Assessing the Use and Value of Energy Monitors in Great Britain

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Contents

Summary of Findings

Based on average results of trials in Great Britain and Europe, electricity savings from In Home Displays (IHDs) are over 9% per year for at least three years, representing a typical saving of at least £147 to a household in Great Britain. Savings on electricity alone will pay for the cost of the IHD in less than four months.

Gas is difficult to measure without a smart meter and is barely represented in the trials, but if the savings for electricity are extrapolated to gas, it represents a saving of £186 over three years. The average combined saving for a customer with electricity and gas is therefore estimated at £318 after the price of the IHD is deducted.

Across Great Britain, when rolled out to all electricity and gas customers, IHDs are expected to deliver[1] electricity savings to residential customers amounting to over £2.8bn (over three years). For gas the saving is expected to be around £3.3bn. The overall saving for British residential energy customers would therefore be over £6bn assuming just three years of usage per IHD (this is not to intimate that IHDs will not be used after that time but that research into savings after that time is not available).

Pilots have mostly been conducted on first generation display products – where large, good quality colour ambient and numeric displays are used (typically £15-20 cost) these can enhance savings to around 11-18%. Best practice concerning IHDs and the programmes that support them, are continuing to improve. Savings from IHDs are therefore expected to improve further as the mandate for IHDs in Great Britain develops.

Consumption reduction is highest for real time feedback. The convenience and presence of an IHD means they are more regularly used than other channels. Other feedback channels such as web pages and informative bills are, however, a valuable addition to IHDs. Savings from web pages are around half that of IHDs.

Evidence suggests that reductions persist and are not short-term gains only. Savings after more than two years are even better than in the first year, but education and awareness prior to IHD installation is essential for high and sustained savings. It is also essential that service providers take the customer through the savings journey by providing ever new and extended ways to save.

Approximately 70-90% of British consumers who have received IHDs are satisfied, and most customers feel that they have already reduced energy consumption as a result.

The introduction of CADs is expected to complement the rollout of IHD and initially give some households an additional route to 'pull' and 'push' data. More research into their effectiveness is needed but with more development and the right business models, they promise to provide a future access point for future additional smart services.

The mandate for IHDs would appear to be a good policy with value for the consumer.

[1] In combination with the programmes in which they are implemented.

Context to the Report

Electricity consumption is typically an invisible by-product of low-attention habitual activities. "Most people have only a vague idea of how much energy they are using for different purposes and what sort of difference they could make by changing day-to-day behaviour or investing in efficiency measures" (Darby 2006). And this is not just a British phenomenon. The European Commission (2010) found that less than half of European households know how much electricity they consume. Numerous other studies have led to widely accepted conclusions that households are scarcely knowledgeable about how much energy they consume, how much they actually pay for their energy or why and how they should save energy. But what if consumers received information about these things? And what if they also received information about how much energy they are using right now; where and how it is being used; how their consumption relates to their energy costs; and how, through their behaviour, they might reduce or control their consumption, energy bills and impact on the environment? Well, then they would be receiving consumption feedback information.

Consumption feedback programmes provide an opportunity to give households the consumption information they need. This type of information can influence the behaviour of residential consumers so that they use energy more efficiently. Darby (2006) found savings ranging up to 12%. Looking at 74 feedback trials, VaasaETT (2011) in "Empower Demand 1" found electricity consumption reduction ranging from 4% to 11% as a result of consumption feedback programmes.

Feedback can be fulfilled in various ways, via different channels and with the use of many alternative technologies. One approach is to use in-home displays, otherwise referred to as IHDs or (Smart) Energy Monitors.

Other channels include web portals, mobile apps, TV displays and paper based communication. All of these channels have so far been tried and tested in Great Britain and elsewhere.

But with IHD distribution already well under way in Great Britain, since 2008 in a voluntary mostly pre-smart way and now as part of a mandated accompaniment to mass smart meter roll out, it is a timely opportunity to learn from recent British and international experiences concerning the use, keys to success and impact of IHDs within consumption feedback.

The Objectives

Consumer behaviour actions only accounted for 1.5% of carbon savings recorded as part of the Carbon Emissions Reduction Target (CERT) between 2008 and 2012.[2] While this largely reflects an insufficiency of behavioural programmes, it additionally reflects the relatively low importance given to behavioural energy efficiency since 2008. After all, it is easier to give someone insulation than to teach them how to use consumption feedback. But the simplest solution is not always the best solution, and should certainly not always be the only one. Nevertheless, the perceived difficulty and lack of impact sometimes associated with behavioural energy efficiency (at least some of this perception has indeed been justified by sub-optimal pilots and analysis) has led to some arguing that policies to change behaviour are not the best way to improve energy efficiency. They believe it is better to focus on passive energy efficiency investments such as double glazed window, or to automate the energy efficiency response through for instance controlling heating systems. Opinions are abundant in this discussion at present, but what do the facts say?

[2] Ofgem (2013), The final report of the Carbon Emissions Reduction Target (CERT) 2008-2012, Reference: 66/13

In this report we investigate what research to date tells us about the value of IHDs, their role within the context of alternative consumption feedback channels, the key drivers of successful use of IHDs, and where they might lead in the near future. Ultimately, we want to know whether the benefits for consumers will outweigh the costs and help consumers save energy and money.

The Methodology

We selected the most relevant British and European feedback programmes[3] from the VaasaETT database of over 110 consumption feedback programmes from around the world. In particular, the main quantitative analysis used six British and European programmes, containing 65 sub pilots and representing over 28,000 participants. A further six British studies, including research from three British utilities, were used for qualitative data. The findings were interpreted in the context of the body of knowledge that VaasaETT has gained over the past five years through the world's most extensive investigation of consumption feedback programmes, as well as its experience of participating directly in such programmes. In order to identify the current and potential impact of IHDs, we integrated data from British energy retailers, vendors and public sources such as Ofgem on the number of IHDs distributed and in use. While some of the data is public, other data is not. Most data was therefore aggregated and anonymised. Where possible, however, we have revealed our sources.

It is important to note that our analysis and estimations are (except where stated otherwise) based on current or recent technologies and practices. In an environment where technologies and best practices are evolving continuously and dramatically, this means that our conclusions should be considered conservative and by no means optimistic. For instance, the UK EDRP trials conducted between 2007 and 2008 delivered modest results by international standards and contained many design characteristics that we today would consider sub-optimal, yet nevertheless represent the most substantial quantitative British consumption feedback trials to date.
Our analysis and estimations, unless stated otherwise, furthermore relate only to residential electricity savings, not gas. This is a significant omission since natural gas is a major source of residential energy in Great Britain. Much of it is furthermore heating related, so it arguably represents the majority of reducible consumption. The reason for this omission is that insufficient comparable research data is currently available for gas. It is however possible to draw some conservative educated estimates concerning how much savings will be increased if applied to gas. These estimates will be given later in this report. Our calculations also do not concern savings related to the automation of domestic appliances such as heating and cooling systems.

The Role of In Home Displays (IHDs)

We estimate[4] that between 2008 and the present, between 3.5 million and 4 million IHDs have been distributed to residential consumers in Great Britain. IHDs are important because they provide a beginning to the consumer's journey towards energy efficiency and a knowledge and motivation basis for future engagement. But they are not only used at the beginning.

[3] Feedback-only programmes and programmes of feedback, time of use and peak pricing.
[4] Based on the integration of various sources: Ofgem, vendors , GB retailers and other sources.

In particular, IHDs allow consumers to explore their environment, to experiment by turning appliances on and off, up and down, comparing what uses the most and the least, and seeing how the behaviour they have always assumed insignificant is, in fact, costing them money that they could so easily save.

"Wow! These little light bulbs use more energy than my laptop", "Does the kettle really cost this much?". "I have saved one pound just by switching this off".

IHDs also provide ambient push-information to consumers, acting as constant reminders of energy usage. A glance from any member of the household towards an IHD as they walk into the kitchen[5] is all that is required to notice whether consumption is unusually high, how much you have spent (or saved) or if you are approaching your budget or pre-payment limit. IHDs can also signal time-of-use or dynamic price movements as part of demand response offerings, and they are an effective way for consumers to check whether their energy use corresponds with what they are being billed for[6]. What's more, this information reaches every member of the household and provides an ambient reminder to all.

Such displays can, for some, even be something to show their friends or neighbours and a tool to educate their children. But what is often forgotten is that for customers who have never received anything tangible from their utility supplier, certainly never any kind of gift, an offer of a useful and desirable device, to help them save money and learn about their own behaviour, can be perceived as a big benefit. It can be a step towards initiating an improved relationship with the customer.

The Impact of IHDs

The quantitative and qualitative research analysed for this report provides an insight into the impact that consumption feedback and IHDs can and do bring to Great Britain and internationally, and the characteristics and pre-requisites of that impact.

Consumption Reduction and Shifting Through IHDs

On average consumption feedback pilots to date (including those with and those without IHDs), have resulted in consumption savings of approximately between 6-7%[7]. Reductions have ranged from marginally positive up to 18%[8]. Time of Use pilots[9] both with and without IHDs have also shown reduced energy consumption, both at peak and at off-peak times. The research clearly indicates however, that savings are greater when IHDs are used. In the case of consumption feedback pilots where energy conservation has been the primary target[10], for instance, the use of IHDs has resulted in average savings of 9%, which is proportionately 81% greater than in pilots where IHDs have not been used[11]. The savings in Time of Use pilots with IHDs have been found to be 29% higher for peak time reductions, and 41% higher for off-peak reductions compared with pilots where IHDs have not been used.

[5] British research has indicated that the large majority of monitors are located in the kitchen or living room.
[6] British research has indicated that for most consumers a key benefit of energy monitors is that the customer can see if their consumption corresponds to what they are being billed for.
[7] 6.18% when normalised for numbers of participants in each sample. Without normalisation the saving is 6.77%.
[8] The pilots with the highest savings are IHD-only feedback pilots.
[9] Time of Use refers to prices that are different for different periods of the day. They are higher when demand within the network is higher (peak) and lower when demand is lower (off-peak). There may be just two or more than two time periods. The peak and off-peak time periods can be different on different days.
[10] Analysis of 29 sub-pilots representing 10069 consumers. Automation of consumption was not used.
[11] The correlation between the incidence of IHDs and consumption savings is R=.499. The independent variable (existence of IHDs or not) is responsible for a variation of 24.9% of the dependent variable (consumption reduction). The results are statistically significant at the 0.01 level.

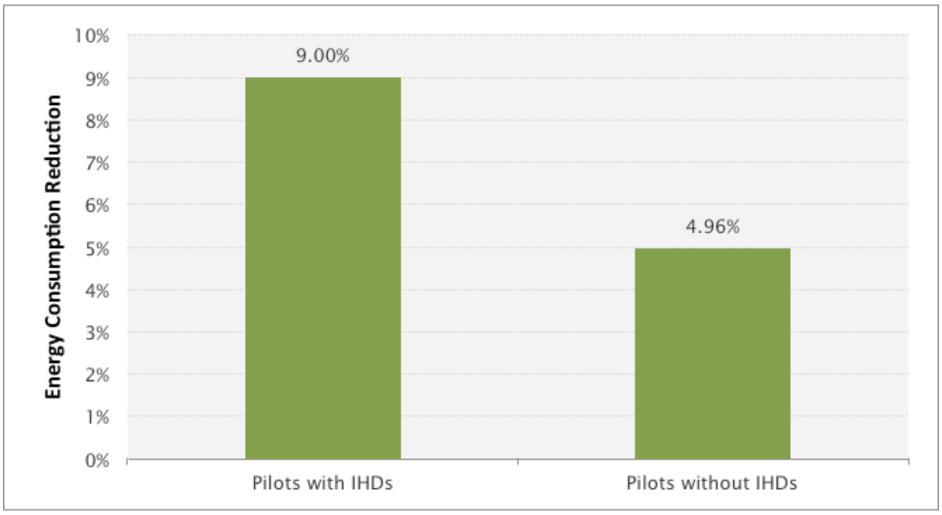


Fig.1. Reduction of consumption in pilots with and without IHDs

Education First

The impact of consumption feedback programmes, regardless of the communication medium, is highly dependent on pre-feedback, pre-technology education. Ideally (but it is not essential), this education will come at least partly from independent sources. A consumer must see the bigger picture, the reason why the utility is embarking on this action (and the trustworthiness of the motivation behind it - not something that should be taken for granted), why the customer should be interested and why the customer, utility and even the community should be working together. It is, after all, not the technology that is the objective. Technology is only a means to an end.

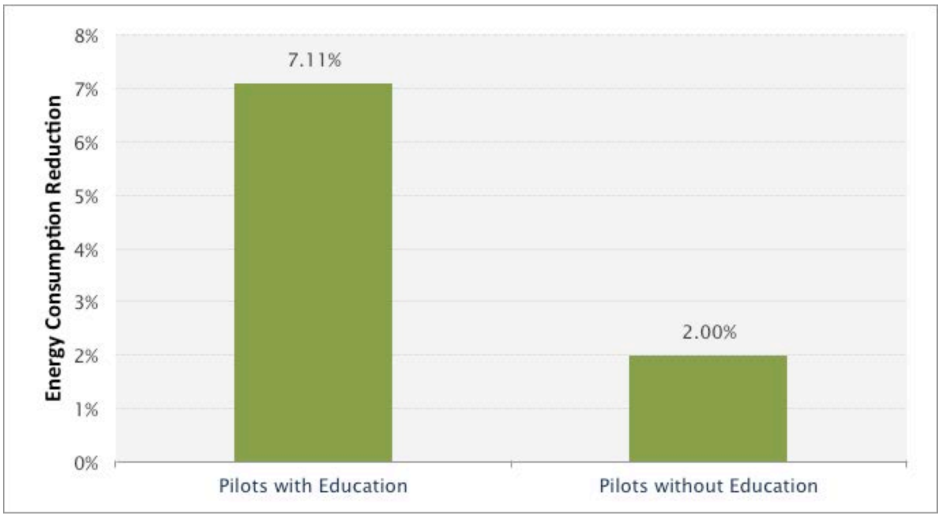


Fig. 2. Influence of education on consumption reduction (all feedback pilots, not just IHDs)[12] [13]

In cases where customers have received a significant level of education about issues such as the nature, purpose and potential benefits of the trial prior to receiving consumption feedback, as well as how fully to use the technology, consumption reductions have on average been over three times as high as in those cases where such education was not received. This may sound extreme, and it is, but such is the importance of education. In one British pilot, education was extremely limited and savings were modest. Such savings should not be the sole basis of Britain's savings estimates from feedback.

[12] Most pilots (including those with IHDs) have had education incorporated.

[13] Data is normalised for sample size variation between pilots.

The Ecology of Supporting Channels

IHDs can be effective on their own, but their benefits are not derived in isolation from the other channels of consumption feedback. In fact, while consumption feedback pilots have shown IHDs to provide far greater savings than webpages or informative bills, research shows that multiple feedback channels can complement each other. Energy usage statements or smart bills via paper, websites or mobile apps can, for instance, aggregate large amounts of information to provide consumers with additional in-depth explanations (if they want them) of their bills. In particular, consumers have been shown to appreciate in-depth analysis of how they compare with their neighbours or with similar households. These other channels can consequently provide consumers with additional information to supplement what they have learnt from IHDs. They also allow consumers to take the insight they have gained through IHDs and dig deeper on certain issues (such as the impact of their CO2 savings on the environment). Or they can help the consumer expand into additional issues such as what else they can do to save energy in their home.

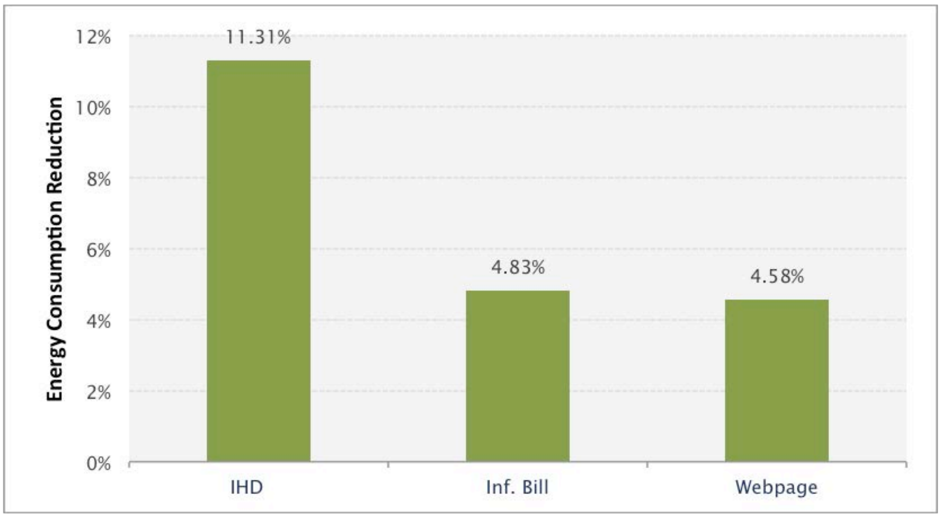


Fig.3. Consumption reduction by channel[14] [15]

These channels are not replacements for IHDs however. Website information via home computers for instance, is generally mostly pull-feedback information, meaning that it is hidden unless requested. If there is no trigger or unless the consumer is sent notifications, the user will not see the information. Research has indicated that in general websites are accessed less frequently than IHDs[16] which provide push-feedback whereby the data is always there and does not require any action from the user to ask for it. It is like the clock on the wall: always on, providing information at a glance.

Mobile apps are also push devices, at least partially, able to provide notifications in the same way that email, Facebook and other notifications are pushed to consumers. But these notifications relate to feedback that a consumer would want to be notified about, selected bits of information such as "you are close to your budgeted limit", or " you have left an appliance turned on", or "you spent £7.50 on

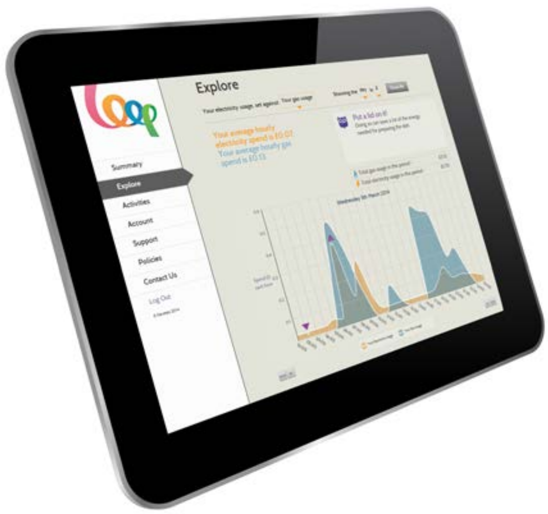
[14] 11.31% refers to the savings achieved by pilots with only IHDs (IHDs were also combined with other feedback channels). This is therefore not the same as the impact of pilots with IHDs. The earlier stated savings from IHD pilots vs. pilots without IHDs refers (in the case of 'with IHDs') to some pilots that included IHDs and some that did not). While the 11.31% savings are higher than the earlier mentioned savings, the somewhat increased statistical quality of the earlier mentioned number is better due to a larger sample size. Data is normalised for sample size variation between pilots.

[15] Data is normalised for sample size variation between pilots.

[16] In one British study consumers with an IHD and access to a supporting website, all customers who used the website also used the display but nearly 40% of customers who used the display did not visit the website, and the IHD was visited far more frequently that the website. British research indicates that over three quarters of consumers tend to prefer IHDs to websites.

your electricity today". While useful to consumers, especially in a mobile sense, senders of such feedback have to be very careful not to annoy consumers by sending irrelevant or over-frequent information[17]. IHDs, while not mobile beyond the home, do not bother consumers. Their feedback is both ambient and unintrusive.

In our opinion, mobile apps should be used to compliment IHDs. They should provide access away from home and provide consumers with supplementary mobile service extensions including essential notifications such as warning of a budget being exceeded or a safety issue. In future, when the technology allows they will be able to do much more (see the later section on "The Emerging Future").



Basic vs. Higher End IHDs

The early days of consumption feedback were characterized by IHDs that were anything but aesthetically appealing. Nor were they particularly intuitive or easy to use. Early displays, including those that were used in early pilots in Great Britain and elsewhere, up until around 2010 and in some cases much later, typically had small grey or monotone colour screens, off-screen buttons and relatively complex operational procedures. A consumer would typically need a manual to use it. Information provided by it was numerical or graphical, based mainly on the level of consumption rather than other meaningful metrics that we see in modern IHDs. A lot of emphasis was placed on kWh, which many consumers do not understand, and information relating to financial costs and savings was either absent or difficult to set. These devices were mostly linked not to smart meters but rather to meters that a digital eye or tail reader clip and transmitter could be attached to, which required additional installation effort from the consumer. These devices were generally not very ambient (although coloured lights to communicate time of use or dynamic pricing periods were incorporated in some cases) and were not designed for people who are not especially interested in gadgets or in their energy use. Essentially, the 'coolness' and desirability factor was missing. It is hardly surprising then that these devices achieved less consumption reduction that those of today. Sceptics of IHDs should not base their conclusions on the results derived only from these kinds of devices.

However, IHDs rapidly evolved to incorporate enhanced aesthetics, usability, intuitiveness and functionality. Larger and partial colour screens appeared, in some cases with touch screens (although touch screen devices were at that time too expensive to be viable for residential consumers, especially given the low volumes of displays that were being purchased by utility suppliers). More meaningful and ambient feedback accompanied these developments, and the 'coolness' and 'desirability factor' had begun to arrive.

At this point, however, attempts at smart home and home energy control through IHDs proved

[17] British research has indicated that while consumers do value notification, notifications should be highly relevant.

ineffective, in part because the ecology of homes, smart home solutions and consumers had not sufficiently evolved: technology costs were too high, consumer awareness and predisposition too low, and the opportunities to save and add convenience and other benefits were not yet contained within the home. Utilities would have to wait for the further development of the internet of things[18] and the presence of elements such as solar, storage, micro-CHP smart heating control, electric vehicles and dynamic pricing to emerge before such home energy management would present a realistic business case.

The most recent generation of IHDs continue to develop better ergonomics, aesthetics, intuitiveness and relevance to consumers' aspirations. They also afford consumers the opportunity to precisely reconcile meter reading, bill and behaviour. Colour touch screens, cool looks, firmware upgradability, combined with far more affordable prices (excellent IHDs are now available for around £15) now make the latest generation of IHDs an appealing offering for consumers and utilities alike. It would appear that this progression has been helped by no small degree, by the existence of the mandate. It has given market competitors confidence to invest vast sums of private money to bring to market rapid evolution of the IHD proposition.

Research shows that significant savings result even from older and the most basic of displays, though more recent displays are more effective than older ones because of their enhanced characteristics. The optimal choice of specifications for modern displays, however, is largely a question of the context within which the display is distributed. Research has shown that the most advanced displays are not necessarily the most popular. What consumers want above all is the set of feedback functions that suits their needs and aspirations. There is no point providing functionality that over complicates the offering, nor providing a display that does not provide sufficient insight or motivation; it would simply increase the cost of the IHD for no discernible benefit to the consumer. For this reason, in some cases it will make more sense to distribute displays with reduced functionality, and in others it may make more sense to offer higher end displays.

Whichever display is used, however, the display should possess good aesthetic and ergonomic qualities, and ideally should possess the 'cool' and 'desirable' factors. While not essential, larger screens and colour displays are a bonus, especially where dynamic pricing and time of use is concerned (where ambience is even more of a virtue).

[18] Term by Kevin Ashton (2009) referring to uniquely identifiable objects and their virtual representations in an internet-like structure (Source: Wikipedia).

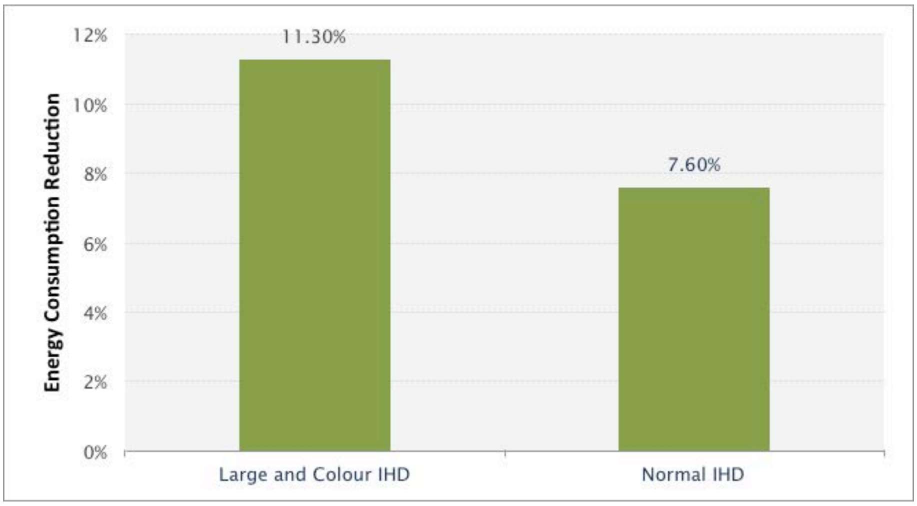


Fig. 4. IHD aesthetics influence in peak reduction, time of use pilots[19]

Getting the Format Right

For IHDs there is a choice between numerical, graphical or ambient content. Ambient has many permutations ranging from consumption speedometers (a popular choice) to pictorial visualisations, animations and even simple balls that change colour according to the level of consumption of the time of use price level. Different customers have different preferences in this respect, and some degree of mass customization or personalization is therefore a virtue, if financially viable. But what is clear is that in general a combination of numerical and ambient information delivers the biggest consumption savings. This provides a simple explanation to the relatively poor results of some pilots.

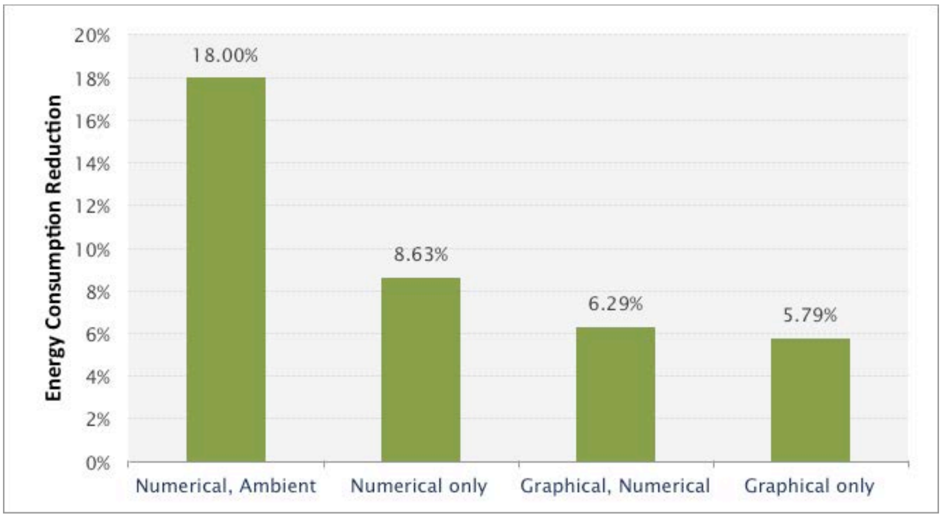


Fig. 5. Consumption reduction by IHD feedback format combination[20]

For other feedback channels that consumers access less frequently such as smart bills, the situation is different. There is more use for graphs showing for instance recent trends and analysis of consumption behaviour, to help customers understand their consumption patterns and their implications in more detail, if they want. For such analysis, graphical representation of feedback can be valuable. Graphical information of this kind can be shown clearly by IHDs, and with good reason, but IHDs currently have less space and capability to clearly provide very extensive or customized graphical information to customers.

[19] Data is normalised for sample size variation between pilots.
[20] Data is normalised for sample size variation between pilots.

Getting the Content Right

But what should feedback programmes be trying to communicate to customers, whether through IHDs or otherwise, in order to achieve optimal impact? The choice is large and really only limited by imagination, but the most effective combinations include for instance consumption level, price/cost, goal achievement, savings to date and tips/advice. While not included in the programmes quantitatively analysed for this research, it is also clear that peer group comparison is also commonly considered valuable content by customers, where available. Essentially, what the research indicates is that multiple forms of information are more effective than fewer, but that does not mean that the more content the better. What appears to matter is giving customers the right mix of actionable information, motive and reward through the feedback.

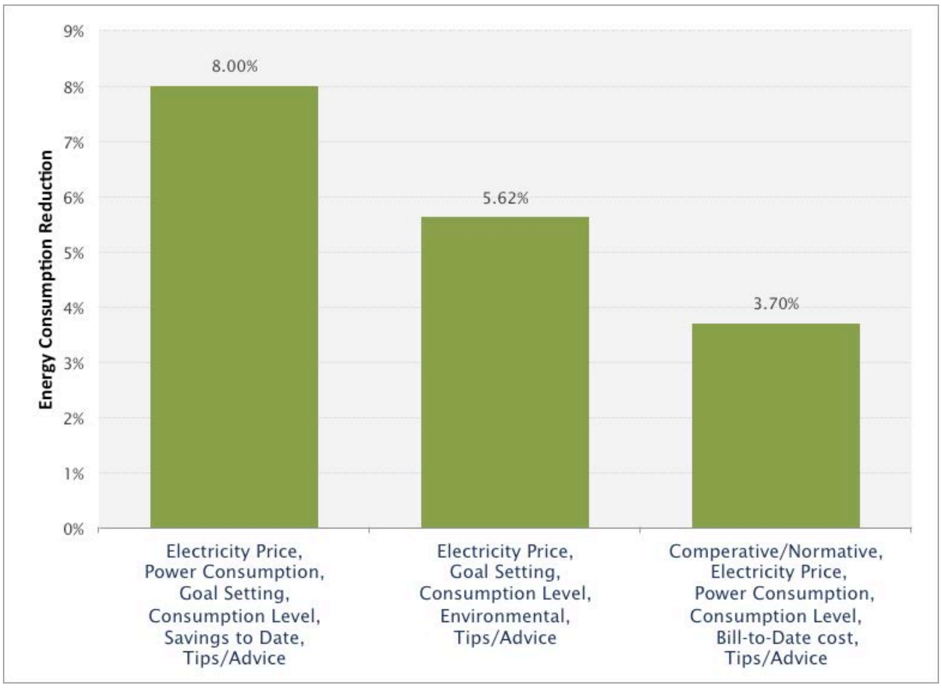


Fig. 6. Consumption reduction by feedback content combination (all feedback pilots, not just IHDs)[21]

Getting the Timing Right

As with so many aspects of customer behaviour, doing the right things at the right time is important also for the customer consumption reduction journey. Most consumption feedback information which is provided long after the event is generally of less value to consumers, even more so in the early stages of feedback programmes when consumers need frequent enough information to allow them to see the link between their behaviour and the amount (and cost) of energy they consume. The most impactful programmes have been where consumption feedback information has been real time (almost immediately after the event) or near real-time (at least within 15 minutes of the event).

There is some feedback which does not always have to be so real time. This includes historical consumption trends and some other comparative information, such as comparing a consumers' consumption against other similar homes. Monthly feedback can be sufficient for this. Real-time data is such a major part of the benefit afforded by feedback information however, that to leave it out would result in far lower savings.

[21] Data is normalised for sample size variation between pilots.

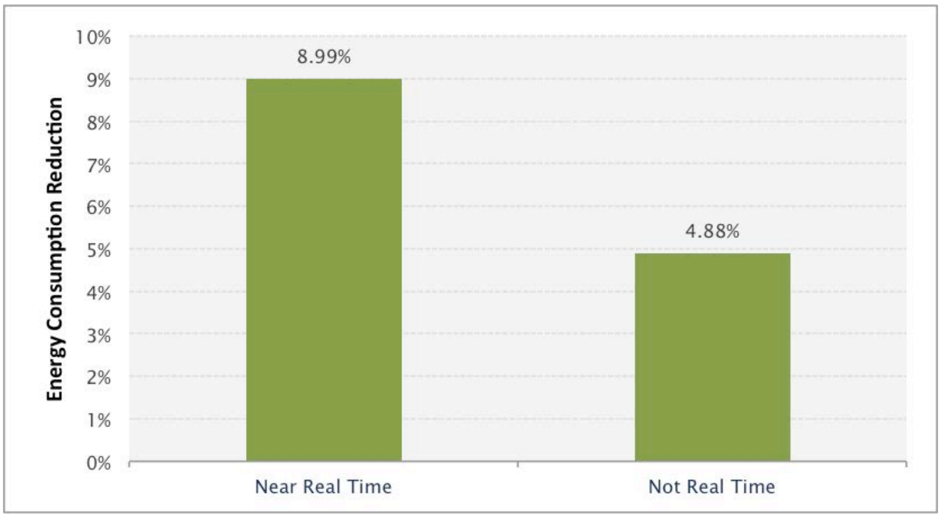


Fig. 7. Consumption reduction for different frequencies of feedback updates (near real-time relates to IHDs only)

Frequency of Use and Longevity

There is a belief by some that consumption feedback programme impact is short lived, that IHDs are thrown away in a few days or weeks, that consumers' interest in energy efficiency will not be sustained, that engagement will vanish as the novelty factor wears off. This is not true.

In fact the quantitative analysis conducted for this research reveals that programmes lasting two years in length appear even more impactful than those that are just a few months or a year in length. The correlation value between the length of the pilot and consumption reduction is consequently a remarkable 0.704[22], indicating that longer pilot durations tend to correspond with higher consumption reduction percentages.

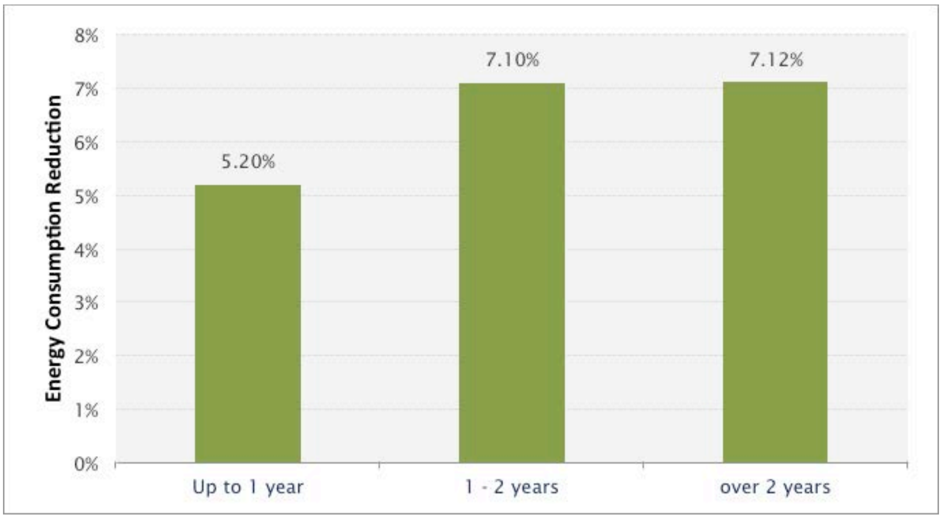


Fig. 8. Length of pilot - consumption reduction correlation (all feedback pilots, not just IHDs)

22 50% of the variation of the consumption reduction can be explained by the variation of the pilot length.

What's the Significance?

Financial Savings

Ultimately, the success of any feedback programme, in the opinion of consumers, will be defined in terms of the money that is saved[23]. In this respect, we have identified key performance indicators[24] [25]:

1. If we apply average consumption feedback reductions found in pilot programmes (those pilots analysed for this research, including some with IHDs and or CADs and some without) we estimate that an average residential electricity customer[26] in Great Britain would save approximately £37[27] as a result of being part of a consumption feedback programme[28] (if we use gov.uk average energy bill data from 2013). If we use current prices, the savings would be £40[29] per year

2. If we apply average consumption feedback reductions found in pilot programmes without IHDs, we estimate that an average residential electricity customer in Great Britain would save approximately £27 per year as a result of being part of a consumption feedback programme (if we use gov.uk average energy bill data from 2013). If we use current prices, the saving would be £30.

3. If we apply typical average consumption feedback reductions found in pilot programmes that included IHDs, we estimate that a typical residential electricity customer in Great Britain would save approximately £49 per year as a result of being part of a consumption feedback programme (if we use gov.uk average energy bill data from 2013). This is an increase in savings of £22 per year over the savings in programmes without IHDs. If we use current prices, the saving would be £54.

4. If we assume that the savings from gas will be proportionately the same as for electricity (we expect the rate to actually be substantially higher for gas[30] but in the absence of comparative supporting research projects we have assumed the same as for electricity) we can estimate

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[23] Our estimates of savings are considered highly conservative, even allowing for any error arising from pilot sampling error (due for instance to customers in pilots being more interested in energy conservation than typical customers).
[24] Savings based on current prices.
[25] Issues with official data: 1. Some official data relates to GB and some to UK. We take GB wherever possible. NB: Some official GB analysis appears to confuse GB and UK data. 2. Official data about gas connections and number of households is not the same as numbers of customers. Households may not always be electricity customers. We take the data relating to number of customers, not number of households or connections. Our analysis relates to GB, not UK. 3. Official bill data published before 2014 is based on 1990s average consumption levels which are lower for electricity and higher for gas than current assumptions. We use the data published in 2014 based on new consumption estimates.
[26] Typical consumption 3800 KWh/year. Source: https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics (2014).
[27] Based on an average residential annual electricity bill of £546 for Great Britain for the whole of 2013: Source: https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics (2014).
[28] How long these and other savings continue will depend on the way the feedback programme is developed.
[29] At current total prices (final price to consumer including tax). Prices for electricity sourced from the European Household Energy Price Index (HEPI): www.energypriceindex.com. These prices are more up to date than the average bill size estimates found elsewhere (gov.uk average bill data is currently from the whole of 2013, while HEPI data is current.
[30] The vast majority of gas consumption relates to heating or hot water. Such consumption is easier to control than average electricity consumption and international research indicates that heating is the primary source of potential residential energy reduction.

savings for residential gas customers in Great Britain. Based on an average British residential customer's gas bill[31] and a saving of 9% we can estimate that an average saving for a customer with an IHD would be £62. A customer with both electricity and gas and an IHD would therefore save £111 per year (based on gov.uk average energy bill data).

5. The research indicates that in general, even excluding the effect of education (see section on education), best practice consumption feedback delivers around 60% higher savings than average. Since IHDs and the practices underpinning their implementation are improving dramatically all the time, and since the pilots used for this analysis are typically a few years old, it is reasonable in our opinion to expect that savings are higher at present and will be even higher in future than they have been at the time of the pilots analysed for this research. If we even assumed a 30% increase in savings due to improvements in practice, this would result in savings for a customer with an IHD and both electricity and gas of approximately £144 per year.

6. Given that a latest generation, best-in class, multi-function energy monitor can cost as little as £15, the hardware costs associated with providing IHDs within a consumption feedback programme could be covered in under two months if the customer has gas and electricity, or in under 4 months for an electricity-only customer. This calculation excludes the impact of the 30% improvement (see point 5 above).

7. If the £49 saving for the first year (for customers with electricity and an IHD) of usage is reduced by £15 to cover the cost of the IHD, making it £34, and then added to two subsequent years of £49 savings, then the saving for an electricity customer with an IHD will be £132 over three years. If applied to the estimated 25.6 million residential electricity customers in Great Britain[32] (assuming an 84% usage rate[33]), the combined savings would be over £2.8bn over three years.

8. If the £62 savings for gas customers with IHDs are then continued also until three years, making £186 and applied to the estimated 21.1 million residential gas customers[34] [35] (assuming the same 84% usage rate) in Great Britain, a further combined saving of £3.3bn would be achieved.

9. The overall saving for British residential energy customers would therefore be over £6bn assuming just three years of usage per IHD.

Consumer Satisfaction

There is no doubt then that consumption feedback information is the biggest benefit to consumers from the installation of smart meters, and that IHDs contribute heavily to this benefit.

And British research[36], conducted by USwitch (2013)[37] indicated that 81% of those with smart meters use the information provided to cut down on overall consumption. 12% of respondents further stated that they trusted their utility (energy supplier) more than before they had a smart meter. It is not known exactly how many of those surveyed had IHDs but based on the nature of the sampling we estimate that a majority of respondents would have had them. This evidence consequently bolsters other evidence,

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[31] An average annual residential gas bill in Great Britain is £689 for the whole of 2013. Source: Source: https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics (2014)
[32] Source: gov.uk (2013)
[33] See section on Frequency, Use and Longevity.
[34] Source: gov.uk (2013)
[35] Not all residential gas customers use gas for heating but average gas bill amounts for residential gas customers with gas heating are far higher than for customers without gas heating.
[36] Survey of 3624 EON and British Gas smart meter customers.
[37] http://www.uswitch.com/gas-electricity/news/2013/12/12/new-research-shows-consumers-are-happy-with-smart-meters/

both quantitative, qualitative ad anecdotal, indicating the importance of consumption feedback and IHDs.

In general it can be said that the body of research in Great Britain, both that mentioned above and other research, indicates that approximately 70-90% of consumers who have received IHDs are satisfied, and that between 50-80% (65%) of customers have already reduced energy as a result.

The Emerging Future

While the mandated roll-out of IHDs progresses, utilities, vendors and independent players are developing the extensions and continuations to the customer journey; for while IHDs are the mainstay of the present when it comes to consumption feedback, they will be just part of the bigger arena of future smart services for energy customers.

Of course it is always difficult, or impossible to predict the future, but what is more clear is the emerging future, the coming few years when technologies that are being developed now are introduced to the energy market.

The overwhelming trend within the residential energy industry at the moment is the development of services to take advantage of the internet of things and the inevitability of the 'connected home'. The idea of smart homes that simply try to automate for convenience and energy savings is being replaced. The energy consumer will soon be connecting home energy management with own-generation, storage, electric vehicles and more. The interaction of all of these elements will create a natural equilibrium forming ecology, whereby consumers can save when the price is high, use when it is low and become increasingly self-sufficient, in addition to receiving a host of associated convenience by-products.

The Role of CADs

In order to achieve this future a number of supporting feedback and control services will be needed by customers. So will a lot of consumer behaviour change. Unless the consumer is completely bypassed through automation (hardly a customer-friendly solution), the consumer needs to know what is going on in their home and have control over their environment. This information and control will take place through Consumer Access Devices (CADs)[38] which are already in the process of being developed for mass roll-out and which have already been tested to some degree within pilot studies[39]. In this report a CAD is defined as an internet gateway which gets smart meter data from the ZigBee HAN (the smart meter's Home Area Network) out onto the cloud via a router.

Once a CAD is connected to the cloud via a router, a consumer can then access their smart meter and its consumption information, and any other appliances in the home or elsewhere that are connected

[38] In Great Britain, there is an official definition of a CAD, set by DECC. It s defined as a device with a GB Specific ZigBee interface. This includes IHDs but also smart appliances, internet gateways, or an interface to another home area network. Typically the term is however associated with an internet gateway which gets smart meter data from the ZigBee HAN out onto the cloud via a router. A SMETS2 communications hub must be able to support up to four CADs capable of joining the ZigBee network..

[39] Far less behavioural research is available regarding the role and impact of CADs

either to the router or otherwise to the related internet service. In this way consumers can for instance[40]:

1. Obtain real time consumption feedback information via a website, mobile phone or tablet app or TV. This affords mobility to consumers,
2. Automatically monitor and control any appliance in the home that can access the internet/router or CAD. This can provide energy consumption savings, convenience, safety (such as home or appliance monitoring, e.g. "Did I turn off the cooker?") and security related services,
3. Engage in and monitor (real time) time of use, dynamic pricing, capacity aggregation and other demand response activities, either voluntarily or through automated response such as remote or automatic heating control,
4. Benefit from big data related services such as heating systems or other control systems that learn to efficiently fit around the consumer's lifestyle,
5. Ultimately realise the connected home / lifestyle of the future. Consumers with electric vehicles will want to be able to decide (even if they mostly automate) when they charge their car; consumers with near self-sufficient or highly energy smart homes (integrating generation, storage, purchase, sale and management of energy) will want to be able to keep track of and manage their home ecology.

All of these benefits are already technically possible and research has indicated that many customers would like such services, but their availability and adoption will depend on a number of criteria being met:

1. Research to date (such as the UK EDRP trials) found that one of the biggest barriers to the adoption of CADs is their installation. They are now far easier to install but customers are only likely to install them if they have a desire to do so. Customers with a fear or technology, those who experience difficulties during the installation process and those who maybe do not have the appropriate router specifications or internet connection speed are unlikely to adopt.
2. The success of CADs will depend on the development and communication of attractive new business models (attractive for service providers and consumers); holistic services that provide maximum benefit for consumers at minimum effort and cost. Technologies need to be affordable before they can be valuable. Recent British research has indicated that most customers will only pay for such services if they offer a positive pay-back to the consumer within two years.
3. Concerns about data security, if not successfully addressed, could frustrate attempts by the energy industry to offer data rich, behaviour-related and automated services to consumers via the Internet. Energy utilities will first have to gain consumer understanding and trust before they will be able to full engage with them to offer such services

Will we need Feedback if we have Automation?

The common argument over whether automation is preferable to self-control is rather inappropriate to the development of energy efficiency. Ultimately, consumers do not seem to be opposed to automation per se. It is after all a convenient, hassle free solution for the consumer. But consumers do not want

[40] Some of these benefits can be achieved without CADs

to be controlled without their permission or in a way that they do not approve of; or without their ability to opt-out, override or modify their involvement. In fact consumers do not want be 'controlled' at all. They want to be served, benefitted, and convenienced. Control is after all effectively what they have always perceived as part of their relationship with their utility. It is a major contributing factor behind their negative image of the energy industry.

It is also important that consumers understand, through manual involvement, the relationship between their consumption behaviour and the consequences for themselves and the environment, before they are provided with automation. Otherwise, consumer's achievements will in the future be limited entirely to the extent facilitated by automation; their understanding of the value of automation will be undermined. Customers who receive only automation without personal involvement, tend to use more energy during non-automated periods than customers who are engaged in a behavioural way. If a customer thinks that their consumption is not their responsibility but rather the responsibility of some automation technology, then they will take less responsibility for their own actions and will not fully understand the implications of either their own actions or those of the automation technology.

What is needed is the integration of behavioural and automation development. It is simply not a case of either automation or feedback. To this end, IHDs, CADs and other consumption feedback channels are essential to future energy savings.

About the Author

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Dr Lewis is an international expert in utility customer behaviour, psychology and marketing relating especially to energy efficiency and other smart utility and competition issues. During 17 years in the utilities industry Dr Lewis has conducted research and strategic support in over 60 countries in five continents for over 500 organizations.

Dr Lewis has been at the strategic forefront of advanced service developments globally for many years, supporting leading players as well as directing and partnering some of the leading international best practice projects such as Respond 2010, the 2013 Ventyx ABB Smart Grid Global Impact report, Empower and the EU funded Advanced project. He is a board member and co-founder of the European Smart Energy Demand Coalition (SEDC), co-wrote one of the World's first state-level smart grid implementation plans in Australia, has stood on the editorial board of the European 'Energy Efficiency' Journal published by Springer, is a reviewer for the International Journal of Energy Sector Management and is on many industry committees. Dr Lewis also edited and co-wrote the World's first book detailing liberalization experiences globally 'The Energyforum Global Report', is the source of Europe's official definition of customer switching and is a Faculty Member for the Diploma of Advanced Studies programme in Renewable Energy Management at the University of St Gallen Executive School in Switzerland.

Formerly head of Marketing Research and Analysis for the UK based retailing subsidiary of Amoco (now BP) and Seeboard (now EDF Energy), during the onset of competition in the British retail energy market, Dr Lewis holds a PhD in Marketing from the University of Edinburgh.

About VaasaETT

VaasaETT is a world leading specialist research and advisory company for the energy utilities (electricity and gas) industry. Through our unique collaborative model, we integrate globally sourced understanding of customer behaviour and psychology, competitive market behaviour and smart energy offerings in order to provide our clients, and the whole energy industry, with unbiased understanding, facts, guidance and ideas to make the most informed decisions and innovations.

In our field of expertise we have followed more energy markets in more detail, for a longer time than any other organization around the world, and our internal experts have provided research, analysis and consulting for over 500 clients globally.

More information at: www.vaasaett.com

About BEAMA

BEAMA is the trade association for manufacturers of electrotechnical equipment, including equipment for the smart meter rollout and smart homes. Its Consumer Energy Display group (CEDIG) comprises leading manufacturers of In Home Displays and other energy feedback products.

More information at: www.beama.org.uk

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