



**How risks and rewards from the perspective of customers  
affects the decision to engage in Smart Grids**

**Linda Hull  
EA Technology  
Operating Agent Task 23**

**December 2013  
Version 1.1**

**International Energy Agency Demand-Side Management Programme  
Task XXIII: The Role of the Demand Side in Delivering Effective Smart Grids**

## **Contributors**

The following National Experts have contributed to this preparation of this document:

Yvonne Boerakker, DNV KEMA Nederland BV

Even Bjørnstad Enova

Chae, Yeoungjin, Korea Power Exchange

Magnus Brolin, SP Technical Research Institute of Sweden

Duncan Yellen, EA Technology

## Participants

The participants in Task 23 are as follows:

NL Agency, Netherlands

Enova, Norway

Korea Power Exchange (KPX), Republic of Korea

Swedish Energy Agency, Sweden

Department of Energy and Climate Change, UK

## Summary

This report examines a range of factors that influence the decision making of individuals. The report demonstrates that a classical economical approach does not accurately predict whether a consumer will adopt a particular initiative or technology.

The factors that are considered to influence the way consumers assess potential losses and gains associated with Smart Grids have been identified. These provide a valuable insight into how Smart Grid initiatives can be structured to help encourage participation.

The report includes a methodology for quantifying the losses and gains associated with Smart Grid implementation from the perspective of consumers, i.e. the end users of electricity. The methodology is used to quantify the potential losses and gains from the perspective of an individual for a case study relating to an offer of free loft insulation. The analysis shows that quantifying losses and gains alone is not sufficient to predict the way a proposition will be viewed by customers.

# Contents

	Page	
<b>1</b>	<b>Introduction</b>	<b>2</b>
1.1	Aims, objectives and scope	2
1.2	Report Structure	4
<b>2</b>	<b>The risks / rewards of Smart Grids</b>	<b>5</b>
2.1	Customer Decision Making	7
<b>3</b>	<b>Definition of Risk and Reward</b>	<b>10</b>
3.1	Definition of risk	10
3.2	Definition of reward	11
<b>4</b>	<b>Decision making – what theory tells us</b>	<b>12</b>
4.1	Impact of the types of choices available	12
4.1.1	Too many choices cause purchasing paralysis	12
4.1.2	Lots of choice does not necessarily lead to satisfaction	12
4.1.3	Choices designed to influence the decision maker – the use of a decoy	13
4.1.4	General comments	14
4.2	Framing Effect – how choices are presented	15
4.3	Opt-in or opt-out – the type of choice/decision to be made	16
4.4	Individuals do not treat risks and rewards in the same way	16
4.5	Risks/benefits are assessed in relative not absolute terms	17
4.6	Faulty discounting	18
4.7	Value action gap	18
4.8	Estimating the probability of events	20
4.9	Priming	20
4.10	False cause	22
4.11	Regret and the anticipation of regret	23
<b>5</b>	<b>Quantifying risks and rewards</b>	<b>24</b>
5.1	The potential losses	25
5.2	The potential gains	27
5.3	Comparing the losses and the gains	28
<b>6</b>	<b>Conclusions</b>	<b>31</b>
<b>Appendix</b>	<b>Overview of IEA Implementing Agreement</b>	

# 1 Introduction

Electricity systems are now expected to respond to challenges they were not designed to deliver, driven largely by the wide ranging measures being implemented to tackle climate change. The wide-scale deployment of time variable renewable generation, particularly wind, presents a number of challenges in relation to maintaining the balance of supply and demand. The electrification of heating in buildings and transport is a key component of the decarbonisation of heat and transport, and is leading to the introduction of new electrical loads onto often already congested networks. As a result, it is no longer considered viable for electricity to be provided 'on demand' in response to the requirements of end-users. Rather, a co-ordinated approach is required whereby energy production and demand are integrated to ensure the use of renewables can be optimised whilst also minimising the use of fossil fuel fired generation and network infrastructure investment. Such an approach is the essence of the Smart Grid concept.

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 would 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.

Therefore, a project has been established within the IEA Demand Side Management Implementing Agreement to focus on investigating the role of consumers in delivering effective Smart Grids<sup>1</sup>. The project is entitled Task 23 – The Role of the Demand Side in Delivering Effective Smart Grids. The aim and objectives of the project are described below.

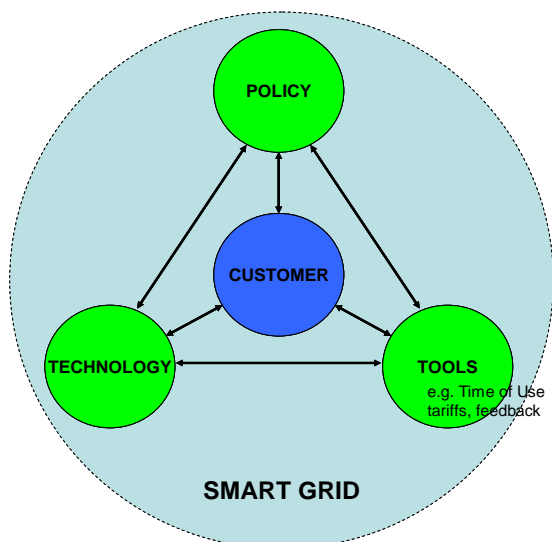
## 1.1 Aims, objectives and scope

The overall aim of the project is to explore the potential risks and rewards associated with Smart Grids from the perspective of consumers. The project draws together international experiences, and identifies best practice to ensure the demand side becomes an integral component of a successful Smart Grid. By identifying the potential risks and rewards, the Task seeks to develop best practice guidelines in order to ensure the demand side contributes to the delivery of effective Smart Grids.

The overall project focuses on the interaction of policies, technologies and tools with consumers, and examines the impact of these interactions on the effectiveness of Smart Grids, as indicated in Figure 1.1.

---

<sup>1</sup> An overview of the IEA DSM Implementing Agreement can be found in Appendix 6.



**Figure 1.1 Overview of Task 23**

There are a number of examples worldwide of Smart Grid and Smart Metering implementations. These have met with varying success and a number have experienced difficulties as a result of resistance on the part of consumers.

There are also a number of initiatives currently underway that focus on Smart Grids and Smart Metering. Examples include the International Smart Grid Action Network (ISGAN)<sup>2</sup> and other IEA activities, as well as country specific work such as US Department of Energy funded trials, and the Low Carbon Network Fund in the UK. These trials and initiatives are primarily focused on the technical aspects of Smart Grids, both in terms of the technology requirements needed for implementation and the policy measures required to facilitate the roll-out of Smart Metering. However, Task 23 specifically focusses on the customer perspective, rather than the more technological aspects.

Specific objectives of Task 23 are, therefore, to:

- Understand the impact of the structure of energy markets on the interactions of consumers with Smart Grids;
- Explore the impact of technologies on the ability and willingness of consumers to contribute towards the successful implementation of Smart Grids;
- Identify the risks and rewards associated with Smart Grids from the perspective of consumers;
- Understand the opportunity for stakeholders to influence these risks and rewards;
- Identify tools to minimise the risks and maximise the rewards associated with the Smart Grid from the point of view of the consumer, whilst still satisfying the needs of other stakeholders;
- Understand consumer reactions and preferences to offers, and the opportunities that a Smart Grid might provide (including local supply); and
- Understand regulatory options, practice and consequences.

<sup>2</sup> The IEA Implementing Agreement for a Co-Operative Programme on Smart Grids (ISGAN), <http://www.iea-isgan.org/>

The scope of the project is limited to those who are, or are expected to be, participants in a Smart Grid initiative. Specifically, the scope of Task 23 will focus on consumers with Smart Meters or those likely to have Smart Meters in the near future, and thus are expected to play an important part in Smart Grids as they become deployed. This therefore 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).

Task 23 comprises five Subtasks, as highlighted below. This report focusses only on Subtask 3 (ST3 in Figure 1.2 below), and considers the factors that influence the way that consumers decide whether or not to engage in Smart Grid related activities. In particular, it focusses on the way customers consider risks and rewards as part of the decision making process.

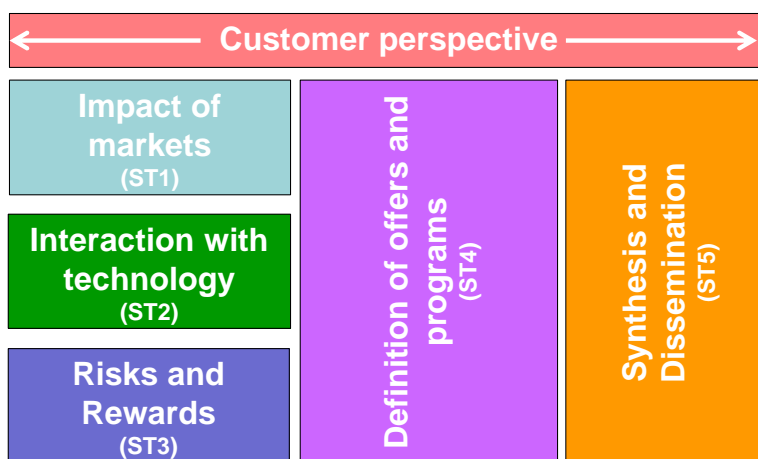


Figure 1.2 Task 23 overall work programme

## 1.2 Report Structure

This report focuses specifically on the risks and rewards of Smart Grids as viewed from the perspective of consumers. In particular, the report reviews how the assessment of risks and rewards influences consumers' decisions to engage (or not) in Smart Grid initiatives.

The report is structured as follows:

- Section 2 describes the risks and rewards associated with Smart Grids from the perspective of individual consumers. This Section also provides an overview of consumer decision making within the context of the energy behavioural model used to guide the work of Task 23.
- Section 3 provides a definition of risk and rewards. This forms the basis for a methodology for quantifying the potential upsides and downsides of Smart Grid related initiatives from the perspective of an individual consumer.
- Section 4 provides an overview of current research on a selection of factors that affect the decision making process. The results demonstrate that individuals do not make decisions that fit within a rational economic approach, whereby a purchase is only made (or approach adopted) if the benefits outweigh the costs.
- Section 5 presents a simple example to demonstrate how risks and rewards might be quantified. The example does not relate specifically to a Smart Grid related initiative, but rather looks at the related issue of energy efficiency schemes.
- The conclusions of the report are presented in Section 6.

## 2 The risks / rewards of Smart Grids

The risks and rewards associated with Smart Grids are typically considered in terms of the overall societal benefits, e.g. deferring network reinforcement that would otherwise be required to facilitate the connection of renewable generation. However, consumers are unlikely to relate directly to these outcomes. Rather, they are more likely to focus on the impact of Smart Grids on a more personal level. Table 2.1 highlights the outcomes that are considered to have a direct impact on consumers. For each category, there are a number of potential 'upsides', i.e. the potential gains or desirable outcomes that could be considered to be a benefit to an individual. Conversely, there are also a number of potential 'downsides', i.e. the potential losses that could be incurred by consumers. As is explained further in Section 3, these outcomes are referred to as consequences in the context of risks and rewards.

A number of the consequences can be associated with a unit of measurement. For example, financial consequences can be measured in terms of the monetary reward consumers receive for participating or in terms of the financial outlay they must make in order to participate. Similarly, comfort could be measured in terms of the amount of time a property is under or over-heated (or cooled), or the extent ( $^{\circ}\text{C}$ ) to which it is under/over-heated.

A 'feel good' factor relates to the reward consumers obtain when they do something simply because they feel it is the right thing to do for society in general. Although this cannot be directly measured, it could be ascertained using 'customer satisfaction' type surveys to determine whether consumers felt positively about their impact on their environment.

In order to compare the overall losses and gains associated with Smart Grids, it is useful to use a consistent unit of measurement. Here, a monetary value is most appropriate. However, placing an equivalent monetary value on the various consequence categories is a very subjective process; and the value will vary from one individual to another, and from one context to another. For example, the value placed on a change in ambient temperature of  $1^{\circ}\text{C}$  will vary from individual to individual, as will the value placed on 1 hour of time wasted or gained. For this reason, it is not practicable to consider an average monetary value for each consequence category, rather, it needs to be considered in context and with reference to the individuals affected.

Table 2.1 provides an overview of possible desirable / undesirable consequences associated with Smart Grid related initiatives. Which ones are relevant to a specific individual will vary considerably from individual to individual. Similarly, the relative value placed on each will vary from individual to individual, and potentially even from one context to another.



**Table 2.1 Desirable / undesirable outcomes associated with Smart Grid interventions from the consumer perspective**

Consequence	Unit of measurement	Potential Losses Undesirable Outcomes ☹	Potential Gains Desirable Outcome ☺
Money / financial	£, \$, € Loyalty points Reward scheme	Spend more on electricity <i>(e.g. ToU tariff &amp; consumer doesn't or can't shift demand to avoid use during peak periods)</i>	Spend less on electricity <i>(e.g. ToU tariff &amp; consumer does shift demand to avoid use during peak periods or already has a favourable pattern of consumption)</i>
		Receive a penalty for not delivering a demand reduction <i>(e.g. SME with a Demand Response contract)</i>	Receive payments for delivering demand reduction / energy efficiency <i>(e.g. SME with a Demand Response contract)</i>
		Up-front payment <i>(e.g. for technology required to enable participation)</i>	Avoided up-front payment <i>(e.g. smart technology provided for free in return for agreeing to participate in a Smart Grid initiative)</i>
Time / Inconvenience	Minutes Hours	Consumer can't use their appliances at times of peak demand <i>(e.g. customers on a restricted hours tariff or on a demand response contract may not be able to use their washing machine when they would otherwise need to)</i>	Ability to turn on / off heating remotely <i>(e.g. delay start of heating cycle when late home from work, thus avoid heating home unnecessarily)</i>
		Time taken to set up a 'contract' with a third party aggregator and register appliances <i>(e.g. to allow a heat pump to participate in a demand response programme)</i>	Ability to more easily switch electricity supplier
Comfort	°C / year of over/under heating	Reduced comfort <i>(e.g. if interruption to heating/air-conditioning system too long, e.g. if there is no option for the individual to over-ride any remote / automatic control)</i>	Improved comfort through avoided under / over-heating of house via improved control system.
Environmental	kg CO <sub>2</sub> / year	Increased CO <sub>2</sub> emissions (operation of standby generators)	Reduced CO <sub>2</sub> emissions (avoided use of fossil fired central generation)
Network Security	CMLs CIs	Reduced security of supply <i>(e.g. electricity supply turned off due to poor payment history)</i>	Improved security of supply <i>(e.g. reduced instances of black-outs/brown outs)</i>
'Feel good'	?	'Feel Bad' if can't do anything to change pattern of demand or help to reduce wastage of energy	'Feel Good' factor <i>(e.g. feeling that 'doing your bit' to help reduce impact on the climate)</i>
Health	Number of 'sick' days	Illness or ill health caused by Smart Grid technologies <i>(e.g. some people have voiced concerns over the impact of electromagnetic radiation on health)</i>	Improved health or wellbeing <i>(e.g. through improved heating/comfort levels)</i>
Safety	Could be expressed in terms of: - Financial - Time - 'feel good'	Fire arising from appliances running unattended while home is unoccupied	Remote / Automated systems could provide warnings that appliances have been left on unattended, or that no electricity use may indicate that an elderly person needs assistance
Privacy	Could be expressed in terms of: - Financial - Time - 'feel good'	Misuse of data <i>(e.g. information on patterns of consumption could indicate when a home is unoccupied, and hence provides opportunity to burglars)</i>	Data could be used to advantage of customers <i>(e.g. remote monitoring of energy consumption of appliances would be used to provide early warning of faulty appliances)</i>

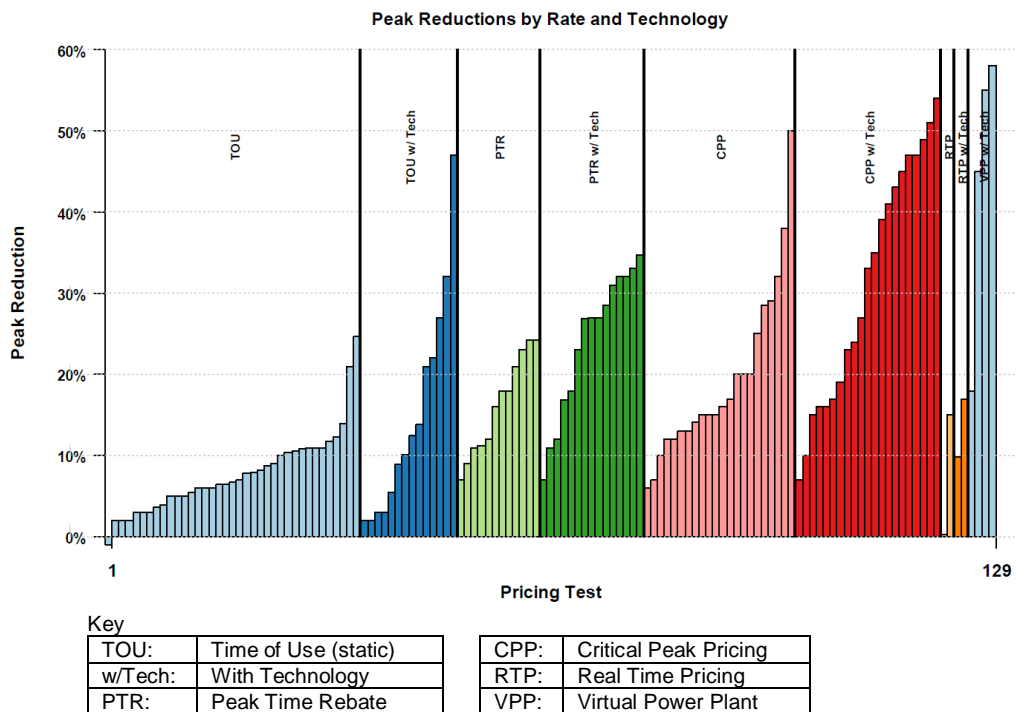
## 2.1 Customer Decision Making

Studies on the impact of new technologies typically involve an appraisal of the economic argument, i.e. does an investment in a new ‘technology’ provide a positive return compared to the alternatives? An investment appraisal can take many forms, but typically involves consideration of the costs involved compared to the savings/returns that can be achieved.

Under a classical economic model, it is assumed that an individual will invest in an opportunity if they can secure a benefit. Thus in this case, if the sum of the ‘upsides’ associated with a Smart Grid initiative is greater than the sum of the total ‘downsides’, then it would be expected that the individual would actively engage in that initiative. However this is not the case, as the following example demonstrates.

The financial benefits are often cited as a key factor in driving energy behaviour change. For example, Time of Use (ToU) tariffs are considered to be a powerful tool to motivate customers to change their pattern of consumption. Those that do change their behaviour are rewarded with reduced energy costs; those that do not, pay more.

As discussed in Subtask 1<sup>3</sup> of this project, the work of Ahmed Faruqi et al highlights the extent to which ToU pricing can lead to energy behaviour change<sup>4</sup>. Figure 2.1 shows the level of peak load reduction delivered in each of 129 individual pilots involving ToU pricing.



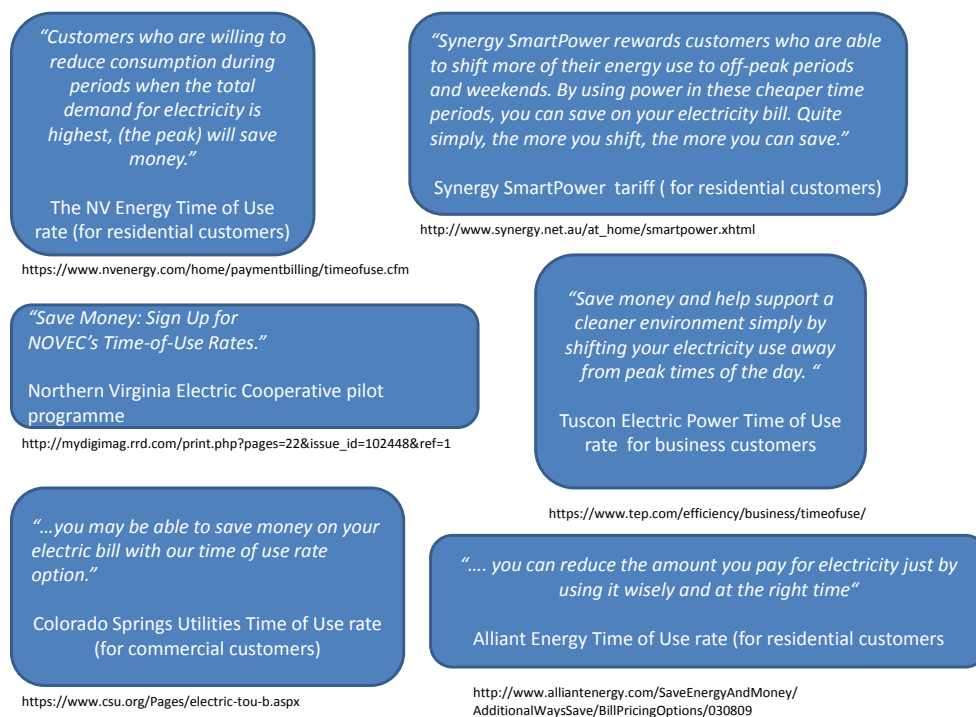
**Figure 2.1 Impact on ToU pricing on peak load**

<sup>3</sup> The Impact of Electricity Markets on Consumers, Subtask 1 Report of Task 23, The Role of the Demand Side in Delivering Effective Smart Grids

<sup>4</sup> The Discovery of Price Responsiveness – A survey of experiments involving dynamic pricing of electricity, Ahmad Faruqi and Jenny Palmer, The Brattle Group, paper submitted to EDI quarterly and accessed via <http://papers.ssrn.com> 28/09/2012

The results show that customers with ToU pricing are able to deliver significant levels of peak load reduction. It is the financial benefit that individuals derive from the tariff that is regarded to be the motivation for energy behaviour change.

ToU tariffs are often described as a means of helping customers save money on their electricity bills. Some examples of the way consumers are enticed to select a ToU tariff are shown in Figure 2.2.



**Figure 2.2 Example ToU tariff promotions by Energy Suppliers**

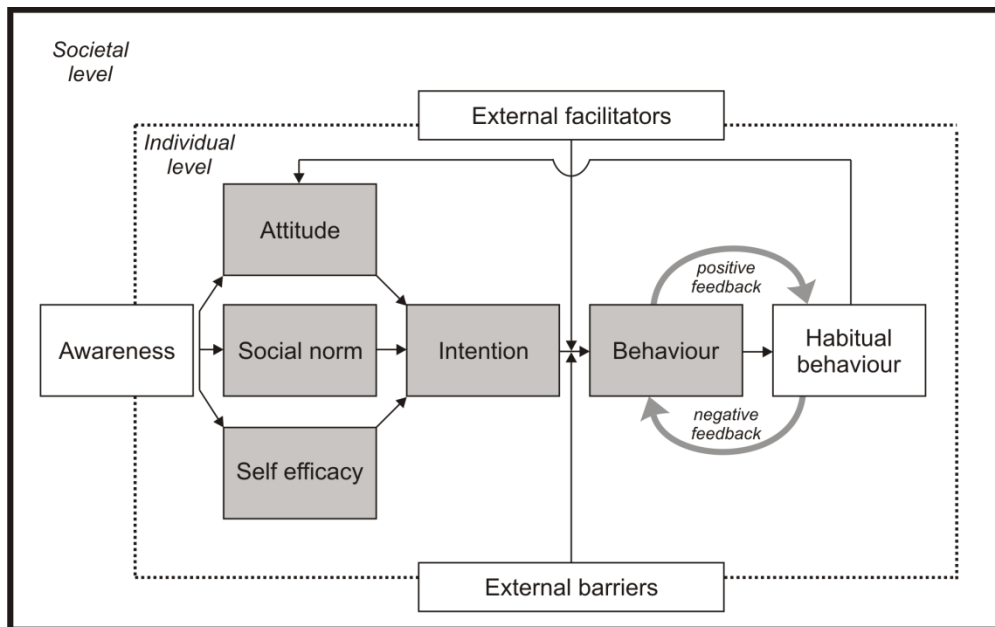
Whilst ToU are marketed as a way to deliver benefits to consumers, their take up is still very low. Around one third of homes and businesses in the United States has a Smart Meter (around 36 million), and, therefore, have the potential to benefit from a ToU tariff. However, only around 1% of consumers have a ToU tariff<sup>5</sup>.

This is just one example that demonstrates that consumers do not make decisions based on price alone. There will be many factors that influence an individual's decision on whether or not to adopt of ToU tariff, as indicated by the energy behaviour model<sup>6,7</sup> shown in Figure 2.3.

<sup>5</sup> <http://www.emeter.com/smart-grid-watch/2012/time-of-use-electricity-prices-why-do-so-few-customers-have-them/>

<sup>6</sup> Predicting and Changing Behaviour: The Reasoned Action Approach; M. Fishbein, and I. Ajzen.; Psychology Press, New York; 2010

<sup>7</sup> Nothing is as practical as a good theory. Analysis of theories and a tool for developing interventions to influence energy-related behaviour; C. Egmond and R. Bruel; SenterNovem; 2007



**Figure 2.3 Theoretical model of energy behaviour<sup>8</sup>**

As Figure 2.3 shows, there are many factors that influence an individual's intention and behaviour. This includes external factors (in this context this could include the availability of and accessibility to ToU pricing and enabling technologies) and internal factors (customer attitudes, social norms and self-efficacy). Thus, two individuals presented with the same opportunity within the same context may behave differently due to their own personal views and beliefs.

Section 4 of this report explores some of the key factors that influence consumers' decisions to engage (or not) in Smart Grid initiatives. In particular, it focusses on the way customers consider the risks and rewards associated with Smart Grids; this represents the 'attitude' element of the model highlighted in Figure 2.3. However, it is important to bear in mind that the way that risks and rewards are evaluated will vary from one individual to another. But first, Section 3 provides a definition of risk and reward as it is applied within the context of this report.

<sup>8</sup> Understanding Household Energy Use Investment Decisions, Even Bjørnstad, Enova SF, Energy Efficiency and Behaviour Conference, Helsinki, 20 September 2012

## 3 Definition of Risk and Reward

### 3.1 Definition of risk

Risk can be described as the possibility 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<sup>9</sup>);
- 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)<sup>10</sup>
- 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<sup>11</sup> 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.

---

<sup>9</sup> Office for National Statistics, Crime in England and Wales, year ending September 2012.

<sup>10</sup> Reducing Burglary Initiative: an analysis of costs, benefits and cost effectiveness, Roger Bowles & Rimawan Pradiptyo, Home Office Online Report 43/04

<sup>11</sup> Office of National Statistics, number of households in England and Wales in 2011

### 3.2 Definition of reward

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 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 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. 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.

## 4 Decision making – what theory tells us

There is an abundance of research available on human behaviour, and this Section considers what this tells us about the way that losses and gains (or risks and rewards) are assessed by individuals.

In particular, there is a growing body of knowledge to support the hypothesis that individuals do not make decisions that fit within a rational economic approach, whereby a purchase is only made (or approach adopted) if the benefits outweigh the costs. The following Sections provide some specific examples of the factors that influence the decision making processes by individuals.

### 4.1 Impact of the types of choices available

#### 4.1.1 Too many choices cause purchasing paralysis

There are many examples in daily life where individuals are provided with an exhaustive array of choices from which they need to make a selection. For example, a quick look at the on-line choices available from a UK supermarket showed that there were almost 100 different types of salad dressings available or over 645 bread products. In this case, many shoppers have already formed their preferences and know what they like and what they want to purchase. However, when faced with too many choices, individuals can be paralysed by an inability to choose from the myriad of options available to them<sup>12</sup>. 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.

This was highlighted in a retail market review conducted by the GB energy regulator, Ofgem, that supported the principle that too much choice is not good for consumers, and helps to explain the low numbers of consumers that switch their energy supplier in the UK<sup>13</sup>.

#### 4.1.2 Lots of choice does not necessarily lead to satisfaction

Sheena Iyenga, Columbia University and Mark Lepper, Stanford University<sup>14</sup> also provide some interesting examples of the impact of choice on decision making. In one of these studies, shoppers were offered the opportunity to sample from a selection of different flavours of jam on display at a supermarket over two five hour periods. During the first of these sessions, shoppers were offered a limited choice of six jams from which to choose, whilst the second session offered an extensive choice of 24 jams. In both cases, all the jams were from a single brand, and great care was taken to ensure the limited sample contained neither the most or least popular flavours. The results showed that whilst the extensive display of jams attracted more initial visitors (60% compared to 40% for the limited display), it did not lead to more sampling of the flavours on offer. The study found that the number of flavours sampled was similar in both cases; the average number sampled by consumers in the extensive choice condition was 1.50 compared to 1.38 for the limited

---

<sup>12</sup> Predictably Irrational Customers, Optimizing Choices for How People Really Buy, Not How we Think They Buy  
Bill Abbott, Alex Mannella, Kyle McNamara, Amaresh Tripathy

<sup>13</sup> Retail Market Review: Domestic Proposals, Publication date: 1 December 2011, Ofgem

<sup>14</sup> When Choice is Demotivating: Can One Desire Too Much of a Good Thing? Sheena S. Iyengar, Columbia University & Mark R. Lepper, Stanford University

choice condition. In both cases, customers sampled only one or two flavours of jam. After sampling the jam, shoppers were provided with a voucher to purchase jam from the store, which stocked the full range of flavours. The results of the trial showed that whilst only 3% of shoppers sampling from the exhaustive range purchased jam, 30% did so when offered the limited choice.

In another study, Iyenga and Lepper offered students the opportunity to sample chocolates, and then examined how they felt about the decision making process and how satisfied they were with the sample they were given.

The students were divided into three groups:

- No choice group
- Limited choice group
- Extensive choice group

Each student in turn was invited to sit at a table containing a display of either 6 (limited choice) or 30 (extensive choice) chocolates. The organisers said they were doing a marketing research study to examine how people select chocolate, and were asked to indicate which chocolate they would select from the display in front of them. The analysis of the results showed that those with the extensive choice took longer to choose, found the decision making more enjoyable and more frustrating than those shown the limited display.

The students were then given the opportunity to sample a chocolate. Those in the choice groups were able to sample the chocolate they had previously selected. Those in the non-choice group were given a random chocolate not from the display in front of them. The students were then asked how satisfied they were with the chocolate they sampled. Those given a choice were more satisfied than those not given a choice. Those who selected from the limited display were more satisfied than those who chose from the exhausted display.

Subsequently, all students were invited to select either a \$5 payment or a box of chocolates worth \$5 as payment for taking part in the study. Students in the limited choice group were more likely to accept the chocolates than those in the other two groups.

#### 4.1.3 Choices designed to influence the decision maker – the use of a decoy

Another example to demonstrate how the number of options available can influence choice is provided by Dan Ariely in his book 'Predictably Irrational'. In the book, the author cites an advert that he came across on a web-site for a subscription to a magazine. The advert offered the reader three potential choices:

- a) A web-based subscription allowing on line access for \$59/year;
- b) A paper-based subscription providing paper copies of the magazine for \$125/year;
- c) A paper and web-based subscription for \$125/year

The author speculates that the advert was deliberately designed to steer people towards option c), i.e. it is a form of manipulation, with option b) merely a decoy to steer people towards the more expensive option.



To test this theory, the author asked 100 of his students to vote on which of these offers they would select. The majority (84 students) selected option c). No-one selected the option b); this is unsurprising, as there would seem to be no logical reason to select option b) over option c) which offers more for the same price. To demonstrate the effect of the 'decoy', only two choices were offered to the same students, i.e.:

- d) A web-based subscription allowing on line access for \$59/year;
- e) A paper and web-based subscription for \$125/year

It might be expected that the responses should be the same, particularly as no-one had previously opted for paper-only subscription offer. However, when faced with only two choices (i.e. the only two that received any votes previously) the majority of students (68 out of 100) now selected the cheaper web-based option, compared to only 16 previously. This is claimed to be a common marketing trick employed to entice people to purchase particular goods and offers.

The results of the voting experiment are summarised in the Table below.

**Table 4.1 Example showing impact of number of options on decision making**

Three options	Number	Two options	Number
A web-based subscription allowing on line access for \$59/year;	16	A web-based subscription allowing on line access for \$59/year;	68
A paper-based subscription providing paper copies of the magazine for \$125/year;	0	A paper and web-based subscription for \$125/year	32
A paper and web-based subscription for \$125/year	84	Total	100
Total	100		

#### 4.1.4 General comments

Whilst too much choice is not considered advantageous, it is also true to say that no choice could also be undesirable.

For example, the decision to mandate the roll-out of smart meters to all households in the Netherlands resulted in a public campaigns voicing concern over loss of privacy by consumer organisations and groups concerns with protecting consumer privacy. The initial proposals for Smart Meter roll-out included provision for fining households up to €17,000 or a six month imprisonment if they did not agree to the Smart Meter installation. As a result, the proposals have been modified to both allow consumers the option of whether or not they would like a Smart Meter and also flexibility over the extent to which the functionality of the Smart Meter is enabled.

A similar backlash was also seen in California, where Smart Meters were mandated for all customers. This resulted in highly publicised and vociferous campaigns against their deployment. In one extreme example, a woman in Texas brandished a handgun in order to prevent the installation of a Smart Meter on the outside of her home<sup>15</sup>.

<sup>15</sup> [http://www.smartgridnews.com/artman/publish/Technologies\\_Metering/Texas-woman-pulls-a-gun-to-stop-smart-meter-installation-4978.html](http://www.smartgridnews.com/artman/publish/Technologies_Metering/Texas-woman-pulls-a-gun-to-stop-smart-meter-installation-4978.html) accessed 3 May 2013

When an individual is unhappy with a situation, they can react by either exiting or voicing their concerns. Thus, when faced with no choice at all, the only recourse available to individuals is to protest.

This suggests that a 'middle ground' (i.e. choice, but not too much choice or no choice at all) is the optimum.

## 4.2 Framing Effect – how choices are presented

When customers are given a number of options, then their decision can be influenced by the way that the offer is 'framed'.

The following is a well cited example of the powerful effect of framing on decision making originally developed by Tversky and Kahneman<sup>16</sup>. They present 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 following shows that the way that the options are framed has a significant impact on the decision made.

In the first instance, the two options are framed as follows:

If Option a) is adopted, then 200 people will be saved.

Or,

If Option b) is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no-one will be saved.

When the options are framed in this way, the majority of people asked will take the risk averse option and select option a). In this case, the prospect of saving 200 lives for sure (no gamble) is more attractive than a risky prospect that on paper, has the same expected value.

The same situation was then presented to another group of individuals, but framed in terms of lives lost (rather than lives saved). The two options offered were thus:

If Option c) is adopted, then 400 people will die

Or,

If Option d) is adopted, there is a 1/3 probability that no-one will die, and a 2/3 probability that 600 will die.

In this case, option d) proves to be the most popular.

This is attributed to the fact that when options are framed in terms of gains, then choices are risk averse. However, when options are framed in terms of losses, then choices tend to be risk taking.

Although not specifically tested in the study, the result might suggest that framing a Smart Grid initiative in terms of how much would be wasted if a certain behaviour was not adopted, or if a particular piece of technology was not employed, would be met with a different response than one focussing on the potential gains to be made. This is reinforced by the

---

<sup>16</sup> The Framing of Decisions and the Evaluation of Prospects, Studies in Logic and the Foundations of Mathematics, Volume 114, 1986, Pages 503-520

results from a UK study<sup>17</sup>, which found that participants in the Home Energy Study were more focussed on the issue of energy wastage than they were on the financial gain that might ensue from reducing the waste.

### 4.3 Opt-in or opt-out – the type of choice/decision to be made

Asking people to voluntarily opt into a scheme, rather than to enrol automatically but allow individuals to opt out, may also have an influencing factor, particularly in terms of the level of participation. There are suggestions that automatically enrolling individuals onto a scheme and allowing them to opt-out if they do not wish to be involved is one way of encouraging people to do something. This could be useful where there is general support for a measure (such as saving for retirement or organ donation), but voluntary participation is low.

For example, in the UK, 90% of people have expressed their support for organ donation, but only 29% have registered to donate their organs<sup>18</sup>. This has led to calls for people to be automatically enrolled as an organ donor unless they expressly choose to opt-out. However, this is no guarantee of higher levels of organ donation. Sweden, for example, has an 'opt out' system but has lower levels of organ donors (as a percentage of population) than the UK with its opt-in system.

As with all the issues discussed in this Section, this highlights, that whilst the option to opt-in or opt-out is important, there are many other factors that also need to be taken into consideration.

### 4.4 Individuals do not treat risks and rewards in the same way

There is a tendency for individuals not to treat risks and rewards in an equivalent way. For example, the pain of losing \$100 is much more than the equivalent 'pleasure' of winning \$100<sup>19</sup>. In this case, it was estimated that losses are twice as painful as gains are pleasurable.

So, consider the following two options offered to an individual as a one-time offer<sup>20</sup>:

- a) 50% chance of winning £200
- b) 100% chance of winning £100

The utility or risk associated with each option is the same, i.e.

- a) Risk = 50% x £200 + 50% x £0 = £100
- b) Risk = 100% x £100 = £100

In this situation, when the options are framed in terms of gains, the majority of respondents (75%) are risk averse, selecting the sure gamble, i.e. option b). The same would also be true if the gamble had a higher value than the sure bet.

<sup>17</sup> Rettie, R., Harries, T. and Bellwood-Howard, I. (2013) CHARM Research Summary 2: The Home Energy Study: qualitative analysis. Behaviour and Practice Research Group, Kingston University. Available at <http://www.projectcharm.info/>

<sup>18</sup> <https://www.gov.uk/government/news/driving-up-organ-donations> accessed 28/03/2013

<sup>19</sup> Rational Choice in an Uncertain World: The Psychology of Judgement and Decision Making, Reid Hastie, Robyn M. Dawes, 2001

<sup>20</sup> Eldar Sharif 'Decisions Constructed Locally' in Kruglanski, A.W. and Higgins, E.T. (2007) Social Psychology: A Handbook of Basic Principles The Guilford Press: New York, London

When an alternative pair of options are presented in terms of losses, see below, the majority of respondents become risk seeking.

- c) 50% chance of losing £200
- d) 100% chance of losing £100

When the options are framed in terms of losses, the majority of respondents (65%) are risk seeking, preferring the gamble, option c), rather than the sure loss.

For Smart Grid related initiatives, this would imply that a simple financial comparison of the costs and benefits associated with different options would not provide a reliable indication of what decision will be made by an individual. In particular, it may not be sufficient for the costs to exceed the benefits.

#### 4.5 Risks/benefits are assessed in relative not absolute terms

Risks and benefits tend to be assessed in relative terms rather than in absolute terms. For example, a customer searching for a more favourable tariff may stop searching once they have found one that is cheaper than their current tariff, even where it is only slightly cheaper and without looking to see if any other options are available<sup>21</sup>.

Dan Ariely shows the impact of relativity in a study originally conducted by Tversky and Kahneman. The study compares two instances where an individual can save a certain amount of money by shopping elsewhere.

In the first instance, individuals were asked to imagine they are about to purchase a nice pen for \$25, when they remember that the same pen is for sale for \$18 at a store located a 15 minute drive away. When asked, whether they would take the 15 minute journey to save \$7, most people responded that they would.

In the second instance, individuals were asked to imagine they were about to purchase an expensive suit costing \$455, when they are informed that the exact suit is available for \$448 at another store which is a 15 minute drive away.

It might be expected, that those that would drive 15 minutes in the first instance to save \$7, would also make the same decision when buying the suit. However, most people respond by saying they would not drive further to make the \$7 saving.

Here, the only thing that has changed is the relative value of the saving, i.e. \$7 relative to \$25 compared to \$7 relative to \$455. So in the first case, people will spend the extra time to save \$7, where-as in the latter, they will spend the extra \$7. Thus, the \$7 saving is not valued in absolute terms, even where the effort required to obtain the benefit (i.e. a 15 minute drive) is the same.

This could be particularly important where the financial gain represents a relatively small proportion of the overall energy bill of the home. Therefore, alternative measures could be used to make the rewards appear to be meaningful. For SMEs, this could include expressing the benefits as a percentage of profits rather than energy spend. For householders, this could include expressing the financial gain against money spent on a leisure activity.

---

<sup>21</sup> What can behavioural economics say about GB energy consumers? Ofgem, 21 March 2011

## 4.6 Faulty discounting

When costs and benefits occur at different times, it is commonplace to use discounting to enable the value of financial transactions to be compared. Here, it is assumed that future rewards are discounted by a fixed percentage for each unit of time it is deferred.

Thus, if the discount rate is 10%, a person would have no preference over whether they receive £100 now or £110 after a year; they have the same value after discounting.

Similarly, receiving £100 after a delay of one year would be considered equivalent to receiving £110 after two years.

Individuals however, do not typically undertake such a detailed and precise calculation to compare costs and benefits at different times. More importantly, a number of studies have shown that customers tend to prefer to receive smaller rewards now rather than a larger reward in the future. However, the further into the future the rewards are received, then the more likely individuals are to delay in order to receive a larger reward. This is more easily demonstrated by the following example.

More people prefer to receive £100 now rather than £110 in a day's time. However, very few people choose £100 after 30 days' time if they have the option to choose £110 in 31 days' time instead. This is despite the fact that both options involve choosing whether or not to gain an additional £10 by delaying payment by one day. Individuals are not happy to delay receiving the benefits by one day now, but are happy to do so in the future. This is referred to as hyperbolic discounting, whereby people tend to prefer to receive a smaller reward sooner rather than a larger reward later<sup>22, 23</sup>. Similarly, consumers would prefer to delay paying for goods and services for as long as possible, even if this results in them paying more<sup>24</sup>.

This would imply customers prefer to receive immediate rewards and defer payments for as long as possible, even if the outcome is less favourable than paying up-front and receiving rewards in the future.

## 4.7 Value action gap

Another interesting element to consider is the fact that what people say and what people do is not always the same. This effect is referred to as the "Value Action Gap", and describes the difference between people's attitudes or values and their actions or behaviours. This makes it difficult to use information about an individual's attitudes to predict what they might actually do.

For example in 2010, a survey looked at public attitudes to climate change and the impact of transport<sup>25</sup>. They were asked whether they were willing to use more sustainable forms of transport, and the responses showed a reasonable proportion of respondents were willing to use public transport (47%) or walk (58%), with cycling viewed less favourably. The respondents were then asked if they were able to use more sustainable transport, and the

<sup>22</sup> Time Discounting and Time Preference: A Critical Review, Shane Frederick; George Loewenstein; Ted O'Donoghue, Journal of Economic Literature, Vol. 40, No. 2. (Jun., 2002), pp. 351-401

<http://links.jstor.org/sici?sici=0022-0515%28200206%2940%3A2%3C351%3ATDTPA%3E2.0.CO%3B2-P>

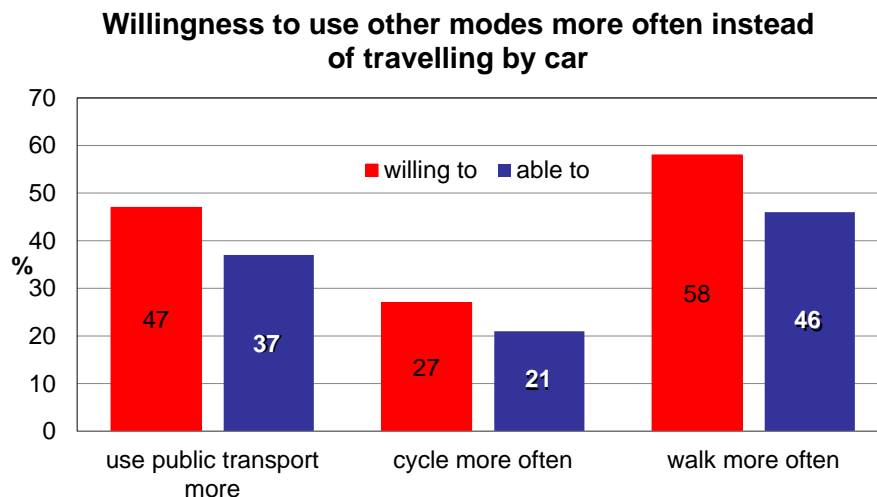
<sup>23</sup> see also <http://www.behaviorlab.org/Papers/Hyperbolic.pdf>

<sup>24</sup> What can behavioural economics say about GB energy consumers?, Ofgem Discussion Paper, 21 March 2011

<sup>25</sup> Public attitudes towards climate change and the impact of transport: 2010 (January 2011 report, ONS)

results showed that fewer people were able to make a change in their lifestyle compared to those who were willing to do so. This could be explained by factors such as:

- the availability of public transport
- the quality of the public transport service;
- the distance to be travelled (i.e. it is too far to walk / cycle to work);
- the individuals own mobility, or that of a passenger
- the need to carry things (e.g. grocery from a supermarket)
- safety of the roads to walk alongside or cycle along



**Figure 4.1 Value Action Gap – willingness vs. ability**

A further example of the gap between what people say they do and what they actual do is that associated with the tradition of tithing a proportion of income. In a national study of how much money was given to faith charities, a quarter of respondents said they tithed 10 per cent of their income to charity. However, when their donations were checked against income figures, only 3 per cent of the group gave more than 5 per cent to charity<sup>26</sup>.

Therefore, it is difficult to predict how consumers will actually behave based on the results of consumer surveys. Whilst such surveys do provide valuable information on customer views and opinions, they also do not always provide accurate information on what customers actually need (as opposed to what they think they need). For example, a survey<sup>27</sup> in the Netherlands asked customers about what options they liked to have on a new thermostat prior to purchase. Following purchase, the additional features were not actually found to be useful by the owners who subsequently preferred thermostats with fewer options.

<sup>26</sup> <http://blogs.thearda.com/trend/featured/parting-with-treasure-easier-said-than-done-churchgoers-give-far-less-than-they-think/> accessed 11 December 2012

<sup>27</sup> Gorsira, Van der Werff, Steg, Bolderdijk, & Keizer, 2011

## 4.8 Estimating the probability of events

As discussed in Section 3, risk is calculated from the probability of an event occurring and the consequences if it does occur. The probability of many events occurring can be determined by considering how often such events have occurred in the past. This provides a direct measure of the probability of an event. However, this is not without its problems; events may go unreported, and the likelihood of events occurring in the past may not necessarily provide a reliable indication of what might happen in the future.

In addition to these effects, individuals apply a number of 'biases' when making a judgement on how likely they think that something will happen. There are a range of such 'biases' including<sup>28</sup>:

- 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 roll 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 know someone who smoked 20 cigarettes a day and reached the age of 90.

## 4.9 Priming

Consumers remember an item best in the form and context in which they first learned about it. This can be shaped by advertising and product placement. This could also be from press articles.

For example, the article shown in Figure 4.2 was published on-line by a UK Newspaper on 27 April 2013, declaring that fridges could be turned off without warning and without consent in order to manage shortages in generation capacity. If this is the first time that customers become aware of smart appliances, then it is seems reasonable to expect that they will have concerns over the possibility that their appliances could be turned off without warning and without consent.

---

<sup>28</sup> List of cognitive biases, [http://en.wikipedia.org/wiki/List\\_of\\_cognitive\\_biases](http://en.wikipedia.org/wiki/List_of_cognitive_biases)

**MailOnline**

Home **News** U.S. | Sport | TV&Showbiz | Femail | Health | Science | Money | RightMinds

News Home | Arts | Headlines | Pictures | Most read | News Board

## Big brother to switch off your fridge: Power giants to make millions - but you must pay for 'sinister' technology

- Computer chips will take control of home appliances when energy is low
- Sensors will detect spikes in demand for power and when grid struggles to meet it, will temporarily shut off appliances
- Can shut down supply without warning - or your consent

By RUSSELL MYERS and MARTIN BECKFORD  
 PUBLISHED: 22:02, 27 April 2013 | UPDATED: 22:10, 27 April 2013

Comments (960) | Share | 57 | Tweet | 315 | Like | 3.9k

Fridges and freezers in millions of British homes will automatically be switched off without the owner's consent under a 'Big Brother' regime to reduce the strain on power stations.

The National Grid is demanding that all new

Figure 4.2 Daily Mail Online Article about Smart Appliances<sup>29</sup>

Such articles are not uncommon, and a selection of similar articles is highlighted in Figure 4.3.

**Government plans to install smart meters in our homes 'will leave us open to cyber attack,** Daily Mail, 8 June 2012

**British families at risk from smart meters, campaigners tell MPs,** The Telegraph, 24 April 2013

**Does my smart meter know when I'm on the loo? The verdict on smart meter privacy, security and health concerns,** The Carbon Brief Blog, 22 June 2012

**Big brother to switch off your fridge: Power giants to make millions - but you must pay for 'sinister' technology,** Daily Mail Online, 27<sup>th</sup> April 2013

**Fridges could be switched off without owner's consent to reduce strain on power stations,** The Telegraph, 28 April 2013

**Householders shielding homes from smart meter radiation,** Daily Herald Sun, 09 April 2012

**Costly fiasco of smart meters that don't work: Millions of devices may be replaced, warns watchdog,** Daily Mail, 27<sup>th</sup> January 2012

**Meter madness spreads to Memphis (Big Brother is watching!), Smart Grid News,** Aug 14, 2013

<sup>29</sup> <http://www.dailymail.co.uk/news/article-2315863/Big-brother-switch-fridge-Power-giants-make-millions--pay-sinister-technology.html> accessed 3 May 2013



### Figure 4.3 Example Smart Grid related news article excerpts

Thus, care needs to be taken to ensure that individuals have access to balanced information on Smart Grids from a trusted source. For example, the switch over from analogue to digital broadcasting in the UK was managed and co-ordinated by Digital UK, a not for profit organisation. This provided factual information to residents on the switch to digital broadcasting, and independent advice on the options available to individuals. Although complex, the switchover was considered to be successful. Much of the credit of the success of the switchover is attributed to the nationwide communication campaigns<sup>30</sup>.

#### 4.10 False cause

False cause (also referred to as post hoc) is the situation where it is concluded that one event causes another simply because the proposed cause occurred first, i.e. 'A' happened then 'B' happened, therefore A caused B. A good example of this is the experiences of PG&E customers.

The roll-out of Smart Meters to all 10 million PG&E customers started in 2006. In late summer 2009, PG&E began to receive a number of complaints from its customers due to large increases in their bills. Customers were concerned that the Smart Meters were the cause of their increased bills, which coupled with concerns over privacy and health issues, culminated in a class action being filed in November 2009. An independent report published in 2010 did not identify any systemic issues with metering and billing of electricity usage with Smart Meters.

The cause of the increased bills was found to be due to a combination of two factors:

- In 2001 an inverted tier tariff structure was introduced. Under this system, the first tranche of electricity is charged at a low per-unit price. At higher consumption levels, the per unit price increases sharply.
- July 2009 was particularly hot and residents who had not previously been exposed to the high per unit costs of the higher tiers were for the first time buying both a large total number of units, and at a much higher rate. This led to the sudden, unexpected increases in bills.

When customers called to complain PG&E did not explain the tariff system and customers awareness of it appeared to be low, leading them to believe that the Smart Meter itself was responsible for the increases.

---

<sup>30</sup> Digital TV Switchover 2008 to 2012, Final Report, Digital TV

Thus, two key learning points from this example are:

- Customers' understanding of their tariffs and their electricity bill needs to be considered;
- Customers' concerns (increased bills / health / privacy) need to be quickly addressed.

Thus, the Smart Meters were not the cause of the increased bills. Rather it was due to the introduction of the inverted tier tariff in 2001, which only took effect during the hot summer of 2009 which closely followed the introduction of Smart Meters.

#### 4.11 Regret and the anticipation of regret

Another factor that has a strong influence on the decision making process is the influence of regret. In this case, individuals prefer to maintain the status-quo, even if they know it is not the ideal option, for fear of making a decision that leads them to being worse off than they are now. This is also referred to as an endowment effect, whereby individuals are much less likely to give something up compared to the utility value associated with acquiring it.

An early example of this effect was demonstrated in 1984 by Knetsch and Sinden<sup>31</sup>. Here, a number of participants were endowed with either a lottery ticket or with \$2.00. The participants were later offered the opportunity to trade the lottery ticket for \$2.00 or vice-versa. Very few participants chose to switch.

This was then followed by further experiments to establish whether the result would be the same if the participants were exposed to a more typical market environment and the opportunity to learn more about the market. In both cases, the actual volume of trades of a commodity (a mug or a pen) was much less than would be predicted based on a properly functioning commodity market.

Further experiments showed that the endowment effect results from the pain of giving something away rather than the enhanced values associated with owning it in the first instant. For example, half the students in a class were given a pen whilst the other half were given a token to redeem for a gift. All students were given the opportunity to rank six gifts in order of attractiveness. Those given the pens did not rate them as being more attractive than those provided with the tokens. However, when the participants were asked to choose between receiving either a pen or two chocolate bars, the impact of the endowment effect could be seen. Over half of those offered the pen chose to keep it (56%) compared to only 24% of those who had been given the token. Thus, whilst the pen was not rated as being significantly more attractive by those endowed with one, they were much less likely to give it up for the alternative (the chocolate bars).

Thus, the implication of this is that individuals have a tendency to prefer to stay with things as they are (the status quo bias) because the disadvantages of changing are more significant than the benefits of change. This could be a major factor preventing customers switching from a flat-rate tariff to a ToU tariff, even though the potential financial benefits could be significant.

---

<sup>31</sup> The Endowment Effect, Loss Aversion and Status Quo Bias, Daniel Kahneman, Jack Knetsch and Richard Thaler, Journal of Economic Perspectives, Volume 5, Number 1, Winter 1991, Pages 193 - 206

## 5 Quantifying risks and rewards

Section 4 provides a number of examples of the many different factors that influence the decision making process of individuals. These examples highlight the difficulties associated with calculating the risk and rewards associated with Smart Grid interventions from the perspective of an individual.

This Section seeks to further highlight these impacts by considering a simple example to demonstrate how risks and rewards might be quantified. The example does not relate specifically to a Smart Grid related initiative, but rather looks at the related issue of energy efficiency schemes. The particular example used is concerned with the provision of loft insulation to households by Kirklees Council. The initiative was recognised internationally as an award winning scheme.

Although the scheme included a range of energy efficiency measures such as heating system and cavity wall insulation, this example focusses only on loft insulation. The scheme provided qualifying households with the offer of free loft insulation, and included new loft openings and hatches, and loft emptying for vulnerable customers in order to facilitate the installation in as many homes as possible.

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). Of 165,686 households visited, 81% agreed to an assessment, 14% did not respond and 5% refused. In total 94,788 homes were surveyed, of which 53% (51,155) subsequently received free insulation. The main reason that the remaining 43,633 homes did not receive insulation was either because it was already installed, or because the property was classed as 'hard to treat' or for other technical reasons. However, a significant proportion of households (25% of those surveyed) did not take up the offer of free insulation. Reasons for not taking up the offer are not extensively reported, but other loft insulation programmes indicate the following as possible factors:

- General scepticism i.e. "why would anyone give me something for free?" What do they want in return?;
- A general dislike of allowing tradesmen into your own home;
- The hassle, both from having to be home when the tradesman call to do the installation, and also the need to clear out the loft space of any personal belongings that have been placed there for storage.

The first of these issues was covered extensively in the material distributed to all householders. Therefore, Section 5.1 focusses on quantifying the potential 'losses' associated with the latter two issues identified above. Section 5.2 then focusses on quantifying the potential 'gains'. These are considered from the perspective of an individual householder based in the UK. It is important to note that the numbers presented here are intended to be *indicative* only, in order to demonstrate how potential losses can be calculated.

## 5.1 The potential losses

The following list represents concerns that might typically be expected to be raised by householders, and are used to demonstrate how the potential losses associated with receiving free loft insulation could be quantified. They do not relate to a specific situation or to a particular group of customers.

Therefore, for the purposes of this example, the potential losses associated with the installation of loft insulation are considered to include:

- 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.

### *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:

$$\text{Risk of minor damage} = \text{€}30 \times 0.33 = \text{€}10$$

### *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 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<sup>32</sup>.

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<sup>33</sup> 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

<sup>32</sup> Removing the hassle factor associated with loft insulation: Results of a behavioural trial, Department of Energy and Climate Change, September 2013

<sup>33</sup> Values of Time and Vehicle Operating Costs, October 2012, Department for Transport, Transport Analysis Guidance

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).

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.

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
<b>Total</b>			<b>~ 90</b>

## 5.2 The potential gains

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<sup>34</sup>.

In addition to the energy cost savings, the amount of CO<sub>2</sub> released into the environment is reduced by an estimated 730kg 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 CO<sub>2</sub> for fuels used for power generation, there is no direct value to the householder for reducing CO<sub>2</sub> emissions. The price to large firms is currently set at £16 per tonne, but the UK Government has set goals for the price to reach £30 by 2020 and £70 by 2030<sup>35</sup>. At the current CO<sub>2</sub> price, the benefit associated with the reduction in emissions of 730kg 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.

### 5.3 Comparing the losses and the gains

The potential risks associated with having loft insulation for the hypothetical householder, in this example, 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 rational economic basis, it would seem that householders should accept the offer as the rewards significantly outweigh the risks. However, as highlighted at the beginning of this Section, 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 4, there are a number of factors that impact on the decision making process. Three of the factors are considered to be particularly pertinent here:

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

Faulty discounting (Section 4.6) 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 than 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.

---

<sup>34</sup> Energy Saving Trust, <http://www.energysavingtrust.org.uk/Insulation/Room-and-loft-insulation>, accessed 21 June 2013

<sup>35</sup> Carbon price floor consultation: the Government response, HM Revenue & Customs, HM Treasury

Section 4.4 shows that risks and rewards are not treated in the same way; the pain of losing \$100 is twice as painful the equivalent 'pleasure' of winning \$100<sup>36</sup>. Therefore, even ignoring discounting the value of money over time, the 'feel good factor' associated with a gain of €210 will only be marginally better than the 'pain' associated with a loss of €90.

Section 4.8 shows that estimating the probability of an event occurring is problematic. The example here shows that a probability of minor damage occurring has been estimated to be 0.33, but of course another individual may consider it to be negligible. In this case, it could be a recency bias (too high a reliance placed on events that have happened recently rather than those that occurred in the past).

It is also interesting to note that the highest component in the overall risk faced by the individual 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 fact, a number of loft insulation companies have offered a service to help those who do not have the time to sort out their belongings. For a small fee, they will empty the loft and replace items afterwards, or take them to the tip or to be recycled after they have been sorted through by the householder. For vulnerable or elderly householders, this service may also be offered for free.

The UK's Department of Energy and Climate Change recently conducted a behavioural trial to explore whether some customers would be willing to pay for a loft clearance service. Although the numbers involved in the trial were unfortunately too small to provide any firm conclusions, the provision of a loft clearance service was considered to be a useful tool to help promote uptake<sup>37</sup>.

This application of the methodology to the loft insulation example leads to the conclusion that a quantitative analysis alone is unlikely to provide a meaningful way of predicting customer response to a particular offering. However, once consumer concerns are identified and understood, the quantification of the potential losses and gains can provide a useful basis for exploring whether a proposition is likely to be attractive to consumers, but only if it is also combined with knowledge of the factors affecting the decision making process. This quantification is not intended to represent the way that customers consider the perceived losses and gains. Rather, the analysis represents a useful tool to quantify losses and gains (as perceived by customers) in a way that is meaningful for implementers of Smart Grid initiatives. In particular, it highlights the main issues that influence customer decision making, and provides a useful starting point for developing solutions to maximise customer engagement. In the example presented here, the time factor is identified as the main issue preventing uptake. The quantification of this, in monetary terms, provides a useful starting point to help identify potential solutions (i.e. those that minimise the time spent by householders clearing their loft) and the starting 'price point' for these solutions (i.e. reflecting the value placed on time wasted by individuals).

It is important to note that the 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. This case study is based on an interpretation of the concerns of customers faced with the decision of whether or not to insulate their loft. Whilst many of the figures used in the analysis are largely illustrative, it is believed that they provide a useful indication of how the proposition is perceived by individuals. The analysis also provides an indication of the extent to which proposals need to be modified in order to make them attractive to end-users.

---

<sup>36</sup> Rational Choice in an Uncertain World: The Psychology of Judgement and Decision Making, Reid Hastie, Robyn M. Dawes, 2001

<sup>37</sup> Removing the hassle factor associated with loft insulation: Results of a behavioural trial, Department of Energy and Climate Change, September 2013



This type of information might be particularly useful for policymakers and implementers of Smart Grids when trying to assess the significance of customer concerns.

Any such analysis must, however, take account of the demands placed on consumers, i.e. what are the householders expected to do? In the case of the loft insulation example the expectations are easily identified. These expectations include:

- customers are required to allow an assessor into their home to assess the technical suitability of their property;
- they must then empty their loft space; and
- they must allow installer into their home.

In the case of Smart Grid initiatives, the demands are very different and potentially more onerous.

## 6 Conclusions

This report demonstrates that there are many different factors that influence the decision making of individuals. In particular, it highlights that a classical economical approach does not accurately predict whether a consumer will adopt a particular initiative or technology.

The factors that are considered to influence the way consumers assess potential losses and gains associated with Smart Grids have been identified. These provide a valuable insight into how Smart Grid initiatives can be structured to help encourage participation. Examples include:

- Risk aversion (Section 4.2); which suggests there may be merit in framing Smart Grid initiatives in terms of “how much is wasted” if a certain behaviour is not adopted, rather than in terms of “how much can be gained” if it is adopted.
- Faulty discounting (Section 4.6); which indicates that customer prefer to receive an immediate reward and defer any payment, rather than pay up-front and receive rewards at a later date.
- Different treatment of risks and rewards (Section 4.4); which implies that the pain of losing €1 is twice as great as the ‘pleasure’ of gaining €1, and therefore, gains need to significantly outweigh any losses.
- Estimating the probability of events (Section 4.8); which results in a skewing of the potential risks towards events with a high consequence but a very low probability of occurrence.

The report includes a methodology for quantifying the losses and gains associated with Smart Grid implementation from the perspective of consumers, i.e. the end users of electricity. The methodology is used to quantify the potential losses and gains from the perspective of an individual for a case study relating to an offer of free loft insulation. This analysis uses the methodology outlined in Section 3 of this report, and compares the perceived losses against the expected gains. The analysis shows that quantifying losses and gains alone is not sufficient to predict the way a proposition will be viewed by customers. In the case study, a small but significant proportion of customers decide not to accept an offer for free loft insulation even though the gains outweigh the losses. However, once knowledge of the decision making process is combined with the quantitative analysis, it is much easier to understand why some customers do not engage. In the example presented in Section 5, it is the high value placed on time wasted that is the determining factor for the many who do not take up the offer of free loft insulation.

Thus, once consumer concerns are identified and understood, the quantification of the potential losses and gains can provide a useful basis for exploring whether a proposition is likely to be attractive to consumers. This information can be combined with knowledge of the factors affecting decision making to help develop solutions to maximise customer engagement.

However, this is only true once the concerns of customers have been identified and understood from the perspective of the customers themselves and within the relevant context. Then, and only then, can such information be combined with theoretical knowledge of the decision making process to help shape Smart Grid initiatives into propositions that are likely to be attractive to consumers.

## Appendix: 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](http://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	New Zealand
Belgium	Norway
Finland	Spain
France	Sweden
India	Switzerland
Italy	United Kingdom
Republic of Korea	United States
Netherlands	EI (sponsor)
	RAP (sponsor)

**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  
Dr. 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  
  
Dr. 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](mailto:anne.bengtson@telia.com)

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