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Overview and the possibilities of Smart Metering deployment in Hungary, in light of a survey

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ABSTRACT OF THESIS submitted by:
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The continuously increasing demand for electricity puts a serious strain on the environment, increases the price, and heavily stresses the power grid. Growing recognition of these issues has led to the need for electricity grid modernization, new approaches in electricity generation and consumption. The smart grid platform is now being widely acknowledged as a tool to help handling these issues and smart metering is believed to be the first step towards smart grids. According to the EU-legislation, member states have to implement intelligent metering systems in electricity consumption by 2020-2022. Practically, it means that old, Ferraris-type meters will be replaced by smart, digital ones, enabling de facto real-time, two-ways communication with consumers.

Despite the obvious benefits of smart metering, consumer acceptance of the devices and the system is not yet fully researched. It is especially true for Hungary, where there has been no comprehensive or officially published study conducted up to date covering this field: consumer acceptance of smart meters has been unknown so far. In current thesis I focus on the introduction of smart electricity meters in Hungary. By means of a qualitative and a quantitative research I attempt to map the main factors and key challenges for how Hungarian consumers would accept smart meters that are absolutely non-existent in the Hungarian market at present. The results of the two researches are reviewed in this paper. Although SM principles are applicable in various utilities like heat, water and gas supply, current thesis will only focus on electricity metering.

Keywords: smart metering, Hungary, consumer acceptance

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List of Abbreviations

AMR - Automatic Meter Reading
ANEC - European Association for the Co-ordination of Consumer Representation in Standardization
BEUC - European Consumers' Organization
CBA - Cost-Benefit Analysis
CECED - European Committee of Domestic Equipment Manufacturers
CEN - European Committee for Standardization
CENELEC - European Committee for Electrotechnical Standardization
CHP - Combined Heat and Power
CIP - Competitiveness and Innovation Framework Program
CPP - Critical Peak Pricing
DCC - Data and Communications Company
DECC - Department of Energy and Climate Change
DG - Distributed Generation
DSL - Digital Subscriber Line
DSO - Distribution System Operator
EC - European Commission
EEGI - European Electricity Grids Initiative
ELMŰ - Elektromos Művek
ERGEG - European Regulators' Group for Electricity and Gas
ERO - Energy Regulatory Office
ESO - Energy Service Operators
ETSI - European Telecommunications Standards Institute
EU - European Union
FP7 - Seventh Framework Program
GGP - Guidelines of Good Practice
GPRS - General Packet Radio Service
HAN - Home Area Network
HEO - Hungarian Energy Office (Magyar Energia Hivatal, MEH)
HUPX - Hungarian Power Exchange
ICT - Information and Communication Technologies
IEA - International Energy Agency
HCSO - Hungarian Central Statistical Office (Központi Statisztikai Hivatal, KSH)
LV - Low Voltage
HEO - Hungarian Energy Office (Magyar Energiahivatal, MEH)
MUC - Multi-Utility Communications
MVM - Hungarian Electricity Works
NAF - New America Foundation
NER - New Entrants Reserve
NACP- National Association for Consumer Protection (Országos Fogyasztóvédelmi Egyesület, OFE)
Ofgem - Office of the Gas and Electricity Markets
PEV - Plug-in electric vehicle
PLC - Power Line Communication
PPS - Purchasing Power Standards
PTR - peak time rebate
PV - Photovoltaic
RTP - Real-Time Pricing

SET - Strategic Energy Technology
SG - Smart Grid
SM - Smart Metering
SME - Small and Medium Enterprise
TOU - Time of Use (tariff)
TSO - Transmission System Operator
WAN - Wide Area Network

Introduction

Demand-side participation is regarded as a key term to improve the overall efficiency of energy markets. Climate change, security of supply, fossil fuel-dependency and fuel shortage are the main trigger factors to promote demand-side programs including “energy usage feedback and information, dynamic pricing, capacity and availability pricing, smart home, in-home and in-building automation, electric vehicle charging management.” (SEDC 2011)

“The use of smart grids and smart meters will bring about a fundamental change in the relationship between customers and energy providers. (...) Smart grids and smart meters will also create enormous economic benefits by empowering consumers to control their energy bills, improving how electricity markets operate, and deferring or reducing investments in costly peaking generation. Smart grids and smart meters will enable customers to deliver and benefit from lower electricity costs.” (Heffner 2011)

There is a need (EU’s 20/20/20 goals[1] to integrate various renewable energy resources to generate electricity in a low-carbon way: currently more than 50% of Europe’s and 70% of the US’s electricity is generated by fossil fuel power plants. Electric power production gives about 40% of European CO^2 emissions. (Eskeland and Mideksa 2009) Smart Metering -using advanced metering and communications technology and being a gateway to Smart Grids- is seen as a tool to enhance demand-side participation: by applying it end-user may become actively involved in the electricity market by, e.g. reacting on changing electricity prices, creating a virtual power plant and responding to information delivered on consumption patterns.

According to calculations, the electricity sector in the EU produces a per annum turnover of over EUR 112 bn - that gives out about 1.5% of the EU GDP (CEER 2009). Total annual investment in the sector amounts approximately EUR 22 bn. As it is stated in the IEA World Energy Outlook 2007, “the electricity investment in Europe will exceed USD 1700 bn over the next twenty-five years, roughly equally split between generation and grids -about 25% for transmission and 75% for distribution. A large portion of the European electricity grids were built 40 and more years ago.

[1] In 2007 EC adopted climate goals aiming to reduce greenhouse gas emissions by 20%, to increase the share of renewable energy in the energy-mix to 20% and to make a 20% improvement in energy efficiency.

Renewal is necessary and it is happening continuously as a part of the grid operators' duties." (IEA 2007) However, without implementing smart solutions, grid restorement would only maintain the current system structure based on aged technology and without gains in efficiency. Non- implementation of smart solutions is expected to lead to inefficient investments and fail to reach the EU energy and climate targets. By promoting smart metering –and, by that, give a push to future smart grids and distributed generation- governments can shift the costs of building new power plants to smaller communities and consumers, while recognizing that neural network-like, decentralized grids are more resilient and able to self-healing. As it is shown in Figure 1., a fully implemented smart grid is more neural-like as compared to today's hierarchical power system. The shift from a one-to-many to a many-to-many approach requires also a shift in paradigm.

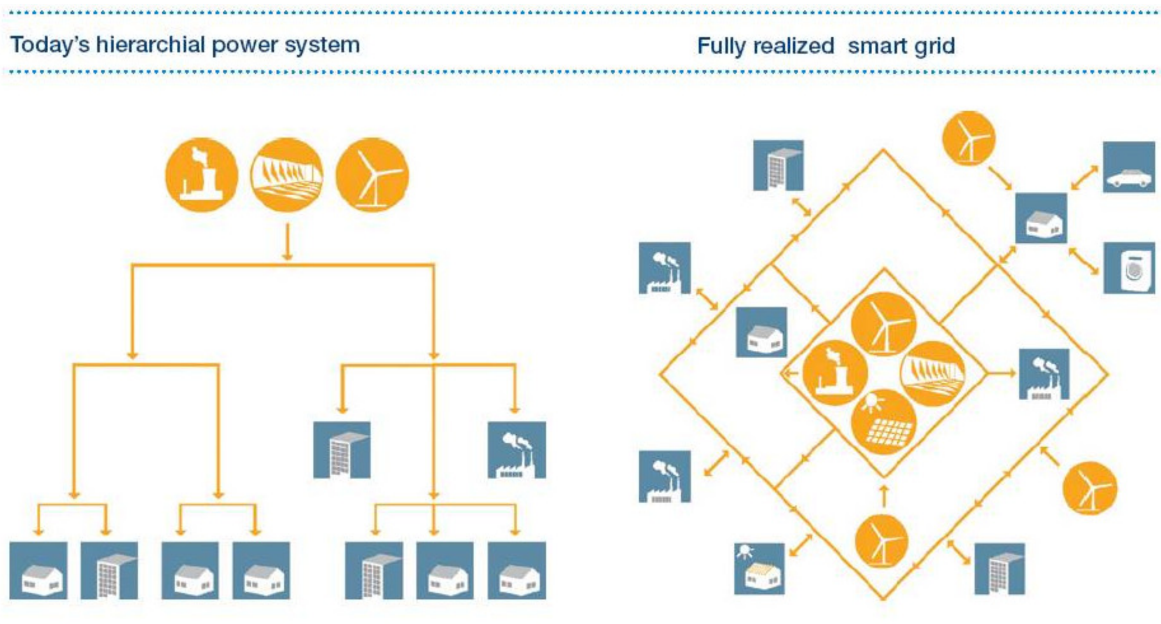

Fig. 1: stuctural difference between current and future grids. While today's hierarchical power system appears as an organizational chart, a smart grid is neural system-like with different actors connecting to each other, ensuring bi-directional flow of power and information. (source: http://www.neuralenergy.info)

In order to accomplish this paradigm shift, strong involvement is needed from all market players including generators, distributors and consumers.

This paper first gives an overview of the smart metering concept and the future potential of smart grid systems. Focusing on Europe, I will elaborate on the EU's legal framework of smart meters, then I shed light on the main uncertanities of introducing them. I will briefly refer to roll-out examples from Europe, then illustrate specialities of the Hungarian electricity market. In the next section framework of the reseach methodology are laid down, then research findings are presented.

Literature review

Description of Smart Metering

Due to the lack of standardization -there is no standard yet for e.g. data transmission protocols to be used in smart meters-, there is no commonly agreed definition of smart metering (SM), nor what functions it should actually include.
As for the European approach, SM is defined as "a metering device along with supporting systems and infrastructure for transfer and management of metered data, which register timely consumption, periodically or on request, in more details that a conventional one and transfers metered data to the Distribution System Operator or other market actor for monitoring and billing purposes." (Morch *et al.* 2007)

Fig. 2.: traditional (left) and smart (right) meters

The process of smart metering involves i) the installation of an intelligent meter at residential homes or sites of end-consumption and ii) regular reading, processing and feed back mechanisms and protocols of consumption data to the customer. Hence a smart meter is expected to provide the following functions:

- *time-stamping*: real-time (or close to real-time) registration of electricity used and generated (locally by means of PV cells or microturbines);
- *remote reading:* enables meter reading both on the metering spot and from a remote location;

- *limiting:* consumption limits can be set both locally and remotely, utilities can remotely dis/reconnect service;
- *interconnection:* meters connect to local networks and devices at the metering spot (e.g. devices can measure electricity generated by local PV-cells);
- *multi-utility metering:* the same device and data transfer protocol is also to be used to meter other utilities (e.g. gas, water) (Gerwen *et al.* 2006)

SM involves a whole process, from metering, data transmission, data processing (aggregation, validation etc.) to feedback distribution and archiving records. There is a strong rationale for smart grid technology: today's electricity systems face several challenges, including

i) ageing infrastructure and need for new capacities, as it was mentioned: according to the estimates, 45,000 km of new or upgraded lines will be needed throughout the EU in the next 10 years (Jones 2011) that has to fulfill

ii) a continously increasing demand: electricity's share within the energy market as total is expected to increase from 24% in 1970 to 40% in 2020 in OECD countries (EC 2003). According to the research firm Greenbang the number of Smart Meters will fold out between 133 million and 145 million in the EU by 2020. It is a market of USD 25 bn (Greenbang 2010). Worldwide deployment of smart meter devices (only for electricity) are expected to be about 302 million by 2015.

Benefits of smart meters

According to results derieved from already rolled-out projects and a priori estimations, smart grids offer several advantages to end users, grid operators, electricity suppliers, metering companies and governments.

- Since SM provides two-ways communication and real-time (or quasi real-time) information about actual consumption, both end users and utilities have better control of energy use by following/adjusting consumption patterns.

  i) End users are able to monitor accurate consumption in time, thus identify and filter out abnormal consumption patterns due to e.g. poor house insulation. According to the European Commission, “the trends show that through smart meters European households could save 10 % of their consumption, i.e. around 60 € per year on average.” (EC COM(2011) 202) The energy savings of households can be even higher if it is combined with innovative ICT solutions to gain consumers' participation. "In the UK, the AlertMe project allows customers to turn off appliances by web interface or mobile; in 8 months, residents have saved roughly 40% electricity." (EC COM(2011) 202)

ii) Through receiving frequently timestamped consumption data, grid operators are able to plan supply more accurately in advance. Due to more accurate planning, surplus (and often oversized) plant capacities can be reduced: it helps to decrease costs and CO^2 emissions.

iii) Utility companies can remotely control electricity supply in households: the system enables electricity supply to be cut off in households for short periods in a controlled way, thus reducing e.g. standby consumption, accounting for over 10% of the electricity used in European households and offices[2] (EC COM(2008)). SM devices also enable pre-paid power services.

- By enabling net metering function consumers receive incentives to deploy virtual pover plants (e.g. micro-scale PV-systems) that can be integrated into the grid system, lowering total carbon emissions and improving energy efficiency.
- SM helps decreasing peak load that greatly increases the overall cost of the sector. "This burden of payment is directly shouldered by end users and consumers, (residential, commercial and industrial), through increased network and electricity tariffs, unnecessarily raising their costs and lowering buying power. Besides this, generation of peak load is usually supplied through CO^2 emission intensive thermal plants." (SEDC 2011) By giving consumers feedback and price incentives (e.g. by persuading them to switch on washing machines at night, when demand is low and prices are down), peak periods can be smoothed out. Reducing energy consumption in peak times leads to more reliable supply, increases energy savings and helps governments reach their energy policy and climate goals. (Gerwen *et al.* 2006) As IEA highlights: "around the world, pilot projects in smart metering show that time-differentiated pricing reduces peak demand by an average of 15%. With

[2] The background study estimated that 3.7 billion products consumed 47 TWh in stand-by mode troughout the EU-25 in 2005. This volume corresponds to EUR 6.4 billion in value and 19 Mt of CO2 emissions.

additional technology in the customer's home or business, these effects can double." (Heffner 2011)

- SM helps in capacity-engineering to design transmission and distribution grids in the proper size: "through co-ordinated grid planning and development of common European, regional and local networks it is possible to implement optimal-sized transmission infrastructure. The data provided by Advanced Metering Systems can improve the utilisation of grid and generation assets. Currently, the DSO has only rudimentary information at best on electricity flows in their grid. The deployment of Smart Metering would allow the DSO to accurately pinpoint outages, reduce non-technical losses and thus optimise the functioning of the distribution grid." (ESMIG 2011)
- By SM actual consumption data are transmitted; therefore network losses, theft and faulty meter readings are much easier to detect. A study reveals that losses derived from those can be reduced 70% through applying SM devices. SM also helps to identify network loss hotspots - in Hungary, network losses for gas and electricity give out as much as 10% of the total amount distributed. (A.T. Kearney and Force Motrice 2010)
- Since SM constantly provides accurate metered data available for customers, it becomes easier, faster and cheaper to switch between suppliers. It improves market competition and efficiency.
- Through automated and distant meter readings offered by SM electricity suppliers may reduce labour costs (meter-reading, call centres, billing, collecting and dis/reconnencting arrears), while costumers receive clear and more accurate bills.
- A standardized SM system would reduces technical barriers between national electricity markets, making it possible to establish a pan-European/international electricity market and grid. According to Greenpeace "this will allow surplus wind energy from the North Sea to be stored in Norwegian Hydro systems, or solar energy from Spain to be delivered to Germany. The proposal for a European grid would cost around EUR 209 billion or EUR 5.225 billion per year till 2050." (Greenpeace 2008)
- With increasing number of consumers owning plug in electric vehicles (PEVs), the need for off-peak, flexible pricing is expected to grow. Through the flexibility offered by smart meters, charging management is achievable.

Costs of smart meters

Cost and benefits of smart meters differ from country to country, depending on geographical, social, economic , etc. conditions; therefore cost–benefit calculations also show great differences. In some countries (e.g. in Poland) power black-outs had caused severe economic problems, creating a strong need for peak reduction and load control. Elsewhere (e.g. in Italy) non-payment, fraud and electricity theft caused major threat to utilities and triggered SM-deployment. Implementation of smart meters require serious investments that can be a significant burden on both the economy and the individual consumers as well. However, if benefits prove to outweigh costs, the return on the investment makes it feasible. According to vast majority of studies (e.g. ESMIG 2009), smart meters do provide benefits on a macro- and microeconomic level. The key issue is that how to distribute benefits along the value chain.

Smart meters do not automatically bring lower electricity bills to consumers. For example, a NAF-Open Technology Initiative position paper (NAF 2010) reports about cases, in which consumers got overcharged due to the utility's poor system planning and wrongly developed cost-benefit analysis. In addition, although dynamic (or time of use) pricing methods offer financial benefits to end-users, it may result in even higher electricity bills in case the consumers do not change their consumption habits. In addition, certain social and age groups are less likely to shift their electricity use and switch to more efficient appliances - typically within the low income layers of the society. Therefore NAF recommends:

i) increased consumer education and involvement

Given the fact that consumer acceptance and participation is crucial for the success of smart metering, smart grids, distributed generation and home automation, it is critical to make consumers understand the mechanism, costs and benefits of SM systems.

NAF suggests that utilities should operate in strong co-operation with local authorities, community organizations etc. to gain insight on consumer needs and demographics. Consumer trust should also be developed through transparency, communication and accountability from the utility’s side.

ii) dynamic tariff design and demand response

The NAF position paper suggests that dynamic (e.g. time of use - TOU) tariffs should be implemented on a voluntary basis. End users must be offered various rate options to be able to shift their energy use. Utilities also have to facilitate consumers with easy access to real-time consumption data and other tools helping them monitoring and supervizing their energy use.

iii) protection programs for e.g. low income consumers

For households of low income, elderly people or consumers with chronic health problems TOU tariffing may cause extra expenses. According to NAF, such consumer groups need special care and protection at pricing.

European Consumers' Organisation (BEUC) also warns thet new metering functions (e.g. TOU tariffs) may pose risks to certain consumers, especially the vulnerable ones. As the organization highlights in a position paper (ANEC and BEUC 2010), there are some issues to consider:

- unfair pricing may occur due to oligopolic market position of power companies. Lack of transparency also may lead to distorted pricing.
- Remote switching or controlling done by utilities or grid operators might be abusive for customers;
- radio-frequency system elements may interfere with other home networks causing inconvenience;
- constrained rights to switch supplier, due to e.g. contract enclosures, poor competition.

Technology

Smart metering infrastructure requires i) metering device, ii) communication and data processing devices and iii) in-house display for energy use (optional).

In order to ensure two-ways communication, meters have to be capable of both submitting metered data and, at the same time, receiving and processing data coming from the operator (e.g. commands for remote (dis-)connection, changes in tariffs, etc.). Practically, it is advised to implement Multi-Utility Communications (MUC) environments (or MUC-compatible environments) to bundle metering functions for other utilities (electricity, gas, heating, water) as well, thus to avoid cost redundancies. (A.T. Kearney and Force Motrice 2010)

There are several possibilities for communication infrastructure between consumer and supplier, depending on geographical distance, cost factors, market specialities, financing opportunities, population density, etc.

- Data might be transmitted from/to customers directly via their home area network (HAN), using wireless or wired protocols (e.g. power line communication, PLC),
- or optionally, in an indirect way through a data centre, transmitting data via e.g. web portals, text messages or by the invoice. (Balmert and Petrov 2010)

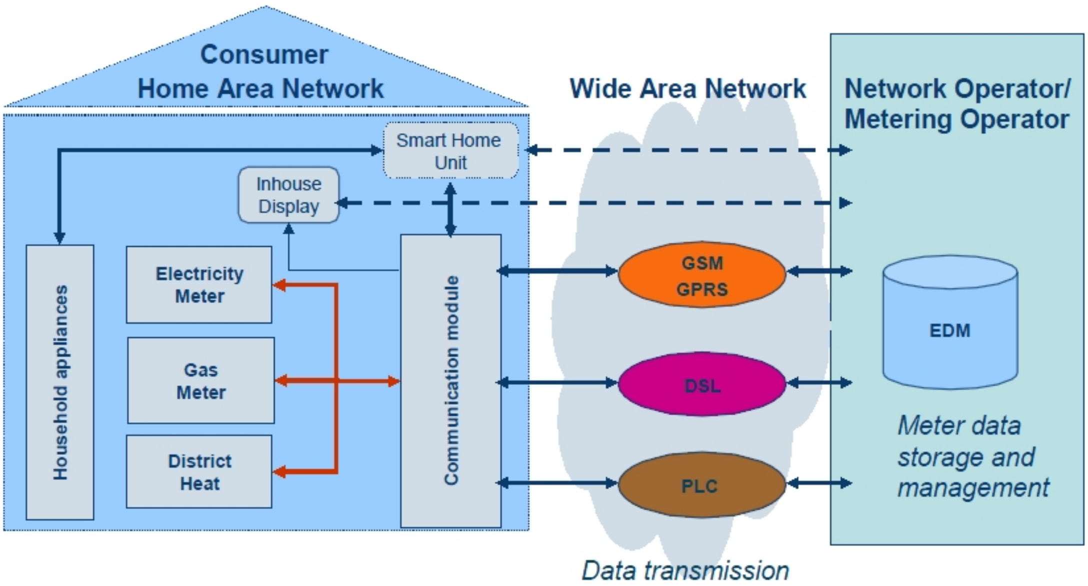

Fig. 3.: Communications infrastructure of smart metering (Balmert and Petrov 2010)

Smart meters generate data time series through regularly timestamping consumption (most often in 15 minutes but the interval can be set to one month as well). Time series are the basics of further analytical purposes: billing, deriving consumption data, giving feedback to consumers, etc. The more frequent the intervals are and the more metering points the system has, the bigger the time series data would be. Excess amount of data can cause problems in data storage management and query performance. (Brown 2011)

For data transmission from customers to data management system/network operator/supplier through the wide area network (WAN) "three technologies are generally used: (1) power line communication (PLC), (2) GSM/GPRS based mobile phone technology or (3) broadband internet connections (DSL)", (Balmert and

Petrov 2010) as it is indicated in fig. 3. Most often a combination of two or more technologies is applicable.

In-home displays

In-home displays are advanced ICTs conveying information to end-users based on continously measured consumption data. Visualization of metered consumption can be achieved through in-home interfaces. These displays are not necessarily considered as parts of the smart metering infrastructure. The display can be either a dedicated one, or a web-based service portal that is to be reached from a computer or a smartphone. In case of direct connection, the device use the consumer's HAN channels, or, in case the data flow is indirect, WAN communications.
In-home displays provide functions such as:

- show how consumers are preforming against the daily electricity budget,
- indicate how much electricity costs in a certain period of time,
- indicate the current cost of electricity per hour,
- indicate different rates.

Fig. 4. shows an example for an in-home display from the UK.

Fig. 4.: an in-home display, Exeter, UK.

Exeter City Council provides loan service for local citizens to borrow displays for a period of up to 3 weeks, in exchange for a £10 deposit. According to the City Council, "the devices help the householder to monitor and identify ways of reducing their electricity consumption, with savings of up to 30% possible." (Exeter City Council [2011])

Web-based monitoring tools are also in use in countries where smart metering solutions are already implemented. Google PowerMeter (fig. 5.), for example, is a free of charge monitoring tool that enables consumers to view the house's energy use online. It functions as an instrument for i) tracking electricity consumption in time, ii) indicating how much energy is being constantly used by e.g. stand-by appliances, iii) assessing electricity costs for a period of time, iv) monitoring pre-set electricity saving goals, v) enabling customers to compare data with other members of the community.

UK's AlertMe is another successful tool aiming to help in-home energy savings: it provides customers with easy to clip-on devices so that they are able to monitor energy consumption of not only the house as a total but specific electronic devices as well, real-time. Thus consumers are enabled to save money on electricity bills. According to the company, this service allowed customers to save roughly 40% of the electricity in 8 months in the UK. (AlertMe [2011])

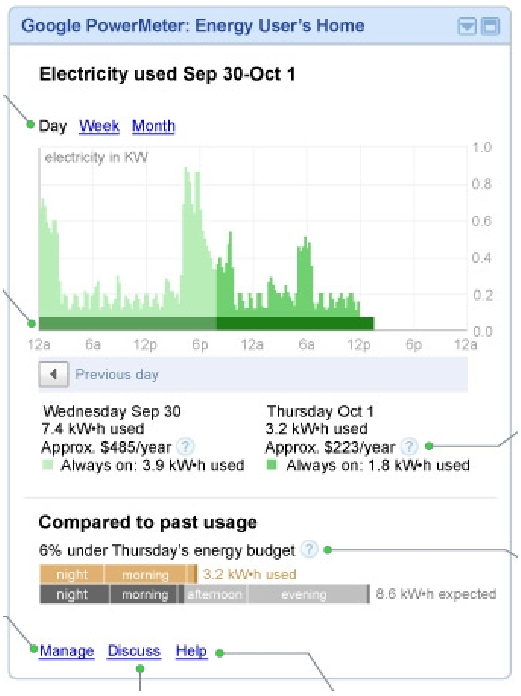

Fig. 5.: Google PowerMeter, an online monitoring tool
(Google PowerMeter [2011])

Smart metering and smart grids

Smart metering is regarded as an inherent part of smart grids (SGs), forming a gateway to a more sophisticated and smarter grid system. Smart grids are advanced, upgraded electricity networks that "can intelligently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies." (EC 2005) As a whole, SGs are electricity networks that use advanced (digital) technology tools in order to monitor and manage electricity transport and distribution form the point of generation to the end-users, considering the varying electricity demands of costumers. Both demand needs and capabilities of all electricity market actors (power plants, utilities, regulators, distributors, costumers etc.) are co-ordinated in order to achieve maximum efficiency, while keeping costs and environmental impacts at the lowest possible level. SGs also improve system reliability by e.g. decreasing the number of blackouts, increase system resilience and stability. IEA claims that in order to improve stability in energy supply, „generation must be controlled by the demand for electricity" (IEA 2002)

By promoting smart metering, the EU has a long-term goal to deploy smart grids (and a cross-boundary super grid). However, it is not certain yet on what timescale it is feasible since "comprehensive adoption has been slowed by several factors: the lack of clear technology standards for smart meters and home-area network communications, uncertainity about the level of regulatory support for necessary investments and disappointing demand for smart grid-enabled services by consumers, who do not perceive a strong value proposition for bringing this technology into their homes. The evolution of the smart grid landscape in the EU will depend on how national regulators and governments decide to support investments and how these decisions influence the investment behaviour of leading European utilities." (Giglioli *et al.* 2010)

Giglioli *et al.* at McKinsey report that despite uncertainties about standards and support, smart meters' penetration have already passed 50% in some markets. „The development of smart grids is essential if the global community is to achieve shared goals for energy security, economic development and climate change mitigation. Smart grids enable increased demand response and energy efficiency, integration of variable renewable energy resources and electric vehicle recharging services, while reducing peak demand and stabilizing the electricity system." (IEA 2011)

Distributed power generation, net metering

Conventional power systems are facing the problems of weak energy efficiency, increasing demand for a highly reliable power supply, pollution and GHG-emission and depletion of fossil fuel resources. In addition, hierarchical grid structure has the increasing problem of licensing new high-voltage transmission lines. (IEA 2002) As a response to all that, experts have recognized the importance of generating power locally at low, distribution voltage by applying non-conventional and/or renewable energy sources, such as wind and solar energy, microturbines, etc. This type of local power generation is termed as distributed generation (DG). DG systems are expected to meet the following criteria:

„(1) It is not centrally planned by the power utility, nor centrally dispatched.

(2) It is normally smaller than 50 MW.

(3) The power sources or distributed generators are usually connected to the distribution system, which are typically of voltages 230/415 V up to 145 kV." (Chowdhury *et al.* 2009)

DG units facilitate bidirectional power flows (i.e. electrical power is fed back to the grid by end-users), thus have to include flexible and intelligent control tools per se such as smart meters and smart grids.

DG systems offer several advantages over conventional power generation and transportation:

- DG offers a diversity in fuels, facilitating the application of renewable energy sources.
- On-site production avoids transmission and distribution losses since the site of consumption is geographically located close to where the power is generated.
- Low voltage generation makes it possible to feed back surplus electricity to the grid. (Chowdhury *et al.* 2009)

Although there are also disadvantages of DG systems (e.g. larger plants generally operate on higher fuel economy and have lower unit capital cost per kilowatt than a small plants), DG -as an inherent part of smart grids- is promoted by the EU. (L'Abbate *et al*. 2007)

"The greatest potential market for DG is displacing power supplied through the grid.

On-site production minimises transmission and distribution losses as well as transmission and distribution costs, a significant part (above 30%) of the total electricity cost." (EC 2003)

Distributed generation is often termed as active network, microgrid or virtual power plant . Since SM devices are able to record electricity flow back and forth between the generator and the power grid, "they provide an easy way to record the net excess electricity consumed or produced by participating customers during a given billing cycle." (Dworkin 2006)

Net metering usually functions as a strong financial incentive for households, smaller communities and businesses to invest in renewable power generation installments.

An example for net metering system is applied in Italy, where financial compensation is provided to e.g. PV-system owners "for any difference between the value of the electricity injected to the grid and the value of the electricity withdrawn" (Italian Regulatory Authority for Electricity and Gas 2010)

EU legal framework

Up to now the EU has developed three energy packages[3] in order to reach the goals of i) creating a single EU energy market, ii) increase competition, iii) in line with the 20/20/20 agenda improve efficiency and iv) ensure security of supply. (Brázai 2009) These legislative pieces aimed to open up the EU's electricity and gas markets to competition. According to the Commission's standpoint both the energy efficiency and the competitiveness of the European economy were to be improved through market liberalisation.

The Directives of the Third Package including Directives 2009/72/EC for electricity and 2009/73/EC for gas contain provisions about smart metering. The aim of promoting smart metering through the Third Package is to inform customers better of their consumption and support awareness of energy consumption. According to the Package, economic assessments are to be carried out considering long-term costs and benefits of market actors (including consumers) to decide on which type of smart metering is economically rational and cost-effective and what timeframe is possible

[3] The First Package included Directives 96/92/EC and 98/30/EC about the common rules for the internal market in electricity and gas, respectively. The Second Package, including Directives 2003/54/EC for electricity and 2003/55/EC for gas took a further step towards liberalized markets. These Directives included "unbundling" of the Member States' energy markets, meaning that "energy transmission networks have to be run independently from the production and supply side."

for the roll-out. The idea is that consumers must gain access to their consumption data.

The Third Package states that national regulatory authorities must guarantee access to these data. Authorities must also ensure the design of a harmonized format for metered data as well as a process for utilities and consumers to gain access to these data countrywide.

Directive 2009/72/EC (Annex 1) states that: "[Member States shall ensure that customers] are properly informed of actual electricity consumption and costs frequently enough to enable them to regulate their electricity consumption (...)",

"Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the electricity supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution. Such assessment shall take place by 3 September 2012 (...). Subject to that assessment, Member States or any competent authority they designate shall prepare a timetable with a target of up to 10 years for the implementation of intelligent metering systems. Where roll-out of smart meters is assessed positively, at least 80 % of consumers shall be equipped with intelligent metering systems by 2020." (2009/72/EC)

The Interpretative Note on Directive 2009/72/EC further explains that:

“It is understood that in the case no economic assessment of the long-term costs and benefits is made, at least 80% of all consumers have to be equipped with intelligent metering systems by 2020.” (Interpretative note on Directive 2009/72/EC)

2009/72/EC also states that “Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the electricity supply market” as well as “a key feature of a smart meter is the ability to provide bi-directional communication between the consumer and supplier/operator. It should also promote services that facilitate energy efficiency within the home.” (2009/72/EC) In case of gas supply, there is no time horizon defined for the implementation of smart meters. Directive 2009/73/EC (Annex 1) states that:

"[Member States shall ensure that customers] are properly informed of actual gas consumption and costs frequently enough to enable them to regulate their own gas consumption. Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the gas supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution. Such assessment shall take place by 3 September 2012. Subject to that assessment, Member States or any competent authority they designate, shall prepare a timetable for the implementation of intelligent metering systems." (2009/73/EC)

Thus, SM in the gas supply will be installed in a more distant future (due to e.g. remote service switch-on/off is much more complicated than in case of electricity for safety reasons) and smart metering will be first applied to electricity supply. (Vajdovich pers.comm.)

According to researches, EU's energy consumption is about 20% more than could be economically reasoned. (CECED 2008) Therefore there is a huge potential for energy savings that can be realized mainly by end-use efficiency measures. Directive 2006/32/EC on energy end-use efficiency and energy services is regarded as the first legislative document prescribing deployment of smart metering: “final customers are provided with competitively priced individual meters that accurately reflect the final customer’s actual energy consumption and that provide information on actual time of use” (2006/32/EC). This Directive also requires suppliers to provide costumers with actual consumption data, apply consumption-based billing so that it should be “performed frequently enough to enable customers to regulate their own energy consumption”. This Directive prescibes consumption-based billing as long as it is financially well-grounded and technically feasible.

Directives 2004/22/EC on Measuring Instruments, Directive 2005/89/EC on Security of Supply and Directive 2004/22/EC on Measuring Instruments also promote advanced, intelligent metering methods.

After the Third Package the leading bodies of the EU have accepted Directive 2010/31/EU in 2010 on the energy performance of buildings, which requires intelligent metering systems in new and fully renovated buildings. (2010/31/EC)

In line with the EU’s 2020 strategy, in the European Commission Communication COM (2010) 639 Energy 2020, "A strategy for competitive, sustainable and secure energy" it is stated that "Smart meters and power grids are the keys to full exploitation of the potential for renewable energy and energy savings as well as improvements in energy services. A clear policy and common standards on smart metering and smart grids are needed well before 2020 to ensure interoperability across the network, providing cities, urban and rural areas with ways of making greater energy savings.” (EC COM(2010) 639)

The strategy highlighted in this Communication gives a frame to the European Commission’s energy strategy till 2020. The strategy consists of pillars such as : i) limiting Europe's energy use; ii) taking steps to build an integrated energy market throughout Europe, iii) increase European leadership in energy-related innovation, iv) enabling consumers to receive a secure service.

EU initiatives and funds for smart meter deployment

The most important EU-organ in SM-deployment is the European Commission (EC), supported by the Task Force on Smart Grids set up in 2009. The mission of the Task Force is to help with and support the process of smart grid roll-out all over Europe. The Task Force provides a joint regulatory, commercial and technological approach for carrying out the deployment of smart grids and detect regulatory issues to be settled in line with the stipulations of the Third Energy Package.

The Task Force collects methods and recent developments of technology worked out by other stakeholder groups, such as the Smart Grids Forum, the European Electricity Grids Initiative (EEGI) or the Smart Grids European Technology Platform. The Task Force -initially was planned to operate till May 2011- involves three Expert Groups pooling all stakeholders from this area, from regulators to consumer organizations, including ANEC, BEUC, CECED, ERGEG, etc. (EC 2010)

Besides the Task Force there are several ongoing EU- co-ordinated smart metering initiatives going on. In February 2011 ERGEG issued its Guidelines of Good Practice (GGP) on Regulatory Aspects of Smart Metering for Electricity and Gas. This set of suggestions provides guidance for interpreting the Third Energy Package stipulations when installing smart metering systems. The GPP manly focus on start-up plans, customer services issues, economic analysis and data security. The document also identifies both basic and optional services and capabilities that SM devices have to offer. However, there are no technical specifications in the document, as ERGEG claims that “implementing smart metering systems in a 'future proof' manner is difficult. Therefore, the GGP are not too technical but rather focused on the services that the customer will be able to benefit from.” (ERGEG 2011)

ERGEG also expects that “open standards and an interoperable architecture for smart meters will be delivered by the European Standardisation Organisations (ESOs) in due time in order to allow Member States to fulfil the provisions in the Third Package.”

Before passing the Third Energy Package, the Commission had trusted (in Commission Mandate M/441) the EU’s standardization bodies -CEN, CENELEC and ETSI- to develop a system architecture for utility meters (both in their hardware and software dimensions) that is open, enables interoperability and also includes communication protocols.

“The Mandate has the general objective to highlight or to harmonise European standards that will enable interoperability of utility meters (water, gas, electricity, heat), which can then improve the means by which customers’ awareness of actual consumption can be raised in order to allow timely adaptation to their demands.” (M/441)

Nevertheless, to date there has been no common standards created in Europe regarding either software or hardware requirements of smart meters. Recently, the EU's communication has been shifted more towards smart grids instead of focusing solely on SMs.

Now it looks that network owners and operators are expected to undertake most of the investments. Giving the fact that all network users benefit from smart grids, public sector investment are supposed to take place. (EC 2010) The Task Force suggests that public-private partnerships should play a key role in initiating the deployment of smart meters and smart grids. To ensure investments, regulators are expected to facilitate support throughout the value chain, depending on the CBA results. According to the Task Force, the transition is complex enough not to be looked at as a single leapfrog from the current networks to smart grids. Transition to smart meters/grids demands better harmonization and partnership among all market and regulatory players to hedge duplication of work and utilize synergies. IEA estimates that alltoghether EUR 1000 bn is going to be invested globally by 2030 to install power grids. It means EUR 45 bn/year as an average, with 50-50% spent on generation and transmission. (IEA 2011)

EU's Electricity Grid Initiative, as part of the Strategic Energy Technology (SET) Plan[4], has suggested an integrated TSO/DSO financial package to support R&D of pilot projects with a budget of EUR 1.9 bn (580 million for research, 1360 million for demonstration purposes) for the years 2010-2018. EU is also financing SM projects through the Structural Funds and the Competitiveness and Innovation Framework Programme (CIP).

EU's seventh Framework Programme (FP7, 2007-2013) funds are the biggest sources for smart grid development projects in the EU (on a competitive basis), with a standard cost reimbursement rate of 50%. There are other financing opportunities as well, for example the New Entrants Reserve (NER) that supports smart grid development in large-scale energy productions' pre-commercial demo projects, with focus on knowledge sharing in the amount of EUR 300 million. Smart grid development is also one of top priorities in the Intelligent Energy Europe II initiative. IEE supports building and spreading of know-how on a smaller scale (of a budget usually between EUR 0.5 – 2.5 million), exchanging experiences, development of market policies, although it does not fund hardware investments, demonstration projects or technical research. Between 2005 and 2010 IEE supported projects with a total budget of almost EUR 600 m. (Przybylik and Jedziniak 2011)

Total investments needed are subject to Member States' individual capabilities, market structures and CBAs. For example, implementation of SM in Poland requires about EUR 1.5 billion to invest at DSO level. Przybylik and Jedziniak calculate that the customer cost of Polish deployment should not exceed USD 138 per metering point, including meters, substations, project expenses, Wide Area Networks (WANs), etc. The key question here -just like in other countries- is that how to distribute the profit to be gained from smart metering. Przybylik and Jedziniak at AT Kearney point out that customers realize vast majority (about 90%) of SM's financial benefits through decrease in energy price, possibility to apply distributed generation and reduction in distribution rates on a longer term. According to their estimations, consumers receive USD 952 million in benefits between 2010-2030. Companies strive to promote that costs should be allocated in the same way as the benefits - it means that Polish households will be expected to should disburse 90% of the deployment costs.

[4] The SET Plan is a strategic scheme of the EC, offering financial means to speed up the expansion and implementation of cost-effective, low carbon technologies.

Value chain

In the last ten years more than EUR 5.5 billion has been invested in all together 300 smart grid projects in Europe. Within that, about EUR 300 million was financed by the EU budget. Despite of that, smart grid deployment is still in a very preliminary phase. So far only about 10% of the European households have been equipped with smart metering devices, that “most do not necessarily provide the full scale of services to consumers. Nonetheless, those consumers with smart meters have reduced their energy consumption by as much as 10%. Some pilot projects suggest that actual energy savings can be even higher.” (EC COM(2011) 202)

Again, these investments are expected to generate significant financial benefits. Studies suggest through smart grids CO^2 emissions can be reduced by 15% globally and that “Smart Grids could reduce the annual primary energy consumption of the EU energy sector by almost 9% by 2020” (EC COM(2011) 202). Smart grids are also expected to create jobs[5] and the smart household appliances market is seen to show a growth from “USD 3.06 bn in 2011 to USD 15.12 bn in 2015 globally”, as it is hoped to contribute to the EU’s economic growth significantly.

Despite the various benefits smart solutions offer, the EC Communication indicates that investors have no optimal model for sharing costs and benefits properly in the value chain. “Neither is there clarity on how to integrate the complex Smart Grids systems, how to choose cost-effective technologies, which technical standards should apply to Smart Grids in the future, and whether consumers will embrace the new technology.” (EC COM(2011) 202)

The Commission paper reveals that there is now a huge gap between current and optimal investment in Europe. “Grid operators and suppliers are expected to carry the main investment burden. However, unless a fair cost sharing model is developed and the right balance is struck between short-term investment costs and long-term profits, the willingness of grid operators to undertake any substantial investment might be limited.” (EC COM(2011) 202) Additionally, there is no universal business case that could be applicable universally since SM solutions are to be tailored according local

[5] According to the Commission’s calculations the low-carbon energy industry has to date generated 1.4 million jobs in Europe.

conditions of e.g. demography, economy, topography, population and investment climate.

Pricing

Pricing is fundamental to all demand response schemes. The general goal is to increase the flexibility of electricity demand by offering end-users price signals that reflect costs more accurately, thus to smooth out peak demands. Haney *et al.* (Haney *et al .2009*) identify that demand response effects of SMs are subject to the tariffs suggested by electricity suppliers. Without smart meters utilities tend to apply either time-invariant rates (flat rates or declining/ inverted block rates that contain per-unit prices) or very limited number of time-bands (e.g. in Hungary consumers are offered only two tariff-bands, with day- and night-time prices). Smart metering constantly handles time as a variable so that utilities may offer more sophisticated tariffs to their customers. The three basic types of time-related rates are identified as:

- *Time-of-U*se (TOU) *rates* that apply diverse per-unit prices for usage at separate blocks of time. The definition of TOU phases varies from utility to utility, based on the periods their peak demands are scheduled over (day, week, etc.). The price scheme is a priori defined. Customers pay different tariffs at different times of the day: off-peak prices are lower than peak-time prices. In some case TOU rates include only two price categories (peak and off-peak), while in some cases more. TOU rates frequently obligatory for large business and industrial consumers.

- *Critical Peak Pricing* (CPP) means that very high per-unit prices (critical peak prices) are applied for certain hours on previously appointed days (frequently narrowed down to 10-15 occasions a year). This pricing is usually combined with a TOU rate.

- In case of *Real-Time Pricing* (RTP) rates fluctuates constantly over time, following the fluctuations of the wholesale prices. Most often, RTP rates offer separate prices for the hours of the day. Customers are being noticed about these prices in advance.

- *Peak Time Rebate* (PTR) tariffs offer credits for load reduction but do not react when the load grows. (Energy and Environmental Economics 2006)

The above pricing concepts have been known for a long time, however, in the past they were not frequently applied. As Ravens (Ravens 2010) points out, more sophisticated pricing methods also result in more complex ways of charging the customers: the system allows utilities to charge end-users according to different rates at different times of the day, by using several daily tariff bands. Since smart meters allow utilities to have better understanding on consumption habits, suppliers are able not only to suggest tariffs that differ in time but also different tariff categories to different user groups, based on their time-stamped and metered consumption patterns. Ravens underlines that further tariffs should be implemented as electric vehicles spread: there will be a need for roaming billing to permit vehicle recharging off the usual location of consumption. Besides, extra discounts should be offered to consumers who volunteer in demand response programs. Ravens argues that utilities should be able take control over particular electronic devices (washing machines etc.) to avoid environmentally hostile and expensive peak loads, switching them off remotely in peak periods. Electricity bills should also reflect these discounts.

Main uncertanities of introducing smart meters

There are several uncertanities about the introduction of smart metering, as they are identified as:

i) risk of regulations:

- unstable legislation: unfavourable changes in legislation,
- unfair return on investments: investors expect realistic return on their investments,
- unfair allocation of benefits: cost bearers expect also benefits of SM,
- lack of supporting measures, financial support

ii) risk of technologies:

- immaturity technologies: lock-in effect due to technological leapfrogs,
- lack of interoperability: investors expect that the devices provided by different vendors can communicate and co-operate,

- lack of standardization: well-defined and common standards are needed,

iii) customer acceptance:

- threat to customer privacy: customers may be distracted by the fact that utilities can monitor them, their lifestyle, habits and privacy,
- not obvious benefits for customers: due to lack of education benefits are not clear for consumers,
- low awareness of functional possibilities,
- health threats: wireless network items emit radio frequency-related electrosmog and it is feared to have negative health impacts. (Przybylik and Jedziniak 2011)

As various studies emphasise, firm customer acceptance plays a key role in the success of SM deployment: "the main driver for the successful uptake of smart meters is consumer confidence, satisfaction and engagement. It is essential to keep the consumer interest at the forefront." (ETP 2010)

Privacy and data protection

One of the most sensitive issues about consumer acceptance is privacy: according to consumer organizations it is feared that remote meter reading would make utilities able to intrude upon the consumers' homes and spy on their lifestyles, overstepping personal intimacy limits. Consumers often have the fear of information proliferation and profiling based on personal information (for the purpose of e.g. targeted marketing or fraud). (Štajnarová 2010)

The EU seeks to protect consumers' privacy on institutional levels by means of legislation. "Developing legal and regulatory regimes that respect consumer privacy in cooperation with the data protection authorities, in particular with the European Data Protection Supervisor, and facilitating consumer access to and control over their energy data processed by third parties is essential for the broad acceptance of Smart Grids by consumers. Any data exchange must also protect the sensitive business data of grid operators and other players, and enable companies to share Smart Grids data in a secure way." (EC COM(2011) 202)

In the EU processing of personal information is regulated by EC Directive 95/46/EC on the protection of personal data. The document focuses on processing principles rather than technology-related issues. Personal data is defined as “any information relating to an identified or identifiable natural person ('data subject'); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity.” (1995/46/EC)

It is particularly important to make a distinction between personal and non-personal data. According to the European Commission's Communication COM(2011) 202, in case the data are technical and cannot be related to any specific individuals (e.g. bulk metered data containing measured meter values of several households), then it can be processed by any actors of the value chain, including distribution system operators (DSOs), SM operators or utility companies without any prior approval from grid users.

The Communication points out that Member States' actions should be in compliance with EU and national data protection laws. To ensure that, Member States might need some modifications in their national legislation, regarding ownership, possession and access to data. The Commission's advisory body, the Smart Grids Task Force suggests the "privacy by design" approach to be applied at all SM deployments. This approach means that data protection measures are embedded into the system right from the start. As the Information and Privacy Commissioner of Ontario, Canada refers to it, the framework of this approach consists of the following principles:

1. proactive and preventative

Instead of being reactive and remedial, privacy risks are being anticipated, prevention is the key term.

2. Privacy as part of the default settings

Automated protection: consumers are not required to take special action to protect their privacy since protective features are set into IT-systems and business models and installed in a way that provides maximum level of safety by default

3. Privacy-embedded design

Privacy functions are embedded into the architecture and core functions of IT-systems, making them inherent part of the communications chain and the business models.

4.Positive-Sum instead of Zero-Sum

Privacy by Design approach avoids the choice between privacy vs. security but instead of that it seeks to create a win-win situation, enabling both.

5. Full lifecycle security

End-to-end protection, data are securely collected, retained and destroyed in a timely way. As a result, protection is delivered throughout the whole lifecycle of the data

6. Visibility, transparency

Business models or technologies applied should be subject to independent verification, operations are to be transparent throughout the entire process, both to users and providers.

7. User-centric measures

System architects and operators are required to keep the interests of the end-users in focus. Proper noticing, privacy-protecting defaults and user-friendly options should be applied. (Cavoukian 2011)

The EC Communication COM(2011) 202 emphasizes the utmost importance of ensuring security and resilience of the SM-infrastructure throughout Europe. To reach this goal, the Commission has launched a multi-stakeholder group (that is the Task Force) to discuss IT security, and resilience challenges on the highest decision-making levels. It will be the Commission's task to monitor and safeguard all the EU provisions when Member States outline their data own protection schemes and to continue co-operating through energy and ICT expert groups to assess and evaluate date security and grid resilience issue. ESOs (energy service operators) will have to develop technical standards for SM and SG based on the ‘privacy by design’ approach. (EC COM(2011) 202)

ERGEG, the European Commission's formal advisory group of energy regulators also points out the importance of data protection: "for ERGEG it is of the utmost importance that the privacy of customers is protected. All reasonable endeavours have to be undertaken to address data security and privacy issues before implementing a smart meter roll-out. ERGEG suggests that national solutions are applied but stresses the importance of cooperation with national agencies dealing with privacy issues and data security, to make sure that the specificities relating to energy are taken into account." (ERGEG 2011)

Vague benefits

Despite the EU's liberalized the energy market, consumers rarely benefit from the advantages of real competition, especially in the CEE-bloc. (BEUC 2011)

Even after SM pilot projects had taken place, surveys carried out by BEUC still identify issues such as difficulties of switching suppliers, lack of real choice between services and blurred bills.

BEUC expresses doubts about whether consumers can significantly change their electricity consumption habits. Besides that, as BEUC states, by integrating renewable energy sources (that are volatile by nature, depending on e.g. weather conditions) in electricity generation -in line with the EU's 20/20/20 goals- volatility increases also on the production side. Having no possibilities of proper scale to store energy, consumption should follow the peaks in order to buffer them out. "However, in order for demand response to work, it should be able to adapt in (almost) real time and at a large scale. We doubt that overall consumers are capable of disposing of sufficiently large volumes, as households’ use energy when they need it." (BEUC 2011)

In addition, by applying time of use tariffs, as an Ovum research states, electricity bills are not necessary decrease: in case consumers, who do not change their habits, electricity bills might even increase after installing smart meters. (Ravens 2010) However, fixed amount tariffs should be avoided since they do not encourage energy savings.

Smart meters have a notable cost factor. Consumers -although CBAs show that they enjoy vast majority of the benefits- (Przybylik and Jedziniak 2011) are less willing to pay for the devices. The utilities' intentions are also often doubted, as it is highlighted in an Ofgem report: "There was some suspicion regarding the motivation of energy companies, partly because some customers could not see why they would want to help their customers reduce their energy usage." (FDS 2010)

Low awareness of functional possibilities

Studies show that Smart Metering in itself saves little. As Darby (Darby 2010) emphasizes, it is the end-user's awareness that has to be focused on: electricity demand is suggested to decrease as general rather than cutting back only peak demands. The key thing is, as Darby says, to find proper forms of interface and feedback solutions in order to reach different and multiple layers of the society. Since the appearance and functionality of new devices may be at first strange and unusual to users in their everyday life (Leikas 2009), active consumer participation require a sort of technical-minded attitude to monitor and react on consumption data visualized by SM- displays. In addition, risk of errors may increase when people seek to control these complex appliance and ICT-environments.

This again supports the importance of the end-user. Ersson and Pyrko reveals that in case of consumer groups who are not concerned about their consumption, feedback only proves that nothing unusual is taking place and reinforce them in their previous lifestyle (Ersson and Pyrko 2009). Other consumer groups may feel that they had previously achieved the maximum of what they could do to decrease consumption. In his research to map consumer reactions on a specific type of in-home display, Hargreaves (Hargreaves 2010) discovered that people responded positively on the devices in general, but on the other hand they found the information the displays conveyed confusing and felt frustrated because of that. In case of social contexts that were pre-conceptionally non-supportive, Hargreaves found that due to the constant flow of information the displays facilitated, respondents felt environmental and financial issues even more hopeless.

According to BEUC, smart meters should allow end-users to set automatic consumption control, since not all consumers will control their household appliances manually after receiving consumption data. (ANEC and BEUC 2010)

Health impacts

Besides power line communications (PLC), smart meters use wireless protocols to transfer metered data between end points. There are concerns about health impacts of radio frequencies (that are everywhere, facilitating mobile phone communications, wireless internet connections, home area networks (HANs) and microwave ovens). The California Council on Science and Technology has published a post roll-out study on the health impacts of SM-devices. The study states that properly installed and operated wireless smart meters emit smaller amount of radio frequency than the majority of the household electronic appliances, especially mobile phones and microwaves. (CCST 2011)

The study also concludes that present customer service standards offer sufficient level of safety against known thermal health impacts of all devices that can be found on the market, including smart meters. CCST stresses that there is no scientific evidence nor confirmed harmful health outcome from any potential non--thermal effect of radio frequency.
However, negative health impact is one of the key arguments of contra-SM consumer groups and communities[6] abroad.

Smart metering roll-outs in Europe

Public awareness of SM technology has increased in Eurpope recently, but it is still in its early phase. The pace of investment and development varies greatly through the continent. More intensive adoption has been hindered by numerous factors: lack of technology standards for SM and HAN, market (regulatory, consumer-acceptance-related and technology) uncertanies and low demand for smart grid-ready services. (Giglioli *et al.* 2010)
Some governments and utilities have placed significant investments to deploy SM systems, but proper management of automated local LV networks and distributed generation are not widespread yet. According to the consulting company McKinsey, the countries of Europe can be divided into four categories as for the deployment of smart meters. (Fig. 6.)

1. Early adopters
In these countries roll-out has already been done or is in a well-advanced phase. Sweden was, for example, the first EU country to mandate automatic meter reading (AMR, only for electricity meters) by legislating new national metering regulations. According to that, consumers can only be invoiced based on de facto consumption. By summer 2009 nearly all Swedish end-users had remotely readable meters installed. However, there is no mandatory requirements for remote meter reading of gas, heat and water. (Swora 2011) In Italy the government lauched SM-deployment in 2002 - since then, 30 million smart meters have been installed, covering almost 100% of the Italian households.

[6] e.g. http://stopsmartmeters.org/

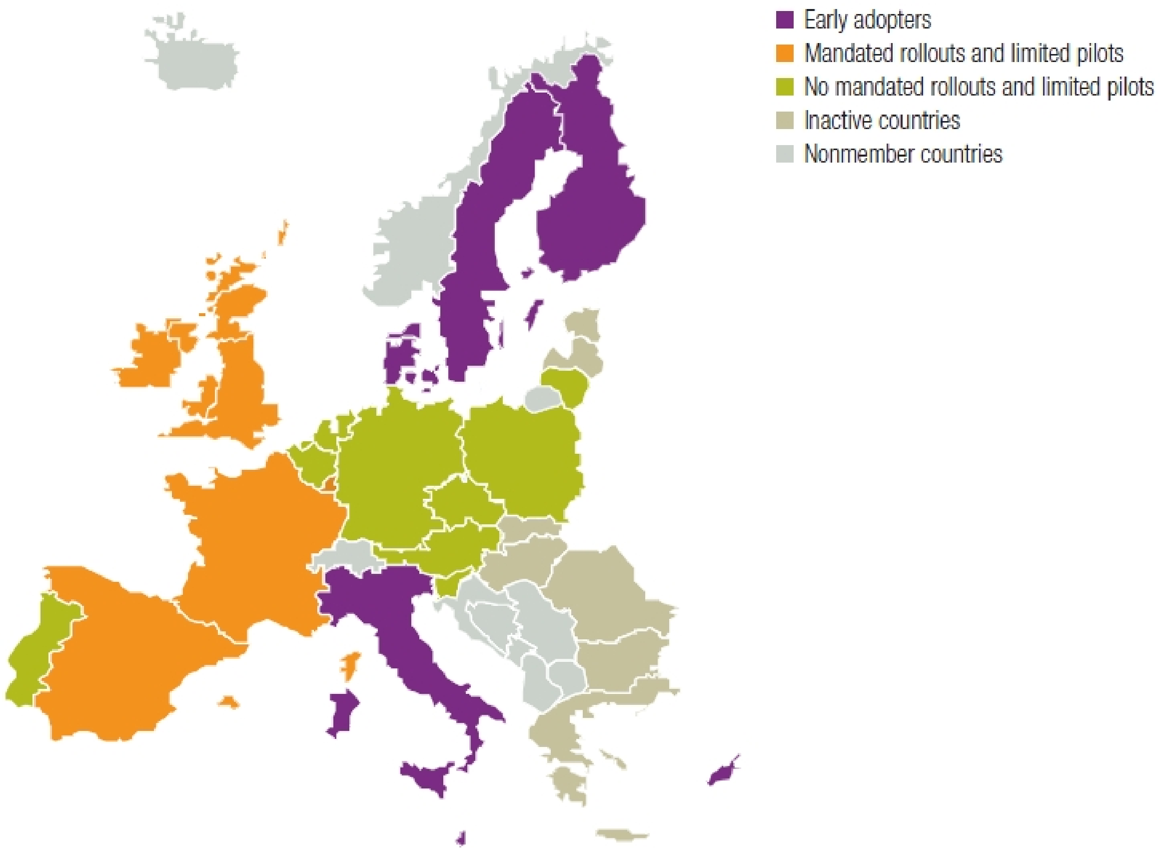

Fig. 6.: SM-deployment by EU member states (Giglioli *et al.* 2010)

The main trigger factor was the high rate of non-payment. The savings gained by cutting back non-payments by means of SM was enough to cover the costs of SM-deployment almost entirely. (Vajdovich pers.comm.) According to one of Italy's utility companies, Enel, "consumption peaks have been reduced by 5% due to greater customer awareness and clear price signals." (EurActiv 2 February 2010)

2. Countries with mandated roll-out and limited pilots

In this group of countries there are already laid-down deadlines for full deployment; for example it is 2016 in France or 2020 in the UK. Pilot projects are in a well advanced test phase. In Spain, for example, the energy act of December 2007 mandates a substitution plan for household electricity meters till the end of 2018. Functional requirements are also prescribed. (Swora 2011)

3. Countries with no mandated roll-out and limited pilots

In Germany, for example, provisions have been made in the Energy Law: legislature demands installing smart meters in new buildings and structures undergoing major renewal from the beginning of 2010. By 2011 electricity suppliers had to offer load-variable or time-of-use tariffs. There are no minimum functional requirements determined for SMs. (Swora 2011) In this group of countries there is no mandated deadline to replace meters. However, tests have already been launched by utility companies.

4. Inactive countries

Involving mainly the former Eastern-bloc countries (Slovakia, Hungary, Romania) where -mainly due to budget stress- no pilot projects have been launched yet.

An early adopter: Sweden

Sweden was the first country in Europe to install remote metering devices that cover almost 100% of the consumers. The roll-out was accomplished by 2009, with total costs estimated at about EUR 1500 million. The Swedish market is in special situation since i) the country is characterized by very intensive use of electricity (in Sweden electricity is excessively used also for heating), average per capita consumption is about 15000 kWh, representing six times the world average and double the OECD-average per year (in 2007), and ii) DSOs were motivated to deploy smart meters due to the legal requirement to apply monthly electricity billing based on actual consumption. Triggered mainly by rising energy prices, electricity metering became an issue on the country's political agenda about a decade ago. Power conservation issues and the problem of incomprehensible electricity bills also emerged: the bills turned out to be inaccurate and not corresponding to the actual consumption. Resulted by the political will to establish correlation between energy costs and consumption, the Swedish regulator examined whether more frequent reading of electricity would be beneficial (beforehand meter reading was done manually, at irregular intervals). They found that automated remote reading would generate a total financial benefit of about EUR 60 million per year. (Balmert and Petrov 2010) By 2006, following governmental and regulatory decisions, all users of average annual energy consumption exceeding 8,000 kWh were expected to read their electricity meters at least once a month. From July 1, 2009, all meters had to be read every month. This resulted in installing smart meters (in some cases it is better termed as remote reading) all over the country. As a field report notes it: " The purpose with the meter stipulations is to give the customers a better understanding of their invoice based on real meter values instead of estimated. Time to correct the billing and settlement is shortened from 13 months to 2 months. Lead time for exporting meter readings to suppliers is shortened from 30 days to 5 days." (Rinta-Jouppi 2009) In Sweden it is normally the DSO that carries out meter reading. In case the DSO is not able to read, metered data are estimated, based on previous year's consumptions. "The estimated data can be collected 2 years in a row; the third has to be read due to requirements in the consumer law. During the reporting to the final customer and the electricity supplier, it should be stated that the metered data has been estimated." (Morch *et al.* 2007)

Although the legislation prescribes monthly reading, many DSOs have claimed that they prefer hourly meter reading instead. Nevertheless, early adoption has a serious disadvantage: since the beginning of the SM deployment, technology has changed significantly. The meters rolled out that time do not fully embrace all functionalities of today's smart meters.

Currently DSOs are deploying smart meters and bear the costs of the installation. About 10%-15% of Sweden's already deployed meters provide data remotely only once a month. These devices are expected to be replaced before the end of their economic lifetime. In Sweden no comprehensive cost-benefit analysis has been prepared so far on a national level about full SM-deployment. There are neither regulatory rules on third party access to metered data, or interoperability of devices in force.

Mandated roll-out: UK

In Britain households are responsible for 26% of the country's total energy use and carbon emissions. According to the government's vision, all households and small businesses will be equipped with smart meters for both electricity and gas by 2020 - practically by 1019. This deployment will include more than 50 million new devices installed on 30 million metering spots. The Office of the Gas and Electricity Markets (Ofgem) reports that "Smart metering will play an important role in Britain's transition to a low-carbon economy, and will help meet the long-term challenge to achieve an affordable, secure and sustainable energy supply. Government estimates the benefits to Britain will exceed £7.3 billion over and above the cost of the £11.3 billion programme. There will be direct benefits to consumers through an improved ability to save energy and indirect benefits to consumers from improvements in how the energy industry operates.” (Ofgem 2011b) Ofgem points out that consumers, besides having the benefits of accurate, more accessible consumption information, will also be able to save money: “government estimates put the average saving at £23 a year by 2020 on combined gas and electricity bills - but some people will find they can save considerably more. Plus there is the non-monetary value of improvements in standards of customer service.” (Ofgem 2011b) Mandatory roll-out starts in 2014, compliance will be monitored and enforced by Ofgem as regulator. A legal entity was created in 2004 (Data and Communications Company (DCC), a trusted body of digital research data) to actively manage measured data flow throughout the whole research lifecycle. After 2014 DCC will be a licensed entity responsible for procurement and contract management and will be independent from data and communications services. Following a consultation process, all roll-out related issues (data access and privacy, roll-out strategy, design requirements, central communications and data management and implementation strategy) are regulated by a document titled as Smart Metering Prospectus 2010. The business case that suggested full roll-out by 2020 was prepared by the Department of Energy and Climate Change (DECC). According to the business case “the Government's impact assessments estimate that the total cost of the rollout programme will be £11.3 billion. (...) This investment is needed in order to support Britain's transition to a low-carbon economy. (...) The Government's impact assessment indicates that there is a strong business case for taking the programme forward. This predicts benefits across the domestic and smaller non-domestic sectors of £18.6 billion over the next twenty years, implying a net benefit of £7.3 billion. These benefits derive in large part from reductions in energy consumption and cost savings in industry processes. The costs and subsequent benefits are expected to come through customers' energy bills.” (Ofgem 2011a) According to the regulaltions, energy suppliers will be responsible for the deployment of smart meters: in the roll-out phase consumers receive a metering device as well as an in-home display, which will help them to monitor their energy use. To protect consumers’ interests (especially vulnerable consumers), deployment and operation will be overseen by Ofgem. The government also aims to protect consumers: legislations are underway to control conditions of e.g. remote switching from credit to prepayment mode, remote disconnection and measures to enable customers to change supplier. The consumers will be allowed to decide on who and how can use their metered data. (Ofgem 2011a)

According to Ofgem there will be no up-front costs of the installation, the expenses will be charged as part of the electricity bills. Proposed costs of SM devices range from "£102 to £242 per meter. This covers the purchase and installation of the meter and communication assets, IT changes and project management. The estimate for Britain is £139 per meter." (Ockenden 2010) As it was mentioned earlier, smart metering is believed to contribute to energy savings through providing consumers with accurate and timely information about their consumption. Together with using time reflective tariffs, consumers' behavior is expected to change as they shift consumption to periods when power generation is cheaper and greener. "The British business case assumes a reduction in domestic energy consumption of 2.8 per cent. This is consistent, even slightly conservative." (Ockenden 2010)

No mandated roll-out: Poland

Due to its vast coal deposits, Poland is the biggest hard coal producer in the EU: nearly all of its electricity (around 92-94%) is generated in coal-fuelled power plants. Poland has several social, economic and political reasons justifying the choice of smart power grids technology: i) according to estimations, electrical energy demand will increase by 50% in the next 20 years, the energy demand is growing twice as fast as the infrastructure grows, ii) network infrastructure is obsolete, mostly established 30-50 years ago, and iii) energy losses in transmission and distribution networks are high, reaching 6-9% of total energy produced. In addition, there is an increasing threat of power system failures and blackouts. (Wąsowski 2011)

The Polish government has already started intensive preparations for the implementation of smart metering, including launching information and educational campaigns in order to promote rational energy consumption (according to the Energy Efficiency Act, energy consumption in Poland has to be decreased by 9% by 2016 comparing to 2007 figures)

Implementing smart meters in Poland requires an investment on the distribution system operator (DSO) level at about EUR 1.5 billion (Przybylik and Jedziniak 2011). The cost of smart meters (and the related infrastructure) is estimated around USD 138 per metering point.

Over the past decade -according to the Polish Ministry of Economy- Poland has decreased the country's energy intensity by one-third. (Łukaszewska 2011) Various initiatives are active aiming to achieve further improvements. As the Journal of

Energy Security reports, "the most promising potential lies in so called white certificates, which are a tool of measurable verification of energy savings made by end users. The increased energy savings derive from an appliance's own demand reduction along with a reduction in electricity, heat and gas transmission and distribution losses. Companies that sell electricity, natural gas and heat will be required to obtain a certain number of certificates depending on the volume of its energy sold. The draft law envisages the creation of 'investment pro-savings' whereby an energy trader will be able to obtain a given quantity of certificates through tenders announced by the Energy Regulatory Authority. The Energy Efficiency Act, which governs these certificates, was accepted by the government on the 12th of October 2010. Incentives designed in the act seek to achieve both energy security and sustainability objectives by reducing the amount of energy needed, and to avoid releasing into the atmosphere additional GHGs." (Łukaszewska 2011)

The Energy Regulatory Office (ERO) of Poland has proposed legislative acts in connection with the introduction of Smart Metering including:

- regulatory contract should be made (under public law) between the ERO and a DSO implementing smart metering projects, regulating costs recovery, performance indicators, supervision, etc.,
- description of functionalities of meters, assuring interoperability,
- net meteringopportunitiesfor finalusers,
- setting up a Central Processing Unit, an independent Metering Data operator.

Up till now three CBAs have been worked out in Poland, done by different institutions. In the Parliament the Committee on Energy has been set up with the task of monitoring and legislative co-ordination. A position paper has been published by the ERO about i) market model of metering market, ii) Home Area Network requirements, iii) safety of metering data, iv) metering requirements for gas and district heating. (Swora 2011)

Characteristics of the Hungarian electricity market

Currently, there are about 5.5 million electricity and 3 million gas meters (electricity: <3*80 A, gas: <20 m^3/h of consumption) installed in Hungarian households. As the AT Kearney assessment reviews, consumer awareness of environmental issues has slightly grown in the recent years but still way behind the levels of Western Europe. Due to the relatively low consumption (fig. 7.) the possible savings are also low. (A.T. Kearney and Force Motrice 2010)

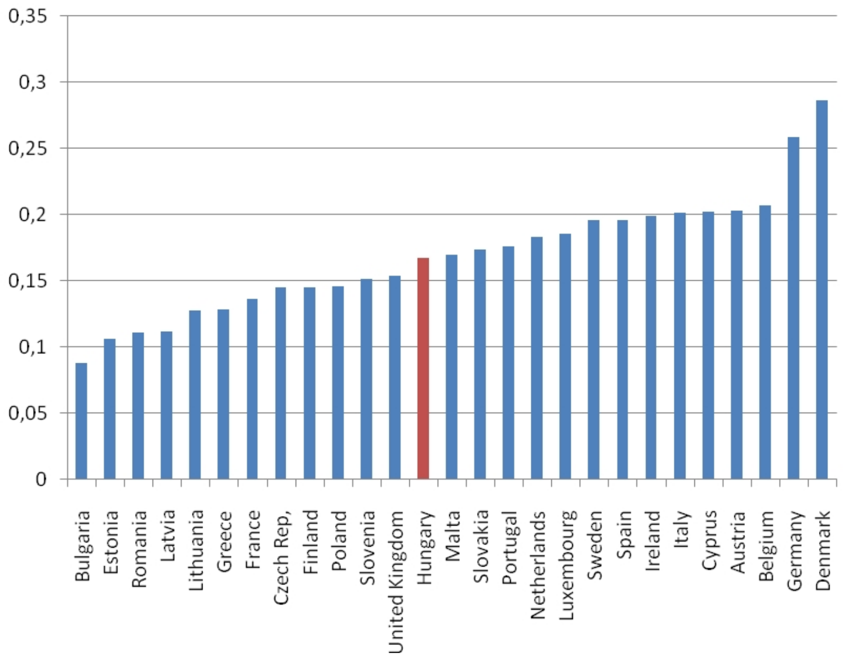

Fig. 7.: Electricity consumption of households (in the < 3,500 kWh/year segment), average amount in euro per one kilowatt, 2011. (source: http://www.energy.eu)

According to Eurostat, household (with annual consumption of 2500 - 5000 kWh, including taxes) electricity prices increased by 5.1%, while gas prices rose by 7.7% in the EU27 from H2 2009 to H2 2010. Average household electricity prices in the second half of 2010 were lowest in Bulgaria (8.3 euro per 100 kWh) (...) and highest in Denmark (27.1)" (*Eurostat* 2011) in Euro terms. As indicated by The Eurostat report, the average electricity price in the EU27 was EUR 17.1/100 kWh. However, when adjusted for purchasing power standards (PPS, reference that eliminates price level differences between countries) household electricity prices were the lowest in France (11.3 PPS/100 kWh) and the highest in Hungary (25.7).

Fig. 8. indicates how househols electricity prices climbed up over the years: between 2002 and 2010 the price level doubled.

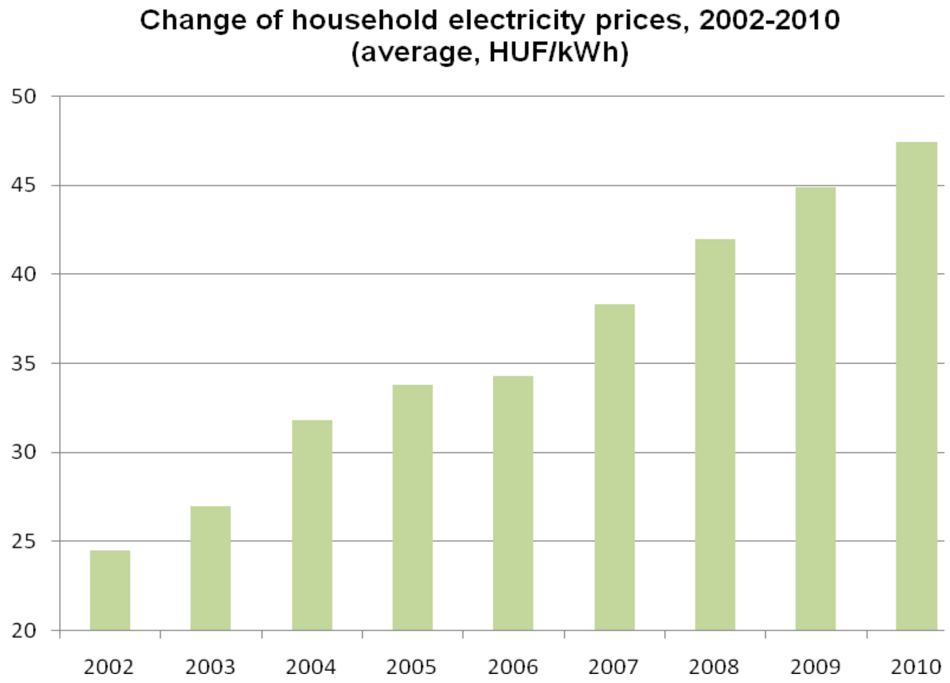

Fig. 8.: electricity prices in the household segment (source: HCSO)

Fürjes and Zarándy claim that "Hungary should build upon the traditional energy sources: it is vital to increase energy efficiency. (...) The best that Hungary can do is providing electric energy at the same price level as the neighboring countries do while offering proper energy security. Renewables are important but they can only play a supplementary role for a long time. The extra burden that the financial support of renewable energy use puts on the economy should be kept on a minimum level." (Fürjes and Zarándy 2011)

Fürjes and Zarándy also mention that the ratio of legislatively regulated price components -including fixed charges and unit prices- are far too high (see: billing) within consumer prices. They suggest to increase cross-boundary capacities and to harmonize legislation in order to diminish regional price differences. Hungary's dependency on import energy is the 14. highest amongst the EU27, with the ratio of imports divided by gross consumption (in Mtoe, primary production plus imports, less exports) giving out 62.5% (http://www.energy.eu/#Domestic) according to 2008 data.

Due to the complex tariff system and low transparency it is hard to assess the consumer prices of electricity in Hungary.

According to the HEO figures (fig. 9.), nuclear power (about 40%), gas (about 30%) and coal (about 19%) dominate the Hungarian energy mix.

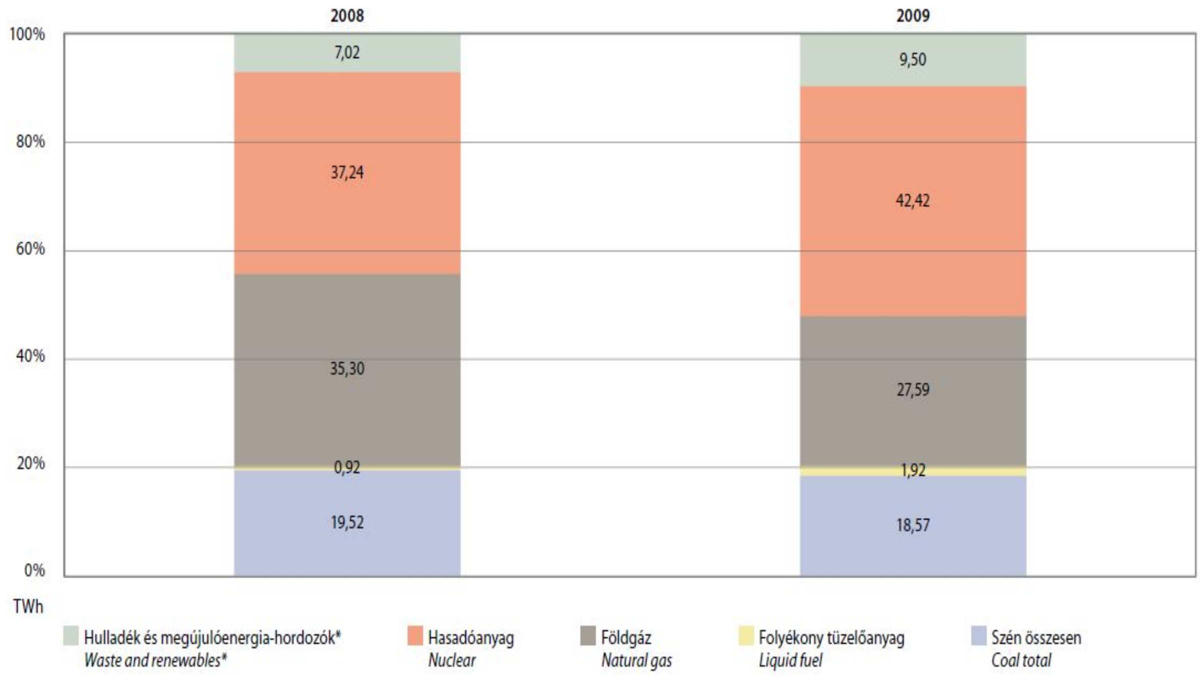

Fig. 9.: Distribution of energy sources used in Hungarian power plants, 2008-2009 (HEO 2010[7])

In 2010 all together 39 TWh electricity was used in Hungary. As compared to that, 33.8 TWh was generated, electricity consumption gave out 34.7TWh, out of which import accounted for about 15% (~5,2TWh). Gross power plant capacity (9317 MW) covered even the highest monthly peak load without import. 21.5% of all generated electricity was sold through the "KÁT" system. ("KÁT" stands for a mandatory off-take system designed to support renewable-based electricity generation and combined heat and power (CHP) units in Hungary. Within "KÁT" the state gave financial support by purchasing renewable-based or cogenerated electricity at prices that were significantly above market prices. "KÁT" was in operation from 01.01.2008. to 01.07.2011.) As Kiss states in KPMG Energy Yearbook (Kiss 2011) there are no risks that could negatively influence the security of Hungary's energy supply on a short or medium term; however, on a longer term there are threats in electricity generation since 70% of Hungary's power plants are older than 30 years, operating at low efficiency and causing high emission. Kiss also underlines that Hungary got stuck in long term gas purchase contracts (mainly with Russia) and this -due to the cemented prices- result in higher purchase prices. This is partly accounted for electricity prices being high. Figure 10. illustrates the difference between long term

[7] Latest available data

contract prices (in terms of Russia and Hungary) and spot prices over 1996-2008. The red bars indicate periods when long term contract prices were below spot prices.

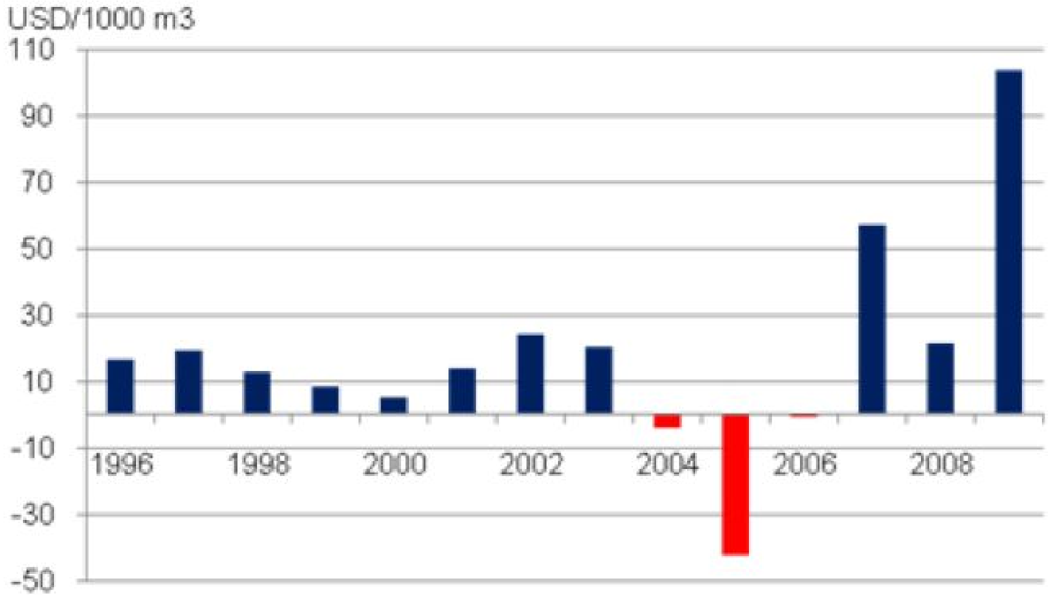

Fig. 10.: price scissors between contracted and spot gas prices (Zsuga 2010)

Kiss estimates that the modernization of Hungary's electricity sector would cost about EUR 10-11 bn, which is a substantial amount as compared to the country's current economic conditions (GKI 2011). In the draft version of the Hungarian Energy Strategy 2030 (Ministry of Rural Development 2011) the government plans to cease operation of several, low efficiency -typically about 30%- coal-, oil- and gas-fuelled power plants and replace them with more efficient (of above 55%) gas-fuelled ones. The government aims to shrink electricity network losses to decrease the present-day difference between primary energy use and end consuption. The draft also points out that "legislation should give a support to smart grid and smart metering solutions that help in optimizing electricity consumption" - however, the document does not reveal any further details about smart metering plans.

According to the Directive 2009/28/EC (2009/28/EC), target for share of energy generated from renewable sources in gross final consumption must be at 14% by 2020. Due to employment reasons (the government expects 70,000 new jobs in the renewable energy industry) and the importance of the issue, a higher, 14.65% target has been set by the government. However, some experts say that any increase that is bigger than the mandatory one generates extra costs for consumers since green energy is still relatively expensive to produce. (Fürjes and Zarándy 2011)

According to a Business Monitor International report (BMI 2011), Hungary's power generation is expected to account for 1.39% of the Central and Eastern European total by 2015. During this time, Hungary is forecasted to stay as a net electricity importer from neighboring states. Energy demand in the CEE region is expected to grow by 13.15% over 2011-2015. Hungary's nuclear capacity is foreseen to increase to 16.5TWh by 2015. As the report projects, CEE region's thermal power generation will come around at 1,447TWh. That means a 10.0% growth and -at the same time- market share of thermal electricity generation is expected to decrease in total, due to environmental concerns, expanding use of renewables, hydro-, and nuclear power.

The report also indicates that Hungary's electricity generation would rise by 29.8% between 2011 and 2020 - it is seen as one of the slowest growth in the region.

In the recent years, housing expenses have increased significantly, while households' incomes went down. The economic crisis has intensified these effects. According to a survey conducted by the Ministry of Social Affairs and Employment (predecessor in title of the Ministry of National Resources) by February 2010, households' total electricity bill debt reached the volume of HUF 18 bn at three utility companies (DÉMÁSZ, ELMŰ-ÉMÁSZ and E.ON) as of 30 June, 2009. Out of the 4.9 million people served by them, 11% had expired electricity bill debts (including the 1-30 days delay) and the average debt per household was HUF 32,000. (Herpai 2010) Thus it seems obvious that households in general can not be financially burdened without a limit - this sets a constraint to the optional technologies and financial models of smart metering design.

In terms of Hungary's economic and social conditions there are significant differences within the country. For example unemployment, as figure 11. indicates, is the highest in the Eastern parts of Hungary.

Due to the poor economic conditions, the ratio of non-payment is high in regions marked in dark green. For example, universal service provider ÉMÁSZ operating in the North-East indicates a HUF 3.5 bn of consumer debt in its 2010 consolidated financial report (ÉMÁSZ 2011).

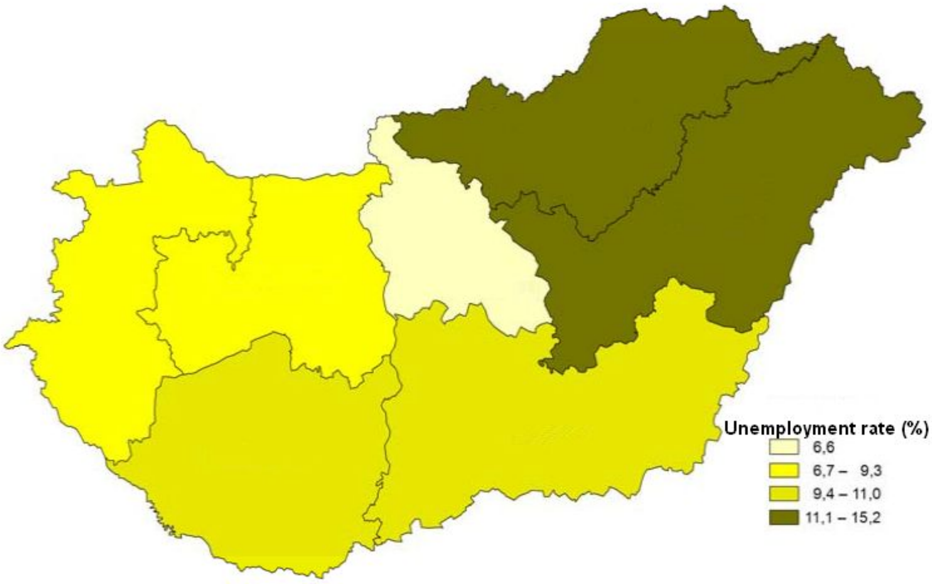

Fig. 11.: unemployment rate in Hungary in 2009 (HCSO 2010)

Economic activity is also considered to be low in the country: according to HCSO data, the number of population in active age (between 15–74) was 7.69 million in 2009. Out of them only 4.2 million, 54.7% was economically active in average for the whole of Hungary. HCSO points out that inactivity was the highest in the Eastern and North-Eastern parts of the country. (HCSO 2010)

Legal framework

Metering and billing of electricity is regulated by the Act LXXXVI of 2007 on Electric Energy, "with a view to setting up an efficiently functioning internal electricity market, to promote energy efficiency and energy conservation within the framework of sustainable development, to provide consumers with a secure and reliable supply of electricity of a specified quality at transparent prices, to integrate the Hungarian electricity market into the converging electricity markets of the European Communities, compliance with the legislation of the European Communities, and to develop an objective and transparent regulatory regime in compliance with the principle of equal treatment." (Act LXXXVI of 2007)

The Act promotes the use of renewable energies, waste-fuelled power generation as well as CHP. The Act refers to EU Directive 2001/77/EC on Electricity Production (2001/77/EC) from Renewable Energy Sources.

The Hungarain regulation also defines the accountability of different parties involved in electric power metering. For example, it says that metering data shall be made available to end users free of charge, in line with Act LXIII of 1992 on the Protection of Personal Data and Access to Information of Public Interest.

Regarding smart meters the 2007 Act on Electrical Energy declares in Section 42 that "authorized operators and authorized producers may establish and maintain closed telecommunications and data transmission systems for the purpose of carrying out their activities and in order to ensure the smooth and reliable operation of the transmission and distribution networks, undisturbed supply to satisfy demand, the rapid and safe elimination of malfunctions, and the transmission of metering results." (Act LXXXVI of 2007) The Act also authorizes the Government to lay down all regulations and carry out practical tasks connected to financing and implementing smart metering pilot projects. The Government is also authorized to define the legal framework of smart grids.

The Act's amendments coming into effect from 30.09.2011. add that in order to carry out a mandatory CBA till 03.September 2012., as it is prescribed in the EU's Third Energy Package, distributor network licensees are allowed to carry out SM pilot projects. From these pilots licensees shall provide proper information to end users, who are -in exchange- mandated to take part in such pilots and accept the metering devices. Licensees -in connection with the pilots- are not allowed to cause any harm to users or charge them extra fee. Licensees also conduct the pilot project under control of the HEO. The Act mandates the licensee to present the documentation of the pilot before launching the project. The results and conclusions shall also be presented to the HEO after closing. Besides Act LXXXVI of 2007 on Electrical Energy several governmental and ministerial decrees regulate prices and services. Metering issues are controlled by the Act XLV of 1991, while the Act LXIII of 1992 regulates the protection of personal data. However, there are no amendments to them that would contain provisions about smart metering.

Market liberalization

According to the EU-legislation, the functions of electricity supply and grid operation have separated from 1 January 2008 in Hungary: the grid is to be maintained and operated by the utility that has the biggest market power in a specific region.

In theory, every Hungarian consumer is able to buy electricity from any, freely chosen market utilities. However, as it is pointed out e.g. by the National Association for Consumer Protection in Hungary (NACP 2010), practice shows that price difference between utilities is so marginal (due to e.g. the comlex system of price regulation) that there is hardly any competiton that can be felt by consumers.

During the process of market liberalization, the one-time state owned, regional electricity monopolies gave way to private companies. To protect small-scale consumers, the term 'universal service provider' has been introduced: universal service providers are mandated to supply electricity in a given region to households, on guaranteed conditions. Households might enter into a supplier contract with any utilities other than their universal service provider.

According to Nagy (Nagy 2010) universal service is one of the most controversial elements of the liberalized Hungarian market. Formerly, it was the monopoly's (i.e. fully state-owned electricity sector) incumbent task to supply service at a reasonable price for everyone. By liberalizing the market, monopolie have gone but the necessity to guarantee public utility service remained, even under free market conditions. Universal service providers are descendants of the regional monopolies, operating more like part of the social care service system rather than an economic category. In this paper I focus on the household segment entitled to draw on universal service.

Universal service can be obtained by customers consuming less than 3*63Amp : 3* 14.5 kW = 43.5 kW (households, SMEs, etc.) and special, legislatively defined groups (certain state-owned institutions, municipalities, schools and churches providing public service etc.). Prices applicable for these consumers are controlled by the HEO.

Universal service providers are mandated to facilitate some guaranteed services that are detailed in the companies' general conditions. A few examples for the service level:

- Service providers are mandated to install new grid connection points within eight working days in case it is required by the consumer (who corresponds to all conditions prescribed).
- In case of faulty billing the amount of money overpaid by the consumer must be reimbursed by the service provider within eight working days (on condition the complaint had been examined and found to be reasonable).

- Service providers must reconnect consumers at whom supply had been previously terminated due to non-payment within one working day if the arrears are proved to be settled. In case the utility does not reconnect the service in due time, a compensation has to be paid to the customer.
- The utility is mandated to reply to all consumer complaints related to electricity supply service within 15 days,
- Consumers may cancel the universal service contracts in a written form with a 30 days notice period, etc. (NACP 2010)

The exaples above suggest that the tasks and services a universal service provider is required to fulfil are manifold, while the profitability of this consumer segment is very limited. Consumers of the universal service segment provide the mass of the electricity market's demand side.

Consumers off the universal service-circle (e.g. large industrial end-users) are mandated to purchase electricity from the market from 1 January 2008, while contracting the regional supplier only for using the grid. Te regional supplier -through its subsidiary- becomes a so called distributor network licensee in such contracts, facilitating only the transport infrastructure.

In the liberalized market each consumer is to enter into three separate contracts:

- *grid connection contract:* to be made to connect a specific location indicated by the consumer. The contract is valid for an undefined period of time and can be modified any time by common assent,
- *grid use contract:* to be made to facilitate the infrastructure. The contract is also valid for an undefined period of time and can be modified any time by common assent.

Customers sign these two contracts with the distributor network licensee. The third contract is to be made with the service provider (the utility):

- *utility (or universal service utility) contract:* enables consumers to purchase electricity from the regionally designated universal service provider or any market utilities. In case of consumers who are entitled to receive a universal service, the price of electricity is also specified in this contract.

On the consumers' demand the universal service provider (or the utility company picked freely from the market) has to handle all three contracts all together.

The actors of the Hungarian electricity market are the following:

- *universal service providers (utilities):* ELMŰ, ÉMÁSZ, DÉMÁSZ EDF, E.ON

- *distributor network licensees:* they transfer electricity (purchased by the utilities from traders/power plants) to the end users through the grid they maintain, develop and operate. Besides that they are responsible for meter readings, changing the meters, repairing grid disturbances etc. They are: ELMŰ Network Ltd, E.ON South-Transdanubian Network Power Co, EDF DÉMÁSZ Power Distribution Ltd, E. ON North-Transdanubian Electricity Power Co., ÉMÁSZ Network Ltd, E. ON Tiszántúl Electricity Power Co.
- *electricity trading companies:* there are 90 licensed trading companies (as of end of June 2011) operating throughout the contry. They buy and sell electricity in OTC markets or in the power exchange[8].
- *system operator:* the Hungarian Transmission System Operator Company Ltd (MAVIR) is responsible to ensure secure "operation of the Hungarian Power System including power plants and of the grid; to supervise the assets of transmission system, to ensure the the access on equal terms for system users; to process the data received from the participants of electricity supply," etc. (MAVIR 2008)
- *licensed electricity producers* (power plants, as of end of June 2011): AES Borsod Energy Ltd. Borsod Thermal Power Plant, Kazincbarcika; Energy Ltd. Borsod Thermal Power Plant, Tiszapalkonya; AES Tisza Power Ltd., Bakony Power Plant Ltd., Budapest Power Plant Inc.; Csepel Power Production Ltd.; EMA-POWER Ltd. ; Danubian Power Plant Inc.; GTER Ltd.; Mátra Power Plant Inc.; Paks Nuclear Power Plant Inc.; PANNONPOWER Inc.; Vértes Power Plant Inc.
- *Hungarian Power Exchange* (HUPX): licensed by the Hungarian Energy Office to operate on the organised power market in Hungary. HUPX expects to trade 5 TWh in 2011, that gives out about 12.5% of Hungary's total electricity consumption. (Vajdovich pers.comm.)

Besides the actors above the *Hungarian Energy Office* (HEO) functions as an administrative body with countrywide competence. HEO is managed by the government and supervised by the Minister of Energy Affairs. HEO issues

[8] Recently traders have expressed concerns about retroactive taxes the Cabinet imposed last year on the energy, financial, retail and telecommunication industries. Due to that for example Nordic utility Vattenfall AB delayed its plan to trade Hungarian electricity.

permissions for universal service providers, monitors market competition and approves legislative pieces on electricity supply.

Through *Hungarian Electricity* Works (MVM) and its subsidiaries, the Hungarian State exercises ownership in electricity generation (e.g. in Paks Nuclear Power Plant), transmission, system operation and electricity trade. MVM also contributes to the implementation of the Hungarian energy strategy. MVM group consists of vertically integrated companies.

Parties (contracts)	Responsible
Contracts between licensees	system operator with the involvement of distribution licensees
Contracts between the connecting users and the licensees	distributor network licensee
Contracts between users connected to the grid and licensees	grid operator
Contracts with foreign partners (cross-boundary energy transportation)	grid operator
Contracts between power plants under 5 MW of performance and the distributor network licensee	distributor network licensee
Contracts between the licensee of private cable (permission needed) and users	distributor network licensee

Table 1.: contractual relationships and responsibilities in the Hungarian electricity market (A.T. Kearney and Force Motrice 2010)

The table above illustrates how different actors of the Hungarian electricity market connect to each other through contractual relationships.

Metering devices are owned by the distributor network licensees, who are also mandated to install, validate and maintain the meters. Every ten years meters need to be re-calibrated on the licensee's own cost. Reading the meters (or receiving self-read metered data from consumers via phone, e-mail, etc.) is also to be carried out by distribution licensees, who then forward the data to the grid operator.

The frequency of meter readings is specified by the 2007 Act on Electrical Energy as:

a) in case of devices that have the functions of displaying and storing metered data the frequency of reading is to be conducted according to the utility regulations,

b) other (i.e. Ferraris-type) meters is to be read at least once a year, on condition the grid use contract does not stipulate it otherwise (intervals can only be shorter than a year). (Act LXXXVI of 2007)

Billing

Figure 12. shows an electricity bill issued by Budapest utility company, ELMŰ.

Mérési adatok

Fogyasztásmérő azonosító	Mért jellemző	Mérőállás előző	Mérőállás utolsó	Szorzó	Mért mennyiség (kWh)	Korrekció	Elszámolt mennyiség (kWh)
9900987058	24 órás	3.473,000	3.501,400	1,000	28,400	0,000	28,400
9900987061	24 órás	6.364,000	6.460,100	1,000	96,100	0,000	96,100
9900987058	24 órás	3.501,400	3.513,800	1,000	12,400	0,000	12,400
9900987061	24 órás	6.460,100	6.502,000	1,000	41,900	0,000	41,900
9900987058	24 órás	3.513,800	3.573,800	1,000	60,000	0,000	60,000
9900987061	24 órás	6.502,000	6.705,100	1,000	203,100	0,000	203,100
9900987058	24 órás	3.573,800	3.577,000	1,000	3,200	0,000	3,200
9900987061	24 órás	6.705,100	6.716,000	1,000	10,900	0,000	10,900
Összesen	**24 órás**				**456,000**	**0,000**	**456,000**

	Elszámolt időszak	Elszámolt mennyiség	Egységár (Ft)	Adó nélkül számított ellenérték (Ft)
Egyetemes szolg. "A1" kedvezményes árszabás díja	2010.10.22-2011.01.31	178,8000 kWh	21,0300	3.760
Egyetemes szolg. "A1" kedvezményes árszabás díja	2011.02.01-2011.06.30	263,1000 kWh	22,2400	5.851
Egyetemes szolg. "A1" kedvezményes árszabás díja	2011.07.01-2011.07.08	14,1000 kWh	21,2800	300
Energia díjak összesen 1.				**9.911**
Szénipari szerkezetátalakítási támogatás	2010.10.22-2010.12.31	124,5000 kWh	0,2300	29
Szénipari szerkezetátalakítási támogatás	2011.01.01-2011.07.08	331,5000 kWh	0,1900	63
Kedvezményes árú vill.energia-támogatás	2010.10.22-2010.12.31	124,5000 kWh	0,0900	11
Kedvezményes árú vill.energia-támogatás	2011.01.01-2011.07.08	331,5000 kWh	0,0700	23
Kapcsolt termelésszerkezet átalakítási díj	2011.07.01-2011.07.08	14,1000 kWh	1,2000	17
Pénzeszközök összesen 2.				**143**
Energiaalapú rendszerhasználati díj "A1"	2010.10.22-2010.12.31	124,5000 kWh	15,0250	1.871
Energiaalapú rendszerhasználati díj "A1"	2011.01.01-2011.07.08	331,5000 kWh	15,0290	4.982
Elosztói alapdíj "A1"	9 hónap	1,0000 db	156,0000	1.404
Rendszerhasználati díjak összesen 3.				**8.257**

Fig. 12.: an ELMŰ reconciliation bill

The utility, as a universal service provider, displays the following cost items on the bill:

1) "energy fees total": (marked with red 1.) contains the value of the electricity actually consumed, calculated by various tariffs. Below 1320 kWh/year (110 kWh/month) of consumption a discount tariff is used; above that a normal tariff is applied. 'A1' is a normal tariff category, while 'A2' contains peak/off-peak consumption tariffs. To choose 'A2' pricing, a special, two-tariffs meter should be installed at the metering point. 'B' indicates a night tariff: it can be picked only as a supplementary category and can be applied only for separately measured appliances, such as water heaters. Category 'B GEO' serves to support geothermal heat-pumps on prescribed conditions. It is to be metered separately and can be picked optionally besides 'A1' or 'A2' tariffs. Other heating appliances' (water pumps, automatic controlling devices connected to e.g. solar panels etc.) consumption can be optionally metered according to tariff category 'H'. It is also to be metered separately.

Budapest energy utility ELMŰ, for example, defines different fee items as it is indicated in table 2. (as of 01.02.2011):

		energy fee	Grid operation fees and other costs stipulated by legislation	VAT (25 %)	Gross electricity fee
A1 discount		22.24	15.289	9.32	**46.85**
A1 normal		23.66	15.289	9.67	**48.62**
A2	**peak-time**	28.92	15.289	10.99	**55.20**
	off-peak time	17.86	15.289	8.22	**41.37**
B		16.32	7.739	5.95	**30.01**
B GEO		17.56	7.739	6.26	**31.56**
H		16.32	7.739	5.95	**30.01**

Table 2.: ELMŰ's household electricity prices (HUF/kWh) (source: www.elmu.hu)

2.) "payables total": this item (marked with red 2.) refers to a social contribution paid to support discount tariffs of e.g. senior citizens retired from electricity sector. This item is regulated by legislation. As part of it, consumers pay the so called *"coal industry transformation support"* transferred to miners employed by a coal-mine owned by Vértes Power Plant. It is not lucrative -not to mention environmental concerns- any more to operate the mine and generate electricity from the coal excavated but due to social reasons mining activity is still carried out. This fee item is also regulated by legislation.

3.) "network service fees total": (marked with red 3.) as NACP reviews (NACP 2010), this item contains network and grid operation fees (paid to cover the costs of high-voltage (HV) grid maintenance, the grid operator's technical and personal costs, the network loss and the grid operator's net profit regulated by legislation) and grid-level service fee to cover the costs of the maintenance of the whole electricity supply system in a secure fashion. This fee item includes the cost of transporting electrical energy from power plants to distribution grid, fixing the grid after unforeseen (e.g. weather-related) disturbances. The volume of these fees are regulated by the Law of Electrical Energy.

The idea behind detailed fee components is that consumers are able to compare the fee structure of different utilities. However, as NACP states, the amount of information displayed makes it hard for consumers to understand the bill. Through behavioural changes households can only have influence on one fee item directly (the energy fees, in fig. 12. representing only 45% of the total) out of three. According to NACP it is a serious constraint for any energy saving actions.

Universal service consumers can be billed according to two methods:

1) consumers execute self-reading and forward the data to utilities via phone, internet etc. every month: in this case they receive a bill that reflects their actual consumption. Once a year (normally) the reading is done by the utility - the difference between self- and utility-read values is then settled at the end of the year.

2) in case consumers fail to provide the utility with monthly consumption data or deliberately opt ot that, the utility makes an estimation based on previous year's consumption and the consumer is billed by a flat fee. At the end of the year the difference between actual and estimated consumption is settled.

Consumer satisfaction

The Hungarian Energy Office examines customer satisfaction trends every year. In the frame of the 2010 research 7600 households and 2600 non-households (institutions, municipal organizations etc.) were surveyed from the universal service circle (Teleszkóp 2010).

The latest, 2010 survey identified the same problems as previous years' surveys: oscillation of voltage level, blackouts (especially longer-lasting ones), improper customer service and long repair times. Household respondents indicated improper handling of complaints and low call center performance as the worst problems. As compared to prior years, growing number of households found electricity bills as non-understandable. As the 2010 survey reveals, 74% of the households knew that they could switch between utilities, but only 5.4% of them planned to switch their utility in the near future. In the non-household segment 84% was aware of the possibility to switch supplier and 8% considered a change.

Perception of short blackouts grew by 8.5% from the previous year, while in case of long blackouts the increase was 7.8%. According to the research, 6.4% of all responding households had costumer service experience in 2010. Vast majority of them were satisfied with costumer care, only 13% reported dissatisfaction. 97% of households regarded the metering as reliable.

In the non-household segment 13.5% of the respondents turned to customer services for some reasons in 2010. 15% of them were definitely dissatisfied with this experience.

Smart metering in Hungary

Up till now little has been done in Hungary to comply with the relevant EU legislation on smart metering: pilot projects have not yet been launched and the legislative background is not yet built. However, the amended 2007 Act on Electrical Energy indicates some preparatory work. As it is shown in table 3., full SM roll-out is estimated to take place over four years.

Year	**Task**	**Status (08.07.2011.)**	**Desired results**
2011	Finalized legislative background: ▪ defining requirements towards smart metering ▪ defining requirements towards pilot projects and their locations	Some amendments in the Act on Electrical Energy, possibilities have been examined, suggestions have been made (by the A.T. Kearney study)	Governmental Decree on Smart Metering
2012	Launching pilots: ▪ testing of pilot systems ▪ 10 000 metering devices to be installed	-	Running pilots
2013	Release of smart metering licenses: ▪ companies with at least 10 000 devices installed could apply for SM-operator licence ▪ HEO works out detailed requirements for market	-	Licensed regional meter operators

	players		
2014	Roll-out of SM-deployment: ▪ expanding regional pilots ▪ regional roll-outs	-	Country-wide roll-out

Table 3.: conceptional time schedule of SM-deployment in Hungary (Vajdovich pers.comm.)

In Hungary's Renewable Energy Action Plan it is stated that smart metering makes consumers able to optimize their electricity consumption and benefit from market competition by using differentiated tariffs. Thus, the document says, consumers become partners in demand-side management, increasing the flexibility of power generation. By introducing smart metering, it becomes possible to protect vulnerable consumers from accumulating debts. The Action Plan adds that SM will also enable to control the level of consumption. Besides economic and technical issues, at the roll-out it will be unavoidable to find solution for legal concerns regarding privacy and data protection, the Action Plan states.

However, the document does not support early deployment of smart meters: according to the Action Plan, "at the moment it seems practical to wait for the international experiences and CBAs in order to pick mature and inexpensive technology to protect Hungarian consumers from paying extra fees for SM devices. (...) This breakthrough of technology can be expected within the coming decade" (Ministry of National Development 2011) The documernt also argues that it would be desirable to have the metering appliances manufactured in Hungary to boost employment.

The total cost of SM full deployment in Hungary is estimated at about HUF 250 bn - that is a significant financial burden. (A.T. Kearney and Force Motrice 2010) By waiting for more international experiences and mature technology, policy makers try to avoid lock-in effect (SM technology is not yet considered as fully developed, early adopters might face additional costs and barriers when the meters are due to be replaced). The AT Kearney study estimates that smart metering would generate approximately HUF 100 bn worth of benefit in the Hungarian economy. As part of it grid loss (now worthing HUF 74 bn a year) could be decreased by 20%, while financial losses from non-payment or late payment (now worthing HUF 27 bn) could be cut by 90%. International benchmarking suggests that there is no country in the EU where the CBA would have shown negative results for SM-deployment.

However, there are no standards (including the field of telecommunications) available yet for smart meters and smart metering systems: without that decision-making is severely hindered due to interoperability and compatibility issues. According to a HEO official, the key question now in Hungary is that who is going to own the metering devices, the communications network and the data centre, where metered data are collected, verified and distributed to all authorized actors. (Vajdovich pers.comm.)

There are logical arguments to support that distributors (i.e. utilities) should own and operate the system since i) they already apply distant meter reading in case of huge industrial consumers (these meters do not allow two-ways communication yet), ii) the meters would be placed at the end points of the electricity grid. Utilities obviously support this way of implementation, although -given the current pricing mechanisms- the return on investment is low.

On the other hand, as the HEO points out, telecom companies already possess the infrastucture, network and data centre necessary for smart metering. Moreover, companies from the telecom sector seem willing to invest from their own budget.

Besides professional arguments, political attitudes also play a major role in the telecom vs. utilities decision: while the former government preferred the telecom sector, the current cabinet favors utilities. (Vajdovich pers.comm.)

The newly amended 2007 Act on Electrical Energy says that roll-out must be anticipated by pilot projects (Act LXXXVI of 2007). Pilots will be regulated by a Governmetal Decree that is now under constuction. The Decree, to be prepared by the HEO, is expected to be ready by the second half of 2011. Deployment should be started by the end of 2012 the latest. (Vajdovich pers.comm.)

Some utilities are already planning to launch pilots (E.ON seeks to deploy 10 000 meters soon), although -due to the lack of regulation- they run a financial risk if these meters turn out to be not compatible with the coming regulatory specifications.

The main goal of the HEO is to avoid the overburdening of consumers but -as it is also the principle elsewhere in Europe- costs will be distributed throughout the value chain to the same proportion as the benefits, thus consumers are expected to pay around 90% of the deployment costs. (Vajdovich pers.comm.)

Research methodology

The aim of the research was to explore consumers' feedbacks to the smart meter-concept and to map their hopes, requirements and concerns regarding SM. As part of this aim, awareness of smart meters was also examined. The research was twofold, data were obtained from 1) in-depth personal interviews and 2) an online survey. The samples are not representative for the whole population due to the relatively small sample size and the geographical concentration. Both researches were conducted in Hungarian language. Quantitative research was evaluated by means of SPSS software.

Qualitative research

As part of the qualitative research four individual in-depth interviews have been carried out. All of the interviewees were recruited from an urban area of Esztergom, a small town located 50 km North of Budapest. The respondents live in the same street and represent various social and economic clusters.

	Social layer	**NRS social grade**[9] (Collins 2009)
1.	Young family with two (age 6 and 4) children	C2, electricity bills are a concern
2.	Senior lady (widowed, lives alone)	E, electricity bills are a concern
3.	Senior couple	B, electricity bills are a concern
4.	Younger couple with no children	C1, electricity bills are not a concern

Table 4.: interviewees' social status

Interviews were audio recorded and were 40 minutes in duration as average. Research ran from 25 to 30 May 2011.
The interviews -although they flew somewhat spontaneously- were carried out based on the guideline below.

[9] According to Ipsos "A= High managerial, administrative or professional, B= Intermediate managerial, administrative or professional, C1= Supervisory, clerical and junior managerial, administrative or professional, C2= Skilled manual workers, D= Semi and unskilled manual workers, E= State pensioners, casual or lowest grade workers, unemployed with state benefits only." (Collins 2009)

1. warm-up (5 minutes)

- Introduction: age, household size, etc.

2. electricity use (10 minutes)

- How much is the monthly consumption?
    - Do you check the bill? What do you check on it? Why that?
    - How is the meter reading done?
    - How much is your monthly bill? Is is too much or just right? Why?
- How much do you care about electricity consumption? Why do you care? Why is it important for you?
    - What do you do to decrease consumption? Why that?
- How would you label your consumption? Wasteful, average, prudent? What is your reason to save electrical energy- is it the bill or environmetal concerns?
- Do you want to change your consumption? Why? Why not? What should happen to change your consumption?
- Can you imagine a device that helps saving electrical energy? What functions should it provide?

3. concept of smart meters (10 minutes)

The following introduction is not an advertisement. Smart metering is a new concept of metering and data transmission that enables continuous measuring of consumption as well as data availability both for the utility and the consumer. Thus all parties constantly know about consumption volumes. This technology exists not only for electricity but other utilities as well. However, we will focus only on electricity. Data transmission is often wireless, using mobile communication technology. Households can monitor consumption by means of an internet tool or a display placed in their homes. According to the EU-legislation, it is highly probable[10] that current meters will be replaced by smart meters by 2020.

Smart meters offer the following advantages for consumers:

[10] Formally based on the results of the CBA to be carried out on a national level.

- *consumers get consumption data not by the monthly bill but constantly, therefore families are able to influence their consumption better.*
- *Since smart meters can be read between invoicing periods any time, it becomes faster to switch utility.*
- *Smart metering -by replacing today's estimate-based invoicing method- provides more accurate billing.*
- *By identifying consumption habits, electricity suppliers can make better offers to consumers, e.g. time of use tariffs. These tariffs enable consumers to decrease their electricity bills by shifting the use of certain devices (e.g. washing machines) to periods when electricity is cheaper.*
- *Due to two-ways communication that smart meters offer, utilities are able to communicate better with consumers, by e.g. noticing them about delays of bill-payment. No utility company employees are required any more to read the meters.*
- *Smart metering enables constant monitoring of the electricity grid, making utilities able to respond to blackouts and voltage level oscillations much faster.*

However, smart meters might have disadvantages as well:

- *Consumers, who do change their (wasteful) consumption habits, might pay more for electricity in case of time of use tariffs.*
- *Intstalling smart meters cost money, utilities will most probably shift the costs (at least partially) to their consumers.*
- *Privacy and healthcare issues.*

▪ What do you think about this concept? What did you like the most and the least? Why?

4. Financing, prices (10 minutes)

▪ Would you be willing to pay for such a device?
▪ How much would you pay for it? If you can not say exact amount, within what period should it return its price?

- Should other parties take part in financing the introduction of smart meters?
- Would you prefer paying it in one amount or in parts? Should it be embedded into the electricity fee?

5. Farewell, end of interview.

Quantitative research

To examine consumers' attitudes towards smart meters an on-line, web-based quantitative survey has been conducted, since an on-line survey offers several advantages:

- it is inexpensive,
- is able to self-administer, and
- the probability of data errors is very low.

However, this method has also a few disadvantages that may cause several possibilities for bias:

- not all desired respondents have internet connection or technocrats' attitude,
- customers may be distrustful of exposing information online. (Bhaskaran [2010])

The sample size was N=293.

The applied method was snowball sampling. It is a nonrandom method, in which existing study subjects recruit further subjects out of their contacts. As Biernacki and Waldorf state, "snowball sampling increases efficiency, identification, and inclusion of hidden populations by having members of the target population recruit other members. However, snowball sampling lacks validity in representation because the composition of the sample is dependent upon the choice of seeds (initial recruits) and short recruitment chains (the recruits of seeds)" (Biernacki and Waldorf 1981), although it is an inexpensive and efficient research method.

Biernacki and Waldorf add that snowball sampling overrepresent hubs (subjects with above-the-average number of acquaintances), thus sampled networks from snowball sampling seem to be less diverse than the original network. Since vast majority respondents live in Budapest, clients of Budapest electricity supplier ELMŰ were overrepresented in the current sample.

Scheduling of the survey included the following phases:

1) designing the questions,
2) programming,
3) pre-testing,
4) posting to Facebook.

Designing the questions

To minimize bias there are certain pitfalls to be avoided when designing questions. (Fielding *et al*. 2008)

- Unclear or foreign words.
- Nonspecific or leading questions.
- Leading questions.
- Misplaced questions.
- Mutually non-exclusive categories.
- Double barreled and dichotomous questions.
- Unbalanced or non-exhaustive listings.

Considering the factors mentioned above, the structure of the questionnaire came across as follows.

Introduction

Present survey -as part of a Central European University master thesis- aims to explore how Hungarian households would accept new electricity consumption metering technologies. Filling in the survey takes aproximately five minutes.

In order to answer all questions, you are required to have knowledge about your household's energy affairs. In case you're personally not familiar with these issues, please hand over or forward this survey to the person who is. Taking part in present survey is voluntary and entirely anonymous. Personal data are not recorded.

Thank you,

Andras Nagy

Section 1: general questions

1.) Which company is your electricity supplier?

( ) E.ON, ( ) ELMŰ-ÉMÁSZ, ( ) DÉMÁSZ, ( ) other, ( ) I do not know/do not answer

2.) Do you self-read the electricity consumption every month or pay an estimation-based monthly flat fee?

( ) monthly self-reading, ( ) pay a monthly flat fee, ( ) I do not know/do not answer

3.) How do you settle your electricity bill?

( ) postal cash payment, ( ) payment by direct debit, ( ) bank transfer, ( ) personally at the customer service office, ( ) other, ( ) I do not know/do not answer

4.) How much is your household's monthly electricity bill? (If do not know, leave it blank)

____

Section 2: consumption and billing-related questions

5.) Do you know how much electricity is consumed by your household in a month?

( ) I know it precisely, ( ) I know it roughly, ( ) I do not know/do not answer

6.) Do you check whether your electricity bill reflects the factual electricity consumption?

( ) yes, regularly, ( ) sometimes, ( ) never, ( ) I do not answer

7.) Electricity bills contain lots of data and information. Do you know what the figures mean?

( ) I know what all the figures and data mean, ( ) I know what most of the figures and data mean, ( ) I do not know what most of the figures and data mean, ( ) I can not interpret the figures and data at all, ( ) I do not answer

8.) Do you know how much your electronic devices (washing machine, TV, refrigerator, etc.) consume?

( ) yes, I know that about all of them, ( ) I know that about some of them, ( ) I know that about none of them, ( ) I do not answer

9.) Please rate how strongly the following statements are typical of you on a scale of 1-6 by placing a check mark in the appropriate box.1 means that not typical at all and 6 means that the statement is strongly typical. You may check the values between to shade your opinion.

	1	2	3	4	5	6
I am interested in new technical solutions/technical appliances.	( )	( )	( )	( )	( )	( )
I use computers regularly.	( )	( )	( )	( )	( )	( )
I regularly use the internet.	( )	( )	( )	( )	( )	( )
I find it important to have a cell phone of the latest technical trends.	( )	( )	( )	( )	( )	( )
I switch off the light when leaving the room.	( )	( )	( )	( )	( )	( )
I try to open the fridge less times to reduce consumption.	( )	( )	( )	( )	( )	( )
When I buy a new electronic device I choose the one that consumes less.	( )	( )	( )	( )	( )	( )
In my opinion it is important to protect the environment.	( )	( )	( )	( )	( )	( )

Table 5.: Likert-scale questions

Section 3: SM-related questions

Hereby I introduce a device that is used for metering electricity consumption. It is called smart meter ("okosmérő"). *Smart meters are smaller in size than the current meters, operate digitally, record consumption data and have network connection. They enable two-way communication with the utility and by means of that electricity consumption can be metered and tracked constantly both for the consumer and the utility. Thus consumption and load can be better planned. By installing this device there is no need either to self-read the meter or meet the utility employee to execute the reading. Such devices might later replace existing gas-meters, too.*

10.) Have you heard about smart meters before?

( ) yes, ( ) no

11.) Please rate how much you like the idea of smart meters on a scale of 1-6. (1= I do not like it al all, 6= I like it very much)

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6

12.) What kind of functions do you think the smart meters should provide? (more options can be checked)

[ ] Gives an alarm when electricity consumption goes above the previous month's average

[ ] Shows electricity consumption real-time, expressed in money terms

[ ] Gives a signal when electricity price is the lowest

13.) Would you replace your current meter with such smart meter?

( ) surely not, ( ) likely not, ( ) likely yes, ( ) surley yes, ( ) I do not know/do not answer

Closing section: demography

15.) Respondent's sex

( ) male, ( ) female

16.) Respondent's age ________

17.) Education

( ) elementary school, ( ) vocational school, ( ) highschool, ( ) college/university

18.) Household's montly net income ________

19.) Number of persons living in the household (together with the respondent)

____

20.) Your household's heating

( ) gas, ( ) coal, ( ) district heating, ( ) wood, ( ) electricity, ( ) other

21.) What electronic appliances do you use in the household? (More options can be checked)

[ ] refrigerator, [ ] freezer, [ ] washing machine, [ ] dish washer, [ ] TV, [ ] HiFi set, [ ] air conditioner, [ ] electric boiler, [ ] other

Thank your for your contribution! In case you have questions about present survey please contact me via okosmerokutatas@gmail.com e-mail address.

András Nagy

Programming and pre-testing

The survey was programmed and executed by means of an online survey tool, Surveygizmo (http://www.surveygizmo.com). This application has many decisive advantages: it is free of charge to a certain limit, supports various languages (including Hungarian) and enables several question types. For pre-testing ten acquaintances were asked to contribute.

Posting to Facebook

Facebook, as the world's most popular social networking site with 640,000,000+[11] registered users provides a very effective platform for posting the survey link. I inserted the link to my profile two times. The deadline for completing the survey was set at one week, from 10 to 17 June. Due to the structure of my social network it was presumed that most of the respondents would be Budapest utility ELMŰ consumers, thus acquaintances were asked to share to link further, especially to social contacts off the ELMŰ service area. However, the sample was strongly biased for ELMŰ consumers.

Fig. 13.: Facebook screenshot with the survey link

[11] March 2011 data

Qualitative research findings

In general, perceptions of smart metering were positive. Interviewees, for whom electricity bill was a concern, showed more interest towards smart meters. The possibility to save money on the bill was the key factor for acceptance, although respondents could not tell why it was good for the utilities to promote energy savings. The potential price of smart meters also proved to be a key issue. Interviewees found the idea of various electricity tariffs positive but they were not sure if they could significantly change their consumption patterns. Only one of the respondents had heard about smart meters before.

On the whole, utilities were not evaluated as positive[12]: consumers feel vulnerable in relation to the utility giants. They mentioned several reasons for that:

- ambiguous price changes,
- vague electricity bills,
- no real competition, no significant price difference in the market,
- problems with customer service.

Electricity use

Respondents did not think that they used too much or were wasting energy, but they think that they pay far too much for it.

"No one [of the consumers] *knows how much electrical energy is actually generated in or imported into the country, we just receive the bill. I think it is the interest of electricity companies to hide this so that they can make extra profit"* (Senior couple, electricity bill is a concern)

As for bill payment, behavior is diverse: two of the four interviewees pay flat fee, while the other two carry out self-reading (one of them dictates the metered data via telephone, one uses the internet). The reason for paying a flat fee is that

i) it is more comfortable:

"We tried to do the self-reading and then dictate it to the utility but we always forgot about it so finally we ended up paying a flat fee." (Younger couple with no children, electricity bill is not a concern)

[12] Can not be handled as a representative opinion, all households interviewed were clients of the same utility.

ii) or being confused by technology, as Interviewee #2 (Senior lady) said that she tried to phone the customer service to dictate the metered data but "*got lost in the automatic call centre"* so finally chose paying a flat fee. This amount should cover actual consumption anyway, she added, since at the end of the year, when the difference between the flat-fee and the actual consumption is setted, receives some thousand forints back from the utility.

The motivation behind self-reading is also diverse: interviewee #1 (Young family with two children, electricity bill is a concern) hopes to decrease their electricity bill this way, while interviewee #3 (Senior couple, electricity bills are a concern) -due to the exactitude of their characters- *"just like to know, how much is being spent"*

All responding households try to save electrical energy one way or other. However, the reason behind that was primarily always the money, environmental concerns came up only as a second reason at best.

„I am pretty sure that I should have said that I was saving energy due to environmental reasons, all those coal-fuelled electricity plants and all that, but I do not think that there was anyone to mention it in the first place. Money concerns are much stronger. It is the best if I also help the environment through my savings, but this is not the core reason" (Young family with two children, electricity bill is a concern)

Generally, interviewees do not check the electricity bill except it is found irregularly high. The usual way of behavior in such cases is that respondents complain at the customer service where typically get informed about consumption figures.

"The ladies explained to me that the bill was right and -according to the metered values- it turned out that we consumed really that much. However, when I put down the receiver, I was still puzzled about actually how we could consume that much"

(Senior couple, electricity bill is a concern)

All respondents were interested in any solution that enhance electricity savings, thus reducing electricity bills. Actually, respondents would be open to purchase more efficient household devices (new fridge or washing machine, LED or compact lights, etc.) but in most cases it is the matter of consumer prices. As for changing habits, they would be open to optimize heating temperature, switch off unused devices and lights, unplug stand-by appliances and washing in energy saving mode - all of them could mention more than one of these actions. However it is still questionable how much they really follow those norms in everyday life.

Interviewees were curious about a "new device that could help them save energy" but there was some uncertainty about whether it is

i) *"a trick from utilities that will cost a lot for ordinary consumers"* (senior lady),

ii) the right way to decrease energy consumption.

Concept of smart meters

Due to the constantly rising energy prices the acceptance of smart meters are expected to be positive in case they really help consumers cut back their electricity bills. Out of the characteristics of the smart meters the following ones were found by the interviewees as most attractive (in descending order):

1. possibility of influencing electricity consumption, thus reducing bills,
2. better transparency, more accurate bills,
3. more consciously planned consumption,
4. possibility of constant monitoring.

"I guess this is where the name comes from: smart meters must be like smart phones, offering better service and more functionality to consumers. If it's not expensive, I'd like to have one" (Younger couple with no children)

Despite these advantages offered by smart meters, there was a certain level of scepticism among the respondents: they said that the current meters also capable of constant measuring and can be checked any time.

„I write our consumption in a notebook every month. During the month it is needless to check the meter - we already take care of consuming as little as possible" (Young family with two children, electricity bill is a concern)

Interviewees definitely liked that smart meters -since they can be read any time between monthly intervals- make it easier to switch electricity supplier. All of the respondents agreed that market competition and diverse tariffs are (in theory) good for the end user: they brought up analogies from mobile telecommunication. However, respondents were confused about how it was possible in practice to switch supplier and whether it creates any benefits. They also said that there was no real competition in the Hungarian market.

"It's all the same if I contract another electricity company: the electricity is generated it the same power plants and distributed through the same network. Additionally, I don't remember receiving any alternative offers from electricity traders." (Younger couple with no children)

When mentioning possible disadvantages of smart meters, privacy issues proved to be a major concern, although respondents had no prior experience with such devices, nor data leaks/piracy. This might be a strong obstacle to the roll-out of smart meters, therefore guaranteeing safe data handling and clear communications seem to be vital for the future.

Since smart meters do not decrease the electricity bill in themselves, consumption habits also need to be changed. At this point, respondents expressed doubts. They said that it was hard to imagine how to alter consumption habits -although they were open to it- in order to decrease electricity bills, since consumption is closely attached to their lifestyles (e.g. they watch TV and turn on the lights in the evening, they need hot water before going to bed etc.). Respondents could only imagine a switch in using washing machines but even that had some serious barriers.

"I don't think that I could do the washing at night: my washing machine is not programmable like that. Besides, it's noisy and the clothes go stinky by the morning." (Senior lady)

However, in general, individual consumption-based, diverse tariffs would be welcome but there was a concern about even less clear and transparent invoicing.

Interviewees were, on the other hand, less enthusiastic about having no utility employees to read the meters: some respondents expressed sympathy towards the workforce to be dismissed. Meter reading was not considered as a burden since i) utilities can be informed about metered data via phone or internet, or ii) in case that it is forgotten in due time, a flat fee-bill is issued.

However, one respondets said it would be definitely better to replace human workforce with remote reading.

“The meter is down in the basement. Sometimes I can’t read it correctly because it’s too dark over there”. (Senior couple)

Regarding the functionality of two-ways communication respondents found it useful to receive price signals, prior notices of blackouts and special price offers through smart meters. One of them was dubious as to whether the system would work effectively and in a reliable fashion.

"Old meters always worked perfectly. I don't know whether they were also accurate but reliable for sure." (Senior couple)

In-home displays are expected to show the actual consumption in money terms. Due to its simplicity, respondents could imagine a traffic light-like system to indicate excess real-time consumption based on e.g. last month's timely average.

"If it suddently turns from green to red it means that something happened, I left the TV on up there. I would find it helpful because it would be a simple way of telling me that I was using a lot of power or not." (Young family with two children)

The idea of utilities being quicker to disconnect non- or late-paying customers was greeted on one hand (*"we pay for the free-riders' consumption"*), but on the other hand it was not found right that *"those multinational companies can do whatever they want"*, including sudden disconnections due to unpredicted system failures. There is a demand for clear and transparent protocols for disconnection.

Increased competition and more accurate metering seemed to be a great advantage of smart meters. Nevertheless, respondents were not sure if the digital devices would be more accurate than the current analogue ones. Internet and wireless data transfer was acknowledged dubiously: interviewees worry about hackers and system cracks - although none of them had such experiences before. In connection with GPRS-technology the problem of mandatory cell-phone/SIM-card subscription also emerged.

Financing

Financing and the price of the devices happened to be the biggest concern above all.

i) In case of mandatory roll-out the uniform opinion was that implementation should be financed by the electricity companies.

"If it's going to be mandatory, it is the electricity companies who should pay for it, since this whole will serve their interest! On the other hand, it is the consumer who will finally pay for it, anyway." (Senior couple)

ii) In case of voluntary roll-out respondents expressed willingness to pay for the devices, but the amount should be low and paid in monthly installments. Generally, respondents are most willing to pay as much as they can save on the energy bill - in practice it is expected to be about HUF 1000-2000/month, investment is expected to return within one or two years. Interviewees estimated the total capital costs (including background infrastructure etc.) of smart meters about HUF 30 -
50 000 / household.

All respondents agreed that both the state (including the EU) and the utilities should take part in financing, although they know that utilities would shift at least part of the costs to their clients. The need for EU financing is also obvious: in respondents' view the EU is looked at as a distant institution that *"used to finance such things".* The best proportion suggested for financing was 1/3 for all parties involved (household-state-utility).

Respondents pointed out that they were willing to pay much less for the metering device in itself since it is a "*mandatory to have item"*.

The most attractive element of the metering infrastructure was the in-home display, although respondents having internet connection (three out of four) preferred a web-based consumption-monitoring tool.

Quantitative research findings

The quantitative research was an attempt to map consumer attitudes towards i) general, electricity and utilitiy-related issues and ii) smart meter-related topics that might influece future roll-out. Descriptive statistics, basic distributions and cross-tabs were used in data evaluation. Due to the facts that respondents did not give complete/assessable answers to all questions and there is a word-length limit, I focused on select findings. Significance level is always set at $\alpha=0.05$.

Among the respondents women represented 50.5%, while men 49.5%. Age of the respondents ranged from 23 to 63 years, the most frequent value was 31. As for education, 83% reported to have university/college education[13], while 16% had highschool and 1.4% vocational school background. 32% live alone, while 36% in a two person household. 15% reported to have 3, 13% said to have 4 people in the household.

As it was anticipated, vast majority, 80% of the respondets were ELMŰ's clients. E.ON consumers represented 11%, DÉMÁSZ's 4% in the sample. Majority (59%) of the sample respondents pay a flat fee and let the utility read the meters once a year, while 40% self-read the meters.

[13] biased due to snowball sampling

The research revealed that postal cash payment is extremely popular amongst respondents to settle their electricity bills: 61% of them reported to pay this way, while only one-quarter of them used bank transfer and 12% direct debit.

	N	Minimum	Maximum	Mean	Std. Deviation
household's monthly electricity bill	257	1750	34000	9542,86	5970,761
Valid N (listwise)	257				

Table 6.: monthly electricity bills

In total 257 respondents indicated the amount of their mothly electricity bill. As it is shown in table 6., the minimum amount paid was HUF 1750, while the maximum came around at HUF 34 000. The mean amount was HUF 9542 a month.

While respondents reported that they were aware of the amount they spend on electricity in a month, they were much less aware of how much electricity they consumed. Only 13% of the respondents claimed to have knowledge about their actual consumption, 45% knew that approximately and 42% did not know about it at all. The latter figure in the distribution reflects a relatively low level of awareness. 38% of the respondents admitted that they never check, whether the electricity bill reflects the factual consumption. 41% check the bill every now and then, while 20% do that regularly. 50% of the sample don't or just partly know what the information on the bill mean, while only 4% answered that they were familiar with all the figures and data. One-third of the respondents did not know at all how much their electronic devices consumed.

Questions in Table 7. were designed to explore respondents' attitudes towards technical gadgets and the environment. Respondents found environmental protection very important (with mean value of 5.38 out of 6), however they did not pay extra attention to save energy (e.g. they don't consider too much to open the fridge less times in order to save energy). Regular use of the internet was very typical of the sample but they were not obsessed with possessing the latest smart phones and were moderately enthusiastic about new technical solutions. In order to facilitate cross-tabs, clusters[14] were formed from answer values (Table 8.)

[14] Not a statistically standard cluster analysis method.

	N	Minimum	Maximum	Mean	Std. Deviation
I am interested in new technical solutions/technical appliances	292	1	6	4,32	1,568
I use computers regularly	293	1	6	5,65	,946
I regularly use the internet	290	1	6	5,62	,938
I find it important to have a cell phone of the latest technical trends	293	1	6	2,82	1,443
I switch off the light when leaving the room	292	1	6	4,92	1,364
I try to open the fridge less times to reduce consumption	293	1	6	4,00	1,658
When I buy a new electronic device I choose the one that consumes less	293	1	6	4,42	1,475
In my opinion it is important to protect the environment.	293	1	6	5,38	1,016
Valid N (listwise)	289				

Table 7.: attitudes

Values	Cluster indicator	Category
< 4.1	1	"Passive conservative"
4.1 - 4.99	2	"Medium eco/tech-conscious"
> 5	3	"Active conscious"

Table 8.: cluster categories

Attitude categories were labelled as "Passive conservative", "Medium eco/tech-conscious" and "Active conscious". As Table 9. shows, 16.7% of the respondents fit into the first cluster, while 45.7% and 36.2% into the second and the third, respectively.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Passive conservative	49	16,7	17,0	17,0
	Medium eco/tech-conscious	134	45,7	46,4	63,3
	Active conscious	106	36,2	36,7	100,0
	Total	289	98,6	100,0	
Missing	System	4	1,4		
Total		293	100,0		

Table 9.: frequency and distribution of cluster categories

Table 10. shows that respondents of the "active conscious" cluster know the consumption of various electronic devices of their households much better than respondents of the "passive conservative" cluster. The correlation between the variables is found to be statistically significant (chi-square with six degrees of freedom = 26.663, p=0.000).

			cluster			Total
			Passive conservative	Medium eco/tech-conscious	Active conscious	
Do you know how much your electronic devices consume?	1	I know that about all of them	2	15	20	37
		% within total	5,4%	40,5%	54,1%	100,0%
		% within cluster	4,1%	11,3%	18,9%	12,8%
	2	I know that about some of them	20	75	66	161
		% within total	12,4%	46,6%	41,0%	100,0%
		% within cluster	40,8%	56,4%	62,3%	55,9%
	3	I know that about none of them	26	43	20	89
		% within total	29,2%	48,3%	22,5%	100,0%
		% within cluster	53,1%	32,3%	18,9%	30,9%
	99	NA	1	0	0	1
		% within total	100,0%	,0%	,0%	100,0%
		% within cluster	2,0%	,0%	,0%	,3%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26,663[a]	6	,000
Likelihood Ratio	25,631	6	,000
Linear-by-Linear Association	4,782	1	,029
N of Valid Cases	288		

Table 10.: Cross-tab between awareness of electricity-consumption and clusters

However, respondents seem to gain consumption information only from the electricity bill: as it is shown in Table 11. respondents, who exactly know how much their devices consume, tend to to check the electricity bills more regularly. Reversely, people who never check the bill, don't know about consumption volumes either. The correlation is statistically significant, p=0.000.

			Do you check whether your electricity bill reflects the factual electricity consumption?				
			yes, regularly	sometimes	never	NA	Total
Do you know how much electricity is consumed by your household in a month?	1	knows it precisely	20	15	0	0	35
		% within total	57,1%	42,9%	,0%	,0%	100,0%
		% within cross-value	35,1%	12,5%	,0%	,0%	12,0%
	2	knows it roughly	33	65	31	1	130
		% within total	25,4%	50,0%	23,8%	,8%	100,0%
		% within cross-value	57,9%	54,2%	27,9%	33,3%	44,7%
	3	does not know	4	40	80	2	126
		% within total	3,2%	31,7%	63,5%	1,6%	100,0%
		% within cross-value	7,0%	33,3%	72,1%	66,7%	43,3%
Total		Count	57	120	111	3	291
		% within total	19,6%	41,2%	38,1%	1,0%	100,0%
		% within cross-value	100,0%	100,0%	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	92,323[a]	6	,000
Likelihood Ratio	104,200	6	,000
Linear-by-Linear Association	2,593	1	,107
N of Valid Cases	291		

Table 11.: frequency of checking the bill and consumption awareness cross-tab

Although there was no significant correlation found between age and the ability to comprehend bill information or between age and consumption awareness, men seem to know the devices' consumption significantly better than women (Table 12.)

			Male	Female	Total
Do you know how much your electronic devices consume?	1	I know that about all of them	25	11	36
		% within total	69,4%	30,6%	100,0%
		% sex distribution	17,9%	7,7%	12,8%
	2	I know that about some of them	83	72	155
		% within total	53,5%	46,5%	100,0%
		% sex distribution	59,3%	50,7%	55,0%
	3	I know that about none of them	31	59	90
		% within total	34,4%	65,6%	100,0%
		% sex distribution	22,1%	41,5%	31,9%
	99	NA	1	0	1
		% within total	100,0%	,0%	100,0%
		% sex distribution	,7%	,0%	,4%
Total		Count	140	142	282
		% within total	49,6%	50,4%	100,0%
		% sex distribution	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15,923[a]	3	,001
Likelihood Ratio	16,602	3	,001
Linear-by-Linear Association	,331	1	,565
N of Valid Cases	282		

Table 12.: respondents' sex and consumption awareness cross-tab

The correlation between the two variables is statistically significant (chi-square with three degrees of freedom = 15.923, p=0.001, that is <0.005).

74.4% of the respondents claimed that they have not heard about smart meters before. After reading the short introduction about smart meters, respondents' opinion was positive: the mean value of the 1-6 scale was 5.07 (Table 13.)

	N	Minimum	Maximum	Mean	Std. Deviation
Please rate how much you like the idea of smart meters	280	1	6	5,07	1,097
Valid N (listwise)	280				

Table 13.: attitude towards smart meters after reading about it

The research has reinforced the initial assumption that environmentally conscious and technically open respondents would like the idea of smart metering much more: respondents of the "active conscious" cluster significantly rated smart meters higher, in this cluster the mean Likert-scale value was 5.47, as compared to "passive conservative" respondents, who gave 4.33 points in average.

cluster	Mean	N	Std. Deviation
Passive conservative	4,33	48	1,277
Medium eco/tech-conscious	5,01	125	1,074
Active conscious	5,47	104	,836
Total	5,06	277	1,101

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Please rate how much you like the idea of smart meters * cluster	Between Groups	(Combined)	43,258	2	21,629	20,326	,000
	Within Groups		291,572	274	1,064		
	Total		334,830	276			

Table 14: rating the idea of SM and cluster values cross-tab

As the one-way analysis of variance (ANOVA table) indicates that "active conscious" respondents significantly liked the idea of smart metering more (p=0.000).

Sex	Mean	N	Std. Deviation
Male	4,93	135	1,198
Female	5,21	139	,989
Total	5,07	274	1,104

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Please rate how much you like the idea of smart meters * sex	Between Groups	(Combined)	5,191	1	5,191	4,313	,039
	Within Groups		327,350	272	1,203		
	Total		332,540	273			

Table 15.: rating the idea of SM and sex values cross-tab

Table 15. shows that women liked the idea of SM more (they rated it 5.21 out of 6 as average) than men did. However, the correlation of the variables is not statistically significant. From the research it also turned out that those respondents, who rated the idea of SM higher, would more certainly replace their meters to smart ones (significant correlation). The idea of smart meters was not ranked significantly higher by either respondents executing self-reading or paying a flat fee for electricity, although members of the first group liked it somewhat more.

Do you know how much your electronic devices consume?	Mean	N	Std. Deviation
I know that about all of them	5,19	36	1,117
I know that about some of them	5,06	155	1,100
I know that about none of them	5,08	87	1,014
NA	1,00	1	.
Total	5,07	279	1,099

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Please rate how much you like the idea of smart meters * Do you know how much your electronic devices consume	Between Groups	(Combined)	17,153	3	5,718	4,936	,002
	Within Groups		318,553	275	1,158		
	Total		335,706	278			

Table 16.: rating the idea of SM and consumption awareness cross-tab

Respondents who know how much their electronic devices consume (that is 13% within all respondents) ranked smart meters higher. (Table 16.) As $p<\alpha$, the correlation is significant.

Finally, as it is indicated in Table 17., the "active conscious" respondents gave the majority of the group aswering *surely, yes* to the question *would you replace your current meter with such smart meter,* while only 6.1% of "passive conservative" respondents shared this opinion. There was a significant correlation between clusters and the willingness to replace meters.

			cluster			Total
			Passive conservative	Medium eco/tech-conscious	Active conscious	
Would you replace your current meter with such smart meter?	1	surely not	0	0	2	2
		% within total	,0%	,0%	100,0%	100,0%
		% within cluster	,0%	,0%	1,9%	,7%
	2	likely not	9	12	6	27
		% within total	33,3%	44,4%	22,2%	100,0%
		% within cluster	18,4%	9,3%	5,7%	9,5%
	3	likely yes	31	81	63	175
		% within total	17,7%	46,3%	36,0%	100,0%
		% within cluster	63,3%	62,8%	60,0%	61,8%
	4	surley yes	3	19	25	47
		% within total	6,4%	40,4%	53,2%	100,0%
		% within cluster	6,1%	14,7%	23,8%	16,6%
	99	NA	6	17	9	32
		% within total	18,8%	53,1%	28,1%	100,0%
		% within cluster	12,2%	13,2%	8,6%	11,3%
Total		Count	49	129	105	283
		% within total	17,3%	45,6%	37,1%	100,0%
		% within cluster	100,0%	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17,033[a]	8	,030
Likelihood Ratio	17,726	8	,023
Linear-by-Linear Association	,689	1	,407
N of Valid Cases	283		

Table 17.: willingness to change for smart meters and cluster values cross-tab

Only 11 respondents indicated an amout they would pay for smart meters. In average, consumers would pay less, than HUF 11,000 for the metering devices.

	N	Minimum	Maximum	Mean	Std. Deviation
How much would you pay for such a device?	11	0	50000	10954,55	14512,847
Valid N (listwise)	11				

Table 18.: willingness to pay for SM

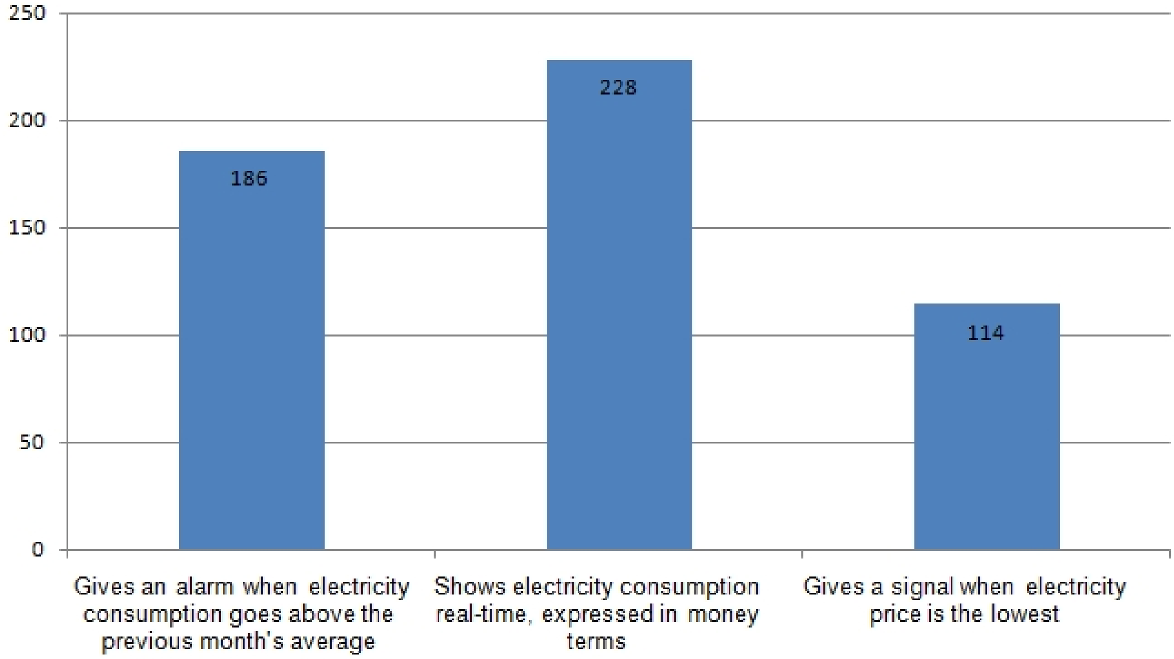

Fig. 14.: desired functions of smart meters, based on respondents' answers

In total, 257 respondents expressed their desires regarding the functionalities SMs (or the displays that could be connected to them) should provide. The most people would prefer to see the visualized electricity consumption defined in money terms. The second most popular feature was the alarm signal sent if the household's consumption exceeds previous month's levels. The less favoured functionality was a signal alerting the user when electricity is inexpensive.

Conclusion

The pace of SM-expansion has slowed down in Europe recently. It is due to various factors, but probably the two most important ones (not to mention the general economic downturn) are: i) the lack of standards and proper regulation and ii) the lack of suitable business models. Some early adopters have already launched pilots and implementation projects. However, regarding the substantial cost factor of SM-deployment and the potential technology lock-in effect, those countries run a significant risk - particularly because there are no common technical and functional requirements identified yet.

Simultaneously, it is now not doubted that smart metering and mainly smart grids are good tools to -among others- decrease GHG-emissions, increase energy efficiency, integrate micro-generation and lift service security on a longer term. Based on cost-benefit calculations smart metering creates benefits in all economies it has been introduced. However, the way benefits will be distributed is still questionable: is it going to be the households or the utilities who benefit the most? .

While bigger economies have taken steps towards SM-deployment, smaller ones, like Hungary, try to wait the process out and seek to adapt the model when it is mature enough (the "advantage of the latecomers").

Nevertheless, the 3 September 2013 deadline set for accomplishing CBAs is rapidly coming for all member states. In order to get a well-grounded analysis, pilot projects must be launched by the end of this year the latest, since one or one and a half years are said to be needed for proper evaluation.

In Hungary minor preparations has been done so far: one comprehensive study was prepared based on the assignment from the Hungarian Energy Office to examine options and possibilities for introducing smart meters in the country. Out of the study only the final report has been published. The Governmental Decree designed to regulate the SM pilot projects is expected to get ready in the second half of 2011 - pilots would be launched only after that. Therefore some have doubts about whether Hungary will be able to meet the deadlines.

It is now clear that neither the system operator (i.e. the state) nor the market actors will be able to implement smart meters alone in Hungary. For a successful implementatiton all stakeholders (political groups, business players, consumer and environmental advocacy groups) must co-operate.

According to several experts, customer acceptance and participation are the key factors for a successful SM-implementation. However, households' electricity consumption patterns and attitudes towards smart meters are not mapped yet in Hungary: that was the idea that present research was based upon.

In the qualitative phase four in-depth interviews have been conducted, while in the quantitative research 293 respondents were recruited by snowball sampling.

For two-third of all the respondents it was the first time to hear about smart meters. In general, the attitude was positive. It was the possibility to decrease consumption and reduce the bill that respondents found the most attractive about SM. Respondents with a technically open and environmentally conscious mindset liked the idea of smart meters significantly more than others. They would also replace their current meters to smart ones with pleasure.

The strongest anti-SM argument was the concern of privacy in personal interviews, although none of the respondents had been victim of data hacking or piracy before.

The most critical issue was the price: how much SMs would cost to the consumers and in what time the investment would return.

59% of the respondents pay estimation-based flat fee for electriciy. 42% of the sample don't know how much electricity their households consume, and 79% not or just seldom check the bill whether the amount is in line with the actual consumption.

This suggests a Iow level of awareness therefore ample amount of education is required to achieve increased demand-side participation in electricity service. It means that total costs of the implementation could be higher than expected.

Besides that -since respondents' answers indicated increased price-sensitivity- price / tax incentives and rewarding schemes may improve the overall acceptance of smart meters. Consumer attitudes are advised to research further (on a more representative sample) since technically and environmentally open customer groups are more likely to volunteer in e.g. SM pilot projects.

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