D4: Report on Innovative Customer Energy Products

ESMA / WP2 / Task 5

Version 2.2

08.05.2008

Andrei Z. Morch (SINTEF Energiforskning AS (Norway)
Pekka Koponen (VTT, Finland)
Vítor Lopes (EDV Energia, Portugal)

Summary

Two recent European Directives: on Energy End Use Efficiency and Energy Services (ESD) and on Measuring Instruments Directive (MID), have raised the Smart Metering-related debate. In the next few years the European energy markets will face a challenging task - implementation of Smart Metering systems for small and middle-size customers. Smart Metering is a broad technical concept, which includes a complicated infrastructure required for registration, transfer and management of metered data. The study reviews the current and previously existed products, based on Smart Metering and looks at the barriers for implementation of these products. The major data input to the task has been gathered from the project partners, providing input about Smart Metering-based products in their respective countries.

The EU Commission emphasises in its ESD Directive the importance of providing timely actual energy consumption data to customers. This enables the Final Customers to have better control of their use of energy and to adjust their consumption patterns. It also allows a frequent registration of electricity consumption and subsequent transfer, management and storage of the consumption data. In practice it makes it possible to develop products, based even on real-time price signals, which will follow the wholesale electricity prices on electric exchange or/and transmission and distribution costs in the network. Smart Metering provides a technological basis for Retail Electricity Suppliers, DSOs and possibly other market actors to offer Final Customers new products and services, which can be divided into three main categories:

- Products, based on frequent pricing of electric energy
- Products, based on frequent pricing of distribution network services
- Other products and services

Legislation is crucially important for a successful implementation of new products and services. On deregulated electricity markets, Electricity Suppliers have usually a fairly free possibility to develop and offer new products and services for Final Customers, provided that the necessary metered data is supplied by an actor, responsible for metering (DSO or Metering Operator) of the potential Final Customers. It is also important that implementation of Smart Metering is done according to certain least technical requirements specifying some key characteristics as, for example, common metering frequency (15, 30 minutes, one hour etc.). Otherwise there are good chances that Final Customers market will be segmented according to output from their metering systems and complicate implementation of new products for RESCs.

Implementation of new products and services will normally require new billing procedures, which may cause extra costs for the actor responsible for it. In some cases it will require additional investments to upgrade the billings system. New products and services should bring sufficient benefits to Final Customers in order to capture their customers' interest. Electric utilities are often exposed to critics and scrutiny from both the public and different authorities. In this situation, improvement of company's reputation is an important and valuable strategic goal.

Table of Contents

The project group consists of:

BEAMA Ltd	Project Coordinator	UK
KAPE	Project Partner	Poland
Ea Energianalyse A/S	Project Partner	Denmark
ECN	Project Partner	The Netherlands
VTT	Project Partner	Finland
Pilot Systems Ltd	Project Partner	UK
EDV Energia	Project Partner	Portugal
SINTEF Energiforskning AS	Project Partner	Norway
SenterNovem	Project Partner	The Netherlands
SPEC (Warshaw Heating Industry Company)	Project Partner	Poland
Ekodoma Ltd	Project Partner	Latvia
SEVEn	Project Partner	Czech Republic
ENDESA Distrbuscion Electrica S.L.	Project Partner	Spain
ENDESA Ingenieria S.L.	Project Partner	Spain

1 Introduction

European Smart Metering Alliance (ESMA) is a European project, which is initiated under support of the Intelligent Energy Europe (IEE) program. In ESMA project metering industry and research organisations cooperate to exchange best practices in the field of Smart Metering in Europe. ESMA will define and spread best practice in smart metering across European member states and maximise the resulting energy savings. ESMA supports Article 13 of the Energy End-Use Efficiency and ESCO Directive [1]. The project will produce a series of reports on key aspects of smart metering that will feed into a Best Practice Guide that will be produced in 2008. In addition, an Alliance has been established linking all key stakeholders, giving them a forum to deal with the issues arising from the introduction of Smart Metering.

1.1 Background

During the last 10-15 years several Distribution System Operators (DSOs) in Europe have conducted small and middle-size pilot tests and voluntary installations of Smart Metering. Among those the Italian ENEL Distribuzione SpA, which has rolled-out and commissioned almost 30 million smart meters and is widely considered to be the industry's flagship. Two recent European Directives, one on Energy End Use Efficiency and Energy Services (ESD) and another on Measuring Instruments Directive (MID) [2] have raised the Smart Metering-related debate to the European level. Article 13 in the Energy End-use Efficiency and Energy Services Directive states the importance of installing informative metering and billing systems allowing consumers to regulate and steer their consumption [1]. Extra information provided by informative metering is proposed as an important technological innovation to improve energy efficiency. In the next few years the European energy markets will face a challenging task – implementation of Smart Metering systems for small and middle-size customers.

1.2 Objectives, data and scope of the study

The main objective of the present study is to review current and previously existed products, based on Smart Metering. The study looks at the barriers for implementation of these products. Smart metering technology has the capability to support much more complex product offerings, such as; energy usage information and advice, dynamic tariffs and demand management. It is an expectation among governments and the European Commission that Retail Energy Supply Companies (RESCs) will lead to increased offers of energy services as opposed to simple energy supplies. The success of this depends on the RESCs recognising and developing such energy service offerings and this report is intended to illustrate successful or early examples of such services.

The major data input to the task has been gathered from the project partners, providing input about Smart Metering-based products in their respective countries. The data were further supplemented by the project partners and other open information sources, including web and periodicals.

The paper uses regular definitions of electricity market actors, which are adopted and used by the European Commission (EC 2006/32, 2006) (see Annex, page 29).

1.3 The reading guide

The first section **Introduction** presents a background for the present project, definition of the objectives and scope of the study.

The next section **Smart Metering and new products and services** starts with a brief description of Smart Metering and its main technical components, including the value chain and explanation of its main components. Afterwards the section describes the key functionality, which is important for development and implementation of new products and services.

The following section describes **Products, based on frequent pricing of electric energy.** The descriptions include: status, benefits, identifies the role of Smart Metering, discusses barriers, challenges and the outlook for the products. **Products related to distribution network tariffs (DSOs)** are described in a similar way in the following section.

This final section **Barriers and success factors: discussion and conclusions** discusses barriers related to the legislation, technical problems in metering and billing, feedback, value to the provider of services and improving of the reputation.

Explanation of abbreviations is given in the Annex on page 28 and the main terms and definitions are presented on page 29.

2 Smart Metering and new products and services

2.1 Smart Metering in brief

Before deregulation, when national electricity markets were dominated by regional electricity monopolies and the electricity tariffs were more or less constant, the need for Smart Metering for end-users was not very evident. Implementation of Smart Metering provides several benefits for Final Customers as well as other actors in electricity industry. It is very a comprehensive topic, which cannot be presented in details in the scope of the present document. Especially interested readers are advised to read deliverables from ESMA project, where these issues will be studied.

Smart Metering is a wide technical concept, which includes a complicated infrastructure required for registration, transfer and management of metered data. An example of Smart Metering value chain is presented in Figure 2.1. Initially electricity consumption is registered by a meter. The registered data is stored in the meter and periodically transferred to Data Collection System or so-called FrontEnd system. The data is further transferred to Metered Value Database (MVDB), where it goes through a quality assurance, where missing or wrong data are identified and replaced. In some cases, especially when it comes to small companies, MVDB is not present and the quality check is done in the FrontEnd system. After the quality check the consumption data are used in the Customer Information System for billing of Final Customers. Final Customers can receive information about their actual consumption from the meter's display, a local display linked to the meter or via Internet browser, receiving data from MVDB or CIS. The meter's display will normally show instantaneous consumption data, while data viewed via Internet will be somewhat delayed, depending on how often data from the meter is transferred to the Data Collection System (daily, weekly or monthly).

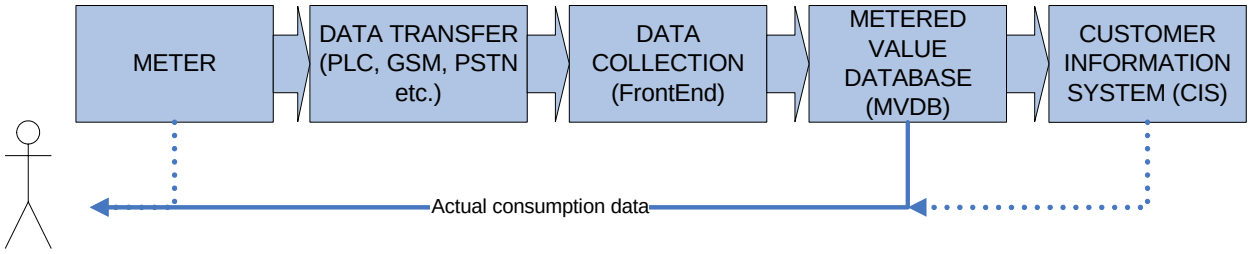

Figure 2.1 Example of Smart Metering value chain

The experience shows that collection and management of metered data require skilled and well-trained personnel in order to maintain high quality of the metered data. Profitability of Smart Metering is normally assessed through cost-benefit evaluations and depends from a number of various factors including type of equipment, its functionality, appropriate communication carriers, implementation scale, number of customers, type of area (urban or rural), organisation of the process etc.

During the recent years it has been a clear pattern showing decline in investments and commissioning costs, making cost-benefits evaluations more and more favourable for implementation of Smart Metering.

As the key advantages, which are relevant in the present document, it can be mentioned that Smart Metering provides several additional functions enabling development and implementation of various new products and services for Final Customer.

2.2 Registration and providing of actual consumption data

The EU Commission emphasises in its ESD Directive the importance of providing timely actual energy consumption data to customers showing real consumption. Smart Metering provides continuous information about actual electricity consumption and gives Final Customers better control of their use of energy by following and adjusting their consumption patterns. Additionally the real consumption data can be corrected according to the outdoor temperature and benchmarked against the normal consumption levels (see Section 5.1). This feedback simplifies identification of abnormal consumption of energy due to, for example, malfunctioning equipment or poor house's insulation and further improving of the situation.

2.3 Frequent pricing

Smart Metering allows frequent registration of electricity consumption of customers and subsequent transfer, management and storage of the consumption data. Normally the metering frequency varies from 15 minutes to one hour (Nordic countries). In practice it makes it possible to develop products, based even on real-time price signals, which will follow the wholesale electricity prices on electric exchange or/and transmission and distribution costs in the network.

2.4 Providing correct and timely billing to Final Customers

Registration of actual consumption data, combined with frequent pricing of electric energy and transmission and distribution services, provides correct and timely billing of Final Customers.

This increases customers' interest to the new products and services and their incentives to respond to the price signals. Final Customers, which are actively trying to adjust their consumption (manually or automatically) to the price signals, will save money.

2.5 Remote load control

Several previous tests of Smart Metering in pilots have proved that many Final Customers find it difficult to adjust their consumption patterns manually and wanted an automated solution, which would optimise their consumption according to the price signals. The remote load control can be implemented as an additional function in Smart Metering. If necessary, this function can also be used by DSO for electricity rationing schemes and other actions.

Smart Metering provides a technological basis for Retail Electricity Suppliers, DSOs and possibly other market actors to offer Final Customers new products and services. This products and services can be divided into three main categories:

- Products, based on frequent pricing of electric energy
- Products, based on frequent pricing of distribution network services
- Other products and services

3 Products, based on frequent pricing of electric energy

3.1 Small customer energy tariff tied on hourly spot-market price

Country	Finland	
Company	Two retail suppliers: Turku Energia and ST1 offer.	
URL		
Current status of the product		In regular use
Type of product		Electricity retail contract
The target customer group		Households and small commercial

3.1.1 Description of the product

Turku Energia retail developed the product to reduce its risks related to the spot market electricity purchase [5], [6]. A bank collaborates by offering the Final Customers financial instruments (savings and loans) that are also tied to spot-price variations but in the opposite direction. Thus the Final Customers can protect themselves from the spot market variations as much as they wish. Those Final Customers that have hourly metering and balance settlement, can respond to the fast price variations by shifting load or switching to alternative fuels (such as firewood) during the spot market price peaks. The electricity prices in Nordic countries are set on the day-ahead market at the Nordic Electricity Exchange (NordPool[1]), and the spot market price is publicly available in the previous day on the Internet. The Final Customer of Turku Energia can also get an alarm if the spot price exceeds a preset price level using e-mail or Short Message Service (SMS).

3.1.2 Benefits

- The retailer costs for managing price peak risks are reduced.
- Spot-markets provide a fair reference price for contracts, thus reducing overhead in the planning of retail offers and contracts.
- The final customers may get electricity cheaper on the average due to reduced retailer margin.

Verification of this point is difficult, because the retail prices in Finland have stayed long periods below and long periods above the spot price levels. Also comparison of retail market products in Finland has been complex due to missing transparency.

- Those Final Customers that have hourly metering and settlement can respond to spot-market price peaks thus avoiding the purchase of high cost electricity.

[1] http://www.nordpool.com

- Energy cost reductions are expected. No reductions in the energy end use are expected. Demand response will improve energy efficiency in electricity generation.

3.1.3 The Role of Smart Metering in the product

Hourly metering and settlement together with the product enable Demand Response. Otherwise the product does not require Smart Metering.

3.1.4 Barriers, challenges and limitations of the product

Since December 2004 electricity market legislation has prevented the demand response aspect of the main target customer group (electrically heated houses with 3x63A fusers or smaller), because it requires that settlement is based on type customer load curves and not on real hourly measurement. Legislative changes are considered to remove this barrier. Further barriers to this DR aspect include quality and costs of necessary metering and building automation. Also the delays in the price peak alarm service should be shorter.

3.1.5 Outlook

The competitiveness of the product will improve much, when the barriers are removed or reduced. As a result the other retailers will likely start to offer similar products and tight competition is expected.

3.2 Fixed price with a right to return

Country	Norway
Company	Trondheim Energi (Trondheim Electric Utility)
URL	http://www.tev.no
Current status of the product (design, testing, regular use)	In regular use
Type of product (electricity contract, network tariff etc.)	Electricity retail contract
The target customer group (households, commercial etc.)	Households and small commercial

3.2.1 Description of the product

It always has been a difficult task to create strong enough incentives for Electricity Suppliers to promote energy saving products simply because these products make Final Customers to consume less electricity and therefore reduce Suppliers' revenues. This product is an attempt to resolve this conflict of interest and providing benefits for both Electricity Supplier and Final Customers.

The product has been developed and introduced to the market by Trondheim Energy[2]. The main difference from regular price-related electricity retail contracts is that this product offers Final Customers to purchase a certain volume of electricity at a fixed price.
The Final Customer is billed according to the final settlement for each time period, which consists of two different parts: financial and spot price settlement.

The financial settlement is similar to the one, which is used for financial contracts on the Nordic Electricity Exchange (NordPool). The volume, which was earlier contracted at a fixed price (not the actually consumed one), is settled against the NordPool's system price during the delivery period. If the system price was higher than the fixed price for the contracted volume, the settlement is positive and the customer receives a financial benefit. If the actual system price has been lower than the contracted one, the settlement will be negative, meaning that the customer receives an extra cost.

The spot price settlement is based on hour-by-hour settlement of the actually consumed volume against the spot price in the given area. (Norway has several spot price areas). Then data from both settlements are put together and the customer is billed according to the final figure. In practice it means that if the customer consumes the previously contracted volume and the spot price has been high, he will be billed according to the contracted fixed price. At the same time, if the customer reduces his consumption during high price periods, he will save money since the difference will be in practice sold back to the market. If the customer exceeds the agreed volume, the difference will be purchased on the spot market. This is illustrated in four cases in Table 3.1. For the sake of simplicity, the example uses round figures as electricity prices and the system price is equal tp the spot price.

Example: In the example a Final Customer purchases initially a volume of 20.000 kWh at a fixed price 0,03 Euro pr kWh.

Table 3.1 Fixed price electricity contract with a sell-back option. Source: www.tev.no

	"High price and normal consumption" (1)	**"Low price and excess consumption" (2)**	**"Very high price and low consumption" (3)**	**"Extrem. high price and low consumption" (4)**
Consumed volume [kWh]	20 000	25 000	15 000	15 000
Actual spot price [Euro]	0,04	0,02	0,06	0,12
Spot price settlement [Euro]	20000*0,04=800	25000*0,02=500	15000*0,06=900	15000*0,12=1800
Financial settlement [Euro]	20000(0,03-0,04)= -200	20000(0,03-0,02)= 200	20000(0,03-0,06)=-600	20000(0,03-0,12)= 1800
To pay [Euro]	600	700	300	0
Price pr. kWh [Euro]	0,030	0,028	0,020	0

The example shows that if the actually consumed volume of electricity is equal to the contracted one (20.000 kWh) the customers pays the contracted price, even though the actual spot price was higher. In the second example the spot price has been low and the customer has an excess consumption, so he has to purchase the gap at the spot-marked. In the third case the price has been twice as high as initially contracted and the customer reduced his consumption from 20.000

[2] Previously – Trondheim Energiverk (TEV)

to 15.000 kWh. The result is that customer pays only a 0,020 Euro pr kWh, which is only one third of the actual spot price. In the fourth example, the spot price has been extremely high, but by reducing his consumption from 20.000 to 15.000 kWh the Final Customer pays nothing (!) for the electricity.

3.2.2 Benefits

This type of contract encourages customers to save electricity, especially when the spot price is high. At the same time the contract is very favourable to the electricity supplier, since it diminishes the existing volume risk, which is present in traditional electricity contracts, related to price and not to the volume. In this way this contract resolves the existing conflict of interests between a Final Customer and electricity supplier, when electricity saving reduces revenues for the supplier. In many ways this is an attempt to transfer the existing financial contracts from NordPool to Final Customers.

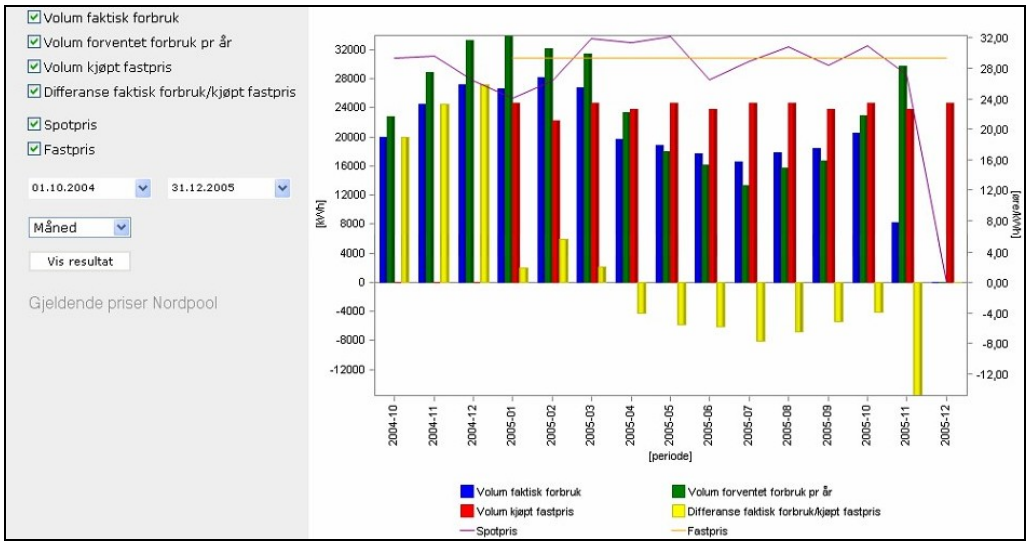

Figure 3.1 Customer's homepage with electricity consumption data. *Source:www.tev.no*

3.2.3 The Role of Smart Metering in the product

Initially this contract was developed, and still works best for customers with hourly metering, so the customers can adjust their consumption according to the development of spot price. NordPool is a so-called "day ahead market", so the spot prices are available one day beforehand. The product is also offered to customers with manual reading. In this case the consumption pattern is estimated according to load profiles, but in this case the opportunity to follow spot prices is missing. These customers have been asked to read their electricity meters and report the data to the utility more often then it is actually required (quarterly), but only few customers have done this.

3.2.4 Barriers, challenges and limitations of the product

The main challenge is to give sufficient price information to the Final Customers both when it comes to the electricity price and the consumption. Trondheim Energy uses individual web pages

for their customers, where they can follow their consumption patterns and development of the spot price.

Lately it has been discovered that price difference between the system price and the area price on the NordPoll can be a risk factor for the Final Customers in certain market situations. This is presently under evaluation [10].

3.2.5 Outlook

The product is offered to household customers on a regular basis [3]. The product has been positively evaluated by Elforsk (Sweden) [4].

The DSO part of Trondheim Energy works on implementation of Smart Metering for its household customers. Accordingly Trondheim Energy RESC works on transferring this product to the hourly metered customers in order to achieve a better utilisation of the product's potential. During autumn 2007 the company plans to upgrade 300 Final Customers having this product with Smart Metering (hourly).

4 Products related to distribution network tariffs (DSOs)

4.1 Remote load reduction in high price periods

Country	Norway	
Company	Malvik electric utility	
URL	http://www.malvik-everk.no/	
Current status of the product		Testing/pilot
Type of product		Combination of electricity contract and ToU tariffs with remote load control.
The target customer group		Households

4.1.1 Description of the product

Malvik Everk is a local DSO in Norway, which has voluntarily installed Smart Metering to all its customers. The company currently carries on an automatic collection of metered data on weekly basis. Since the installed technology allows metering with one-hour resolution, the company studies how this functionality can be utilised [8].

Several previous projects have shown that Final Customers are willing to adjust their consumption according to external price signals as for example distribution network Time of Use Tariffs (ToU) or electricity spot price. At the same time medium and middle-size customers, especially residential customers, whose money saving benefits are fairly small, would rather prefer an automated adjustment of consumption.

Electricity spot prices on Nordic Electricity Exchange (NordPool) vary on an hourly basis, so it is necessarily to register customers'' electricity consumption at least with one hour resolution in order to document actual load reductions and bill the customer accordingly. Based on this, Malvik Everk in Norway has started testing of several new products:

- Time of Use distribution network tariff with two hours peak load price periods pr day (08:00 -10:00 in mornings and 17:00-19:00 in afternoons)
- Electricity contract, based on electricity spot price
- Remote load reduction in peak price periods

The remote load reduction is done by disconnection of low priority electric appliances, usually water heaters for tapping water (VVB) and space heating (VB). In order to make it easier for households to remember the pricing time plan, it was made and distributed special reminders shaped as magnet stickers as it is illustrated in Figure 4.1.

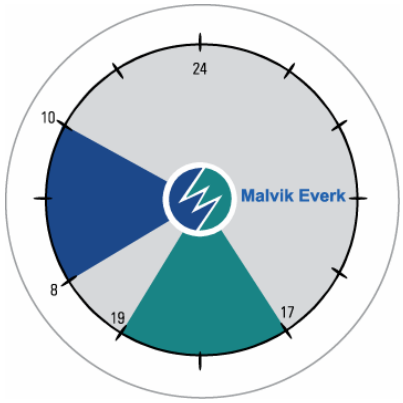

Figure 4.1 Reminder (magnet sticker) for participants in the project. ***Source: [10]***

Each household has received three stickers, which can be mounted on different home appliances (dishwasher, washing machine, drying tumbler etc.).

4.1.2 Benefits

Results of remote load reduction are presented in Figure 4.2. The diagram shows load profiles for customers who disconnect:

- Water heaters for tapping water (VVB) for load reduction
- Water heaters for tapping water and for space heating (VVB+VB) for load reduction
- Other type of equipment for load reduction (Rest)

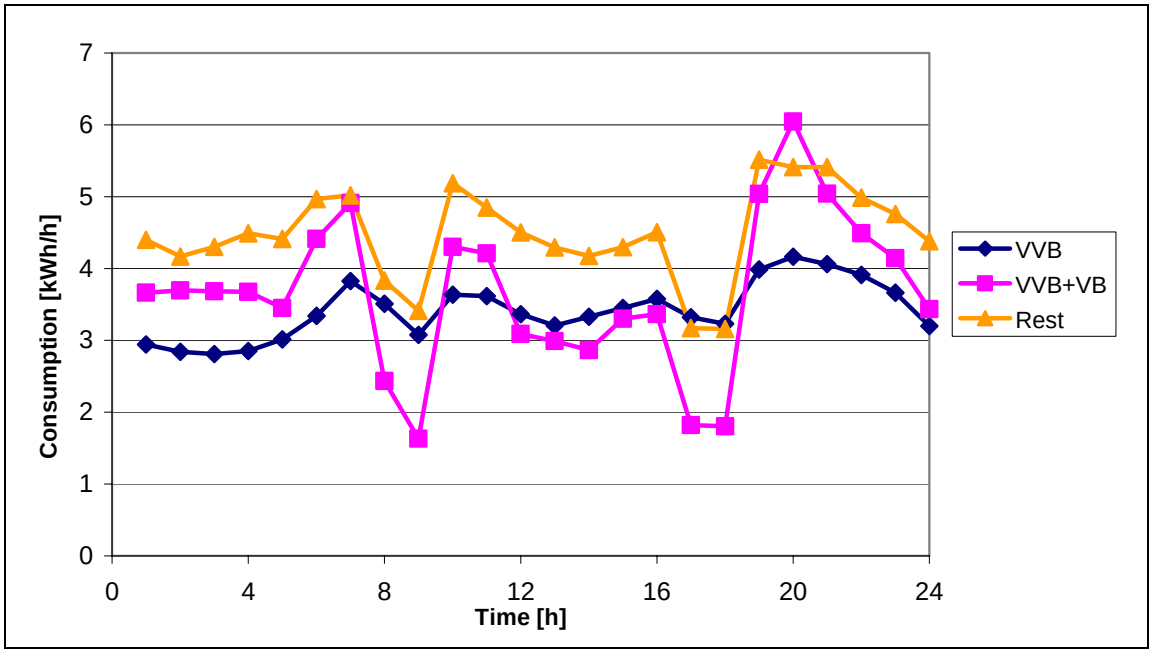

Figure 4.2 Load profiles for customers with remote load reduction. ***Source: SINTEF Energiforskning AS, project MabFot [10].***

Since it is an ongoing pilot project it is still too early to evaluate how this product contributed to overall energy consumption. It is however interesting to mention that the major share of the customers have not noticed any discomfort due to remote load reduction.

4.1.3 The Role of Smart Metering in the product

Smart Metering is essential for implementation of this product. The product includes three following parts:

- Collection of price signals: electricity spot prices are received from the Nordic Electricity Exchange (NordPool), which operates so-called day-ahead electricity market.
- Remote disconnection of loads is done by using an optional functionality, which is embedded into the Smart Metering. It is also possible to apply external load control equipment, even though it may complicate interaction between different parts of the system.
- Registration and confirmation of disconnected loads requires electricity metering, which will correspond to the local pricing. In the present case it corresponds to hourly electricity pricing in NordPool.

The product requires frequent registration of electricity consumption in order to create correct cost-saving benefits to the Final Customers and incentives to accept a certain reduction of comfort in some periods.

4.1.4 Barriers, challenges and limitations of the product

This type of product may temporally reduce the customers' comfort over a shorter period of time. Experience from similar projects shows that if this type of products does not operate in a correct manner, it may create very negative reactions from the Final Customers. It is very difficult to restore the customers' trust and interest to the product if, for example, it fails several times to switch back on space heating for a long time period.

Potential customers' savings vary according to electricity price variations on daily basis. If variation is low, the saving will be marginal. This is a test product, which does not correspond the present legal requirements, so the utility has applied the Regulator for a dispensation in order to implement it.

4.1.5 Outlook

The product has been tested in a pilot project for a limited number of customers (41 household). Implementation of the product in a broader scale will depend from the final results of the trial.

4.2 Product: Time of use tariffs

Country	Finland

Company	Most utilities in Finland offer the product
URL	
Current status of the product	in large scale regular use
Type of product	Electricity retail contract and also electricity distribution contract
The target customer group	Households and small commercial

4.2.1 Description of the product

Times of Use (ToU) tariffs reflect regularly repeating daily and seasonal variations in electricity transmission and distribution purchase. During weekends and nights a lower electricity price is applied and during working days a higher price is applied.

In Finland there is decades of experience on large scale deployment of time-of-use tariffs for electrically heated houses. All the DSOs are obliged to provide two-time metering and settlement for those customers that want it. The tariffs comprise two time zones. About 1.2 GW of ToU-heating loads are switched on in the cold winter evenings as two steps. Most retailers and DSOs offer two-time-tariffs.

4.2.2 Benefits

ToU control flattens the regular load variations in the national balance. ToU control causes slight increase in end use energy consumption, but reduces the need for peak generation capacity thus improving energy efficiency in electricity generation.

4.2.3 The Role of Smart Metering in the product

Either time of use meters or hourly metering meters are needed for metering of the electricity consumption for customers with ToU tariffs. At least one control output is necessary for switching load and control set-points according to the time zone.

4.2.4 Barriers, challenges and limitations of the product

- Large scale switching on/off of the ToU loads causes extra balancing costs for the System Operator (SO) or reduces security margins
- Opening of the market to international electricity trade has reduced regular daily price variations, thus reducing the profitability of fixed ToU-control (both for the retailer and for the customer). The price difference between the price periods has diminished.
- The Finnish market area of NordPool has experienced high peak prices also during the low price periods of the ToU-tariff. That is likely to happen also in the future.

- A large electricity company decided to stop the provision of ToU tariffs but was forced to cancel the decision due to political pressure stemming from the fact that the investments that many customers had made on ToU would have been stranded. Eventually our legislation now requires that DSOs provide ToU metering to those who wants it.
- The periods of constant high prices in the two-time-tariff are so long (16 hours) that at a lot of heat storing capacity is needed. Otherwise comfort may be lost and loads may switch back on during the evening market price peak.

Based on a survey, done by VTT Technical Research Centre of Finland [9], it can be extrapolated that about 25 % of the ToU-meters are such that the time periods are remotely controlled, but the present legislation prevents flexible time periods.

4.2.5 Outlook

About 25 % of ToU meters in Finland are so old that it is time to replace them. In the electricity market in Finland there is a need for more dynamic demand response methods than ToU.

5 Other products

5.1 Monitoring electricity consumption and providing of feedback to the customers

Country	Portugal	
Company	ISA – Intelligent Sensing Anywhere, S.A.	
URL	http://www.isasensing.com/	
Current status of the product		**Regular use**
Type of product		**Electricity metering and sub-metering + water and gas metering**
The target customer group		**All buildings**

5.1.1 Description of the product

Experts in energy efficiency advocate that a combination of improved technology and behavioural shifts are key ingredients to get the envisaged financial and environmental savings. In fact, recent deployments of smart metering systems have demonstrated that appliance control and real-time customer feedback are mandatory to achieve the desired energy efficiency improvements.

The product consists of a set of measuring devices that read electricity, gas, and water consumptions in residential or office buildings. The consumption data is concentrated in a central unit that informs people about the building's energy behaviour. Indoor and outdoor temperatures are also measured and used to correlate with energy consumptions. Circuit breaking capabilities are included in the devices' functionality in order to perform energy efficiency operations.

The iMeter was deployed in an innovative energy efficiency pilot project sponsored by Quercus, the leading environmental non-governmental organisation (NGO) in Portugal.

5.1.2 Benefits

The iMeter allows the end user to know, where energy is being consumed in the home. It gives the home owner an accurate, up to the minute profile of the energy-wasting appliances, as well as it provides benchmarking against well-established normal rates of consumption. It also allows the utilities to perform automatic meter reading from a convenient central location, what reduces meter reading expenses. Figure 5.1 shows an example of a feedback to the customers.

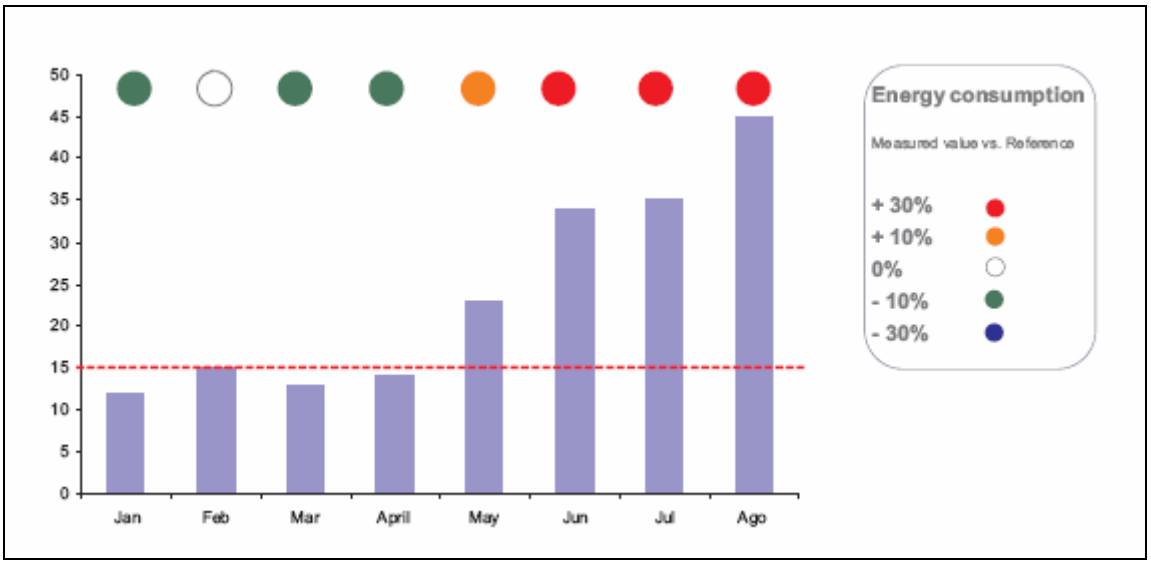

Figure 5.1 Example of a feedback to the customers. ***Source: Intelligent Sensing Anywhere, S.A.***

Energy savings of the home user depend on each consumer's energy spending behaviour and how the consumer is willing to change its behaviour according to the data provided. However, immediate savings can be achieved by having the iMeter automatically turning off heating and air conditioning where there is nobody in the room. The utilities also have immediate savings by taking advantage of the iMeter's multi-metering capabilities.

5.1.3 The Role of Smart Metering in the product

The iMeter was built from the ground up with smart metering and sub-metering in mind. The system is capable of monitoring the water, gas, and electricity meters coming into the home, as well as individually discriminating the different electricity consumptions inside the home. The system's overview is shown in Figure 5.2.

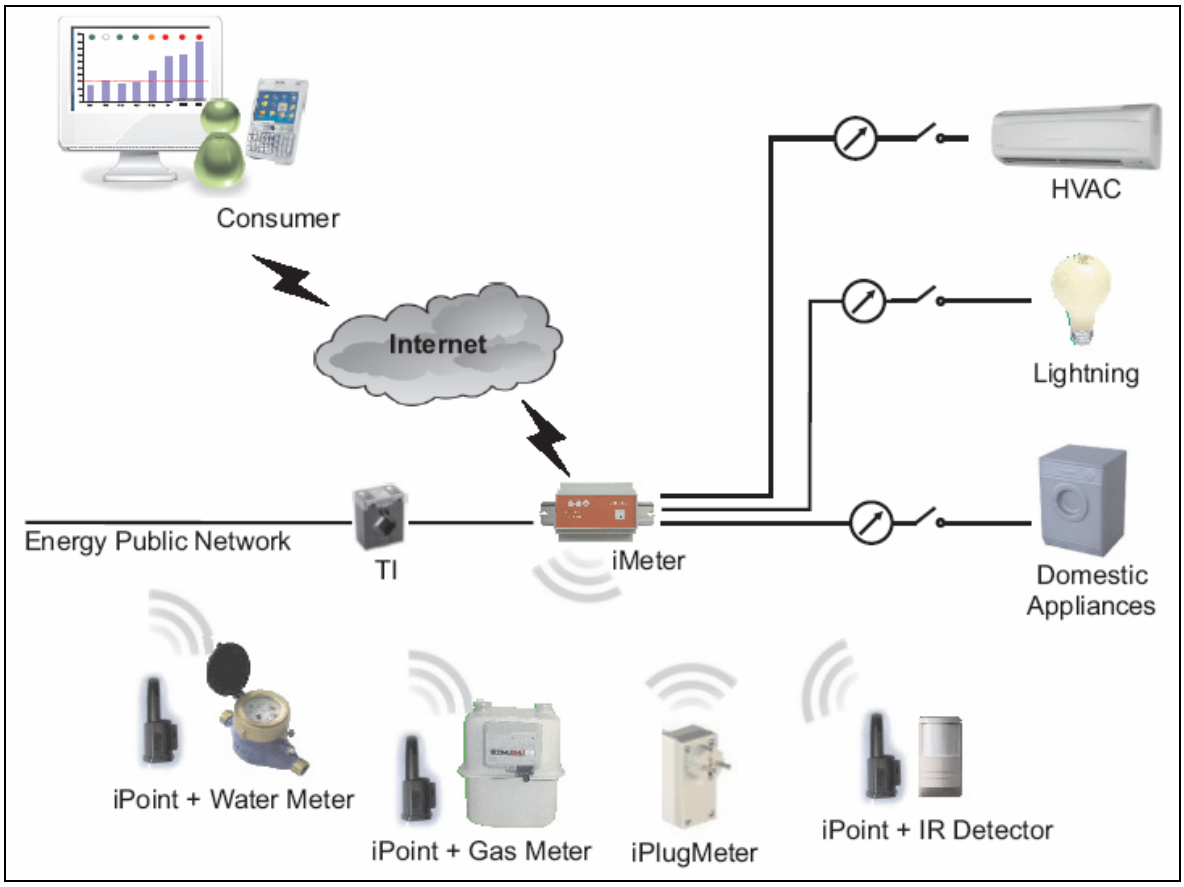

Figure 5.2 Oveview of iMeter systems. *Source: Intelligent Sensing Anywhere, S.A.*

The iMeter can function without smart metering because it is also a home automation device, capable of performing sub-metering inside the home, and turning on and off specific appliances. However, the full potential is realized when the Smart Metering capabilities are taken into account.

The iMeter's requirements are next to none. It is deployed in a standard DIN rack on the electrical closet. Once installed, it immediately communicates with a central database where the end user can check the consumptions.

5.1.4 Barriers, challenges and limitations of the product

The iMeter should be installed by a licensed electrician. Once it is installed, however, current usage is simplicity itself. Furthermore, the system can be expanded by deploying sub-metering devices throughout the home by simply inserting a plug into a wall socket.

5.1.5 Outlook

The product is part of ISA's strategy to enter the energy efficiency market. The company anticipates that all future homes will have an iMeter or a similar product monitoring energy and water consumption and advising the consumer on resource-saving strategies. Furthermore, we hope that major European Utilities will recognize the huge savings potential that arises from the iMeter's energy efficiency and smart metering capabilities.

5.1.6 References

http://www.isasensing.com/documentation/iMeter_UK.pdf

6 Barriers and success factors: discussion and conclusions

6.1 Legislation

Legislation is crucially important for a successful implementation of new products and services. On deregulated electricity markets, Electricity Suppliers have usually a fairly free possibility to develop and offer new products and services for Final Customers, provided that the necessary metered data is supplied by an actor, responsible for metering (DSO or Metering Operator) of the potential Final Customers. In this way the Fixed Price with Right to Return product (see Section 3.2) has been introduced to the market. However, it was pointed out that at least in one country the present legislation may create obstacles for this because its requirements are outdated (see Section 3.1). It is also important that implementation of Smart Metering is done according to certain least technical requirements specifying some key characteristics as, for example, common metering frequency (15, 30 minutes, one hour etc.). Otherwise there are good chances that Final Customers market will be segmented according to output from their metering systems. This may complicate implementation of new products for RESCs.

The situation is slightly different when it comes to products related to pricing of distribution network services: Distribution System Operators as natural monopolies may be less interested in implementation of new products, based on Smart Metering, unless it can improve their own situation as, for example, changing the local load patterns and reduction of congestions in the distribution network. This can be solved, if Regulators will oblige DSOs to provide network tariffs (ToU, capacity-related etc.), which will correspond to the functionality of the installed Smart Metering systems and fully utilise their potential.

6.2 Metering and billing: technical problems and costs

Implementation of new products and services will normally require new billing procedures, which will likely cause extra costs for the actor responsible for it. In some cases the billing system may not have technical capability, which is necessary for a complicated billing procedures as, for example, billing based on real-time electricity spot prices for small customers. It will require additional investments to upgrade the billings system.

6.3 Sufficient feedback to the Final Customers

Several new products require provision of timely and clear feedback to the Final Customers about their consumption, price signals and other information (see Section 3.2). This can be done in several ways, for example by using web-pages in areas, where the customers' access to Internet is sufficient, or by using the meter itself. This requires constant update and maintenance of the information and attention from the Final Customers. Providing metered data in real time directly from the meters would be ideal for fast Demand Response schemes, end-use energy management and for energy saving. An important barrier is that many Smart Meters, which are recently installed, may be specified not to give the metered data directly to the Final Customer.

6.4 Benefits to Final Customers

New products and services should bring sufficient benefits to Final Customers in order to capture their customers' interest. It may be for example better service or/and potential savings. The problem is however that many products may require a lot of effort from the customers, which will try to adjust themselves to the price signals, yet the potential savings will be marginal. The situation can be improved if the load adjustment procedure is automated (see 4.1) so the customer does not have to follow the price signals manually. The same time it may cause some unexpected reductions of their comfort, which have to be accepted.

6.5 Value for the provider

Finally, the products should bring some kind of value to the provider itself. If it is related to electricity retail, it can for example gain new customers and increase the RESC's market share or/and reduce its costs for hedging (see Section 3.2). When it comes to DSOs, new products can contribute to improving of the local load profiles and respectively more efficient operation of the distribution network. Implementation of the new products and services is often very costly thus it is important to run an internal cost/benefit evaluation in order to study the potential benefits of the given product.

6.6 Improving the reputation

Electric utilities are often exposed to critics and scrutiny from both the public and different authorities. In this situation, improvement of company's reputation is an important and valuable strategic goal. Presently a strong focus is aimed on the technology of the Smart Metering systems. This may be a wrong focus as the metering is simply an enabler for new energy products. The new technology that has become available does, though, makes possible implementation of a whole range of new product offerings. Given that RESCs and DSOs are going to come under increased public pressure to promote energy saving, implementation of these products will improve their reputation among customers.

7 References

[1] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC. Official Journal of the European Union 27.04.2006

[2] Directive 2004/22/EC of the European Parliament and of the Council of 5 April 2006 on of 31 March 2004 on measuring instruments. Official Journal of the European Union 30.04.2004

[3] http://www.tev.no/tev/privatkunder/kraftprodukt_fastpris_returrett.asp

[4] "New price product reduces trade risks, creates opportunities for distributors" Elforsk Market Design Newsletter # 6 www.marketdesign.se/archives/2006/news/mdn_6_en.pdf

[5] www.markkinasahko.com (In Finnish)

[6] www.st1.fi (In Finnish)

[7] Koponen P., Kärkkäinen S., Farin J., Pihala H., *Markkinahintasignaaleihin perustuva pienkuluttajien sähkönkäytön ohjaus, Loppuraportti* (Control of small customer electricity demand with spot-market price signals, Final report), VTT Research Notes 2362 (In Finnish, Abstract in English)

[8] Ove S. Grande, Inge H. Vognild and Audun H. Wilberg "*Market-based demand reponse. End-user involvement and experiences from Norwegian pilots"*, CIRED 19th International Conference on Electricity Distribution, Vienna 21-24 May 2007

[9] Kärkkäinen, S., Koponen, S., Martikainen, A., Pihala, H., "Sähkön pienkuluttajien etäluettavan mittaroinnin tila ja luomat mahdollisuudet" VTTR0904806, VTT, 2006 (In Finnish)

[10] Grande O. S., Sæle H. and Solem. G., "*Økt priselastisitet hos husholdningskunder. Kunderespons og endring i forbruksmønstrer i pilottester*", Technical Report TR A6561, SINTEF Energiforskning AS, Trondheim 2007 (In Norwegian)

8 Annex

8.1 List of abbreviations

AMR	Automatic Meter Reading
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DSO	Distribution System Operator
ESD	Energy End Use Efficiency and Energy Services Directive
ESMA	European Smart Metering Alliance
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
IEE	Intelligent Energy Europe
MAM	Meter Asset Management
MAP	Meter Asset Provider
MID	Metering Instruments Directive
MO	Meter Operator
MVDB	Metered Value Database
NGO	Non-governmental organisation
NordPool	The Nordic Electricity Exchange
PSTN	Public switched telephone network
R&D	Research and Development
REMA	Regulation in Electricity and Metering Arrangements
RESC	Retail Energy Sales Company
SMS	Short Message Service
ToU	Time of Use tariff
TSO	Transmission System Operator
VVB	Electric water heaters for tapping water

8.2 Terms and Definitions

Source: DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC http://eur-lex.europa.eu

- **Energy Efficiency**: a ratio between an output of performance, service, goods or energy, and an input of energy;

- **Energy Efficiency Improvement**: an increase in energy end-use efficiency as a result of technological, behavioural and/or economic changes;

- **Final customer:** a natural or legal person that purchases energy for his own end use;

- **Distribution System Operator (DSO):** a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system of electricity or natural gas in a given area and, where applicable, its interconnections with other systems, and for ensuring the long term ability of the system to meet reasonable demands for the distribution of electricity or natural gas;

- **Smart Metering** does not have an official definition at present. Development of this definition is actually one of objectives of European Smart Metering Alliance (ESMA). The present questionnaire complies with Article 13 of ESD, which refers to: "*individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use"*