CONCERTED ACTION
ENERGY EFFICIENCY
DIRECTIVE

Core Theme Series Report:
Concerted Action Energy
Efficiency Directive

3

Current status and issues of EED Articles 9, 10, 11 and 15 (Metering and billing, Smart meters, Grid and infrastructure efficiency, Demand response)

Fernando Martins, Dir. Of Portuguese NEEAP
for the Ministry of Economy, Portugal

March 2017

Content

1 Introduction and context ... 3
2 Current status and issues of metering and billing (Article 9, 10 and 11) ... 4
3 Billing and billing information (Article 9, 10 and 11) ... 5
4 Cost effectiveness of individual metering/billing (Article 9, 10 and 11) ... 7
5 Consumer engagement (Article 9, 10 and 11) ... 11
6 Service market development for smart electricity and gas metering (Article 9) ... 13
7 The state of (smart) metering implementation (Article 9) ... 15
8 Measures undertaken and planned to enable and promote Demand Response (Article 15) ... 17
9 Infrastructure efficiency potential assessment (Article 15) ... 21
10 Energy efficiency in network design and regulation (Article 15) ... 22
11 Concluding remarks ... 24
Legal disclaimer ... 28

1 Introduction and context

The Concerted Action for the Energy Efficiency Directive (CA EED) was launched in spring 2013 in order to support the effective implementation of the Directive on Energy Efficiency (2012/27/EU) in all EU Member States as well as Norway.

By providing a trusted forum for exchange of experiences and for collaboration, the CA EED helps countries learn from each other, avoid pitfalls and build on successful approaches when implementing the Directive. This report summarises the work of the CA EED on the current status of, and issues related to, EED Articles 9, 10, 11 and 15, carried out between January 2013 and October 2016.

With regards to Articles 9, 10 and 11, the objective of this work was to assess the current status of, and issues related to, Metering and Billing, focusing on topics such as billing information requirements, cost effectiveness assessments, functionalities of smart meters, data privacy and protection as well as consumer engagement. Linked to Article 15, the work was developed surrounding the infrastructure efficiency potential assessment and takes an overview of measures undertaken and planned to enable and promote Demand Response in each Member State (MS).

The energy market is changing. Since 2011, many modifications have been made to European Union legislation, mainly to define rules and measures to ensure competition and proper consumer protection in the energy market.

On 9th March 2012, the European Commission set out detailed recommendations (on preparations for the roll-out of smart metering systems [Official Journal L 73 of 13.3.2012]) regarding:

- Data protection and security;
- Methodology for the economic assessment of the long-term costs and benefits of the roll-out of smart metering systems;
- Common minimum functional requirements for smart metering systems for electricity.

EU Member States are encouraged to take all necessary measures to follow the recommendation, and to draw the attention of all stakeholders involved in designing and operating smart grid applications within the EU to it.

In this context, the EED includes three Articles referring to billing and metering. Article 9 is directly related to the metering of energy consumption and Articles 10 and 11 require MS to create rules for billing information and the costs of metering and billing information.

Article 15 of the EED is entitled 'Energy Transformation, Transmission and Distribution' and it is interrelated to Annex XI and Annex XII. The main objectives of the Article and Annexes are to maximise grid and infrastructure efficiency and to promote demand response.

CA EED participants from all MS provided inputs which have resulted in a comprehensive view of the challenges associated with billing, metering, smart metering options and demand response.

2 Current status and issues of metering and billing (Article 9, 10 and 11)

The purpose of the work carried out under this topic was to share experiences and to learn about some good examples of metering and billing. Other important documents related to EED implementation that must be taken into account are the Directives 2009/72/EC and 2009/73/EC. Due to failures of the internal market in electricity and gas, the European Commission considered it necessary to redefine the rules and measures applying to the market to ensure fair competition and appropriate consumer protection. In the Electricity Directive, the European Union goal is to have a smart meter roll-out plan covering 80% of all positively assessed cases from the 500 million European Union citizens by 2020.

Metering and billing

There are many different metering and billing situations in the EU for the five different network-based energy products (electricity, natural gas, district heating and cooling, and domestic hot water). Many existing meters in the EU already reflect actual total energy consumption, but this is not the case for information on actual time of use. MS are divided about the statement that existing meters are already competitively priced. The implementation of the EED for electricity can be achieved in the short-term by almost all Member States. In some MS, the costs and technical difficulties related to natural gas are more evident and will bring additional challenges. The implementation of EED requirements as regards individualised metering and consumption-based, frequent billing for district heating, cooling and hot water is perceived as presenting a higher degree of difficulty due to the technical and physical necessity in many situations of installing several meters or heat cost allocators to obtain the consumption of a single end-user.

The general opinion of the CA participants was that current feedback for final customers and the definition of 'technically possible, financially reasonable and proportionate' are not yet satisfactory. There is a need for further sharing of experience and expertise to understand what type of billing information is most effective to trigger energy savings, and to allow sharing of criteria to establish what is 'technically possible, financially reasonable and proportionate'.

Regarding district heating, cooling and domestic hot water, the local situations and views on implementing the metering and billing requirements are not yet fully clear and seem to vary significantly between MS. Therefore, more effort to retrieve information from MS to construct a 'blueprint' of the district heating, cooling and hot water situations of the EU-27 is recommended. An important result of the work carried out under this topic is the recommendation that for heating, cooling and hot water, individual meters should take into account both volume and temperature.

Regarding the cost of access to metering and billing information, Article 11 of the EED stipulates that MS shall ensure that final customers receive this information free of charge, but most CA participants expect that energy companies will not act accordingly. Therefore, it is relevant to discuss how the implementation of European legislation can be ensured.

3 Billing and billing information (Article 9, 10 and 11)

The primary difference between billing and billing information is that the former is exclusively financial and commercial. Costs and charges detailing energy consumption will have to be presented at least once a year, and must be based on actual values read on meters. By these means, at least once a year, the energy supplier and final energy consumer can settle accounts based on actual consumption from the past year. Meanwhile, billing information provides an additional tool to final consumers. This allows final consumers to manage their consumption based on at least two real readings a year, or four readings a year, if so requested by the consumer. Billing information also provides a means for the energy supplier to provide advice and important information free of charge to the final consumer, so they can manage their energy consumption in the most efficient way and avoid any energy waste - areas often neglected due to the lack of knowledge of the final consumer.

Minimum information contained in the bill

Independently of whether smart meters have been installed or not, MS must ensure that bills are presented in clear and understandable terms to final energy users (Article 10, EED).

According to EED Annex VII, MS shall ensure that, where appropriate, the following minimum information is made available to final customers in clear and understandable terms in or with their bills:

- **a.** Actual current energy prices
- **b.** Actual energy consumption
- **c.** Comparisons of the final customer's current energy consumption with consumption for the same period in the previous year, preferably in graphic form
- **d.** Contact information from credible organisations that can help end users reduce their energy consumption.

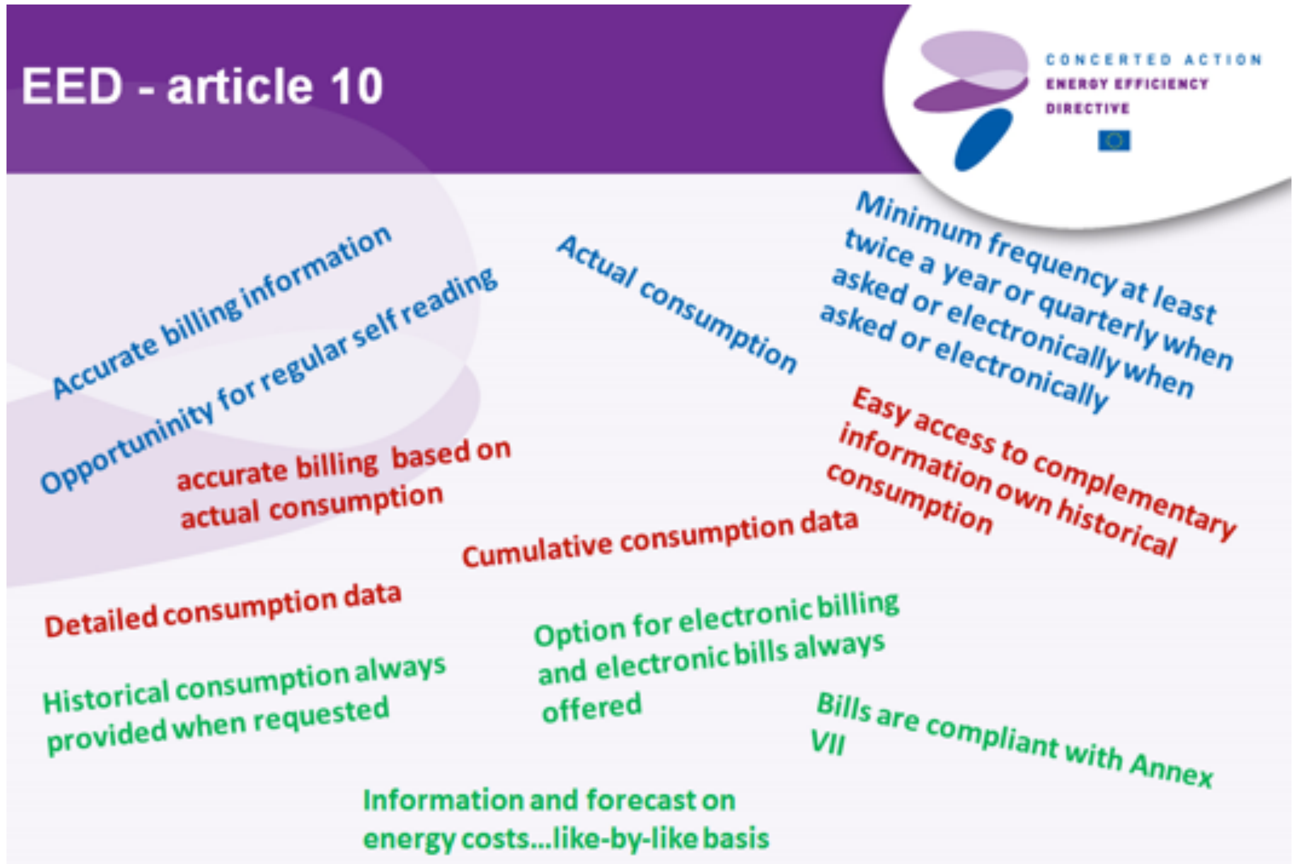
Billing is often the starting point for a dialogue between the energy supplier and the customer. This dialogue is important and must be treated with respect. A structured system for the dialogue is a clear advantage.

Billing information requirements

A bill, in the sense of an actual request for the customers to settle an amount due, may not be the only or best available tool or instrument to create awareness among consumers about consumption and energy efficiency. Given that an actual billing/settling process has a cost which may not justify repeating it too frequently, billing information (i.e. without a request to settle any amount), such as information based on actual usage, may be needed more frequently and presented in a different way to increase consumers' awareness about energy efficiency potential.

The Energy Efficiency Directive (EED) defines that MS shall ensure, by 31st December 2014 that billing information is accurate and based on actual consumption. In accordance with paragraph 1.1 of Annex VII, this applies to all sectors covered by the EED, including energy distributors, distribution system operators and retail energy sales companies. This requires that billing information be made available at least quarterly upon request or where customers have chosen electronic billing, otherwise it should be provided twice a year. Under Article 10(1), these minimum requirements do not need to be followed if it is not "technically possible and economically justified" (Figure 1).

Figure 1 - EED minimum requirements - Article 10



Although defined in Article 10, EED gives MS the freedom to choose new minimum requirement indicators to include in the billing information. For example, wherever possible and useful, comparisons with an average normalised or benchmarked final customer in the same user category should be made available to final customers. Another possible indicator is the hot and cool degree day correction. This indicator gives real feedback to final consumers because summer and winter temperatures are not always equal every year and this could interfere with total energy consumption, giving the wrong idea about energy efficiency, or lack thereof, to the final customer.

In the context of Article 9 and 10, it is simpler to meet the Article 10 and Annex VII requirements in the electricity sector, however in the gas sector there are many situations where billing on actual consumption is not "technically possible and economically justified" because it is not possible to install individual meters in all facilities. Particularly where centralised distribution in a building or neighbourhood exists, as the installation of individual meters is rendered economically unfeasible by the physical complexity of the gas distribution infrastructure.

In this discussion, it is important to remember that Article 11(1) requires MS to ensure that final customers receive all their consumption data, as well as bills and billing information free of charge.

4 Cost effectiveness of individual metering/billing (Article 9, 10 and 11)

There are different perspectives over what is the best way to analyse different cost effectiveness scenarios. However, it seems obvious that it is necessary to evaluate the cost effectiveness from the customer's side and from the MS's side. For the individual consumer the cost-benefit analysis resulting in a positive net present value (NPV) at a typical market based discount rate over the meter's economic lifetime is cost effective. However, the MS must take a different approach. For example, it is very important to take into account elements like investment costs, ongoing costs and cost savings. In this scenario, the purpose of the work carried out under this topic was to identify criteria to establish the cost-effectiveness of individual metering/billing of heating/cooling and hot water consumption, and to identify both good and bad examples of metering/billing in this area.

In all MS, while developing a national metering and sub-metering plan, the cost effectiveness of individual metering (e.g. metering per apartment or unit) should be addressed as required by Article 9. In that sense, it is crucial to assess the actual cost effectiveness of metering, which can be determined by comparing the cost of metering plus associated added-value engineering services, and measures to the value of the possible energy savings. According to the information exchanged during the CA, this assessment is generally done over a period of 5 to 6 years and is properly discounted. Of course, this is not the only possible approach (for instance, simple payback analysis can also determine the cost effectiveness of the metering system), but it is the most common approach when it comes to energy efficiency measures.

Most CA participants agree on the criteria that should be used in the cost effectiveness assessment of individual metering for heating, cooling and hot water (please see Table 2). They for instance believe that on the costs side, the costs for educating end-users to use the meter data to save energy should be taken into account. On the benefits side, the energy savings should be considered; however, the consumption reductions depend on the energy performance of the building (case studies and pilot projects about individual metering for heating, cooling and hot water indicate an average consumption reduction of 20% in some buildings in Poland).

Table 1: Cost effectiveness criteria

<table>
<tr><th rowspan="2">General</th><th colspan="2">Specific</th></tr>
<tr><th>Costs</th><th>Savings</th></tr>
<tr><td>1.Cost elements of economic assessment</td><td>I Type of costs:
a Installation costs, including costs for Metering and Billing.
b Operational costs, e.g.:
– maintenance costs
– reading and processing costs
– billing costs.
c Costs for measures, i.e. costs other than operational costs for activities towards consumers to use the meter data to save energy.
d Calibration costs.

II Cost allocation methods
a Cost allocation common units.
b Need for compensation of inefficient individual units.

III Defining other relevant cost factors
a Subsidy opportunities.
b Tax regime.
c Depreciation rules.</td><td>I Type of savings:
a Savings at building level.
b Saving in common units.
c Savings on individual unit level.</td></tr>
<tr><td>2. Stakeholder analyses</td><td colspan="2">IV Relevant issues for:
a Building owner.
b Operator or supplier.
c End user.</td></tr>
<tr><td>3. Specific characteristics</td><td colspan="2">V Relevant cost issues for:
a Heating.
b Cooling.
c Hot water.</td></tr>
<tr><td>4. Situations</td><td colspan="2">VI Relevant cost issues for:
a Building with central district heating.
b Multi-apartment or multi-purpose building with individual units.</td></tr>
</table>

Another important point to be considered is the difference in metering and sub-metering cost effectiveness between the public and private sector. The effective tax rate is the main reason for the difference in metering cost effectiveness between the public and private sectors. Due to the effect of taxes, public sector projects present a shorter payback than private sector projects. Typically, the public sector is also often more patient in accepting longer paybacks than the private sector. In the public sector, payback periods of five years or less often seem to be acceptable. However, payback periods longer than two years are often not accepted in the private sector.

There are good examples throughout Europe, especially in Denmark, Poland, the Netherlands and Malta. Several factors make Malta a particularly good example. These include: sharing information about real implementation with 82 residential buildings equipped with heating and cooling, and supplied with a centralized heating and cooling system via a 4 piped system, which makes use of sea water as part of the process. The billing is done per residence and is based on (i) the temperature change of the pipe entering and exiting the apartment and (ii) the flow.

Smart meter roll-out

Smart metering[1] provides many advantages when compared to conventional metering systems, such as cost effectiveness, accuracy and interactivity, both for end users, energy companies and Distribution System Operators (DSOs),. The roll-out of smart meters for electricity and gas is making progress in the EU mainly due to Directives 2009/72/CE and 2009/73/CE, which are the legal basis for this deployment, and the related guidelines in EC Recommendation 2012/148/EU.

CA participants show a broadly similar interpretation of the relationship between the EED and smart metering: there is a clear link between the roll-out of smart meters and the relevant metering and billing stipulations in the EED. The roll-out of smart meters has a direct impact on costs and benefits, and on technical aspects of the various stipulations in Articles 9, 10 and 11. As the roll-out of smart meters is rapidly developing in many MS, it is a challenge to define the exact impact of EED on metering, billing and billing information issues. However, it is clear that the EED does not directly require any type of smart meter roll-out; the legislative provisions for electricity and gas smart metering roll-out are in Directives 2009/72/EC and 2009/73/EC, respectively. The EED, in contrast, specifies certain requirements that must be met if and when smart meters are rolled-out in accordance with those Directives.

Regarding information supplied to end users about the potential advantages of smart meters, MS have different market models resulting in different responsibilities for different parties. Therefore, it is relevant to explore whether there will be complications if the party that should provide information is not the same party that installs the meter.

1 Smart metering system means an electronic system that can measure energy consumption, adding more information than a conventional meter, and can transmit and receive data using a form of electronic communication (2012/148/EU)

Table 2: Summary of MS experiences on CBA (cost benefit analysis) on smart meters for electricity and gas (24 responses received before 1 January 2011), source: ERGEG (Ref. document: C11RMC-44-03)

Status of CBA in CEER[2] countries	Electricity	Gas
Countries have conducted a CBA	11	6
Positive result of CBA	7	5
Countries plan (or ongoing) to conduct a CBA (in some cases for the second time)	12	14
Countries do not plan CBA	2	5
Countries with no CBA, but no longer relevant (yes/no of roll-out already decided)	3	0

Based on information available from the Commission services[3], so far 22 EU MS have in fact conducted a CBA for electricity, out of which 14 found a positive result for large-scale deployment by 2020. 2 MS have neither an official CBA, nor a made a decision regarding rollout. Regarding Gas, 19 MS have conducted a CBA, out of which 7 found a positive outcome; 6 of these are proceeding with a wide roll-out. 17 Member States have committed to rolling-out electricity smart metering on a large-scale, and 2 to a selected segment of consumers, resulting in the installation in total of close to 195 million smart meters for electricity, and 45 million for gas by 2020, worth some €45 billion.

2 CEER membership is open to the national energy regulatory authorities of the European Union and the European Economic Area (EEA). The CEER currently has 32 members, the energy regulators from the 28 EU-Member States plus Iceland and Norway - as well as 2 observers – the energy regulators from Switzerland and the Republic of Macedonia.

3 Earlier information under COM(2014) 356 ("Benchmarking smart metering deployment in the EU-27 with a focus on electricity" and supporting SWD(2014) 188, SWD(2014) 189), and recently complemented with the receipt of two extra national CBAs notified to the Commission services.

5 Consumer engagement (Article 9, 10 and 11)

Consumer engagement and acceptance is a critical success factor for the roll-out of smart meters. The EED requires that appropriate advice and information be given to customers at the time of installation of smart meters (Articles 9 and 12). A questionnaire was sent to all MS in December 2014 and 26 MS responded. 6 MS have already developed a consumer engagement strategy. As the roll-out of smart meters is still in an early phase, the majority of MS do not have a strategy yet, but are likely to develop one: 14 MS responded that they do not have a strategy yet, but outlined their thoughts and ideas related to such a strategy.

In most MS, the DSO is responsible for the roll-out of smart meters and is thus the primary link to the consumer for their installation. The DSOs are therefore strategically important for smart meter consumer engagement: in 9 MS the government or another authority is providing guidance to the DSOs on how to inform consumers at the time of the smart meter installation. In many countries, the obligation for DSOs to inform consumers about energy efficiency during the roll-out is required by law.

Once in place, interactive smart meters (with display and/or webpage access) can allow users to control and manage their individual consumption patterns, providing strong incentives for efficient energy use through behavioural change. Some studies have estimated the average savings to be around 3% for electricity and 1.7% for gas[4]. According to the results of the questionnaire, 11 MS had pilot studies or similar where actual savings from smart meters had been measured. It can be concluded that smart metering in combination with direct feedback, particularly in-home displays, can lead to considerable and persistent household energy reductions. Showing average savings up to 6% for electricity and 7% for gas in pilot studies, in-home displays appear to be the most important factor and a crucial 'stepping stone' in kick-starting active consumer interest and engagement for accessing energy information.

Functionalities of smart meters, data privacy and protection

According to EED Article 9, MS shall ensure that the objectives of energy efficiency and benefits for final customers are fully taken into account when establishing the minimum functionalities of the meters. 62% of MS that responded to the questionnaire affirm their interest in retaining all 10 functionalities recommended[5] by the European Commission (16 MS). Among these, 10 MS will include additional functionalities and new measures.

MS shall also ensure the security of the smart meters and data communication, and the privacy of final customers. The importance of privacy and protection of data gathered by smart meters is consistent among all MS. As a response MS have independently assembled interdisciplinary work groups in order to minimise any possible problems which may occur in the future.

Another important area is the development of energy services based on data from smart meters, demand response and dynamic prices where progress has recently been made.

4 COM(2014) 356

5 EC Recommendation 2012/148/EU

The issue about privacy and protection of smart meter data was also covered in CA activities. In this context the first clear topic to address was the Commission Recommendation COM(2014/724/EU) from October 2014 on the Data Protection Impact Assessment (DPIA) Template for Smart Grid and Smart Metering Systems. This template is an evaluation and decision-making tool which helps entities planning or executing investments in smart grids to identify and anticipate risks to data protection, privacy and security. The DPIA provides guidance to help ensure fundamental rights with regard to the protection of personal data and to privacy in the deployment of smart grid applications and systems and smart metering roll-out. The Recommendation foresees a two year test phase to gather feedback on the DPIA Template. Based on this feedback and in light of the upcoming data protection reform, at the end of such two year testing the template could be further fine-tuned to enhance its efficiency and user-friendliness.

It became clear during the CA activities that privacy, market roles and responsibilities, and technical requirements go hand-in-hand. It also became clear that smart meters are an enabler for smart grid functionalities as ESCOs, suppliers and DSOs are able to retrieve high frequency meter readings that can be used for network management. However, explicit consent from the consumer is required under all circumstances. The key lesson is that consumer awareness and consumer commitment should be an integrated element of all smart grid plans.

6 Service market development for smart electricity and gas metering (Article 9)

Constant feedback on energy use to the consumer has been identified as key to leveraging the energy efficiency potential of smart meter data. Manufacturers of appliances and devices and software developers are expected to build functional services around smart metering systems to provide additional benefits for final consumers and the electricity system at large. Hence, it is relevant to discuss how to foster the emergence of markets for these systems.

The smart meter rollout will change the way suppliers interact with their customers and compete in the market. Energy utilities will have a fundamental role in the process. By investing in smart meter infrastructure and service they will, for instance, improve their data quality and feedback with the final customer. Although most MS said that smart metering would not increase the cost of energy, half of the respondents in our survey with MS indicated that smart metering would have a cost effect. Although it is true that the acquisition and installation price of a smart meter/grid will have an initial cost for the final customer, the investment may be recovered over a couple of years from consumer´s behaviour changes due the increased knowledge about their consumption. Customer's knowledge about how smart meters can help reduce their bills will boost the development of this market around Europe.

Demand response and/or home automation services are the most common type of services already being implemented in some MS. Furthermore, virtual power plants have been established and dynamic tariffs introduced, which has improved billing and consumer information about energy consumption.

The vast majority of survey respondents (19 out of 23 MS) indicated that new business opportunities might arise from the rollout of smart meters in their countries, namely: hardware development and sale, development of auxiliary devices (e.g. displays and energy storage equipment and devices); development of smart appliances and devices which should be able to communicate with smart meters in general; installation of smart meters and training of professional installers; development of services and platforms to visualise the specific consumption of one or more forms of energy; the possibility of developing dynamic tariffs and demand side management; and the development of bundled metering services.[6]

MS identified barriers and challenges regarding the development of a market for services around smart meters:

Barriers:

- Lack of demand for smart metering services, e.g. due to a lack of knowledge regarding the opportunities for these services and/or due to small potential for individual cost savings
- Lack of a rollout policy or slow rollout of smart meters: the economic impracticality of the smart meter rollout when high costs of rollout meet relatively small individual opportunities for savings (due to low energy consumption or costs)
- Data security, or the availability of data

Challenges:

- Low funding for the rollout, or economic impracticality due to various reasons
- Low confidence in the technology and privacy issues
- Lack of professional structures

6 Concerted Action, "Service market development for smart electricity and gas metering, Executive Summary 3.7 - Metering and Billing", April 2016

Feedback from experts

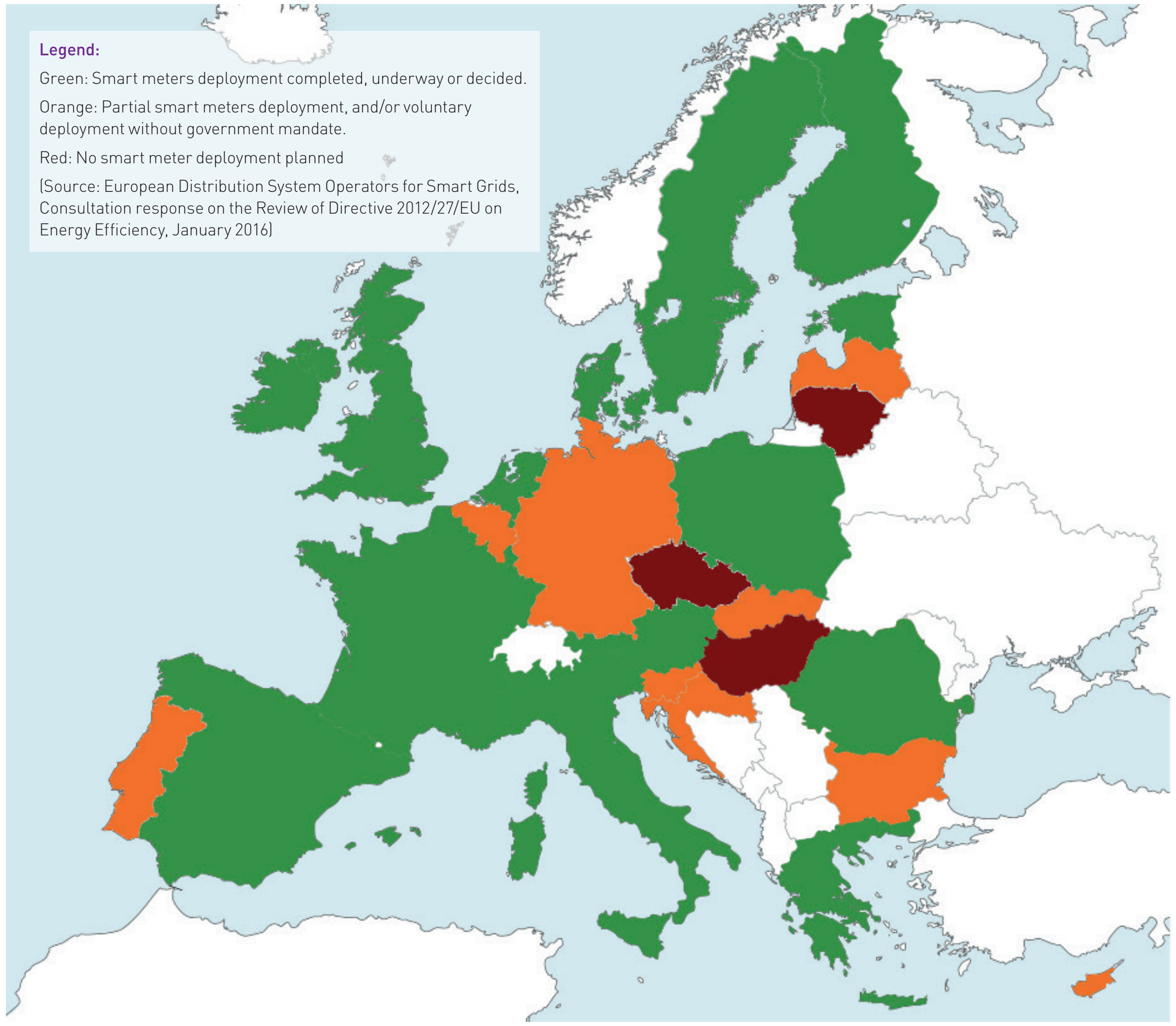
All experts agreed that there can be value for consumers in having access to information regarding their energy consumption, especially if provided on a near real-time basis. Nevertheless, there has not been a huge interest from consumers, even in MS where the smart meter rollout is well under way. On the other hand, market actors, like systems operators and service companies, are very interested in this data to optimise their offerings. It is important therefore that smart meter applications are user-friendly, for instance:

- Introduce a smart tariff that builds on hourly rates that is easily understandable for consumers
- An in-house interface on the meter to engage a range of consumers beyond the "energy-literate"
- The ability to control which parties may access their smart meter data and for what purposes

7 The state of (smart) metering implementation (Article 9)

MS are proceeding with the roll-out of meters, though at different paces, thus providing information on accurate energy consumption and actual time of use as described in article 9.1. When implementing smart meters, MS must attend to various obligations under article 9.2. Moreover EED, under article 9.3 requires that individual meters should be installed by 31st December 2016, given technical and economic feasibility. Results regarding the state of the smart meter implementation for electricity, gas, hot water and district heating and cooling are referred to below.

Figure 2 - Current state of implementation in EU Member States for electricity smart metering



The roll-out of gas meters is lagging behind the electricity meter roll-out: 17 to 20 MS for electricity, and 7 to 18 MS for gas. (Variations are due to use of source; a JRC report shows lower figures than those reported by MS in questionnaire.)

Despite some uncertainty about the outcome of technical and/or economic studies regarding individual metering installation, more than half of the CT3 participants predict that they will do it by the end of 2016. There are several projects already implemented that show evidence of between 1% to 3% of energy savings as a result of information on actual energy consumption on electricity and gas.

Regarding hot water, district heating and cooling the EED implementation seems to be more challenging given the technical and physical necessity, when installing individual meters or heat cost allocators, to obtain the consumption of a single end-user.

Individual metering installation works as a promotor for the introduction of smart meters. These must comply with the five requirements in Article 9.2 and have ten minimum functionalities (described in European Commission Recommendation 2012/148/EU), which are being met by half of the MS.

Due to different MS opinions regarding which objectives and which benefits to final customers should be taken into account when installing smart meters, there are different levels of (legal) arrangements regarding the minimum functionality for energy efficiency and consumer benefits (Art. 9.2a), respect for privacy and security (Art. 9.2b), the supporting of product and market developments (Art. 9.2d) and providing advice and meter reading management (Art. 9.2e). Only the requirement to allow the export of electricity to the grid from final customer premises (Art. 9.2c) seems to be standardised for smart meters in most MS.

Practical examples of smart metering implementation

Two MS (Spain and Slovakia) provided practical examples that demonstrated that the implementation of Article 9 is already a reality, especially if the main topic is smart metering.

In Spain billing is based on real (and actual) meter readings from smart meters. The functionality of household electricity smart meters' permit registers for different time periods (6 time periods can be programmed), including active and reactive energy and maximum demanded power every 15 minutes. Moreover, it is possible to programme registration periods of a maximum interval of 1 hour, with all data being integrated in a remote management and metering system collected by the DSO. The data, once completed and revised, is used for two different processes: billing of electricity consumers (retail level) and the settlement of both generation and demand in the electricity market (wholesale level).

The functionality of the remote management system in Spain includes a set of characteristics, namely remote reading of active and reactive energy, power and of quality parameters; remote parameter setting of metering equipment; activation of power control mode; remote periodic synchronisation with the system; power remote control and load management capacity.

In Slovakia, Heat2go is a monitoring system to control the energy consumption and to acquire a complete overview of heat, water, electricity and gas consumption in multi-apartment and multi-purpose buildings. Measured data outputs are transparent and established based on the requirements of customers. An important tool is the web interface, which enables export readings in tabular or graphical reports. An additional very important feature is the ability to create multiple and different levels of platform users, allowing the possibility of creating users only to view the final consumption or users with administrator permission, that might act more effectively in real time on final consumption.

Power Line Communication (PLC) is used in smart metering for telecommunication, tele-protection and tele-monitoring between electrical substations through power lines at high voltages, such as 110 kV, 220 kV and 400 kV. This can be used by utilities for advanced energy management techniques such as smart metering infrastructure, demand side management and demand response. This technology supports high transmission rates, reaching up to 200Mbps at various frequencies between 1.7 MHz and 30 MHz. The electricity network is full of electronic equipment that causes noise in the frequency range used. It is essential that a single protocol is developed for smart meter data transmission using PLC to ensure exclusive use on the above mentioned frequency range.

8 Measures undertaken and planned to enable and promote Demand Response (Article 15)

Demand response is the change in end-users electricity consumption patterns in response to changes in the price of electricity over time, or to incentive payments. As such, demand response brings savings both to consumers and utility companies, and more efficiency to the energy system.

Demand Response challenges

Demand response participation involves active and engaged customers, and where appropriate, demand-side management (DSM) measures by utility providers to ensure an even supply of electricity by smoothing out peaks. Together, these components will bring benefits for customers, suppliers and distributors.

The Council of European Energy Regulators (CEER) described four leading principles that should be in place for any consumer and for any energy contract, including demand response[7]. These four principles are described by CEER from a customer perspective. [CEER subsequently in 2014 issued actual advice on DSF[8].]

Reliability – in the physical supply of energy and in commercial systems and processes that provide continuous access and affect customer service levels, such as billing. It also means reliability in the processes that allow problems and disputes to be resolved transparently, fairly and quickly.

Affordability – such that charges are clear and kept to fair and reasonable levels for all customers, reflecting value for money at a level consistent with funding necessary investments to develop energy networks, and to achieve energy policy targets (for example, renewable energy), whilst taking into account the real needs of customers. This can be secured through network regulation and other appropriate measures, if and when necessary, and by providing customers with effective choice over truly competing offers and new, innovative services. Energy sector specific measures as well as wider social policies also have an important role to play, especially for the poorest and more vulnerable.

Simplicity – in how information is provided to customers, and especially residential consumers, such that it is easy for them to understand their bill and better manage their energy consumption, making the choices that are right for them. It also means simplicity and transparency in how key processes that affect customers operate. Many customers, and especially many residential consumers, want to be able to take quick and simple decisions in energy markets.

Protection & Empowerment – to ensure access to energy supplies, and to guard against unfair commercial practices and unsatisfactory outcomes, recognising the diverse needs of customers, in particular the most vulnerable in society. For customers to be engaged, to take choices and to exercise their rights as energy customers, based on trust in, and knowledge of, how the energy sector operates. As responsibilities shift and consumers are increasingly expected to become more active in energy markets (through developments such as Demand Response, smart metering, micro-generation or energy efficiency measures), it is important that their right to choose by whom and how their energy is to be provided and charged is recognised. Although this freedom could be framed by regulation, offering meaningful choice for

7 CEER Response to DRAFT THINK REPORT "Shift, not drift: Towards active demand response and beyond", 24 May 2013

8 http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/Tab3/C14-SDE-40-03_CEER%20Advice%20on%20Demand-Side%20Flexibility_26-June-2014.pdf

customers (including residential consumers) is a key way to ensure their full protection.

Demand response benefits

The most important benefit of demand response is improved resource-efficiency of electricity production or gas use due to closer alignment between customers' electricity and gas prices and the real value of these commodities.

Increasing participation of customers (bill savings)

Demand response implies that the customer becomes active in managing his/her consumption, in order to achieve efficiency gains and, by this means, monetary/economic benefits.

This means that customers, either directly or through aggregation, are expected to communicate and interact more intensely with energy companies. Most of this interaction is likely to be automated. This means that households communicate via an intelligent solution with their aggregator or energy supplier according to pre-defined parameters (set by the household). This is likely to create more dynamic relationships between these players.

The meaning of "participation of customers" is that, with demand response, the customer is no longer an end user who consumes energy and pays the bill, but has become an active market player who communicates with energy suppliers (or other market players, such as aggregators). As a result of this communication the consumer is active in changing energy usage.

Reducing and/or shifting consumption (realising energy savings)

The European Commission estimates that the average yearly bill for the consumer can be reduced between 2% and 4% if demand response mechanisms are implemented. It is estimated that 10% of household consumption and 20% of industrial consumption can be shifted towards cheaper periods.[9]

Incentive payments for end users are expected to lower electricity use at times of high wholesale market prices or when system reliability is jeopardised. Demand response aims to reduce electricity consumption in times of high energy cost or network constraints by allowing customers to respond to price or quantity signals.

More optimal use of network and generation assets

In the long term, this operational value of demand response can lead to reduced or postponed investments in network reinforcement and flexible thermal generation, and to less investment to meet decarbonisation targets, as the electricity system is used more efficiently.

Improving system balance between generation and demand

In the short term, demand response can make balancing easier by shifting demand to times when there is more renewable power available, and it can help manage congestion by peak-shaving; thus helping the integration of renewable energy sources in the electricity system and reducing the high operation costs of flexible generation units.

Demand response challenges

In contrast to the wide consensus on the value and necessity of demand response in smart grids, there is little consensus on how to engage consumers or align industry incentives. There are several challenges for demand response if it is to play its expected role of flexibility provider.[10]

Discussion on the role of different actors

There is lively debate on the role of different actors, incumbent (transmission system operators, distribution system operators, suppliers, etc.) or emergent (aggregators, manufacturers of appliances and devices, retailers in other sectors than electricity, ICT companies), in the organisation of smart grids and demand response.[11]

9 Source: Presentation by Jan Panek, Head of Unit B3 Internal Market III during the European Sustainable Energy week in Brussels, June 26. 2013. Title: Smart Metering in Europe: Are We on Track?

10 This section uses analyses from the THINK-report, 'Shift, not Drift: Towards Active Demand Response and Beyond'. This report is highly recommended and can be found at http://www.eui.eu/Projects/THINK/Documents/Thinktopic/Topic11digital.pdf

11 Expert Group 3 of the Smart Grids Task Force (SGTF) has published the report 'Regulatory Recommendations for the Deployment of Flexibility' which, among others, discusses the possible relations between the actors involved in provision of flexibility. This report can be found at https://ec.europa.eu/energy/sites/ener/files/documents/EG3%20Final%20-%20January%202015.pdf

The split incentives of intermediaries and the distribution of the value of demand response along the value chain explain the difficulty of reaching consensus on the appropriate business model for demand response.

Indeed, if the total value were to be passed on to the responding consumers, industry would not be engaged, and if industry did not pass sufficient value to the consumers, the latter would not participate in demand response.

Dependency on smart meter roll-out

A second challenge exists in the roll-out of smart appliances and enabling advanced metering infrastructure (smart meters). A recent survey of pilot studies on demand response demonstrates that smart appliances and enabling infrastructure significantly improve the responsiveness of consumers to dynamic price signals.

Yet there appears to be a chicken-and-egg problem: without the infrastructure, smart appliances and demand response cannot be used to their expected potential, and without demand response through smart appliances, the remaining benefits of the enabling infrastructure may not justify the costs of its roll-out.

Furthermore, the minimum recommended functionalities for these smart technologies, to ensure their added value for consumers, are not yet firmly established; instead they are part of a European Commission Recommendation that is not fully implemented by all Member States rolling out smart meters. Several mandates to standardise appliances and infrastructure to ensure their interoperability are still ongoing. The Smart Grids Task Force[12] is currently analysing the status of functionalities, interfaces (based on the standardised smart metering communication architecture) and interoperability in the smart metering systems being rolled-out in Member States, in the context of facilitating the provision of energy management services for consumers' benefit.

Current research also focuses on how consumers can offer demand response with their current and future smart appliances, and what the associated benefits could be for the electricity system.

No one-size-fits-all solution

There are several more reasons why a 'one-size-fits-all' approach is not advisable when aiming at energy consumption reduction or shifting.

'One-size-fits-all' approaches usually focus on providing financial incentives, assuming that people are mainly economically motivated to participate. However, there is plenty of evidence that people are not predominantly motivated by financial gains, but can also have other motivations that relate to environmental goals, health, comfort, etc.

Research on DSM aimed at energy consumption reduction has shown that approaches that target individual behaviour alone, without addressing the social and physical environment in which behaviours are embedded, have not been very successful in achieving lasting behavioural changes. In the case of dynamic pricing, it is relevant to take into account the characteristics of the house, the appliances, and the social processes within a household.

The risk of rebound during or after the pilot is larger if individuals are targeted with financial incentives only. No social norms are addressed; no beneficial social behaviour is likely to occur (which is needed if the longer-term goal is to facilitate the transition to a more sustainable energy system).

Studies show that often a small percentage of participants are responsible for the response, while it remains unclear why and how they responded and why the rest did not. On average, 30% of households were responsible for 80% of the load shifting (for the total energy that was shifted or reduced by end users in the pilots and studies) (see THINK-report[13] for more details).

12 The Smart Grids Task Force Expert Group 1 on standards and interoperability (EG1) is looking into this issue, pooling expertise from the M/490 Smart Grid Coordination Group which has successfully completed its mandate.

13 Think-Report Shift, not Drift: Towards Active Demand Response and Beyond. http://www.eui.eu/Projects/THINK/Documents/Thinktopic/Topic11digital.pdf

Demand Response challenges (continued)

Ongoing 'post liberalisation' legacy issues, such as end price regulation

Customers cannot be expected to participate in retail markets if price signals remain blurred: wholesale and retail markets should be better synchronised to ensure that well-functioning and integrated wholesale markets promote a 'level playing field' at the retail level.

End-user price regulation - currently present in 19 out of 27 Member States – is often specifically mentioned as a barrier to demand response. The reason for this is that the idea of a maximum price for end users (defined in advance by regulators) does not fit with the principle of end users paying market prices. Demand response may need some consumer protection, such as ensuring transparent and understandable contracts, and guaranteeing that demand response must always be based on the explicit permission of a customer. With regard to prices, the most important principle is that customers should react to communications that reflect market prices (high or low). Limiting this will decrease the advantages of demand response and might reduce and limit the attractiveness of demand response for all parties involved.

An external point of view

Kjartan Skaugvoll, CEO of Cuculus, a smart grid facilitating company, analysed all current costs that are related to renewable energy production and are paid by consumers. He stressed in his presentation that renewable energy sources cause extra costs for consumers via hidden volatility charges in the supply tariffs, but that consumers do not have the opportunity to benefit from the advantages of the low marginal costs of renewables. Therefore, he recommends demand response solutions to allow consumers not only to pay for the energy transition but also to benefit from it, by taking advantage of the low marginal costs of renewables.

Demand response pilot cases in the Netherlands

The Office for Energy Regulation (ACM), from the Netherlands, demonstrated that demand response will only be successful if the consumer is put at its heart. One demand response pilot indicated that only some 20% of consumers react to standard financial impulses only. If social and emotional impulses are added and tailored to specific customer needs and situations, the participation percentage of consumers can increase to around80% and more.

Another pilot focusing more on challenges for different market actors showed that successful demand response requires new market roles, such as aggregators, and amendments in current market roles, such as introducing direct communication from grid operators and suppliers to consumers.

9 Infrastructure efficiency potential assessment (Article 15)

Given the relevance of the topic, the work encompassed not only the energy efficiency from the demand side and grid issues but also the promotion of energy efficiency from the supply side. For that reason this topic was developed in a partnership with the Efficiency in Energy Supply Core Theme. Article 15.2 of the EED requires all MS to assess the potential for improved energy efficiency in energy grids (electricity and natural gas), and to specify measures to improve efficiency.

A survey was undertaken to assess the regulatory setup of the MS and the level of implementation. The survey shows that regulatory regimes vary somewhat across MS regarding mandates to define and implement the assessment, as well as in defining and implementing relevant measures.

Although few MS have made the comprehensive potential assessment prescribed in Article 15(2), several MS report of initiatives undertaken to improve grid efficiency.

On average, MS consider the potential to be distributed quite evenly across a range of measures such as grid re-enforcement, demand response, dynamic tariffs and improved access to distributed generators.

Criteria and requirements for promoting energy efficiency are specified in Annexes XI and XII. While the annexes provide guidance regarding regulations of tariffs and energy efficiency requirements, the framework is highly open for interpretation concerning the methodology of undertaking an assessment of energy efficiency potentials according to Article 15(2). MS can benefit from sharing best practices and lessons learned from a particular approach, methodology etc. from other MS. The Concerted Action and the plenary meetings can function as powerful tools to stimulate information sharing of these assessments.

Regulation and incentives, for access to distributed generators for heating or cooling, could further impact on the supply mix, hence, the overall energy efficiency of the system. Additionally, regulation for heating or cooling systems would have an impact on overall efficiency. To some extent, there could be a dynamic relationship between these impacts; for example, efficient incentives to promote demand response would alleviate the need for more upstream capacity.

MS and stakeholders such as systems operators should take an integrated view on incentives and regulation of entire energy systems to promote the most cost-effective mechanisms to achieving more efficient systems. From such an integrated approach, the promotion of relevant demand responses should be taken into account as well.

10 Energy efficiency in network design and regulation (Article 15)

It is important to consider which measures will be implemented in Europe and what will be the future impact in transport and energy distribution networks. In this context, Article 15 (2b) introduces the concepts of operation and design of the gas and electricity infrastructure, while the related Annex XI and Annex XII aim at maximising grid and infrastructure efficiency and promoting demand response.

Smart grids, encompassing smart meters, will monitor and manage the transmission of electrical power from all generation sources to meet the varying electricity demands of end-users, thus maximising the system reliability, resilience and stability, and minimising costs and environmental impacts. A survey was conducted to assess how to improve the networks' infrastructure, identifying loss reduction in electricity and gas grids, and planning/operational efficiency in electricity grids.

Identification of key measures for gas and electrical grids

The key energy efficiency measures to deal with losses can be divided in two main categories:

a. 'Traditional' measures of component replacement;

Classical replacement of equipment is gains a lot of savings. The main measures used for network architecture and management solutions are: network reconfiguration, balancing three-phase loads, demand side management, reduction of fixed losses, distributed generation and use of renewable energy sources, reactive power management, network reconfiguration and power flow controllers

b) Measures that achieve a reduction of losses by an improved management of the power system

Measures on planning/operational efficiency in the electricity grid can in particular be related to:

- Optimisation of investment planning, where the use of flexibility of distributed energy resources (feed-in control of distributed generation, storage, demand response) is currently being explored as an alternative to traditional grid reinforcements (e.g. high efficiency transformers, expanding line capacity)
- Optimisation of grid operation (e.g. smart grid assets, network reconfiguration, switching off redundant transformers, voltage optimisation, Conservation Voltage Reduction (CVR) and balancing 3-phase loads)

For gas, energy efficiency measures can be related to the transmission network, compressor stations and distribution network.

The introduction of smart meters has increased the capability to provide such measures. Installation of smart meters is also a prerequisite for providing demand side management measures. 16 MS plan to introduce smart grids in electricity and 11 in smart gas grids. Some elements for smart grids are already installed, however operational measures are less utilised. 8 MS have also identified measures of other electricity and gas market players, e.g. supporting the renewables and distributed generation, using energy services and ESCOs, regular information to consumers or the introduction of energy saving programmes at local levels.

A survey has been undertaken to gather information on what is on-going at MS-level regarding the improvement of the infrastructures. More than 80% of MS have identified at least one measure set for energy efficiency in electricity and gas networks. The following percentages refer to the number of MS that have responded about the measure. Regarding **equipment replacement solutions**, 79% of MS have installed energy efficient transformers, 77% have expanded the capacity of network lines and 54% have increased the system voltage levels. Regarding **network architecture and management solutions**, 45% have switched off transformers, 55% have established more direct in the network configuration, 75% have activated tools for demand side management, 64% are increasing distributed generation and RES penetration in the network, less than 50% are using reactive power management or imposing penalties for low power factor, 54% have made operational network reconfiguration of some type, and almost 60% have or are in the process of balancing three-phase loads. Regarding **operational measures solutions**, 50% have tried to enhance network stability through the support of distributed generation, less than 20% underwent a switching out of an under-utilised plant, 42% have implemented systems for substation ambient temperature control. Regarding **measures to reduce network reinforcement**, 85% have installed smart meters and 58% have implemented demand side response.

11 Concluding remarks

Many existing meters in the EU already reflect actual total energy consumption, but this is not the case for information on actual time of use. An important result of the various CA EED activities on metering and billing is that further discussions need to take place, to exchange information and experience on what is considered 'technically possible', 'financially reasonable' and 'proportionate in relation to potential energy savings' in the different MS, by sharing information on critical assumptions, costs and expected benefits. In 2015, the European Commission was organising a series of workshops specifically on the topic of metering and billing of heating, cooling and hot water, and has charged a consultant with developing draft guidelines on related aspects; in particular how to apply technical feasibility and cost-effectiveness criteria in the context of Articles 9 and 10. A workshop to discuss the draft guidelines was organised on 22 October 2015 in Luxembourg (back-to-back with the 6th Plenary Meeting of the EED Concerted Action).

One of many important conclusions around the work developed in CA EED activities was that the EED allows some freedom in the implementation of the concept of billing information, mainly in the type of indicators used for each MS.

The difficulties presented by MS regarding the interpretation of the difference between the terms billing and billing information were completely dispelled after the Directorate-General Energy (DG ENER) presentation. Article 10(3d) states that:

- Bills - carry the obligation to settle the due amount; and
- Billing information - which do not carry this obligation, but will normally contain the same information.

It is important to note that billing information can be made available together with the bill or separately. Naturally, billing information needs to be based on actual consumption. Its primary objective is to assist the final consumer by providing a comparison between the current energy consumption and the amount consumed during the same period in the previous year. This can also be done through an alternative indicator freely chosen by each MS, which should be graphically represented.

As previously stated, Article 10 gives MS the freedom to choose new indicators to include in the billing information. In this context the three most important minimum requirements identified by MS during CA EED activities, are:

- Comparison of current energy consumption with the amount consumed during the same period in the previous years;
- Comparison with energy use of a similar consumer, for example one neighbour (indicator used in the USA) or a benchmarking tool (for example, standard consumers or even the consumption correction taking into account the heating and cooling degree days);
- All types of energy should be presented in the same units (kWh), to facilitate the comparison of different types of energy

Despite the efforts that have been made in recent years, the gas sector continues to have cases where it is not technically possible or economically justified to provide all customers with quarterly billing information based on actual consumption. However, the expectation is that it will become easier to plan the best way to overcome this difficulty in the gas sector and learn from the maturity and experiences of the electricity sector.

In the context of heating or cooling or domestic hot water, Article 9(3) requires that individual consumption meters/heat cost allocators for measuring individual consumption of heating or cooling or domestic hot water must be installed in multi-apartment buildings by 31st December 2016. In such buildings where this has not yet taken place, the implementation of the obligation to provide accurate billing information based on actual consumption in line with Article 10(1) therefore does not have to take place before the implementation Article 9(3), i.e. by 31st December 2016, at the latest.

Another conclusion is that each MS should be free to create the most efficient billing model, taking into consideration the characteristics and peculiarities of the energy system and energy market in their country, and the minimum requirements according to Article 10 and annex VII EED. However, the creation of minimum indicators that should be part of billing information, as well as the clarification of the purpose of the billing information concept according to Article 10 and annex VII EED, will be beneficial for all MS.

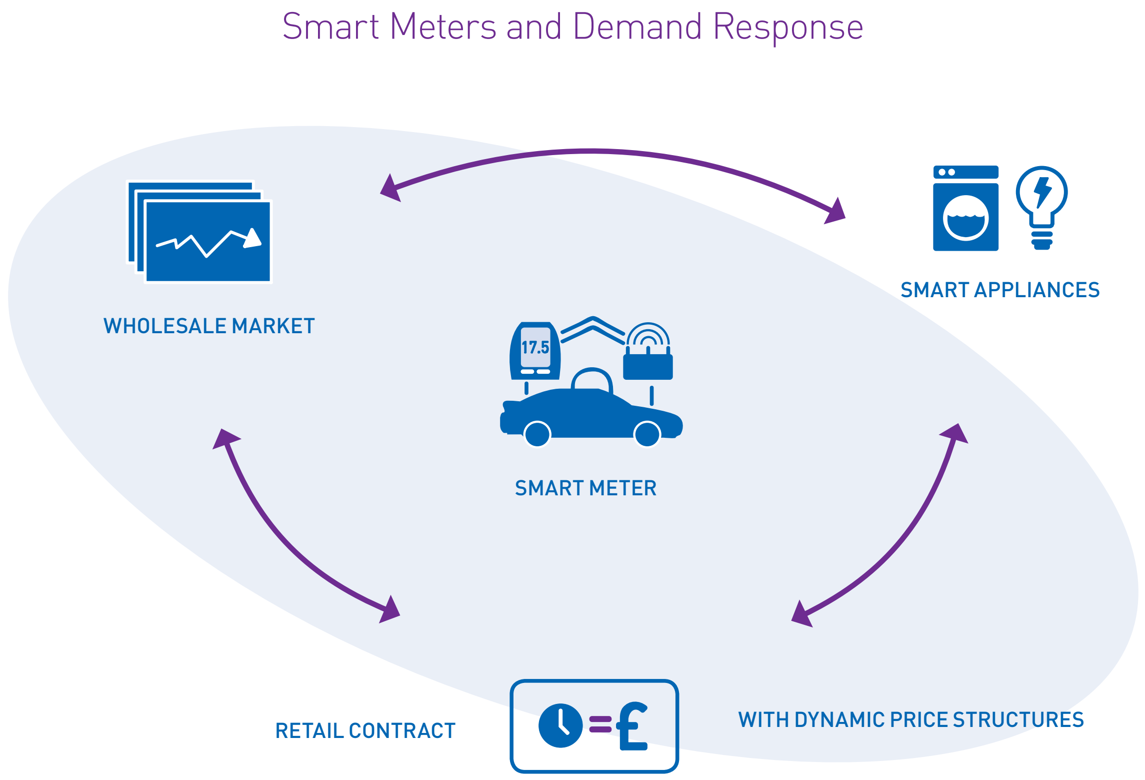
Concerning the cost effectiveness assessment of individual metering for heating, cooling and domestic hot water, it is difficult to characterise the current situation across the MS. It is a sensitive and complex subject, not only because of its technical difficulties but also because there are many important differences between MS. Thus, there is no single solution and each MS has to adapt their solution to their own reality. Nevertheless, the CA discussions showed that there is a need to legislate and invest in the combination of control systems and individual metering for heating, cooling and hot water in order to reduce the payback period. Notwithstanding, individual metering is considered, by default, not to be technically and economically feasible in the case of existing buildings.

A recommendation drawn from the discussion at the CA activities is that in order for the smart meter roll-out to become as successful as possible – in order for all consumers, independent of age, level of education and level of interest, to be engaged in their energy consumption - the market should offer solutions that are easy to understand, easy to set up and cost effective. The market is evolving in the right direction but all MS should learn more from each other. Regarding privacy and data protection of smart meters, due the lack of experience in the energy sector within this specific area, it is important that a test phase is accounted for, along with some time to learn and identify all necessary requirements for positive and secure smart meter and grid implementation and operation. At this moment MS are expecting the results from a two-year test-phase (DG ENER promoted the test-phase kick-off on March 5th, 2015).

During the CA EED activities, we have seen different set-ups of demand response where different actors - such as suppliers, DSOs and of course aggregators - have different responsibilities towards consumers. This is a consequence of the different market models that exist in Europe. An important factor is the responsibility of the DSO: we see pilots where the DSO provides end customers with price signals because of the DSO's responsibility for avoiding network congestion. We also see pilots where DSOs cannot give signals to end customers, because that is a sole responsibility of the supplier (or aggregator). As a result, we can state that the different market models in Europe affect the different market models for demand response. A wide range of pilots and lack of a standard market model for remand response indicate that demand response is not a standard solution. The CA participants from half of the MS consider that demand response products are absolutely necessary to achieve energy efficiency effects among end users, and that it is very important to involve the customer as a part of the solution.

For this to happen, implementation of the EED for Metering and Billing is essential, and the deployment of smart meters and grid infrastructure are increasingly important (see Figure 3). One must have in mind, though, that smart meters themselves do not save energy: lifestyle and behavioural change do. Providing useful information from smart metering will help that change.

Figure 3 - Relationships between demand response and other relevant developments (Oval shape indicates scope of EED Articles 9, 10, 11 and 15)



Demand response pilots show that tailor made demand response stimuli will result in consumers changing behaviour and contributing to energy efficiency objectives. Demand response can only be successful if many new and existing market players are encouraged to contribute to implementing it. Demand response solutions and dynamic pricing contracts will allow end users to pay prices that reflect market prices.

The THINK-report that was published at the start of 2013 provided a sophisticated overview of contract types and consumer preferences (risks). This overview could be used by MS to ensure that end users benefit from dynamic pricing and customer friendly demand response solutions that fit their needs.

The implementation of Article 15(2) is complex in terms of data gathering and analysis. Also, at an institutional level implementing it is challenging, not least because it involves several stakeholders, including the national authorities, the regulators, the TSOs and the DSOs. There seems to be a need for greater exchange of experiences and methods for the implementation of 15(2) between all MS.

Legal Disclaimer
The sole responsibility for the content of this report lies with the authors.

It does not necessarily reflect the opinion of the European Union or the Member States. Neither EASME nor the European Commission are responsible for any use that may be made of the information contained therein. The Concerted Action for the Energy Efficiency Directive (CAEED) was launched with support from the Intelligent Energy Europe (IEE) in spring 2013 to provide a structured framework for the exchange of information between the 28 Member States and Norway during their implementation of the Energy Efficiency Directive (EED).

For further information please visit **www.ca-eed.eu** or email **caeed@ca-eed.eu**

CONCERTED ACTION
ENERGY EFFICIENCY
DIRECTIVE

Core Theme Series Reports

Co-funded by the Intelligent Energy Europe Programme of the European Union