# Smart Metering

July 2006

by Rob van Gerwen, Saskia Jaarsma and Rob Wilhite, KEMA, The Netherlands

## Abstract

Smart metering is a topic that recently has attracted much attention. Smart metering promises many benefits and projects in Europe, the USA and other countries show that smart metering is technically feasible. Main issues are the actual value of the benefits, the cost involved and the distribution of cost and benefits of smart metering between market parties involved. An advanced metering infrastructure offers the possibility for additional energy related services such as demand side management and realisation of virtual power plants. The future of smart metering will depend heavily on the policy and decisiveness of the governmental bodies involved. Energy savings and an increased security of supply will be main drivers and believe in smart metering as a means to reach these goals is indispensable.

## Introduction

Smart metering is without any doubt a topic that recently has attracted much attention. Many countries within the EU and outside are already involved in projects with smart metering on a demonstration scale or larger. A variety of benefits are generally attributed to smart meters and these will be discussed in detail in this paper.

Many questions arise, even if we focus on smart metering for electricity use only. What are the exact functions of smart meters and what are the benefits? What is the status of the technology? Which smart metering projects are carried out at this moment? What are the (intermediate) results of these projects? Are there any barriers for implementation and what is the nature of these barriers (technical, economical, organisational)? What is the projected future and impact of smart metering?

This paper will guide you through these questions and provide you with insight into the status and future of smart metering. This paper will focus on electricity meters in Europe, but will also incorporate results from important projects out of Europe. It will conclude with a general view on the future of smart metering.

# Smart meters, what do they do?

Smart metering generally involves the installation of an intelligent meter at residential customers and the regular reading, processing and feed back of consumption data to the customer. A "smart" meter has the following capabilities:

- real-time or near-time registration of electricity use and possibly electricity generated locally e.g., in case of photovoltaic cells;
- offering the possibility to read the meter both locally and remotely (on demand);
- remote limitation of the throughput through the meter (in the extreme case cutting of the electricity to the customer)
- interconnection to premise-based networks and devices (e.g., distributed generation)
- ability to read other, on-premise or nearby commodity meters (e.g., gas, water).

Usually, a smart meter is considered for registry of electricity and gas use, but also water consumption registration is a possibility. In figure 1, an example of a typical smart meter and its functions are schematically shown.

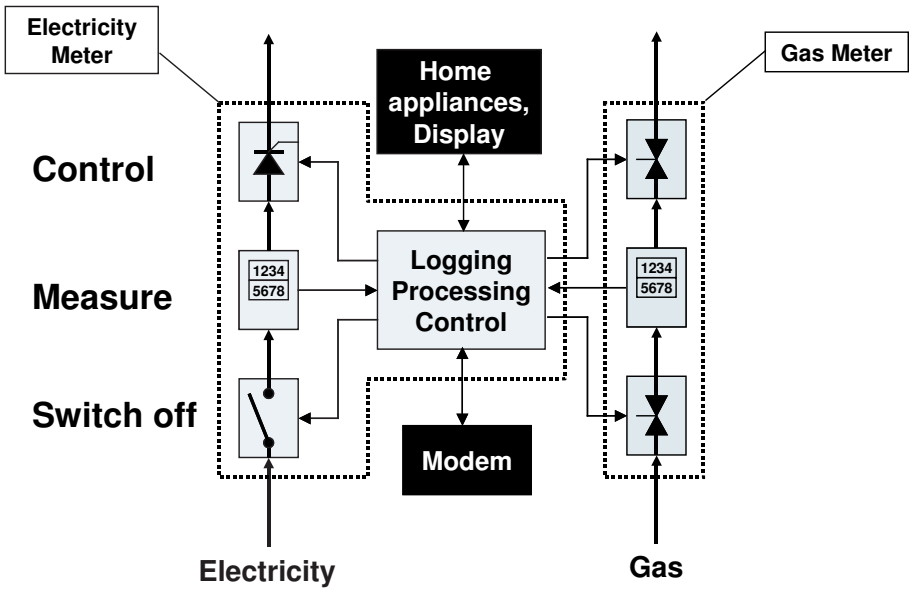


Figure 1: Schematic overview of a typical smart meter configuration [1]

The 'intelligence' of the meter is incorporated in the electricity meter. It has three basic functions: measure the electricity used (or generated), remotely switch the customer off and remotely control the maximum electricity consumption. The electricity meter communicates by means of a modem. An important characteristic is the communication infrastructure used by the smart meter for this communication. Amongst the possibilities are Power Line Carrier (PLC, using the existing electricity grid); a wireless modem (GSM

of GPRS) or an existing permanent internet connection (ADSL). An interface connects the smart meter to home appliances or a home display. Appliances can be controlled directly and the display can be used to show (historic) energy data and energy cost. In this example a gas meter is coupled to the electricity meters and borrows the "intelligence" and communication facilities of the electricity meter.

Technologically, there are no obstacles for the introduction of smart metering. The Italian case (roll out of approximately 30 million smart meters at residential customers) and numerous demonstration projects in other countries show that the technology (smart meter, infrastructure, data processing) is mature and can be implemented on a large scale. A smart meter is a logical successor of the mechanical electricity meter, just as the pick-up, the dial phone and the typewriter are replaced with digital, more intelligent alternatives.

Smart Metering is often referred to as automated meter reading (AMR), or in the case of real-time, two-way communications, as advanced metering infrastructure (AMI).

## Benefits of smart meters and parties involved

Many advantages are attributed to smart metering, including lower metering cost, energy savings for residential customers, more reliability of supply, variable pricing schemes to attract new customers and easier detection of fraud. Additional benefits are foreseen in relation to distributed generation (DG). The smart meter can be used to separately measure electricity delivered by the DG to the grid and the smart metering communication infrastructure can be used to remotely control DG (e.g., in a virtual power plant concept).

Smart meters offer benefits to multiple parties. Therefore, a distinction is made between energy users, grid company, metering company, supplier and government. Not all countries make a distinction between grid and metering company, but as their tasks differ this paper uses the distinction for clarity. Benefits can be explained by looking at the differences between the current situation with the old meter and the future situation with the new meter, as shown schematically in figure 2.

Demand response by domestic energy users is not yet a common practice, but would be enabled by smart metering. Smart meters are capable of limiting or even cutting off the energy use when triggered by market developments[1]. When all households and small to medium enterprises (SME's) in a country would be able to adapt their energy use during a period of high prices or diminished availability, this would improve the reliability of supply en enhance energy market transactions, energy savings, energy awareness and

[1]Limiting the electricity use may be accomplished by cutting off the electricity when the flow exceeds a certain maximum value during a certain time and restore it when the flow is reduced.

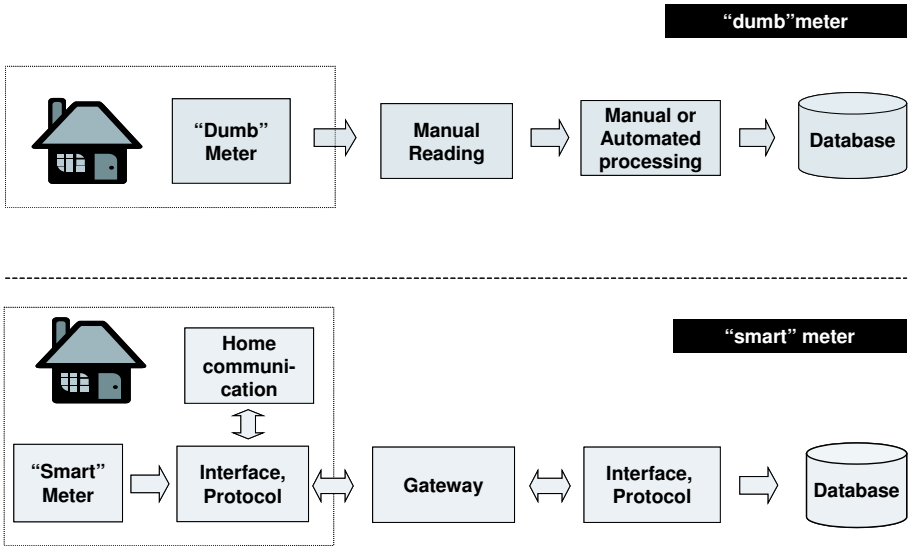


Figure 2: Difference between the conventional and the smart meter data process [1]

energy efficiency. These long term advantages of smart meters may well contribute to energy policy goals of governmental bodies.

On the shorter term, energy users benefit from the smart meter as they have a direct review possibility of their energy use. By adjusting their behaviour, they can reduce their energy cost. Also, they may receive a final bill on monthly basis instead of paying an advance (although some customers prefer a fixed monthly payment anyway).

The metering company faces the challenge of initially replacing old meters by smart meters. When smart meters are installed, this requires another type of operation for data collection and data communication. As smart meters introduce a high amount of frequent data flows, processes and systems must be adapted and prepared accordingly. The data collection process will not depend on clients being at home but will be a continuous, automated process, which should simplify daily operation of the metering company.

When all energy use is monitored by smart meters, grid companies will receive a much more actual and accurate overview of energy consumption in their region. This means they can examine suspicious areas where energy use is higher than expected, and thus smart metering will provide grid operators with a tool to detect fraud. In times of electricity shortage, the grid operator has the option to limit electricity use. Gathering all data, the grid operator will be able to predict electricity flows more accurately and use this knowledge in network and maintenance planning. The automation of the data collection process, with more, recent data on a higher frequency, will put higher requirements on systems. This will also have impact on market facilitating processes, as reconciliation of formerly profiled users may become unnecessary.

To the supplier, the smart meter offers possibilities to offer new and dedicated services to

their customers. The smart meter may become a gateway into the home of the customer, to provide new value added services. Also for the billing process, real consumption data can be used, simplifying the current process of advances and recalculation.

Figure 3 gives an example of automatic meter reading (AMR) benefits for a typical US situation. Normal read savings refer to the reduction of direct and indirect meter reading labour. The labour reduction refers to additional reduction in call centre labour, billing and collection and disconnection of defaulters. Process improvements include reduced energy theft, increased billing accuracy and tighter billing and collection. Infrastructure improvements refer to the benefits of a more accurate, digital meter and the fact that installing new meters in a whole area will reduce the future meter replacement budget.

Smart metering offers a potential yearly benefit of 11-39 EUR, according to figure 3. Smart metering cost may vary but €80 for a smart meter and € 40 for installation are reasonable estimates. So smart metering looks feasible but it depends on the financial assessment made.

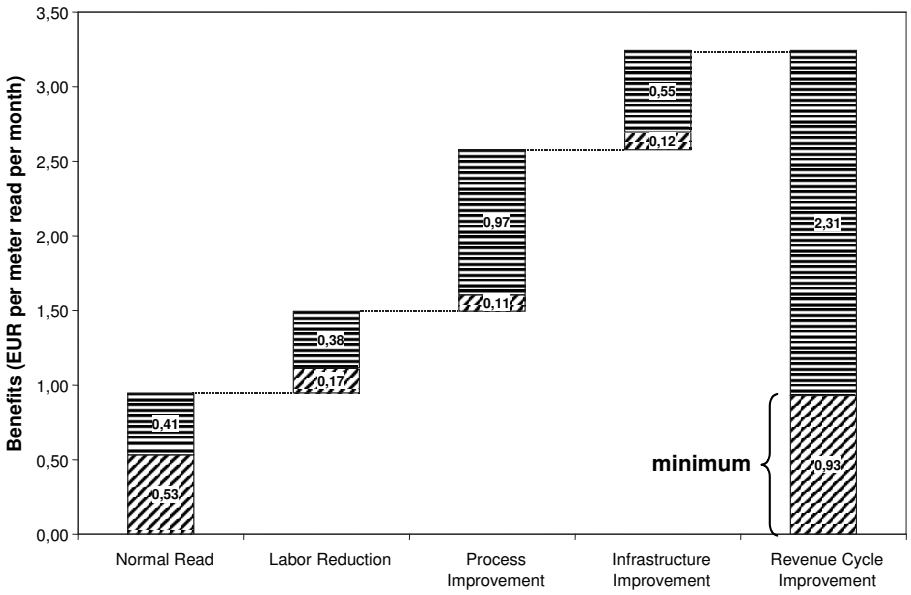


Figure 3: Example of AMR minimum and maximum benefits

# Current projects

This section contains an overview of smart meter projects in Italy, Sweden, the Netherlands, the United Kingdom, Victoria (Australia), Ontario (Canada), California (USA) and Northern Ireland.

The Italian utility ENEL introduced smart meters already in 2001 in their "Telegestore project" [2, 3]. Before deregulation of the energy market ENEL (still as a state-owned monopolist) made the in-company investment decision to introduce smart meters as first utility worldwide. Important reasons for ENEL were the expected savings or revenues in the areas purchasing and logistics, field operations, customer services and revenue protection (fraud). The regulator or government or other market parties had no or only marginal influence on requirements ENEL had to fulfil. Regarding the type of meter or the communication infrastructure ENEL was left totally free. ENEL has chosen for a smart electricity meter that communicates through PLC to the nearest substation. Next, centralised control rooms read the data through GSM. By the end of 2005, ENEL had 27 million smart meters installed, of which 24 million meters are being remotely managed and bimonthly read.

In Sweden the first studies into smart metering were carried out in 2001 [4]. Some companies had pilot projects then, but the government foresaw opportunities for energy savings and wanted to exploit the potential benefits. By obliging the grid companies to a monthly meter reading for all electricity users by 2009, the government stimulated the introduction of smart metering. This bill was passed in 2003. Since, investments in smart metering have developed in a faster rate than required by law.

In the Netherlands, the government is considering legislation to introduce smart metering after having conducted a detailed cost-benefit analysis for nation wide introduction of AMR [5]. The proposed legislation should become public by September 2006. Starting in 2008, all residential customers will get a smart meter. Proposed time frame for this introduction is 6 years. Minimum requirements for these meters are currently being established. In the mean time some pilot projects are being developed.

The Dutch grid operator Continuon [6] has started with a pilot project in 2006. Some 50,000 smart meters will be installed with selected customers in 2006 to build experience with all operational aspects of smart meters. The smart meter (Metripoint) registers both electricity and gas and communicates through PLC.

Also a new energy supplier and certified metering company in The Netherlands, Oxxio [7], has started in 2006 to offer smart meters to its customers. Oxxio chose to pursue this initiative as they kept being confronted with administrative problems at their counter partners. Customers with a smart meter also have entry to a personal website with the actual energy use and energy costs. Oxxio's smart meter registers both electricity and

gas and communicates through GSM/GPRS.

In the UK, regulator Ofgem has recently been exploring the potential of smart meters [3]. Drivers are among others the potential contribution to meeting requirements from the Kyoto protocol, requirements by the EU Energy Services directive, rising energy prices and international developments in smart meters. Ofgem is still open to all options, the consultation process will take some more time.

In Victoria, Australia, increasing summer electricity demand peaks by air conditioning caused extra investments on low use plants [3]. Introduction of smart meters to customers was seen as a mechanism to link wholesale and retail markets. The government changed legislation as instigated by the Essential Services Commission of Victoria. Installation is started in 2006 for dedicated categories, in 2013 about one million smart meters should be installed.

In Ontario, Canada, increasing electricity demand peaks were also the driver for smart metering [3]. Energy conservation and demand side management have become important objectives within the energy policy. The Ontario Energy Board has proposed basic smart metering functions and some minimal technical standards. Each energy company is free to develop its own smart metering framework. Targets are installation of 800.000 meters by the end of 2007 and covering all 4.3 million Ontario customers by the end of 2010.

The main driver for introducing AMR in California is to increase the reliability of electricity supply in this state, through the reduction of consumer peak demand. California has a summer peak demand for power during approximately 50 to 100 hours per year. This peak is mainly due to the increasing use of air conditioners. The main energy agencies of California saw demand response as an important mechanism to decrease this peak. All three major California utilities [2] developed their own plans to implement AMI systems to all residential customers. Deployment plans call for installing all advanced meters and communications infrastructure by 2012 or 2013, and represent some of the largest AMI deployments in the world. In response, a number of significant changes are occurring in AMI technology innovation and price reductions, as vendors seek to capture their share of this market.

The Northern Ireland Electricity plc. used prepayment meters [3]. Complaints and operational costs were increasing and necessitated installation of a new system. The introduction of the 'Liberty 'Credit Management' keypad meter' has started since 2000. By 2005, some 155 000 meters have been installed, covering 22% of customers. Since 2005 also trials have been undertaken in new customer services. These focus on pricing, offering different rates in specific periods, and indicate reduction of energy use by customers.

[2]Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric. Together, these utilities are automating approximately 16 million meters.

# The future of smart metering

So what is the future of smart metering? Is it a hype that stops after some (demonstration) projects or will smart metering become common technology for utilities within the next decade?

There is no doubt about the potential benefits of smart metering. Smart meters appear to be the biggest innovative development of the last year, and indispensable for all market parties:

- for metering companies to decrease meter reading costs;
- for grid operators who want to prepare their grid to the future;
- for energy suppliers who want to introduce new, customer made services and reduce call centre cost;
- for governments to reach energy saving & efficiency targets and to improve free market processes;
- for end users to increase energy awareness and decrease energy use and energy cost.

Introduction of smart metering seems also a logical step in a world where all communication is digitalized and standardized (Internet, E-mail, SMS, chat boxes etc.) and where cost of 'digital intelligence' are still rapidly decreasing.

Moreover, an advanced metering infrastructure offers more than just reading and controlling smart meters. It can be seen as a dedicated gateway to the customers home, offering additional energy related services. It can be used both for demand response (stimulate the customer to change his energy behaviour) and demand side management (direct control of household appliances such as the washing machine or the air conditioner). In relation to local generation of electricity (micro-CHP), it offers the possibility to realise a virtual power plant.

However, two important issues hamper the general introduction of smart metering. Firstly, there are many parties involved, and the benefits of smart metering may accrue to other parties than the ones that bear the costs. Secondly, there is still much uncertainty about the quantification of the benefits as practical experience and historical data are lacking. Therefore, investments in smart metering means taking risks. In a liberalized market, these risks are weighted carefully. In a regulated market there are often no incentives to take risks. This sometimes leads to an impasse in the energy market.

Currently, the way to break through this impasse is by setting (inter)national standards and adopting appropriate national and/or international rules and legislation based on a firm energy policy. For Sweden, the Netherlands and California, this is the main driver.

Italy is an exemption, but the decision for introducing smart metering there was made by a monopolist before liberalization of the market.

So it looks like future of smart metering will depend heavily on the energy policy and decisiveness of the governmental bodies involved. Energy savings and an increased security of supply will be main drivers and believe in smart metering as a means to reach these goals is indispensable.

# References

[1] Gerwen, R.J.F., Jaarsma, S. and Koenis, F., Domme meters worden slim? Kostenbatenanalyse slimme meetinfrastructuur, Arnhem, 30 augustus 2005

[2] "Evaluating The Leading-Edge Italian Telegestore Project", presentation by Fabio Borghese, ENEL, Business Development Executive, Infrastructure and Networks Division

[3] Domestic Metering Innovation, Consultation Document, Ofgem (UK), February 1, 2006.

[4] Maandelijks uitlezen van elektriciteitsmeters, Eindverslag van regeringsopdracht 27-05-2002, Statens Energimyndighet (Sweden)

[5] Gerwen, R.J.F., Jaarsma, S. and Koenis, F., Cost Benefit Analysis for Smart Metering, Metering International, issue 4, 2005

[6] Information on smart metering project on Continuon website: http://www.continuon.nl, visited June 8, 2006.

[7] Information on website Oxxio: http://www.oxxio.nl visited June 8, 2006 and brochure C 06-05-02 "Het slimme meetsysteem van Oxxio" on this website.