Chapter 15
Energy Smart Metering Diffusion and Policy Issues

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Introduction

Environmental degradation and global warming are among the major global challenges facing our societies. Strong action is needed at a global level to better manage water resources, halt the loss of biodiversity, increase prudent use of natural resources and rare materials, reduce green house gas emissions, and tackle climate change.[1] Among these challenges, the most immediately pressing is to reduce the increase of green house gases in the atmosphere and possibly to decrease the absolute level of green house gases of all kinds.

ICT and Climate Change

ICT has a major role to play in improving environmental performance and addressing climate change across all sectors of the economy. ICT technologies can help reduce energy consumption and manage scarce resources, can improve efficiency, and contribute to cut carbon emissions. Europe recognizes the importance of ICT solutions in achieving energy efficiency. This was clearly underlined since 2008 at the world's biggest computer trade exhibition (*Centre of Office and Information technology*—CeBIT) when the European Union Commission's President Barroso said that "Europe must more than double its rate of improvement

[1] See on this Pupillo, Salanave & Vickery (2009), Introduction to Communications & Strategies N. 76 , 4 Quarter

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in energy efficiency and there is tremendous untapped potential in using ICTs. The real gain in energy efficiency will come from ICT as an enabler to improve energy efficiency across the economy. ICT matters for energy reduction, especially in transport and the energy intensive sectors. ICT's ability to organize and innovate is a key factor."

On the basis of *Directive 2006/32/EC* on energy end-use efficiency and energy services, each EU member State has prepared its *Energy Efficiency Action Plan* (EEAP) which describes the energy efficiency improvement measures planned at national level to achieve the energy savings target, to be reached by way of energy services and other energy efficiency improvement measures. The full implementation of the EEAP can help in reducing energy consumption and is therefore an important tool to achieve the ambitious "20-20-20" goal by 2020: saving 20% of the EU's primary energy consumption, reducing by 20% the emission of greenhouse gases (GHG), and increasing to 20% the share of renewable energies.

Smart Grid and Smart Metering

Energy efficiency is both the result of policy developments and the application of concrete measures. Technology development, environmental legislation, taxation, and other fiscal measures provide strong incentives for markets to realize cost-effective energy savings.

Governments along with the energy industry are looking for better and greener ways to produce and use energy. User-friendly ICT-based energy monitoring and optimization systems can intelligently connect more energy-efficient components and accelerate the changes in consumer behavior. An important aspect in any attempt to tackle climate change is to promote energy efficiency in residential and commercial buildings and the introduction of smart applications is a key part of enabling consumers to use less energy and use it in a "smarter" way.

Smart Grids are one of the most important ICT-enabled solutions with the highest potential to reduce CO_2 emissions. The Climate Group[2] defines "smart grid" as a set of software and hardware tools that provides specific and real-time information to end-users, grid operators, and distributed generators with the aim of reducing energy losses, improving network operational efficiency, achieving better quality and reliability of energy supply, allowing customer to control of their energy use and, finally, reducing GHG emissions. The smart grid is an innovation that has the potential to revolutionize the transmission, distribution, and conservation of energy. ICT achieves this by: (1) transitioning the grid from a radial system to an

[2]Climate Group, SMART 2020: Enabling the Low Carbon Economy in the Information Age, 2008. Available:

http://www.theclimategroup.org/publications/2008/6/19/smart2020-enabling-the-low-carbon-economy-in-the-information-age/

interconnected network, where distributed sources and end-users are connected; (2) automating processes using distributed intelligence; and (3) enabling, through smart metering, two-way communication between customers and suppliers to create a real-time marketplace for energy consumption. ICT can help modernize the electrical grid reducing transmission and distribution losses, reporting real-time usage and cost data to increase consumption awareness and integrating renewable energy.

To achieve these objectives, priority is given to Smart Metering deployment. Indeed, the current electricity grids fail to achieve the objectives that are set in the "Climate-Energy Package." A real "décarbonisation" calls for a modernization of power systems, improved performance, and a new generation of micro and macro-technologies.

Therefore, meter modernization is a logical step in the context of energy markets evolution and consumer uses. Indeed, the widespread deployment of advanced metering systems is, in electricity as well as gas, a major issue in the long term, for all European countries. Directive 2009/72/EC concerning common rules for the internal market in electricity encourages the development of smart grids and smart metering, to help reduction of European energy bill and *greenhouse gas emissions* (GHG).

The balance of this chapter is organized into five sections. Section II presents the benefits from smart metering diffusion. Section III focuses on the obstacles to large-scale implementation of smart meters. Section IV then discusses how policy can help in getting over these obstacles and presents the case study of the energy efficiency project E-Cube, a Private Public Partnership partially funded by the Italian Ministry of Economic Development, as an application of smart metering technologies. Section V concludes and discusses the challenges for further research.

Benefits from Smart Metering

There are four major benefits from smart metering diffusion: (1) increasing consumer awareness of energy consumption; (2) fostering retail competition; (3) offering real-time pricing; and (4) integrating renewable energy.

Increasing Consumer Awareness

Smart Meters technology allows consumer to have an accurate representation of energy consumption. There is broad evidence in the literature that consumers save energy when aware of their consumption pattern. Saving from direct feedback ranges from 5 to 15% (Darby 2006).

Indeed, consumers have very limited information on energy consumption and any feedback enabled by smart meters will be of great interest. It will increase the awareness of energy consumption by making it both more visible on a daily basis but also clearer and more accurate, enabling better understanding of energy use.

According to Darby (2006), there are two important feedbacks:

- *Direct feedback:* it leads to a reduction in energy consumption in the range of 5–15%. It is considered immediate information available via a digital display (*in-home display*). Indeed, the view in real time will facilitate the understanding of consumption and will help consumers through a clearer billing system.
- *Indirect feedback*: the raw data are processed by the utility and sent out to customers on a regular basis. The bills can be sent more frequently and can be complemented with historical feedback and annual or quarterly report on energy consumption. This feedback leads to savings up to 10% on energy bills.

Furthermore, better access to information about the price of electricity can help to reduce up to 20% of consumers' energy consumption (OECD 2010). Indeed, the presence of a permanent display connected to the meter via wireless devices enables consumers to monitor their electricity consumption and cost in real time and allows the adjustment of energy use in response to price changes at different time of day, for instance by delaying the use of a device with high energy consumption later in the day at a time when the electricity price is lower (*peak/off-peak*). This adjustment can be performed manually or automatically by using a pre-programmed system for the device.

Fostering Retail Competition

Energy is one of the less competitive sectors in Europe. In the European Union in 2008/2009, less than 45% of consumers found it easy to compare offers from energy suppliers, and only 7% have changed their gas supplier and 8% their electricity supplier (compared to 25% of consumers that have changed their auto insurance and 22% of subscribers have already switched their Internet service provider).

Two reasons may explain this trend: first, electricity rates do not offer enough incentives to switch and second, there is a lack of transparent information to customers about energy prices. Smart meter technology, making the market more transparent and efficient, should enable consumers to switch energy supplier more easily. The deployment of smart meters should encourage competition in the retail energy market, with benefits for everyone involved, consumers as well as providers. Indeed, opening of the market will force companies to offer services and quality at attractive price to meet their current and future customers' needs.

Offering Real-Time Pricing

The introduction of variable pricing and demand side management (DSM) is one stated goal for rolling out smart metering at the national level. However, at the moment, the variable rate offers are still at the trial stage and the results show that a great percentage of consumers (about 57%) may choose to remain at flat tariffs. One of the reasons can be that the different pricing schemes currently used in the trials do not encourage consumers to shift load as a reaction to peak/off-peak pricing. Customers need to be better informed not only about prices but also about carbon costs and greenhouse emissions, thereby making their choice of reducing energy consumption more geared toward a more sustainable future.

Integrating Renewable Energy

According to the International Energy Agency, the world electric consumption is going to increase by 2.2% per year until 2035. Therefore, on the one hand, it will be essential for customers to optimize their consumption, and on the other hand to drive the integration from the different sources of the renewable energy available in the grid, especially during peak consumption. Renewable energy supply is discontinuous and depends on climate (wind farms need wind, solar energy a minimum of light, etc.). However, we can mix these several energies advantageously with more constant energy resources such as biomass, biogas, and geothermal, etc. Smart metering can help in two ways:

- *Upstream*: through the delivery of data for distribution operators to optimize grid management
- *Downstream*: Smart meters may interact with smart appliances to allow for network-driven load shifting activities

Overall, smart metering can play a key role in the integration of renewable energy with the traditional energy sources.

However, while there are substantial benefits from smart metering adoption, today only 10% of European households have a smart meter installed and only a few countries like Italy, Sweden, and Finland have all households with a smart meter at home. This situation is explained by the existence of substantial obstacles to large scale implementation of smart meters.

Obstacles to Large Scale Implementation of Smart Meters [3]

The current development of smart meters in Europe is characterized by a lack of technical and regulatory harmonization, which as often in such situations, creates additional costs in the production process, reduces potential economies of scale at the expense of consumers and suppliers and introduces new barriers to full integration of new technology in the market. Furthermore, additional obstacles may reside in the low propensity of individuals and companies, to adhere to this new

[3]This section draws from GESI Report (2008)

technology and to accept and promote the effective deployment of smart meters. We will discuss now in more detail the potential obstacles to smart metering implementation. They have different natures: technical and organizational, economic and regulatory, behavioural and informational.

Technical and Organizational Obstacles

A key requirement of the operational framework is the provision of a *flexible, secure*, and *interoperable platform*, for smart meters operation. This platform should be able to support innovation in smart metering and others technologies.

Lack of Standardization

Technical interoperability is the ability of systems or devices to provide services and exchange information in order to work together effectively and predictably, without intervention of third entities. This process will place suppliers in a fully competitive market.

Indeed, the development of standards is a necessary condition for the deployment of the *Smart Metering Infrastructure* (SMI). Technological and organizational innovation of the Smart Grid is constantly growing, as competition in the smart meters market. Development of standards will be a necessary step to allow multiple uses and exploit benefits made possible by new technology and to avoid restrictive use of technology: "Advanced metering infrastructure will be encouraged by improving and expanding interoperability, open standards for communication protocols and meter data reporting standards. Development of these standards would enable the development of new technologies, such as smart appliances, to support broader application of demand response programs and dynamic pricing" (*FERC, 2009).*

In March 2009, the European Commission issued *mandate 441*[4] to set out standards and have interoperability between smart meter providers, involving communication protocols and various other functions. The following figure presents the scope of this mandate (Fig. 15.1):

Personal Data Protection

The smart meters will collect and record information about domestic energy consumption. But now several questions need to be answered: *what will be the data flow? How will these data be used? How will it be possible to control?*

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[4]« Mandat M441 » available on http://www.cen.eu/cen/Sectors/Sectors/Measurement/Pages/default.aspx

General objective :

"*to create 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 adaption to their demands*»

Mandated issued to the European Standards Organisations (CEN/CENELEC/ETSI) in March 2009 for:

- ✓ The development of an open architecture for utility meters (software & hardware).
- ✓ Supporting secure bi-directional communication.
- ✓ Enabling interoperability.
- ✓ Allowing advanced information and management & control systems for consumers and suppliers.

Objectives:

- ✓ To create European standards that will enable the interoperability of utility meters (in electricity, gas, water, heat).
- ✓ Must permit fully integrated solutions, modular and multi-part solutions.
- ✓ Architecture must be scalable and adaptable to future communications media.
- ✓ Must allow secure data exchange.

Fig. 15.1 Mandate M/441

Indeed, by collecting data every 30 min, meter data supplier could build a very detailed profile (work habits; at what times the consumer is outside or inside the house; when the household is on holiday or away for a prolonged period; estimate on the number of people present in the home; usage patterns for specific appliances, etc.). Then, advertising companies could use those data for specific behavioral campaigns: the owner of an apartment can use these data to demonstrate whether or not the tenant did or did not have a pressing need for housing. In addition, internal revenue authorities could benefit from accurate and detailed measurement data and prove, for example, if a house or apartment is used as a residence by the taxpayer or not.

Therefore, data protection will require careful attention to ensure the development of smart meters systems complaint with consumer privacy protection.

Uncertainly in the Development in the Supporting Data Infrastructure

The supporting data infrastructure is still not well defined. While one player has adopted the PLC technique for instance, other players prefer Internet and GSM or a combination with PLC. Also the maintenance cost could be extremely high and there is fear within the network companies that the technology does not last very long.

Economic and Regulatory Obstacles

Smart technologies represent a long-term investment. Regulatory certainty and a framework that allows more easily to recover the investments are particularly important.

Regulated or Liberalized Meter Market?

The deployment of smart meters in Europe faces a market complexity. There are two main types of governance of the meters market: *the regulated market* where companies are designated to conduct activities in a clear legal framework and *liberalized market* where the market for smart meters is open to competition. All EU countries except Germany, the Netherlands, and the United Kingdom have a regulated framework.

In a *regulated market,* the metering service is provided by a company in monopoly (the distributor) and therefore paid by the end-user (through a regulated rate or involving some network costs).

In a *liberalized market*, consumers or providers decide which kind of meter they want and a third company provides metering services. This requires that the level of standardization and interoperability of the meters installed shall be established beforehand, to avoid technical barriers such as switching cost borne by the consumer.

Operator Incentives for Demand Side Management

Compared to the electricity supply options, the DSM is difficult to implement due to the presence of barriers in several markets. These conditions limit the acquisition of customers and reduce the incentive for electric utilities to invest in DSM programs.

Barriers that affect the client's absorption include the lack of information and knowledge on energy efficiency and financial aspects such as accessibility to the meter, the competing investment priorities, or access to finance. Together, those barriers lead to transaction costs that will discourage investment, even when it is profitable to do so. Barriers that prevent utilities to undertake DSM programs include lack of sufficient financial incentive due to deregulation, restructuring, hidden subsidies for other options, and a lack of expertise and infrastructure to deliver DSM programs. Those barriers can be eliminated by government policy and appropriate legislation.

Meters are Expensive to Replace

Smart meters deployment will be the point of departure of one of the largest and complex sites that the energy market has never undertaken. It will result in the quasi complete renewal of the meters park for consumers (individuals and companies) for the next 10 years.

Low Tolerance for Errors: Disincentive to be a « First Mover »

In the market for smart meters, the economic penalties related to inefficiencies create a disincentive to become the "first mover." Smart meters installation is very uncertain, and the first that will install the meters will not necessarily be the one who will reap all the profits. Therefore, the tendency to be the “second mover” is reinforced.

Behavioural and Informational Obstacles

Lack of Energy Management Skills, Reduces the Propensity to use Green ICT

The lack of energy management skills and expertise is a major obstacle companies face during their path to green ICT. Beside the provision of best practices, a small number of governments are additionally providing green ICT-related training for managers and their employees (4 out of 50 programs).

According to the Green IT Barometer, when we look at different ICT companies' energy reduction strategies, two major gaps emerge:

- *Lack of visibility*: Companies in Information Technology (in Europe) are not able to improve their infrastructure energy consumption. A study shows that 31 of the organizations surveyed didn't know what was the electricity consumed by their data center and 89% said they were unaware of the energy consumption of distributed computing environment.
- *Lack of incentives*: Companies in Information Technology have small incentives to reduce their energy consumption, 70% of organizations surveyed had no incentive to reduce their energy consumption and 17% of organizations surveyed had actually commissioned their service to pay for energy consumed. As a result, only 7% of them reported a specific objective of reducing energy consumption.

Lack of Awareness About the Economic and Energy-Related Savings

Small and medium consumers need greater awareness on the use and costs of energy consumption. Therefore, consumers would need to be guided in the process of energy saving and be educated on the wide benefits that smart metering technology will bring them.

Meter Ownership

One of the challenges of the smart meter deployment is related to the meter ownership. *The* SMI is characterized by a system of several elements, and the economics of the supply chain of SMI according to Fig. 15.2 show the presence of potential competition in the first and last stages of the chain. Two options are considered:

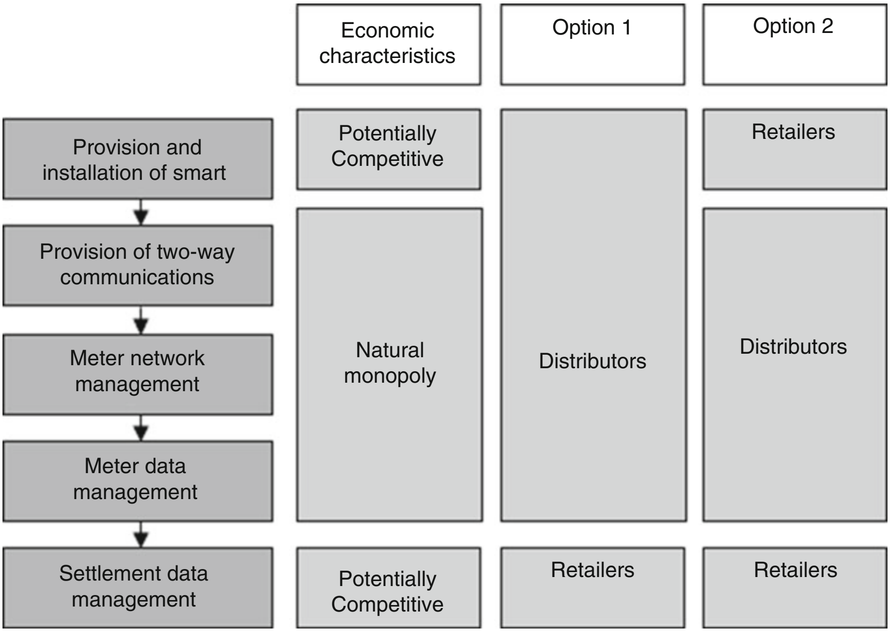

Fig. 15.2 Options for the allocation of roles and responsibilities across the *Smart Metering Infrastructure* (SMI) supply chain. *ENA submission (2009)*

Option 1: Exclusive Provision of Smart Metering Infrastructure, with Settlement Data Management Competition

It assumes that in the absence of effective competition (whether actual or potential), the least expensive way to provide services to the SMI is a supply chain of SMI vertically integrated operation with a distributor to the point where the settlement data are produced. Under this option, competition helps increase the supply of smart meters (assuming that interoperability is maintained), and maintenance of competition in the provision of settlement services data management. The information for these services is achieved by natural monopoly infrastructure using standardized B2B systems. This option necessarily involves the development of procedures B2B for free access to the system of functional SMI.

The main advantage of this approach is that it allows economies of scale in technical interactions between the network and counters the SMI: the system of data management, communication system and the optimization of the counter (and therefore to lower costs). In addition, it avoids the need to implement arrangements for access between the meter (which is a fairly complex task), to prevent retailers that use the meter installations to oust the competition for customers that change their supplier.

In addition, it allows the network to obtain many benefits associated with the interaction and coordination of network operation in general. It also provides system security and reliability with coordination and effective management.

Option 2: Competition in the Provision of Meters and Meter Data Management Services

It would allow the retailer to install their own smart meter, interoperable with a communication center and a system of SMI operations. Similarly, the management of settlement data can be obtained through competition in the provision of meters. The main advantage of this option is the ability for the retailer to choose both the meter and service management of settlement data, which gives it an element of differentiation and a more competitive market for the end-user.

Policy Issues and Case Study of the E-Cube Project in Italy

ICT applications can make environmental impacts positive or negative and the balance of these outcomes can be strongly determined by incentive structures and policies that shape behaviors. Although currently only few EU countries have set up a policy framework to promote smart metering technology, this experience is taken more and more into consideration.

Smart Meters Policy in UE

The EU Legislative Initiatives Related to Smart Metering

The electricity sector is quite diversified across Europe, but for some countries, there are many actors present in the energy value chain, with a separation along it that will be maintained in separate business units. Those providers cover the management of electricity, gas and sometimes water and telecommunications. Generally, these countries still have one or a few large players in the energy market (with ENEL for Italy, France with EDF, e.g.).

EU Policies for electricity and gas have been constructed through the following directives:

- *Energy Services Directive* (ESD) adopted in 2006 requires member states to develop a plan to achieve energy savings for end-users. The meter should be able to process information related using time consumption of one appliance, bills should be based on actual consumption, not estimations, and finally information must be provided to customers about prices and benchmarks (previous year and typical customer).

- *The Metering Directive*[5] adopted in 2004 has streamlined regulations, so that electric, gas, and water meters approved in one member state are automatically approved for use in all other member states. The objectives of this Directive are to make it easier for EU meter manufacturers to market their products throughout Europe, thus increasing competition in the metering market.
- *Finally, Mandate M/441* (European Commission 2009), as describes above.

In addition, the *third Package* of legislation adopted by the European Commission (September 19, 2007) is the milestone for achieving internal electricity and gas markets. Relevant to smart metering, the following are the major legislative concepts promoted in third Energy Package (European Commission 2010; ERGEG, 2010, p. 11; European Parliament, 2009).

The European Commission has also set three goals for 2020 under the name « *Energy-Climate Package* »[6] adopted in January 2008 by the European Commission. This "legislative package" has subsequently been the subject of political agreement among the 27 Heads of State and Government at the Brussels European Council of 11 and 12 December 2008. It was then formally adopted by the European Parliament and the Council of Ministers in December 2008. It is part of the future Framework Directive renewable energy. Also called the project "Program 20-20-20" because it set the following goals:

- 20% Improvement in energy efficiency
- 20% Reduction in emissions of greenhouse gas emissions
- 20% of energy from renewable sources

Finally, it is interesting to note that Smart Grids is at the heart of discussion of the *Infrastructure Energy Package* and it assumes as priorities to accelerate investment in energy infrastructure. Finally, the European Commission published on 8 March 2011, a *European Plan for Energy Efficiency* which offers various activities to reduce energy consumption. These operations are focused on the networks deployment and smart meters that provide consumers with the information and services necessary to optimize energy use and calculate their savings.

Policy Assessment for the Adoption of Smart Meters

The different policy drivers for smart meters are: the liberalization of energy markets, particularly full retail competition, as presented in the EU in July 2007; the evolution of regulatory frameworks for a more competitive market environment,

[5]Directive 2004/22/EC of Parliament and Council European, 31 of March 2004 on measuring instruments.

[6]Available on http://ec.europa.eu/clima/policies/package/index_en.htm.

the changes in technology; and finally the rising electricity prices and consumer interest in reducing their electricity bills and the need to reduce energy consumption.

To focus government action on the deployment of smart meters and reduction of GHG emissions, a number of policies can be identified. Those policies must also overcome the various problems that stand in the way for wide implementation of smart meters. In particular, governments can play a role *regulating* or *promoting* smart meters.

Finally, the ICT industry should educate consumers about the benefits of smart grids and smart metering investments. Consumer awareness for both environmental and economic benefits of networking will help put pressure on regulators and utilities to make ICT investments. The industry should also include open platforms and interoperability, a necessary step to take full advantage of smart metering.

Furthermore, while smart metering can produce positive impacts, such as reduced energy use and better environmental management in primary production and household activities, it also raises new consumer protection concerns and may produce negative impacts on privacy from potentially exploitative applications. Therefore, in order to guarantee a successful smart meters deployment, it is necessary to address all these issues.

One of the main tasks of government is to encourage network operators to offer the most efficient service at the lowest cost. Furthermore, the emergence of smart grids and other "Smart" technologies in the energy sector is making more challenging the mission of the regulator. Indeed, the amount of investment involved in smart grids is high: the International Energy Agency estimates investment needs of electricity distribution networks in Europe around €480 billion by 2035. Cost Benefits Analysis (CBA) can help in making policy suggestions. Indeed, CBA helps in ensuring that system operators take into account all the externalities in investment decisions and in designing a regulatory framework for securing riskier investments.

Cost Benefit Analysis and Policy Prescriptions: The Case Study of the E-Cube Project

We will focus our attention on the case study of the E-Cube project in Italy. The E-Cube project is an application of smart metering technologies. This project is partially funded by the "Industry 2015 Program" promoted by the Italian Ministry of Economic Development and is supported by a consortium of 12 major Italian companies and universities that represent the complete value chain of the energy industry. The objectives of the E-Cube project are the creation of a system including components and scalable infrastructures enabling the control, optimization, and dynamic management of energy consumption, both for residential and commercial/industrial facilities. The optimization efforts will be driven by energy efficient and effective policies, defined and exploited by the project. The full objective of the system is to rationalize power consumption, allowing energy saving simultaneously

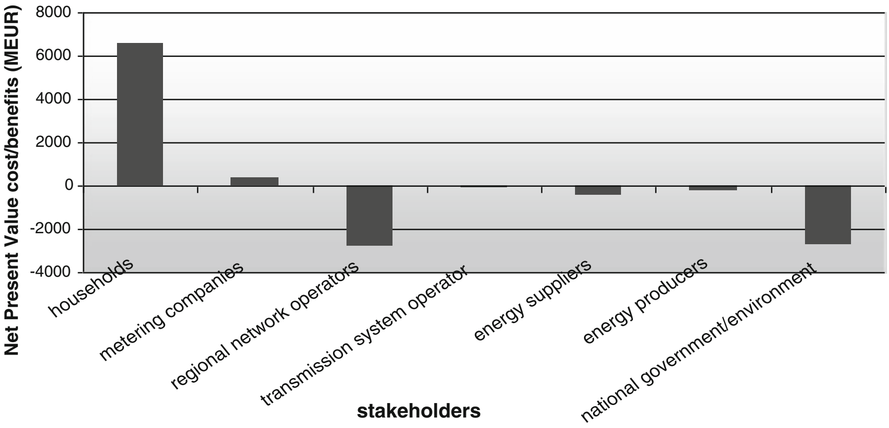

Fig. 15.3 Distribution of net present costs and benefits among the different parties. *KEMA (2010)*

with perceived comfort increase, by balancing the user wellness and the environment advantages obtainable by applying the project outcomes.

The CBA has not yet been made for the E-Cube project; therefore, we will follow the one provided by the KEMA study in the 2010 draft « Smart meters in the Netherlands: Revised financial analysis and policy advice ».

According to the KEMA study, the introduction of smart metering in the Netherlands generates a net present value of €770 million with significant benefits in energy savings, and increased competition and operational efficiency of the process by network operators and suppliers (Fig. 15.3).

The largest benefits are those gained by consumers. The cost and installation of smart meters, installation of the SMI, and establishing of a monthly billing system is what requires the most effort in terms of costs. So, the households will benefit the most from the smart meter implementation, while the metering companies bear all the costs. Network administrators and energy suppliers will also carry costs that will exceed the benefits they will derive.

General Framework for Analysis: From First to Second Generation of Smart Meters

Because the CBA for the E-Cube project is not yet available, we will consider as a starting point for the comparison with the benefits and costs from the diffusion of the E-Cube devices, a large-scale deployment of smart meters of first generation.

Indeed, the Italian market has already the first generation of meters installed, with 32 million meters in place. Therefore, the CBA approach will require highlighting changes in functionality between the first and second generation of smart

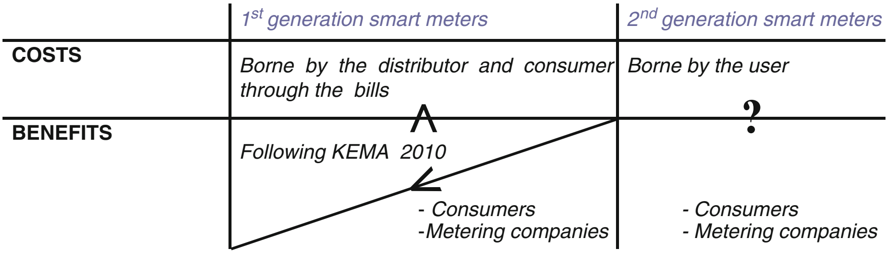

Fig. 15.4 First and second generation of smart meters: costs & benefits

		Obstacles viewed by market players	
		Large	*Small*
Cost-benefits analysis (CBA)	*Positive result*	1. Steps by government	2. Steps by the market
	Negative result	3. No steps	4. ?

Fig. 15.5 Framework for conclusion. *Source*: *SenterNovem (*2005*)*

meters (E-Cube devices) and to show the costs that are borne by market players (news features of news meters have to be taken into account). To do this, we will focus on the incremental costs incurred for an effective deployment.

Figure 15.4 shows how this approach can be implemented.

Figure 15.4 shows that there are more benefits for the second generation of smart meters, but consumers will have to bear the costs. Therefore, the effective deployment will depend on benefits from adoption to be greater than costs.

Figure 15.5 will help in understanding potential roles for the government.

This framework assumes four possibilities with regard to steps that would be or would not be taken:

1. Cost benefit analysis is *positive* and market players perceive *large obstacles*: steps by the *government* are required.
2. Cost benefit analysis is *positive* and market players hardly perceive *any obstacles* (or only small ones): steps will be taken by the *market players* themselves.
3. Cost benefit analysis is *negative* and market players perceive *large obstacles*: government and market players take *no steps* because implementing SMI is not attractive.
4. Cost benefit analysis is *negative* and market players hardly perceive *any obstacles* (or only small ones): *status quo*, until the cost benefit analysis becomes positive (i.e., by changing parameters).

Let's now focus on the analysis of potential obstacles to the diffusion of the E-Cube devices mentioned before.

(a) Lack of standardization

LARGE	SMALL
	✓

- ZigBee technology

In the context of standardization, even if the options are various, E-Cube promotes the adoption of standardized solutions, to ensure interoperability for smart meter use in Italy and Europe. This solution is based on the specific standard "ZigBee" for the *Home Area Network* (HAN). Therefore, we can say that standardization barriers can be considered small in Italy.

(b) Personal data protection

LARGE	SMALL
	✓

E-Cube project adopts the Privacy by Design approach.

(c) Uncertainty in the development of the supporting data infrastructure

LARGE	SMALL
	✓

In Italy, the first generation of smart meters has already been installed, including infrastructure itself. However, we can still consider adding additional features such as the presence of basic functionality.

In HAN infrastructure, there is also a lack of enforcement regarding the management of certain services necessitating the development of these applications. So, regarding E-Cube project case, that will not be a major obstacle.

(d) Regulated or liberalized Meter Market?

LARGE	SMALL
	✓

In Italy, we have already a *regulated market*.

(e) Operator incentives for DSM

LARGE	SMALL
	✓

This obstacle can be eliminated not only by the government policies and appropriate regulations but also by market players with a careful design of the implementation of DSM program. Three factors determine the results: the initial level of energy use, regulatory environment, and the effectiveness of the program. Results: if regulators fail to structure the market, so that such energy savings benefit to suppliers, they will not be any reason to implement a DSM program, but if they do, the incentive positive result.

The information used to evaluate the measures and program design will be used to assess the financial interest of a DSM program. The costs and benefits of a DSM program will be different for each party involved in the program (the user, the utility that sets up the, and the government that implements the strategy).

We can consider it as a small obstacle.

(f) Meters are expensive to replace

LARGE	SMALL
	✓

In Italy, the key issue will be the development of various devices that the household could adopt. From the E-Cube project, we can provide preliminary estimates of the costs of the new metering technologies borne by the consumers.

The Home Gateway (HG)	Smart plug	Meter
The HG of the telecommunications operator is a device that is always switch-on, always connected using broadband and that can perform the functions of Smart Home Controller for the management of household appliances with one another in a ZigBee connection. The estimated price is about 50–90, with 50% in Broadband and 50% in Energy Management (not yet available).	Allowing ZigBee connection. Basic cost for a smart addition is estimated around 10 for existing prototypes.	Actually we can consider a price of about 60.

For Home Energy Monitoring and control, today different solutions are proposed by retailers. Figure 15.7 shows some of the meter propositions offered in the same range of price and characteristics.

Figures 15.6 and 15.7 show two price options. For the first one, the cost borne by the end-user is about 135 that takes into account the price of different devices necessary for the system to run.

The second option is the one proposed by retailers that are involved in energy saving solutions, as shown in Fig. 15.7. It is already known that, at the moment, retail solutions are not very much used by consumers. Indeed average current cost for this solution of Energy saving is on average 114, and we know that actually this offer is not appealing for consumers.

Finally, we can see that in a mature market, end-users have more interests in the use of one network that is more “practical” (Internet security, connecting TV)

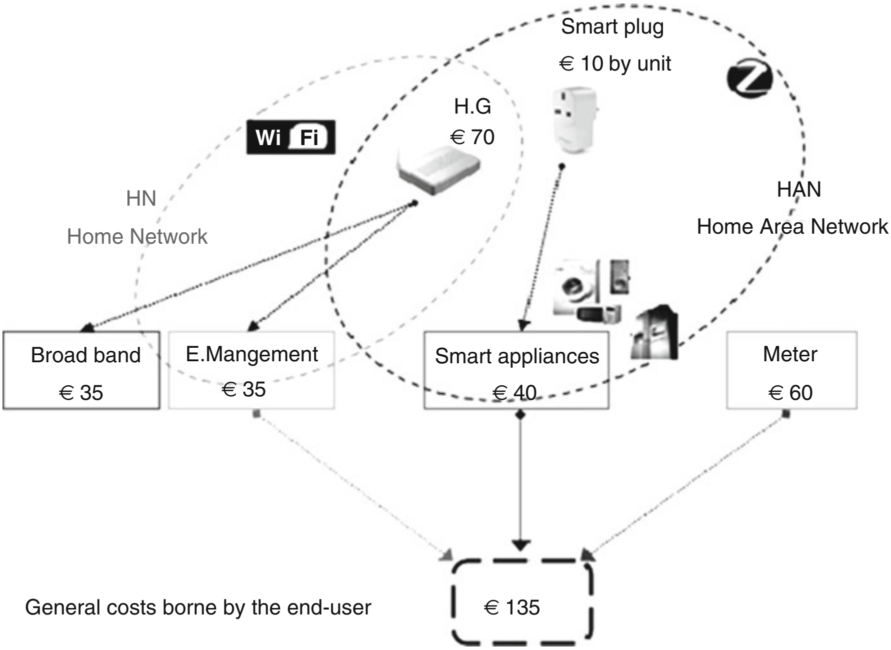

Fig. 15.6 Example of a consumer's tariff profile

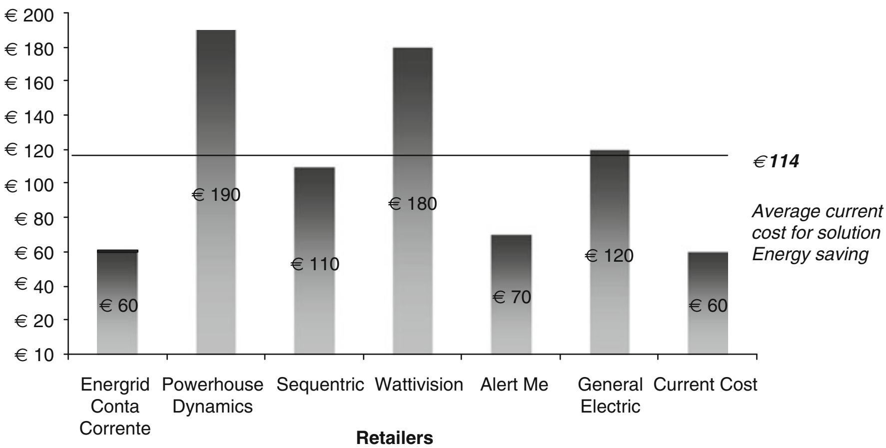

Fig. 15.7 Cost of meters: retailer solution.
Source: calculation from Telecom Italia "Home Energy Monitoring" (2011)

than the use of features that are too "futuristic" (Fig. 15.8), even if the technology is already available. This position may be due to:

– The lack of communication on these services by providers (sometimes the user does not even know such services exist)

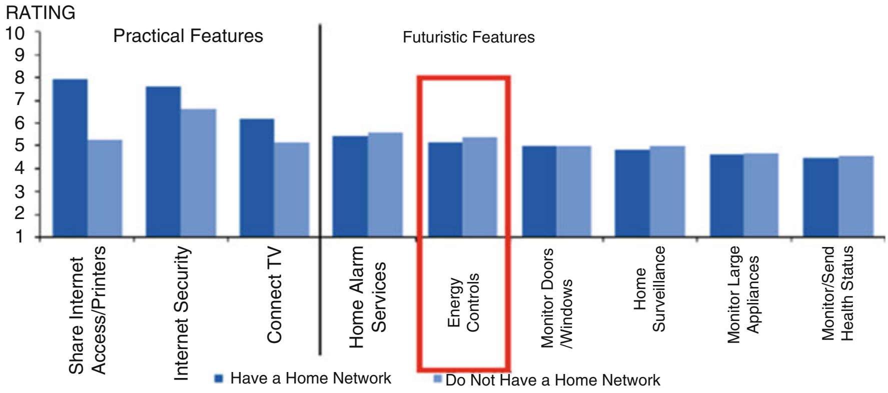

Fig. 15.8 Desirability of features for the Digital Home in the Mature Market.
Source: Gartner (October 2010): "User Survey Analysis: Home Network Adoption in Mature Markets"

– The lack of concrete vision of the possible positive impact of such services on the user' lifestyle technology seen as too complex
– Doubts about the reliability of technologies

(g) Low tolerance for errors: disincentives to be a first mover

LARGE	SMALL
	✓

This is not an obstacle in our case; meters are already in place in Italy with 32 millions that are installed.

(h) Lack of energy management skills reduces the propensity to use Green ICT

LARGE	SMALL
	✓

This is not an obstacle, even if in this case, state aid could help foster a better use and management of energy.

(i) Lack of awareness about the economy and energy-related saving

LARGE	SMALL
	✓

There are two levels of awareness, on the economic side (*How much can we save?*), and one environmental aspect (*what the environment could benefit for the optimal consumption?*), but in our project that is not a large obstacle for its success.

(j) Meter ownership (to reduce switching cost)

LARGE	SMALL
	✓

Actually in Italy, the distributors are the owners of the first generation of meters. As shown in Fig. 15.4, they bear the cost of their implementation, and the costs of second generation meters will be borne by the users.

We will also have to focus our thinking on the same cost of the meter, because even if it is proven that consumers will enjoy as much of these benefits brought by smart meters, its benefits are still yet quite unclear, and therefore the incentive to pay for its adoption is threatened.

Finally, the question of who will be the owner of the meter remains a very important issue.

In conclusion of this analysis on the E-Cube project we can say that:

- In general, CBA that have been done in the last year in different countries are *positives*, so even if we still don't have one for the Italian market, we can expect a positive result.
- *Costs* are the most important concerns.
- Considering Fig. 15.5, even if we need more results, we can expect to be on quadrant one, where CBA is positive and market players perceive large obstacles. Therefore, steps by the government are recommended.

Conclusion

This paper has featured the issues related to the diffusion of smart metering and how policies can help in getting over the obstacles of this process. In particular, focusing on the case study of the E-Cube project, the paper has recommended an active role of the government to guarantee the diffusion of E-Cube devices.

There are no doubts about the potential benefits of smart metering:

- Metering companies to decrease meter reading costs
- Grid operators who want to prepare their grid to the future
- Energy suppliers who want to introduce new customer-made services and reduce call centre cost
- Governments to reach energy saving and efficiency targets and to improve free market processes
- End-users to increase energy awareness and decrease energy use and energy cost

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

However, as shown in the paper, there are important issues that need to be addressed to guarantee smart meters adoption. Some have been already mentioned in this chapter, but others are new issues for further research, such as industry coordination, standardization, and adoption of national and international rules based on a solid energy policy.

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