

Direct feedback on gas and power consumption helps to save energy

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Research indicates that direct feedback on gas and power consumption can help consumers to realise significant energy savings. This is the result of a recent study by Nuon (one of the large Dutch energy suppliers), SenterNovem (a government agency dealing with executing sustainable energy policies) and UCPartners (an Amsterdam based energy & utility research and consulting firm), in collaboration with Home Automation Europe (a company specialising in home automation solutions) and Technical University Eindhoven.

Globally, many initiatives are underway to install “smart meter” solutions in residential settings. “Smart meters” are gas- and power meters that are (minimally) able to digitally store and remotely communicate consumption data. Usually this information is transferred to the energy distribution or supply company (in varying frequencies), primarily to support market and billing processes. Since investments in a smart meter infrastructure are significant, an additional expectation about smart meter benefits is that more frequent information can help consumers to save energy. Saving energy is no direct benefit for energy supply companies (reducing their volume end revenue), but does represent a larger public value. Reducing primary energy demand has a positive impact on the global climate issue and reduces the effort needed for transitioning to a sustainable energy economy. And, of course, it saves people money on their energy bills.

Traditionally residential customers receive a monthly bill with (estimated) consumption volumes that, in many countries, are averaged across the months of the year to avoid large differences in monthly payments. Once a year a statement is produced to financially settle the bill, based on a – manual – meter reading. This once-a-year meter reading is the only reliable volume information a residential energy consumer receives from his energy supplier. Digital meters with remote communication capabilities can increase the frequency of information delivery significantly. This information is supposed to motivate consumers to save energy, either through behavioural changes or through changes in buying habits. In the Netherlands a one-off energy saving of 2% (as a national average) is incorporated in the overall business case of a nationwide smart meter roll-out.

It appears to be essential however how and in what specific frequency this information is made available. Generally speaking, the higher the frequency and the closer feedback follows “real-time” consumption, the better. Also, the less effort (or “cost”) for the user to access the information the better.

To acquire and analyse energy consumption information four different approaches are currently practiced:

1. Periodic information (letter, e-mail, website): a periodic overview of energy consumption, issued by the energy supplier to make energy consumers aware of their consumption.

- European regulation asks from energy suppliers to regularly inform their customers about their energy consumption. Frequency and method is left to the member states¹.
2. Internet; the consumer gets access to a website where he or she can track household consumption; this information is updated frequently (mostly daily), but runs behind actual consumption, usually by 1-2 days; real-time usage is usually unavailable and would require a specific infrastructure².
 3. Displays; a – special purpose – display directly linked (wired or wireless) to the smart meter can provide consumers real time information on actual energy use and can be seen any time of day. The display can either be stand-alone or be integrated with other functions (eg. with a central heating thermostat, a home security system etc.).
 4. A fourth option is the good old pencil & paper device; a consumer can read his meter manually, eg. on a fixed day every week, and note down and analyse the results manually (or in a spread-sheet); this approach does not require new technology and there are actually consumers who track their energy consumption like this and save energy successfully over the years. Obviously, it needs a special motivation to keep this up for a longer period of time.

The four options are assessed in the table below, whereby + and – indicate to what extent each method will contribute to energy conservation from a theoretical perspective³:

Method	Frequency	“Real time” information	Effort required
Periodic information	(very) low –	none –	low +
Internet	potentially high +	none –	average ⁴ +/-
Display	potentially very high ++	yes +	low +
Manual registration	low –	none –	high –

This overview suggests the hypothesis that a “real time display” will deliver superior energy saving results compared with the other methods described.

To test this hypothesis and to make an assessment of the order of magnitude of such an effect Nuon, SenterNovem and Home Automation Europe developed a display that was installed in a selected number of households.

¹ European Directive 2006/32/EC; in the Netherlands this Directive is translated into an intent to inform customers at least 6 times per year.

² This can only be realised in a cost-effective way when smart meters would be “on-line” permanently, which is quite a challenge considering the number of meters that would be involved on a national scale.

³ To be seen as an average; individuals can achieve good energy saving results with any method or even without any of the methods mentioned. It is not the information itself but behavioural change as a possible (not necessary) consequence of information that saves energy. Research shows however that reducing the effort required to demonstrate “good” environmental behaviour (or acquiring information to this end) leads to more people actually adopting this behaviour.

⁴ Depends on computer “literacy” and accessibility.

Households were selected in a step-by-step procedure. One neighbourhood was selected, in the town of Arnhem, where Nuon's distribution company Continuon⁵ had already installed smart meters, since smart meter availability was a prerequisite for the test. In this neighbourhood 1000 households were asked to participate in a survey on environmental behaviour and motivation; close to 200 households were prepared to participate and received the survey, based on previous research from the Technical University of Eindhoven. The survey results enabled the research team to split potential participants in individuals with a relatively "high" or relatively "low" environmental motivation.

From these groups two test-groups were formed. Both groups (of 18 participants each, evenly split across "high" and "low" motivated households) were asked to try to save energy during three months in the 2008/2009 winter period and received general advice on how to save power or gas in day-to-day living. Both groups were also asked to manually note down weekly meter readings. Only one group however was given the test-display to support these tasks.

Apart from analysing energy consumption patterns and saving results in both groups, extensive qualitative research was conducted around energy use related behaviour and attitudes and around the display used (as pre-commercial product). The research was done by UCPartners in collaboration with the Technical University Eindhoven in 2008/2009 and is one of the first of this kind in Europe.



⁵ At the time of installation Continuon was part of Nuon. Since July 2009 Nuon and Continuon (now named Liander) are separate companies.

The display provides information on actual power use, allowing participants to learn appliance by appliance how much power is used. Also, lowest and highest kWh consumption is recorded within a period that can be selected by the user. Especially the lower level educates users about the minimum “base-load” level that can be attained in the house when most of the equipment is turned off (eg. during the night or when people leave the house for

school or work). For both gas and power, participants can define a saving target that is used to calculate a “monthly budget” (in volume or euro’s) for gas and power. A coloured indicator is used to tell the user whether he is within (“green”) or outside (“red”) of his cumulative target for the period.

The research was explorative, meaning that no absolute value should be attributed to the results. The number of household was limited and not representative for a specific population, because participation in the study was largely based on self-selection. Participants were randomly put in either the display or the non-display group and were unaware of each other and the specific test objectives.

The research does however provide a valid insight into the *relative* impact of a smart meter with a separate display against the current situation (analog meter) or a smart meter without a display (which, for a consumer, is no material difference).

Keeping this in mind, the study delivered interesting results that can be further explored and validated in follow-up research.

These results are:

- Households with a display were more successful in saving energy than households without a display (81% vs. 47% for power and 100% vs. 65% for gas⁶).
- The spread in saving results is smaller in the group with the display than in the group without a display.
- Maximum savings for power are comparable for both groups (34% saving in the display group vs. 30% in the non-display group); for gas, maximum savings in the display group appeared to be higher (32%) than in the non-display group (22%).
- Average savings in the display group were considerably higher than in the non-display group (9% saving on power and 14% on gas in the display group, against 3% and 2% in the non-display group).
- A display clearly has an “educating” effect. For the first time (ever) consumers get insight into their domestic energy consumption, as a powerful trigger for behavioural change.
- Behavioural change is seen both in day-to-day living (avoiding energy waste or using appliances more efficiently) as in buying behaviour (buying energy efficient products).
- Especially households scoring “high” on environmental motivation and with a relatively high current energy consumption level appear to be very successful in realising energy savings.
- For households scoring “low” on environmental motivation we do not see an improvement in their motivation by using the display during the test-period.
- Participants using the display were quite happy during the test. They enjoyed participating and did not complain about the time or effort required. Participants in the

⁶ Gas usage during the test and reference periods was corrected for Heating Degree Days.

other group developed more negative feelings and considered participating more as a burden. This difference in “emotional reward” may indicate that a display will also help in sustaining behavioural change over time.

The study thereby confirms the assumption that a display generating direct feedback on household energy consumption can contribute significantly a) to consumer willingness to change some behaviours in order to reduce energy usage and b) to the resulting saving level achieved. This particularly applies to “heavy user” households (eg. families with children) that already share a relatively high environmental motivation. Consumers without this motivation will not change their behaviour as a consequence of having an energy display alone. Additional triggers may be needed to get this group moving. Further research is needed to explore what triggers may work to this effect.

Regarding the global “smart meter movement” and the almost universal expectation that such meters lead to energy savings, this study warrants a clear “yes, but...” Smart meters *can* deliver better and more frequent information to consumers and such information *can* lead to behavioural change to save energy, but unlocking this information is key to realising these results. Governments or energy companies that introduce smart meter infrastructures without putting such unlocking mechanism in place should therefore not set their hopes too high regarding the potential energy saving impact that will be achieved. For consumers a special purpose “living-room” display that delivers real time energy usage information, like the one tested in this study, seems quite adequate for the intended purpose.

In follow-up research the effectiveness of the display can be tested against internet based information. In our present study participants indicated a clear preference for the display. A display is more “in-your-face”, is easily accessible (no start-up time), and available for all members of the family, old or young, computer literate or not.

When “home automation” gets more footing in the house, over time a convergence of different display technologies may become the norm⁷.

For more information about this study please contact us at: www.ucpartners.eu or office@ucpartners.eu

⁷ The latest generation of “smart phones” already provides such converged technologies, potentially putting an energy display in everyone’s pocket. Several companies (Nokia, IBM, Microsoft, Google) already announced initiatives to this end.