grid implementation and are able to define the outcomes they require from consumers. However, they may be less well placed to understand how to target consumers.

It is recommended that all readers do, however, review the information provided in Steps 4 to 6, as these represent the key findings of the overall project.

The step-by-step approach described in Table 3.1 has been designed to ensure that all elements of the energy behavioural model, introduced in Section 2.2, are addressed in the design of the Smart Grid initiative. The linkages between the energy behaviour model and the step-by step process are illustrated in Figure 3.1.

Table 3.1 High level overview of the step-by-step approach

Step	Overview
Step 1. **Understand the drivers** **Section 4, page 15**	This Step examines how the drivers for Smart Grids influence the design of the initiative. Whilst the needs of the industry stakeholders represent the primary drivers for Smart Grids, this Section outlines why identifying the needs of consumers is also important. The Section demonstrates how understanding the interactions between market stakeholders, and the context within which the Smart Grid initiative must be designed, is an important first step in designing Smart Grid initiatives. This defines the external barriers and facilitators (opportunities) in the energy behavioural model introduced in Section 2.2.
Step 2. **Define Outcomes** **Section 5, page 23**	This Step illustrates the elements of the Smart Grid over which it is envisaged that consumers will retain control. It represents the 'behaviour' element of the energy behavioural model introduced in Section 2.2, i.e. the elements over which individuals can make decisions as to whether (or not) to perform an action. Specifically, it considers how energy behaviour change can help to achieve certain outcomes required by industry stakeholders.
Step 3. **Target Consumers** **Section 6, page 31**	This Step describes how to identify potential consumers who may be able to deliver the outcomes identified in Step 2. The starting point for identifying potential consumers is to consider whether the drivers for Smart Grids (see Step 1) and/or the required outcomes (see Step 2) are directly linked to a specific end use. If so, then it would seem sensible to first look to targeting consumers with those loads. This Step also introduces the concept of Customer Segmentation, which uses lifestyle factors, attitudes and motivations to define groups of consumers so that offerings can be designed specifically to meet the needs of a particular group.
Step 4. **Design offering** **Section 7, page 38**	This step describes the key factors that need to be taken into consideration when designing the Smart Grid initiative to ensure that consumers are willing to 'sign-up' to the initiative. This Section focusses on the following elements of the behavioural model introduced in Section 2.2, and how they influence the intention to perform an action: • Awareness • Attitude • Social Norms • Self-Efficacy

Table 3.1 continued

Step	Overview
Step 5. **On-going support** **Section 8, page 67**	Step 5 examines how to go about ensuring that consumers stay signed up to the initiative and deliver the required outcomes. In addition to the Awareness, Attitude, Social Norms, and Self-efficacy elements of the model, this Step also considers how the positive and negative feedback that an individual experiences once they are 'signed up' influences the on-going intention to perform an action.
Step 6. **Assess benefits** **Section 9, page 76**	This Section of the document describes the potential benefits of Smart Grid initiatives for consumers, and also considers how the overall benefits are distributed amongst stakeholders.
Step 7. **Monitor and Evaluate** **Section 10, page 87**	In addition to measuring the impact on energy consumption, this Step explains the need to assess what elements of an initiative have been successful and for whom they have been successful. This Section identifies the need for a consistent method for evaluating initiatives aimed at delivering energy behaviour change. Although no such tool currently exists, one is being developed by Task 24 of the IEA DSM Implementing Agreement.
Step 8. **Implement** **Section 11, page 91**	Once Steps 1 to 7 have been put in place, all that remains is then to put it all into practice.
Tools to assist implementers **Section 12, page 92**	This Section includes some additional tools / methodologies that may be useful for implementers. This includes: • A simple Excel spreadsheet to help explore how the benefits of Smart Grid initiatives are distributed amongst stakeholders. • An example to show how the benefits and risks associated with Smart Grid initiatives can be quantified. • An overview of a selection of customer segmentation models (as described in Section 6), which may be helpful when targeting consumers.
Further reading **Section 12.4, page 113**	A list of documents which readers may find useful.
Glossary **Page 116**	A glossary of the terms used in this document.

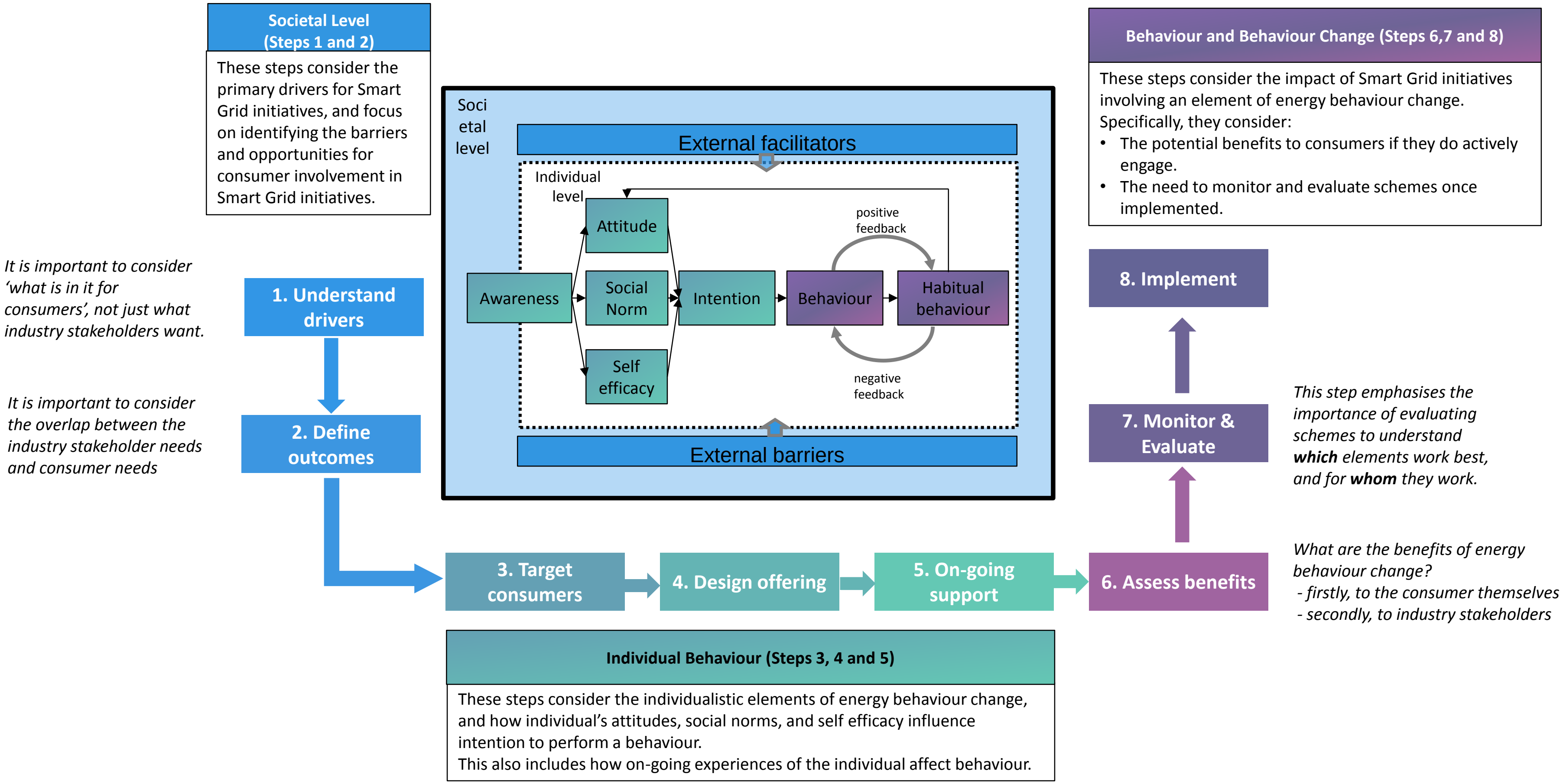


Figure 3.1 Linkage between the step-by-step process and the energy behavioural model

4 Step 1. Understand the drivers for Smart Grid implementation

4.1 The consumer perspective

The main impetus for the development of Smart Grids is their potential to efficiently deliver sustainable, economic and secure electricity supplies (see Section 2.1). These benefits primarily fall to electricity industry stakeholders (as outlined in Table 4.1). However, the fundamental purpose of Smart Grids is to enable the actions of ***all*** users that are connected to the system (generators, consumers and those that do both) to be integrated. Therefore, there is a real risk that Smart Grids will not achieve their full potential if consumers do not adopt new approaches to the way that they consume electricity.

However, it is not the role of consumers to either provide sustainable, economic and secure supplies, or to maintain and operate the electricity networks for the delivery of energy. These roles are met by industry stakeholders. However, these activities are precisely what the Smart Grid can facilitate.

Consumers are beneficiaries of a sustainable, economic and secure electricity supply, but this is not considered sufficient to motivate consumers to change their energy behaviour. This is especially important where the benefits that arise due to the actions of a few engaged consumers are distributed amongst all consumers. Therefore, an important part of the first step is to consider 'what is in it for consumers' if they do participate, i.e. what are the drivers (or the needs of consumers themselves). However, in order to answer this question, it is first necessary to understand what is expected of consumers, i.e. what are consumers being asked to do. So, whilst ensuring Smart Grids provide tangible benefits to consumers is considered to be one of the most important aspects, this is considered later, in Step 6 (Section 9), i.e. after what is required of consumers has been explored.

It is believed that the step-by-step approach presented here will ensure that Smart Grid initiatives are designed to meet both industry stakeholder needs ***and*** consumer needs. Identifying and addressing consumer needs is considered in further detail in the remaining steps. This Section, therefore, highlights how the drivers for Smart Grid implementation influence the external facilitators and barriers in the energy behaviour model introduced in Section 2.2.

4.2 The context

The drivers for the implementation of Smart Grids differ from one context to another. Therefore Smart Grid initiatives need to be designed with reference to the specific context within which they will be implemented. This includes considering the needs of the electricity system as a whole, rather than just the 'local' network. Otherwise, there is a risk that conflicts will arise, which could undermine overall effectiveness. This Section examines how the drivers for Smart Grid implementation influence the design, and discusses how potential conflicts can be identified.

Example 4.1 Differing drivers for Smart Grid implementation

Norway

Circumventing constraints on the existing networks is one of the key motivations for introducing Smart Grids in Norway. This is related to the large share of electricity used for direct electric space heating in homes and businesses. If the winter has periods with extremely low temperatures, this high heating need adds to the normal within day peaks, causing situations where the capacity of the network is more or less fully utilised. Finding ways to reduce these loads will increase security of supply, without having to reinforce the existing network, and is thus an important strategic driver for Smart Grids in Norway.

Netherlands

In the Netherlands, it is anticipated that the share of wind, PV and other intermittent generation sources, and potentially micro-CP, will increase; as well as the number of electric vehicles and heat pumps. Thus, the balance between supply and demand, and hence the affordability and reliability of energy supply is a key driver for Smart Grids in the Netherlands.

Understanding these drivers provides a starting point for the design of the Smart Grid initiative; essentially, it defines the problem that needs to be solved.

In Norway, the Smart Grid needs to find solutions to meeting peak loads that occur during the winter, i.e. for several hours at a time, possible over several days and weeks. Additionally, the network is already constrained; therefore care must be taken to avoid simply moving the peak to another time of the day. In Netherlands, however, the focus is more on providing flexibility to deal with the unpredictability of wind and other intermittent generation. Solutions to helping balance demand and generation could be required at any time of the year and at any time of the day. The amount of notice available could be much less than that in the Norway example.

The drivers for Smart Grids vary from stakeholder to stakeholder, as highlighted in Table 4.1.

Table 4.1 Electricity market stakeholders and their main drivers (if any) for Smart Grids

Who		Why
Government		Facilitates the delivery of energy policy – in terms of support for renewable generation, decentralised generation, and decarbonisation of heating and transport.
Generators	**Centralised**	Traditionally, generation has been the dominant resource used to maintain electricity demand and generation in balance at all times. As the proportion of generation met by renewable resources increases, this will become increasingly more challenging. The Smart Grid represents an alternative to relying solely on the resources of central generation to balance electricity supply and demand. Thus, centralised generators will have little reason to engage actively in Smart Grids. They may even be opposed to their development.
	De-centralised	Local generation represents a challenge for the management of distribution networks, particularly where significant flows of locally generated electricity cause local network constraints. However, where the output can be controlled, they also represent a valuable resource to help manage local constraints. Smart Grids facilitate the connection of de-centralised generators with reduced or avoided network investment.
Suppliers / Energy Retail		Electricity wholesale prices could become increasingly peaky. Effective Smart Grids provide the opportunity for demand to be optimised to make best use of the available resources, thus minimising energy costs to the Energy Supplier and reducing risk. Smart Meters provide Energy Suppliers with the opportunity to provide energy advice and tailored solutions to customers, depending upon the extent to which Suppliers have access to the data. However, some Energy Suppliers have invested heavily in conventional generation capacity and, therefore, may not feel the need to rely on Smart Grid based solutions to manage their energy portfolio. This will not be the case for smaller Energy Suppliers or those just entering the market.
Distribution Network Companies		De-carbonisation of heating and transport could lead to significant increases in electricity consumption due to growth in heat pumps and electric vehicles. Energy efficiency and actively managing the pattern of demand helps to defer and/or avoid network investment. Access to more detailed information on consumer end loads could also help to improve the efficiency with which networks are managed and operated.
Technology Developers / Appliance Manufacturers		Smart grid and smart metering represent potential new business opportunities for technology developers and appliance manufacturers.
Energy Service Companies		Smart Grids and Smart Metering represent potential new business opportunities for energy service companies. They can offer services or products to help consumers better understand and manage their consumption. They could also provide energy advice, innovative products and tailored solutions to customers based on a detailed understanding of the consumer's energy consumption.
Consumers		Smart Grids offer the potential for consumers to manage their energy consumption. This could include In-Home Displays to reduce energy consumption, Time of Use tariffs to optimise energy costs by managing the pattern of demand, or remotely controlling home appliances. More information is provided in Section 4.1.

4.3 Conflicts between stakeholders

The needs of one stakeholder may not necessarily align with the needs of another. Whilst understanding the needs of a particular stakeholder is important, it is also important to ensure that potential conflicts are identified and managed.

Managing potential conflicts between the various stakeholders will be an important element in the design of Smart Grid initiatives, particularly where the electricity market is unbundled. Although such conflicts are not well reported to date, they have the potential to become increasingly relevant in the future as renewable generation accounts for a greater proportion of overall generation capacity. The following example helps to illustrate the conflict that could occur between energy suppliers and distribution network operators.

Example 4.2 Potential for conflicts between stakeholders

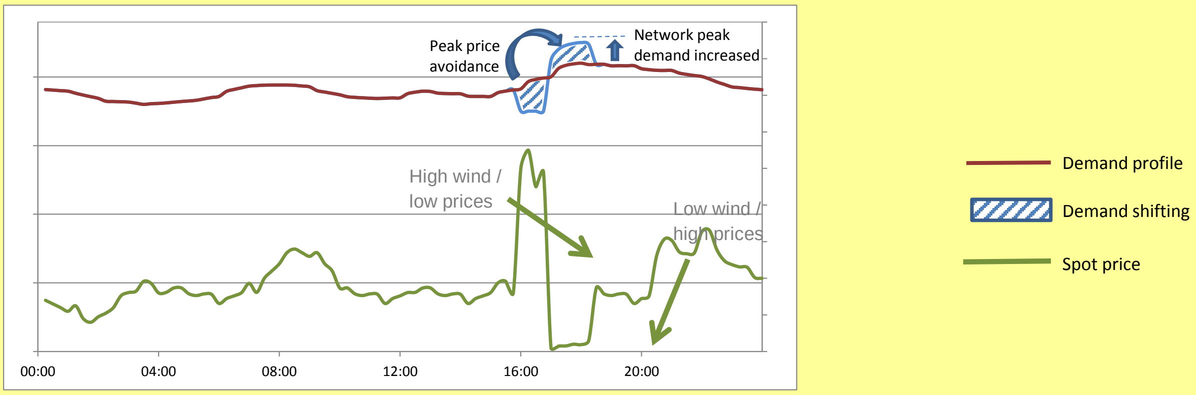
Potential for conflict between a Distribution Network Operator and an Energy Supplier

Electricity prices reflect the amount of generation available and the demand for that generation. So, electricity prices typically increase as demand increases, reflecting the reduced margin that exists between generation capacity and demand.

Consider an electricity system dominated by wind generation. The amount of electricity produce will vary according to the wind speed. During periods of low wind, the output will fall to zero. As a result, electricity prices no longer 'follow' the demand profile. Rather, they are now influenced by the availability of wind power.

Managing such an eventuality is one of the key drivers for Smart Grids, but is also a potential source of conflict.

The red line in the diagram below shows a demand curve over a 24 hour period. The green line indicates how electricity prices might vary over the same period of time. In this case, electricity prices are very high between 16:00 and 17:00, but fall away to much lower levels there-after.



From an Energy Supplier perspective, there is a significant advantage in shifting electricity demand to coincide with the availability of low cost wind generation.

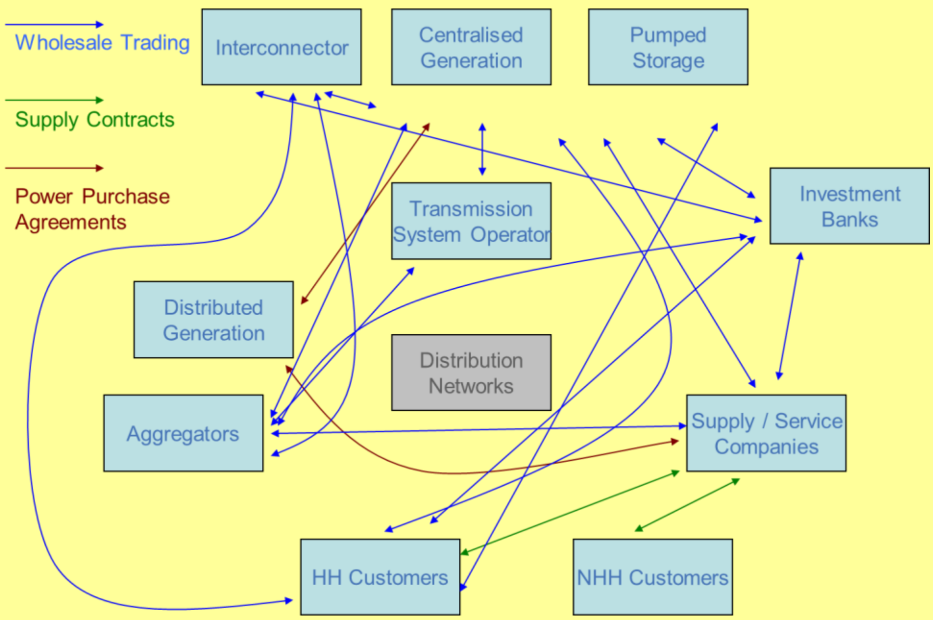
However, such actions might impact on the Distribution Network Operator by increasing demand on an already constrained network, as shown by the blue shaded area on the graph.

Understanding the drivers for Smart Grids and managing conflicts is an important consideration for Smart Grid implementers. Knowledge of the drivers helps to identify the context within which Smart Grid initiatives must be designed and implemented, and the opportunities and barriers that exist.

Market maps, such as that illustrated in Example 4.3, were prepared by each of the participating countries to define the various interactions between the market stakeholders.

Example 4.3 Market Mapping[12].

Energy Purchasing (flow of money between stakeholders) in GB



This is one of three market maps for GB that illustrates the interactions between stakeholders in the current market, and defines the flow of money associated with energy purchasing interactions. Other maps were also produced to show the physical flow of energy and network access charging arrangements.

Further details of these and the market maps for other participating countries can be found in the Sub-Task 1 report

Understanding these interactions, and the impact of the energy system as a whole, is an important first step in designing Smart Grid initiatives; as it defines the external barriers and facilitators (opportunities) in the energy behavioural model introduced in Section 2.2.

Table 4.2 highlights how the electricity market represents barriers and opportunities from a consumer perspective. It demonstrates that the impacts are wide ranging, and there is often no 'one-size' fits all solution, with features often presenting both barriers and opportunities.

[12] IEA DSM. (2013) *The Impact of Electricity Markets on Consumers,* (Task 23 Report for Sub-Task 1), January 2013

Table 4.2 How the electricity market impacts on consumers (the opportunities and barriers)

	Positives (from who/what/why perspective)	Negative (from a who/what/why perspective)
Fully unbundled network activities	**Who/What**: Potential for new entrants to enter the market, and offer innovative solutions and services	**What:** Broken value chain - benefits distributed amongst number of stakeholders. Who/What: Role of individual stakeholders may not be fully understood by consumers.
Significant competition in energy retail market	**Who/What**: Additional choice for consumers **Who/What**: Competition between suppliers may lead to innovation as companies try to attract and retain consumers	**Who:** Too much choice for consumers - makes it difficult for consumers to compare offerings and select the one that is best for them (purchasing paralysis). **What:** Companies may be reluctant to offer something which may 'upset' consumers as they risk their consumers switching to another supplier (loss of business)
Mandated approach to way that energy information collected by Smart Meters is presented to consumers	**What**: Ensures a minimum level of information is provided as 'standard' to all consumers to increase consumer awareness. **What:** Can ensure that 'best practice' is deployed.	**What:** Limits innovation by Metering providers, who may be well placed to understand needs of specific consumer groups, e.g. elderly or low-income households. **What:** Little is currently understood about the way that consumers react to information and the extent to which it drives behaviour change.
Mechanism in place to ensure consumer concerns over data access and privacy are addressed	**What:** Reduces possibility of a 'consumer backlash', so that consumers are less likely to refuse to accept Smart Metering.	**Why/What:** Could restrict the use of Smart Meter data by the wider stakeholder group, which could limit innovation in products and services, which could be to the detriment of consumers in the long term.
Disaggregated tariff information provided to consumers	**What/Why**: Consumers better able to understand impact of changes to their energy consumption habits on total electricity costs.	**What**: Added complexity could confuse consumers.
Time of use tariffs mandated	**What:** Ensures that cost reflective tariffs are in place to drive behaviour change.	**What**: Limits the flexibility for Energy Suppliers to offer products and services that are most favoured by consumers. **What:** Little is understood of the way that consumers may react to these tariffs.
Smart Metering interval data for settlement	**Why/What**: Ensures that the value of changing patterns of demand can be captured by consumers and by Energy Suppliers.	**What**: Could increase the financial burden on consumers for little benefit, if it does not lead to behaviour change.
Statutory consumer organisation	**What**: Has statutory authority to ensure that consumer concerns can be effectively handled. **What:** Can represent needs of consumers in industry Consultations.	-

The barriers and opportunities highlighted in Table 4.2 only provide a high level overview of how the design of the electricity market impacts on the barriers and opportunities for Smart Grid initiatives from a consumer perspective. For a particular context, it is important to understand what can (and what cannot) be achieved within the existing rules and regulations. In some cases, it may be necessary for Government or the Energy Regulator to make changes to energy policy and/or regulations to remove barriers. One such example of this is highlighted below.

Example 4.4 Removing barriers to DSR

Equalising Incentives

Prior to 2010, the revenue that distribution network operators (DNOs) in GB were permitted to collect from consumers was regulated under an incentive based regime (referred to as RPI-X). Under these arrangements, they were permitted to earn a certain level of return (known as the regulatory return) on their asset base (i.e. the value of their network assets). If they outperformed in certain areas (e.g. if capital expenditure was less than planned) they were permitted to retain some of the savings for a prescribed period until they were passed back to customers.

However, this dis-incentivised DNOs to consider demand side solutions, as expenditure on demand side activities could not be added to the value of the 'asset base' and thus they were not able to earn a return on such investments.

Recognising this, the Energy Regulator (Ofgem) introduced an equalising incentive in April 2010[13]. Under this incentive, all operating and capital expenditure is combined into a single 'pot' which is treated as follows:

- 85% is treated as 'slow' money and added to the Regulatory Asset Value on which DNOs are allowed to earn a return.
- 15% is treated as 'fast money'.

Thus, expenditure on 'DSM contracts' could be considered as a direct alternative to network investment.

[13] Ofgem. (2009) *Electricity Distribution Price Control Review, Final Proposals - Incentives and Obligations.* (Reference 145/09). Ofgem. 07 December 2009.

4.4 The key messages associated with Step 1

Key message	Potential solutions / actions	Who is responsible
Ensure the Smart Grid initiative provides benefits to consumers.	Although not considered specifically addressed in this Section, it is important to first acknowledge what consumers themselves want from Smart Grids. (See Section 9 for more details).	**All stakeholders** interested in the successful implementation of Smart Grids.
Ensure 'industry' drivers for developing Smart Grids are understood by all relevant stakeholders.	Develop a Smart Grid road map to define the drivers for Smart Grids, including: - Synergies / conflicts between market stakeholders - Timeframes	***Smart Grid implementers:*** who can define the drivers for Smart Grids in terms of their own business needs as well as the obligations placed upon them by the Government and/or Energy Regulator.
Identify the impact of the electricity market on Smart Grid initiatives from a consumer perspective (i.e. the external barriers and facilitators in Figure 2.2)	Use market mapping to understand the interactions between market stakeholders and the impact on Smart Grid initiatives.	**All stakeholders** interested in implementing or facilitating Smart Grid initiatives.
	Assess whether any barriers need to be removed in order to ensure Smart Grid initiatives can develop.	**Government / Energy Regulator** who are responsible for defining the rules and regulations for the energy sector.

5 Step 2. Define the outcomes that consumers are required to deliver

This document considers Smart Grid initiatives that involve an element of consumer behaviour change. Consumer energy behaviour change can deliver one or more of the following outcomes:

- An overall reduction in electricity consumption.
- A different underlying pattern of consumption that is enduring (i.e. does not change from one day to another).
- A different pattern of consumption that responds dynamically to the varying operational requirements faced by the electricity system on a daily and seasonal basis (i.e. the demand profile could vary from one day to the next, depending on the specific requirements of the electricity system).
- Information sharing – access to energy consumption data (e.g. through the use of Smart Meters) can provide a range of efficiency benefits to industry stakeholders.

These aspects represent the elements of the Smart Grid over which it is envisaged that consumers will retain control once the Smart Grid is in place.

At first glance, it might appear that all of the outcomes, to a greater or lesser extent, could be achieved without the active involvement of consumers. For example, energy efficiency can be delivered through mechanisms such as minimum energy efficiency standards for all new appliances. However, all do require an element of active engagement by the consumers. At the very minimum, they require an element of consumer acceptance.

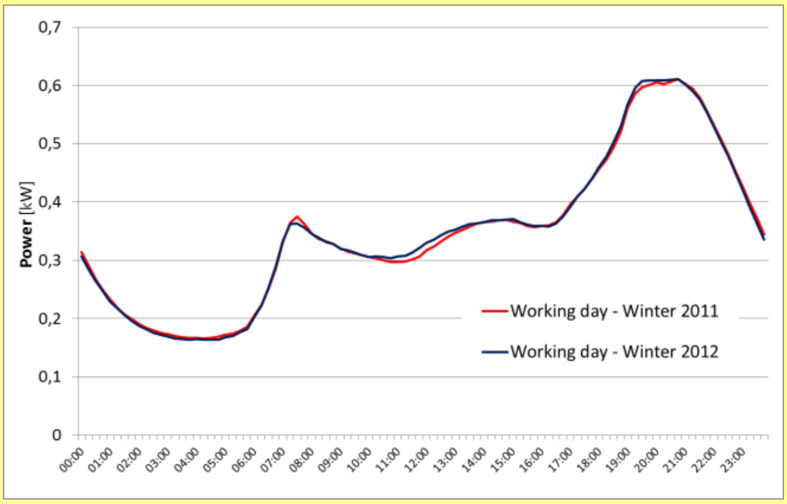
For example, it is envisaged that consumers will be able to choose which type of tariff they have (see Section 7 for information on the need to provide an element of choice). Never-the-less, even if a Time of Use tariff is mandated (i.e. there is no possibility to opt-out), consumers will retain the option to choose whether or not they ***wish*** to change their energy behaviours in response to the prevailing tariff, as illustrated in Example 5.1.

Example 5.1 Mandated roll out of Time of Use Pricing does not guarantee demand response is delivered[14]

Mandatory Time of Use Tariff, Italy

A mandatory Time of Use Tariff was introduced in Italy in July 2010. This tariff is the only option for all consumers who choose to have their electricity supplied by the incumbent utility company. Under these arrangements, around 20 million households now have a Time of Use electricity tariff, whereby a higher rate is charged for all electricity consumed during the peak hours of 8am to 7pm on weekdays. As an alternative, consumers can opt to choose a supplier on the competitive retail market.

The Italian research organisation RSE SpA has investigated the extent to which the tariff has impacted on consumers' energy consumption. Data from a sample of some 28,000 consumers has been analysed, and the results are illustrated here.



Source: RSE SpA

Results indicate that over half (61.5%) of consumers shifted consumption from the peak to the off-peak, whilst the remaining consumers actually shifted consumption in the opposite direction (i.e. to the on-peak)[15]. The overall result on demand is therefore minimal. At the time of writing, no information was available on why some consumers reduced peak demand whilst others did not.

Smart Grid initiatives are generally associated with motivating consumers to actively undertaking measures to change their energy consumption, either by reducing the amount of energy that is consumed or changing their pattern of demand. In addition, the deployment of Smart Meters leads to an increase in the availability of energy consumption data. In some contexts, consumers will be able to elect how and/or with whom energy consumption data is shared and used. For example, in many Smart Meter roll-outs, the provision for customers not to utilise the full Smart Metering capability has been retained.

[14] Maggiore. S, Evaluation of the effects of a tariff change on the Italian residential customers subject to a mandatory Time-of-Use tariff. Task 23 Experts' Meeting. 4th July 2013. Steinkjer, Norway.

[15] IEA DSM (2013) *Interaction between Consumers and Smart Grid Related Initiatives,* (Task 23 Report for Sub-Task 2), November 2013. See Case Study IT1.

Example 5.2. Mass Roll out of Smart Meters does not guarantee that the functionality of Smart Meters is fully utilised

Smart Meter roll out in Netherlands

Following the Dutch First Chamber's refusal to approve the Smart Metering Bill, the decision was made to make the installation of Smart Meters voluntary or to allow consumers the option of having the meter installed but with all the smart features turned off. As a result, consumers now have three options from which they can select after their Smart Meter is installed:

1. Remote meter reading functionality is turned off. In this case, the option for supply to be remotely disconnected is also turned off.
2. Meter reading takes place every second month, or when switching supplier or moving house. This is the default option.
3. Quarter-hourly meter data collected on a daily basis.

Source: Presentation by Rob Kool[16]

In all cases, the consumer retains the ability to access accurate meter data in real time.

Thus, consumers need to actively select option 3 to allow the meter readings to be collected by the network operator on a daily basis. Only then will full use be made of the functionality of the Smart Meter.

Rather than requiring consumers to change their energy practices to deliver changes in demand patterns, it is possible to use technology to do it for them. In certain cases, automatic or remote control could be almost completely non-intrusive from the perspective of a consumer (i.e. consumers are not always aware of short term interruptions to air-conditioning units or heating). Even if the consumers are not aware, they may not necessarily like it. Thus, consumers may need to be persuaded to adopt 'Smart Grid' compatible appliances (or smart plugs) and/or allow third party access to enable the appliances to be remotely controlled.

The lack of standards for communication and control technologies means that the wide-scale roll out of automatic / remote control technologies is not currently available (or attractive) to the mass-market. Once Smart Grids are in place, it is anticipated that such technologies could become commonplace. However, even if it is mandatory for all new appliances to be Smart Grid ready, consumers will inevitably still retain the ability to decide ***how*** and ***when*** they use their appliances and Smart Grid technologies. Similarly, consumers may elect for the Smart Meter to provide only basic meter data for billing purposes, rather than permit more detailed data to be shared with electricity industry stakeholders (for example their energy supplier and network operator).

[16] Kool. R, (2013) DSM: *On the cutting edge of Energy Efficiency (Examples of what we do).* Current issues in DSM. 16 October 2013. Lucerne, Switzerland.

Thus, it is important to ensure the desired outcome is clearly defined at the outset. This will depend very much on the problem the implementer is trying to solve, as indicated in Figure 5.1. This includes a clear definition of the magnitude, duration, time of day/year, frequency of any energy demand changes required[17]. If these are not defined, it will be impossible to identify the potential impacts on consumers, and hence identify potential routes to tailoring the solution to meet consumer needs.

One such example showing how the required outcomes are defined by an industry is provided below.

Example 5.3 Defining required outcomes

National Grid Consultation on Demand Side Balancing Reserve

In June 2013, Following concerns over narrowing generation capacity margins, National Grid, the GB Transmission System Operator, published a consultation document to explore options for two new balancing services[18]. Only one of these services (Demand Side Balancing Reserve) is described here:

The document describes:

- why the service is needed (to maintain security of supply with narrow generation capacity margins)
- what is required (demand reduction on working weekdays between 4pm and 8pm, sustainable for a continuous period of at least 2 hours, with the option for pro-rata payment for those providing less than 2 hours)
- over what time frame it is needed (the first contracts are expected to be placed in 2014/15 with additional resource required in 2015/16)
- the amount National Grid is prepared to pay for the service (set up costs of £5 – 10 / kW and a utilisation cost between £500 / MWh and £15,000 / MWh.)

The document sought views from stakeholders on a number of issues including:

- the product definition
- the value

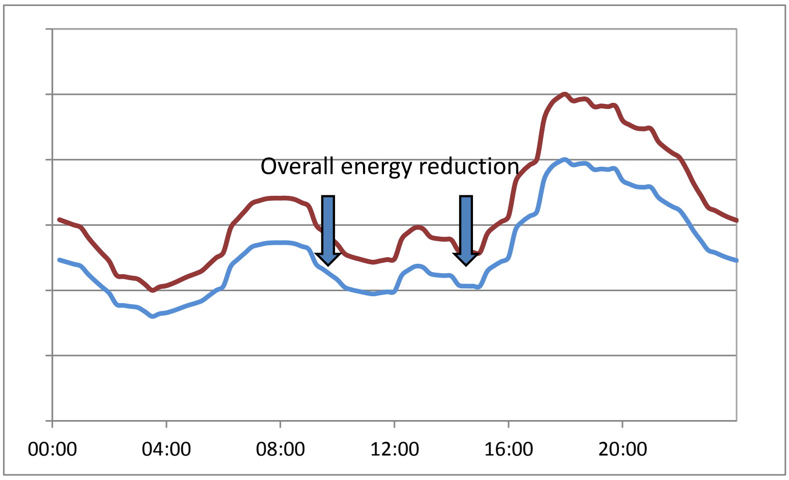
Following extensive stakeholder dialogue, including a stakeholder workshop, National Grid published a 'Service Description' document in February 2014 outlining the details of the scheme[19].

This includes a number of amendments to the initial proposals set out in June 2013. For example, the scheme now includes provision for an 'administration fee' to encourage and support intermediaries, such as Aggregators and Suppliers, to recruit and manage a large numbers of smaller sites.

It is too early to determine the extent to which this approach has ensured National Grid is able to secure the additional resources it needs.

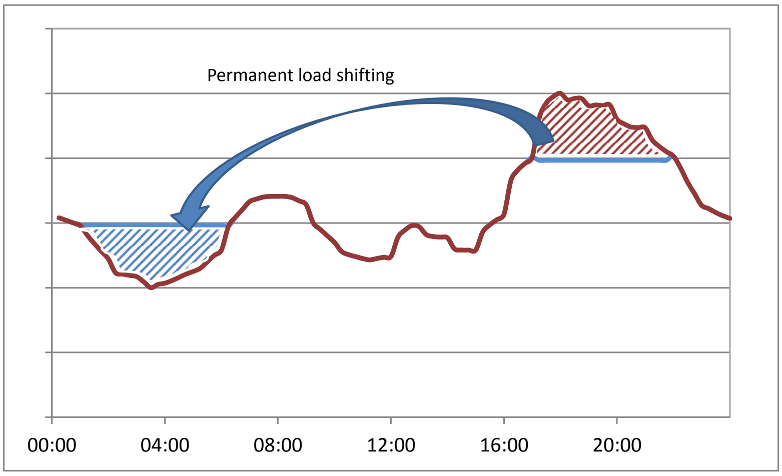
[17] IEA DSM . (2006) Practical Guide to Demand Side Bidding (Report of Task 8: Demand Side Bidding in a Competitive Electricity Market) - See Section 12.4 for further details.
[18] National Grid, (2013) Demand Side Balancing Reserve and Supplemental Balancing Reserve (Informal consultation on the development and procurement of two new balancing services)
[19] Peter Bingham, National Grid, (2014) Service Description Demand Side Balancing Reserve

Figure 5.1 below provides a brief description of the various outcomes that could be delivered through Smart Grid initiatives.



Overall energy consumption is reduced, but the pattern of consumption is not significantly altered.

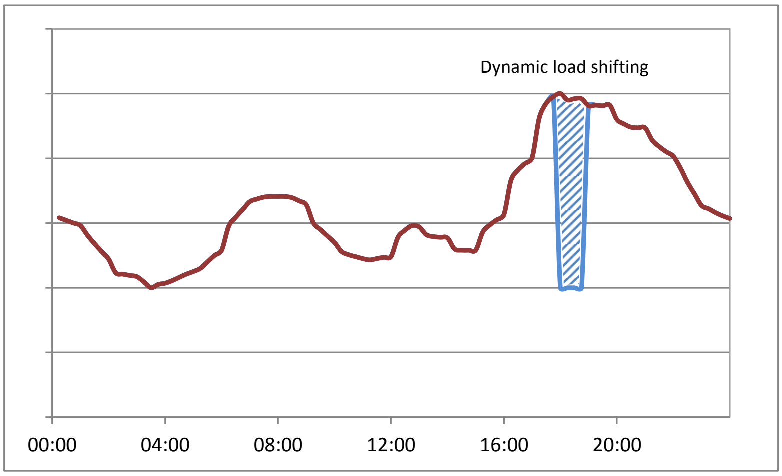
This may seem to be the logical place to start, as the outcome is enduring. However, if the primary goal is to reduce peaks, then aiming to achieve an alternative pattern of consumption may be more effective than seeking energy efficiency solutions.



If solutions are required to address the impact of peak demands that occur over extended periods of time (several hours or over several weeks), then solutions that seek a permanent change to the load profile will be advantageous.

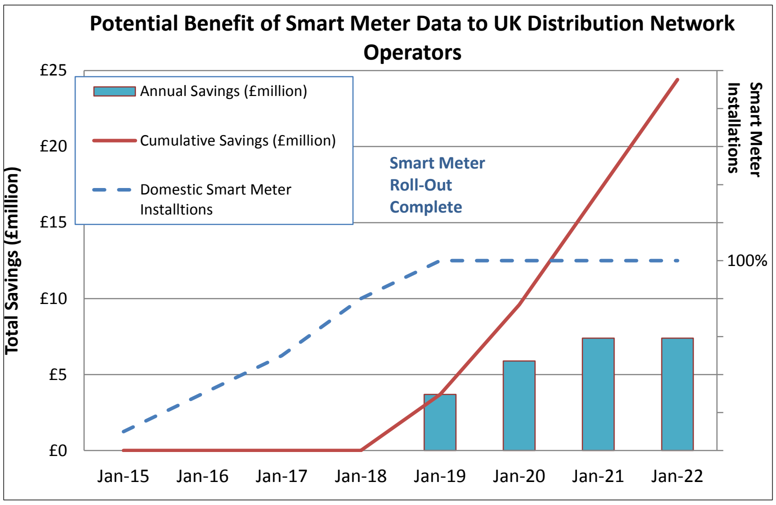
These will generally require significant changes to customer end uses of electricity, but once accepted, will become an established part of their energy practices.

Figure 5.1 Identifying the outcomes required of consumers



If solutions are required to address the impact of peak demands over shorter time frames, and on an in-frequent basis, then solutions that seek dynamic changes to the load profile may be more advantageous.

Whilst individual events may have a significant impact on consumers' energy practices, they may only occur a limited number of times per year. As such, consumers' energy practices will not be impacted on a routine basis.



Source: DNV Kema[20]

Improved information about electricity usage and voltage levels on the distribution networks offers the potential for network operators to optimise the way they manage and operate their networks.

The graph on the left represents one of the potential benefits of Smart Meter data. It shows that access to Smart Meter data could enable network investments for load growth to be reduced by around £25million.

Figure 5.1 continued Identifying the outcomes required of consumers

[20] DNV Kema. (2013) *Review of Network Benefits of Smart Meter Message Flows A Report for the Energy Networks Association.* DNV Kema, 30 April 2013

The following Table describes who might be interested in achieving these outcomes and why. In each case, these needs will very much depend on the specific circumstances of each stakeholder and the context within which they operate.

Table 5.1 Who might be interested in delivering outcomes linked to behavioural change and why?

Outcome	Who?	Why?
Reducing energy consumption	Consumers	To reduce energy consumption / energy costs To reduce environmental impact
	Government	To meet carbon emission reduction targets
	Energy service companies	For additional income achieved by helping consumers better manage their energy consumption
Permanent load shifting	Energy Suppliers	To reduce costs of energy supply to consumers by avoiding use of peak power
	Network operators	To optimise the use of the existing electricity network To facilitate the connection of new loads and intermittent generation capacity whilst avoiding or deferring the need for network reinforcement.
Dynamic demand management	Energy Suppliers	To reduce costs of energy supply to consumers by avoiding use of peak power
	Network operators	To optimise the use of the existing electricity network To facilitate the connection of new loads and intermittent generation capacity whilst avoiding or deferring the need for network reinforcement.
	De-centralised wind generators	To maximise the use of renewable generation resources
	Consumers	To maximise the use of on-site generation To minimise energy costs under a Time of Use tariff.
Information sharing	Third party service providers / Energy Suppliers	For additional income achieved through the provision of energy optimisation solutions to consumers
	Third party service providers	For additional income achieved through the provision of aggregated demand response services
	Network operators	To optimise the use of the existing electricity network
	Consumers	To access tailored energy solutions via third parties.

Some of the reasons for delivering the outcomes identified in Table 5.1 are linked to delivering benefits to industry stakeholders. In such cases, it will be important to explore why consumers would want to help deliver these benefits, i.e. what is in it for them. Others are related to the consumers themselves, i.e. they arise from a direct interest from the consumers themselves. In this case, the focus is on identifying these needs and providing potential solutions that meet these needs – this is an opportunity for third party service companies, aggregators and technology providers who are often well placed to identify consumer needs. In some instances, there will be an overlap between the needs of industry stakeholders and the needs of consumers. Identifying these overlaps could help to make Smart Grid initiatives requiring consumer involvement more attractive to both industry stakeholders and consumers.

5.1 The key messages associated with Step 2

Key message	Potential solutions / actions	Who is responsible
What are the outcomes required by consumers?	Consumer surveys could help identify what consumers say they want. Trials and pilots would then be needed to validate the results.	**All stakeholders** interested in the successful implementation of Smart Grids.
What are the outcomes required by industry stakeholders?	Define what is needed and consult with industry stakeholders to tailor the initiative to consumer requirements.	***Smart Grid implementers***
Ensure that the outcomes consumers could help deliver to industry stakeholders are clearly defined and understood by all relevant parties	Use market mapping to identify potential stakeholders. Effective communication to ensure the needs are understood.	***Smart Grid implementers***
Tailor initiatives to meet specific needs of consumer and industry stakeholders	Identify overlaps between industry stakeholder needs and consumer needs. If there are no overlaps, the design of the initiative will need to be reconsidered.	***Smart Grid implementers***

6 Step 3. Target customers who could deliver the required outcomes

Having understood the drivers (Step 1) and defined the desired outcomes (Step 2) of the Smart Grid Initiative, we now turn to the types of customers who may be able to deliver those outcomes.

Here it is assumed that:

- Some consumers are more amenable to Demand Side Response than others, due to the type of loads and/or the presence of on-site generation;
- Some customers are more accepting of Demand Side Response than others.

6.1 Overview of Step 3

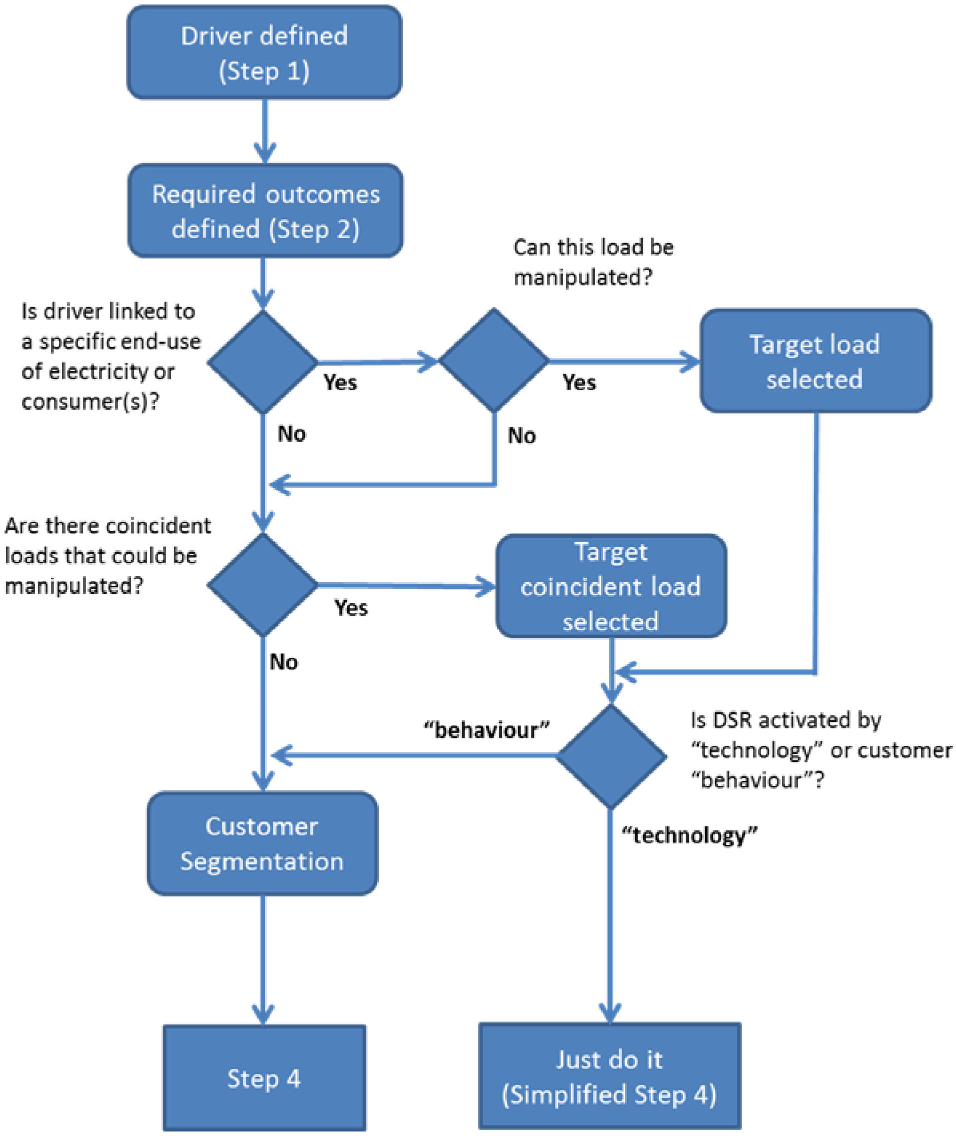


Figure 6.1 Step 3 process flow chart

Figure 6.1 provides an overview of the Step 3 process. The starting point should be whether the drivers for Smart Grid Implementation and the required outcomes are directly linked to a specific end use. For example, if the uptake of domestic heat pumps is, or will become in the near future, the cause of the problem, then it is logical to look to manipulating those heat pump loads as a means of reducing the problem.

It is likely, however, that some drivers will not be caused by a specific load or loads, or, if they are, those specific loads cannot be manipulated. In this case, looking for coincident loads may help to overcome the problem. Thus, if the late afternoon peak demand from (non-heating) domestic customers is causing a Distribution constraint, finding a coincident load, such as the freezers in the local food retailer, could help to alleviate the problem.

Returning to the heat pump example, Demand Side Response of heat pumps might be delivered by customer behaviour changes, such as responding to a Time of Use Tariff, or it might be simply the result of a technological solution that the customer is unaware of. In the latter case this could involve the switching to an alternative fuel at times of high electricity demand through the use of a hybrid heat pump (see Example 6.1 for an expanded description of the heat pump example).

In certain instances it will not be possible to identify a candidate end use load to target. For example, consider an electricity system with a low generating capacity margin and no single dominant end use load. In this case, the required outcome might be to achieve an overall level of energy reduction. This could, in theory, be provided by ***any*** consumer.

Where the customer has to be actively involved in the delivery of the Smart Grid solution, either by making changes to his or her behaviour or by being part of a general energy reduction programme, experience has shown that some customers are more amenable to this than others. Here we turn to the idea of Customer Segmentation, either to identify groups of customers who will actively participate, or to tailor the Smart Grid initiative in different ways to be attractive to different groups of customer. Customer Segmentation is discussed further in Section 6.2 below.

Of course, there could be situations where the either/or decision shown in Figure 6.1 between “behaviour” and “technology” may not be quite so clear cut as shown. For example, a technology activated solution (such as the heat pump example) may still benefit from some consideration of Customer Segmentation, if only at the point of deciding which type of device (heat pump) to purchase.

The outcome of these deliberations then feeds into Step 4 that will be introduced in Section 7.

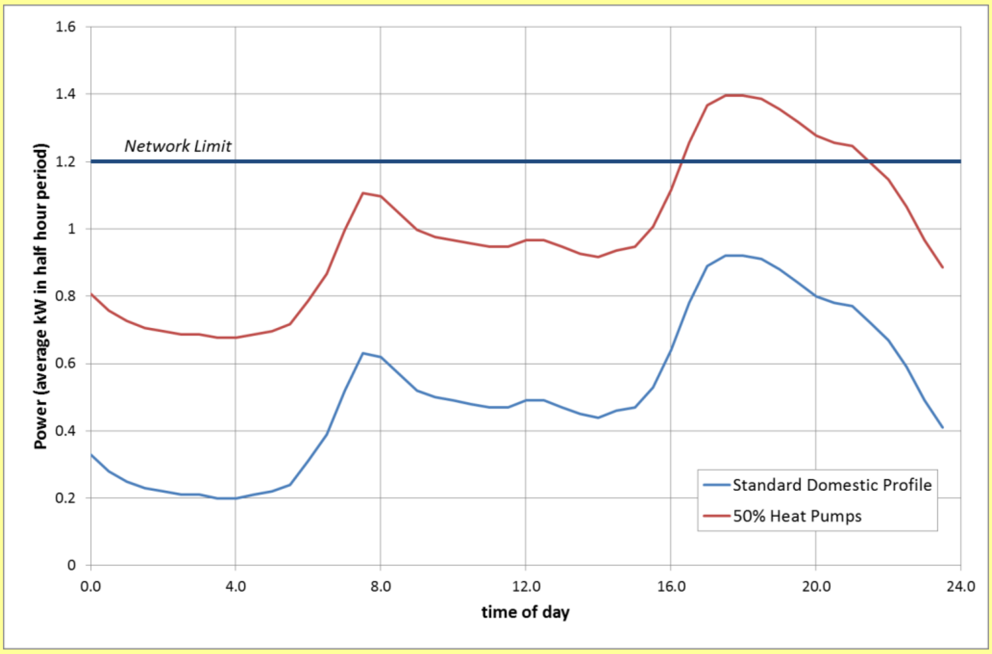
Example 6.1 Targeting consumers

Domestic Heat Pumps

In the UK, heat pumps are widely regarded as one of the more promising methods of decarbonising domestic heating. Currently (2014) there are very few domestic heat pumps in the UK (as a percentage of the number of households). However, if long-term Government CO_2 reduction targets are to be met, wide-spread adoption is likely in many areas of the country.

The demand for domestic space heating varies widely across the year – unlike the demand for non-heating electricity use which is similar each day (with some seasonal variations mainly due to lighting). A high uptake of heat pumps will lead to greatly increased peak demands on networks during periods of cold weather.

The diagram below provides an example of how heat pumps could affect the maximum demand on a network on cold days. In this example the standard domestic profile has a peak demand of around 0.9 kW in the late afternoon and the network maximum demand capability is assumed to be 1.2 kW. The 50% heat pump line is calculated by adding a heat pump profile (in this case taken from a UK Distribution Network investment tool*) to the standard domestic profile, but assuming that only 50% of the properties on the network have heat pumps. Clearly we now have a situation in which the network limit is exceeded for several hours of the day.

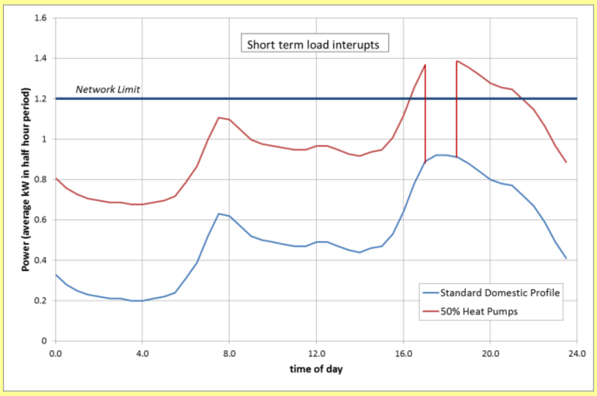


* Transform Model®

There are several approaches to Demand Side Management that could help to alleviate the problem. These include:

- load interruptions (short term load avoidance);
- load shifting through the use of thermal storage; and
- load avoidance / fuel substitution through the use of hybrid systems.

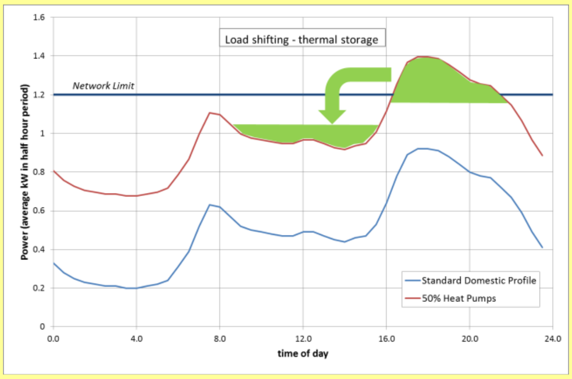
The first of these could either be automated or driven by Customer behavioural changes – for example in response to a Time of Use Tariff. Customer preferences (e.g. room temperature settings) and house type (particularly its thermal mass) may mean that a customer override is essential to maintain customer satisfaction.

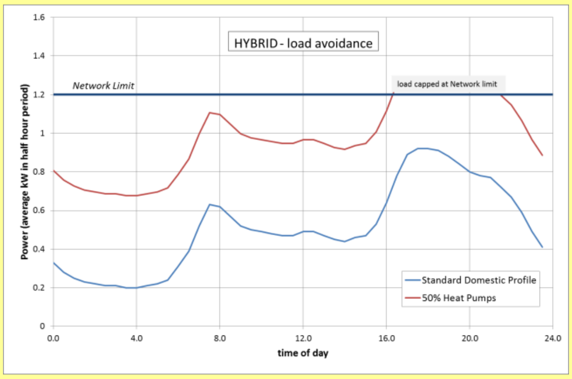


With a simple DSR measure such as this, Customer Segmentation is likely to be of great value in setting-up and maximising the benefits of the Smart Grid Initiative.

It is interesting to note that the typical 1 hour interrupt talked about in terms of DSR for heat pumps is unlikely to be beneficial in this example, although improvement could be made through staggering the response of many customers.

A better approach is shown here, in which load is shifted to a period of the day when the network has spare capacity. This would typically be achieved by the use of thermal storage with the heat pump charging the store in the mid-afternoon (as shown) or overnight.





The third DSR option is the use of a hybrid system, such as gas heating supplementing the electrically driven heat pump. In the graph shown here the heat pump runs at a reduced rate at peak hours with the alternative fuel supplementing the output. Other hybrid arrangements are possible.

Both the hybrid and the thermal store are essentially "technical" (rather than "behavioural") solutions. Thus, once installed, the customer need not be aware of the DSR activity.

6.2 Customer Segmentation

Current experience of using Time of Use tariffs to motivate behaviour change shows the majority of the load shifting can be attributed to a small proportion of the participants. For example, a Dutch report analysing programs worldwide[21] states that, on average, 30% of households were responsible for 80% of the load shifting.

Therefore, it is more effective to target specific consumers so that the initiative can be designed specifically to meet the requirements of a particular group of consumers. This requires a way of segmenting consumers into different categories.

For households, the criterion for segmenting households has traditionally centred on socio-demographic factors such as age, income, number of occupants and building characteristics. Whilst these have been found to be good indicators of the ***amount*** of energy consumed by a household, no such link has been found with energy savings or energy shifting potential. The Dutch reports notes that lifestyle factors, attitudes and motivations are now known to be as important, if not more so, in predicting the potential for energy behaviour changes.

The report suggests that a segmentation model should include the following elements; all of which will have a direct impact on energy consumption habits and the predisposition to make changes:

- Attitudes towards energy and energy savings;
- Factors affecting motivation to change energy consumption behaviour, i.e. some will be motivated to save money whilst others will be motivated to reduce environmental impact;
- Capabilities; i.e. it will be easier for some to reduce energy consumption or change their pattern of consumptions;
- Socio-demographic variables;
- House-related characteristics;
- Household occupancy, i.e. the number of occupants and the pattern of occupancy;
- Appliances; i.e. the number and type of appliances, their age and whether or not they are ‘Smart Grid’ ready or not; and
- Lifestyle and leisure activities.

These elements align with the behavioural model introduced in Section 2.2. For example, attitude and capability (self-efficacy) are elements that influence the individual’s decision whether or not to perform a behaviour. Socio-demographic variables, lifestyle and leisure will have an impact on social-norms, whilst house-related characteristics and household occupancy will influence an ability to change their energy behaviour.

It is understood that such extensive segmentation models do not yet exist. However, some first steps towards their development have been made. Some deal principally with attitudes to energy consumption while others target energy consumption within the context of wider environmental behaviours. An overview of one segmentation model is provided in Example 6.2. More information on this and other approaches is provided in Section 12.3.

[21] Breukers, S.C., Mourik, R.M. (2013) *The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours*, *Report for Netbeheer Nederland*, DuneWorks B.V. March 2013

Example 6.2 Customer Segmentation[22]

Idealistic Savers

- Show most effort to save energy
- Driven by idealism
- Willing to make financial sacrifices and impose restrictions.
- Knowledgeable

Selfless inconsistent energy savers

- Highly motivated
- Highly educated
- Show significant energy saving activities
- But not very consistent in terms of energy efficiency

Thrifty energy savers

- Support energy saving as long as it does not bring financial consequences

Materialistic energy savers

- Do little to save energy
- But are open to energy efficiency measures for the house
- Not positive about policies that have financial implications for them

Comfort orientated indifferent energy consumers

- The least likely to adopt energy saving behaviours
- Do not care about potential societal problems due to increasing energy consumption
- Behaviour is driven by their desire to achieve personal comfort

Problem conscious welfare-orientated energy consumers

- Not enthusiastic about saving energy
- Aware of the consequences of their behaviour
- Believe that energy saving behaviour can make a difference
- But, do not feel need to act

The segmentation approach shown in Example 6.2 was used to inform Dutch network operators on designing dynamic pricing schemes. The results were used to create an in-depth understanding of which dynamic pricing tools work best for different consumer segments. In this way, the offering can be tailored to meet the needs of specific target groups.

Developing a segmentation model is expensive. Therefore, it might be useful to consider whether an existing segmentation model could be utilised. For example, the segmentation model highlighted in Example 6.2 was not developed specifically for the Dutch market, but was developed as part of a Swiss study. Although the segments were not considered to be directly transferable to the Dutch context, the authors of the report previously mentioned[21] (see page 35) believed it to be sufficiently representative of the end users in the Netherlands.

[22] Breukers, S.C., Mourik, R.M. (2013) *The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours*, *Report for Netbeheer Nederland*, DuneWorks B.V. March 2013

6.3 The key messages associated with Step 3

Key message	Potential solutions / actions	Who is responsible
Target consumers so that initiative can be tailored	Use the flow chart identified in Section 6 (Figure 6.1) to help identify loads and consumers more amenable to Smart Grid initiatives.	***Smart Grid implementers:*** i.e. as the designer of the Smart Grid initiative. ***Third party aggregators:*** who could identify potential consumers for Smart Grid implementers.
Identify potential coincident loads.	Understand consumer energy loads so that coincident loads can be identified.	***Smart Grid implementers:*** either through in- house knowledge or developing links with organisations that already have a good understanding of end use energy consumption, such as third party aggregators, industrial energy forums, and business forums. ***Third party aggregators:*** who can offer potential solutions to Smart Grid implementers ***Appliance manufacturers:*** who can develop technical solutions for coincident end-use loads or those directly linked to the drivers for Smart Grid initiatives.
Determine whether there is a "technology" fix (and identify the best one), or are "behavioural changes" required?	If there is a 'pure' technical fix, the focus should be on the following activities: - designing and testing the products that can provide the 'fix' - commercialisation of the product so that it is attractive to consumers	***Appliance/Technology designers and manufacturers, Installers:*** who are responsible for developing and installing new technologies. **Smart Grid Implementers** to ensure the product offers value to consumers (for example by meeting a consumer need). **Government:** who need to make sure any technological fixes can be applied within existing support mechanisms, such as incentives for renewable heat.
Where behavioural changes are required: Identify suitable consumer segmentation models	Review existing models and assess suitability for different applications / different contexts. Develop new customer segmentation models.	***Social Science experts:*** who can help Smart Grid implementers assess existing and develop new consumer segmentation models **Marketing Organisations:** who can design segmentation approaches, identify which segments to target and how to target them.

7 Step 4. Design Customer Offering

This step describes the key factors that need to be taken into consideration when designing the Smart Grid initiative to ensure that consumers are willing to actively engage. This should be undertaken once the drivers for implementation (Step 1), the required outcomes (Step 2) and the target audience (Step 3) are fully understood.

Actively engaged, in the context of this document, implies that the target customers:

- 'sign-up' to the initiative; and
- remain 'signed-up' and deliver the required outcomes.

Thus, Step 4: "Design Consumer Offerings" is essentially how to go about ensuring that consumers will be interested in 'signing-up' to the Smart Grid Initiative. It is to do with thinking about how groups of consumers react to different offerings and how to tailor offerings in a way that will increase the chances of success (i.e. Consumer recruitment). Step 5: "Design Consumer Engagement" then examines how to go about ensuring that consumers stay 'signed-up' and deliver the required outcome.

This Section focusses on the following elements of the behavioural model introduced in Section 2.2 (Figure 2.2):

Awareness: This is knowledge of the behaviour itself and of why the behaviour is desirable. For example;

- Switching off my appliances when they are not needed will reduce energy consumption; and
- The cost of energy wasted due to my appliances being left switched on when they are not used is (for example) £90 per year.

Attitude: This is the sum of beliefs about a particular behaviour, with overall attitude depending on the relative importance of each belief. For example, beliefs about switching off appliances to reduce energy consumption might include:

- Switching my home computer off when I'm not using it is good way to reduce energy consumption; and
- Switching off my home computer is inconvenient because I won't be able to instantly access my computer whenever I need to.

Social norms: This looks at the influence of other people, and the relative importance placed on these opinions. For example:

- Following a school project on sustainability, my children constantly remind me that it is important to switch off appliances when they are not in use; and
- My employer expects me to respond promptly to e-mails sent day or night.

Self-Efficacy: This is an individual's belief in their ability to perform a task. For example:

- It's really awkward to turn off my PC and all the peripheral equipment.

Important considerations in designing consumer offerings include:

- ensuring initiatives provide tangible benefits;
- leveraging key events (such as the purchase of a new appliance or switching Energy Supplier);
- finding ways to attract the majority of consumers and not just "early adopters";
- providing choice; and
- how best to "frame" the initiative.

These will now be discussed in detail below, with key messages for each highlighted in blue text-boxes at the end of each Section. The findings reported here reflect findings from earlier stages of this project. For further detailed information, readers should refer to the other reports from this project; see Section 12.4 (Further Reading).

7.1 Ensure initiative provides tangible benefits

A significant amount of analysis has been undertaken, and is currently on-going, to demonstrate the benefits of Smart Grids. Many of these studies focus on the benefits to industry stakeholders or to society as a whole. However, it is important to ensure that they also provide tangible benefits directly to consumers themselves.

A review[23] of a number of surveys of consumer attitudes and views towards Smart Grid related activities shows that consumers generally say that they prefer to receive a financial reward.

Little is known about the level of reward consumers would expect to receive for participating in Smart Grid initiatives, but it is likely that the values could vary significantly and in some cases be unrealistic. A survey was conducted in 2013 to explore the views of a sample of 1,000 consumers in the UK[24]. This included a number of questions focussing on the rewards they would expect to receive in return for reducing energy consumption during the winter peak (i.e. during the early evening). When asked 'unprompted' to comment on the level of reward expected, the responses were wide-ranging. The average (mean) level of reward expected was over £2,000 per annum, but this was skewed by several respondents suggesting unrealistically large sums (2 over £1 million!). When prompted with various suggested levels of reward, around half (49%) would see participation in a DSR scheme as worthwhile if yielding rewards of up to £50 p.a. Around a quarter (23%) would be likely to participate for rewards of only up to £25 p.a. This represents the views of 1,000 UK consumers, and little is known of how these expectations vary for different initiatives and in different contexts.

[23] IEA DSM. (2013) *Interaction between Consumers and Smart Grid Related Initiatives*, (Task 23 Report for Sub-Task 2), November 2013
[24] Ibid. See Consumer Survey CS23 Market research data obtained by UK National Team for Task 23.

Example 7.1 Providing an Incentive for Customers to Participate[25]

The Effect of Providing a Financial Incentive

Western Power Distribution (a GB DNO) wished to install voltage monitoring equipment within customers' homes in order to provide data for a Smart Grid project. The equipment was approximately the size of the existing electricity meter and would involve a power outage of approximately 30 minutes. The monitor did not provide any benefit to the consumer (i.e. it was not related to energy saving or other 'lifestyle' benefits).

The initial engagement approach was as follows:

- A letter was sent which outlined the equipment being installed, the benefits of the project and details of the installation. A leaflet explaining the project in more detail was also enclosed.
- Follow-up telephone call.
- Visit by installation staff to install meter, or to leave a postcard if there was no-one at the property.
- A follow-up postal or web based survey.

During this phase of the project installers and the call centre were often being asked "what's in it for me?" by customers.

Changes were made to the engagement approach and an incentive was offered in order to increase the 'success rate' (i.e. the number of monitors installed).

- Customers who agreed to have a monitor installed were given a £10 gift voucher and entered into a prize draw to win an iPad.
- The content of the engagement letter was simplified and incorporated more emphasis on the benefits of the Project.

The change in engagement approach the provision of an incentive to the customer resulted in a statistically significant increase (from 12% to 18%) in the number of customers agreeing to the installation of the monitoring equipment.

It is important to note that ensuring consumers are financially better off (i.e. they receive direct benefits not available to those who do not participate) is not sufficient to guarantee that consumers will take action. See the analysis presented in Section 12.2 for more information on examples of quantifying benefits and dis-benefits.

Smart Grids have the potential to offer other tangible benefits to consumer. These are not limited to direct financial benefits, but include other aspects such as improved comfort, improved health or reduced environmental impact. Therefore, an important first step is to understand what benefits are valued by the target consumers. More information on assessing benefits is provided in Step 6 (Section 9).

[25] Western Power Distribution (2013). *LV Network Templates for a Low-Carbon Future. Close Down Report.* [Online] Available from:- http://www.westernpowerinnovation.co.uk/Documents/LVT-Closedown-Final.aspx [Accessed 15 March 2014]

7.1.1 Key message for Section 7.1

Ensure the initiative provides direct benefits to the consumer - This includes benefits other than direct financial benefits

Potential solutions / actions	**Who is responsible**
Identify benefits valued by the target consumers	***Smart Grid implementers:*** *i.e. As the designers of Smart Grid initiatives.* ***Social Science experts:*** who can help Smart Grid implementers design schemes that deliver benefits valued by consumers.

7.2 Leverage key events

The number of occasions that an individual might consider signing-up to a Smart Grid related initiative is limited. Therefore it is important to ensure that maximum use is made of the opportunities that do arise.

Two such occasions are:

- when consumers are considering switching their energy supplier
- when consumers are purchasing new appliances

7.2.1 Switching Energy Supplier and/or reviewing energy contracts

Statistics show that consumers rarely review their energy contracts and/or switch Energy Supplier. As a result, switching rates are generally low. For example, a 2013 report showed that only 40% of SMEs in GB had switched their energy supplier within the previous five years[26]. It is believed that low switching rates are not just a feature of the UK market, but elsewhere also.

One approach that could result in higher switching rates more frequently is to avoid the use of enduring energy contracts. This could help to ensure consumers review their energy contracts on a regular basis, and consequently, may increase the opportunities to engage consumers in Smart Grid initiatives.

It has not been possible to evaluate the effect of such an approach may have on the take up of Smart Grid initiatives. However, the time of contract renewal provides an opportunity to inform consumers about Smart Grid initiatives, such as Time of Use tariffs or recruiting new participants for demand response schemes, as well as increase consumer awareness of Smart Grid activities and the benefits associated with participation.

[26] The Research Perspective, Element Energy (2013), *Quantitative Research into Non-Domestic Consumer Engagement in, and Experience of, the Energy Market, Report for Ofgem* The Research Perspective and Element Energy, 18 December 2013

This is likely to become more relevant in the near future, once the Smart Grid is in place' and the roll-out of Smart Meters is complete. However, avoiding the use of enduring contracts is unlikely to be supported by Energy Suppliers who invest a lot to acquire and retain new consumers in a fiercely competitive energy market. Therefore, some form of legislation may be required to ensure it takes place.

7.2.2 Purchasing new appliances

The purchase of household appliances is largely driven by the individual needs of a consumer, e.g. replacing a broken washing machine. Ensuring that all new appliances are '*Smart Grid ready'*, allows for participants to take part in Smart Grid programs at some future date. The time of purchase of such appliances also provides an opportunity for consumers be informed about the options available to them once they have made their purchases.

It may not be feasible, or even necessary, to ensure all appliances are Smart Grid ready. It may be sufficient to only focus on certain key items such as direct electric heating, heat pumps, air-conditioning and electric vehicles. Thus, it is first necessary to identify which loads/appliances should be 'Smart Grid' ready and what is meant by 'Smart Grid' ready. This could take the form of an impact assessment study, similar to that conducted by DEFRA in the UK[27].

In the DEFRA Smart Appliances study, a range of end use loads (e.g. washing machines and refrigerators) where assessed to determine their potential impact and the ease of implementation.

The results were plotted in the form of a priority matrix, see Figure 7.1, identifying the 'quick wins' (i.e. measures that have a high impact and are easy to implement) and those that should be avoided (i.e. those with a low impact and are difficult to implement).

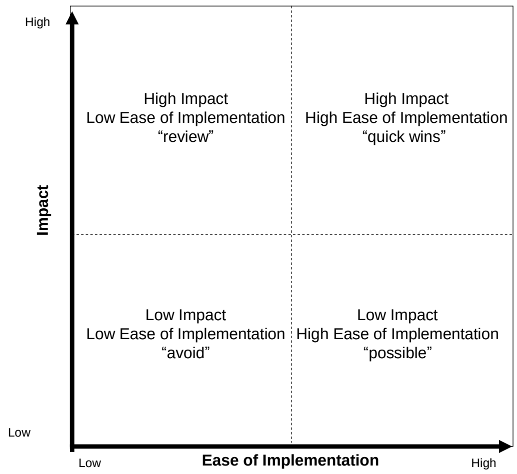


Figure 7.1 Priority Matrix

Once this is done, a roadmap can be developed that sets out the route to developing the standards required and the timeframes for implementation. This requires the involvement of a range of stakeholders as indicated below:

- Standards bodies who are responsible for the implementation of new energy performance and other relevant standards;
- Smart Grid implementers and technology / appliance developers who are well placed to define the requirements for any new standards;
- Governments who are responsible for the implementation of legislation for minimum design standards.

[27] Great Britain. Department for Environment, Food and Rural Affairs. (2011) *Delivering the Benefits of Smart Appliances* (Report Reference SPMT10_043), September 2011

7.2.3 Key message for Section 7.2

Leverage key events

- Avoid use of enduring (open – ended) energy contracts
- Consider making selected appliances / end use loads ‘Smart Grid ready’

<table>
<tr><th colspan="2">Potential solutions / actions</th><th>Who is responsible</th></tr>
<tr><td>Avoid use of enduring (open-ended) energy contracts</td><td>Ensure all energy contracts are renewed regularly (e.g. every 12 months).</td><td>Energy Suppliers: via a voluntary agreement

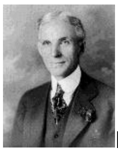
Government / Energy regulator: via introduction of legislation</td></tr>
<tr><td rowspan="5">Ensure appliances are ‘Smart Grid’ ready</td><td>Define the standard for ‘Smart Grid’ ready appliances.</td><td>Standards bodies: who are responsible for the development of national and international standards.</td></tr>
<tr><td>Identify which appliances should be ‘Smart Grid’ ready.
- Undertake an impact assessment to identify which appliances / end use loads have greatest potential to help deliver sustainable, economic and secure electricity supplies.</td><td rowspan="3">Governments: who are responsible for setting legislation for minimum appliance standards.</td></tr>
<tr><td>Define what is meant by ‘Smart Grid’ ready.</td></tr>
<tr><td>Introduce legislation to ensure these selected appliances / loads are ‘Smart Grid’ ready.</td></tr>
<tr><td>Identify potential problems faced by consumers (i.e. consumer needs) that could be solved with ‘Smart Grid’ ready appliances.</td><td>Technology developers / appliance manufacturers: who can fulfil an existing customer need using Smart Grid ready appliances. This opens the possibility for Smart Grid initiatives to be introduced alongside.</td></tr>
</table>

7.3 Can the initiative provide a solution to an existing problem?

Ensuring that a Smart Grid initiative provides a solution to an existing problem faced by consumers is a key factor in enabling the chasm identified in Section 2.3 to be crossed. This is relevant for behavioural change relating to the adoption (or up-take) of new technologies. For example, the growing number of elderly presents a number of challenges to governments worldwide, including those relating to health care. Therefore, Smart Grid initiatives that provide alerts to carers when there are deviations from the normal patterns of electricity consumption may be attractive to housing associations and local authorities.

Technology developers and appliance manufacturers may be particularly well placed to identify consumer 'needs', whilst also providing solutions for network operators and energy suppliers.

What customer say they want


Henry Ford

"If I had asked people what they wanted, they would have said faster horses."

These needs are not yet well understood by Smart Grid implementers, or by technology / appliance developers. Recognising this, a UK Energy Supplier set about exploring how consumers interact with Smart Grid technologies in order to learn more. The trial, as outlined in Example 7.2, involved only a small number of households. These are likely to be innovators / early adopters in the 'Diffusion of Innovations' model introduced in Section 2.3.

Example 7.2 Identifying consumer needs[28]

Thinking Energy Trial, UK

Thinking Energy is a three-year research, demonstration and development programme looking at the technical readiness, customer acceptance and value opportunities of Smart Home technologies in domestic settings.

A total of 75 households took part in the trial of a 'Smart Home Platform' which:

- allowed householders to remotely control some of their household appliances;
- allowed householders to remotely control their heating system; and
- allowed the energy consumption of individual appliances to be monitored.

The trial itself was very much designed to be a 'journey of investigation', with focus on learning how the householders interacted with the Smart Home platform.

The feedback from the participants showed that the technology was valued for its ability to add to a household's lifestyle, rather than its energy saving abilities, per se. Aspects which were valued by the trial participants included:

- Being able to use the remote control of appliances in novel ways to improve their lifestyle (e.g. the ability to remotely switch on the kettle as they are returning home from walking the dog, so they could have a cup of tea as soon as they got back into their home);
- Improving comfort levels within the house by using the heating controls.

[28] See Case Study UK 3 in IEA DSM. (2013) Interaction between Consumers and Smart Grid Related Initiatives, (Task 23 Report for Sub-Task 2). November 2013.

7.3.1 The key message for Section 7.3

Crossing the chasm - Can the initiative be designed to solve an immediate need of the target consumers?

Potential solutions / actions	Who is responsible
Identify potential problems faced by consumers now (i.e. consumer needs) that could be solved with 'Smart Grid' ready appliances. This opens the possibility for Smart Grid initiatives to be introduced alongside measures that meet an existing customer need.	***Technology developers / appliance manufacturers:*** who can fulfil an existing customer need using Smart Grid ready appliances.

7.4 Community Engagement

Facilitating community engagement can be an effective way of encouraging consumers to participate. This can involve the community working together to deliver benefits to the community as a whole. These can be direct benefits, such as funding for schools or community facilities, or in-direct benefits, such as avoiding the need to build new overhead power lines in the local area.

A sense of community has been an important factor in a number of case studies in motivating consumers to engage in Smart Grid activities. A 'community champion' can also play an important role in recruiting consumers. Many consumers prefer to wait and see whether new technologies work in practice. Thus, community champions take on the role of 'opinion leaders' and encourage others to take up the new technology or initiative. They are the 'early adopters' in the 'Diffusion of Innovations' theory introduced in Section 2.3, and play an important part in helping new technologies and initiatives 'cross the chasm' mentioned in Section 2.3 and 7.3.

However, such community engagement may only be successful where there is already a strong sense of community, i.e. the initiative should build upon an existing community rather than seek to create a sense of community in the first instance. In which case, the focus should be on issues already of relevance to that community.

Example 7.3 The Role of Community Champions[29]

My Electric Avenue' Low Carbon Network Fund project, UK

'My Electric Avenue' is a UK project that is investigating a potential solution to resolve some of the anticipated problems for the electricity distribution network that may be caused by clusters of Electric Vehicle(EV).

The project is seeking clusters of at least 10 neighbours where each person will drive an electric vehicle (EV) for 18 months as part of a 'technical' trial to test a new technology

To date (March 2013), over 100 participants in 7 clusters have been successfully recruited. Much of the success in forming the clusters is attributed to Community Champions who recruited their neighbours as fellow participants onto the trial.

7.4.1 Key message for Section 7.4

Community engagement, and community champions, are an important element in the recruitment process

Potential solutions / actions	Who is responsible
Consider designing the Smart Grid initiative to deliver benefits to the community. This requires two elements: - An existing community - A issue of common interest to the community	***Smart Grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Enrol Community Champions to take on the role of 'opinion leaders' and encourage others to take up the new technology or initiative	***Smart Grid implementers:*** i.e. as the designers of Smart Grid initiatives.

7.5 Provide access to reliable and trustworthy information

Consumers remember an item or event best in the form and context in which they first learned about it, this is referred to as 'priming'. This can be shaped by advertising and product placement, but also by 'word of mouth' reports from friends and family members. Therefore, it is important to ensure that consumers are provided with reliable information about any new initiative from the outset, so that they can make up their own informed decisions and views.

[29] My Electric Avenue. (2014) *Drive an electric vehicle as part of My Electric Avenue and help us shape a low carbon future – and save you money* [Online]. Available from http://myelectricavenue.info/drive-electric-vehicle-part-my-electric-avenue-and-help-us-shape-low-carbon-future-%E2%80%93-and-save-you [Accessed: 28 March 2014]

Information consumers receive via the press is important in setting the basis upon which consumers formulate their views and beliefs (i.e. it influences the 'attitudes' element of the behavioural model introduced in Section 2.2). It is easy to understand why consumers have reservations about Smart Grids when they are faced with negative publicity such as those illustrated below.

Figure 7.2 Selected Smart Grid related news article excerpts

Therefore, it is important to be honest and realistic about what consumers will gain from initiatives. Otherwise, consumers can be disillusioned. This is particularly relevant to early adopters, so that they can 'spread the word' to the early majority (see Section 2.3 for a description). Otherwise, consumers will mistrust claims made by implementers. For example, the energy performance of one in five energy-saving products across Europe does not match their energy efficiency claims[30]. Once consumers are aware of this, it is only reasonable for consumers to begin to doubt the energy efficiency claims made by product manufacturers in the future.

Although all stakeholders have a role to play in providing reliable information, consumer groups could be especially important by ensuring consumers have access to reliable, impartial information.

[30] Centre for Strategy and Evaluation Services. (2012) *Evaluation and review of the Ecodesign Directive (2009/125/EC), Final Report,* Oxford Research, March 2012

7.5.1 Key message for Section 7.5

Ensure consumers have reliable information with which to make informed decisions

Potential solutions / actions		**Who is responsible**
Provide consumers with reliable trustworthy information	Do not 'over-state' the potential benefits. Be realistic and honest about the magnitude of potential benefits for the target consumers	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
	Avoid providing consumers with conflicting advice	***All stakeholders*** *interested in the roll-out of Smart Grids*
	Tailor the advice to meet the needs of the target consumers	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Set up an independent organisation to provide consumers with impartial advice		***Government:*** who can set up an organisation and devolve certain powers or authorities to it. ***Consumer groups:*** who can take on the role of independent advisors.

7.6 Provide choice

As is seen in many areas of our lives, e.g. in health care, it is important to provide individuals with the ability to make their own informed decisions. Similarly, Smart Grids should respect the autonomy of consumers, i.e. they should enable consumers to make informed decisions on the way that they consume electricity.

Therefore, it is important that Smart Grid initiatives should always provide consumers with an element of choice. Otherwise, individuals have no recourse available other than to protest when they are unhappy with a situation.

When faced with too many choices, however, individuals can be paralysed by an inability to choose from the myriad of options available to them[31]. This has been attributed to factors such as:

- Concern that they may make the wrong choice;
- Difficulty of assessing the trade-offs between various options.

Therefore the number of choices should not be too great otherwise consumers will find it difficult to compare the options available to them.

More information on the impact of the choice on decision making can be found in the report from Sub-task 3 of this report - see Section 12.4 for details.

[31] Abbot, B et al (2007) *Predictably Irrational Customers, Optimizing Choices for How People Really Buy, Not How we Think They Buy*, Diamond Management and Technology Consultants, 2007

7.6.1 Key message for Section 7.6

Offer consumers choices, but not too many.

- Too many choices leads to purchasing paralysis
- No choice removes the ability of consumers to make informed choices, which can lead to protest

Potential solutions / actions		Who is responsible
Always provide consumers with an element of choice, where-ever possible.	Offer a limited range of energy tariffs from which consumers can select. Offer a range of ways that consumers can participate, for example for direct load schemes.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Avoid providing too much choice.	Limit the number of options available to avoid 'overloading' consumers.	***Energy Suppliers:*** via a voluntary agreement ***Government / Energy regulator:*** via introduction of legislation

7.7 Take care when framing the initiative

The way that Smart Grid initiatives are framed has an important impact on the way they are assessed and evaluated by consumers.

As indicated in Section 2.2, individuals exhibit a range of views and opinions, and as a result they display a range of responses to a given situation. Whilst it is not possible to make generalisations that apply to all individuals, this Section provides some insights into general characteristics of individuals. However, it is important to bear in mind that responses will vary from one individual to another.

Techniques for framing offerings in a way that have been shown to increase the chances of successfully recruiting consumers are:

- stressing the avoidance of losses rather than concentrating on achieving benefits
- paying attention to the most appropriate reference point to compare savings against (e.g. profit rather than turnover in the case of an SME)
- paying attention to the timing of benefits

7.7.1 Avoiding loss rather than achieving benefits

Many consumers are risk averse, i.e. they are reluctant to take a course of action that has an uncertain outcome. They are more likely to select an option where the outcome is certain, even if the expected outcome from an alternative, but uncertain, option is higher. A good example of this is the risk averse investor who prefers to put their money in a bank account with a fixed, but low, interest rate rather than investing on the stock market which has much higher expected returns, but where there is a possibility that their investment will lose value.

However, the flip-side to this is that individuals do not exhibit such a preference for the risk averse option when dealing with potential losses. Rather, they are much more willing to 'take a gamble' where losses are involved. This effect is demonstrated by the example below, which demonstrates the powerful effect on framing on decision making.

Example 7.4 Impact of framing on decision making[32]

The following is a well cited example of the powerful effect of framing on decision making that was originally developed by Tversky and Kahneman.

Consider a scenario where an unusual disease is expected to kill 600 people. Two alternative programs have been proposed to combat the disease, with different outcomes expected.

The way that these programs are framed has a significant impact on which of the proposed programs is preferred.

The majority select the risk averse outcome when the options are framed in terms of gains. However, when the options are framed in terms of losses, the preference is for risk taking.

		Scenario A: Expected outcomes framed in terms of potential gains (i.e. lives saved)	**Scenario B:** Expected outcomes framed in terms of the potential losses (i.e. lives lost)
Options Available	**Program 1**	200 people will be saved	1/3 probability that 600 people will be saved, and a 2/3 probability that no-one will be saved
	or		
	Program 2	400 people will die	1/3 probability that no-one will die, and a 2/3 probability that 600 will die
Results			
Preferred programme		Program 1	Program 2
Proportion of respondents (%) who voted in favour of preferred program)		(72%)	(78%)

None of the case studies evaluated for this project attempted to frame their initiatives in this way; therefore the potential impact on consumer up-take is not yet known. Never-the-less, it would seem reasonable to suggest that it merits further consideration by Smart Grid implementers.

[32] Tversky, A., Kahneman, D. (1981) *The Framing of Decisions and the Psychology of Choice*, Science, New Series, Vol. 211, No. 4481 (Jan 30 1981), pp 453-458

7.7.2 Selecting the most appropriate reference point

Risks and benefits tend to be assessed in relative terms rather than in absolute terms – i.e. the absolute level of saving achieved is less important than the percentage saving. Therefore, it is important to consider how the potential benefits (or the potential losses avoided) are expressed. This could be particularly relevant where energy cost savings (or other financial rewards) represent a relatively small proportion of the total expenditure on energy. For households, this could include expressing the benefits in terms of leisure activities, such as contributing to a family meal out.

For SMEs, it could include expressing benefits as a percentage of profits, which could be particularly powerful as energy cost savings go straight to the bottom line of a business. This is highlighted in the example below.

Example 7.5 Impact of reference point for savings

Manufacturing Business A has an annual sales turnover of $60m and annual profits of $3m. Their current annual electricity cost is $700k.

Their energy supplier informs them that they could consider switching to a Time of Use tariff. It is estimated that by altering their pattern of consumption, Manufacturing Business A will reduce their electricity costs by 15%.

At first consideration, the company may think that it is not worth the hassle of altering their manufacturing schedules in order to achieve a saving of $105k, as it represents such a small proportion of their overall turnover of $60m.

Profit and Loss Statement

Total revenue		60,000,000
Less	**Expenses**	-
	Accounting and legal fees	702,000
	Advertising	900,000
	Depreciaion	4,350,600
	Electricity	700,000
	Insurance	912,000
	Interest and bank charges	1,638,000
	Materials	19,505,400
	Training	414,000
	Vehicle operating costs	1,200,000
	Wages and salaries	26,678,000
	Total Expenses	57,000,000
	Net Profit	~~3,000,000~~
	Saving via ToU tariff	105,000
	Revised Net Profit	3,105,000

However, the annual saving goes straight to the bottom line of the business, increasing their profit by $105k – an increase of 3.5%.

With an average profit margin on the goods they sell of 5%, sales turnover would need to increase by 10% to achieve the equivalent increase in profits. Expressing the impact in these terms is likely to have a bigger impact that expressing the gains in terms of the expenditure on electricity.

7.7.3 Timing of rewards

Evidence shows that consumers generally prefer to get ‘rewards’ sooner rather than later, but delay payment for as long as possible even if it costs them more. For example, consumers chose credit cards that have very low introductory interest rates, but much higher charges after the introductory period is over[33]. This behaviour is attributed to ‘time inconsistency’ or ‘faulty discounting’.

[33] Ofgem. (2011) *What can behavioural economics say about GB energy consumers?* Discussion paper, Ofgem, 21 March 2011

Example 7.6 Faulty discounting

More people prefer to receive $100 now rather than $110 in a day's time. However, very few people choose to receive $100 in 30 days' time if they can get $110 in 31 days.

Some of the case studies evaluated during this project offered consumers an up-front incentive for agreeing to take part in a trial – others, however, did not. Very few required consumers to make an upfront investment in technology, although this may not always become the case in the future.

The following example provides an overview of one demand response scheme from the USA that provided consumers with an up-front financial reward to encourage customers to join a demand response scheme.

Example 7.7 Providing up-front incentives[34]

Long Island Power Authority LIPAedge

Long Island Power Authority (LIPA) is a non-profit making municipal electricity operator. It is responsible for operating the Transmission and Distribution networks on Long Island and is also an electricity supplier.

In 2001 LIPA introduced a scheme, called LIPAedge, to use central control of residential and small commercial air-conditioning thermostats to reduce the peak load on the network during the summer months. Scheme participants were required to agree to have their central air conditioning system remotely controlled.

Under the scheme, the set-point of their air conditioning system could be adjusted (increased) between the hours of 2pm and 6pm, up to a maximum of seven days over the summer months. Participants, did however, have the option to override events.

Consumers were offered an upfront incentive of a payment of US$25 and a 'Comfort Choice' remotely accessible, programmable, internet thermostat. During the first year of the programme, LIPAedge customers were offered the opportunity to earn an additional US$20 for each customer referral they provided who then participated in the scheme, increasing take-up via 'word of mouth'.

By 31 July 2003, the program was closed to new participants because LIPA had enough air-conditioning load under direct load control. The total number of air-conditioning units fitted with the remotely accessible thermostats was 23,400 air-conditioning units, with a combined load of 97.4 MW. The expected level of demand response (based on the monitored performance of 400 units) was 24.9 MW.

[34] IEA DSM. (2011) *Task 15 Case Study – LIPAedge Direct Load Control Program - USA*. [Online] Available from: http://www.ieadsm.org/ViewArticle.aspx?id=9 [Accessed: 28 March 2014]

7.7.4 Key message for Section 7.7

Key message	Potential solutions / actions	Who is responsible
Frame the initiative in terms of avoiding loss rather than achieving benefits	Consider framing the Smart Grid initiative in terms of how much would be wasted (if a certain behaviour is not adopted, or if a particular piece of technology is not employed), rather than in terms of the potential gains to be made. This could also include reference to avoided investment in nuclear generation or network infrastructure.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Frame the benefits in absolute terms using a meaningful reference point	Identify the most appropriate reference point for consumers. This could be closely related to a customer need, for example: - For businesses, compare to profit or the equivalent increase in sales turnover required to deliver the same profit. - For households, compare to activities or items that are valued by the household, i.e. a leisure activity.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Consider the timing of payments and rewards	Can rewards be made up front? Can payments be delayed till later?	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Minimise risk to consumers	Provide realistic assessment of the potential gains Consider providing assurance that costs will not be greater	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives. ***Governments***: who could establish an independent organisation to provide reliable, trustworthy information to consumers.

7.8 Identify Consumer Concerns

The following provides an overview of the many different consumer concerns that were identified during a review of Smart Grid case studies[35]. The findings of the study, combined with other anecdotal evidence gathered during the course of this project, demonstrate that there are a number of common themes to consumer concerns.

These include:

- Disruption to property or to lifestyles;
- Health, safety or privacy issues;
- Onerous requirements on the participants;
- Financial commitments and lack of certainty over potential 'gains';

The following Sections provide an overview of some of the concerns raised by consumers within each of these 'common' themes.

Many of these concerns have been cited as reasons for ***not*** taking part in an initiative. Therefore, it is important to learn lessons from individuals who do not wish to engage in Smart Grid activities, as well as those who do.

7.8.1 Disruption

Consumers cited a number of concerns relating to disruption to their property or routines. Many relate to the installation process itself, i.e. the inconvenience associated with the time spent waiting for installers to arrive and the need to be present in the house whilst installation takes place. Householders can also be discouraged by factors such as the need to move possessions in order to allow the installation to take place or the need to redecorate after the installation has been completed. The following example demonstrates how such concerns can impact on consumer enrolment.

[35] IEA DSM. (2013) Interaction between Consumers and Smart Grid Related Initiatives, (Task 23 Report for Sub-Task 2), November 2013

Example 7.8 The ETSA Utilities Demand Management Program[36]

The ETSA Utilities Demand Management Program

The growth in popularity of domestic air-conditioning had started to put pressure on the distribution network in parts of Australia. The contribution of these units to peak electricity demand was especially critical. ETSA Utilities commissioned a series of projects designed to investigate the extent to which residential air conditioning units could be directly controlled to help mitigate this problem.

Important lessons were learnt from the trial about householder attitudes towards their home and allowing access to it.

Phase 3 of the project comprised a total of 855 air-conditioning units. The installation of the technology to enable the air-conditioning units to be controlled remotely was found to be considerably more complex than had originally been anticipated during the initial consumer recruitment stage. There was a risk of potential damage occurring to the external covers of the air-conditioning units, and the installation time would be considerably longer than had been initially indicated to householders.

As a result, the trial was scaled back to just 30 volunteers. When these were contacted by phone it was explained that in addition to the increased installation time, there was need to obtain internal access to the home. Around 23 of the volunteers subsequently decided to withdraw from the trial. All offered to pay back an 'incentive payment' of $100 they had already received for registering as a volunteer. Just under half of those withdrawing cited that they were not willing to have installers in their homes and had only volunteered because it was supposed to have been a simple garden installation.

Concerns over the inconvenience caused during the installation can be minimised by providing flexibility over when installations take place.

Concerns about damage or disruption during the installation process can be alleviated by employing reliable and properly skilled tradesmen, and also by providing a mechanism to deal with the (hopefully) rare occasions when things do go wrong. The following example demonstrates one successful approach to dealing with such concerns.

[36] ETSA Utilities, (2007) *Demand Management Program Interim Report No.1*, June 2007,

Example 7.9 The Kirklees Warm Zone scheme[37]

Kirklees Warm Zone

All residents within the Kirklees area of West Yorkshire, UK were eligible for free insulation (cavity wall or loft) via the Kirklees Warm Zone project which ran from 2007 to 2010. The installation of insulation measures can be potentially disruptive for various reasons, including:

- The need to clear space for the installation to take place (e.g. empty the loft);
- Needing to be at home for the installation to take place;
- Potential of damage during the installation; and
- Cleaning up after the tradespeople had left.

The Kirklees scheme identified the importance of residents being able to trust the 'brand' (i.e. Kirklees Warm Zone) and, by association, the company carrying out the installation. This trust was ensured by:

- Monitoring and analysing feedback received for each surveyor and installation crew;
- Dealing with complaints at a senior level and with urgency; and
- Admitting and regretting whenever any damage occurred and quickly fixing the issue.

The scheme was acknowledged as a "success story" within the industry, receiving various awards. It resulted in a take up rate of 31% (based on the number of houses eligible and the number of measures installed) – significantly higher than normal, area-based schemes.

A number of concerns were also voiced about the negative impact on their lifestyle and routines. This included concerns about the need to change their routine to avoid electricity usage during intervals of high pricing, as well as the impact these changes may have on their energy practices.

A panel of 1,000 residential customers were asked for their attitudes towards DSR as part of a survey undertaken by the Task 23 UK team. Reasons for not taking part in such a scheme were often related to a perceived interference in routine energy practices. Two examples are provided on the following page[38]:

[37] Kirklees Council (2010) *Kirklees Warm Zone. Final Report 2007-2010*. [Online]. Available from: http://www.kirklees.gov.uk/community/environment/energyconservation/warmzone/WarmZoneReport.pdf [Accessed: 28 March 2014]

[38] DSR Research carried out by DH Research. Results presented to UK Team in September 2013.

Respondent 144: "Although retired I still have grandchildren round early morning before school and during the early evening. I would not like to be restricted to not being able to cook my evening meal or watch TV"

Respondent 348: "Not really practical asking people not to use appliances at the times when they have to feed the family, get the kids ready for school/bed etc."

Potential noise from appliances such as washing machines or dishwashers operating during the night is another area of concern. This relates to concerns from within the immediate household, but also due to concerns over the impact on neighbours, which are particularly important for those living in flats and apartments[39]. Consumers may also be concerned about any impact a DSR scheme could have on the functionality of their appliance – e.g. damp clothes waiting to be emptied in a washing machine which had operated during the night may begin to smell and so need to be washed again.

Finding solutions to these issues are complex. In some cases, they can be solved by careful design (i.e. technology provides a solution), e.g. a washing machine / tumble drier can be operated to run in such a way that clothes are not compromised. Concerns that directly impact on household day to day routines and energy practices, however, should not be underestimated. This is where social science, such as that described in another IEA DSM Task[40], could play an important part in identifying tools and approaches to achieving energy behaviour changes.

7.8.2 Safety, health and privacy issues

A number of potential health concerns have been associated with Smart Grid related initiatives, including the potential impact on health from electromagnetic radiation from Smart Meters. These concerns can be addressed by providing consumers with access to reliable information from a trustworthy source, so they are able to make an informed judgement. However, health concerns can be a cause of great anxiety to some individuals, for example those with pacemakers or those requiring other medical equipment which might be affected by the RF signals emitted by Smart Meters. Forcing individuals to accept the Smart Meter against their will is likely to lead to significant 'bad feeling' and 'negative publicity', such as that experienced by a number of Utilities in the USA, who have replaced Smart Meters against the wishes of a number of vulnerable consumers. This provides another example of the need to provide consumers with an element of choice (see Section 7.6).

[39] Demand Side Response: A Discussion Paper. Ofgem. July 2010. Available from: https://www.ofgem.gov.uk/ofgem-publications/57026/dsr-150710.pdf Accessed 01/04/2014

[40] IEA DSM, Task 24 Closing the Loop – Behaviour change in DSM, from theory to policies and practice

Consumers have also raised a number of concerns relating to potential safety risks associated with DSR schemes asking for changes to appliance use patterns. For example, consumers in the UK voiced concerns over the potential risk of fire and flood caused by operating washing machines or dishwashers at night or when they are out of the house.

Such concerns are reasonable when given the statistics on house fires caused by faulty appliances, and the potential consequences of events. Therefore, it is important to ensure consumers are provided with clear advice on whether it is safe to operate appliances at night, the potential risks associated with doing so and how they can be mitigated. They should not be provided with conflicting advice - see example below.

Example 7.10 Conflicting advice for householders

Running household appliances at night – is it OK?	
Government fire safety advice[41]:	**Energy Supplier energy tips[42]**
• *"Un-plug things that use electricity. But not things like fridges and freezers."* • *"Do not leave the washer on at night."*	• *"Use plug-in or in-built timers with electrical appliances such as washing machines, tumble dryers and dishwashers so that they come on during the 7 hour night rate period, when electricity is cheaper"*

Householders have voiced concerns over the implications for food safety if their fridge or freezer is involved in demand response programs. Such concerns would also apply to food retailers, such as supermarkets. Credible field trials can provide evidence that the risks are minimal. In addition, other safe guards can be provided to ensure the risks to consumers are minimised. For example, there is a significant track record of large cold stores providing demand response[43,44,45]. Similar concerns relating to food quality were also raised by the operators of the cold storage warehouses when first approached with the concept. The one-to-one dialogue that occurred ensured that concerns could be effectively addressed by understanding the consumer perspective. Such dialogue led to the suggestion that a manual over-ride should be an essential pre-requisite for participation by large industrial consumers. Similar provision can also be useful for making propositions more attractive to households and small businesses.

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[41] Communities and Local Government (n.d.) Fire – make your home safe leaflet. [Online]. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/49760/Fire_-_Make_your_home_safe__Easy_Read__-_Version_2.pdf. [Accessed: 31 March 2014]

[42] Npower. (2014) *How* to make the most out of Economy 7, [Online]. Available from http://www.npower.com/home/electricity-and-gas/types-of-meter/economy7/ [Accessed: 21 March 2014)

[43] Goli et al (2011) *Demand Response Opportunities in Industrial Warehouses in California*, Ernest Orlando Lawrence Berkeley National Laboratory, July 2011 LBNL-4837E

[44] Enernoc (2014) *Case Studies*, [Online] Available from http://www.enernoc.com/our-resources/case-studies [Accessed: 31 March 2014)

[45] Flexitricity (2014) *Load management helps Norish reduce UK carbon emissions and generate revenue*, Case Study, [Online] Available from http://www.flexitricity.com/docLibrary/Norish_Flexitricity_Case_Study_1.0.pdf [Accessed: 31 March 2014]

Example 7.11 Addressing potential concerns by providing consumers with the option to override demand response events[46]

Customer Led Network Revolution – Smart Washing Machine Trial

Various aspects of Smart Grids are being tested as part of a large trial based in the North East of England, including domestic ToU tariffs, in-home balancing of PV generation, and control of heat pumps and washing machines[47].

A total of 151 'smart' washing machines have been installed. Approximately two-thirds (97) of these are part of a 'direct load control' trial – whereby the local DNO can interrupt the operation of the appliance during specified windows.

As part of the design of the trial the following conditions were applied:

- Maximum number of interruptions per year: 15
- Maximum number of interruptions per day: 1
- Up to 10 consecutive days
- Each interruption will be for less than 4 hours
- Will only occur during peak periods
- **Customer can override without penalty**

This flexibility (i.e. an override option) was thought to be important in order to be able to recruit customers to take part in the trial. No information is currently available to determine the extent to which consumers activated the override option.

For initiatives involving large numbers of households, face-to-face dialogue with all individuals is not feasible. Therefore, interaction with key consumer groups and consumer representatives may be more effective.

Significant concerns are also raised over the security of energy consumption data. This includes concerns that unauthorised access to data can leave householders liable to burglary if the data is used to identify when the home is unoccupied.

[46] Sachinis (2013), *Customer-Led Network Revolution. Why 12,000 customers joined the revolution*, (National knowledge sharing event 2013; results from our customer trials) Stavros Sachinis, British Gas. 1st October 2013, [Online] Available from: http://www.networkrevolution.co.uk/industryzone/projectlibrary [Accessed: 28 March 2014]
[47] See Case Study UK4 in IEA DSM. (2013) *Interaction between Consumers and Smart Grid Related Initiatives*, (Task 23 Report for Sub-Task 2), November 2013

Concerns have been raised by some consumers over the potential impact on privacy from the installation of Smart Meters. This led to one case where a resident in Houston, Texas, USA, brandished a gun when the electricity company employee arrived at her home to install a Smart Meter. Following the incident she spoke to a local news agency, saying, "*Our constitution allows us not to have that kind of intrusion on our personal privacy…they'll be able to tell if you are running your computer, air conditioner, whatever it is*"[48].

Although solutions could be implemented by individual stakeholders, they may be better addressed at an industry level, for example by the establishment of a framework that sets out the rules for data access, and to which all industry stakeholders are required to follow. In addition, the provisions of the framework need to be explained to consumers in an appropriate way (i.e. in advance of the installation of a Smart Meter and using 'consumer friendly' language). One such example of an industry wide framework setting out the rules for data collection and data access is provided in Example 7.12.

Concerns relating to damage, safety, privacy and health concerns should not be underestimated. Even if the industry consensus is that the risks are minimal, they can quickly escalate and consumer responses can be extreme.

[48] Daily News (2012) *Houston woman Thelma Taormina pulls gun on electric company worker for trying to install a 'smart meter'. [Online]. Available from* http://www.nydailynews.com/news/national/houston-woman-thelma-taormina-pulls-gun-electric-company-worker-install-smart-meter-article-1.1118051 [Accessed: 28 March 2014]

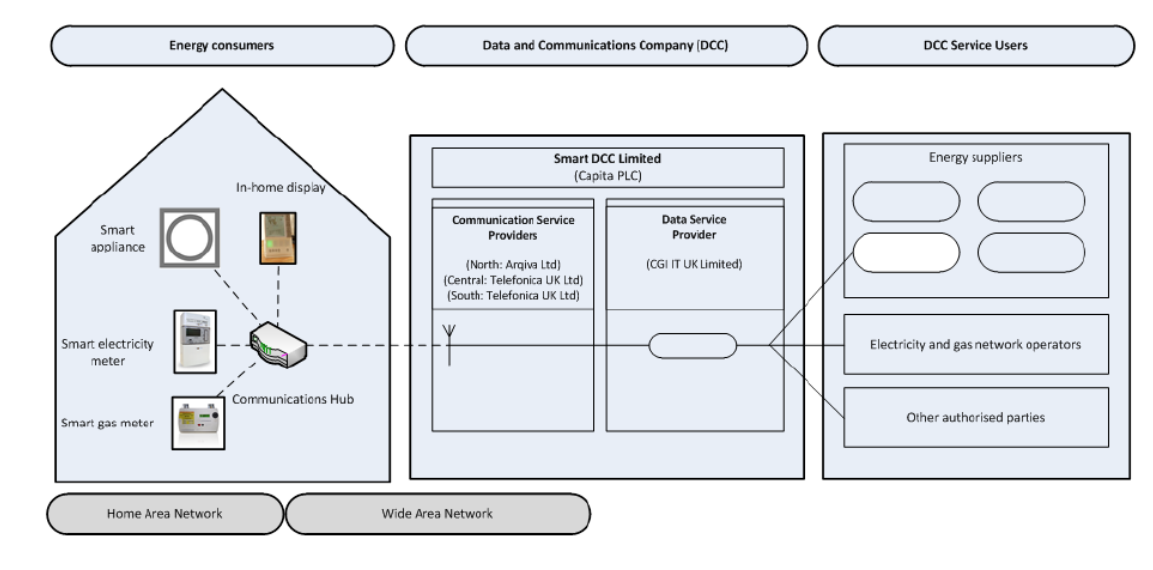
Example 7.12 Addressing consumer privacy concerns via a framework for Smart Meter data collection and access.

The Data Communications Company and the Smart Meter Roll Out

Smart Meters are being rolled out to all domestic customers in the UK by the end of 2020. A Data Communications Company (DCC) has been established to act as the conduit for getting consumer energy consumption data from Smart Meters to Energy Suppliers, DNOs and energy services companies.

The rules governing data collection and data access are set out in the Smart Energy Code[49]. The objectives of the Smart Energy Code include:

The role of the DCC is to put in place the shared data and communications infrastructure linking Smart Meters with potential users of Smart Meter data, as shown by the schematic below[50].



The UK Government has developed a data access and privacy framework which sets out the way in which Smart Meter data can be accessed, by whom, for which purposes, and the choices consumers have regarding access to their data[51]. Under the arrangements, data access for Energy Suppliers is limited, as follows[52]:

- Total consumption data, once per month;
- Daily consumption data if the reason for this is explained to the consumer and unless the consumer opts out. This data cannot be used for marketing purposes;
- Access data for periods of less than a day with the explicit consent of the customer (i.e. 'opt-in').

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[49] https://www.smartenergycodecompany.co.uk/sec/about-the-sec Accessed 01/04/2014
[50] Smart Metering Implementation Programme Leaflet. DECC. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/248729/The_Smart_Metering_System_Leaflet.pdf Accessed 02/04/2014
[51] Great Britain, Department of Energy and Climate Change (2012), *Smart Metering Implementation Programme, Data access and privacy, Government response to consultation,* Department of Energy and Climate Change, December 2012
[52] Consumer Focus (2014), *Consumer Information,* [Online] Available from http://www.consumerfocus.org.uk/get-advice/energy/smart-meters-what-are-they-and-how-can-i-find-out-more/privacy-and-security-issues [Accessed: 02 April 2014]

Once the framework is in place, there is still a need to communicate this to consumers to ensure they are aware of their choices, and have enough information to make an informed decision. Example 7.13 provides one example of how Energy Suppliers in the UK, who are bound by the terms of the Smart Energy Code described in the previous example, are explaining the benefits of sharing data

Example 7.13 Informing consumers of their options for data sharing[53].

> *"The reports have given me the power to make small changes for the future, every day."*
> **Michael, Leicestershire**

More control, more choice

By understanding how you use energy, you'll have more control. That's why, after each bill you receive from us, we'll send you a tailored Smart Energy Report. This report is a guide showing you how your energy use breaks down, where you might be wasting energy and it gives you personalised advice on how to make savings.

The Smart Energy Report is created using data from your smart meter. Since you have a choice over how often your smart meter sends us data, you have control over how accurate your Smart Energy Report is. You can choose whether you'd like your smart meter to give us data once every half hour, once a day or opt out of receiving it by choosing monthly. If you choose to give us more detailed half hourly readings, we'll be able to give you better advice. It's a lot easier to change a habit when you can see the benefit almost immediately.

To change how often smart data is collected, call us on 0800 980 6121.

We promise to take care of your energy data, and keep it secure. If you choose to give us half hourly and daily readings you have the right at any time to withdraw consent by contacting us.

For a more accurate view of your energy usage choose half hourly data!

[53] British Gas Smart Meter Information Leaflet. 'Welcome to your smart meters'. Available from: http://www.britishgas.co.uk/content/dam/british-gas/documents/WelcomeBooklet_printversion.pdf Accessed 02/04/2014

7.8.3 Requirements, expectations and capabilities

Consumers may also be uncertain of what is expected of them, or whether they will be able to meet these expectations. For example, consumers with a Time of Use tariff may be anxious about missing price signals or being unable to respond when they are issued. Consumers with in-home displays or other feedback devices may not feel confident about installing and/or setting up the equipment themselves. A survey carried out by Ipsos MORI on behalf of the UK Department of Energy and Climate Change discovered that 22% of households that owned In-Home Displays had not even installed them. Householders may not always understand technical terms such as kWh, kW or CO_2; with householders finding currency (£, $, € etc.) more tangible and meaningful[54]. Therefore, it is important to provide consumers with technology that is easy to use. Example 7.14 provides one example to demonstrate how ease of use might impact on the outcome.

Example 7.14 Impact of Ease of Use of Technology[55]

Blacon Energy Management Programme(BEMP)

The BEMP sought to investigate the effectiveness of different types of technological intervention. Some of the trial participants were given a real time display (Wattson™) while another group were given a more advanced management system (AlertMe™).

Wattson™ Classic

Source: http://www.diykyoto.com

The Wattson™ device provided real time electricity consumption data as well as a record of electricity use over regular intervals

AlertMe™

Source: https://www.alertme.com/

The AlertMe™ system is internet based, requiring the householder to log into the system to access electricity consumption data. This system could also switch appliances on and off remotely.

Feedback from the group provided with Wattson™ devices showed that 76% found it to be fairly easy or very easy to use. In contrast only 41% of the group provided with the AlertMe™ system found it to be fairly easy or very easy to use.

82% of households who were provided with the Wattson™ devices thought that it had helped them save electricity compared to only 37% who were provided with the AlertMe™ system.

[54] Breukers, S.C., Mourik, R.M. (2013) *The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours, Report for Netbeheer*, DuneWorks B.V., March 2013, P30

[55] See Case Study UK 15 in IEA DSM. (2013) Interaction between Consumers and Smart Grid Related Initiatives, (Task 23 Report for Sub-Task 2). November 2013.

Some Smart Grid initiatives have specific requirements that must be met in order for participants to enrol. This could include a requirement for new appliances or specific technologies or could involve the consumer switching to a new Energy Supplier. These requirements can be regarded as too onerous for some individuals.

Whilst providing choice (see Section 7.6) is recognised as being important, this is not always possible. In some situations it may be necessary to set minimum requirements for participation. For example, analogue TV broadcasting in the UK was withdrawn in a number of phases, and replaced with digital broadcasting. In order to be able to continue watching TV, householders were required to ensure they had technology in place to receive and de-code the digital TV signals. This represented a significant disruption to householders. However, the switchover was considered to be very successful, with very little concern raised by householders. Much of the credit for this success was attributed to the nationwide communication campaigns organised by Digital UK, the not for profit organisation responsible for co-ordinating the switchover process[56]. They ensured that consumers were provided with factual information on the switchover, and independent advice on the options available to them. The switchover campaign used a variety of different approaches and media to communicate, with the approach targeted to specific groups. This ranged from informative talks aimed at children aged as young as 7 to leaflets targeting the elderly delivered by 'meals on wheels' service providers.

7.8.4 Financial commitments and uncertainty over the potential gains

The anticipation of regret, i.e. of being worse off, is a big factor in why consumers do not take up new offers. This includes switching Energy Supplier as well as switching from a flat rate tariff to a Time of Use rate. The possibility that they will end up paying more than they do at the moment outweighs the possibility that they will end up paying less.

This could be particularly relevant where there is uncertainty over the level of the benefits that will actually be achieved. Therefore, it is essential to provide consumers with information that is as accurate and reliable as possible; for example a tailored estimated based on knowledge of current energy consumption, and the impact of altering existing energy practices. This could be achieved using energy consumption data from the Smart Meter and some basic understanding of energy practices within the household. Some schemes, particularly pilots and trials, have removed this risk by providing assurances that consumers will not pay more under the new tariff than they would have done on their existing tariff. Whilst this may help consumers enrol, it may not necessarily provide a cost effective approach for stakeholders. For example, the principle of not exposing the consumers to any risks can constitute a barrier for the Distribution Network Operator for a larger rollout – it may lower revenue and thereby decrease the possibilities for the network operator to invest and operate the system[57].

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[56] DigitalUK (2012) *TV Switchover 2008 to 2012*, Final Report, Digital UK, November 2012

[57] IEA DSM. (2013) Interaction between Consumers and Smart Grid Related Initiatives, (Task 23 Report for Sub-Task 2)

Example 7.15 Minimising risk to consumers[58]

Pacific Gas and Electric Company: SmartRate scheme

Research has shown that a significant number of customers are deterred from enrolling on dynamic tariff schemes because of the 'anticipation of regret' – they are concerned that their bill may go up rather than down. PG&E therefore offered a guarantee for the participants' first year. Under the guarantee, participants on the SmartRate scheme are assured that their electricity bill will not be any higher than it would have been on their prior tariff.

By 2011, 23,000 households had enrolled onto the scheme, with 50% of scheme members classed as 'low income' households. The number enrolled had increased to 120,000 by September 2013[59].

The vast majority of households who sign onto the scheme stay on it.

Many consumers may not be able to achieve the level of savings or benefits claimed. For example, statements[60] that In-Home Displays or other direct feedback can help householders to save up to 10% on their bills represent the upper limit on the savings obtained from trials. In practice, many consumers achieve savings much lower than this. Overstating the benefits can lead to dissatisfaction and disappointment. If this is a message that consumers hear from 'early adopters', it could lead them to question the level of savings they could achieve. Therefore, it is important to provide information that is specific and relevant to the individual.

Lack of confidence over the level of benefits could be even more important where an individual has to make an upfront investment to participate, i.e. they know how much they need to invest but may not have certainty over when (or if) they will get a return on their investment.

[58] Ibid. See Case Study INT3
[59] Pacific Gas and Electric Company (2013) *Status of Smart Grid Investments, Annual Report* , Pacific Gas and Electric Company, October 2013
[60] For example, see British Gas (2014), *A Touch of Class in your home,* [Online] Available from http://www.britishgas.co.uk/smarter-living/control-energy/a-touch-of-class.html [Accessed: 31 March 2014]

7.8.5 Key messages for Section 0

Identify consumer concerns and make sure the design of the Smart Grid initiative addresses them adequately

<table>
<tr><th colspan="2">Potential solutions / actions</th><th>Who is responsible</th></tr>
<tr><td rowspan="2">Learn lessons from other Smart Grid related activities.</td><td>Conduct on-going review of Smart Grid studies to learn lessons from new studies as they become available, so supplement the lessons learnt in Task 23.</td><td>Smart grid implementers: i.e. as the designers of Smart Grid initiatives.</td></tr>
<tr><td>Produce an international data-base of Smart Grid case studies to enable lessons learnt to be evaluated.</td><td>International collaborative bodies such as the IEA: who can organise collaborative research projects.</td></tr>
<tr><td colspan="2">Ensure any misunderstandings are addressed promptly</td><td>Smart grid implementers: i.e. as the designers of Smart Grid initiatives.</td></tr>
<tr><td colspan="2">Incorporate solutions that address known consumer concerns. Examples include:
- provide flexibility over the installation process
- use reputable and properly trained installers
- ensure consumers understand what is expected of them
- don’t make requirements too onerous
- provide choices
- provide reliable information on the likely benefits that consumers will achieve
- consider providing mechanisms to ensure that consumers will not be worse off if they do enrol in a new scheme
- provide a variety of ways to help consumers meet any upfront financial investments</td><td>Smart grid implementers: i.e. as the designers of Smart Grid initiatives.</td></tr>
<tr><td colspan="2">Put in place a mechanism to ensure that if and when things go wrong, they are put right quickly.</td><td>Smart grid implementers: i.e. as the designers of Smart Grid initiatives.</td></tr>
<tr><td>Make it as easy as possible for consumers to participate.</td><td>Minimise the requirements placed on consumers.

Provide choice.</td><td>Smart grid implementers: i.e. as the designers of Smart Grid initiatives.</td></tr>
</table>

8 Step 5. On-going Support

Step 5: "On-going support" examines how to go about ensuring that consumers stay signed up to the initiative and deliver the required outcomes. It considers what support and information needs to be provided to consumers in order to increase the chances of success. Important considerations in designing the consumer engagement approach include:

- ensuring any new consumer concerns are identified as they arise
- providing on-going support to ensure outcomes are delivered

In addition to the Awareness, Attitude, Self-Efficacy and Social Norms elements of the behaviour model introduced in Section 2.2, this Step considers the positive and negative feedback elements and how they influence the individuals' intention to perform an action once they are 'signed-up' to the initiative.

Each of these will now be discussed in detail below in the following Section.

8.1 Address consumer concerns

As previously discussed in Section 7 (Step 4), the design of the initiative must reflect and address concerns that consumers may have. Many concerns can be identified in advance; for example, by examining the lessons learnt from other Smart Grid related initiatives. However, the results of one study will not necessarily apply to a different group of consumers within a similar context or to similar groups of consumers in different contexts.

Three examples are used to highlight the extent to which consumer concerns can vary. These demonstrate the extent to which consumer concerns can differ from one context to another, although the initiative (in this case the mandated roll-out of Smart Meters) is similar.

In the first example, Smart Meters are made mandatory for all consumers, but no major concerns are raised by the consumers. However, in the second two examples, the concerns of consumers are such that the decision to mandate Smart Meters is reversed, with consumers provided with an element of choice. In Netherlands, the main concerns were focussed around privacy issues; where-as in California the concerns centred on the potential risks to health, although loss of privacy and inaccurate billing were also important factors.

Example 8.1 Smart Meter Roll Out in Italy[61]

Between 2001 and 2006, the Italian distribution company Enel SpA deployed Smart Meters across their entire network (approx. 30 million meters). The functionality of the meters includes the following features:

- the ability for the meters to be read remotely
- multi-tariff structure capability, which can be updated remotely
- remote disconnection, for example for bad payers

The roll-out by Enel was driven by the desire to improve the cost-effectiveness of their metering activities, prior to the introduction of legislation in 2006 that required all network companies in Italy to install Smart Meters for all consumers.

The consumers themselves, however, were not provided with any choice – they were obliged to have their existing meter replaced with a Smart Meter.

Despite this lack of choice, there was no strong opposition raised by consumers to the roll-out.

Example 8.2 Proposed Smart Meter Roll Out in Netherlands[62]

A similar approach was also considered for the Netherlands, where it was proposed that Smart Meters would be made compulsory for all Dutch households, with fines of up to €17,000 or six months in prison for those refusing to have them installed.

However, after consumer groups raised privacy concerns, the Dutch First Chamber refused to approve the Smart Metering Bill. The concerns centred on the following issues:

- the meters would constitute a violation of consumers' rights to privacy and the freedom to do as they please in the confines of their homes;
- the possibility that the metering data could provide information on the consumers' habits, such as when they leave the home and when they return, which could be useful to burglars; and
- the possibility that information about a person's energy use could fall into the hands of third parties such as the police or insurance companies.

As a result, consumers now have three options from which they can select after their Smart Meter is installed:

- Remote meter reading functionality is turned off. In this case, the option for supply to be remotely disconnected is also turned off.
- Meter reading takes place every second month, or when switching supplier or moving house. This is the default option.
- Quarter-hourly meter data collected on a daily basis.

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[61] OPEN meter Consortium (2009), *Report on Regulatory Requirements (D1.2)*, Open Public Extended network Metering, European Commission 7th Framework Programme Project, 17th July 2009

[62] Intelligent Energy (2011), *European Smart Metering Landscape Report, SmartRegions Deliverable 2.1,* Intelligent Energy, February 2011

Example 8.3 Smart Meter Roll Out by Pacific Gas and Electric, California[63]

The Pacific Gas and Electric Company (PG&E) of California originally planned to roll-out Smart Meters to all of its 10 million consumers by the end of 2011. By September 2012, the meters had been rolled-out to over 9 million consumers. The roll-out, however, was not without its difficulties, with many high profile actions instigated by consumers to stop the process altogether.

The concerns centred on the following issues:

- The possible adverse health impacts of the electromagnetic radiation emitted by the Smart Meters, which has been linked with a range of symptoms including dizziness, headaches, and cancer;
- They have been linked to higher electricity bills; and
- Loss of privacy.

In December 2011, and following a series of high profile actions by consumers, PG&E sought approval from the California Public Utility commission to provide choice to consumers. The request was approved, and PG&E now provide consumers with the possibility of opting out of having a Smart Meter. However, this option requires the payment of an up-front fee of US$75 and a monthly fee of US$10. This is reduced to U$10 and US$5/month for low income consumers[64].

Source: www.DDees.com

'National Day of Action to Stop Smart Meters', October 2012[65].

Whilst it may not be possible to identify and address all potential concerns in advance, there should be a mechanism in place to ensure that when concerns are raised they are addressed promptly.

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[63] GreenTechMedia (2011), *PG&E's Smart Meter Opt-Out: The Ins and Outs,* [Online] Available from http://www.greentechmedia.com/articles/read/pges-smart-meter-opt-out-the-ins-and-outs [Accessed: 20 February 2014]

[64] PG&E (2012), *Smart Meter Opt Out Program,* [Online] Available from http://www.pge.com/myhome/consumerservice/smartmeter/optout/ [Accessed: 24 September 2012]

[65] Action Day to Stop Smart Meters (2012) http://actiondaytostopsmartmeters.org/ [Accessed: 29 October 2012]

8.2 Ensure misunderstandings are addressed promptly

Whilst many consumer concerns are well-founded, in some cases they may relate to misunderstandings about what is expected or what will be required of them. Therefore, it is essential to learn from the 'non-participants'. Many misunderstandings can be avoided by providing consumers with access to reliable information. For example, a focus group of consumers was asked to comment on whether they could manage their energy uses to reduce demand during the early evening peak. The initial responses included an element of scepticism that the energy network companies were doing this to 'make more money'. However, once they understood the concept of network constraints and the implications of high peak demands, they couldn't understand why network companies didn't already charge more for energy used during the peak[66].

Misunderstandings can creep into the equation once a consumer is signed up to an initiative. For example, 'false cause' can lead consumers to infer that a negative occurrence which occurs soon after joining a Smart Grid initiative is in fact a direct result of that initiative.

The following provides an example of 'false cause', whereby consumers attribute increases in their energy bills to their recently installed Smart Meters. It demonstrates how issues can quickly escalate.

Example 8.4 Misunderstanding the link between tariff and consumption

Bakersfield, California

The roll-out of Smart Meters commenced in 2006. By late summer 2009, the electricity company (PG&E) began to receive a number of complaints due to large increases in electricity bills.

In November 2009[67], Bakersfield residents filed a class-action against PG&E claiming that the Smart Meters were not functioning correctly.

As a result of the rising public opposition to Smart Meters (due to both increased bills, and perceived safety and privacy issues), the roll-out process was temporarily paused.

An independent report was commissioned in order to understand the cause of the consumer complaints. This report[68], published in July 2010, concluded that July 2009 was much hotter than previous summers. As a result, consumers used much more energy in a single billing period than previously due to the use of air conditioning.

This increase in consumption meant that consumers were exposed to the higher rates on their inverted block tariff system for the first time. Their awareness of the tariff was low and therefore their bills increased by much more than they were expecting (as they were consuming more electricity whilst also being charged more for the electricity they were using).

The missing link, in this case, was the consumer understanding of their electricity tariff and the impact of their consumption on their final electricity bill.

[66] Focus group of 9 UK participants, part of a survey of UK consumers by UK National Team for Task 23.
[67] Consumer Affairs (2009), *Class Action Accuses PG&E of Overcharges,* [Online] Available from http://www.consumeraffairs.com/news04/2009/11/pge_suit.html [Accessed: 31 March 2014]
[68] Structure Consulting (2010), *PG&E Advanced Metering Assessment Report,* (A.07-12-009 COM/MP1/jt2), Commissioned by the California Public Utilities Commission, Prepared and Presented by Structure Consulting Group, 07, July 2010
.

Whilst it may not be possible to identify all potential sources of misunderstandings in advance, there should be a mechanism in place to ensure that when they do, they are addressed promptly.

8.3 Never underestimate the strength of consumer concerns

It is essential that the strength of consumer concerns is not underestimated. Even when the potential financial gains associated with an initiative are high, seemingly innocuous concerns can lead to consumer unwillingness to participate.

The following uses a case study relating to an offer to provide free loft insulation to households. The example is based on an award winning scheme offering a range of energy efficiency measures to households in Kirklees, an area in the North of England. Although the scheme included a range of energy efficiency measures, only loft insulation is considered here.

The households in the Kirklees area were informed of the scheme via posters and flyers distributed to each household. Each household was also sent a letter explaining the programme of work and what was on offer. An assessor then called at each house to ascertain which properties qualified for loft insulation (or the other measures being offered).

The scheme involved a total of 165,686 households. A significant number of these did not engage from the outset; 6% would not agree to an assessor entering their home whilst a further 16% of households did not respond to the various attempts to make contact.

Of those homes that were assessed, not all qualified for the free loft insulation either for technical reasons (hard to treat properties) or because loft insulation was already installed. However, a large number of households did not take up their offer of free loft insulation where it was feasible to do so.

Reasons for not taking up the offer are not specifically reported by the study. Feedback from other loft insulation programmes, however, indicates the following as possible factors for consumer reluctance to accept similar offers:

- General scepticism i.e. “why would anyone give me something for free?” What do they want in return?;
- A general dislike of allowing tradespeople into their own home;
- The hassle or time wasted. This relates to having to be home when tradespeople visit to undertake the installation. Also, for this example, there could be a need to clear-out the loft space of any personal belongings that have been placed there for storage, before the installation can go ahead.

The Kirklees scheme placed great emphasis on addressing all of the concerns above, particularly in terms of building trust. The ‘hassle’ factor was addressed by providing consumers with as much flexibility as possible over the timing of home visits and the installation process. However, the need for consumers to empty their loft space could not be avoided. Recognising this as an important step in increasing participation levels, the UK

Department of Energy and Climate Change[69] recently conducted a behavioural trial to explore whether and how much some customers would be willing to pay for a loft clearance service. Although the numbers involved in the trial were too small to be able to draw any firm conclusions, the provision of a loft clearance service was considered to be a useful tool to help promote uptake.

Figure 8.1 below highlights the level of consumer engagement at various stages of the initiative. The scheme was recognised as being industry leading, particularly in terms of the final number of properties insulated. Nevertheless, as the caption shows, a proportion of households did not engage in the process.

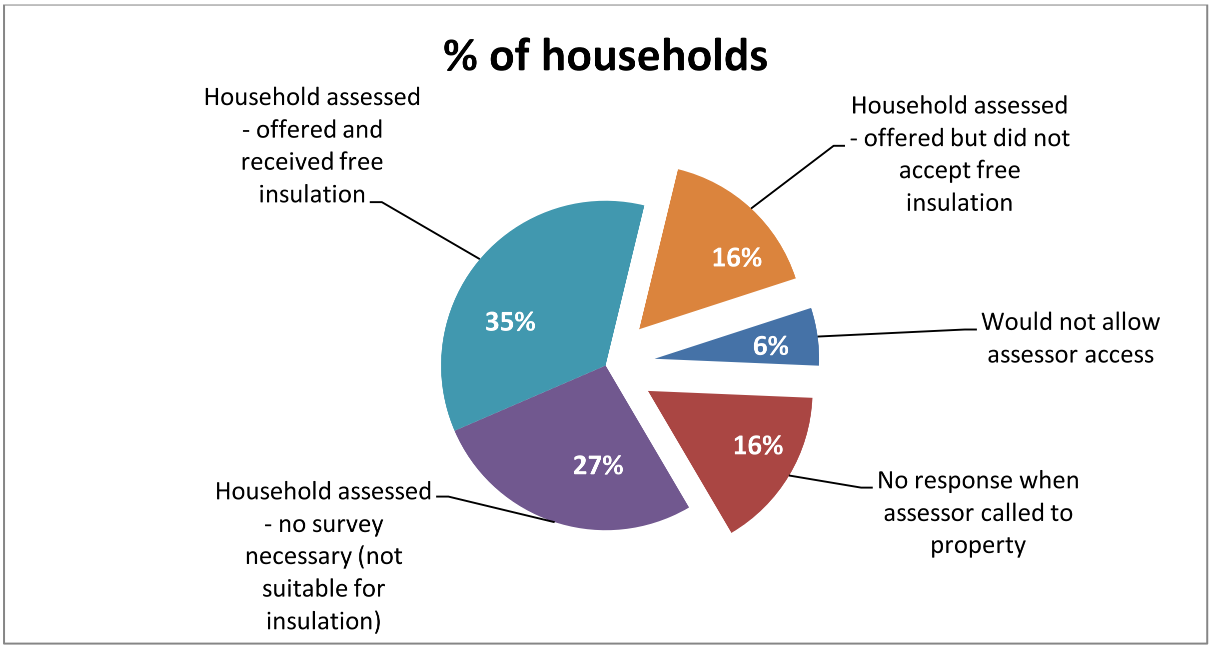

Figure 8.1 Level of consumer engagement in an initiative offering free loft insulation to households

8.4 Provide adequate ongoing support – technology is not always the answer

Providing technology alone will not ensure that energy behaviour change happens. For example, providing an In-Home Display with information on real time energy consumption does not guarantee that consumers will change their energy consumption, or that, if they do, it will be 'long lasting'. In particular, In-Home displays provide information on how much energy is used and when – but this alone does not provide householders with the whole story. Furthermore, information based on kW and kWh is not always well understood by consumers[70]. They still need to interpret the data to work out which end-uses are the biggest energy users and they need to be able to identify how they can change their energy practices to achieve changes in energy consumption.

[69] Great Britain. Department of Energy and Climate Change (2013) *Removing the hassle factor associated with loft insulation: Results of a behavioural trial*, September 2013.
[70] Breukers, S.C., Mourik, R.M. (2013) The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours, Report for Netbeheer, p30 DuneWorks B.V., March 2013

Example 8.5 Technology is not always enough

***Technology solution**– provides consumers with information on their daily load profile*

Representation of an In –Home Display

It does not tell consumers how much energy is used by an individual appliance

***The response** - what consumers said*

It would be good to see how much energy different appliances use. When I found out that the kettle takes a lot of energy to boil, I now only fill up for the number of cups I'm making. [71]

Source: Focus group conducted by O_2 in 2013, "Effectively engaging consumers to ensure smart meter success"

As the energy behaviour model at the beginning of this document shows, individual behaviour depends on a range of factors, including the views and beliefs of the individual as well as their capabilities and skills. Providing technology does not always guarantee they have the capability to deliver the behaviour change (the efficacy element of the behaviour model presented in Section 2.2).

Requirements will vary from one individual to another. Some individuals are perfectly happy to run around switching off appliances and watching their In-Home Display to see what happens to their energy consumption in real time. Many have reported that they have enjoyed learning about their energy consumption in this way, and it has provided an opportunity for the family to learn together. Once armed with the knowledge gained from their interaction with their In-Home Display, they are motivated to make changes to their energy practices. Others, however, report feeling anxious because of the information provided, whilst others have no desire to interact. The following provides an insight into some of the different attitudes of consumers towards In-Home Displays, how they interact with them and how they view them.

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[71] $O_{2\ (2013)}$ *Effectively engaging consumers to ensure smart meter success. [Online].* Available from http://static.o2.co.uk/www/docs/enterprise/j879_smart-metering-report-a4_06_aw_hr_gs.pdf. [Accessed: 31 March 2014]

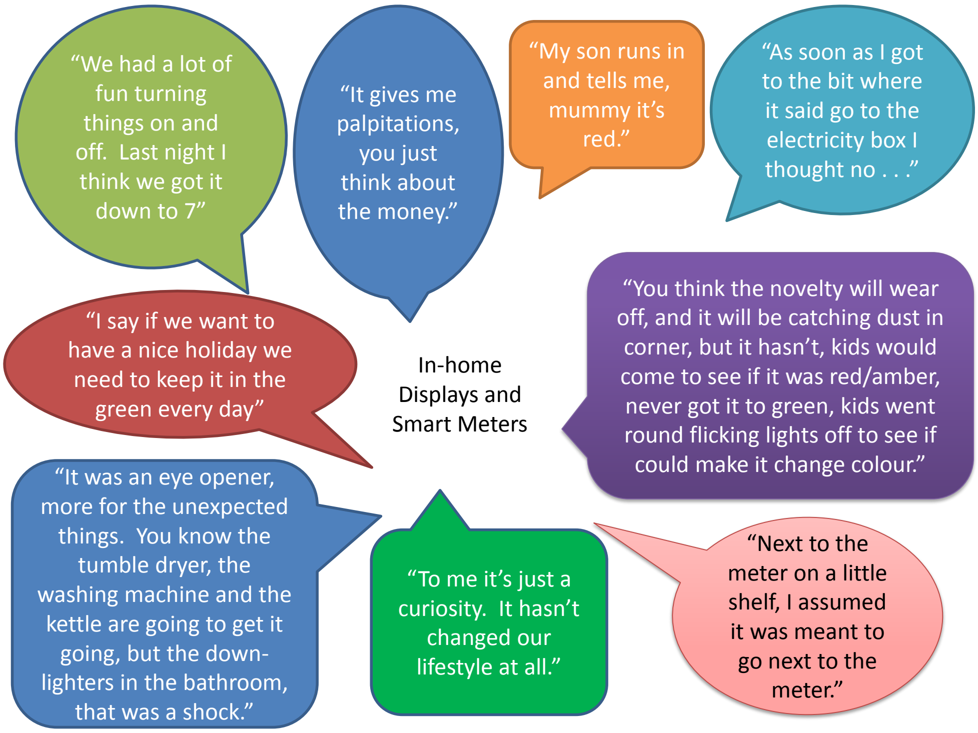

Figure 8.2 Public responses to In-Home Displays[72]

[72] Great Britain. Department of Energy and Climate Change. *Research Report - Smart Meters: research into public attitudes*, Navigator, May 2012, p17 to p20

8.5 The key messages associated with Step 5

Key message	Potential solutions / actions	Who is responsible
Don't assume what works with one group of consumers will also work for another (similar) group in another context. (See Section 8.1 for more details)	Check with target consumers to assess if any new concerns need to be taken into consideration.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Check to confirm that the design of the Smart Grid initiative addresses consumer concerns	Check to see if any new (unforeseen) concerns have been raised by consumers.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives. ***Social Science experts:*** who can help Smart Grid implementers evaluate and monitor initiatives.
	Ensure any misunderstandings are addressed promptly	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.
Do not underestimate the strength of consumer concerns (see Section 8.3)	Learn from the non-participants.	***Social Science experts:*** who can help Smart Grid implementers assess consumer responses.
Do not assume that technology always provides the solution	Check consumers are using technology as had been intended once they are signed-up to the initiative.	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives. ***Technology developers / appliance manufacturers:*** who can build in reporting/diagnostic tools to provide remote evaluation of how appliances are being used.
Expect things to go wrong (see Section 0)	When they do, accept responsibility and make sure they are put right quickly	***Smart grid implementers:*** i.e. as the designers of Smart Grid initiatives.

9 Step 6. Assess the benefits

Smart Grids have the potential to provide significant benefits to the electricity system and to society as a whole. The focus of this Step, however, is not to quantify the overall benefits of Smart Grids per se, but rather to assess the benefits from the perspective of consumers, of Smart Grid initiatives that involve an element of behaviour change.

Therefore, this Section considers the following issues:

- Identifying the benefits that Smart Grid initiatives provide for consumers; and
- The distribution of benefits arising from customer behaviour change.

Before doing this, however, it is first useful to consider whether or not consumers actually need to benefit directly, or whether it is sufficient for benefits to accrue to society as a whole.

9.1 Should Smart Grids provide direct benefits to consumers?

There are initiatives that demonstrate that behaviour change can be achieved without the need to provide direct financial benefits to consumers. One such example is household recycling.

The rates of household recycling in the England have been rising significantly in recent years, from 10% to over 40% in around 12 years[73], as shown in Figure 9.1 below.

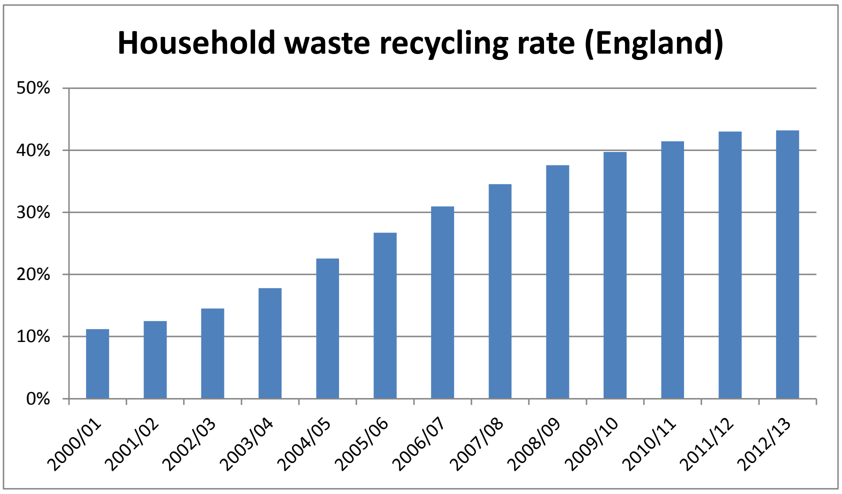

Figure 9.1 Rate of household recycling in England

The benefits of recycling include reduced landfill, reduced use of natural resources and reduce energy consumption. These are benefits to society as a whole, and individuals who

[73] Great Britain. Department for Environment, Food and Rural Affairs (2014) Local Authority Collected Waste Management. Waste Generation from 2000/01 to 2012/13 (England and regions data), [Online] Available from https://www.gov.uk [Accessed: 31 March 2014]

recycle more than others do not receive any individual reward. Although local councils are able to impose fines on those individuals who do not recycle, these are rarely used, with only 5,000 fines issued during the 12 months from May 2010 to April 2011[74].

The reasons why householders are willing to recycle their household rubbish for no direct reward are wide ranging, but includes factors such as;

- It is easy for householders to recycle. Local councils provide bins for different types of household waste (non-recycled, paper, glass, waste food, garden waste etc.). This makes it very easy for households to recycle their waste.
- It is becoming increasingly difficult not to recycle. Many local councils collect the 'general waste' on a fortnightly basis. Therefore, households that don't recycle often find their bin is full before the next collection is due.
- It is socially acceptable (a social norm) to recycle rubbish. For example, children are taught about the value of recycling in school, and are familiar with the 're-use, reduce, recycle' message. They are also exposed to 'cartoon' type characters that incorporate recycling into their daily routines.
- Land-fill sites are not liked. No-one wants to have a landfill site near to their home, and there is a growing acceptance that action needs to be taken to reduce the amount of waste going to landfill.

A number of surveys[75] have been conducted to investigate consumer attitudes and views towards Smart Grids, some of which have focussed on exploring what would motivate consumers to participate in Smart Grid related activities. The results from these indicate that consumers value the potential to save money or receive a financial reward. The results of one such survey are shown below[76].

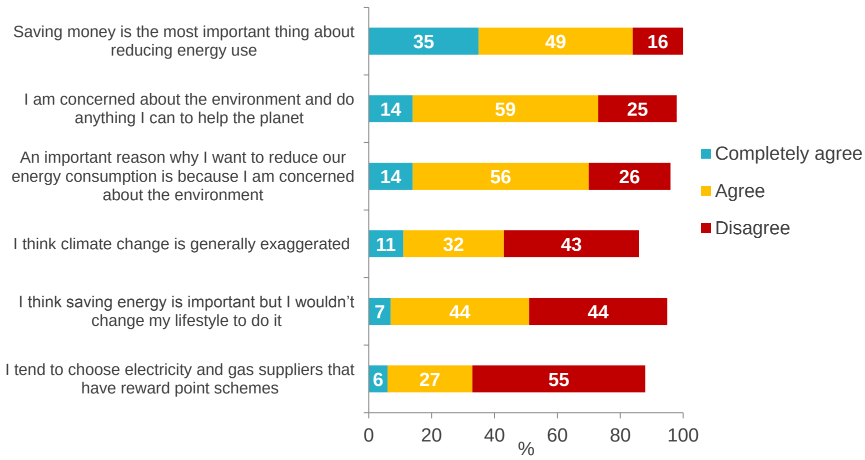

Figure 9.2 What consumers say they want in return for participating

[74] BBC News. (2012) *Rubbish bin fines to be scrapped under new plans*, 15 January 2012, [Online] Available from www.bbc.co.uk
[75] IEA DSM. (2013) Interaction between Consumers and Smart Grid Related Initiatives, (Task 23 Report for Sub-Task 2)
[76] Market research conducted by UK National Team for Task 23

The results shown above are also echoed in recent research conducted on behalf of the UK Government to assess consumer opinions towards community energy schemes[77]. In this example, 51% of UK adults would be motivated to take part in a community energy project if it could save them money, compared to only 17% who would do so to reduce carbon emission.

However, it is important to bear in mind that "*what people say, what people do, and what they say they do are entirely different things*"[78]. Whilst individuals say they most value obtaining a financial reward, receiving a financial reward is not always necessary, as illustrated in Example 9.1.

Example 9.1 Smart Grid initiative without direct financial payments to participants[79]

Brittany – EcoWatt scheme

Useful facts on energy consumption and generation in the region:

- Only a small proportion (8%) of the electricity consumed in the region is generated locally.
- A large proportion of homes in the area (28%) are heated by electricity.

Source: http://www.discover-brittany.info/brittany_maps.php

Due to constraints on the existing network infrastructure, the region faces the risk of power cuts during periods of high peak demand.

To reduce the risk of these power cuts, the operator of the French electricity transmission system (RTE) set up the EcoWatt scheme.

In addition to seeking innovative ways to reduce demand during peak times, the project also aimed to raise awareness of local balancing issues.

Inhabitants of Brittany were keen not to have a nuclear power station built on the peninsula which provided additional motivation to participate in the scheme.

The scheme is based on voluntary participation, i.e. consumers voluntarily agree to take part and receive no direct financial payment or other reward for reducing demand. Consumers who have signed up to the initiative receive e-mail and SMS alerts warning them of an expected peak demand event during the forthcoming day, and they are encouraged to reduce their energy consumption.

By 2012, there were 57,000 subscribers (including householders and local businesses) enrolled in the scheme which achieved an estimated reduction in electricity consumption of 3% in response to the alerts issued during February 2012[80].

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[77] Great Britain, Department for Energy And Climate Change (2014) *Community Energy Strategy: Full Report*, Department of Energy And Climate Change, 27 January 2014

[78] Quotation by Margaret Mead

[79] IEA DSM (2013) *Interaction between Consumers and Smart Grid Related Initiatives,* (Task 23 Report for Sub-Task 2), November 2013. See Case Study INT1.

[80] RTE (2011), *Activity Report 2011,* [Online] Available from http://www.rte-france.com/uploads/Mediatheque_docs/Presentation_RTE/Rapport_activite/2011/an/RA_RTE_2011_RA_web_UK.pdf [Accessed: 03 April 2014]

Whilst the evidence from various pilots and trials demonstrate that the offer of a financial benefit alone does not guarantee that customers will engage in an activity, it seems reasonable to suggest that Smart Grids should provide some tangible benefits to consumers. These benefits do not need to focus solely on the financial benefits, even though it is the financial aspects that appeal most to consumers.

The following Table lists the range of potential benefits that Smart Grids potentially offer to consumers.

Table 9.1 Potential benefits to Consumers from Smart Grids

Category	Unit of measurement	Benefit – desirable outcome
Money / financial	£, $, € Loyalty points Reward scheme	Spend less on electricity
		Gain reward points or cash to spend on other goods / services
		Receive payments for delivering demand response
Time / inconvenience	Minutes / Hours	Time saved
Comfort	^{o}C / year of under/over heating	Improved comfort through avoided under / over-heating
Environmental	kg CO_2 / year	Reduced CO2 emissions (e.g. contribution towards avoided use of fossil fired central generation)
Health	Number of 'sick days'	Improved health or wellbeing
Safety		Improved safety for householders (i.e. warnings that appliances have been left switched on)
Control		Ability to remotely control appliances when away from the home.

Many of the benefits listed above can be directly measured in terms of financial savings, or some other measure such as: time saved, ^{o}C of under-heating avoided or reduced number of days of ill health. Others, such as safety, can only be measured indirectly, for example in financial terms by considering the implications or consequences of events that are avoided. Providing individuals with greater control of their household appliances may provide benefits in terms of lifestyle improvements. For example, individuals may be able to turn on the heating system to ensure the home is heated just in time for their arrival back home.

The categories listed above represent both potential upsides (desirable outcomes) and also the potential downsides (undesirable outcomes) of Smart Grids from a consumer perspective. For example, consumer concerns relating to Smart Grids often focus on the potential impacts on health, privacy and security. (See Step 5 for more information on consumer concerns).

9.2 Distribution of Smart Grid benefits

A methodology has been developed in order to assess how the benefits of Smart Grid initiatives are distributed amongst stakeholders. The methodology links the expected outcomes (as identified in Step 2) of an initiative to the benefits by considering the effect on the energy system. The benefits are then distributed amongst the relevant stakeholders. This is shown diagrammatically below, where the outcomes are those identified during Step 2 (Section 5) and which are complementary to the drivers identified during Step 1 (Section 4).

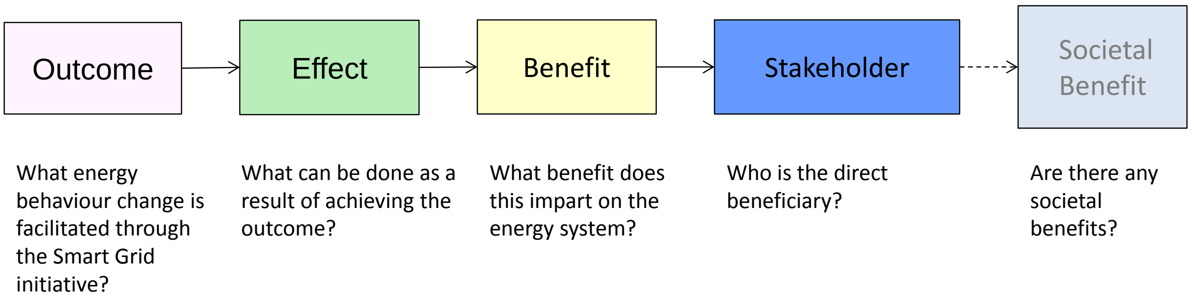

Figure 9.3 The interrelationship between Smart Grid activities and Stakeholder benefits

A Smart Grid initiative can lead to multiple outcomes, which in turn can lead to a range of benefits to a number of different stakeholders. Thus, rather than the simple flow diagram shown above, there is a complex inter-relationship between the benefits of a Smart Grid initiative and stakeholders.

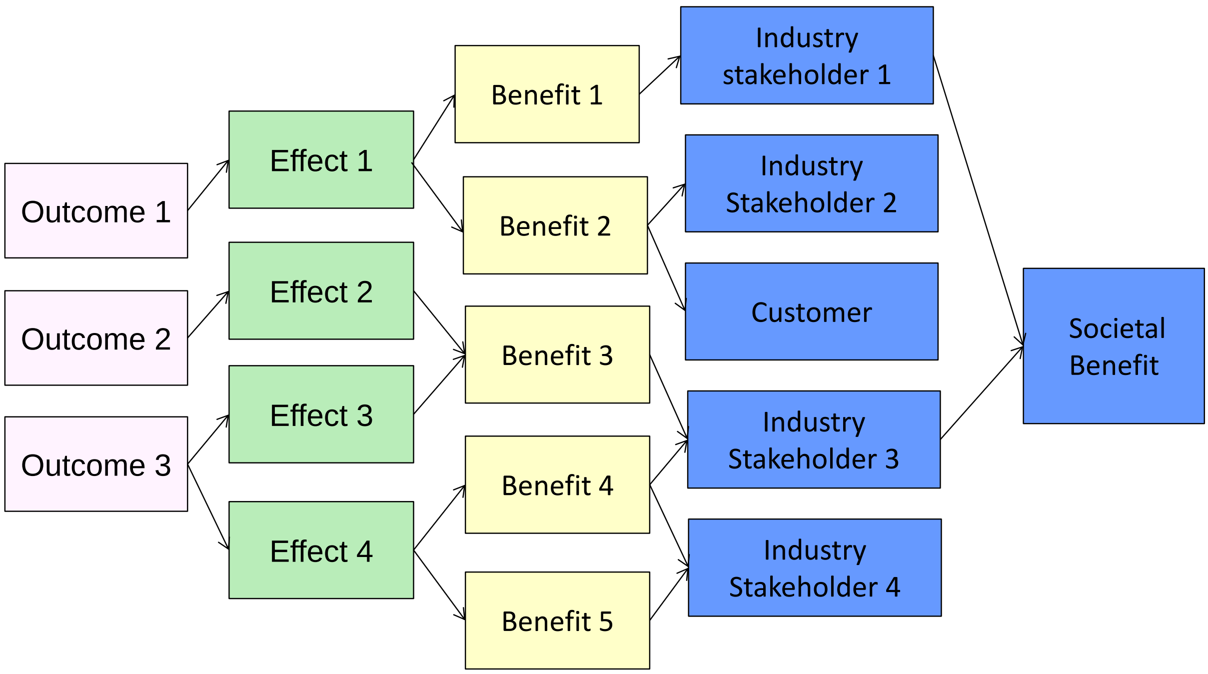

Figure 9.4 The distribution of Smart Grid related benefits

Considering the benefits in this way provides a tool for implementers that will assess benefits both qualitatively and quantitatively. Before demonstrating how the tool can be applied, it is important to first define the potential outcomes, effects and benefits.

9.2.1 Outcomes

The overall project focusses on Smart Grid initiatives that involve an element of behaviour change. As already defined in Step 2, Smart Grid initiatives involving an element of behaviour change include one or more of the following outcomes:

- Reduced energy consumption
- Change pattern of energy consumption (static)
- Change pattern of energy consumption (dynamic)
- Information sharing with industry stakeholders

9.2.2 Effects

The outcomes described above enable certain activities or actions to take place. For example, reducing peak load can lead to the optimised use of existing network assets; i.e. load growth can be accommodated on an already constrained network.

Another potential effect of reducing peak demand is that the need to purchase expensive, peak electricity can be reduced or avoided.

The effects on the electricity system are complex, and a single outcome can lead to a number of different, but interrelated effects depending upon the characteristics of the energy system. These can be simplified into the following ten categories that align with the key drivers for the deployment of Smart Grids:

- Reduce / avoid the use of fossil fired generation
- Facilitate the connection of renewable / de-centralised generation
- Maximise the use of renewable / de-centralised generation
- Facilitate the connection of new electric loads (e.g. heat pumps / electric vehicles)
- Reduce / avoid the need for the purchase of peak power
- Optimise the use of existing network assets
- Provide a resource to maintain quality and security of supply
- Facilitate the provision of tailored energy solutions
- Facilitate active management of the network
- Reduce volume of energy purchasing

9.2.3 Benefits

The benefits imparted on the electricity system due to the effects listed above reflect the main reasons for implementing Smart Grid related initiatives. So, whilst the effect of reducing peak load is to optimise the use of network assets, the main benefit of doing so is the avoidance of network investment.

The potential benefits associated with Smart Grid initiatives can be categorised as follows:

- Reduced carbon emissions
- Avoided / deferred network reinforcement
- New business opportunity
- Reduced cost of energy
- Reduced system balancing cost
- Improved comfort / convenience
- Additional income

9.2.4 Stakeholders

The potential stakeholders who stand to directly benefit from the successful deployment of Smart Grids are wide-ranging, and include:

- Government
- Generators (renewable / de-centralised)
- System operator
- Network operator
- Energy supplier / retailer
- Third party service companies / aggregators
- Technology / appliance developers / manufacturers
- Consumers / prosumers

9.2.5 Consumer Indirect benefits

Whilst the primary beneficiary of Smart Grid activities may be industry stakeholders, these benefits may also be passed onto consumers. For example, whilst achieving reduced carbon emissions may be the primary focus of Government, the benefits ultimately pass onto society as a whole (i.e. the societal benefits). Similarly, whilst avoiding network investment is of direct benefit to network companies, these benefits could be passed onto consumers in the form of reduced network charges, or, alternatively, avoided increases in future charges. These benefits are generally shared amongst all consumers, regardless of whether they themselves have contributed. There is also a significant time delay between the activity and the realisation of the benefits.

9.2.6 Example application

Categorising the outcomes, effects, benefits and stakeholders in this way provides a framework to evaluate Smart Grid related initiatives. It also allows the complex interrelationships between effects, benefits and stakeholders to be identified.

The following demonstrates application of the framework using a simple (quantitative) example.

Example 9.2 Demand Side Balancing Reserve – application of the framework approach to assessing benefits

Description

National Grid is the operator of the transmission system for the whole of Great Britain, i.e. the System Operator. It is responsible for co-ordinating and directing the flow of electricity into and along the transmission system. In order to do this, it procures services, referred to as 'balancing services', to balance differences between the amount of electricity being fed into the transmission system by generators and the amount being taken from the grid. This is predominantly achieved through the Balancing Mechanism[81]. In order to maintain security of supply with the narrow generating margins expected during the period 2015 – 2017, National Grid has begun exploring the options available to secure additional reserves to help support its existing balancing activities. One such option is the procurement of a new service, Demand Side Balancing Reserve (DSBR).

Although the measure is specifically aimed at consumers with a demand of 100kW or more, the following example considers the participation of householders.

The new DSBR service will be required between 4pm and 8pm on weekdays, i.e. coincident with system maximum demand. (For this example, it is assumed that participants do not have to provide response across the whole of the 4 hour peak period)

In return, the National Grid has suggested that participants would receive the following direct financial incentives:

- Set-up payment in the region of £5 / kW to £10 / kW per annum (€5.9 to 11.7 / kW)[82]
- Utilisation payment ranging from £500 / MWh to £15,000 / MWh (€0.6 to 17.6 / kWh)

The utilisation payments are very high, reflecting the fact this this is considered an extreme measure to be used only when system margins are threatened, and not for routine use.

Outcome

Let's assume that the outcome required by National Grid to make the scheme worthwhile is an overall demand reduction of 2 GW between 16:30 and 19:30, on a maximum of 10 occasions during the winter.

It is estimated that the maximum demand of individual households during this time ranges from 1.5kW to 3kW. It is estimated that each participant would be able to provide around 0.8kW of demand reduction over the three hour period. This implies that householders would be required to curtail all electricity consumption associated with cooking, TV's, consumer electronics and wet appliances during this period. Consumers could view events as an opportunity to go out to the cinema or out for a family meal. Framing the initiative in this way may even appeal to certain customer segments – see Step 4 for more information.

This is an onerous requirement, and thus any such scheme is unlikely to have mass market appeal. It is therefore, only likely to appeal to innovators and early adopters, which typically account for 2.5% and 13.5% of the market respectively[83].

With around 23 million households in GB, participation would be required by just over 10% of households to achieve the 2 GW response required (i.e. 2.5 million households). Thus, achieving the outcome of 2 GW seems feasible. This is where customer segmentation can help to identify potential customers to target – see Step 3 for more information.

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[81] The balancing mechanism is used to balance supply and demand in each half hour trading period of every day
[82] £1 = €1.17
[83] See Figure 2.3

Effect

If generation margins are low, there is a real risk of a black out occurring in the event of the sudden un-availability of a generator during the winter peak period. Thus, the availability of an alternative balancing resource could help to prevent such an event.

The effect on the system is the availability of additional resource to help maintain the quality and security of supply.

The value of this 'effect' is determined by considering the financial impact on National Grid in the event they are not able to secure an alternative resource, and are unable to supply electricity to consumers. Rather than risk a black out, National Grid would be forced to shed load to selected consumers to ensure that security of the overall system is not compromised. So, let's say, that they would alternatively disconnect 2 GW of load from the system if it could not be procured via the Demand Side Balancing Reserve.

The impact of this can be quantified with reference to the value of lost load, currently determined to be around £16,940 / MWh[84].

The cost to National Grid of shedding is therefore calculated as follows:

For a single 3 hour event, the amount of load that needs to be shed (i.e. the load otherwise provided by DSBR)	= 2 GW x 3 hours = 6 GWh
Cost of energy not supplied	= £16,940 / MWh
Total cost of energy not supplied	= 6 GWh x £16,940 / MWh = £102 million
If there are 10 events over a winter, the total cost	= £1,020 million

Benefits

The benefit to participants (i.e. those providing the service to National Grid) is the income they receive in return for participating.

It is assumed that participation by householders would only be secured with payments towards the higher end of the range (say £10 / kW set up fee and an utilisation fee of £10,000 / MWh). Therefore, The financial payment for a householder providing 0.8 kW of demand response for a 3 hour period is as follows:

Set up payment =	= £10
Demand response per event	= 0.8 kW x 3 hours = 2.4 kWh
Utilisation fee	= £10,000 / MWh = £10 / kWh
Utilisation payment per event	= 2.4 kWh x £10 / kWh = £24
Utilisation payment per year (10 events)	= £240
Annual income (set up + utilisation payments)	= £250 per household
The total number of households participating	= 2.5 million
The total payment (across all households)	= £625 million

[84] OFGEM / DECC (2013) *Weighted average Value of Lost Load for domestic and SME users in GB for winter, peak, weekday, The Value of Lost Load (VoLL) for Electricity in Great Britai,n Final Report*, London Economics, July 2013

The benefit to consumers / third party service providers

The administration of such a scheme would require the services of third parties to aggregate the response from the householders and provide a single point of contact for National Grid. Therefore, it is assumed that the benefits paid to providers will need to be split between consumers and a third party aggregator.

For simplicity, it is assumed that the method of controlling consumer demand can be done with existing technology (i.e. via the Smart Meter), i.e. there are no additional investment costs required. It is also assumed that payments for participation are split equally between the householder and the aggregator.

Therefore,
Income received by households = £312.5 million

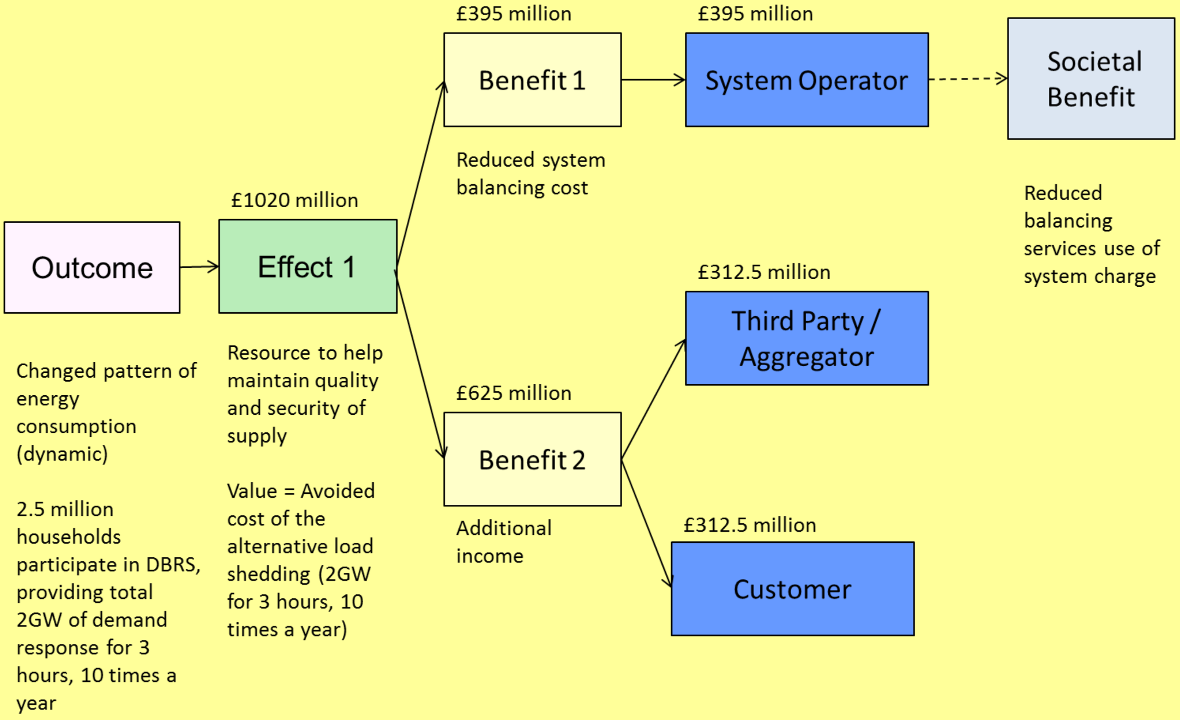
Income received by aggregator(s) = £312.5 million

The benefit to National Grid

The benefit to National Grid is the difference between the cost of load shedding (i.e. what would happen if the service was not available) and that paid to Demand Side Balancing Reserve participants (i.e. once the service is deployed), i.e.

= £1020 million - £ 625 million
= £395 million

This is shown diagrammatically below.



The framework has been developed in a Microsoft Excel spreadsheet. This enables all the potential linkages between the outcomes associated with a Smart Grid initiative and the benefits to stakeholders to be established and quantified. Further information on the spreadsheet is provided in Section 12.1.

The distribution of the benefits of Smart Grid related activities are not necessarily as simple as indicated in the earlier DSBR example. Smart Grid initiatives may have a number of different outcomes leading to a range of effects and benefits depending upon the specific context. This leads to a complex interrelationship between an initiative and the benefits to the various stakeholders. In such cases, the framework analysis tool will be particularly useful for identifying how benefits of Smart Grid related initiatives are distributed. For this, only the relevant links between the various levels of the framework need to be identified.

However, by quantifying the effect, and applying weightings to the various linkages, it is also possible to use the same framework to undertake a quantitative assessment of the distribution of benefits.

Other, non-financial, benefits of Smart Grids, as described in Table 9.1, can also be considered. However, a consistent unit of measurement, i.e. in financial terms, will be needed. Converting benefits into financial units must be done from the perspective of the individual – as it is they who make the decision. For example, the value placed on a unit of time saved, or for an increased level of comfort, will vary from individual to individual. Using ‘average’ or ‘typical’ values, provides a useful starting point for assessing whether an initiative is likely to be attractive, but may not predict the behaviour of an individual.

9.3 The key messages associated with Step 6

<table>
<tr><th>Key message</th><th>Potential solutions / actions</th><th>Who is responsible</th></tr>
<tr><td>Ensure the initiative provides tangible benefits to consumers</td><td rowspan="3">The Smart Grid can provide a range of tangible benefits to consumers. It is important to identify which (if any) are valued (or needed) by the target consumers?

Does the initiative:
- meet an immediate need of the consumers, of which they are already aware.
- avoid investment in local energy infrastructure, and so can deliver specific benefits to the community.</td><td rowspan="3">Smart grid implementers: i.e. as the designers of Smart Grid initiatives.

Social Science experts: who can help Smart Grid implementers design schemes specifically from the consumer perspective.

Appliance manufacturers / technology developers: who will be aware of consumer needs and can help define Smart Grid solutions that meet immediate needs of consumers as well as those of Smart Grid implementers.</td></tr>
<tr><td>Identify the needs of the consumers</td></tr>
<tr><td>Do not assume that providing a financial reward is sufficient to persuade someone to participate.</td></tr>
</table>

10 Step 7. Monitor and Evaluate

It is essential to be able to assess whether the Smart Grid initiative is considered to be successful, i.e. have the outcomes identified in Step 2 been delivered?

However, it is not sufficient to only measure the impact on energy consumption and energy related expenditure to determine whether an initiative has been successful or not. It is also important to assess what elements of an initiative have been successful and for whom they have been successful.

A range of case studies and consumer surveys were evaluated as part of this project in order to understand how consumers interacted with various Smart Grid related interventions[85] (e.g. technology, feedback or novel tariffs). Many of these case studies only report the energy saved (either in total, or as an average per consumer). Rarely do they say how this was achieved, or give contextual factors such as the demographics of trial participants. This lack of information makes translating successful techniques to other contexts, or understanding the reasons behind unsuccessful trials more difficult.

The result of a Smart Grid initiative (i.e. the outcome defined in Step 2) will depend on the behaviour of consumers. This in turn is driven by a number of factors relating to the individual and the societal context in which they operate. This is illustrated by the theoretical model of behaviour change introduced in Section 2.2. These aspects should also be monitored as part of the evaluation of the success of a Smart Grid initiative.

Monitoring additional factors (i.e. beyond energy savings or peak load reduction) allows the Smart Grid implementer (e.g. DNO/DSO or Energy Supplier) to understand the reasons behind the outcomes which are observed. It enables the aspects of the initiative that have been successful to be identified, why they have been successful and for whom they have been successful.

Using a consistent framework to monitor and evaluate initiatives involving an element of behaviour change, enables results of different initiatives to be contrasted and compared. Whilst a number of evaluation and monitoring frameworks currently exist, they no not enable trials to be compared against each other in a consistent manner. To date, no such common framework exists, and work has commenced on the development of a tool to evaluate programs aimed at delivering energy behaviour change within Task 24 of the IEA DSM Implementing Agreement[86]. A summary of the framework is provided in Section 12.4.

[85] IEA DSM. (2013) *Interaction between Consumers and Smart Grid Related Initiatives*, (Task 23 Report for Sub-Task 2), November 2013

[86] Task 24 – Closing the Loop – Behaviour Change in DSM, From Theory to Policies and Practice

It is believed that one reason for this lack of a common framework is the vast number of different scientific propositions to understanding behaviour and approaches to behaviour change.

Task 23 has selected the energy behaviour model described in Section 2.2, supported by the market diffusion theory because they are considered to be the most appropriate tools for helping to explain energy behaviour within a Smart Grid context. Therefore, the monitoring and evaluation approach outlined here is focussed on collecting information on the different variables identified in the behavioural model in Section 2.2.

The approach is described in terms of the following three phases, which are described in the following Sections:

i. Understanding what the initiative is attempting to achieve, i.e. what are the questions that need to be answered during monitoring and evaluation?
ii. Understanding the relevant behaviours, i.e. what needs to be measured in order to get a meaningful evaluation?
iii. How should the program be designed, i.e. to ensure it answers the questions in point i) by monitoring the variables identified in point ii) as efficiently as possible?

10.1 Understand the programme

The first step in any evaluation programme is to understand what the Smart Grid initiative is trying to achieve. This requires an understanding of the specific goals of the initiative and of the behaviours that are being targeted.

The goals of the Smart Grid initiative are encompassed in the following elements of the Step-by-Step process:

- The drivers for Smart Grid development identified during Step 1 (Section 4);
- The specific outcome that the program wishes to achieve, as defined during Step 2 (Section) 5;
- The expected benefits provided to consumers, assessed during Step 6 (Section 9);
- The expected benefits provided to the implementers and other stakeholders, also assessed during Step 6.

The energy behaviours being targeted are encompassed primarily within Step 3 (Section 6) of the Step-by-Step process, which identifies the consumers and the end use loads to be targeted – i.e. what are consumers expected to do.

10.2 Understand the relevant behaviours

The next step in designing the monitoring and evaluation is to identify which of the variables in the energy behaviour model described in Section 2.2 are relevant to the Smart Grid initiative, and therefore need to be measured. This information is encompassed primarily within Step 4 (Section 7) and Step 5 (Section 8), as highlighted with the examples below:

- If the initiative is seeking to make it more likely for consumers to take action by framing the initiative in a certain way, then it is important to monitor consumer **attitude**.
- If the initiative involves community engagement or uses community champions, then it is important to ensure that the impact of **social norms** is measured.
- If the initiative is focussed on encouraging behaviour change by providing information, then there is a need to focus on evaluating consumer **awareness** in order to understand the effectiveness of the information provided to consumers.
- If the initiative is centred on a technology solution that makes it easier for consumers to perform certain tasks, then it is important to measure **self-efficacy** to establish whether consumers are using the technology as intended and to understand whether they do find the tasks easier to perform once the technology is in place.

10.3 Conduct the monitoring / evaluation efficiently

The final step is then to design the evaluation and monitoring program to assess its effectiveness in delivering the achieving the required goals by changing the behaviours identified.

Many different approaches exist, but they can broadly be categorised into the following three types:

- Experimental
- Quasi-experimental
- Non-experimental

All measure the effectiveness of the initiative in achieving the desired goal compared to a specific reference point, by comparing data collected before and after the initiative is put in place. However, there are differences in ***how*** the reference point is established. The Table 12.1 provides a brief overview and comparison the different approaches.

Table 10.1 Approaches to evaluation and monitoring

	Description	Cost(i)	Robustness(ii)
Experimental	Individuals randomly assigned to one of two groups: • Treatment Group • Control Group	£££	√√√
Quasi-Experimental	Non-participants are selected by ensuring that essential characteristics are comparable to those of the participants:	££	√√
Reflexive Comparison	A quasi-experimental approach whereby the participants are compared to themselves before and after the initiative has been put in place.	££	√√
Non-experimental	Participants compared to non-participants using statistical methods to account for differences between the two groups.	£	√

(i) approximate indication of relative cost – qualitative only, e.g. £££ most expensive, £ least expensive.
(ii) approximate indication of relative robustness – qualitative only, e.g. √√√ most robust, £ least robust

It is unlikely that a non-experimental approach will be suitable for evaluating Smart Grid initiatives due to the current lack of statistical data upon against which a comparison can be made. However, this could change over time as more and more data becomes available.

The choice between an experimental or quasi-experimental approach will depend very much upon the questions that need to be answered and the way that the initiative is rolled out. For example, if the initiative is nationwide, it will not be possible to adopt an experimental (or randomized) approach as it will not be possible to establish a control group. If the trial is focussed on the impact on habitual behaviours over a long period of time, then there is a risk that 'external' factors, other than those relating to the initiative itself, may influence the behaviours of the non-participants. If these 'external' factors cannot be identified and monitored, the validity of a quasi-experimental approach could be compromised.

10.4 The key messages associated with Step 8

Key message	Potential solutions / actions	Who is responsible
Ensure monitoring and evaluation program identifies which elements have been most successful in achieving the overall outcome(s), why they have been successful, and for whom have they been most successful?	Confirm what the program is trying to achieve, and identify the questions that need to be answered.	***Smart grid implementers***: i.e. as the designers of Smart Grid initiatives.
	Understand the relevant behaviours in order to identify which variables need to be monitored.	***Social Science experts:*** who can help Smart Grid implementers design schemes specifically designed to target energy behaviour.
	Design the monitoring and evaluation program to ensure that the questions identified above are answered in an efficient way.	***Evaluation program designers and implementers***: who can ensure programmes are delivered as efficiently as possible without compromising validity of the results.

11 Step 8. Implement

It is believed that the Step by Step approach described here represents the elements that need to be addressed in order to ensure consumers are more willing to 'sign-up' to Smart Grid initiatives and deliver the expected outcomes. Each of the steps addresses different elements of the energy behavioural model introduced in Section 2.2. In particular, it ensures that the Smart Grid initiative has been designed to ensure that:

- tangible benefits are delivered to consumers;
- specific needs of the relevant industry stakeholders are met;
- outcomes are monitored to evaluate what elements have been successful, why they have been successful and for whom they have been successful.

All that remains, therefore, is to put it all into practice.

12 Tools to help implementers

This Section provides some additional tools or methodologies to assist Smart Grid implementers. This includes:

- Section 12.1 sets out the interrelationships matrix described in Section 9.2, which can be used to understand how the benefits of Smart Grid initiatives are distributed amongst stakeholders.
- Section 12.2 uses a simple example to demonstrate a methodology for quantifying risks and benefits (gains). Although the example does not relate specifically to a Smart Grid related activities, it provides a useful starting point for designers wishing to quantify the risks and benefits from the perspective of consumers. The example demonstrates that whilst risks and benefits can be quantified, they do not reliably predict behaviour. Nevertheless, the analysis is believed to have merits for Smart Grid implementers wishing to explore whether an initiative might be attractive to consumers or evaluating implementing solutions to meet consumer concerns.
- Section 12.3 provides a summary of a selection of customer segmentation models, which may be helpful when targeting consumers, as described in Section 6.

12.1 Interrelationships Matrix

The framework described in Section 9.2 has been developed in the form of a Microsoft Excel spreadsheet. This enables all the potential linkages between the outcomes associated with a Smart Grid initiative and the benefits to stakeholders to be established and quantified.

This could be particularly useful for exploring the distribution of the benefits of Smart Grid related activities.

The spreadsheet can be used in one of the following two ways:

- Qualitatively: i.e. to investigate where benefits are distributed
- Quantitatively, i.e. the extent to which benefits are distributed

The *Benefits mapping* spreadsheet includes the following worksheets:

Categories

Outcome-Effect

Effect-Benefit

Benefit-SH

Yellow cells indicate where users can enter data. Grey cells contain descriptions or user prompts. Calculated values are shown in white cells these cells contain formulae which are accessible for those wishing to edit or amend the calculations. Users have the options of ‘locking’ these cells to prevent inadvertently removing or editing formulae. It is also recommended that users make a copy of the spreadsheet before commencing any analysis.

The worksheets are each described in Sections 12.1.1 to 12.1.4 below.

12.1.1 Categories worksheet

The categories sheet lists the categories of outcomes, effects, benefits and stakeholders as used in the remainder of the spreadsheet.

The descriptions of these categories can be modified by the user. The sheet currently lists four outcomes, ten effects, seven benefits and eight stakeholders. However, users can add additional values to the bottom of the categories tables, as shown in Figure 12.1. The new outcomes, effects, benefits and stakeholders are numbered automatically.

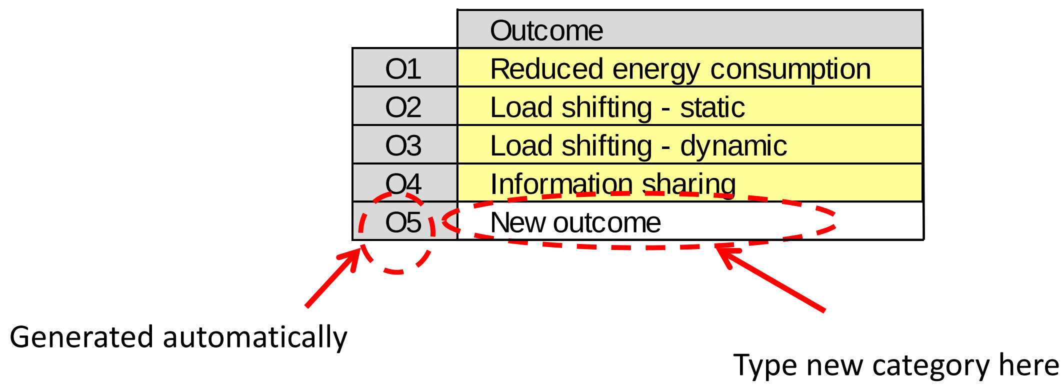


Figure 12.1 Adding a new category

12.1.2 Outcome – Effect worksheet

The *Outcome – Effect* worksheet contains a table linking one of the selected outcomes to the effects. The outcome is selected from a drop down list in cell C7, as shown below.

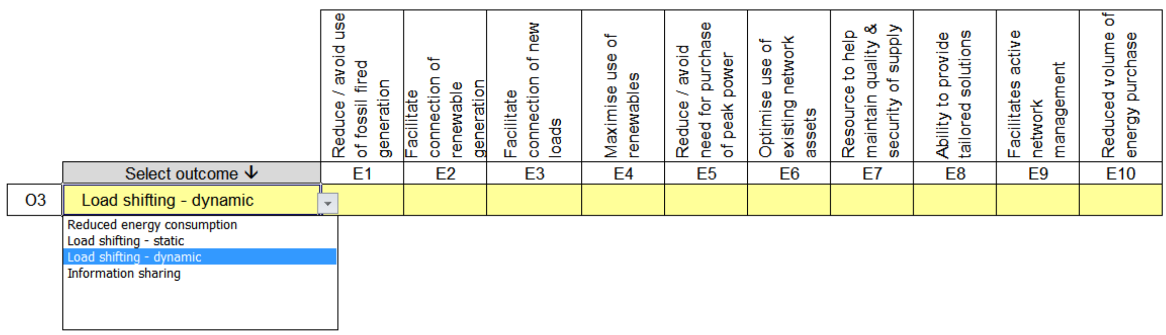


Figure 12.2 Selecting an outcome and linking to effects

To make the worksheet as user friendly as possible, only one outcome at a time is considered. If multiple outcomes need to be considered, the user will need to consider each outcome in turn, and then add the overall results together.

The yellow cells then indicate where data can be entered by the user. Each cell represents the value of the effect. In the case of Example 9.2, only one effect of load shifting on the electricity system was considered. In that example, the demand response was used as a resource to maintain the quality and security of supply, and was valued at £1,020million. However, dynamic load shifting has the potential to deliver multiple effects. In some cases, the effects are directly linked to each other. For example, avoiding the purchase of power during peak periods often leads to reducing the output from fossil fired generation, as would be the case in the Netherlands. However, this is not the case in Norway where electricity generation is dominated by hydro-power. For this reason the effects are uniquely identified to allow only those relevant to the context to be considered.

For a qualitative analysis, it is not necessary to assign a specific value to each of the effects that arise from a particular outcome. In this case, a nominal value of 1 can be placed to indicate that a benefit does exist. Thus, an initiative involving dynamic load management could be linked to a wide range of effects as indicated below.

		Reduce / avoid use of fossil fired generation	Facilitate connection of renewable generation	Facilitate connection of new loads	Maximise use of renewables	Reduce / avoid need for purchase of peak power	Optimise use of existing network assets	Resource to help maintain quality & security of supply	Ability to provide tailored solutions	Facilitates active network management	Reduced volume of energy purchase
	Select outcome ↓	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
O3	Load shifting - dynamic	1	1	1	1		1	1		1	

Figure 12.3 Linking effects to outcomes for a qualitative analysis

Figure 12.3 indicates that dynamic load shifting enables the following 'activities' to take place:

- Reduces or avoids the use of fossil fired generation;
- Facilitates the connection of renewable generation, i.e. more renewable generation can be connected to the existing network than might not otherwise be possible;
- Facilitates the connection of new loads (particularly EVs and heat pumps) to the existing network that might not otherwise be possible;
- Optimises the use of existing network assets, e.g. by alleviating an existing network constraint
- Provides a resource to maintain the quality and security of supply
- Facilitates active management of the distribution network; for example by helping network operators manage fault conditions.

12.1.3 Effect – Benefit worksheet

This worksheet contains two Tables. The first links the effects to the benefits; specifically the user is required to define how the effect is distributed. The cells that need to be completed by the user are automatically highlighted in yellow, depending on the information provided in the *Outcomes to Effect* worksheet. The user assigns how the benefits associated with a particular effect are distributed by entering a percentage into the relevant cells. An error message will appear in column *F* if the total benefits do not total 100%, and the corresponding cells will be shaded in red.

In the case of Example 9.2, the resource to help maintain the quality and security of supply is associated with two benefits:

- Reduced system balancing costs
- Additional income

This is entered into the worksheet as indicated in Figure 12.4.

Effect \ Benefit		*Error check*	Reduced carbon emissions	Avoided / deferred reinforcement	New business opportunity	Reduced energy cost	Reduced system balancing cost	Additional income	Improved convenience / comfort
			B1	B2	B3	B4	B5	B6	B7
E1	Reduce / avoid use of fossil fired generation								
E2	Facilitate connection of renewable generation								
E3	Facilitate connection of new loads								
E4	Maximise use of renewables								
E5	Reduce / avoid need for purchase of peak power								
E6	Optimise use of existing network assets								
E7	Resource to help maintain quality & security of supply						39%	61%	
E8	Ability to provide tailored solutions								
E9	Facilitates active network management								
E10	Reduced volume of energy purchase								

Figure 12.4 Linking benefits to effects

The second Table on the Effects – Benefit worksheet then indicates the value (rather than the proportion) of each effect-benefit linkage, and also includes a summation of the overall benefits for each category, as shown below which relates to Example 9.2 presented earlier in this report.

Effect \ Benefit		Effect value	Reduced carbon emissions	Avoided / deferred reinforcement	New business opportunity	Reduced energy cost	Reduced system balancing cost	Additional income	Improved convenience / comfort
			B1	B2	B3	B4	B5	B6	B7
			0	0	0	0	394.995	625.005	0
E1	Reduce / avoid use of fossil fired generation	0							
E2	Facilitate connection of renewable generation	0							
E3	Facilitate connection of new loads	0							
E4	Maximise use of renewables	0							
E5	Reduce / avoid need for purchase of peak power	0							
E6	Optimise use of existing network assets	0							
E7	Resource to help maintain quality & security of supply	1020					395.0	625.0	
E8	Ability to provide tailored solutions	0							
E9	Facilitates active network management	0							
E10	Reduced volume of energy purchase	0							

Figure 12.5 Linking benefits to effects - continued

12.1.4 Benefits – SH worksheet

The benefits – SH (stakeholders) worksheet contains two Tables. The first links the benefits to the stakeholders; specifically the user is required to define how the benefit is distributed. The cells that need to be completed by the user are automatically highlighted in yellow, depending on the information provided in the *Effect to Benefits* worksheet. The user assigns how the benefits are distributed by entering a percentage into the relevant cells. An error message will appear in column *F* if the total benefits do not total 100%, and the corresponding cells will be shaded in red.

In the case of Example 9.2, the benefits associated with reduced system balancing cost are assigned to the System Operator. The benefits associated with additional income are equally shared between the Third Party Aggregator and the Consumer.

This is entered into the worksheet as indicated in Figure 12.6.

Benefit \ Stakeholder		Error check	Government	System Operator	De-centralised / Renewable Generators	Suppliers / Energy Retailers	Network Operators	Third party Service Companies	Technology / Appliance Developers	Consumer	De-centralised / Renewable Generators
			S1	S2	S3	S4	S5	S6	S7	S8	S9
B1	Reduced carbon emissions										
B2	Avoided / deferred reinforcement										
B3	New business opportunity										
B4	Reduced energy cost										
B5	Reduced system balancing cost			100%							
B6	Additional income							50%		50%	
B7	Improved convenience / comfort										

Figure 12.6 Linking benefits to stakeholders

The overall results are then presented in the second Table which indicates how the initial values presented in the *Outcome – Effects* worksheet have been distributed. In the case of Example 9.2, the results would be as presented in Figure 12.7

Benefit \ Stakeholder		Benefit value	Government	System Operator	De-centralised / Renewable Generators	Suppliers / Energy Retailers	Network Operators	Third party Service Companies	Technology / Appliance Developers	Consumer	De-centralised / Renewable Generators
			S1	S2	S3	S4	S5	S6	S7	S8	S9
			0.0	395.0	0.0	0.0	0.0	312.5	0.0	312.5	
B1	Reduced carbon emissions	0.0									
B2	Avoided / deferred reinforcement	0.0									
B3	New business opportunity	0.0									
B4	Reduced energy cost	0.0									
B5	Reduced system balancing cost	395.0		395.0							
B6	Additional income	625.0						312.5		312.5	
B7	Improved convenience / comfort	0.0									

Figure 12.7 Allocation of benefits between stakeholders

The example used to demonstrate the application of the worksheet is very simple, with only a limited number of benefits considered. However, the spreadsheet can enable more complex initiatives, involving numerous benefits and stakeholders, to be considered.

The spreadsheet could be particularly valuable in qualitative analysis considering where benefits are distributed. In this case, no value needs to be assigned to an effect, and the distribution of effects and benefits can be determined using 'brain-storming' type workshops with key stakeholders. In this way, an overall picture of the benefits can be built up based on expert judgement and opinion.

12.2 Quantifying benefits (and dis-benefits)

Implementers may wish to compare the overall benefits (or gains) and dis-benefits (or losses) of Smart Grid related activities from a consumer perspective, in order to gain a better insight into whether an initiative might be attractive to consumers. To do so, it is important to consider all the potential gains and losses, and not just the financial implications. However, establishing whether the benefits outweigh the gains requires them to be compared using a consistent unit of measurement. For this purpose, it is sensible to use an equivalent monetary value.

This opens up the possibility of undertaking a neo-classical economic analysis to predict whether an initiative is likely to be attractive to consumers or not. This does not represent how an individual will consider a specific proposition. For this, it is more appropriate to use an energy behaviour model, such as that introduced in Section 2.2. However, it may provide valuable information to help implementers design Smart Grid initiatives.

The following Table provides some suggestions for placing a monetary value on the different types of benefits. In practice, the values can only be determined by investigating what decisions individuals make under different circumstances. As discussed in Section 7, consumers do not always value benefits in absolute terms, so a $1 saving in one context is not the same as $1 saved in another (Section 7.7.2). Thus, whilst a value on time wasted can be inferred by looking at consumer willingness to pay in order to reduce travel times (i.e. payment for a toll road in order to avoid congested areas), this will not necessarily relate to how time is valued in other situations.

Placing a monetary value on, say, time will vary significantly from individual to individual. Using 'average' values based on the opinion of a wide group of consumers will provide implementers with a useful ***starting point*** for exploring whether an initiative is likely to be attractive to consumers. It will also help implementers develop solutions to maximise consumer engagement. However, it should not be relied upon as an approach for predicting consumer behaviour.

Table 12.1 Valuing benefits and dis-benefits

Category	Unit of measurement	Potential approaches for converting into financial terms
Money / financial	£, $, €	-
Other direct reward	Loyalty points to spend on goods or services	Convert to equivalent cost of buying the goods or services - Only relevant if the goods and services would otherwise be purchased directly, i.e. represent an avoided cost. Otherwise, could be given much lower value by consumers.
Time / inconvenience	Minutes / Hours	Monetary value on each unit of time gained or lost could be inferred from salary, or from studies investigating how much people are willing to spend in order to save time. - Will vary considerably from individual to individual, depending on the context.
Comfort	^{o}C / year of under/over heating	A monetary value on each ^{o}C of under/overheating could be determined by considering the consequences of under heating, e.g. the health impacts or productivity in the workplace.
Environmental	kg CO_2 / year	Value of Carbon
Safety	Indirectly measured	This could be determined by considering the consequences where safety is compromised. For example, the financial consequences caused by fire or flooding.

12.2.1 Quantifying the potential risks (or losses)

Risk can be described as the possibility (or expected value) of misfortune or loss and is generally defined as the combination of:

- The probability / likelihood of an undesirable event or outcome occurring; and
- The resulting consequences / impacts if the undesirable event occurs.

The following provides an example showing how the risk associated with burglary from the home is quantified.

- Let's say that the probability of a burglary occurring to a household is 3%. (This is broadly equivalent to the incident rate of 28 burglaries per 1000 households in England and Wales, UK);
- Let's say that the average consequences of burglary is estimated to be around €1,400 (This is broadly equivalent to the average cost of burglary to households in England and Wales, UK)
- Therefore, the risk associated with burglary to an average household is

$$0.03 \times €1,400 = €42$$

The use of probability and consequences in this way is particularly useful when considering the risk associated with multiple events or for a population as a whole. Thus, the risk associated with burglary for all households in England and Wales is €983 million (based on a €42 risk per household and 23.4 million households in total). In this case, the risk faced by the population of households represents a meaningful figure, i.e. the true cost of burglary to all households in England and Wales. This risk is apportioned amongst the households as follows:

- 3% of households face average consequences of €1,400
- 97% of households are unaffected by burglary

Thus, from an individual's perspective, the consequences of burglary will be either zero (if they don't get burgled), or £1,400 (if they do).

From an individual's perspective, the perceived risk could vary anywhere between €0 (if they do not consider any probability that they will be burgled) to several million €s if they have significant valuables and perceive that burglary is a real possibility.

12.2.2 Quantifying the potential rewards (or gains)

There is no term in general use that is the antonym of risk. Therefore, in this project, the term reward is used to describe the possibility of (or expected value) of the benefit or gain, defined as the combination of:

- The probability / likelihood of a desirable event or outcome occurring; and
- The resulting consequences / impacts if the desirable event occurs.

The following provides an example showing how the expected value of the reward or benefit associated with winning the lottery could be quantified.

- The probability of matching all six numbers is 1 in 13,983,816;
- Let's say that the lottery jackpot stands at €3 million;
- Therefore, the 'reward' associated with winning the lottery is

$$1 / 13{,}983{,}816 \times €3{,}000{,}000 = €0.2$$

The quantified value of the 'reward' or 'gain' to an individual is therefore €0.2. If the loss associated with acquiring the ticket (i.e. the purchase cost) is €1, it can be seen that the loss outweighs the gain (€1 x 100%). However, the prospect of winning the jackpot of €3 million is sufficient to entice millions to enter each week. This is just one example that demonstrates that simply comparing the losses and gains faced by an individual does not provide a reliable basis to predict or forecast behaviour.

12.2.3 Example

The following provides an example showing how the risks and rewards (or losses and gains) can be quantified. The example does not relate to a Smart Grid initiative, but at the related issue of energy efficiency, namely the provision of free loft insulation to households.

This example is taken directly from the Sub-task 3 report.

The potential losses (risks)

The following list represents concerns that might typically be expected to be raised by householders in relation to an offer for free loft insulation.

- Minor damage to property, such as scratched paintwork as workmen carry ladders in and out of the home;
- Major damage to property, for example, caused by poorly qualified tradesmen;
- Damage to wiring due to poor workmanship;
- Inconvenience associated with emptying the loft, and sorting out possessions.
- Potential theft of valuable items by unscrupulous tradesmen.

Each of these is considered in the following Sections.

Minor damage to property

There is a perceived risk that tradesmen do not always take sufficient care when working in other people's homes, and as a result, there is always the possibility that minor damage can occur. For example, it is the author's own experience that tradesmen have accidentally scratched paintwork whilst carrying ladders into the house to gain access to the loft space. The consequences of such damage can be quantified by considering the cost of repair. For the purposes of this example, it is assumed that repairs can be carried out for a modest amount, say €30. The amount will, of course, vary from property to property, reflecting the nature of the house. For example, the consequences in a very grand and newly decorated house would be expected to be much greater than that in a modest house that was already in need of decoration.

The probability of damage occurring is more difficult to assess. In the author's own experience, such minor damage has occurred on one of the three occasions that tradesmen have brought ladders into the house. Information on how often such instances occur across the general population is not readily available. Therefore, for this example, the probability of minor damage occurring is assumed to be 33% (i.e. damage occurring once in every three occasions).

It is recognised that the actual probability of minor damage occurring is likely to be lower. However, what is important to the individual, is their own assessment of the potential losses, is their perception of the probability of failure.

Thus the risk associated with minor damage is estimated to be:

Risk of minor damage= €30 x 0.33 = €10

Major damage to property

Following on from the above, there is also the possibility that tradesmen may not be properly qualified to undertake the task required, and as a result major damage to property could be incurred. For example, an incompetent installer may fall through the ceiling or damage wiring whilst fitting loft insulation.

The risk associated with major ceiling damage can therefore be determined with reference to the cost of repairing the ceiling and the likelihood of it occurring. For the purposes of this example, the following assumptions are made:

- The cost of repairing a damaged ceiling = €200
- The likelihood of an installer causing ceiling damage = 1 in a 1000 installations.

The consequence associated with damaged wiring could be fairly modest (say €150 to make good any direct damage to the wiring itself) or could be significant (say several thousands of Euros due to the resulting impact of a fire caused by the damaged wiring). The likelihood of either of these events occurring is extremely low, and for the purposes of this example the following assumptions are made:

- Likelihood of damage to wiring (no consequential impact) = 1 in a 1000 installations
- Likelihood of fire damage arising from faulty wiring < 1 in 1,000,000 installations

Therefore the risks associated with major damage to property are as follows:

Risk of damage to ceiling = €200 x 0.001 < €1
Risk of damage to wiring (no consequential impact) = €150 x 0.001 < €1
Risk of fire damage arising from faulty wiring = €500,000 x 0.000,001 < €1

The overall risk of major damage is estimated (in this particular example) to be negligible, (i.e. < €1)

Inconvenience

Inconvenience relates to the time that must be spent by the householder, which can include time wasted while the survey and the installation take place. In addition, householders may need to empty the loft of their possessions, which may then need to be stored elsewhere or placed back into the loft afterwards. This may also require the householder to sort through their possessions to determine what needs to be kept and what can be disposed of. These processes all take time, and with people having increasingly busy lifestyles, a resource that is not always readily available.

This ‘hassle factor’ has been recognised as a major barrier to the installation of loft insulation by the UK’s Department of Energy and Climate Change[87].

For the purposes of this example, it is assumed that the total time that a householder needs to spend to empty and relocate the contents of their loft space is 8 hours. In this case, it is assumed that this is a certainty (i.e. the probability of this amount of time being required is 100%).

In order to be able to add up the different elements of risk, it is necessary to relate all consequences in a single unit of measurement, i.e. a monetary value (€). Thus, a monetary value needs to be placed on a unit of time wasted.

The value placed on a unit of time will vary from one individual to another, and for one individual will vary according to the specific circumstances (i.e. a unit of time wasted when they are travelling to/from work could be valued differently to the time wasted on other journeys). A guide by the UK Department for Transport[88] provides some monetary examples of the value of time spent travelling. For workers, the average market price of time spent travelling is around £34/hour (or around €40/hour). For non-workers, this value reduces to around £6/hour (approx. €7/hour). Most people are likely to fall some-where between these two values, and therefore, for the purposes of this example, it is assumed that time is valued at €10/hour, i.e. towards the lower end of this range.

Therefore the risks associated with time wasted are as follows:

Consequences = €10/hour x 8 hours = €80

Likelihood of wasting 8 hours = 100%

Risk of associated with time wasted = €80 x 1 = €80

Theft

Householders may also dislike tradesmen entering their home due to the perceived risk that a valuable item may be stolen by an unscrupulous individual. An estimate of the likelihood of this happening has been determined by considering crime statistics for the UK.

The number of thefts from UK households in 2012 was 1.4 million, of which around 8 per cent (approximately 0.1 million households) related to thefts from inside a house. It is likely that only a very small proportion of these were undertaken by workmen who were authorised to be in the property. For the purposes of this example, a figure of 10% is assumed. The total number of households in the UK is 26 million, therefore, the likelihood of having something stolen by a workmen whilst they are in a property is very small – 4 households in every 100,000 properties (0.00004).

[87] Removing the hassle factor associated with loft insulation: Results of a behavioural trial, Department of Energy and Climate Change, September 2013
[88] Values of Time and Vehicle Operating Costs, October 2012, Department for Transport, Transport Analysis Guidance

Therefore, even if the value of the item is high (say €1000), the risk is low due to the low probability of it occurring.

Overall losses

The overall losses for this particular example (based on the assumptions highlighted) are therefore estimated to be around €90, as highlighted in Table 12.2

Table 12.2 Summary of losses

Type	Consequence (€)	Probability	Risk (€)
Minor damage			
scratched paintwork	30	0.33	10
Major damage			
damaged ceiling	200	0.001	< 1
damaged wiring – no consequential impact	150	0.001	< 1
fire damage arising from faulty wiring	500,000	0.000001	< 1
Inconvenience			
time wasted	80	1	80
Theft			
loss of valuable item	1000	0.000004	< 1
Total			**~ 90**

The potential gains (rewards)

The main benefit to the householder of receiving loft insulation is the reduced energy losses from their home. If the home is poorly heated, this benefit would be taken in the form of improved comfort. However, if the home is maintained at a comfortable temperature, the benefit would be taken in the form of reduced heating bills. The latter is considered here.

The energy cost saving realised by a householder will depend upon many factors, including

- How many hours each day the home is heated
- The size of the property
- The temperature at which the home is maintained

The energy cost saving for a gas-heated, three-bedroomed semi-detached home in the UK is estimated to be £180 per year[89].

In addition to the energy cost savings, the amount of CO2 released into the environment is reduced by an estimated 730 kg per year. This benefit will not be seen directly by the householder, and hence no value is attributed.

Whilst firms in the UK are charged per tonne of CO2 for fuels used for power generation, there is no direct value to the householder for reducing CO2 emissions. The price to large firms is currently set at £16 per tonne, but the UK Government has set goals for the price to

[89] Energy Saving Trust, http://www.energysavingtrust.org.uk/Insulation/Roof-and-loft-insulation, accessed 21 June 2013

reach £30 by 2020 and £70 by 2030[90]. At the current CO2 price, the benefit associated with the reduction in emissions of 730 kg per year is approximately £12 per year.

Some individuals will gain a significant 'feel good factor' from reducing their carbon footprint, and may therefore value their actions at (or even above) £12/year. However, this is assumed not to be the case for the individual in this example.

Therefore, the total gain, or reward, associated with this example is estimated to be £180/year, or €210.

Comparing the gains and the losses

The potential risks associated with having loft insulation for the example householder, in this case, amount to around €90. The potential rewards, however, amount to €210 per annum – i.e. they are received over the lifetime of the property.

On a purely rational economic basis, it would seem that householders should accept the offer as the rewards significantly outweigh the risks. However, as highlighted in Section 8.3, experience shows that a small, but sizeable, proportion of homes do not take up the offer of free loft insulation.

As previously discussed in Section 7, there are a number of factors that impact on the decision making process. Three of the factors which are considered to be particularly pertinent here are as follows:

- different treatment of risks and benefits;
- faulty discounting; and
- estimating the probability of events.

Risks and rewards (or losses and gains) are not treated in the same way; therefore, it is not practical to directly compare losses with gains. Rather, the pain of losing €100 is significantly more painful than the pleasure of winning €100.

Faulty discounting (Section 7.7.3) means that customers would much prefer to receive immediate rewards and defer payments for as long as possible, even if the outcome is less favourable that paying up-front and receiving rewards in the future. In the loft insulation example, however, payment is made up front (at the time of installation), whilst savings are spread out across the year. In this case 'payment' relates to the investment in time that customers must make to enable the installation to take place.

[90] Carbon price floor consultation: the Government response, HM Revenue & Customs, HM Treasury

Individuals also apply a number of 'biases' when making a judgement on how likely they think that something will happen. This can lead to individuals assigning a probability that is very different to that of '*industry experts*'. There are a range of such 'biases' including[91]:

- Conservatism, which is the tendency to underestimate high likelihoods but overestimate low ones.
- Exaggerated expectation, where real world evidence tends to be less extreme than expectations.
- Negativity bias, which is the tendency for an individual to pay more attention to and give more weight to negative rather than positive experiences.
- Pessimism, which is the tendency for individuals to overestimate the likelihood of negative things happening.
- Recency bias, which is the tendency for individuals to place much more reliance on events that have happened recently, rather than those that occurred in the past.

Another example of the factors that impact the ability of an individual to judge the likelihood of an event is the 'Availability Heuristic'. In this case, an individual makes a judgment based on how easy it is for them to think of examples, i.e. the easier it is to think of examples, then the more likely it is to happen. This would suggest that if one householder can think of a specific example of a negative (or positive) outcome occurring in relation to the role out of Smart Metering or Smart Grids, then it is possible that they will assume there is a high possibility that this could also happen to them, even if statistics show that the likelihood is very small. For example, it is not unknown for individuals to discount the theory that smoking causes cancer because they knew someone who smoked 20 cigarettes a day and reached the age of 90.

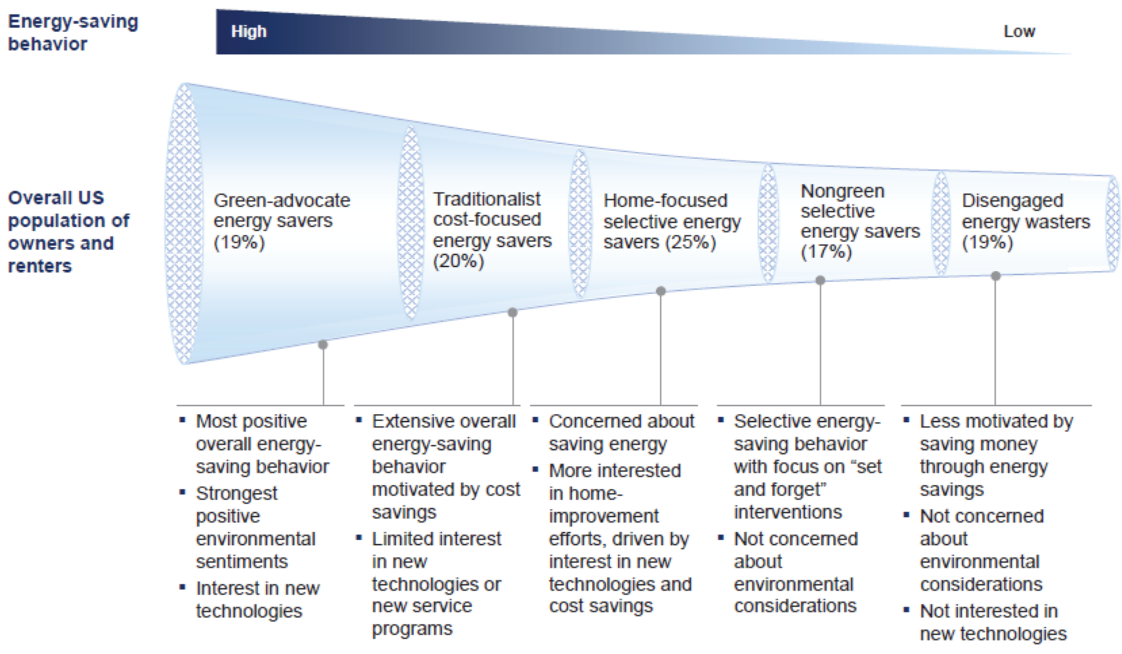
Although quantifying the losses and gains in this way does not provide a reliable indication of how an individual with behave, it does provide a high level overview of the potential concerns. In this example, it shows that the highest component in the overall risk is the time element. Time is a non-renewable resource, and an increasingly rare resource, as lifestyles become more hectic and working hours longer. Recognising this, loft insulation schemes now offer consumers the option of paying for a service to help empty out their loft.

This process of quantifying losses and gains is only meaningful if it is approached from the perspective of the individuals concerned, and within the relevant context. By considering specific consumer segments, the results could help implementers address specific consumer concerns.

[91] List of cognitive biases, http://en.wikipedia.org/wiki/List_of_cognitive_biases

12.3 Segmentation models

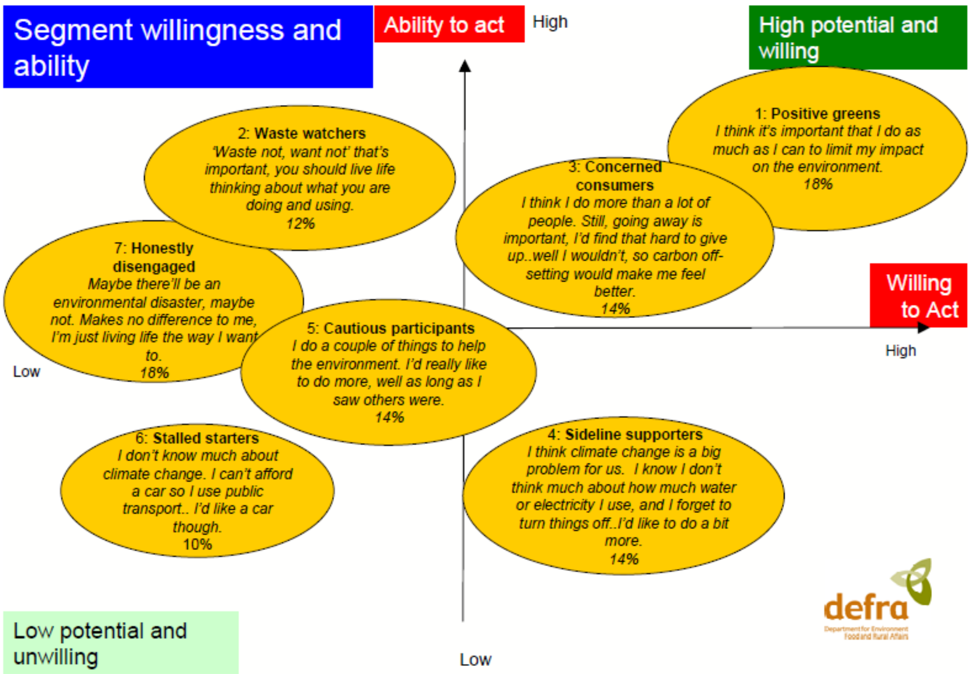
A number of different studies have been published proposing various methods of segmenting populations for the purpose of influencing their energy consumption behaviour. Some approaches deal principally with attitudes to energy consumption while others target energy consumption within the context of wider environmental behaviours. The brief summaries below aim to provide an introduction to some of the work available. A limited number of relevant studies have been published that examine the business sector and these too have been included.

Using a consumer-segmentation approach to make energy-efficiency gains in the residential market David Frankel, Stefan Heck, Humayun Tai, McKinsey & Company	
Date	2013
Population	US
Scope	Assist industry participants to focus messages and value propositions, converting more customers onto the right energy-efficiency actions.
Purpose	To assist those supplying energy-efficiency products to US residential customers
Summary	Based on consumer attitudes, behaviours and demographic indicators.
Categorisation	
Web link	http://www.mckinsey.com/~/media/McKinsey/dotcom/client_service/EPNG/PDFs/Using_a_consumer-segmentation_approach_to_make_energy-efficiency_gains_in_the_residential_market.

A Framework for pro-environmental behaviours Department for Environment, Food and Rural Affairs, UK	
Date	January 2008
Population	UK, particularly England
Scope	Wider environmental attitudes incorporating micro-generation, energy management and efficiency
Purpose	To assist all sectors interested in supporting greener lifestyles
Summary	Population split into seven categories. It judges the likelihood of members of each segment taking action on particular issues (see below). It provides information on the likely socio-demographics, lifestyle, motivations and barriers and knowledge and engagement of each segment. It may be of particular use to those concentrating on the English market.

Categorisation

The seven population segments



Web link	http://archive.defra.gov.uk/evidence/social/behaviour/documents/behaviours-jan08-report.pdf

Segmentation for sustainability: The Development of a Welsh Model to Engage the Public in Sustainability-Related Issues, Wooter Poortinga and Andrew Darnton, Welsh School of Architecture, Cardiff University	
Date	January 2014
Population	Wales, UK
Scope	Attitudes to sustainability and environment (including household energy use) within a Welsh context
Purpose	Tool to assist engaging the Welsh public in sustainability related behaviours
Summary	This Welsh-centric study has concentrated on mapping core personal values and public beliefs into six population categories. In order to ensure that the categories are less vulnerable to change the authors specifically excluded behaviour from the survey. The study was based a nationally representative questionnaire of 1,538 people.

Categorisation

Enthusiasts
- Engaged
- Positive views on all aspects of sustainability
- Concern about climate change

Pragmatists
- Slightly less engaged than 'Enthusiasts'
- Relatively concerned about climate change
- Only moderately engaged with environmental sustainability and energy security issues

Aspirers
- Interested in self-enhancement
- Open to change
- Endorse economic sustainability but less concerned about energy security

Community Focused
- Typically conservative approach but engaged with their community
- Probably pro-environmental beliefs but prioritise the economy
- Highly sceptical about climate change but very concerned about energy security

Self-Reliant
- Very disengaged,
- Negative views on environmental sustainability, sustainable living and economic sustainability,

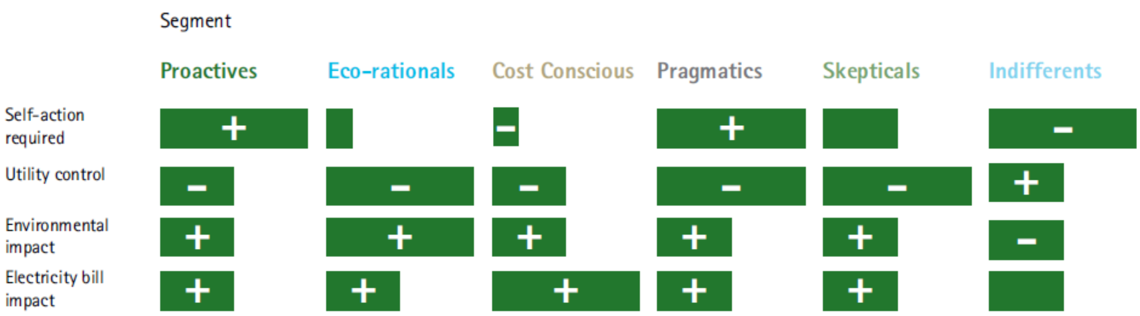
Web-link	http://www.cardiff.ac.uk/archi/images/working%20papers/WSA%20Working%20Paper%2001-2014.pdf

Engaging the New Energy Consumer, Accenture	
Date	2010
Population	Global
Scope	Attitudes towards the energy sector and energy consumption
Purpose	To assist companies operating in the energy sector understand their market
Summary	This report suggests that energy providers marketing new products and services should be trying to understand consumers' attitudes and behaviours to assist them to promote the uptake and regular usage of products.

Categorisation

- **Proactives:** willing to take action to reduce appliance use but low interest in reducing their environmental impact
- **Eco-rational:** high interest in reducing their environmental impact, energy efficiency products and services, highest willingness to decrease their comfort level
- **Cost conscious:** highest sensitivity to electricity bill savings, highest trust level towards electricity provider, most likely to be discouraged by more complicated bills or energy management schemes that require their time,
- **Pragmatics:** lowest acceptance of utility control, sensitive to bill savings, less willing to adopt new technology
- **Skepticals:** lowest acceptance of utility control or trust of electricity provider, lowest sensitivity to bill savings or social pressure,
- **Indifferents:** higher acceptance of utility control, lowest willingness to reduce use of major appliances, less likely to think electricity has a negative environmental impact, inhibited by bill complexity or time commitments

Figure 6.
Weighting placed on adoption decision criteria by each segment.



Web link http://www.accenture.com/SiteCollectionDocuments/PDF/Engaging_New_Energy_Consumer_10-0230_May_2010.pdf

The end-users as starting point for designing dynamic pricing approaches to change household energy consumption behaviours, Dr. S. Breukers and Dr. R. Mourik, DuneWorks B.V.	
Date	2013
Population	The Netherlands
Scope	Taking the end-user as a starting point in the design of dynamic price incentives.
Purpose	To assist Dutch DSOs to create effective demand shifting offering that encourage householders to change their energy behaviours.
Summary	This report encourages DSO's to consider the individuality of the end user and ensure that appropriate offerings are designed for them and offered to them. Segmentation offers a means towards this approach. It addresses attitudes, motivation, levels of awareness and reported actual behaviour.

Categorisation

Idealistic Savers
- Show most effort to save energy
- Driven by idealism
- Willing to make financial sacrifices and impose restrictions.
- Knowledgeable

Selfless inconsistent energy savers
- Highly motivated.
- Show significant energy saving activities
- But inconsistent in terms of energy efficiency

Thrifty energy savers
- Support energy saving as long as it does not bring financial consequences.

Materialistic energy savers
- Do little to save energy
- But are open to energy efficiency measures for the home

Comfort orientated indifferent energy consumers
- The least likely to adopt energy saving behaviours
- Indifferent about societal impacts of increasing energy consumption on
- Behaviour is driven by their desire to achieve personal comfort

Problem conscious welfare-orientated energy consumers
- Not enthusiastic about saving energy
- Aware of the consequences of their behaviour
- Believe that energy saving behaviour can make a difference
- But, do not feel need to act

Web link	http://www.netbeheernederland.nl/WMSDownload/Download?file=SHsqKq417xZISEnzZyMvv4MNd0FTe90IwySMfKK67AFWYdZd8Tp80OzgROZAZi%2BI&sectionName=Nieuws%20-%20Persberichten&type=files.

Segmenting the energy market: problems and successes, Lyndon Simkin and Sally Dibb, The Open University	
Date	2011
Population	UK
Scope	Energy supply.
Purpose	Study of the experience of a UK energy supplier attempting to introduce customer segmentation into its business
Summary	This document explores the process of implementing a customer segmentation approach for business and residential customers within one of the large UK energy suppliers. While the document is subject to business confidentiality requirements it provides an insight into the company's approach and some information about the categories that commercial customers were organised into.

Categorisation

Examples of multi-site organisation segments

Energy Savvy	Low awareness Purchasers	Site churners	Frequent Switchers
• Large, multi-site, energy aware businesses (e.g. retail chains, hotel groups, large manufacturers) • Usually have knowledgeable in-house energy team • Want significant cost savings • Reliable multi-site bills important	• Multi-site customers • Want to save costs • Not energy-savvy • Not focused on energy trends	• Multi-site operators • Have quick turn-over of site portfolios, • Price is important but highly value service levels to address frequent property portfolio changes.	• Multi-sited frequent switchers, • Fully deal-lead, • Little supplier loyalty,

Examples of commercial small business segments

Independents	Ego-stroked Proprietors	The Buyers
• Price-conscious owners of small companies (e.g. shops or business services), • Focused on reducing costs and increasing profitability, • Influenced by media views.	• Deal seeking local chains/SMEs • Entrepreneurs ego must be pampered and owner made to feel important	• Energy-aware light manufacturers and small industry, • Have professional energy buyers and facility managers, • Want a simple buying process • Looking for good value.

Example of Public Sector Segments

The Professionals	No Change Traditionalists
• Professional purchasing managers • Focused on value for money and good service • Increasingly concerned about carbon footprint and green issues • Often have in-house energy specialists or advising consultants,	• Risk-averse public sector traditionalists, • Committee-led decision-making, • Influenced by their own networks and activities of similar organisations

Web link	http://www.emeraldinsight.com/journals.htm?articleid=1953962

12.4 Task 24 Evaluation and Monitoring Tool

Recognising the need for a consistent tool to enable the results of initiatives involving an element of energy behaviour change to be compared, work has commenced on the development of a tool to evaluated programs aimed at delivering energy behaviour change within Task 24 of the IEA DSM Implementing Agreement[92]. This is largely based on the work of Beth Karlin and Rebecca Ford[93].

This work developed an initial 'tool' to enable the outcomes of trials involving an element of behaviour change to be monitored. The factors considered by this tool include:

- Demographics: gender, age, race, marital status, income, education level, whether the participant would describe themselves as an "environmentalist";
- Housing: type of dwelling (flat, house etc.), time at address, anticipated time before moving home, ownership status (own or rent home), number of people at home and number of rooms;
- Attitudes: the participant is asked to rate statements to assess their energy consciousness, social norms, performance efficacy (whether they feel able to reduce/manage their energy use), response efficacy (how much of an impact they feel they can have) and motivations;
- Behaviours: the participant selects any energy efficiency investments they have already made (e.g. installed insulation or made their lighting more energy efficient) and how often they carry out certain energy efficient behaviours (e.g. limiting time in shower, turn off appliances which are not in use);
- Knowledge: a series of statements which the participant indicates whether they agree or disagree, to show whether they understand ways in which they can reduce energy use (e.g. do they agree or disagree that "energy efficient light bulbs use a quarter of the electricity and last 10 times as long as regular bulbs"); and
- User Experience: participants are asked about how easy they found it to use the intervention (e.g. information provided) and how likely they would be to use it again.

The tool specifies that monitoring should be designed to capture the participants' feelings throughout the scheme. This could be evaluated at the following points:

- Before the trial/scheme: a questionnaire including 'Context', 'Attitudes', 'Behaviours' and 'Knowledge' from the list above;
- After the initiative has been implemented: 'User Experience' questions; and
- After a delay (particular for initiatives which aim for a change in habitual behaviour, or increasing knowledge): a repeat of the questions regarding 'Knowledge', 'Attitudes' and 'Behaviours' from the list above.

Elements of the tool could be adapted to evaluate the effectiveness of the Smart Grid initiatives developed using the Step-by-Step approach described in this guidance document.

[92] Task 24 – Closing the Loop – Behaviour Change in DSM, From Theory to Policies and Practice
[93] Karlin, B., Ford, R., (2013) Beyond kWh: A New Tool for Assessing Behaviour-Based Energy Interventions. 2013 International Energy Program Evaluation Conference, Chicago. Unpublished

13 Further reading

IEA Task 23 Reports

The Impact of Electricity Markets on Consumers, Sub-Task 1 report for IEA DSM Task 23 The Role of the Demand Side in Delivering Effective Smart Grids, January 2013

Interaction between Consumers and Smart Grid Related Initiatives, Sub-Task 2 report for IEA DSM Task 23 The Role of the Demand Side in Delivering Effective Smart Grids November 2013

How risks and rewards from the perspective of customers affects the decision to engage in Smart Grids, Sub-Task 3 report for IEA DSM Task 23 The Role of the Demand Side in Delivering Effective Smart Grids November 2013

IEA Task 24 Reports

Analysis of case studies IEA DSM Task 24 Closing the Loop - Behaviour Change in DSM: From Theory to Practice, Mourik, R and Rotmann, S. November 2013.

The Monster. Subtask 1 analysis of IEA DSM Task 24: Closing the Loop: Behaviour Change in DSM – From Theory to Practice, Mourik, R and Rotmann, S. November 2013.

Other IEA DSM Publications

Practical Guide to Demand Side Bidding, Report for IEA DSM Task 8 Demand Side Bidding in a Competitive Electricity Market, December 2006

Energy Practice

Comfort, Cleanliness and Convenience, The Social Organization of Normality, Elizabeth Shove, July 2003, Berg Publishers

Decision Making

Predictably Irrational, Dan Ariely, 2009, Harper Collins

Nudge, Thaler and Sunstein, Penguin

Glossary

A

Aggregators	Intermediaries that help consumers take part in activities such as demand response. They often pool together a number of consumers to provide valuable resource to other interested parties.

B

Balancing Mechanism	This is one of the tools that the System Operator in GB (National Grid) uses to balance electricity supply and demand close to real time. Where National Grid predicts that there will be a discrepancy between the amount of electricity produced and that which will be in demand during a certain time period, they may accept a 'bid' or 'offer' to either increase or decrease generation (or consumption). The balancing mechanism is used to balance supply and demand in each half hour trading period. Similar mechanisms exist elsewhere.
Balancing Services	Services procured by the Transmission System Operator to maintain the quality and security of supply.

C

Centralised generation	Large generators connected to the Transmission System. They provide bulk power.
Constrained network	A network is constrained when it is unable to transmit the power supplied to the location of demand due to congestion on the network.
Consumer	End user of electricity. They may also own their own generation equipment, in which case they could also be referred to as a 'prosumer'. The scope of this document refers specifically to the following end-users: Domestic consumers Small and medium sized businesses

D

De-centralised generation	Energy generated from a number of small, de-centralised sources, often connected to the distribution network.
Diffusion of Innovations theory	A theory that seeks to explain how, why and at what rate new ideas and technologies are spread through cultures.

Distribution Network Operator	The owner and operator of the network of cables and equipment that take electricity from the transmission network to the end-user. These networks traditionally are 'dumb', with little monitoring of the quantity of electricity flowing through it. This system was designed with the expectation that electricity would only flow one way through the system.
Distribution System Operator	See Distribution Network Operator
Dynamic load shifting	Changes in electric usage by end-users compared to their normal pattern of consumption in response to fluctuations in the price of electricity or a remote control signal.

E

Early Adopters	This is the second fastest category of individuals who adopt an innovation (see Diffusion of Innovations Theory). They have the highest degree of opinion leadership among adopter categories.
Early Majority	Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters.
Economy 7	The name given to a type of Time of Use tariff used in the UK that provides consumers with 7 hours of low cost electricity during the night, with a higher rate charged for the remainder of the day.
Energy behaviour	An action that impacts on the use of energy, i.e. switching off lights, buying low energy light bulbs, reducing the indoor temperature or deciding when to use the washing machine, deciding what type of washing machine to purchase.
Energy practice	An activity that involves the use of energy, such as washing clothes, personal hygiene, entertainment and leisure activities.
Energy Regulator	An organisation responsible for regulating the energy sector.
Energy Service Company	An organisation that provides a wide range of energy solutions to end-users.
Energy Supplier	An organisation that buys electricity from generators and sells it to end-users.

H

Habitual Behaviour	Routine behaviour, i.e. something that is repeated and often goes unnoticed by the person performing the behaviour.
Heat pump	A device that absorbs heat from a colder area and transfers it to a hotter area.

Housing associations	A not for profit organisation that rents houses and flats to people on low income or other special needs.
Hybrid heat pump	A hybrid heat pump combines a heat pump with an alternative (non-direct-electric) source of heat, such as a gas.

I

Innovators	Innovators are the first individuals to adopt an innovation (see Diffusion of Innovations Theory). They are willing to take risks, are therefore willing to adopt technologies which may ultimately fail.
Intermittent generation	A source of electricity generation that is not continuously available due to a factor outside of any direct control. For example, wind power, which varies according to the strength of the prevailing wind.
Inverted block tariff	An Inverted block tariff has a tiered pricing structure whereby the price per unit of electricity increases as electricity usage increases. Therefore, higher usage customers pay a higher marginal rate than those with a lower consumption. This price signal is intended to encourage energy efficiency.

L

Laggards	Individuals in this category are the last to adopt an innovation (see Diffusion of Innovations Theory). They typically have an aversion to change, and are focused on "traditions".
Late Majority	Individuals in this category will adopt an innovation (see Diffusion of Innovations Theory) after the average member of the society. They approach an innovation with a high degree of scepticism and after it has been adopted by the majority of society.

N

Network Capacity	The maximum capacity of a network to transmit power to the location of demand

P

Permanent load shifting	Changes in electric usage by end-users leading to a new, normal pattern of consumption.

S

Self-efficacy	The extent of an individual's belief in their ability to perform a task.

Smart Grid	An electricity system that integrates the actions of all users that are connected to the system (generators, consumers and those that do both) in order to efficiently deliver sustainable, economic and secure electricity supplies.
Smart Grid Initiative	An initiative involving Time of Use Tariffs, Feedback, Advice or Remote Control to motivate consumers to change their energy behaviour.
Smart Meter	An electronic device that records consumption information at regular intervals, usually of an hour or less, and is able to communicate this information to a central registry. The central registry can communicate information to the smart meter.
System Frequency	A continuously changing measurement determined by the total amount of generation being feed into an electricity network and the sum of electricity demand. If demand is greater than generation, frequency falls, but if generation is greater than demand then frequency rises. A System Operator is usually expected to maintain system frequency within set boundaries. If system frequency is not managed there is the potential for blackouts to occur.
System Operator	See Transmission System Operator

T

Technology developer	An organisation involved in the development of new technologies
Thermal storage	The storage of heat for later use.
Third party	An intermediary, typically between consumers and energy suppliers / network operators
Time of Use tariff	A tariff whereby the price of electricity varies by time of day. In the context of this report, this includes all of the following: - Static time of use tariffs (where-by the price varies within the day, but there is no change from day to day) - Dynamic time of use tariffs (where the price varies within the day and from day to day) - Critical peak pricing, where prices vary during specified events, the day and time of which are not known in advance. At other times, either a flat rate, or a static time of use tariff will apply.
Transmission Operator	The owner and operator of the high voltage system that takes electricity from central generation sources to the low voltage, local, network usually operated by a distribution network operator.
Transmission System Operator	As well as the responsibilities of a Transmission Operator, a Transmission System Operator will have responsibility for ensuring that the correct amount of electricity is fed into the Transmission Network at appropriate points and that the quality of supply is maintained.

U

Unbundled network	The separation of the various activities associated with electricity production and delivery, i.e. generation, transmission, distribution and supply).

Abbreviations

DSM	Demand Side Management
DNO	Distribution Network Operator
DSO	Distribution System Operator
EV	Electric Vehicle
IEA	International Energy Agency
IHD	In Home Display
IRL	Initiative Readiness Level
Micro CHP	Micro Combined Heat and Power
MRL	Market Readiness Levels
PV	Photo Voltaic
SME	Small to medium sized enterprise
ToU	Time of Use
TRL	Technology Readiness Level

Appendix I Overview of the International Energy Agency and the Implementing Agreement on Demand Side Management Technologies and Programmes

The International Energy Agency (IEA) is an autonomous agency established in 1974. The IEA carries out a comprehensive programme of energy co-operation among 28 advanced economies, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The aims of the IEA are to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

To attain these goals, increased co-operation between industries, businesses and government energy technology research is indispensable. The public and private sectors must work together, share burdens and resources, while at the same time multiplying results and outcomes.

The multilateral technology initiatives (Implementing Agreements) supported by the IEA are a flexible and effective framework for IEA member and non-member countries, businesses, industries, international organisations and non-government organisations to research breakthrough technologies, to fill existing research gaps,, to build pilot plants, to carry out deployment or demonstration programmes – in short to encourage technology-related activities that support energy security, economic growth and environmental protection.

More than 6,000 specialists carry out a vast body of research through these various initiatives. To date, more than 1,000 projects have been completed. There are currently 41 Implementing Agreements (IA) working in the areas of:

- Cross-Cutting Activities (information exchange, modelling, technology transfer)
- End-Use (buildings, electricity, industry, transport)
- Fossil Fuels (greenhouse-gas mitigation, supply, transformation)
- Fusion Power (international experiments)
- Renewable Energies and Hydrogen (technologies and deployment)

The IAs are at the core of a network of senior experts consisting of the Committee on Energy Research and Technology (CERT), four working parties and three expert groups. A key role of the CERT is to provide leadership by guiding the IAs to shape work programmes that address current energy issues productively, by regularly reviewing their accomplishments, and suggesting reinforced efforts where needed. For further information on the IEA, the CERT and the IAs, please consult www.iea.org/techinitiatives.

The Implementing Agreement on Demand Side Management Technologies and Programmes belongs to the End-Use category above.

IEA Demand Side Management Programme

The Demand-Side Management (DSM) Programme is one of more than 40 co-operative energy technology programmes within the framework of the International Energy Agency (IEA).The Demand-Side Management (DSM) Programme, which was initiated in 1993, deals with a variety of strategies to reduce energy demand. The following member countries and sponsors have been working to identify and promote opportunities for DSM:

Austria	Norway
Belgium	Spain
Finland	Sweden
France	Switzerland
India	United Kingdom
Italy	United States
Republic of Korea	ECI (sponsor)
Netherlands	RAP (sponsor)
New Zealand	

Programme Vision during the period: Demand side activities should be active elements and the first choice in all energy policy decisions designed to create more reliable and more sustainable energy systems

Programme Mission: Deliver to its stakeholders, materials that are readily applicable for them in crafting and implementing policies and measures. The Programme should also deliver technology and applications that either facilitate operations of energy systems or facilitate necessary market transformations

The Programme's work is organized into two clusters:

- The load shape cluster, and
- The load level cluster.

The 'load shape" cluster will include Tasks that seek to impact the shape of the load curve over very short (minutes-hours-day) to longer (days-week-season) time periods. Work within this cluster primarily increases the reliability of systems. The "load level" will include Tasks that seek to shift the load curve to lower demand levels or shift between loads from one energy system to another. Work within this cluster primarily targets the reduction of emissions.

A total of 23 projects or "Tasks" have been initiated since the beginning of the DSM Programme. The overall program is monitored by an Executive Committee consisting of representatives from each contracting party to the Implementing Agreement. The leadership and management of the individual Tasks are the responsibility of Operating Agents. These Tasks and their respective Operating Agents are:

- Task 1 International Database on Demand-Side Management & Evaluation Guidebook on the Impact of DSM and EE for Kyoto's GHG Targets – Completed
  Harry Vreuls, NOVEM, the Netherlands

- Task 2 Communications Technologies for Demand-Side Management – Completed
  Richard Formby, EA Technology, United Kingdom

- Task 3 Cooperative Procurement of Innovative Technologies for Demand-Side Management – Completed
  Hans Westling, Promandat AB, Sweden

- Task 4 Development of Improved Methods for Integrating Demand-Side Management into Resource Planning – Completed
  Grayson Heffner, EPRI, United States

- Task 5 Techniques for Implementation of Demand-Side Management Technology in the Marketplace – Completed
  Juan Comas, FECSA, Spain

- Task 6 DSM and Energy Efficiency in Changing Electricity Business Environments – Completed
  David Crossley, Energy Futures, Australia Pty. Ltd., Australia

- Task 7 International Collaboration on Market Transformation – Completed
  Verney Ryan, BRE, United Kingdom

- Task 8 Demand-Side Bidding in a Competitive Electricity Market – Completed
  Linda Hull, EA Technology Ltd, United Kingdom

- Task 9 The Role of Municipalities in a Liberalised System – Completed
  Martin Cahn, Energie Cites, France

- Task 10 Performance Contracting – Completed
  Hans Westling, Promandat AB, Sweden

- Task 11 Time of Use Pricing and Energy Use for Demand Management Delivery- Completed
  Richard Formby, EA Technology Ltd, United Kingdom

- Task 12 Energy Standards
  To be determined

- Task 13 Demand Response Resources - Completed
  Ross Malme, RETX, United States

- Task 14 White Certificates – Completed
  Antonio Capozza, CESI, Italy

- Task 15 Network-Driven DSM - Completed
  David Crossley, Energy Futures Australia Pty. Ltd, Australia

- Task 16 Competitive Energy Services
  Jan W. Bleyl, Graz Energy Agency, Austria / Seppo Silvonen/Pertti Koski, Motiva, Finland

- Task 17 Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages
  Seppo Kärkkäinen, Elektraflex Oy, Finland

- Task 18 Demand Side Management and Climate Change - Completed
  David Crossley, Energy Futures Australia Pty. Ltd, Australia

- Task 19 Micro Demand Response and Energy Saving - Completed
  Linda Hull, EA Technology Ltd, United Kingdom

- Task 20 Branding of Energy Efficiency
  Balawant Joshi, ABPS Infrastructure Private Limited, India

- Task 21 Standardisation of Energy Savings Calculations
  Harry Vreuls, SenterNovem, Netherlands

- Task 22 Energy Efficiency Portfolio Standards - Completed
  Balawant Joshi, ABPS Infrastructure Private Limited, India

- Task 23 The Role of Customers in Delivering Effective Smart Grids
  Linda Hull. EA Technology Ltd, United Kingdom

- Task 24 Closing the loop - Behaviour change in DSM, from theory to policies and practice
  Sea Rotmann, SEA, New Zealand and Ruth Mourik DuneWorks, Netherlands

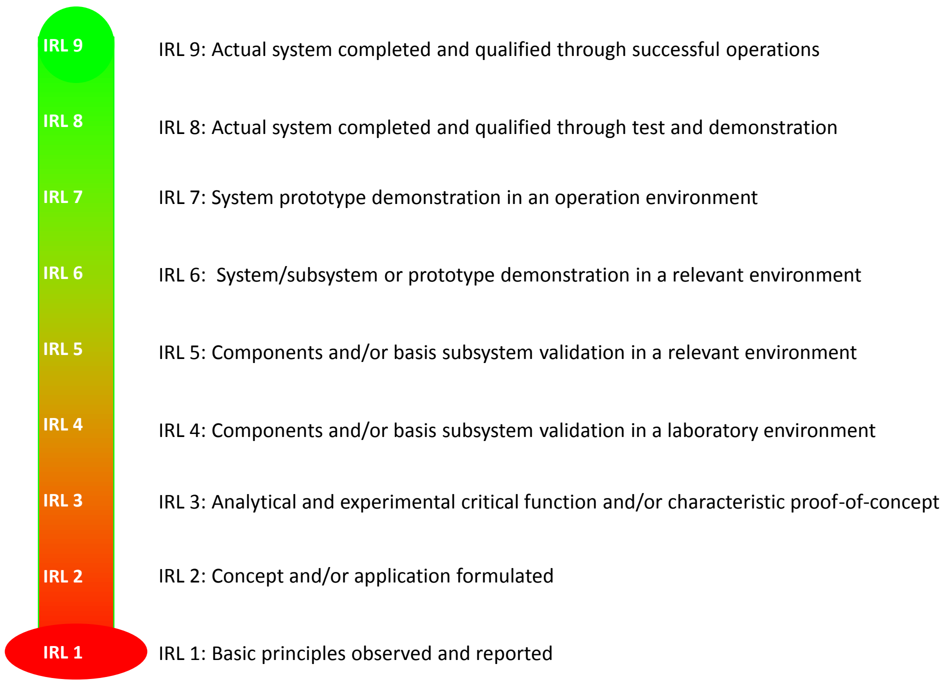
For additional Information contact the DSM Executive Secretary, Anne Bengtson, Liljeholmstorget 18,11761 Stockholm, Sweden. Phone: +46 70 7818501. E-mail: anne.bengtson@telia.com

Also, visit the IEA DSM website: http://www.ieadsm.org

Appendix II
Initiative Readiness Levels and Market Readiness Levels

Initiative readiness level

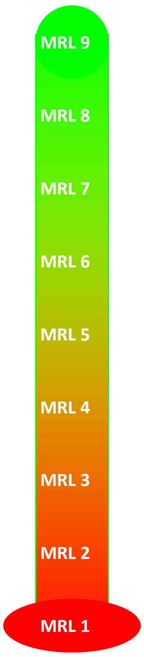
A Technology readiness level (TRL) framework is used to grade technologies on a scale of 1 to 9. The upper end of the scale, 9, indicates a technology that has been qualified through prolonged operation and a number of units are in commercial operations. The lower end of the scale, 1, indicates that only the basic principles involved in a concept have been observed and reported. An equivalent Initiative Readiness Level (IRL) was used to assess the readiness of the initiative (i.e. package of interventions within a trial), using the same scale used for assessing TRLs, as shown below.



Initiative Readiness Levels

Market readiness level

Although an initiative (i.e. package of interventions) may be sufficiently developed, the market may not be 'ready' for implementation. For example, whilst technologies might exist to allow washing machines to be remotely controlled by a third party, customers may not yet be willing to accept the intervention. The term 'Market Readiness Level' or MRL is used to describe customer attitudes towards specific Smart Grid initiatives. Unlike TRLs, there is no standard definition of a MRL scale, therefore a scale has been defined specifically for the purpose of Task 23. Again, a nine point scale has been used to ensure comparability with the TRL scale, as shown in below.



MRL 9: Approach fully understood and accepted by vast majority of consumers. (e.g. a mobile phone has become a social 'norm' rather than landlines for many calls)

MRL 8: Most consumers understand the principles, but only accepted as the 'norm' for certain groups (e.g. the use of a Smart Phone to access the internet is regarded as the 'norm' for young)

MRL 7: Benefits reasonably well understood by all, but may not be sufficient to drive demand except for certain niche markets (i.e. costs considered to outweigh the benefits) (e.g. iPAD)

MRL 6: General awareness of benefits, but majority of individuals unable to identify the costs/benefits to themselves. (e.g. need for a 3D TV not well justified)

MRL 5: Some customers actively attempting to find out more, i.e. there is some 'market pull' from early adopters, but benefits/costs not well understood by most customers.

MRL 4: Some customers aware of basic principles , but limited or no information on potential benefits/costs)

MRL 3: Some consumers starting to actively find out more

MRL 2: Some consumer awareness – but limited, small minority open minded to the idea

MRL 1: Consumers as a whole are unaware

Market Readiness Levels