Smarte målere (AMS) og feedback

Vil informasjon og tilbakemelding om faktisk strømforbruk stimulere til energieffektivisering blant norske forbrukere?

72
2014

RAPPORT

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Norges vassdrags- og energidirektorat
2014

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Smarte målere (AMS) og feedback

Utgitt av: Norges vassdrags- og energidirektorat

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Sammendrag: Denne rapporten undersøker effekten av feedbackløsninger som kommunikasjonskanal mot norske sluttbrukere. I hvilken grad vil slike løsninger kunne stimulere til energieffektivisering og hva er forventet sparepotensiale?

Emneord: Feedback, AMS, smarte målere, forbrukeratferd, energieffektivisering

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Forord

Denne rapporten undersøker effekten av feedbackløsninger for norske sluttbrukere. I hvilken grad vil slike løsninger kunne stimulere til energieffektivisering og hva er forventet sparepotensiale?

Rapporten er en del av FoU-prosjektet «Sluttbrukermarkedet og klima». Prosjektet har til hensikt å frembringe kunnskap om hvilke tiltak i sluttbrukermarkedet som kan bidra til at forbrukere tar i bruk mulighetene som følger med utrullingen av smarte strømmålere (AMS). Innen 1. januar 2019 skal alle norske strømkunder ha installert en slik strømmåler.

Forskning viser at informasjon og tilbakemelding om faktisk energiforbruk, såkalt feedback, er et av de mest effektive tiltakene for å bevisstgjøre kunder om eget forbruk og motivere til å spare strøm. For å vite den faktiske effekten av feedback i Norge må ulike kommunikasjonsløsninger testes i stor skala blant norske strømkunder. Denne rapporten er et relevant utgangspunkt for videre arbeid og kan forhåpentligvis bidra inn i forberedelsene til fremtidige storskala pilotprosjekt.

Oslo, oktober 2014

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avdelingsdirektør

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Assessing the Potential of Energy Consumption Feedback in Norway

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October 2014

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Abbreviations and Terminology

- **Ambience:** In this report ambience refers to indications of consumption that are apparent to a consumer without the consumer needing to actively look for them. Essentially it is information that is present in the atmosphere around the consumer. For instance a sound, colour of light or visual imagery that the consumer can be aware of in the course of their day-to-day activities. Non-ambient indicators would require the consumer to pro-actively go looking for them. There is a continuum from non-ambient to ambient, and so some indicators may be ambiguous in their definition. A phone notification is one such instance (and in this report considered not to be ambient). The information comes to the customer, but the customer still needs to actively engage to fully gather the information.
- **Apps:** Applications for smart phones, tablets and other smart devices.
- **Behavioural Energy Efficiency:** Energy efficiency through conscious behavioural change by consumers.
- **Consumption Feedback:** the provision of information to consumers about their energy consumption to assist them to change their consumption behaviour.
- **Energy:** Electricity
- **Energy Retailer:** Supplier of energy to customers. This excludes distribution and other upstream parts of the supply chain. Often referred to as an Energy Supplier.
- **HAN:** Home area network
- **IHD:** In Home Display, otherwise referred to as (Smart) Energy Monitors.
- **Liberalised Market:** A market where customers are free to choose which retailer they buy their energy from. Often referred to as a deregulated market.
- **Utility / Utilities:** Electricity, Gas, Water
- **Utility Company**: Any company providing utility services to end customers

Acknowledgements

We would like to thank all those who so generously provided advice, information or materials for this report, including but not limited to Heidi Kvalvåg and Cathrine Åsegg Hagen from NVE, Patrick Caiger Smith and Simon Anderson from Green Energy Options (GEO), Emily Hallet, Giulia Gioffreda and Nicholas Payton from Opower, Mike Woodhall from Chameleon Technology, Vidar Kristoffersen from Fredrikstad Energinett, Chris Saunders from Navetas, as well as various people from In Home Displays and British Gas.

Summary of Findings

Based only on relevant findings from the world's largest body of international research into Energy Consumption Feedback[1] (referred to here simply as Feedback) - the process of providing energy consumers with enlightening information in order to engage them willingly in more energy efficient behaviour, VaasaETT estimates that Norwegian households could save around seven TWh within two years if effective feedback were applied following the roll out of smart meters, due to take place in Norway by 1th of January 2019.

Why Should Norway Save Energy?

Norway has the highest per capita and typical household electricity consumption in Europe. Almost all residential heating is electric. While Norwegian electricity consumers pay relatively low prices for their electricity (the lowest in Europe) and are among the wealthiest in Europe, the electricity bill as a share of disposable income is nevertheless significant. At five per cent it is the third highest in Europe[2]. For customers who want to save money on their energy bill in Norway, there are three options: through competition (switching retailer), through changing tariff or through lowering their consumption. Since the large majority of households have still not switched after so many years of competition, and since supplier margins typically do not allow large savings through changing contracts, energy consumption reduction presents Norwegian consumers with an important opportunity to save on their electricity costs.

But the benefits of consumption reduction in Norway should not only be measured in terms of KWh or money. Although nearly all of Norway's electricity is generated by hydro, the issue of reduction of CO2 through energy conservation is still extremely important. In fact Norway's increased conservation of energy would reduce the need for imports of energy and enable more exports of low or zero CO2 emissions to other Nordic markets and other parts of Europe. The process of increasing customers' awareness of energy consumption and how to reduce it would also provide impetus for greater demand response to cope with the increase of electric vehicles in Norway, Norway's increasing stock of intermittent distributed generation and the opportunity to export more energy to other parts of Europe during their peak demand or low supply periods.

About the Research

The potential for residential energy savings in Norway resulting from feedback has not yet been explored. Some small studies have taken place, primarily as proof of technical principle, but no state-of-the-art, consumer focused, scientific behavioural programme of a robust size has yet taken place. Ultimately, a detailed estimate of the true benefit from such feedback would require a comprehensive pilot study involving the implementation of a major feedback programme in Norway. As a first step however, it was considered important to identify from research around the world to-date, if consumption feedback appears to be a good way forward for Norway and how it might be successfully achieved. VaasaETT, under the commission of NVE, therefore analysed 91 relevant samples from energy consumption feedback programmes around Europe and elsewhere, relating to over 30.000 energy consumers. The results of this analysis form the basis of this report.

Potential Savings For Norwegian Households

The research finds that savings of at least 6% per year would be realistic for Norwegian households with electric heating and no automation, assuming a mean price of 51.74 NOK øre/KWh (6.21 euro cents/KWh) as the price of electricity excluding distribution fees[3]. For an

[1] VaasaETT holds the world's largest database of smart energy demand related programmes including consumption feedback. Its database includes hundreds of programmes related to consumption feedback, demand response, time of use, smart billing, smart grid and more. VaasaETT has furthermore conducted a huge body of direct research and participation in the field of smart energy demand.

[2] Although many other markets additionally use gas or district heating extensively for heating, cooking and hot water.

[3] The long term impact of a consumption reduction on the transmission tariff for each customer is complicated to calculate. Potential savings have therefore been calculated using an average residential

average consumer this would mean a saving of 976 KWh. For a detached house, the saving would be KWh 1217. For a large household the savings would be much higher. These savings would be heavily increased however if more optimal feedback channels, best practice and latest tools were applied to the feedback mix. Conservative estimates put average energy savings at around 11% per year or 1774 KWh if such conditions were applied, even if automation is excluded. This would represent in the range of NOK 900-950 (€110) for an average household in Norway.

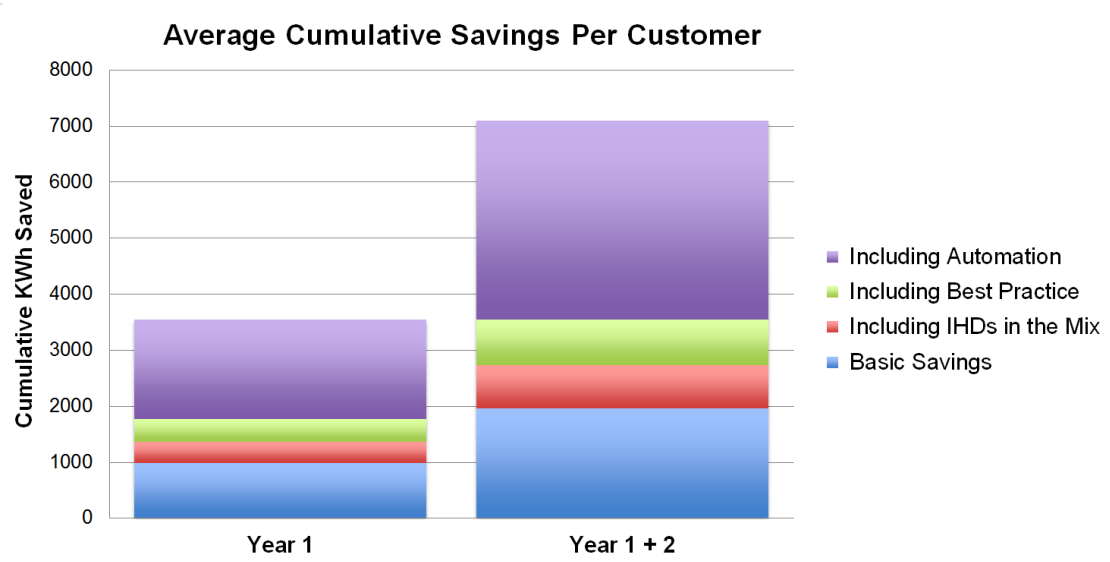


Fig. 1. Average cumulative savings per customer. Estimations for Norway. Source: VaasaETT

If the savings were continued for two years - a realistic minimum for an initial feedback programme[4] - the savings become significant at approximately NOK 3.6 billion or 7 TWh for all Norwegian residential electricity customers, assuming an 80% IHD usage rate. To this could be added the impact of SMEs and commercial buildings, which could be offered related services.

These savings would be increased even substantially more however, if heating automation were included in the equation. Automation is left out of the estimates to make it more realistic in the short term. Extensive research[5] indicates that the addition of automation could double the savings realised through feedback alone.

electricity price for 2013/2014 that excludes the rent for transmission. Hence the total savings potential is conservatively estimated.

[4] Evidence suggests that consumption reductions, for IHD and other forms of feedback, persist and are not short-term gains only. Savings in the second and third year are typically better than in the first year within good programmes.

[5] For instance, Stromback, J., Dromacque, C. & Yassin, M. H. (2011). The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison. Prepared for ESMIG. VaasaETT Global Energy Think Tank. Available online at: <http://www.esmig.eu/press/filestor/empower-demand-report.pdf>.

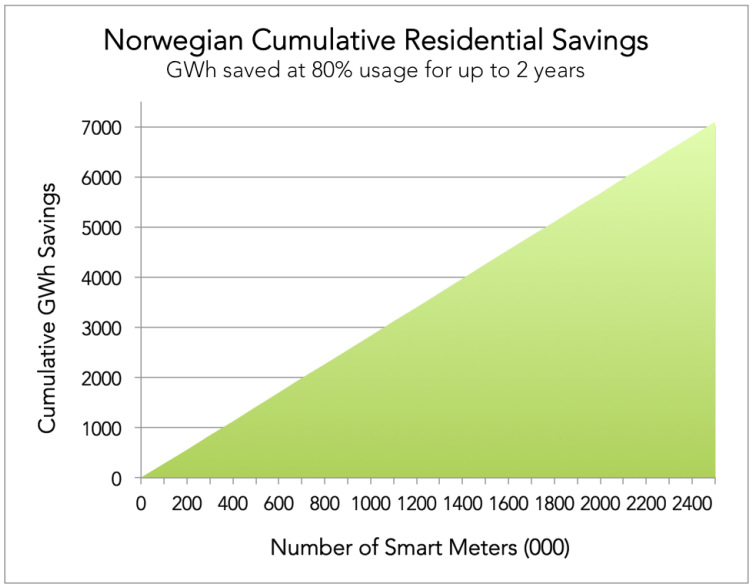


Fig. 2. Norwegian Cumulative Residential Savings Estimations. Source: VaasaETT

Who is Feedback Relevant To?

Who is relevant for feedback depends less on demographics (who it is presented to) and more on what is in people's minds and how we present feedback to them. It is about finding out what makes different customers tick, what stimulates them, what makes them engage in saving energy, whatever their motive. Essentially research indicates that feedback is relevant, at least to some extent and in one form or another, to almost all consumers.

Why Not Just Go Straight Into Automation?

Some would argue that there is no point trying to change customers' behaviour, that it makes more sense to just automate consumption. Feedback, it follows, is not necessary. In fact, while automation can double the consumption reduction resulting from behavioural change, it does exactly that. It builds on behavioural change, it does not replace it. Why settle for 6%, if you can save 12%?

Besides, research has also indicated that where automation is introduced without prior behavioural change, consumption at off-peak periods (when automation is not taking place) can actually be even higher than it would have been without automation[6]. This is because consumers with automation and not behavioural change tend to put all their reliance on the automation and therefore take little or no consideration of their own behaviour.

Feedback should therefore not be seen as an alternative to Automation, but rather a preparation and support for it.

[6] Stromback, J., Dromacque, C. & Yassin, M. H. (2011). The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison. Prepared for ESMIG. VaasaETT Global Energy Think Tank. Available online at: <http://www.esmig.eu/press/filestor/empower-demand-report.pdf>.

Feedback in Norway

Norway is in fact already one of the pioneers of feedback and related services such as home automation and demand response. Feedback services have been offered, for instance, by the utility Lyse. The Lyse solution offers feedback together with a smart home solution containing heating control from a smart phone and tablet based app. According to Lyse, the combined 'Smartly' feedback and heating control solution service can save customers up to 2% of their consumption (if they automate their electric heating system) and the financial savings can cover the cost of the investment within two to four years.


Fredrikstad Energinett

Feedback through an interesting In Home Display has also been developed for instance as part of the Smart Energy Hvaler project, a project by the Fredrikstad Enegi Network made up of Fredrikstad Energinett, the Hvaler municipality and the Norwegian Centre of Expertise. This project also recently provided savings of approximately 20% when combined with a capacity based tariff where the price increased with the power level.

Which Channels Are Best?

There is a lot of debate surrounding the question of which channels are best for feedback. In-Home Displays (IHDs), Informative Bills and Leaflets, Web Portals and Mobile Applications (mobile apps) are the most commonly used. Feedback may also take place via ambient displays such as lamps that change colour, through TV screens, smart thermostats or other channels. Other new and innovative channels will appear. Research indicates that to-date IHDs have been the most effective for energy efficiency, but different - arguably all - feedback channels are beneficial, they just suit different roles, and a multiple channel approach seems to work the best. Currently it is difficult to identify the relative impact of real or near real-time mobile apps because of the lack of available pilots that have taken place.

The following roles are suggested by this report, but ultimately a service provider's choice of mix of feedback channels needs to suit its budget and strategies.

	IHDs	Web Portals	Mobile Apps
Suggested Role	Main base tool for the early stages of feedback, to engage large proportions of consumers and whole households. Fun and enlightening relationship changer. A useful ongoing household reference point for energy efficiency, demand response and other service.	Supporting feedback for consumers who want to go deeper into the analysis and learn more about what they can do to save energy. A point of interaction with the service provider. Good for customers who do not have a smart mobile device.	Personalised feedback direct to the consumer, anywhere, any time. A point of interaction with the service provider A lower cost, limited alternative to IHDs. A mobile replacement for web portals. The future hub of the services that will grow from and around feedback.

Table 1. Suggested roles of different channels

A provider that wants to improve the awareness of most of its customers as a pre-cursor to future energy services, and has a sufficient budget available, would be well suited to offering IHDs and informative leaflets[7] / web portal to all of its customers, while developing a mobile app service to take the customers to the next level (future energy services) when those consumers and the services are ready. A provider with a smaller budget or who feels that their customers are already sufficiently aware and otherwise ready for the future energy services, may be more suited to offering mobile apps from the outset.

Other Keys to Successful Feedback

Successful feedback is however, about much more than choosing the right channels. Good feedback requires sufficiently ambient information. You cannot expect the customer to go to the data. It must be real-time where appropriate. You cannot explore with yesterday's information. And it must be supported by extensive preparatory education of consumers, provided at a public and personal level, by respected independent bodies as well as by service providers.

It also requires the right mix of types and formats of content (the report explores this in detail), and it should be delivered in an intuitive, aesthetic and enjoyable way.

Fig. 3. Feedback Types. Source: VaasaETT (2014)

Keep it Going

Customers do not get bored after the first week or month or even year. Done well, if the programme is designed with the longer term in mind, consumers can be kept engaged for at least three years. It may even be longer, but few programmes have lasted longer than three years. What's more, savings from feedback actually seem to increase beyond the first year and remain remarkably constant thereafter. In fact 50% of the variation in consumption reduction between different pilots can be explained by variation of the lengths of the pilot, with longer pilots on the whole delivering bigger savings.

What is essential for long-term success, however, is to take the consumer through a journey. The journey should be a continuous one, of steady enlightenment, behavioural change and habit development and overall growth of the consumer. The journey should not be broken - better to drip feed consumers with feedback, support and direction rather than overwhelm them and then run out of ideas. But the journey need not be long, the customer should not be rushed, they should grow at the speed they feel comfortable, but change can happen at stealth through planning, customization, rapid research and development and optimal timing. The is a right time for everything, when the customer's environment is right, and the customer is ready, the solutions can be offered.

[7] Informative leaflets largely fulfil the same role as web portals except that they are likely to be read by a larger audience since they do not require the receiver to be proactive (visit a web page). If sent to a smart phone and linked directly to the web page, a web page notification may be similarly effective.

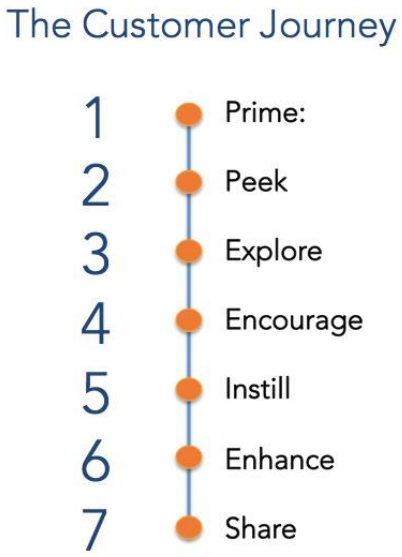


Fig. 4: Stages of the Customer Journey

Customer Satisfaction

Satisfaction is extremely dependent on the experience and benefits that consumers are able to derive from the experience. Given the savings that are possible in Norwegian context, and tendency for Norwegians to be enthusiastic and capable adopters of innovative energy and technology related services (including the feedback services that have so far been tested in Norway), along with Norwegians' relatively positive attitude towards the energy industry, their interest in environmental issues and their track record of competitive market activity, it would seem logical to expect a level of satisfaction from feedback that would at least be as good as the international average. It is therefore expected that - if delivered to a standard roughly consistent with international best practice levels - 70-90% of Norwegian consumers on feedback programmes would be satisfied and most would feel that they have reduced their energy consumption as a result.

Benefits for Energy Companies

It is often questioned why energy companies - that earn entirely from the volume of energy sold - would want to help consumers use less volume of energy. In fact there are some major reasons why energy companies would want to reduce or control consumption. From the perspective of network companies, revenue in Norway is essentially adjusted to compensate for reduced consumption. Controlling consumption helps them manage congestion and other pressures on the network, supporting the resilience and flexibility of the network and facilitating the integration of additional intermittent renewable and distributed generation.

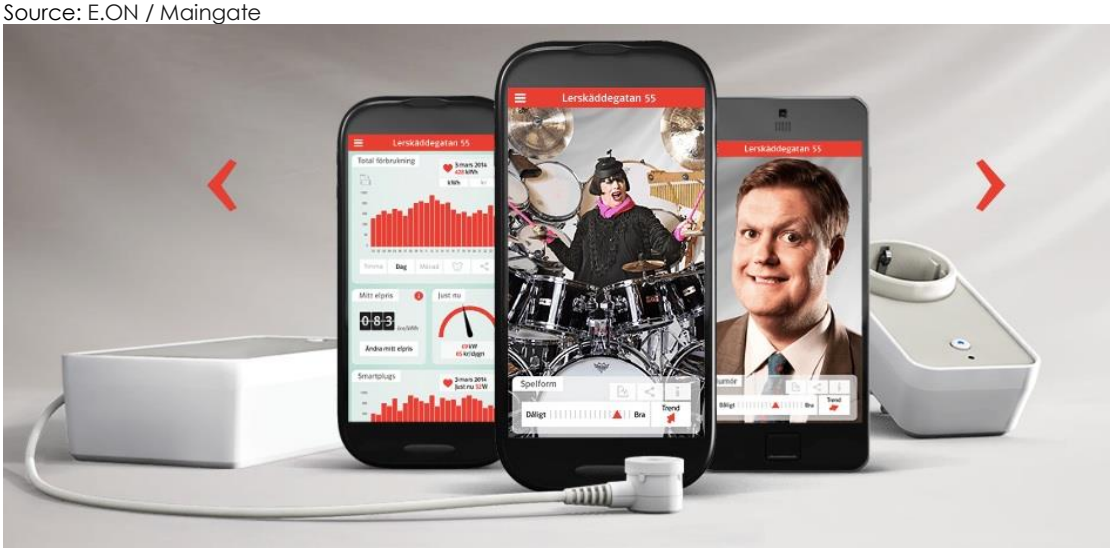
From the perspective of suppliers of energy, feedback can deliver impressive improvements in customer loyalty. For companies that have a large proportion of customers who are switchers - customers that have switched at least once - the loyalty of those customers is usually a more significant determinant of the customer lifetime value (CLV) of those customers than the possible loss of revenue from reducing consumption due to feedback services. Even though feedback typically leads to revenue reductions, our research shows that the CLV improvements more than compensates for this reduction.

Ultimately, the customer journey is also expected to lead to new business opportunities for the energy industry. The chance to sell additional services to consumers, to compensate for the falling revenues that the energy industry around the developed world is experiencing (regardless of feedback). The chance to compete against the threat of new entrants offering smart energy services through new business models.

The Way of the Future

The connected home is approaching, Apple, Google, Samsung and other leading players are pushing hard to ensure it succeeds. Against the backdrop of emerging universal platforms, realistic home energy management offerings, far more cost effective distributed generation and storage, and the rapid increase in the number of electric vehicles, feedback will provide the energy related knowledge and engagement necessary to drive the adoption of new energy related services. Feedback will not be made redundant by the future, it will be a central element of it.

Source: E.ON / Maingate



Consumption Feedback - An Overview

Consumption Feedback Explained

Electricity consumption is typically an invisible by-product of low-attention habitual activities. The European Commission (2010)[8] 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.

"*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).

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 want and need, in turn influencing the behaviour of residential consumers so that they use energy more efficiently.

Potential of Feedback

Hundreds of programmes around the world have now been conducted, relating to millions of customers. The impact has, overall been substantial. One US provider of feedback services for instance has estimated that the savings of consumers on its programmes alone have led to savings equivalent to the annual energy generation of the Hoover Dam. Darby (2006) found savings ranging up to 12%. Looking at 74 feedback trials, VaasaETT (2011)[9] found electricity consumption reduction ranging from 4% to 11% as a result of consumption feedback programmes (excluding the effect of automation).

It is not unheard of for savings from feedback programmes to be over 10% and even up to nearly 20% for some segments of customers, purely resulting from feedback driven 'behavioural energy efficiency', without any form of automation or physical energy efficiency. This level of savings generally applies to programmes where only a small but reasonably representative proportion of customers in a customer base are in the programme[10], those interested in the programme, prompting claims of bias in the findings. The level of bias is in fact surprisingly small in those programmes that are done in a robust manner, the samples after all represent nearly half of all customers invited to participate.

When feedback programmes are applied to all customers in a customer base, with the option of opt-out[11], the savings remain substantial. Research by the feedback service provider Opower for instance has found that average long-term savings are around 2%, relating to just one or more non-device based feedback channels (primarily customized feedback leaflets). This may not seem very large but it is when applied to (almost) the entire customer base of a utility company with hundreds of thousands or even millions of household customers. For a market such as Norway, this saving alone would mean nearly two and a half TWh in savings over a three-year period.

[8] Commission Staff working paper (2010). An Energy Policy for consumers. Available online at: <http://ec.europa.eu/energy/gas_electricity/doc/forum_citizen_energy/2012111314_citizen_forum_meeting_working_group_report.pdf>.
[9] Stromback, J., Dromacque, C. & Yassin, M. H. (2011). The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison. Prepared for ESMIG. VaasaETT. Available online at: <http://www.esmig.eu/press/filestor/empower-demand-report.pdf>.
[10] Typically, response rates to randomly distributed requests for participation are around 40%.
[11] Typically, opt-out rates are a few per cent of the entire customer base.

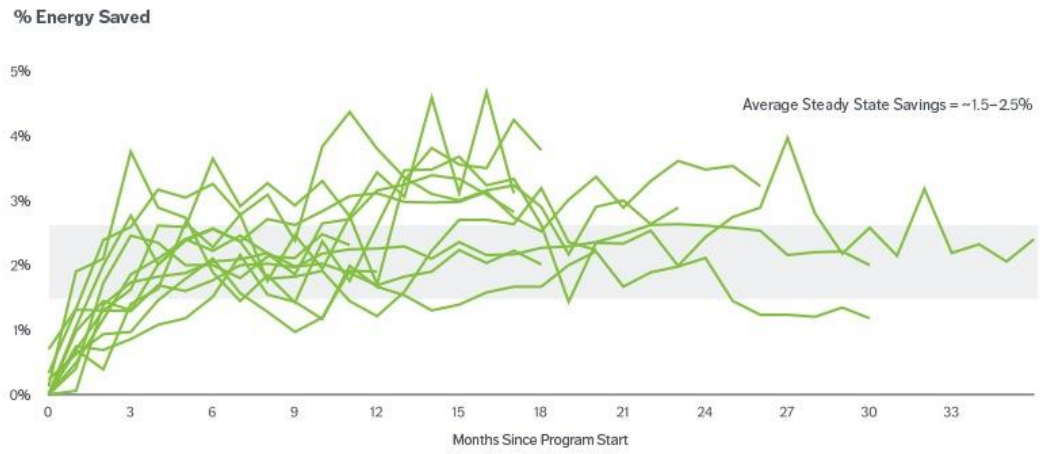


Fig. 5. Combinations of feedback means[12]

Consumption feedback services should not be seen as only having one leg, however. Saving energy is not the only objective either for consumers or those utilities and third parties offering the services.

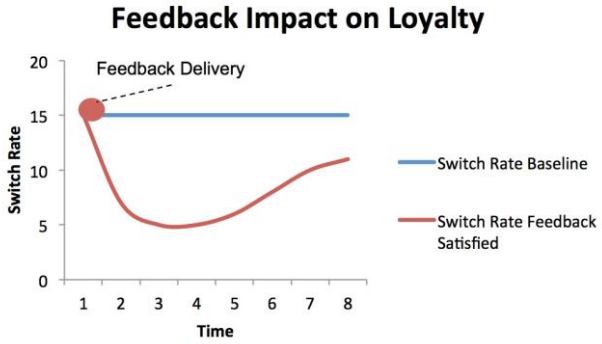


Fig.6. Importance of Ambient Displays. Source: VaasaETT

From a utility company perspective, consumption feedback services, done well, lead to major improvements in customer loyalty and since customer lifetime value in an active liberalised market is a function of profitability multiplied by length of the relationship, feedback services can massively increase the value of customers to utility companies.

Company	Region	Switch Rate without Feedback	Switch Rate with Satisfied Feedback
Incumbent Retailer	Scandinavia	7.5%	2%
Large Incumbent Retailer	Oceania	25%	5%
Competitor Retailer	North America	11%	4%

Table. 2. Loyalty through consumption feedback programmes[13]

[12] Source: OPower
[13] Source: VaasaETT 2014

Providers of feedback services also benefit from the feedback channel as an opportunity to market additional services to the customer and can be a prelude to the smart and extended home.

From a customer perspective, feedback programmes provide a sense of insight, awareness, empowerment and achievement that they have never before known with regards to their consumption of energy. In some cases, even just knowing, finally, that the bill you receive and the reading on your meter (the amount of energy you have used) are the same, that you are not being ripped off by your energy retailer, is benefit enough. The feeling of receiving advice and help from your energy provider is also often highly appreciated. The reasons for satisfaction are many and savings is only one of them.

Motives for Consumption Reduction

Different people have different motives[14] for saving energy. Money savings is just one of them. Many customers can be extremely satisfied with feedback programmes without even knowing for sure if they have saved any energy or money, because they feel that they have saved, or now know how they can save, or where their money goes. The feeling of increased control and predictability regarding finances, and of not wasting energy or money can be as or more important than the feeling of saving. Feelings of achieving, making oneself a more efficient and comparatively better citizen, the feeling of reaching one's targets or staying within budget are also motivating and rewarding.

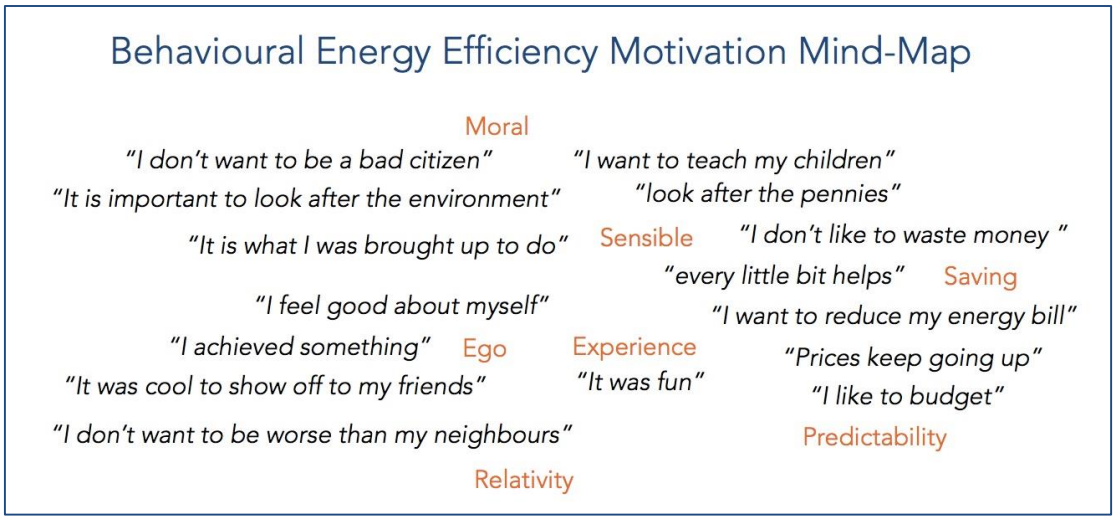


Fig. 7. Examples of Behavioural Energy Efficiency Motivations - Partial Mind-Map.
Source: VaasaETT.

Where direct savings are the driver, savings objectives are often not as great as one might expect. The realisation that saving really is possible simply through small actions, is often consonant with our sense of looking after the pennies. After all, if you drop a coin on the floor, you normally pick it up. So we also turn off the light switch before leaving the room and turn down the heating by one degree, when we realise that it is like picking money off the floor.

[14] More information: Lewis et. al. (2012), EMPOWER DEMAND 2, Energy Efficiency through Information and Communication Technology

Why Not Just Go Straight Into Automation?

Some would argue that there is no point trying to change customers' behaviour, that it makes more sense to just automate consumption. Feedback, it follows, is not necessary. In fact, while automation can double the consumption reduction resulting from behavioural change, it does exactly that. It builds on behavioural change, it does not replace it. Why settle for 6%, if you can save 12%?

Besides, research has also indicated that where automation is introduced without prior behavioural change, consumption at off-peak periods (when automation is not taking place) can actually be even higher that it would have been without automation[15]. This is because consumers with automation and not behavioural change tend to put all their reliance on the automation and therefore take little or no consideration of their own behaviour.

Feedback should therefore not be seen as an alternative to Automation, but rather a preparation and support for it.

Who is Relevant for Feedback?

In principle almost anyone is suitable for consumption feedback and if it is to impact on the consumption of a nation, then feedback programmes must engage the vast majority of any customer base. Research and experiences to date have clearly indicated that feedback programmes done well engage the masses. In Great Britain where IHDs must now be offered to all residential customers with a smart meter, usage rates of around 85% have been observed on a large scale. Providers of non-IHD feedback services have also found that opt-out[16] is generally better than opt-in since in practice few customers choose to opt-out and the service is used by most kinds of customers.

But who uses feedback services the most? Well the nearly complete European funded ADVANCED Active Demand project[17], a project integrating the results of programmes by RWE, ERDF, ENEL and Iberdrola, has provisionally found that while some groups of more engaged customers are rather predictable, such as people with larger consumption, other groups are more surprising. Older people in particular appear to be highly interested in energy issues. This does not mean that younger people are not interested, but it does mean that early adopter theories are dangerous in the context of energy efficiency. If feedback technologies and services are to achieve their potential and serve the people who value energy efficiency the most, they must be simple enough to be used by young and old alike.

Research has also indicated that feedback is no less significant to people who can afford to waste energy or people who have little to save. Even well off people with families and large houses often have a good reason to save. People with little to save are often surprised how easy it is to watch the pennies. Budgeting is for all sorts of customers and the desire to be efficient with energy and money has as much to do with the desire not to waste as it does with the desire to save. And for people who are not motivated by money, there are other powerful motives. As shown by the experience of Opower, the power of self-comparison is a powerful driver. Who wants to be the most inefficient, who does not feel good when they are better than others.

The fact is that who is relevant for feedback depends on how it is presented as much as who it is presented to. It is about finding out what makes different customers tick, what makes them

[15] Stromback, J., Dromacque, C. & Yassin, M. H. (2011). The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison. Prepared for ESMIG. VaasaETT Global Energy Think Tank. Available online at: <http://www.esmig.eu/press/filestor/empower-demand-report.pdf>.
[16] Opt out should always be presented as a customer led choice. Customers should not feel imposed upon or trapped in any way. Customers are already suspicious of electricity suppliers.
[17] http://www.advancedfp7.eu

engage in saving energy, whatever their motive. Ultimately, who is relevant depends less on demographics and more on what is in people's minds and how we stimulate them.

Feedback Types

There are many forms of feedback content types (hereafter termed Feedback Types), really only limited by imagination. They can be categorised into the following content psychological categories[18]: Situation, Exploration, Empowerment, Compete (SEEC).

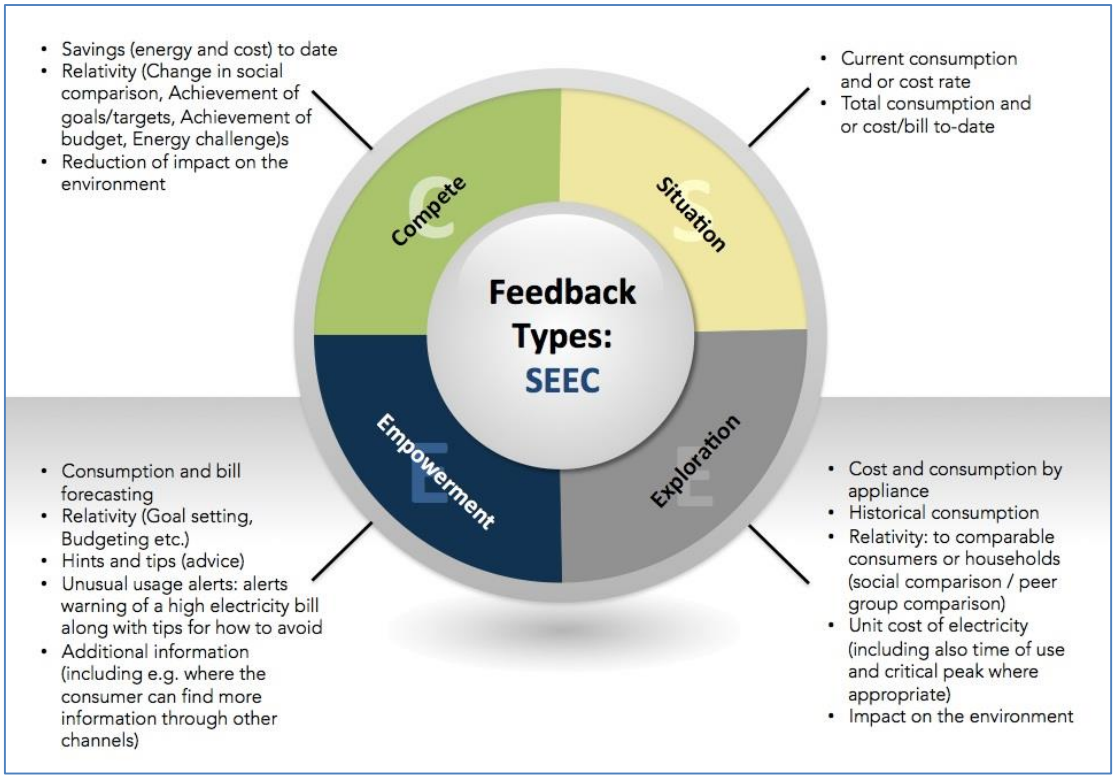


Fig. 8. Feedback Types. Source: VaasaETT (2014)

Feedback Channels

Feedback can be fulfilled in various ways, via different channels and with the use of many alternative technologies. There is extensive debate about which channel is the best, revolving most intensively around whether it is necessary to give people a dedicated IHD or whether it is enough for customers to use existing devices such as smart phones, tablets, computers or cheaper solutions that do not require any device such as leaflets[19]. In reality the question is not whether IHDs or their alternatives should be used but how they should complement each other. There is for sure no best type of feedback, but rather different applications for different situations. Four main channels are explored in more detail in this report:

1. In-home Displays,
2. Informative Bills/Leaflets,

[18] Modified from and more information available at: Lewis et. al. (2012), EMPOWER DEMAND 2, Energy Efficiency through Information and Communication Technology

[19] Leaflets sometimes refer to information provided in or with bills. It is not recommended to include information in or with bills since customers rarely read their bills and increasingly receive bills to online banking systems or equivalent.

3. Web Portals,
4. Mobile Applications

Each of these channels has virtues and limitations. This research does not aim to suggest a single channel, but to identify what we know, from research to-date, about these channels, their roles, pre-requisites and potentials.

Other channels of feedback include TV displays, symbolic ambient displays (see section on Ambient Displays) and even smart thermostats. Such channels are generally considered marginal to mainstream feedback efforts going forwards either due to their ineffectiveness in trials to date (e.g. TV displays) or due to their cost or shortage of available research data (e.g. ambient displays) or because of their limited focus on feedback (e.g. smart thermostats). This report pays less attention to these channels.

In-Home Displays (IHDs)

IHDs are generally seen as most relevant to the early stages of feedback, but can play a longer term role. They are supported by a large body of research. Millions have been distributed around the world[20].

IHD evolution has been a steep learning curve from largely engineer led solutions to the modern, trendy solutions of today. In just a few short years, IHDs have transformed into desirable consumables. The evolution of IHDs has not by any means matured, however. The new models and concepts for 2015 and beyond continue to put the models of the past in the shade in terms of affordability, capability, usability, compatibility and appeal. The IHDs of today are already commercially viable but are expected to continue to improve for a few more years. Because of this pace of evolution of IHDs, it should be borne in mind that the impact of IHDs in past pilots somewhat underestimates the true potential of best practice IHDs available currently and in the very near future.

Essentially the best practice IHDs of today provide a broad set of real or near real-time (within one minute of the consumption activity) feedback to consumers via colour, touch screen. They are typically intuitive (manuals are not essential) and have screens similar in size to a smart phone. If bought on, large scale IHDs currently cost under NOK 170 (€20). They are typically an un-directional source of communication from the meter to the consumer, sometimes including personalised messaging from the service provider (e.g. energy company) to the consumer.

[20] Over 5 million have already been distributed 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. Only a small proportion of these customers have been the subject of research and an even smaller proportion have been researched scientifically.

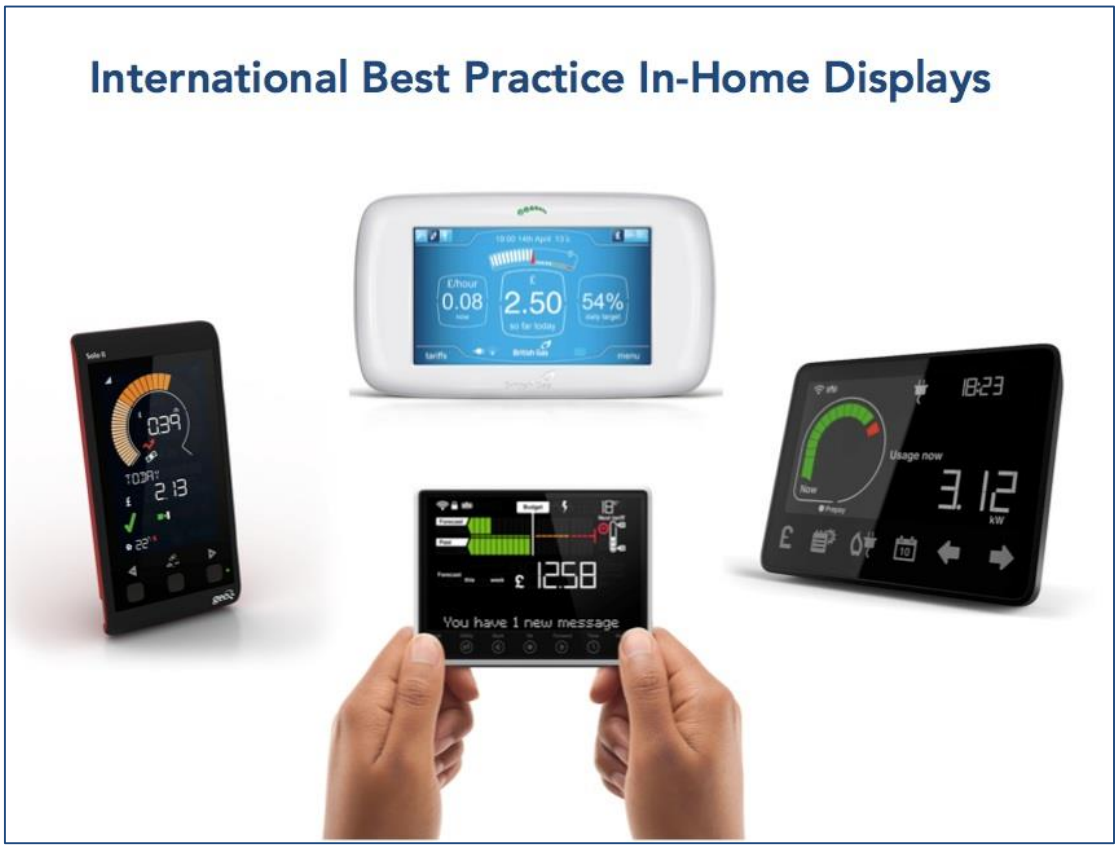


Fig. 9. Examples of International Best Practice In-Home Displays[21]

Informative Bills and Leaflets

Informative (normally paper) bills and leaflets typically contain historical information. Informative bills have generally lost favour since many customers either do not receive paper bills (more and more receive online bills) or do not open them (because they are not interested or for other reasons such as that they pay by direct debit) and customers tend to feel less positive towards their energy companies at the moment of receiving their bills. Separate leaflets are therefore now the preferred choice.

Some of the most innovative informative leaflets in recent years have been provided by energy companies in partnership with the specialist energy data and feedback service provider Opower. Opower innovated, among other things, the provision of Peer Group Comparison feedback - feedback to customers on how their consumption compares to other consumers (similar types of customers, averages of neighbours, other norms). Opower's service (provided to customers by the customer's energy company) was unique not only in the feedback it provided, but also in that it is an opt-out service whereby all customers receive it unless they request otherwise. It was originally a service provided through paper leaflets but is now provided also through web portals and mobile applications). This kind of feedback is now becoming increasingly a part of best practice feedback and is being offered by an increasing number of competing vendors and energy companies in the market. A substantial body of research exists by which to consider the impact of informative bills and leaflets on the behavioural energy efficiency of customers.

[21] Devices Illustrated: Top: Landis & Gyr for British Gas; right: Chamelion Technologies; bottom: Chamelion Technologies; right; Green Energy Options (GEO).

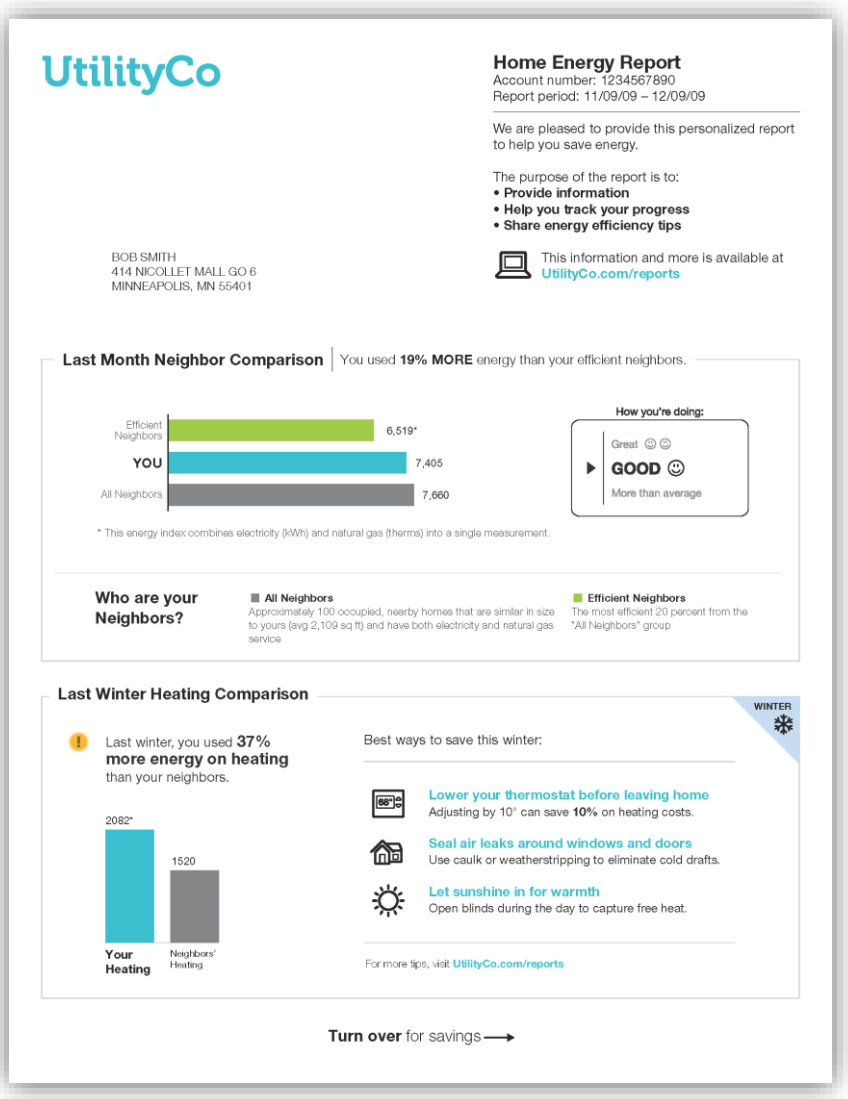


Fig. 10. Example of Informative Leaflet. Source: Opower

Web Portals

A very large and increasing proportion of energy companies around the world provide webs portals where their customers can view their energy consumption history. These websites are typically quite rarely visited but provide the customer with access to a broad array of typically historical (not real or near real-time) feedback that includes and extends upon, in an interactive way, the content of informative bills and leaflets. A substantial body of research exists by which to consider the impact of web portals on the behavioural energy efficiency of customers.

Fig. 11. Example of Web Portal - Source: Helsinki Energy

Mobile Applications (mobile apps)

Mobile apps are largely intended to combine the characteristics of IHDs, Web Portals and Informative Bills and Leaflets.

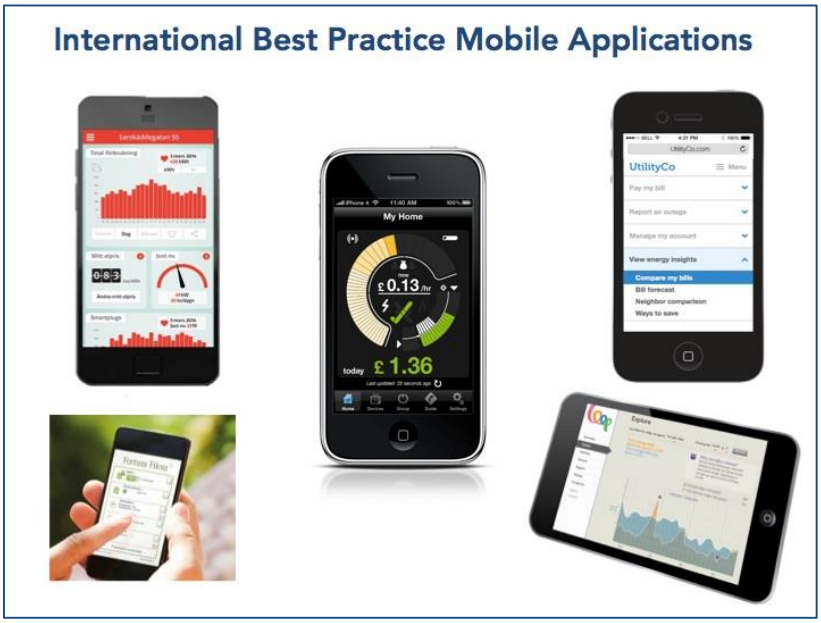


Fig. 12. Examples of International Best Practice Mobile Applications[22]

[22] Examples: Top left: E.ON/Maingate; Bottom left: Fortum/There Corporation; Middle: Green Energy Options (GEO); Top right: OPower; Bottom right: Navetas

A mobile app can typically provide real or near real-time feedback with interactivity and the ability to provide large amounts of information, although most mobile apps to-date have often not provided real or near real-time feedback and have thus been little more than websites providing historical feedback via a mobile device. The challenge with providing real or near real-time feedback through mobile apps is that it requires meter data to be fed through to the internet so that the app can obtain the meter data. The only effective way to do this until recently has been to fit a reader-transmitter to the non-smart meter (not all conventional meters can be read in this way) to pass the meter readings though to a receiver that can then be attached to an internet router in the home. This is neither cheap nor hassle-free (from the perspective of a typical customer) and has therefore often been considered undesirable. When smart meters are installed with a suitable wireless Home Area Network (HAN) communication into the home, the challenge is made a lot easier and all that is needed is a receiver attached to a home in internet router. A router that contains a receiver paired to the meter is however the easiest option.

Source: Fredrikstad Energinett

Feedback and Norway

Relevance of Feedback to Norway

The Norwegian Electricity Market

The Norwegian electricity market has been formally open to competition since the Norwegian Energy Act entered into force in 1991. Norway was among the first countries to open their electricity markets in Europe. The development of the Norwegian market has been successively followed by the other Nordic countries, with a common Swedish-Norwegian wholesale market already from 1996. From early 2000, all the Nordic countries have been included in a common market place. The Energy Act authorises regulations and licences necessary to establish and regulate an efficient power market, with free choice of supplier and regulated access to the networks. As of today, the Norwegian end-market consist of a total of 117 electricity suppliers, 154 DSOs and approximately 2 497 000 residential consumers.

There are no regulated prices in Norway. Norwegian electricity prices are primarily determined by supply and demand in the Nordic power market and by the power balance in countries outside this region. Variations in weather and temperature also have a large effect on the market price. How significant the price change is for the individual consumer depends on what type of contract the consumer uses. Today the majority of Norwegian households have contracts that follow market prices, however, there are a small percentage of consumers who uses various types of fixed-price contracts.

Energy Consumption and Price Significance in Norway

Norway has the highest per capita and typical household electricity consumption in Europe. Almost all residential heating is electric. While Norwegian electricity consumers pay relatively low prices for their electricity (the lowest in Europe) and are among the wealthiest in Europe, the electricity bill as a share of disposable income is nevertheless significant. At five per cent it is the third highest in Europe, although many other markets additionally use gas or district heating extensively for heating, cooking and hot water.

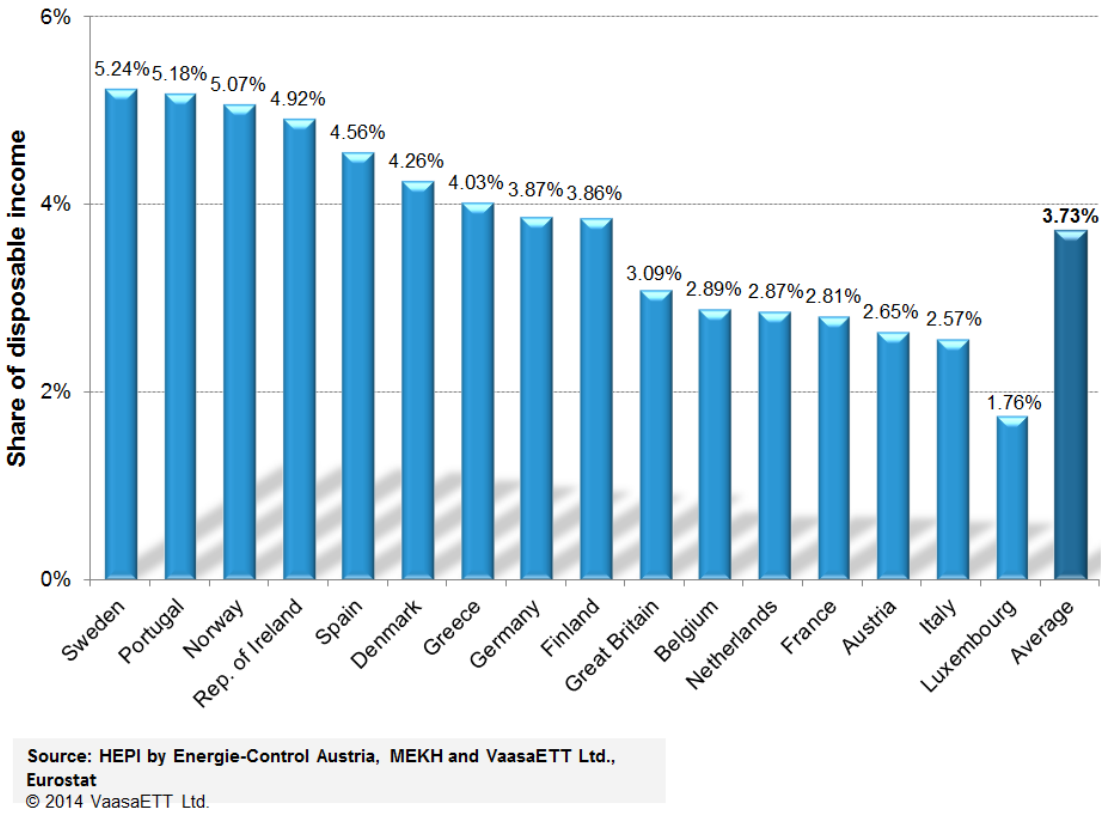


Fig. 13. Electricity Bill as Share of Disposable Income in Europe. Source: HEPI by Energie-Control Austria, MEKH and VaasaETT Ltd., Eurostat[23]©2014 VaasaETT Ltd.

The energy bill in Norway consists of the following components; the electricity price, consumption tax, VAT, rent for transmission and a levy on the transmission tariff earmarked for the Energy Fund[24]. The cost of electricity and taxes vary with the amount of energy consumed. The transmission tariff, however, is dominated by fixed components. Transmission tariffs also vary from one grid company to another. This is because of natural conditions, and thus the cost of distributing electricity to the customer differs widely around the country.

For customers who want to save money on their energy bill in Norway, there are three options: through competition (switching retailer), through changing tariff or through lowering their consumption. A recent interview of over 10 000 household electricity customers in 19 countries including Norway found that 91 per cent of respondents said that the opportunity to reduce their electricity bill is the most important factor that would encourage them to adopt an electricity management program (Accenture 2012:51).

Approximately 258 700 households switched to a different supplier in 2013, slightly more than 15 per cent of all households in Norway. This indicates that there are a large number of active household customers, which should maintain a reasonable high level of competitive pressure on the retailers in the market. However, the facilitation of active, well-informed consumer behaviour is considered a challenge for the Norwegian retail market, given the large majority of consumers who have never switched.

The Norwegian electricity market is set to undergo substantial structural changes in the coming years. The implementation of smart metering by 2019 will be a focal point of these changes. Smart meters are expected to contribute to increased energy efficiency and peak load management, by providing detailed feedback on consumption to consumers. New

[23] European residential energy pricing report 2014. VaasaETT, p.27-29.
[24] Activities at the state-owned Enova company are financed through the Energy Fund. Enova's tasks are to promote more efficient energy use, the production of new renewable forms of energy, and environment-friendly use of natural gas.

technology will also help to raise awareness of a customer's electricity consumption and give consumers more opportunities in the power market.

Although nearly all of Norway's electricity is generated by hydro, the issue of reduction of CO2 through energy conservation is no less important in Norway. Quite the contrary is the case in fact, since Norway's increased conservation of energy would reduce the need for imports of energy and enable more exports of low or zero CO2 emissions to other Nordic markets and other parts of Europe. Norway has the potential to lower Europe's CO2 emissions through consumption feedback services in Norway.

The process of increasing customers' awareness of energy consumption and how to reduce it would also provide impetus for greater demand response to cope with the increase of electric vehicles in Norway, Norway's increasing stock of intermittent distributed generation and the opportunity to export more energy to other parts of Europe during their peak demand or low supply periods.

Norway is therefore considered to be a very relevant market for feedback services, with a reason to be interested in saving energy and otherwise similar to other markets where significant savings from feedback have taken place.

Picture: Lyse

Feedback in Norway

Norway is in fact already one of the pioneers of feedback and related services such as home automation and demand response. Feedback services have been offered for instance by the utility Lyse. The Lyse solution, offered so far as part of a nine month commercial pilot but due to be broadly marketed already in Autumn 2014, offers feedback together with a smart home solution containing heating control from a smart phone and tablet based app.

According to Lyse, the combined 'Smartly' feedback and heating control solution service can save customers up to 20% of their consumption (if they automate their electric heating system) and the financial savings can cover the cost of the investment within two to four years. It is possible for the customer to obtain the feedback service (without automation) for free but there is no available data on the savings from feedback alone.

The smartly service provides only relatively limited consumption feedback information compared with the other state of art feedback services illustrated in this report, but it is a highly advanced solution that pioneers the commercial use of feedback and control in the Norwegian electricity market.

Other exciting feedback studies in Norway have been conducted but not in a substantial scale. An interesting display has been developed for instance as part of the Smart Energy Hvaler project, a project by the Fredrikstad Enegi Network made up of Fredrikstad Energinett, the Hvaler municipality and the Norwegian Centre of Expertise, which recently provided savings of approximately 20% when combined with a capacity based tariff where the price increased with the power level.

Picture: Fredrikstad Energinett

Source: GEO

Research Objectives and Methodology

Objectives

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 energy efficiency through conscious behavioural change by consumers, referred to in this report as Behavioural Energy Efficiency 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 only on passive energy efficiency investments such as building regulations, 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?

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The potential for residential energy savings in Norway resulting from IHD's and other feedback has not yet been explored. Some small studies have taken place, primarily as proof of technical principle, but no state-of-the-art, consumer focused, scientific behavioural programme of a robust size has yet taken place.

Ultimately, a detailed estimate of the true benefit from such feedback would require a comprehensive pilot study involving the implementation of a major feedback programme in Norway. As a first step however, it is considered important to identify:

1. **Typical energy savings** that have been found in feedback programmes around the world to-date and the approximate potential savings from feedback if done optimally,

2. **Pre-requisites and drivers** of successful feedback programmes, and the steps that a Norwegian pilot would need to take to be successful,

3. **The appropriateness of the Norwegian electricity market** for consumption feedback and the approximate savings (consumption and financial) that might be expected in Norway if the findings from the rest of the world were applied to a Norwegian context,

4. **The best feedback technologies** that are currently on offer that might be appropriate in a Norwegian pilot and a consideration of their cost.

This report therefore attempts to answer the above four questions and in doing so identify if consumption feedback is a good way forward for Norway and how it might be successfully achieved.

Methodology

VaasaETT holds the world's largest database of smart energy demand related programmes including consumption feedback. Its database includes hundreds of programmes related to consumption feedback, demand response, time of use, smart billing, smart grid and more. VaasaETT has furthermore conducted a huge body of direct research and participation in the field of smart energy demand.

More specifically, the database for quantitative analysis of pilots comprises 120 feedback and dynamic pricing pilot programs from around the world. These pilots are chosen from a far larger pool, which include pilots whose design or reporting of results were not sufficiently detailed or comparable with the others to be included. Analysing and comparing such a large number of pilots offers the possibility to spot consistent results and allows visualization of exciting emerging patterns.

The findings were interpreted in the context of VaasaETT's body of knowledge to provide an up-to-date answer to the specific questions posed in this report. 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.

Our analysis and estimations, unless stated otherwise, relate to feedback-only targeted energy consumption reduction programmes and not also the shifting of energy consumption through for instance price incentives. In some case (where it states "all feedback studies") programmes have been included where customers also received feedback for the purpose of shifting energy. Furthermore, unless otherwise stated they relate only to residential electricity savings. Our calculations also do not concern savings related to the automation of domestic appliances such as heating and cooling systems. Extensive research[25] indicates that the addition of automation will at least double the savings realised through feedback alone. This targeted sampling reduced the number of programmes, samples and participants in the research. Nevertheless the main body of research in this section relates to research concerning 30.000 electricity consumers.

[25] Stromback, J., Dromacque, C. & Yassin, M. H. (2011). The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison. Prepared for ESMIG. VaasaETT Global Energy Think Tank. Available online at: <http://www.esmig.eu/press/filestor/empower-demand-report.pdf>.

Research Findings

Energy Savings from Feedback Programmes

It is a general rule that customers in feedback programmes save on average around 6% regardless of the region. It is not only in hot regions with air conditioning where customers save energy through feedback. Savings are remarkably consistent in temperate parts of central and Northern Europe.

All Feedback Pilots	Cons. Reduction	No Samples	No Participants
European	5.86%	63	26283
All areas	6.32%	91	30116

Table. 3. Consumption reduction by region[26]. Source: VaasaETT

Due to the targeted sampling referred to in the previous section, it is reasonable to assume that these findings are relevant and appropriate also to Norway.

Impact of Channel Choice

If we break down how the savings are driven, we can see that in home displays (IHDs) are the most effective of the channels for providing consumption feedback. Other channels than these were analysed but sample size was too small to be compared statistically.

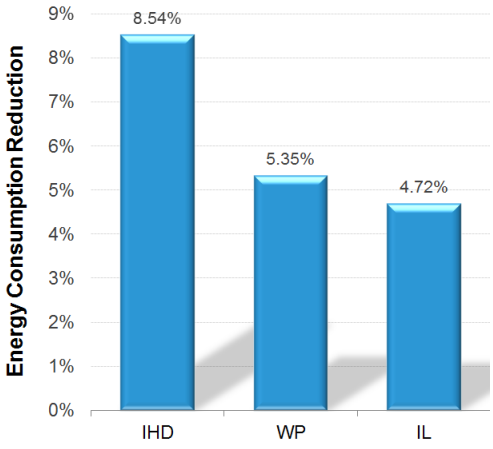

Fig. 14. Combinations of feedback channels[27]

That though does not mean that only IHDs should be used for feedback. Far from it. Other feedback channels are also very important and multiple feedback channels can clearly complement each other. In fact, the more feedback channels are used in programmes the better, as long as sufficient development focus is provided to each. In the case of IHDs this is not always the case since IHDs need to be heavily developed to fulfil their potential.

[26] The proportion of European pilots in the 'all areas' pilots is 66%. Feedback Pilots include feedback only pilots and feedback pilots with Dynamic Pricing; none of the pilots include automation.
[27] Refers to all feedback pilots analysed. WP = Web Pages, IL = Informative Bills and Leaflets.

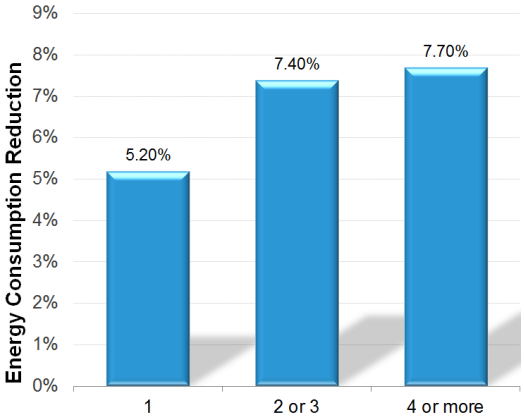

Fig. 15. Number of Feedback Channels

Role of IHDs

IHDs can provide a powerful 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.

Strengths of IHDs

1. **Real-time exploration.** The real time or near real time feedback information provided by IHDs allows 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. As such they are an effective way for consumers to check whether their energy use corresponds with what they are being billed for[28].

2. **Ambience:** IHDs provide ambient[29] push-information to consumers, acting as constant reminders of energy usage. What's more, this information reaches every member of the household, providing an ambient reminder to all (open communal feedback). Other forms of feedback are individual. A glance from any member of the household towards an IHD as they walk into the kitchen[30] 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 preferred budget limit. Users do not even have to think about asking for information – in fact the IHD ambiently triggers them to pay attention.

3. **Uptake and Usage:** Recent best practice IHDs have been shown to have high initial uptake and usage rates of approximately 80-90%[31] of the consumers to whom they were offered. Research indicates that these proportions are far higher than, and fall off less rapidly than with web portals or mobile apps.

4. **Supports Demand Response:** IHDs can also signal time-of-use or dynamic price movements as part of demand response offerings.

5. **Tangible Aesthetics / Desirability:** IHDs can, for some, be something desirable, an aesthetic gadget, to try out, to play with, to show their friends or neighbours and a tool to educate children with.

6. **Symbolism:** For customers who have never received anything tangible from their utility retailer, certainly never any kind of gift, an offer of a useful and desirable, and even cool

[28] 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.
[29] A definition of the term 'Ambienct' is given in the Abbreviations and Terminology section in this report.
[30] British research has indicated that the large majority of monitors are located in the kitchen or living room.
[31] See section on Frequency of Use and Longevity for more explanation.

and fun device, to help them save money and learn about their own behaviour, can be perceived as a big benefit and a sign of a changing or changed relationship between the customer and the retailer.

Concerns and Limitations with IHDs

There are though some concerns with IHDs, including the following issues.

1. **Cost:** A typical best practice IHD currently costs around NOK 170 (€20) or less in Great Britain, the only market in Europe, which has so far seen a mass market roll out of IHDs. This is seen as an unnecessary, and in some cases un-affordable cost (for a retailer earning little more net margin than this amount from a typical retail customer in a year) by some who feel that the same benefits can be delivered without the need for a dedicated device. As discussed later in this report, however, depending on the specification that is required, the costs of alternatives may not necessarily be so different.

2. **Convenience:** The current best practice IHDs are relatively simple to set up, only needing to be paired with the meter, but even this and the process of setting up for more advanced functions such as targets and budgeting can be problematic for some consumers. In practice, a very small proportion of consumers appear to have such issues, but as will all technologies, there will be laggards - those who are less able or willing to use them.

3. **Uptake and Usage:** Some pilots have experienced a rapid drop off of interest in IHDs, with customers initially using them and then rapidly forgetting about them. International research suggests though that given a good IHD and good support from the retailer (a good programme), most customers continue to use the display for one to two years. There is an inevitable drop off after the initial period of excitement and experimentation, and usage does decrease over time thereafter, but this does not mean that the customers who stopped using the IHD or use it less often are bored with it or found it of no use, but mostly they feel that they had already learned what they needed or wanted to learn from it. Customers who use a good IHD within a good programme for a short period of time are still typically highly satisfied. The key requirement for continued use of the IHD is to regularly find new ways for the customer to engage with it, new reasons to use it. Regular insights for the customer to check out, as well as comparisons (with peer groups, norms or themselves), competitions or games are just some of the possibilities. If customers use the IHD for budgeting or targeting they will in any case be more likely to continue using it. The retailer needs to be creative and keep new and interesting insights, tasks and challenges up their sleeves.

4. **Battery Life:** What if the batteries run out or the plug is pulled out? It is not good if the batteries run out and the device is not plugged in or if the device is unplugged and has no batteries installed. Customers may not replace batteries or find a new plug socket for the IHD. For this reason best practice IHDs now have batteries and low energy usage that enable them to last for up to two years without any need for new batteries. This is as long as the in home display is likely to be needed for. Typically IHDs also have a plug. It is generally recommended to provide IHDs that are equipped to run with or without batteries.

5. **Coverage:** Sometimes IHDs do not manage to receive a signal from the meter. This can be for reasons such as the thickness of walls or the location of meters. This is a rare problem in practice with the latest IHDs but it can does happen. It should be remembered thought that best practice IHDs have been rolled out in various markets including the Nordics and the coverage issue, whilst a challenge initially, appears to have been largely overcome.

6. **Interactivity and Support:** IHDs typically provide consumers with information from the meter. The latest ones can also, if specified so, be used to send alerts and other messages from the energy company to the consumer via the smart meter. They do not though provide an extensive interactive experience for the consumer since they are not connected to the internet and do not communicate back to the meter, or therefore, the service provider. The forthcoming generation of IHDs will however have be able to connect to the internet

and back to the meter, providing the opportunity for a more interactive experience. Such functionality may though add additional, possibly inhibitive cost to the IHD.

Role of Web Portals, Informative Bills and Leaflets

Web portals [32] can provide support for IHDs, mobile applications and other feedback channels.[33] They can be beneficial throughout the energy efficiency journey but should not be seen as a primary initiator of interest. Leaflets should be seen as a providing similar but more limited and un-interactive feedback opportunities for consumers who do not have internet. In the early stages of feedback however, leaflets represent a more accessible channel of feedback, a taste of what can be offered online. It is also important to remember that the effectiveness of leaflets represents the surprisingly significant amount that can be achieved without the use of consumer technologies.

Strengths of Web Portals

1. **Information Volume and Depth:** Web portals can aggregate large amounts of information to provide consumers with in-depth explanations (if they want them) of their consumption. They also allow consumers to take the insight they have gained through IHDs or other sources and dig deeper on certain issues (such as the impact of their CO2 savings on the environment).

2. **Interactive and Support:** Web portals can provide extensive targeted energy efficiency advice through powerful online engines, allowing the consumer to expand into additional issues such as what else they can do to save energy in their home as well as linking them to products and services that can help them with their energy efficiency efforts, while bringing additional revenue to the energy company and other service providers.

3. **Cost:** Web portals are generally relatively inexpensive to set up and they become substantially cheaper (per user) as they scale-up.

Concerns and Limitations with Web Portals

1. **Uptake and Usage:** Web portals are generally not very heavily used. Customers need to make the effort to visit them, and they will only do that if they feel the need, which few will do unless they have experienced the benefit of them. This paradox is a serious issue with web portals. Customers may additionally be deterred by the need to register for and set up[34] the service and log in each time they use it. As with all feedback channels, web portals experience reduced usage over time, even more so though, because of their low ambience and higher level of required effort-to-access.

2. **Ambience:** Web portals offer a very low level of ambience. It is possible to set up email or mobile phone alerts, but essentially they are out of sight unless the consumer is stimulated to think about them and because they require a relatively large amount of effort to access (compared for instance to an IHD where a consumer only needs to glance at it to access basic feedback information).

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[32] 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.

[33] Research by one British utility (2013) - survey of 831 consumers with IHDs - found that 41% of respondents would also like to have an online display in addition to (not instead of) their IHD, although only 18% stated that they would strongly want one. In research by British Gas (2013) - sample of 1229/1327 respondents who have and use an IHD - respondents who recalled having received energy reports were 25% more likely to state that they had saved money as a result of the information provided by the IHD, and 28% more likely to state that they felt more in control of their money.

[34] As part of the set up process customers usually need to provide essential details such as meter and customer number and other information if they want additional services such as comparison with peer groups.

3. **Tangible Aesthetics / Desirability:** Web portals are only desirable through the relevance of their content. Web portals are often (but not always - Opower being a notable example of an exception) full of graphs and text. Visually they are typically not aesthetic and they are definitely not trendy or fun. A consumer is only likely to be drawn there for the mundane, pragmatic task of understanding or lowering their energy consumption or environmental impact, rather than for instance, for the fun of enlightenment or competition or the aesthetics or self-image from a gadget.

4. **Real-Time Exploration:** Web portals typically provide customers only with historical consumption information. It is possible to provide real or near real time information through web portals, but it requires additional infrastructure in the home, as described in the following section mobile apps.

5. **Suitability for Demand Response:** Due to the lack of timeliness of the data and the unlikelihood that consumers would see it even if it was, web portals are not considered suitable for demand response service, except in combination with mobile apps as described in the following section.

Role of Mobile Apps

There have been cases of consumers saving significant amounts of energy through the use of mobile apps[35]. Some argue therefore that mobile apps[36] are a direct replacement for IHDs as well as web portals and leaflets. This would not appear to be the case, although they do have many advantages. They would appear to be the main source of feedback and energy related interaction in the future, but in the earlier stages of behavioural energy efficiency they would appear to best play a more collaborative role in partnership with other channels.

Strengths of Mobile Apps

1. **Cost:** Nearly all consumers already have a mobile device (or more than one) that can run consumption feedback apps. There is no cost of purchasing a new device.

2. **Mobility:** Mobile apps allow consumers to view their consumption anywhere, anytime.

3. **Additional Services:** Mobile apps allow the provision of additional mobile smart energy, smart home, home energy management and other energy related services. Perhaps even more importantly, they allow the integration of energy services into broader smart mobile services that go beyond energy. The smart mobile services of the future will after all not necessarily be initiated from an energy perspective. They might be initiated from security, entertainment or other mobility related perspectives, and will likely form integrated services. Energy related services will ultimately have to compliment and fit into the bigger picture.

4. **Information Volume and Depth:** Mobile apps on larger displays such as tablets, can aggregate large amounts of information to provide consumers with in-depth explanations (if they want them) of their consumption. They also allow consumers to take the insight they have gained through IHDs or other sources and dig deeper on certain issues (such as the impact of their CO2 savings on the environment). In some cases[37] they can also take meter data direct from the meter and even disaggregate consumption in the home, to enable consumers to identify how much energy different appliances in the home are using.

5. **Online Interactive Support:** Mobile apps can provide extensive targeted energy efficiency advice through powerful online engines, allowing the consumer to expand into additional issues such as what else they can do to save energy in their home as well as linking them to

[35] For instance in trials in Sweden by Maingate Solutions and E.ON, savings of over 15% were recorded using a mobile application service.
[36] Sometimes referred to as virtual IHDs or VIHDs.
[37] For instance Navetas.

products and services that can help them with their energy efficiency efforts, while bringing additional revenue to the energy company and other service providers.

6. **Real-time exploration.** The real time or near real time feedback information provided by mobile apps (only some mobile apps provide real or near real time data) allow the customer to explore their energy consumption behaviour implications as they walk around the home[38], just as with an IHD. Mobile applications also enable feedback and even control while away from the home.

7. **Ambience:** Mobile apps provide ambient feedback in the form of alerts relating to for instance consumption or budget limits or unusual consumption.

8. **Supports Demand Response:** Mobile apps can signal (through alerts) time-of-use or dynamic price movements as part of demand response offerings.

Concerns and Limitations with Mobile Apps

1. **Convenience/Hassle:** Mobile apps currently require more set up complication than IHDs in order to make them real or near real-time. Whereas an IHD is designed to be paired with a smart meter for instance, a mobile device is not and must either take consumption information from the meter via the energy supply company through the internet (in which case the data is not real or even near real-time), or pair up the meter with their home internet connection via a router (in which case it is too difficult or at least a hassle for many consumers) or use a wireless or bluetooth connection between the meter and the mobile device - if the meter offers this functionality - (in which case many consumers find it too much hassle and the mobile app will then not operate outside the home).

2. **Cost:** The cost of this adaptive technology is not as much as the cost of an IHD, but it is a significant cost nevertheless.

3. **Ambience:** Mobile apps are essentially "pull information" services in that the consumer has to consciously open the app and request information, and they provide information to individuals rather than the open community in the home (although it is possible for multiple members of a household to have access to the same information through their own mobile devices) and the app can be left on. A mobile device though, such as a smart phone or tablet, is not always turned on, but even when it is, the app may not be, and if it is, then if it invades the consumer's attention too much it is likely to be turned off or alerts ("push information") muted. Mobile applications relating to energy consumption feedback must compete with all the other applications and alerts on the mobile device. The likelihood of the feedback application getting crowded out and forgotten is very high after an initial usage period. For sure, the screen will not always be showing consumption feedback information as with an IHD.

4. **Accessibility:** Mobile apps are not accessible to people without smart mobile devices, and for real or near real time feedback they typically also require a home internet connection. While most consumers (energy customers) have both, these requirements do exclude some segments of the population such as some children and some elderly people.

5. **Tangible Aesthetics:** An app is less tangible and aesthetic than an IHD. By receiving an app, a consumer does not receive a gadget, something physical that they can touch and hold. It is less of a gift than an IHD.

6. **Symbolism:** An app is less a sign of a changed relationship than an IHD. Customers feel less surprised and appreciative when they receive a mobile app. An app is less of a departure from convention than an IHD and as such does less to boost the relationship between the energy supplier and the consumer.

[38] IHDs can also have batteries (in addition to a plug and adapter) that enable them to become mobile within the home. The ultra low consumption nature of the market leading IHDs typically means that they can operate for up to a couple of years on their batteries if needed.

Integrating Channels

It would therefore seem that the three main channels: IHDs, Web Portals and Mobile Apps each have diverse strengths and weaknesses, but overall they complement each other.

	IHDs	Web Portals	Mobile Apps
Cost			
Accessibility			
Uptake and Usage			
Convenience/Hassle			
Tangible Aesthetics / Desirability			
Ambience			
Information volume and depth			
Interactivity and Support			
Real-Time Exploration			
Mobility			
Supports Demand Response			
Additional services			
Symbolism			

Table. 4. Strengths and Weaknesses per Channel. Source: VaasaETT

Key			
	Relativity: Darker is Better		

Put simply, it can be stated that IHDs provide the 'at a glance, always on awareness for the whole household; web portals[39] provide in depth analysis opportunities for customers who want them; and mobile apps provide the exploration[40], mobility and future control that will be so important as part of the development of energy efficiency and energy related services of the future.

Fig. 16. Importance of Ambient Displays. Source: Green Energy Options (GEO)

[39] Mobile apps on larger display devices can also provide this.
[40] IHDs can also provide this.

But there is some significant overlap between the functionalities delivered by the three channels. Ultimately different consumers and different service providers will suit different combinations and or balances of the solutions, decided based on the match between objectives/preferences, budgets and the strengths and weaknesses of each channel. There would though appear to be a strong case for service providers to at least offer a combination of all three channels.

	IHDs	Web Portals	Mobile Apps
Suggested Role	Main base tool for the early stages of feedback, to engage large proportions of consumers and whole households. Fun and enlightening relationship changer. A useful ongoing household reference point for energy efficiency, demand response and other service.	Supporting feedback for consumers who want to go deeper into the analysis and learn more about what they can do to save energy. A point of interaction with the service provider. Good for customers who do not have a smart mobile device.	Personalised feedback direct to the consumer, anywhere, any time. A point of interaction with the service provider A lower cost, limited alternative to IHDs. A mobile replacement for web portals. The future hub of the services that will grow from and around feedback.

Table. 5. Suggested Roles of Different Feedback Channels. Source: VaasaETT

Impact of Education

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.

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 to fully use the technology, consumption reductions have on average been nearly 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.

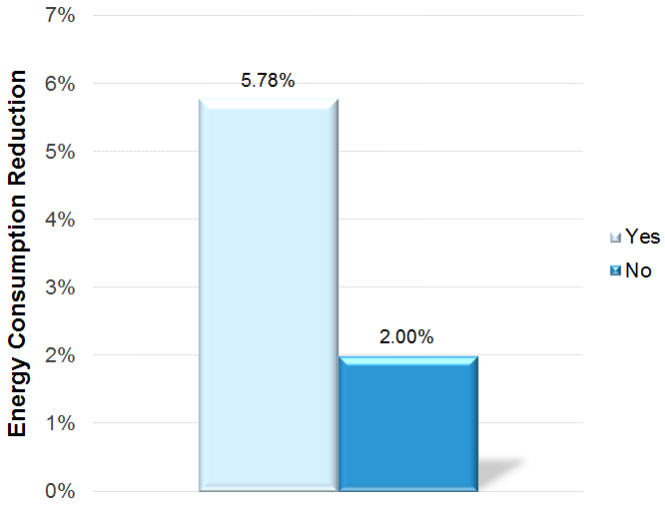


Fig. 17. Education of Participants[41] [42]

Impact of Feedback Content

What should feedback programmes be trying to communicate to customers in order to achieve optimal impact? Many were listed earlier in this report, of which the following have been statistically analysed.

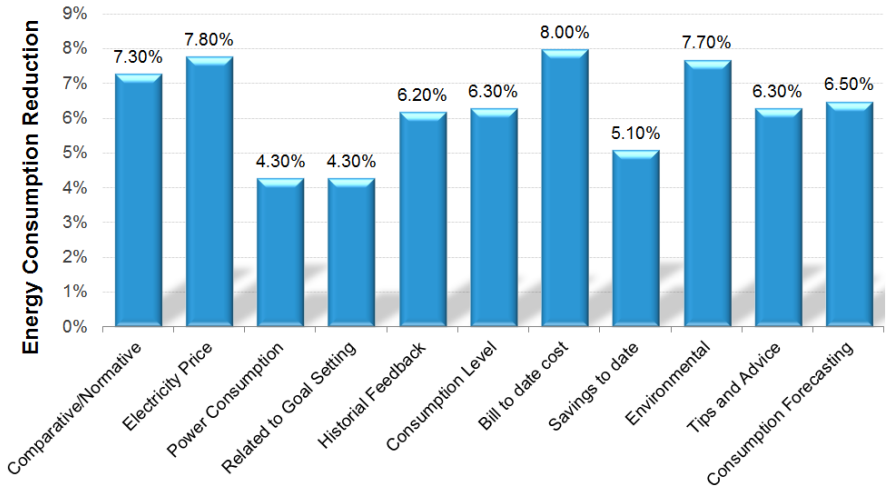


Fig.18. Feedback types

All of the above and more provide value to customers and are important, though Bill-to-date, electricity price, environmental and also comparative/normative information would appear to been the most important within the programmes researched for this report. 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.

[41] All Feedback pilots.
[42] Most pilots (including those with IHDs) have had education incorporated.

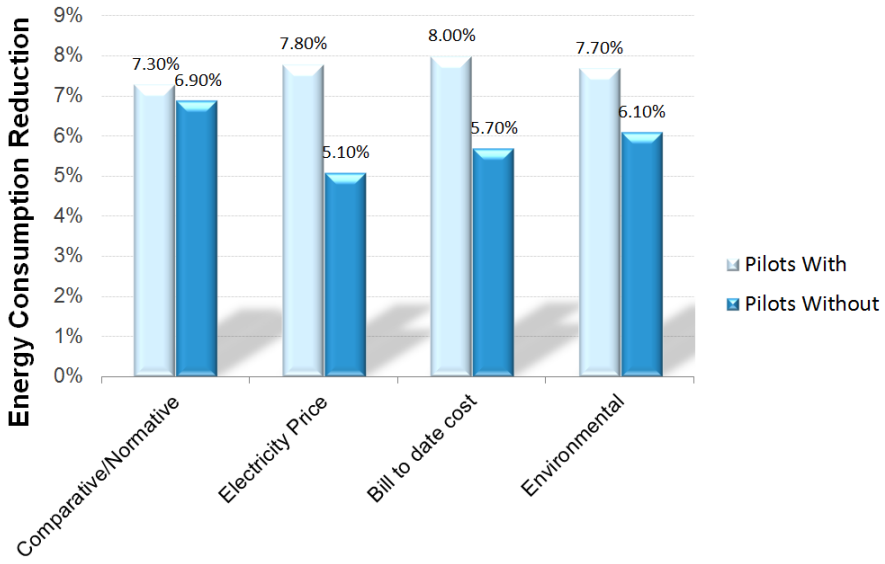


Fig.19. Feedback types

The research indicates, however, that multiple forms of information are more effective than fewer. 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. Different customers want different feedback content types and different feedback content types are suitable to different situations and purposes. It is therefore essential to offer a comprehensive variety of relevant and desirable feedback types, in an easy to choose and uncluttered manner.

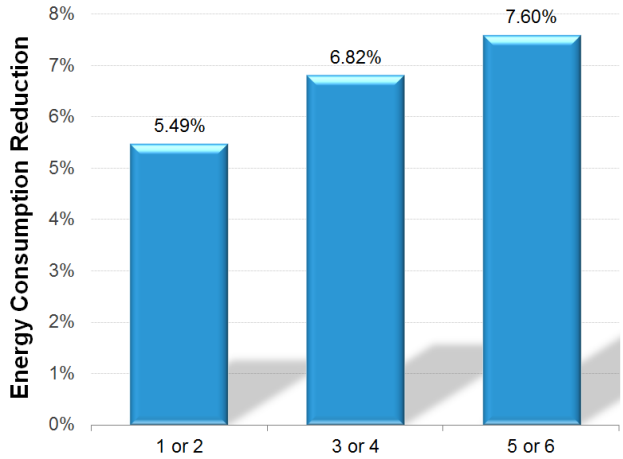


Fig.20. Number of Feedback types

Role of KWh

Customers value KWh information, for instance to compare their usage against their bill, or compare their consumption against a peer group. However, in general customers do not understand KWh. Where possible, more interesting forms of conveying consumption and especially cost should be used, but more innovative and visual means such as colours and movement are also very effective, more meaningful (to most customers) and more ambient.

Numerical vs. Graphical Feedback

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 numerical information delivers the biggest consumption savings, especially for IHDs and mobile apps. This provides a simple explanation to the relatively poor results of some pilots from the past that have tended to show graphs.

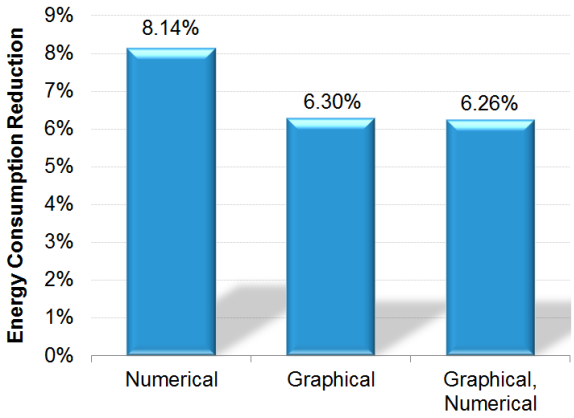


Fig. 21. Consumption reduction by feedback format combination

For other feedback channels that consumers access less frequently such as smart bills, the situation is somewhat 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 highly valuable. Graphical information of this kind can be shown clearly by IHDs, smart phones and tablets (such as IPads), and with good reason, but IHDs and smart phones (less so tablets) currently have less space and capability to clearly provide very extensive or customized graphical information to customers.

Ambient Feedback

IHDs (and to a far lesser extent smart phones and tablets) are by their very nature - or at least should be - ambient, but the degree of ambience matters. The more ambient, the more effective, in general. Here we have identified the impact of displays and other feedback devices that are considered distinctly ambient - the information visually stands out and catches your attention from a distance - as opposed to simply ambient because they only need a glance to look at them.

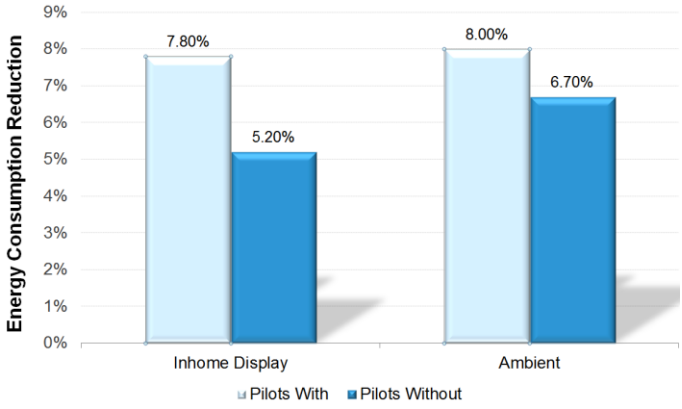


Fig. 22. Importance of Ambient Displays[43]

Some IHDs, for instance, have colour signals to support usage, cost, price or other feedback. Essentially colour signals can be used to denote any desired meaning. But it does not have to be colour, it could be any ambient visual that expresses the necessary feedback, such as a speedometer or movement of some kind, or pictures. Ambience can be even more extreme. In fact to the point of having no apparent content at all. Such devices can be surprisingly communicative and effective. They can for instance illustrate consumption levels as well as times-of-use through simply changes in colour. In one cool and fun example by the Interactive Institute, a power cable changes colour and emits a feeling of movement as the consumption increased, becoming red and spiralling more rapidly when consumption is higher. In another example known as the Orb, the colour changes according to consumption level and energy peak and off peak periods.

Fig.23. Ambient Feedback Examples[44]

[43] All Feedback pilots.

[44] Examples: Top left: Green Energy Option (GEO); Bottom left: Interactive Institute; Top right: Panasonic; Bottom right: In Home Displays

Impact of Basic vs. Higher End Devices

The early days of consumption feedback were characterized by channels and content that were anything but aesthetically appealing. Nor were they particularly intuitive or easy to use. In this research, the impact of device development is focused on IHDs because insufficient evidence exists for other types of feedback devices, such as mobile devices or smart thermostats. The impact of development is expected to be broadly the same however, regardless of the type of device concerned.

Early IHDs for instance, 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 one. 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 retailers). More meaningful and ambient feedback accompanied these developments, and the 'coolness' and 'desirability factor' had begun to arrive.

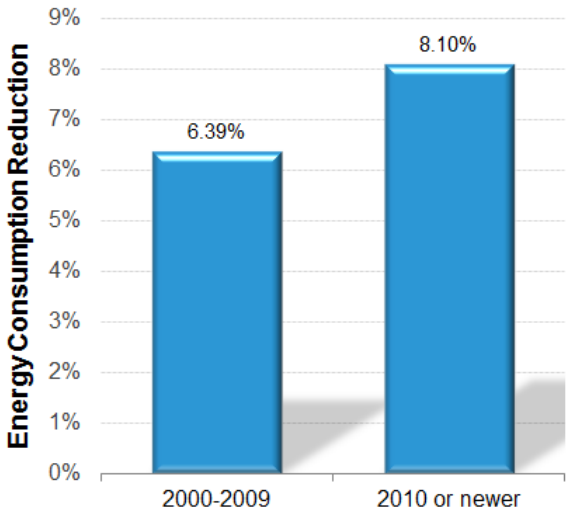


Fig. 24. Year of Pilot

At this point, however, attempts at smart home and home energy control through IHDs proved 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[45] 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 €18) now make the latest generation of IHDs an appealing offering for consumers and utilities alike.

The aesthetics of both devices and the feedback they deliver, has developed greatly over recent years. In the case of IHDs, for which the most extensive research data exists in this respect (and which are therefore the focus of this section on feedback aesthetics), it would appear that this progression has been helped by no small degree, by the existence of an IHD mandate in Great Britain which has provided European IHD developers with the market scale they need for genuine mass-market solutions. It has given market competitors confidence to invest vast sums of private money to bring to market rapid evolution of the IHD proposition.

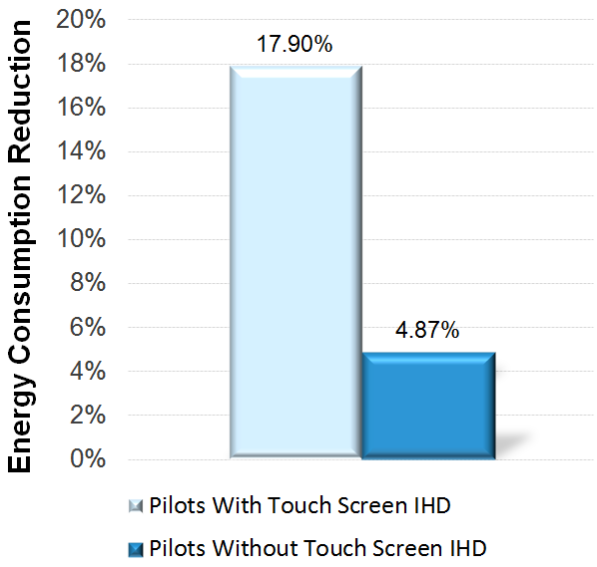


Fig. 25. Feedback Aesthetics influence in peak reduction, time of use pilots[46]

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

[45] Term by Kevin Ashton (2009) referring to uniquely identifiable objects and their virtual representations in an internet-like structure (Source: Wikipedia).
[46] Data is normalised for sample size variation between pilots. No automation is applied.

use is concerned (where ambience is even more of a virtue).

Impact of Timing

Real Time Feedback

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).

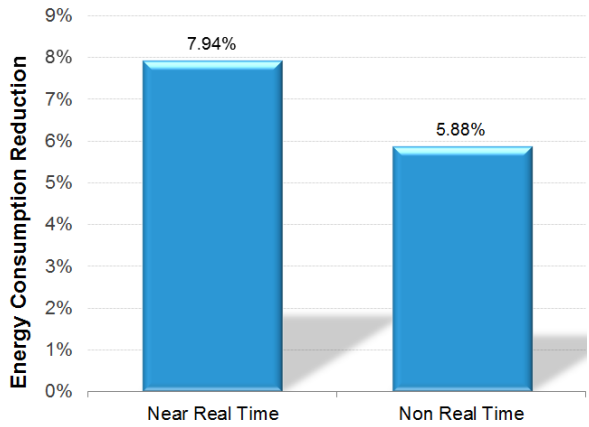


Fig. 26. Consumption reduction for different frequencies of feedback updates (near real-time relates to IHDs only)

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.

Frequency of Feedback 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 leaflets, web portals and mobile apps are only read or visited once and 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. Furthermore, VaasaETT (not British Gas) tentatively hypothesises from British Gas research data that initially, and for a sustained period, 40% of consumers with IHDs use them daily[47] and a further 28% used them at least weekly. After the initial excitement period[48] there is

[47] Different research sources have in fact indicated that during the first few days the usage tends to be far more intense. It should also be noted that the reason why some do not use them is because of technical issues.

[48] The awareness that results from the initial enlightenment can be transformed into motivation by which

only a partial drop off in usage. Around a year or more after the initial application, daily usage remains at 29%, with a further 19% using the IHD at least weekly. Even after so long, over 70% of recipients still use the IHD[49]. Other research has indicated usage rates of up to 89%. This is a phenomenal usage rate and certainly not in line with the argument that IHDs are only of fleeting interest.

The correlation value between the length of the pilot and consumption reduction is consequently a remarkable 0.704[50], indicating that longer pilot durations tend to correspond with higher consumption reduction percentages.

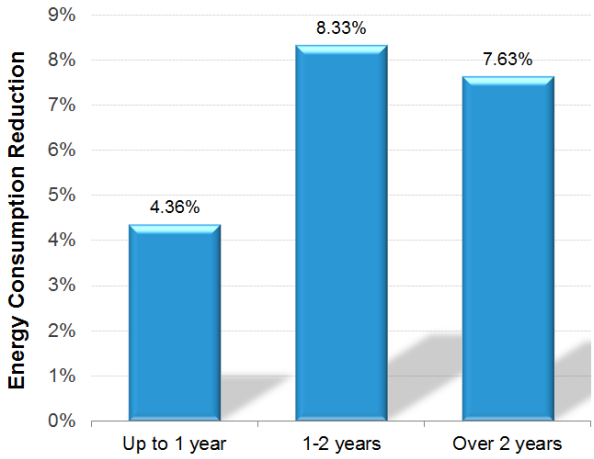


Fig.27. Length of Pilot

To ensure longevity of savings, a customer needs to be taken through a journey (see: Customer Engagement Process). As part of this process a good tool can be a weekly energy statement.

customers gradually transform their habits, supported by on-going reinforcement through advice, additional information, incentives and rewards (source: various research sources).

[49] This is consistent with other research findings internationally.

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

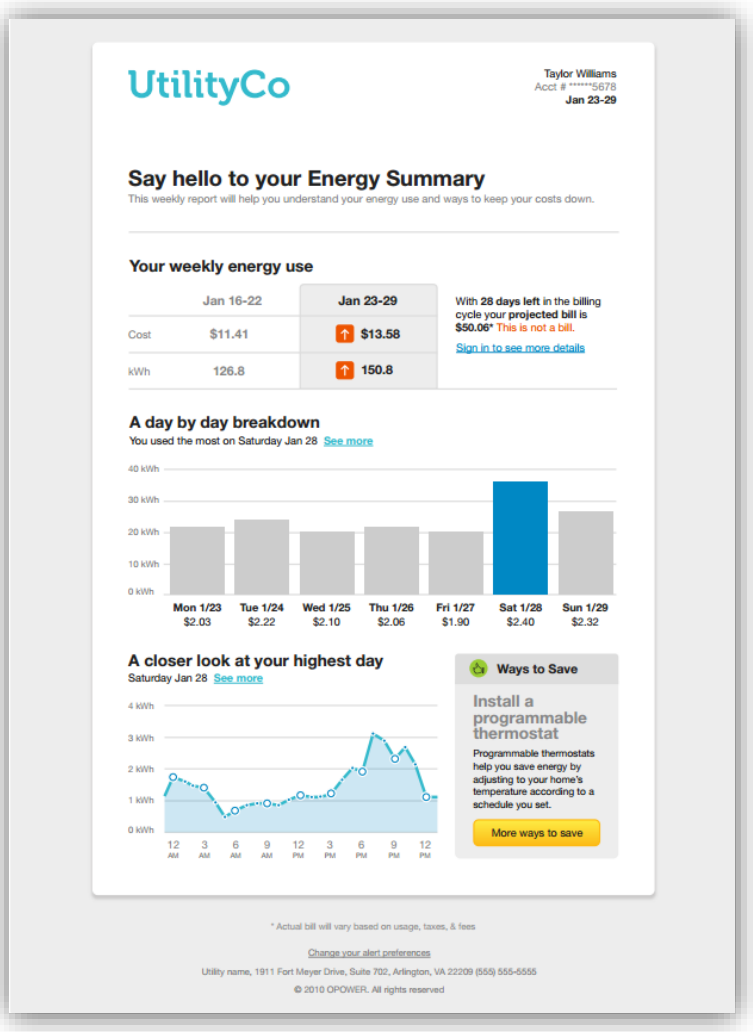


Fig.28. Weekly Energy Summary. Source: OPower

Customer Satisfaction

Customers may not be interested in feedback services before they receive them, but they are mostly very satisfied once they have experienced them. In general it can be said that the body of research, both that mentioned above and other research, indicates that approximately 70-90% of customers who have received feedback services are satisfied, and that between 50-80% (65%) of customers have already reduced energy as a result.

Research by Opower into its feedback implementations with utilities in North America and Europe found that customers who receive feedback (without in home displays) have a typical satisfaction rating of 86% vs. 81% for customers who are not receiving feedback.[51]

A British Gas (2013)[52] survey indicated that 79% of customers with smart meters who have used their IHDs feel that they are more aware of their energy consumption as a result. More than two thirds of those feel that they know a lot more. The same research showed that 57% of customers with smart meters who have used their IHDs felt that consumption feedback information was the biggest benefit (specifically, the sense of awareness and control[53] of

[51] Opower 2014. 95% confidence level.
[52] Survey of 1327 residential consumers who have and use an IHD.
[53] 55-64% of consumers feel more in control.

energy costs coming from the feedback information seems to be the biggest benefit), compared with only 13% who felt that 'no longer receiving estimated bills' - originally seen as the biggest benefit for consumers from smart meters - was the biggest benefit. Finally the research indicated that 54%[54] of customers estimated that they had saved money as a result of the feedback that they had received. 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.

In line with the above research findings, another British utility (2013) found that over 80% of surveyed respondents with IHDs stated that the information they had received form the IHD was useful. And research[55], conducted by USwitch (2013)[56] 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 retailer) 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, both quantitative, qualitative and anecdotal, indicating the importance of consumption feedback and IHDs.

The Customer Engagement Process

Engaging customers in feedback is not about a one off activity of sending a customer a mobile application, information leaflet or IHD. On the contrary, it is about taking the customer through a journey, allowing the customer to evolve from a customer who has little knowledge of energy issues and maybe even little interest in knowing, and developing their awareness and behavioural energy efficiency.

VaasaETT, incorporating also elements from other approaches including those from Green Energy Options and Opower, two of the most advanced providers of consumption feedback solutions, has developed a staged approach to the advancement of customer feedback induced behavioural energy efficiency. Their model proposes a 7-stage feedback journey that service providers should try to take customers through:

- **Prime:** Customers first have to be primed. A comprehensive education based customer engagement campaign prior to a wider roll-out is essential in raising awareness about the benefits associated with behavioural energy efficiency. A collective impact approach combined with clear, open and honest direct information to customers, demonstration of the benefits, positive customer experience and experimentation, independent media support and word of mouth, careful handling of data privacy and security issues, and a chance for customers to ask questions, get involved in the debate and influence the way forward is all included in the best way to go. Thank you letters and welcome packs for those to be involved in roll-out are also valuable. This priming period should not be all about information though, it should also be fun.

- **Peek:** First impressions count. Customers need to learn that feedback is helpful, fun and above all easy. This is like the first door of an advent calendar. The first view of the calendar must appeal and the first contents excite. It is not about big benefits but about showing that even small amounts of information and small acts of behaviour can make real savings. It is about realising something that you never realised before. It is also about immediate value including: insights, not data; personal value, not data; proactive help; and real savings. It should be so easy to experience the first benefits that the customer does it just to try it, because, well, "why not", it only takes a moment.

  This and the next stage should already help the customer to trust that the service provider is trying to give them something for the customer's benefit, to help them. The Danish utility company Seas-NVE for instance managed to get over 100,000 of their customers, over one third of their customers, to provide their meter reading data to the

[54] Sample: 1229 residential consumers who have and use an IHD.
[55] Survey of 3624 EON and British Gas smart meter customers.
[56] http://www.uswitch.com/gas-electricity/news/2013/12/12/new-research-shows-consumers-are-happy-with-smart-meters/

utility by comparing the meter reading to a lottery machine and providing a prize draw each month based only on the meter reading number. This initiated interest in the meter and the meter reading and was followed up by the provision of useful information to customers about their consumption.

This stage can be provided to everyone, but opt-out must be a straightforward option. Mandatory elements, if there are any, must 'feel like a choice', there must be quick response to customers concerns, careful handling of public media coverage, technical Issues must be kept invisible to consumers, electricity costs must be kept consistent, consumer expectations must be managed well (don't promise too much – the same goes for governments), and clear simple, information packages must be given to customers.

- **Explore –** If the first peek is rewarding, then the customer will be convinced to go on a more thorough learning expedition, with the help of the feedback tools and also, importantly, the provider of the service. Customers will start to gain a holistic picture of how much all their appliances use, how they can become a better citizen, better relative to their past and their neighbours, how they can better budget their energy, avoid big or surprising bills and much more. Again the customer should learn that benefits are simple and they should realise why they should continue what they have started. This stage needs to be a progressive and relatively natural process, where the customer is supported and led by the service provider, but not led or given too much to do. It is also important for the customer to realise that this is a collaborative process, one where there is stakeholdership for the customer and the service provider. That the more the customer trusts the retailer, the more they will benefit.

- **Encourage –** Showing people how well they are doing is an important aspect, especially with energy, which is so intangible. It is when a customer finally knows that they are paying less or have made a real difference that they will know that they are doing it right and should continue on the path.

- **Instil –** Even the best picture will become part of the background after a period of time though, and so it is with information. Information, however well presented is still only information – what is needed is the means to get people to do something with the information and to make it part of a new habit such as checking that you have not left something on when going to bed or leaving the house. A really good example of this is re-cycling: people could buy-in to the concept and understand the need but it was only when fortnightly recycling collections were introduced that it became a routine and recycling levels increased.

- **Enhance –** Once you have peoples' interest, use it to take them on a journey and show them what to tackle next. For instance some informative leaflets give customers suggestions how to reduce their bill, an indication of the impact and a way to automate it. Another aspect of this is don't try and do too much too soon – it makes the entry barrier too high and leaves little scope for progression. Think of it like learning karate and progressing through the belts – the feeling of progress and comparison with your peers is an important motivator.

- **Share –** Customer value is not much use if the masses don't know about it and society will not normalise behaviour they cannot see around them. The power of word of mouth and the media should not be under-estimated. Sometimes this can be promoted by utilities' own marketing, including social media, but a good product supported by a good number of customers who have experienced it will often be enough to spread the word to others.

From a macro perspective, and considering feedback in the context of the larger customer-related smart grid picture, the market needs to be taken along a clearly staged roadmap of gradual public, customer and technological development.

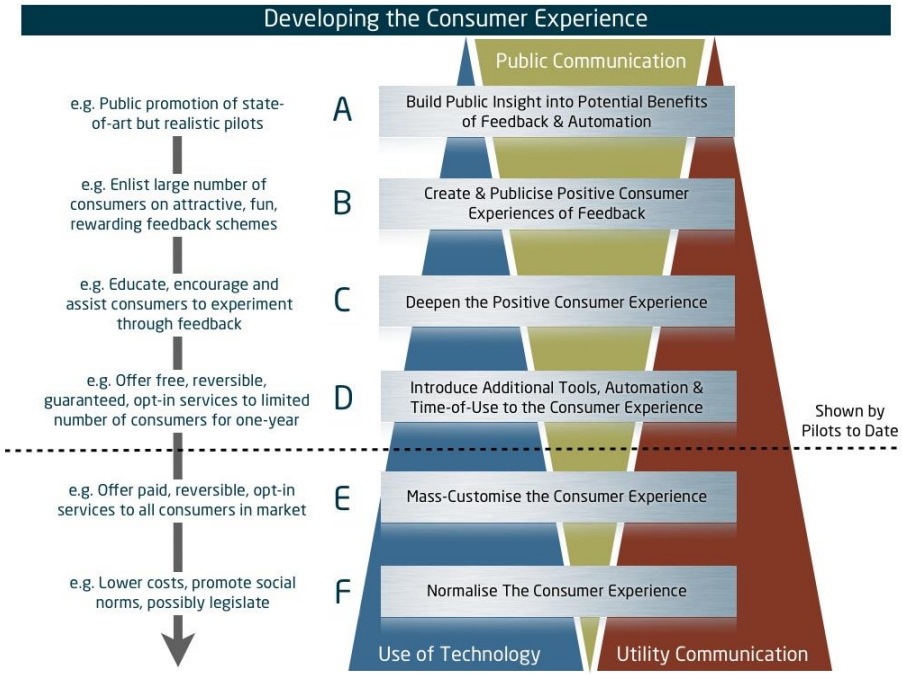
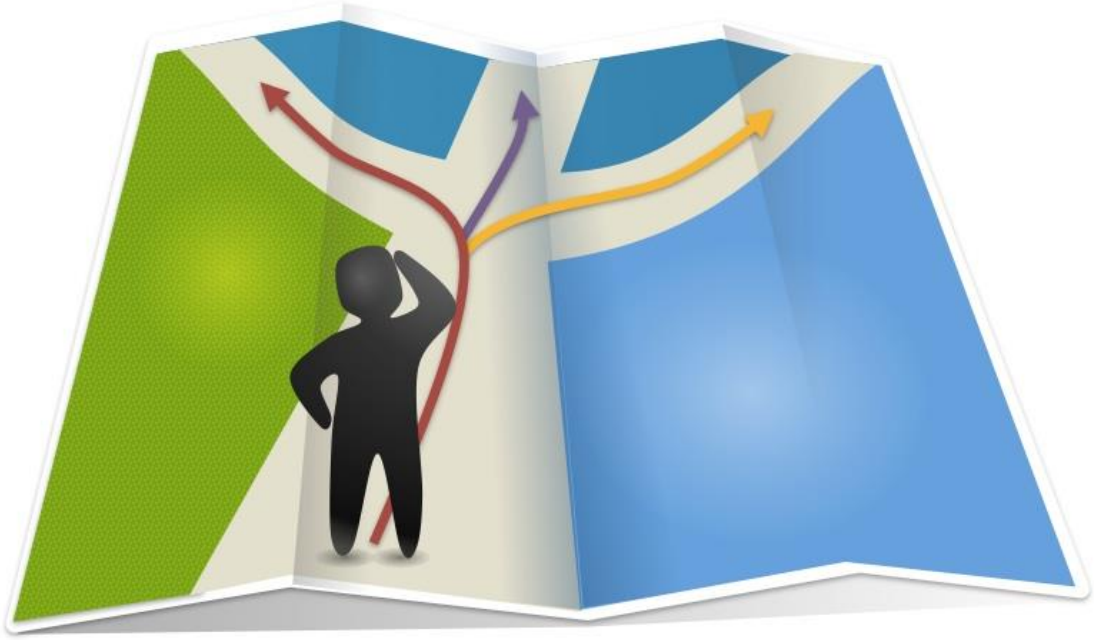


Fig.29. Developing the consumer experience. Source: VaasaETT

Optimal Potential Savings from Feedback

The savings shown by pilots to date are not optimal. Feedback programmes are not always well designed or applied and technologies and methods are improving all the time, exponentially in fact. The best devices and other tools shown in this report were not available when the pilots were done and what we know today from all the research and pilots will only be realised within the pilots and implementations of tomorrow. Furthermore, pilots do not have the opportunity to take customers through a full journey. And we know from the research that automation can double the impact of feedback, but is not included in the savings presented in this report.

VaasaETT estimates, based on the above research findings, that the average 6% savings from international feedback programmes would roughly increase by 60% (around 30% for best practice and around 30% for new tools and practices) if best practice and best tools (IHD, leaflets, apps etc.) were applied over the coming few (up to 4) years. It is difficult to estimate any additional impact from an optimised journey, but it would add to this value. If automation (of appliances) were added to the feedback, we would estimate the optimised savings value to increase by at least another 60% of the unautomated optimised savings value. These estimations are naturally very rough and rely on various assumptions, but are also considered modest in their outlook.



Implications for Norway

Norwegian Savings Potential

The energy bill in Norway consists of the following components: the electricity price, consumption tax, VAT, rent for transmission and a levy on the transmission tariff earmarked for the Energy Fund[57]. The cost of electricity and taxes vary with the amount of energy consumed, hence they are directly related to consumption reduction. The long term impact on the transmission tariff for each customer, however, is complicated to calculate. One reason for this is that grid companies in Norway face several conditions that impact the cost of supplying power to consumers, which makes the grid tariff for consumption vary between the different grid companies. Also, because of the revenue cap regulation, which set the grid companies permitted income over time, a reduction in income because of a consumption reduction one year might result in higher tariffs the following years. Potential savings has therefore been calculated using an average residential electricity price for 2013/2014 that excludes the rent for transmission.

If we use average historical savings (6.11% per year) [58] from international feedback programmes for customers with electric heating and no automation, assume a mean price of 51.74 NOK[59] øre/KWh (6.21 eurocents/KWh[60]), it is possible to apply international savings to Norway, assuming that Norway would respond approximately similarly to the average of other markets. The following table shows the consumption reductions[61] and the corresponding cost reduction potential for various Norwegian household types and sizes[62].

	Mean Consumption (KWh)	Estimated Cons. Reduction (KWh)	Estimated Cost Reduction NOK	Estimated Cost Reduction €
Total	15977	976	505	61
House Type				
Farm House	18818	1150	595	71
Detached House	19919	1217	630	76
Rowhouse	14764	902	467	56
Flat	9191	562	291	35
Household Size				
1 person	10925	668	345	41
2 persons	16913	1033	535	64
3 persons	19280	1178	610	73
4 persons	22281	1361	704	85
5 and more	23322	1425	737	89

Table. 6. Potential savings in Norway by household type. Source: VaasaETT

[57] Activities at the state-owned Enova company are financed through the Energy Fund. Enova's tasks are to promote more efficient energy use, the production of new renewable forms of energy, and environment-friendly use of natural gas.
[58] 18859 customers in 56 samples
[59] Average residential electricity price for Norway for 2013-2014 (price includes electricity and taxes but excludes distribution. Source: NVE.
[60] The exchange rate used for the calculation of prices in NOK was 1euro=8.33 NOK.
[61] 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). Savings based on current prices.
[62] Source of yearly consumption of each household type: Statistics Norway: (http://www.ssb.no/en/energi-og-industri/statistikker/husenergi).

Ultimately, the success of any feedback programme, in the opinion of consumers, will be defined in terms of the money that is saved. In this respect, we have identified key performance indicators that could be expected to be achieved if the feedback services were delivered in a reasonably optimal way:

1. If IHDs were included as a channel of feedback, savings would be around 8.54% or 1364 KWh or NOK 706 (€85) per year for an average customer.

2. If we assume even half of the 60% increase in savings due to improvements in practice, technologies and tools, this would result in savings for an average customer of approximately 11.1% or 1774 KWh or NOK 918 (€110) per year.

3. Given that a latest generation, best-in class, multi-function energy monitor can cost between NOK 125-167 (€15-20), the hardware costs associated with providing IHDs within a consumption feedback programme could be covered in around three to four months, excluding the cost of distribution and support.

4. If feedback programmes were maintained for at least two years then the saving for an electricity customer would be 3548 KWh or NOK 1836 (€220) over two years. These savings are similar to those from the most advanced smart home offerings in the Norwegian market at present, but at a fraction of the cost and suitable to be rolled out to most of the population rather than a small number of interested customers.

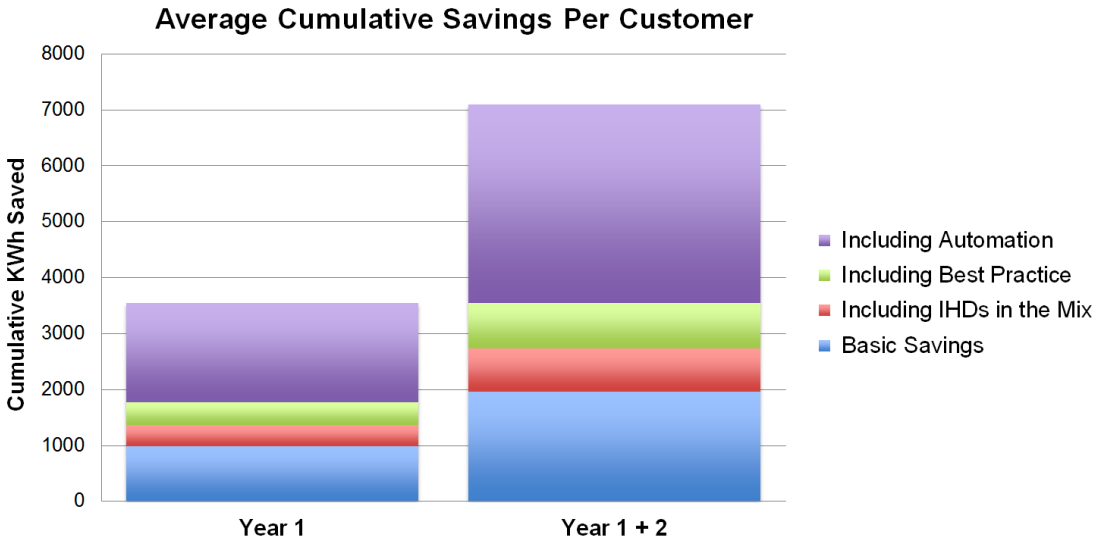


Fig. 30. Average cumulative savings per customer. Estimations for Norway. Source: VaasaETT

5. If applied to the estimated 2 449 000[63] (end of 2012) residential electricity customers in Norway and assuming an 80% IHD usage rate[64], the combined savings would be NOK 3.6 billion (€431m) over two years or 6.95 TWh.

[63] Norwegian Water Resources and Energy Directorate (NVE) National Report <http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202013/NR_En/C13_NR_Norway-EN.pdf>.
[64] See section on Frequency of Feedback and Longevity.

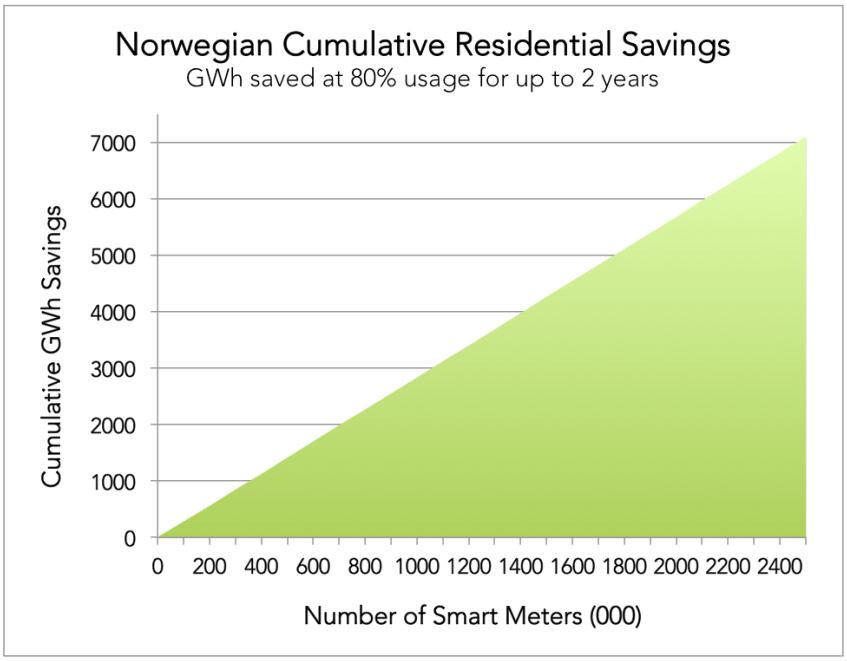


Fig. 31. Norwegian Cumulative Residential Savings Estimations.
Source: VaasaETT

What Should Feedback For Norway Be Like?

Essentially, feedback for Norway should be the same as for any other market. In the case of IHDs the features described in the following table should be targeted.

For Web Portals, they should essentially focus on the in-depth explanatory and comparative information that they typically focus on today. They need to be less technical than they often tend to be however, they should try to be more fun, simple, insightful and original, focusing less on traditional graphs and more on informatics. Less on the past and more on how consumers can change behaviour and the predictive impact - especially for them - if they do. If a customer needs to concentrate to understand what the graphs or numbers in front of them mean, then they are too complicated.

For Mobile Apps, the focus should be on combining all the best qualities of IHDs and Web Portals. Reasons to visit the app, keep it open and allow notifications should be a key focus. A constant flow of interesting insight and support should be provided by the app for the consumer. Set up should also be made as simple as possible.

CHARACTERISTIC	FEATURES
Overall	Small, portable, device that shows a consumer's electricity usage in real time by accessing information from a smart meter.
Aesthetics	Desirable, attractive, trendy consumable.
Ergonomics	Touch screen, intuitive usage (manual not essential).
Feedback information	Provision of simple, clear and easy to understand feedback information. Primarily numerical and pictorial information including but not limited to: 1. Amount of energy currently being used (visual magnitude, KWh/period) 2. Amount of cost/period (e.g. NOK/hour/day/week/month) 3. Amount of energy used since a given point (e.g. since start of the month) 4. Forecast cost (per day/week/month) 5. Budget setting: customer can set a budget and the IHD will show how much of the budget has been used and is forecast to be used 6. Comparative/normative benchmarking 7. (Messaging: tips/advice/alerts/other). Note: This may add to IHD cost 8. Able to measure and incorporate outdoor temperature into feedback algorithms
Ambiance	Big display. Information visible from afar. Colour display. Perhaps colour light (ambient alert) to indicate high consumption, cost, price etc.
Frequency of Information	Near real time - e.g. updates every 5 seconds
Power Source	Plug, plus battery. One to two years of battery life. Device should be ultra power efficient.
Communication	Compliant with Norwegian smart meter home area network communication (HAN).
Scalability	Capable to be
Future proofing options	A Wi-Fi (or similar) connectability to a wireless router or similar would provide the ability to link the display directly to online services. This would add cost to the display and its usefulness will depend on the planned role of the IHD.

Table. 7. What should an IHD for Norway be like. Source: VaasaETT

Incorporating Outdoor Temperature Into Feedback Algorithms

An additional consideration is that feedback in Norway should incorporate a consideration of the outdoor temperature. The massive temperature swings that take place in Norway, not only between seasons but also within seasons, mean that a given energy usage one day, may not be comparative to the same consumption the next day. The consumption may only be higher, for instance because there was a significant drop in temperature between the two days. By measuring the outside temperature, allowance for the temperature change can be made. If the indoor temperature is also measured (by a smart thermostat for instance) and the consumption tracked, estimates of the consumption and cost implications of an indoor temperature change can therefore be estimated for any given outdoor temperature.

Picture: Lyse

Looking Forwards

Rapid Change

The consumption feedback space is moving at a rapid pace. Knowledge of how best to apply consumption feedback is constantly improving, tools are becoming ever more commercialised and realistic and technologies are developing rapidly as the scale of implementation in markets such as Great Britain drives their numbers into the tens of millons. Tools such as those by Opower and Green Energy Options are now proven comprehensive, cost-effective and appealing to mass customer bases.

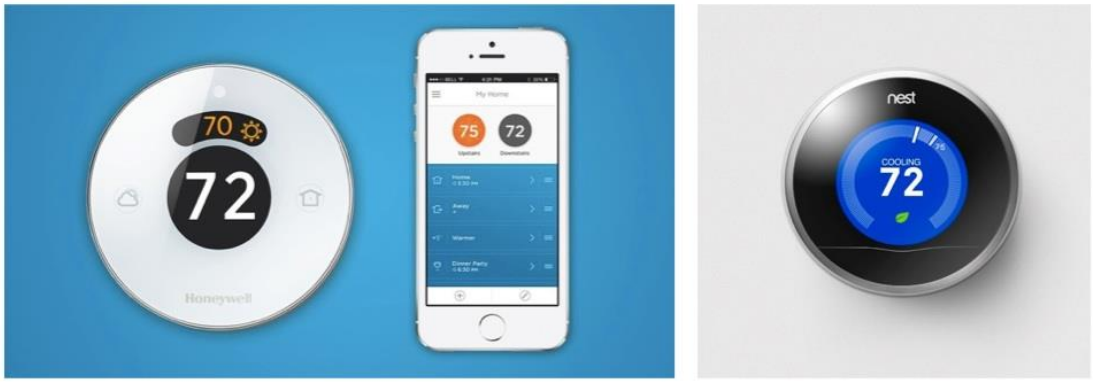
In planning the role and application of consumption feedback in Norway, it is important to consider where the future is heading.

The Connected Home

The present tools for feedback will be just part of the bigger picture of future smart services for energy customers. The development of services to take advantage of the internet of things and the inevitability of the 'connected home' will mean that the energy consumer will soon be connecting home energy management with own-generation, storage, electric vehicles and more. The interaction 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.

Elements of these services have already been offered, including in Norway (e.g. Lyse's Smartly smart home offering), but the real acceleration of such services is likely to evolve rapidly following some imminent developments:

1. **The availability of a common mass market Platform for Connected Home.** This move has already been initiated by Apple's Home Kit, launched in May 2014, "a new framework for communicating with and controlling connected devices in a user's home. Apps can enable users to discover devices in their home and configure them, and can create actions to control those devices. Users can group actions together and trigger them using Siri".



Pictures: Honeywell Smart Thermostat (Left), Apple Home Kit (middle), Nest by Google (right)

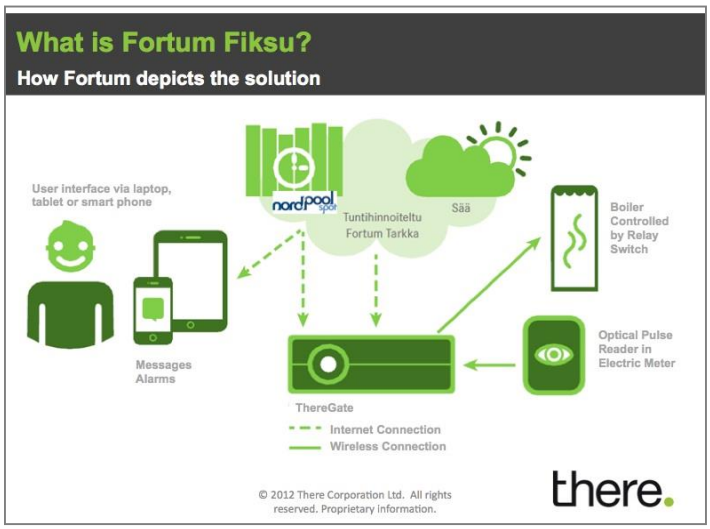
It is likely to be only a matter of time until Android partners launch their own equivalent (Samsung recently acquired the company Smart Things for instance, a smart home platform provider) and by that time, billions of energy customers, and nearly all Norwegian energy customers will have a device in their hands through which they can observe and control their home. Offerings such as Honeywell's smart thermostat have already been developed to work with Home Kit, competing with the Google owned Nest smart thermostat. From this point on, as long as a device in the home, including the smart meter and an in-home display, can connect to the internet (even indirectly through a home router) then it will be visible and controllable via a person's phone without additional

gateways and even fuse box infrastructure in the home and regardless of the service provider (except for the dependency on the phone operating system). Inter-connectivity has arrived. Until now, the complexity and cost of installing the underlying smart home platform has been excessive due to the need for gateways and even fuse box modifications.

Pictures: Smart Things by Samsung

2. **Smart Appliances.** Once a common platform exists, the appliances that work with the platform will appear. Mass market appliances, especially those that are energy intensive, such as heat related appliances will begin to be sold (though only the mid to higher end models) with connected home capabilities included. For a service provider to control the energy efficiency behaviour of a customer with such appliances, all that will then be needed is an app. This will massively reduce the cost of the connected home which, research has indicated, customers will not buy into unless they are offered a positive pay-back within two years.

3. **Smart Meters.** There is no doubt that feedback works better with the support of smart meters, not only because of the delivery of real-time or near real-time data to the home, but also because the alternative is that customers have to attach a reader/transmitter to the meter, which whilst not an excessive effort is nevertheless an effort too great for many customers. Through smart meters retailers will, as they have already started to do, be able to offer more timely pricing tariffs that will allow prices and resource costs to match even more closely than they do at present. In fact Lyse's Smartly smart home service can be set to use less energy at times of day when prices are higher. Fortum in Finland and Sweden offers a service for electrically heated homes where the heating in the home is adjusted up or down every hour of the day to take account of the wholesale price of electricity.



Picture: There Corporation, Fortum

4. **The growth in Electric Vehicles.** An electric vehicle, or two, connected to the home presents a huge opportunity for extra savings and convenience for the customer. Honda, for example has already developed an app to coordinate home energy management with electric vehicle charging. As Norway leads the world in the proportionate rate of uptake of electric vehicles, it will not be long before there is a genuine mass market of electric vehicles in Norway, and along with it, mass market of cost-effective solutions.

Picture: Honda

5. **Cost-effective Storage.** Cost-effective distributed storage is perhaps the largest missing link in the connected home of the future, but it will undoubtedly be available very soon. When it does, it will provide equipped homes with the ability to be more or even completely self sufficient in terms of energy needs and it will enable them to store energy when it (their own generation or from the network) is readily available or cheap, and save it for when it is scarce, congested or simply expensive. This will not only provide some customers with convenience and a strong sense of independence and freedom from utilities, but it will also provide them with the ability to essentially be - with the help of aggregation company services[65] - their own utility with the value that will come with it.

Will we need Feedback with Connected Home?

Naturally, the connected home, done well, will eventually lead to automation of behavioural energy efficiency. The common argument over whether automation is preferable to self-control is rather inappropriate to the development of energy efficiency however. 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 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.

[65] Companies that will bring many customers together to form virtual utilities. This is not considered the same as a virtual power plant which typically is a utility company led solution, rather it will be a solution that empowers active customers to earn in essentially the same way as energy retailers do.

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, consumption feedback channels are essential to future energy savings.

Further Reading

VaasaETT has a database of hundreds of pilots and programmes from around the world, in all smart issues, including but not limited to: feedback and behavioural energy efficiency; demand response and time of use; smart billing, renewable integration and smart grid. A selection of the European pilots used for this research are given below so that the reader may explore further by themselves. For more information, please contact VaasaETT.

List of Example Pilots for Further Reading

Pilot name	Country	Dates	Number of participants (control groups not included)	Link
Enel Info+	Italy	2012 - Ongoing	4000	http://www.enel.it/it-IT/reti/smart_info/ In Italian
E-DEMA	Germany	2008-2013	700	http://www.rwe.com/web/cms/en/183218/rwe/innovation/projects-technologies/energy-application/e-energy/
Customer-Led Network Revolution Project	UK	2012	14000 Residential and Commercial	http://www.networkrevolution.co.uk
Perth Solar City	Australia	2009-2011	1147	http://perthsolarcity.com.au/art/PSC_-_2012_ANNUAL_REPORT.pdf
CER (2011) - Electricity smart metering customer behaviour trials (CBT)	Republic of Ireland	2010	3858	http://www.esb.ie/main/press/pressreleaseWS.jsp?id=1494 http://www.cer.ie/document-detail/Smart-Metering-Cost-Benefit-Analysis-and-Trials-Findings-Reports/340/2372,2373,2374,2375,2376,2377,2378,2379,2380,2381
IntelliEkon (2011) - Smart metering in Germany and Austria - results of providing feedback information in a field trial	Germany/ Austria	2009-2010	1114	www.intelliekon.de/praxisforum/Symposium/B_R7_c_Goelz.pdf

Table. 8. Further reading

About the Authors

The Writer

Dr Philip E. Lewis, CEO and Founder, VaasaETT

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 hundreds of 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 international specialist research and advisory company. We analyse and model experience and thought leadership from around the globe to drive customer focus into the energy utilities value chain. We build value for customers, the energy industry and the environment through Marketing, Competition and the development of Smart and Demand Side Services, backed by our world class market monitoring, unmatched insight into customers and our global information network.

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 NVE

The Norwegian Water Resources and Energy Directorate (NVE) is a directorate under the Ministry of Petroleum and Energy. Concerning energy NVE's mandate is to promote efficient energy markets and cost-effective energy systems and contribute to efficient energy.

More information at: **www.nve.no/en/**

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Nr. 6 New version (v.1.1.1) of the seNorge snow model and snow maps for Norway. Tuomo Saloranta
Nr. 7 EBO Evaluering av modeller for klimajustering av energibruk
Nr. 8 Erfaringer fra ekstremværet Hilde, november 2013
Nr. 9 Erfaringer fra ekstremværet Ivar, desember 2013
Nr. 10 Kvartalsrapport for kraftmarknaden. 4. kvartal 2013. Ellen Skaansar (red.)v
Nr. 11 Energibruksrapporten 2013
Nr. 12 Fjernvarmens rolle i energisystemet
Nr. 13 Naturfareprosjektet Dp. 5 Flom og vann på avveie. Karakterisering av flomregimer. Delprosjekt. 5.1.5
Nr. 14 Naturfareprosjektet Dp. 6 Kvikkleire. En omforent anbefaling for bruk av anisotropifaktorer i prosjektering i norske leirer
Nr. 15 Tilleggsrapport: Oppsummering av Energimyndighetens og NVEs gjennomgang av elsertifikatordningen
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Nr. 19 Flom og jordskred i Nordland og Trøndelag desember 2013. Elin Langsholt, Erik Holmqvist, Delia Welle Kejo
Nr. 20 Vindkraft i produksjon i 2013
Nr. 21 FoU-prosjekt 81072 Pilotstudie: Snøskredfarekartlegging med ATES (Avalanche Terrain Exposure Scale) Klassifisering av snøskredterreng for trygg ferdsel
Nr. 22 Naturfareprosjektet: Delprosjekt 3.1. Hvordan beregne ekstremverdier for gitte gjentaksintervaller? Manual for å beregne returverdier av nedbør for ulike gjentaksintervaller (for ikke-statistikker)
Nr. 23 Flomsonekart Delprosjekt Tuv. Kjartan Orvedal, Julio Pereira
Nr. 24 Summary of the review of the electricity certificates system by the Swedish Energy Agency and the Norwegian Water Resources and Energy Directorate (NVE)
Nr. 25 Landsomfattende mark- og grunnvannsnett. Drift og formidling 2011. Jonatan Haga Per Alve Glad
Nr. 26 Naturfareprosjektet: Delprosjekt 1 Naturskadestrategi. Sammenligning av risikoakseptkriterier for skred og flom. Utredning for Naturfareprogrammet (NIFS)
Nr. 27 Naturfareprosjektet Dp. 6 Kvikkleire. Skredfarekartlegging i strandsonen
Nr. 28 Naturfareprosjektet Dp. 5 Flom og vann på avveie. ”Kvistdammer” i Slovakia. Små terskler laget av stedegent materiale, erfaringer fra studietur for mulig bruk i Norge
Nr. 29 Reestablishing vegetation on interventions along rivers. A compilation of methods and experiences from the Tana River valley
Nr. 30 Naturfareprosjektet Dp. 5 Flom og vann på avveie. Karakterisering av flomregimer
Nr. 31 Småkraftverk: Tetthet og reproduksjon av ørret på utbygde strekninger med krav om minstevannføring Svein Jakob Saltveit og Henning Pavels
Nr. 32 Kanalforvaltningen rundt 1814 – del av en fungerende statsadministrasjon for det norske selvstendighetsprosjektet. Grunnlovsjubileet 2014
Nr. 33 Museumsordningen 10 år
Nr. 34 Naturfareprosjektet Dp. 6 Kvikkleire. Skredfarekartlegging i strandsonen -videreføring
Nr. 35 Naturfareprosjektet Dp. 5 Flom og vann på avveie. Karakterisering av flomregimer Delprosjekt. 5.1.5. Revisjon av rapport 13-2014
Nr. 36 Kvartalsrapport for kraftmarknaden 1. kvartal 2014. Gudmund Bartnes (red.)
Nr. 37 Preliminary regionalization and susceptibility analysis for landslide early warning purposes in Norway

Nr. 38 Driften av kraftsystemet 2013
Nr. 39 Naturfareprosjektet Dp. 6 Kvikkleire. Effekt av progressivbruddutvikling for utbygging i områder med kvikkleire: Sensitivitetsanalyse basert på data fra grunnundersøkelser på vegstrekningen Sund-Bradden i Rissa
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