European Smart Metering Landscape Report

"Utilities and Consumers"

USmartConsumer Project
www.usmartconsumer.eu

2016

Escan, s.l. consulting, Spain
Central Finland Energy Agency, Finland
Centre for Sustainable Energy, UK
The Polish Nat. Energy Conservation Agency, Poland
Austrian Energy Agency, Austria
AISFOR, Italy
RVO Netherlands Enterprise Agency, The Netherlands
REE-Management, Germany
WEMAG, Germany
Polish Consumer Fed. National Council, Poland

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

Madrid (Spain), November 2016

This publication is Deliverable D2.1 of the project "USmart Consumer - You are a Smart Consumer" funded by Intelligent Energy – Europe, inside WP2-task2.1. More information at www.usmartconsumer.eu.

For permission requests: addressed "Attention: Permissions USmartConsumer publication," at Francisco Puente, escan@escansa.com, +34913232643, www.escansa.com

Table of contents

1. Executive Summary

1.1. Scope of this report

Member States are required to ensure the implementation of smart metering to consumers under EU energy market legislation in the Third Energy Package. This implementation may be subject to a long-term cost-benefit analysis (CBA). In cases where the CBA is positive, there is a roll-out target of at least 80% market penetration for electricity by 2020.

By May 2014, Member States committed to rolling out close to 200 million smart meters for electricity and 45 million for gas by 2020 at a total potential investment of €45 billion. By 2020, it is expected that almost 72% of European consumers will have a smart meter for electricity while 40% will have one for gas. Up to date, 80 million smart meters have been installed in the EU28 and Norway, which constitutes 30% of the overall European electricity metering points.

USmartConsumer has accounted 80.000.000 smart meters installed in the EU28 and Norway up to date, which constitutes 30% of the overall European electricity metering points

The goal of USmartConsumer is to promote utilities smart meter rollouts and innovative smart metering services to consumers, that have the potential to achieve energy savings and peak load reduction in Member States. In order to do so the *European Smart Metering Landscape Report 2016* collects updated information on the situation of smart metering and innovative services throughout Europe, identifying the current national regulations and the offered smart metering services.

The information has been gathered from utilities, European and national regulators, national energy agencies and officials, previous and on-going IEE- and other European projects, and other secondary sources as well as literature. This information is assessed by a group of energy and IT experts.

This report has been developed by a group of expert independent organizations, partners of the USmartConsumer project, coordinated by Escan energy consulting (www.escansa.com).

Table 1 : Partner organizations monitoring the European Smart Metering Landscape Report

ESCAN Energy Cons.	Spain, Portugal and Malta
CFEA	Finland, Norway, Sweden, Estonia
CSE	UK, Ireland, France

KAPE	Poland, Latvia, Lithuania, Romania
AEA	Austria, Croatia, Slovenia, Hungary
AISFOR	Italy, Cyprus, Greece, Bulgaria
RVO	The Netherlands, Belgium, Denmark, Luxemburg
REEM	Germany, Slovak Republic, Czech Republic

1.2. Main conclusions

Smart meter landscape in European countries

- The EU smart meter roll-out keeps a steady progress forward, but within very different operational environments and speed in each member state. Sweden and Italy are the exceptions with fully rollout since years.
- Countries with a clear mandatory regulatory framework and/or positive cost-benefit analysis are reaching their targets according to national plans (Denmark, Finland, France, Ireland, Norway, The Netherlands, Slovenia, Spain or UK). Some other countries which have more neutral cost-benefit or policy support was weaker at some point are progressing slower (Austria, Germany or Poland) but with a clear path.

Countries with a clear mandatory regulatory framework and/or positive cost-benefit analysis are reaching their targets according to national plans.

- Countries without mandatory smart meter roll-out (Portugal), negative cost-benefit for massive or specific scenarios (Czech Republic, Belgium), those with conclusions on their cost-benefit analysis indicating possible negative results for the proposed scenario (Belgium, Slovakia) or those with lack of a clear legal framework (Bulgaria, Croatia, Latvia, Lithuania) are facing delays.
- The average situation in Europe is now in the "Dynamic Movers" area. This means that both the average legal and regulatory framework and the market conditions for smart metering services are in the 60% considering the overall European Union situation. Compared to 2014, this indicates a 12% positive progress in the EU, and over 25% if compared to 2013.

The average situation in Europe is now in the "Dynamic Movers" area.

- The primary drivers for rolling out smart meters are EU legislation, energy efficiency and network modernization. Most of the roll-outs are based on a clear regulatory push and implemented by the DSOs (except in UK where the retailer is in charge). Also, some roll-outs are primarily based on business cases such as

reducing non-technical losses, increasing operational efficiency, or gaining competitive advance.

- Smart metering is an enabling technology but needs to be coupled with innovative customer-oriented services to realize all its potential benefits and to create the basis for better demand side energy management and smart grids. In this, consumer engagement is a major driver.

- The wider progress in the European countries' roll-out shows the need for further and clearer debates among the market actors, involving utilities, consumer representatives, public administrations, regulators and equipment and service providers. At this stage, it is clear that for smart meters to realise their full potential in each EU country, there is need to create a clear roll-out plan, undertake a cost-benefit analysis and establish a common understanding on how the consumers' information is going to be managed to benefit both the energy companies and the own consumers.

- At the same time, favourable market conditions have to be created for new services, products and entrants, as these are needed to reap the full benefits of smart meters. The market for using smart meter data and functionalities to create added value for consumers should be supported with the right quantity and quality of regulation and by reasonable energy market procedures.

Favourable market conditions have to be created for new services, products and entrants, as these are needed to reap the full benefits of smart meters.

- Three important differences outstand between gas and electricity smart meter rollouts which might make more difficult for a gas smart meter rollout to have a profitable cost-benefit analysis in some EU countries. Firstly, it would need an electricity supply (the electric meter already has it). Secondly, the cost of natural gas is lower reducing the potential economic savings, and lastly there are no natural gas demand "peaks" as identifiable as the ones found for electricity demand.

Recent progresses in the European legal framework

The Energy Efficiency Directive (EED, 2012) and guidance notes require that final customers for electricity, natural gas, district heating, district cooling and hot water should have a competitively priced individual meter that accurately reflects their energy consumption and provides information on the time of their energy use.

- When introducing smart metering systems for electricity and natural gas, information must be provided on actual time of use, energy efficiency and benefits for final customers must be fully taken into account, data communication must be secure and privacy must be in compliance with EU legislation and appropriate ad-

vice and information must be given to final customers with regard to monitoring of energy consumption.

- Member States should develop consumer information and empowering programmes, taking appropriate measures to promote and facilitate an efficient use of energy by small energy customers, including domestic customers. These measures shall include one or more of the following elements: (i) fiscal incentives; (ii) access to finance, grants or subsidies; (iii) information provision; (iv) exemplary projects; (v) workplace activities.

- Final customers still with traditional individual meters (not smart metering) should normally be told at least every 6 months how much they will be billed for the energy they used in the last period – every 3 months if they ask for it or are billed electronically.

Member States should develop consumer information and empowering programmes to promote and facilitate an efficient use of energy by small energy customers

The Directives on the Internal Market for Electricity and Gas (Directives 2009/72/EC and 2009/73/EC) included in the Third Energy Package, require Member States to ensure the implementation of intelligent metering systems to assist the active participation of consumers in the electricity and gas supply markets.

- As regards electricity, where an economic assessment of the long-term costs and benefits has been made, at least 80% of those consumers who have been assessed positively have to be equipped with intelligent metering systems for electricity by 2020. Where no economic assessment of the long-term costs and benefits is made, at least 80 % of all consumers have to be equipped with intelligent metering systems by 2020.

- As regards natural gas, no deadline is given but the preparation of a timetable is required, subject to an assessment of long-term costs and benefits. The Directives also state that final customers must be properly informed of actual electricity/gas consumption and costs frequently enough to enable them to regulate their own consumption.

- The Directive on internal markets (2009/72/EC), demands that, in order to promote energy efficiency, Member States or regulatory authorities shall strongly recommend that electricity undertakings optimise electricity use by, for example, introducing intelligent metering systems or smart grids.

The recast of the Energy Performance of Buildings directive (2010/31/EU, EPBD) includes a provision on the introduction of intelligent metering systems. It specifies that Member States shall encourage the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation. Additionally, Member States

may encourage the installation of active control systems such as automation, control and monitoring systems that aim to save energy.

Smart metering services for EU homes

The developments within the metering service market have the potential to bring actual energy savings. Even while it is still under debate as to what extent these services will in fact achieve energy savings, it is at the same time clear that without services based on frequent or real time information there is no benefit for the end customer.

It will be difficult to convince customers of the added value of new metering technology if metering data is only of use for operational changes within utilities

It will be difficult to convince customers of the added value of new metering technology and the modernisation of the European electricity grids, if metering data is only of use for operational changes within utilities (to reduce non-technical losses, for remote reading and switching or the simplification of billing procedures, etc.). This is particularly important because the real advantages of smart metering will and have to be compared with the related costs that will be borne by customers (in monetary terms, but also in terms of privacy intervention and other non-monetary issues).

Besides feedback tools that enable customers to regulate their energy consumption, a number of utilities test and operate demand response programmes in order to limit the peak load that has to be provided in the market. Nordic countries, Spain, as well as several other EU member states, have put into the market demand response services that provide with accurate information, innovative market-based tariffs and other economic incentives aiming to achieve certain customer behaviours or apply direct load curtailment within the contractual framework.

This report provides an overview of available services based on smart metering technologies and data in EU Member States. It is by no means a complete picture of the hundreds of different technologies available at the moment. It should rather be a starting point for interested stakeholders to learn and replicate from services that are in use in EU member states and Norway, including relevant developments of innovative services.

In order to facilitate the understanding, services for household sector have been classified in three groups:

- Frequent information to consumer and feedback
- Real-time information to consumer and feedback
- Demand response

2. Smart meter landscape in European countries

2.1. The European Map

Due to the regulatory push by the European Union's Third Energy Market Package, most EU Member States have implemented some form of legal framework for the installation of smart meters. Moreover, in some Member States electronic meters with bi-directional communication are installed for economic reasons even without any specific legal requirements.

Active policies and efforts made by market players have led to a dynamic development of smart metering legislation and regulation in the European Union. Based on the information gathered in this Smart Metering Landscape Report, we analysed all countries along two dimensions:

Due to the regulatory push by the European Union's Third Energy Market Package, most EU Member States have implemented some form of legal framework for the installation of smart meters

(1) Legal and regulatory status: by the legal and regulatory status we evaluate whether or not a framework has been created to provide clear guidelines to utilities for installing meters and whether this supports the goal of achieving energy savings and/or demand response effects for the energy consumers.

To classify each country the status quo has been assessed on the following dimensions:

a) cost benefit analysis existing or not,

b) rollout plan existing and timeline for the rollout,

c) barriers from additional legislation and regulation, e.g. privacy and data protection, measurement and calibrating meters,

d) legal minimum functional requirements for consumer smart meter services;

(2) Progress in market implementation: by the progress in implementation we refer to the number of smart meters and corresponding services projects existing, and also to the progress towards a clear and realistic implementation roadmap for metering technologies that enable new services to benefit consumers, once again with the goal of achieving energy savings and/or demand response.

To classify each country the status quo has been assessed on the following dimensions:

a) enabling infrastructure to manage data for different purposes and market actors,

b) smart metering rollout status in % of electricity consumers,

c) number of services based on smart meter data already available to customers;

As the functionalities of smart meters are crucial for the future deployment of the full potential of the meter-related services, the functionalities were the special focus of the survey.

Along these lines we classified all Member States and Norway in five groups:

1. (New) The "***front runners***" have finished their rollout (>95% smart meters installed) and provide services to consumers based in the SM data, or will reach 75% in 2016. These countries have a clear regulation for smart meters and consumers information, policy support, have solved all or most of the technological barriers and services to consumers are provided widely, as in Finland, Spain, Sweden, Estonia or Malta.

Several front runner countries have completed their smart meter rollout, or will be above 75% in 2016, and provide services to consumers

2. The "***dynamic movers***" are characterised by a clear path towards a full rollout of smart metering, and this group together with "front runners" involve more than 50% of the EU countries. Either the mandatory rollout is already decided, or there are major pilot projects that are paving the way for a subsequent decision. Also, smart metering services are offered to consumers or this market has already started and is in progress. Austria, Denmark, France, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Slovenia and the UK come under this group.

3. The "***market drivers***" are countries where there are no legal requirements for a rollout. Some DSOs or legally responsible metering companies nevertheless go ahead with installing electronic meters either because of internal synergetic effects or because of customer demand. Cyprus and Poland are in this group.

4. Germany, Greece, Hungary and Romania ("***ambiguous movers***") represent a situation where a legal and/or regulatory framework has been established to some extent and the issue is high on the agenda of the relevant stakeholders. However, due to lack of clarity within the framework, at this point only some DSOs have decided to install smart meters.

5. The "***waverers***" show some interest in smart metering from regulators, the utilities or the ministries. However, corresponding initiatives have either just started, are still in progress or have not yet resulted in a regulatory push towards smart metering implementation. We rank Bulgaria, Croatia, Czech Republic, Latvia, Lithuania and the Slovak Republic in this group.

6. Finally, *"**laggards**"* are countries where smart metering is not yet an issue. There are no members of this group as a consequence of the transposition of Directive 2009/72EC along the EU.

The developments since the Landscape Report last edition updated in 2014 show a new group of "Front Runners" in smart metering and consumers services deployment. Spain and Estonia have joined the pioneers Sweden, Finland and Malta.

Italy and Spain add together 57 million smart meters, over 70% of the units operated in the European Union

"Dynamic Movers" constitute the largest group and go ahead in their roll-outs, with a variety of situations. Italy has a close to full rollout but still massive services to consumers are scarce, The Netherlands is progressing according to the renovated regulation for smart metering and UK's electricity suppliers are installing displays at homes. Germany and Austria have limited their deployments due to their cost-benefit results for specific segments, Poland keeps a good progress leaded by their utilities, similar to France and Portugal that are gaining speed in 2016.

There are still several "Market Drivers" countries as Belgium and Cyprus, affected by cost-benefit analysis or regulation, and "Ambiguous Movers" as Germany (Digitalization of the Energy Transition Law, 2016), Greece, Hungary and Romania.

Bulgaria, Croatia, Latvia and Lithuania constitute the "Waverers" without clear legal frameworks or plans for smart metering and first rollouts happening recently. There are no members of the "Laggards" group as a consequence of the transposition of Directive 2009/72EC along the EU.

The following figure provides a graphical overview of the legal and regulatory situation vis-à-vis the process of implementing smart metering (for electricity consumption) enabling technologies and services with the goal of achieving energy savings and/or peak load shifting.

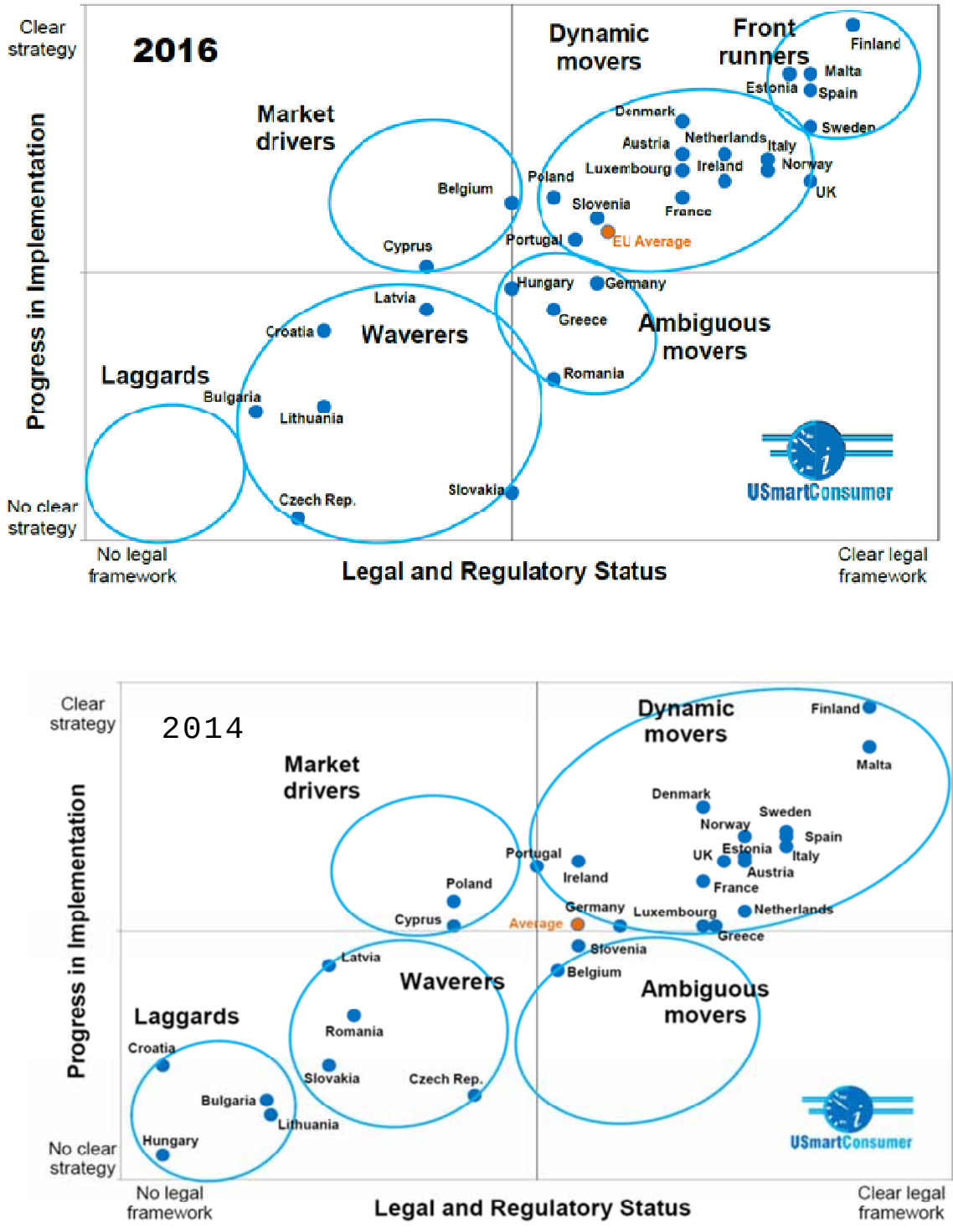


Figure 1: Legal, regulatory and market situation in the European electric smart metering implementing process (Progress in September 2014 and September 2016)

As regards services from smart meter consumer data in Europe, there is a range of feedback tools available in several EU countries, usually provided by energy utilities to consumers, in the form of displays, websites, information on mobile devices and TV, informative bills etc. The development within this market and the services that are offered to the end customers are key in achieving actual energy savings from the alleged saving potential.

Even though the literature disputes the energy savings achieved by these services, it is clear that without these feedback tools and additional consumer oriented services there is little or no benefit for end consumers. The added value of the new metering technology and access to their own information is necessary to strengthen the consumer's position. The modernisation of the European electricity grids by means of the smart metering data cannot be considered only for operational changes within utilities (to reduce non-technical losses, for remote reading and switching or the simplification of billing procedures, etc.). This is particularly important because the advantages of smart metering will and have to be compared with the related costs that will be borne by customers (not only in monetary terms, but also in terms of privacy intervention and other non-monetary issues). Only efficient services based on frequent and real smart meter data will benefit the consumer, improving his/her consumption pattern thus reaching energy savings.

Only efficient services based on frequent and real smart meter data will benefit the consumer, improving his/her consumption pattern thus reaching energy savings.

Besides feedback tools that enable customers to regulate their energy consumption, a number of utilities test and operate **demand response and direct load control programmes** in order to limit the peak load that has to be provided to the market. With this aim, Nordic countries - with high average electricity consumption at their homes -have piloted relevant demand response programmes. Customer are provided with accurate information, innovative tariffs and other economic incentives to achieve certain behaviours or apply direct load curtailment within the contractual framework, resulting in promising results.

2.2. National smart metering rollouts in the EU28 countries and Norway

In order to present the recent progresses in the European Union smart meter deployment, Table 2 provides an overview of the situation in each Member State and Norway regarding the regulatory and legal situation and the actual implementation of smart metering on the ground.

Table 2: Smart metering table for each EU country

Member state	Legal and regulatory status	Implementation status
Austria	In October 2011 the Energy Regulatory Authority (E-Control (2011)) issued a decree according to the Electricity Act which determines the functional requirements of smart metering systems in Austria. As expected by the stakeholders, the regulator mainly determined in this decree the topics mentioned in a catalogue with minimum function requirements for smart metering systems, which was already published in June 2010 for public consultation. In spring 2012 E-Control published a proposal for the mandatory Information of customers equipped with a smart meter. This regulation entered into force in January 2013. In an amendment of the Electricity Act in August 2013 the possibility for customers to opt-out was set by the legislator. There are 3 categories of meters: 1. Smart Meter "Opt in": approval by the customer is necessary (metering and storage in 15 minutes interval; 60 days storage of the data, remote interruption and unblocking possible; only the actual meter reading is visible at the display) 2. Smart Meter with its basic functionalities (metering and storage of daily data; apart from that like Opt in") 3. Smart Meter "Opt out" (no storage of metering reading in the meter, only transmission to the network operator; transmission of data possible, when provider change, change of tariff, move), no remote reduction of performance or switch off; no charts about the consumption data)	On 24 April 2012 the Minister of the Economy issued a decree, which determines the mandatory timetable for the rollout of smart metering services in Austria (BMWFJ (2012)). The new decree will accelerate the rollout of smart meters. The main rollout of smarter can be expected in 2016 and 2017.The electricity network operators have to equip at least 95 per cent of all metering points by the end of 2019. In September 2014 the Minister of the Economy communicated a legislative proposal to weaken the targets for the mandatory roll-out. The 10% target by 2015 should vanish. In the meantime it is clear that the 95%- goal by the end of 2019 will be failed. The regulator estimates that less than 70% will be reached. In spring 2013 the Regulatory Authority E-Control carried out the first monitoring of the implementation. In the actual monitoring report it is stated that in Austria 456.000 smart meters are installed which constitutes 7,4% of the metering points (versus 2014: 4,9%), and 740.000 smart meters are either installed or already ordered which constitutes 12,1% (versus 2014: 6,3%).
Belgium	In Belgium the energy policy is shared between the federal and the regional administrations. The introduction of smart meters in Belgium has been stalled because of conflicting outcomes of economic cost-benefit analyses (CBA) in the regions Flanders, Wallonia and the Brussels Re-	In March 2014, The Flemish regulator VREG published another update of the cost-benefit analysis for the introduction of smart meters in Flanders. The latest report shows a negative business case for a non-segmented roll out of smart meters and a positive business case for a segmented rollout in Flanders. The

Member state	Legal and regulatory status	Implementation status
	gion, all with highly autonomous energy authorities. Flanders region developed two CBAs by the Regional Energy Regulator (VREG) with variable results depending on the scenarios and boundary conditions. In the Brussels Capital region, the advanced scenario of the CBA turned out negative outcomes. In the Wallonia region the CBA Full Roll-out scenario was negative, while a Smart Meter Friendly scenario resulted in positive CBA. Because of the uncertainties following from these economic assessments, the Belgium government concluded that the conditions for the large scale introduction of smart meters are not sufficiently in place. Belgium is not legally bound to have smart meters installed in 80% of all households in 2020 as prescribed in the 3rd Energy Package.	distinction between segments is important, because energy consumption tariffs in Belgium also differ, according to a legal social classification system. This implies that consumers with higher tariffs can financially benefit more from smart meter energy savings, than low tariff consumers. For Brussels and Wallonia, in 2012 an updated extensive scenario based cost-benefit analyses showed a negative business case. Because of this, the Brussels regulator BRUGEL and the Walloon regulator CWaPE decided that the conditions for a general roll out of smart meters are insufficient for the moment Although there is no smart meter rollout planned, the Belgian energy market is about to evolve remarkably in 2018. The creation of a new federal clearing house and the implementation of the new energy market process model will have a significant impact on the data exchange and the market processes structuring the electricity and gas market today. The new clearing house will simplify the data exchange between participants in the energy market while the new market model will incorporate the latest technologies, such as the availability of smart meters and decentralized production.
Bulgaria	There are no official plans for a nationwide rollout of intelligent metering systems and no legislative or regulatory initiatives. A cost-benefit-analysis has not been published yet.	The first electronic meters with remote reading were installed in 2006 in order to reduce non-technical losses and the number of complaints about erroneous invoices. 550 000 smart electricity meters based on PRIME technology will be installed between 2016 and 2019 by EVN Bulgaria. The project will span over the next four years, with the first delivery planned till the end of 2016. EVN Bulgaria supplies with electricity more than 1.5 million customers in South-East Bulgaria
Croatia	There is no clear legal framework demanding a mandatory electricity smart metering rollout, but at the same time the current legislation does not hinder the development of smart metering markets. It seems that legal obligations will be the driver for the rollout. Metering issues are decided in privatization contracts by the government.	Croatia started with the modernisation of its electricity distribution network. The first stage of smart grid transformation started beginning of 2016. With this step the utility was able to improve their billing services and minimize system costs. Optimised metering processes enable better monitoring of metering data and allow HEP ODS to perform demand response. HEP ODS manages a network consisting of 2.3 million metering points and plans to equip 45.000 metering points throughout the country (households and small commercial environments) within one year. The roll-out of Iskraemeco smart meters already began in September 2016. Croatia intends to equip the entire network with smart meters by end of 2030.

Member state	Legal and regulatory status	Implementation status
Cyprus	There is no legal framework demanding a mandatory rollout, but at the same time the current legislation does not hinder the development of smart metering markets. Cost-benefit analysis was developed in 2013 Cyprus carried out a cost-benefit assessment which turned out positive for a wide-scale rollout but it is still not clear if a decision has been taken and no public information was found.	The DSO of Cyprus started a pilot project in July 2010 with 3000 smart meters. Other small pilots were developed during 2013. KIB-TEK, which is the only electricity company serving Northern Cyprus, has a customer base of 160.000 and is considered to be one of the most advanced utilities. The smart meter rollout for their customers started in 2015 and will end by late 2016. There is not a wide gas network in Cyprus and no reason for a cost-benefit analysis or smart gas meter business case.
Czech Republic	Following a negative cost-benefit analysis (2012), the Czech government formally decided against an obligatory rollout of smart meters. A new cost-benefit analysis is under discussion. So far, an implementation plan at local or national level has not been developed (CEER, 2013). However, an action plan for smart grids is expected before the end of 2015 (CEER, 2014). Contents and details are either still under discussion and/or not publicly available. In January 2014, the Czech Republic was formally requested by the European Commission to bring its national law in line with the EU Energy Services Directive (2006/32). The Directive prompts member states to ensure that final energy customers are provided with competitively priced individual meters that accurately reflect their actual consumption. Actually the Directive had to be fully transposed into national law by May 17, 2008 (Metering International Magazine, 2014). Currently there are still no obligations concerning smart metering in Czechia. A second cost-benefit analysis also came to a negative result that smart metering is not economically feasible. Nevertheless in March 2015 the Czech government approved the national action plan for smart grids which mainly deals with the electricity system. It defines measures within a time horizon of years 2015 – 2020, with an outlook to 2040. It presumes a gradual introduction of smart grids and other measures in several stages. The way and speed of deployment of smart grids are trailored to benefits for consumers so that the progress is cost-optimal and cost correspond with benefits.	Several smart meter pilot projects have been carried out or are still in progress in the Czech Republic: E.ON ČeskáRepublika installed 4000 smart meters in South Moravia in 2006, PRE recently completed a project in Prague with 3000 meters, and ČEZ installed 2000 meters in east Bohemia. ČEZ is currently involved in FUTUR/E/MOTION, a smart grid project with 32,000 meters which will provide a basis for the cost-benefit analysis. Further rollouts are not currently planned. Besides those projects the Czech government states officially that the smart meter implementation will not start before 2018. In 2015 the Czech telecommunications company ČeskéRadiokomunikac started a pilot project in Prague and surrounding suburbs with the LoRA Technology which could be a key for the cheap implementation of smart meters.

Member state	Legal and regulatory status	Implementation status
Denmark	Since 2005 hourly metering has been mandatory for customers with a yearly consumption larger than 100,000 kWh. In April 2013 a Smart Grid Strategy 2.0 for Denmark was launched, building on the smart meter infrastructure. During this year an updated economic evaluation was also finalised, covering 1,4 million metering points resulting in a positive outcome. There are already 1,6 million metering points installed based a voluntary roll-out started by the DSO. The positive CBA resulted in the establishment of the obligation to full smart metering roll-out. In terms of the 2013 executive order from the Climate, Energy and Building minister, the rollout is required to be completed to all homes by 2020 in compliance with EU requirements but also to meet the country's smart grid strategy which envisages an increasingly renewables-based intelligent energy system. In Denmark the focus is related to flexibility due to the potential of having 50 % electricity production from Wind power within 2020. According to literature, published in October 2013 by order of the Danish regulator, smart meters result in an average household energy savings of roughly 2%.	In 2016, more than half of the country's homes, accounting for more than three-quarters of the consumption, already have a smart meter. Currently in Denmark some synergies start to come together. On the one side there is a government push with legislation and incentives for smart grids to secure societal benefits with renewable integration and more flexible demand. On the other hand are utilities starting to see the potential benefits of investing, especially on the operations side of the smart meter business. Underlying it is a push for "transparency" throughout the energy system all the way to the end consumers in order to bring them in as participants.
Estonia	Following a positive result in the economic evaluation, regulation requires the roll-out of metering systems that measure hourly electricity consumption as of 2017. The target is to cover 100 % of the customers. The functionalities include remote reading, two-way communication, as well as remote activation or de-activation by the customer or DSO. The consumption data from each customer is forwarded to customer and to one or more suppliers (through legal right or customer authorization) via Estonian Data Hub operated by the TSO Elering. The meters will also have an open port through which the consumers can have access to their data. Consumers can receive their hourly electricity consumption data and costs on the following day. Market processes such as supplier switching and availability of different tariffs are being improved as smart meters are rolled out.	The DSOs are currently rolling out smart metering systems. The dominant DSO, Elektrilevi OÜ, part of EestiEnergia group, is having a major rollout of 630,000 meters. The roll-out started with a pilot of installing 5,700 smart meters in 2012 and is completed by January 2017. The consumers with smart meters can view their hourly consumption their DSO's and supplier's on-line service and from the Estonian Data Hub website. The largest retailer EestiEnergiaalso offers mobile application to monitor and analyse power consumption and pay bills. Other consumer benefits of smart metering include automatic reading, accurate bills, smarter supplier comparisons and easier switch of supplier. Hourly electricity tariffs are available for smart metered consumers. The TSO Elering maintains the Estonian Data Hub for electricity metering data exchange and market processes. In the Data Hub, consumers can also grant electricity suppliers authorization to access their consumption data for making personal price offers.

Member state	Legal and regulatory status	Implementation status
Finland	The regulation adopted in 2009 demands smart meters capable of hourly remote metering for at least 80% of all customers by the end of 2013. The DSOs are responsible for the roll-out, reading the meters, and reporting and forwarding the meter data. From the beginning of 2014, hourly consumption data had to be made available on the next day to the customer, electricity supplier, and also to a 3rd party if authorised by the customer. The regulator has defined minimum functional requirements for the metering system, including hourly metering, two-way communication, standardized connection for real-time electricity consumption, and load control abilities. According to the regulation, the balance settlement has to be based on hourly consumption values. The Finnish TSO FingridOyjis developing Datahubfor electricitymeter data exchange and market processes in the Finnish electricity market, estimated to beoperational on1st August 2019.	The first DSOs started a widespread roll-out already in the early 2000's. Electricity smart meter rollouts are now completed and nearly 100 % of consumers have smart meters and access to their hourly consumption data through on-line services and apps offered by DSOs and suppliers. Suppliers and other market players have brought new smart metering-based services and products to the market, such as in-home displays and other real-time feedback solutions, demand response and smart home products. For example, customers with electric or oil heating can have automated demand response services adjusting their heating to the cheapest hours in the electricity spot-market. All consumers can now have hourly tariffs based on the Nordpool Spot market price, from over 50 different suppliers. In district heat, over 80% of meters are remotely readable, with a major part delivering hourly data and the rest monthly data. Most of the suppliers have on-line district heat consumption reporting available, while some deliver hourly district heat data and others monthly. Utilities also provide monthly district heat consumption reporting to their customers via informative bills.
France	The Cost-Benefit Analysis was carried out based on the outcome of the pilot project Linky undertaken by Enedis (previously known as ERDF). Two possible scenarios were considered that showed either a neutral or positive outcome. A government decree in September 2010 defined the terms of a mandatory rollout, aiming to achieve 95% coverage by the end of 2020. As of 2016 the time scale has been extended to the end of 2021, however there is now a detailed rollout timetable in place and available for public view at: http://www.enedis.fr/linky-bientot-chez-vous. Since January 2012, all new electricity meters installed must be smart meters. The regulator has defined some guidelines and minimum functional requirements for electricity meters. The change has been made obligatory for all households, and the meters will be installed free of charge to the consumer. Enedis is responsible for the deployment. Country's smart electricity metering rollout and is on target to have deployed the first phase of 3 million smart meters deployed by the end of 2016.	In September 2011, after several successful pilot projects, the French government announced the rollout of 35 million smart electricity meters, starting in 2013 and ending in 2020. Enedis (ERDF) is responsible for the deployment. The country's smart electricity metering rollout will have a first phase of 3 million smart meters to be deployed by 2016. Enedis developed Linky meter was under test in a 300,000 meter pilot in Touraine and Lyon since 2009. In addition more than 25,000 Linky meters have been deployed in some of the dozen other smart grid pilots that ERDF currently has under way across France. The smart metering pilot, including 300,000 meters and 7,000 concentrators in total, was carried out in order to validate the technical performance of the smart metering solution and the smart Linky-meters by ERDF. Installation, logistics and rollout management practices were tested and verified. An initial smart gas meter pilot was carried out by GrDF, installing around 18,500 smart gas meters from April 2010 to June 2011. The first of 11m main roll out of Gazpar, gas smart meters are due to start arriving in homes during 2017.

Member state	Legal and regulatory status	Implementation status
Germany	On 8th of July 2016 the law on the digitization of the energy transition ("GesetzzurDigitalisierungder Energiewende") was passed. The beginning ofthe rollout is planned for January 2017. The legislation and the rollout are a result of a cost-benefit analysis commissioned in summer 2013 by the Ministry of Economy. This CBA came to the conclusion that the widespread rollout of smart metering systems in Germany is not economically feasibleuntil 2020. Therefore, the law provides equipment required for a conditional rollout. In the first step, only large customers with a consumption of over 10,000 kWhand renewable energy generators distributed generation above 7 kW of installed capacity have to install a smart meter ("intelligenteMesssysteme") to measure their electricity consumption. From 2020 the rollout scheme includes consumer with annual electricity consumption higher than 2,000 kWh. Furthermore as modern measuring ("moderneMesseinrichtungen") devices are seen as obligatory basic equipment, the EnWG provides the mandatory installation in new buildings, at major renovations and at the regular exchange of old meters ("Ferraris"). These measuring devices are digital electric meter with a better illustration of consumption which can be integrated via an interface to an intelligent measurement system, if necessary.	With the adopted government bill on the digitization of the energy transition, the legal and regulatory basis for the installation of smart meters is specified. Currentlydelays in the widespread adoption of smart meters may occur. This is especially due to the fact that there is currently a lack of clear definitions of the technical and organizational requirements to ensure data protection and data security. The Federal Office for Information Security (BSI) was not yet far enough with its certification work for anin-time introduction of smart meter devices. The Federal Network Agency ("Bundesnetzagentur") is currently working on a transition model for the data communication. However it is seen quite critical to start with the distribution of the meterin the beginning of 2017 as laid out in the lawon the digitization of the energy transition. The altered access to meter data is in the current debate about the digitization law one of the main points of contention between distribution network operators (DSO) on the one side and the transmission system operators (TSO) on the other side. By now a compromise has been found which enables both DSo and TSO to access the data. In recent years, a number of German utilities have begun testing smart meters in pilot projects. Most studies currently give only information about the savings with reference to the installation of smart meters. The studies show that consumer interest on own energy consumption after the initial euphoria decreases greatly and thus remain the energy savings far below expectations.
Greece	Greece is proceeding with a rollout of electricity smart meters and adopted a legal framework (Article 15 of law 3855/2010). A cost-benefit analysis was developed in the country and will proceed with a full rollout by 2020. The outcome of the CBA referring to the scenario of 'electricity meters only with PLC over LV/MV networks' were positive. Greece has defined some minimum functional requirements and has defined two-way communication as the minimum requirement for the communication system for smart meters in electricity.	The dominating Public Power Corporation (PPC) has plans to install 60,000 smart meters in large-end customers with low voltage connections, many of which are residential. This project will later be extended to all customers throughout Greece, according to the decision taken due to the positive cost-benefit analysis. The tender concerning the placement of approximately 200,000 Smart Meters across Greece is one of the key strategic projects to be implemented by HEDNO (Hellenic Electricity Distribution Network Operator). A failed tender process happened in 2016, but it will be opened again in November 2016. The Possibility of extending the electricity metering system to include metering water and natural gas consumption is explored with the Athens Water Supply and Sewerage Company (EYDAP SA) and the Athens Gas Supply Company (EPA SA).

Member state	Legal and regulatory status	Implementation status
Hungary	No legal framework for a mandatory roll-outis existing. Currently there is only an obligation to provide smart meters and variable tariffs where it is economically reasonable. An economic assessment was carried out in 2012 with the conclusions that it was not economically reasonable to implement smart meters in the residential sector. This assessment was based on a theoretical CBA analysis. Since then, there have been Pilot Projects in 2012-14 performed by the electricity DSOs with the involvement of more than 10.000 household customers. The evaluations of these projects have been finished in 2015, with the same results, that is, the implementation of smart meters is still not economically reasonable.	There was an EC decision, which allocated some funds (38 M EUR - originated from the CO2 emission quota allocation) for a centralized smart metering Pilot Project managed by MAVIR (Hungarian TSO) and targeted a model based on centralize metering operator concept. The project provides data for economical assessment according to 2009/73 EC directive appendix 1. point 2. The launch of the Pilot Project is expected in October, 2016 by a subsidiary company of MAVIR pursuant to the provisions of the Government Regulation No. 26/2016, involving approximately 20.000 consumers, chiefly in electricity, and in lesser proportion in gas, water utility and district heating
Ireland	The Commission for Energy Regulation (CER) is now in Phase 3 of smart meter implementation programme and concluded a two year process of analysis, engagement and consultation on issues around smart meter son the 15th April 2016. In Phase 2 the smart meter requirements and procurement conditions were defined and this followed the positive outcome of the CBA performed in 2011. Data will be stored with the supplier (the Steady State Model) which was considered the optimal model for flexibility and usefulness for consumers and industry. Real time consumption data will be available to customers via a Utility Home Area Network (where feasible). The smart meter will not carry Time of Use (TOU) or tariff information which will be available from the supplier either online, via apps, or mobile phone. Pay as you go balance information will be available for prepayment meter customers in a similar way, and no customer interaction with the meter will be required. Minimum information requirements for customers will be through three channels: mandatory In Home Displays (IHD) for real time consumption data, smart bill and 'harmonised downloadable file' with historic information which the consumer can analyse or share. Customer IHD support will be provided for 2 years after installation. Electricity TOU tariffs will be available to all customers. A default TOU tariff will be set as smart meters are installed, with criteria set by CER for other TOU tariff offers by suppliers from which consumers can choose. TOU gas tariffs are not mandatory.	Phase 1 of the Irish smart metering programme indicated that the €1 billion investment for roll out would generate an additional €229 million net present value over 20 years. Electricity smart meter trials were also conducted with 10,000 meters across the country. In Phase 2 there have been no further consumer trials. Focus groups in 2012 on Time of Use tariffs, billing and billing information found that Time of Use tariffs were broadly accepted. They reminded people of variable phone charges, something they'd already experienced. Energy Suppliers are already marketing "smart pay-as-you-go" as a way of attracting new customers, installing smart meters as consumers change to the new supplier. Phase 3 Build and test will runs in 2015-17, followed by the final deployment phase, Due to a delay in the procurement process for smart meters this is now due to start in 2017 for completion in 2020. There is a target for 87% installations with 13% of properties being 'inaccessible' and 2% refusing an installation.

Member state	Legal and regulatory status	Implementation status
Italy	The installation of remotely readable electronic meters is mandatory. The largest Italian distributor e-distribuzione carried out an internal CBA with a positive outcome before proceeding with the large scale smart metering roll-out. The solution adopted by e-distribuzione brought forward the minimum provisions required by the EU recommendation 148/2012.: The main functionalities implemented are: Acquisition of certified metering data, Historical and current consumption data, Setup of frequency for reading rate, Remote disconnection and power limitation, Alphanumeric Display, Multi tariff-registers, Load curves acquisition, Bidirectional active/reactive energy measurements, Acquisition of QoS and network status data, Tampering alarms, Fraud alarms, Energy Balance monitoring, Full integration with DSO legacy systems, Security Mechanisms for data protection and privacy, Remote management of contractual parameters, Remote update of meterand data concentrator firmware. The metering data registered by the smart meter are owned by the final customer (decree 102/2014, art. 9, comma 3b) according to the customer data ownership principle. The DSO is the actor responsible for the metering process. Regulation about metering data exchange between the DSO and traders/third parties is under discussion, some guidelines have been published by the Italian authority for electricity, gas and water (AEEGSI) within the scope of resolution 87/2016. These guidelines also covers the provision of data to the final customer within the home area network (HAN).	Rollout of the first generation of smart meters started in 2001 and by the end of 2011 95% of 36 million customers had received electronic meters. By the end of 2016 a new generation of smart meters will be rolled out by e-distribuzione. The technical features of these meters and the related remote metering management infrastructure will cover the requirements on data management and data exchanged specified in resolution 87/2016 published by the Italian authority for electricity, gas and water (AEEGSI). A PLCband C communication channel from the meter to the HAN will be established. Data - stored within the smart meter - will be sent to in home local visualization devices using an open protocol whose specifications will be delivered by CEI (Italian Electrical standardization Committee) through the publication of a new technical standard.
Latvia	No legal framework is in place. The CBAs for large-scale roll-out by 2020 was negative or inconclusive (no public information available), but the smart metering was found to be economically justified for particular groups of customers. The main reason for the negative economic evaluation is justified by the fact that peak-load or load shifting benefits are not relevant, as most customers have a reduced energy consumption. The Latvian competent authority for smart metering is the Ministry of Economics, Energy Department, Division of energy markets, infrastructure and coordination of cooperation. The installation of smart meters depends on the activity of DSO.	JSC Sadales tīkls (ST) power distribution operator in Latvia, providing operation and development of distribution networks. ST reaches over one million customers covering 99% of country's territory with their provision of electricity, network monitoring and electricity metering. Since 2014, ST initiated a rollout of smart metering, including PRIME ADD Grup Smart meters, DCUs and head-end systems. In 2015 ST was responsible for deploying for more than 100.000 ADD Grup PRIME meters. It is expected a renovation of another 100.000 electricity meter units per year with special interest by using smart metering units.

Member state	Legal and regulatory status	Implementation status
Lithuania	No legal framework, and no national rollout plans are available. Some workshops and consultations have been developed led by the Ministry of Energy, the competent authority in smart metering roll-out. In Lithuania, the CBA for large-scale roll-out by 2020 was negative and there is no continuation of legal or practical activation in the smart metering field.	Lithuania has one of the lowest average electricity consumption per household in the EU. ESO, which serves 1.6 million customers throughout Lithuania, awarded a contract for a pilot project in 2016. The DSO indicated the purpose of pilot is to analyze the cost-benefit of smart meter deployments in Lithuania, with 3,600 smart meters as well as part of the ADDAX IMS advanced metering infrastructure system. The main communication will be based on PRIME PLC. The utility, which manages electricity supply and distribution, natural gas distribution, said the pilot project is being implemented by Lithuania's commitment to the European Commission (EC) to test smart metering. Depending on the results of the project, the company will decide whether to take the massive introduction of smart meters by end 2017.
Luxem-bourg	In 2012, the government took a legal decision to introduce smart metering to all households, based on the positive outcome of a national cost-benefit analysis, reaching 95% in 2020. The project was devised by electricity and natural gas providers in Luxembourg. The law came into effect on June 19th 2015, modifying the laws of July 7th 2012 & August 1st 2007, which introduces Smart Metering in Luxembourg. All legacy gas and electricity meters to be replaced by Smart Meters. All meters to be read by one national central system, operated by a common operator. Besides gas and electricity meters, the system must be open for other metering data like water and district heat	From July 1st 2016 every new installed gas & electricity meter will be a smart meter. Also a common central platform will be launched, operated by all 7 gas & electricity Distribution System Operators (DSO). The smart meters will be 'multifluid': besides gas and electricity meters, the system will be open for water and district heat. Main implementation targets: >95% of all electricity meters must be replaced by December 31st 2019. And >90% of all gas meters must be replaced by December 31st 2020.
Malta	A mandatory rollout started in 2010 to reduce the costs of bi-monthly billing and non-technical losses. By the year 2012 all Enemalta Corporation customers should be provided with the installation of smart meters. No information related to the development of a CBA has been found. One of the objectives is to implement demand management methods and facilitate the feed-in of electricity into the low voltage network	Mandatory rollout was decided and started in 2009 with a pilot phase. In 2010 Enemalta launched a rollout plan to replace all electricity and water meters for 275,000 customers by the end of 2012, even when some delays in the implementation have occurred. Over 250,000 smart meters have been replaced to date and an online portal allows customers to access to their details. There is no wide gas network in Malta so no national Cost-Benefit analysis or business case has been developed.

Member state	Legal and regulatory status	Implementation status
Netherlands	In April 2014 the Dutch parliament approved additional implementing regulation for the large scale rollout of smart meters from 2015. The basis for this regulation, the revised Dutch Electricity Act and the Gas Act (lawful since 2012) mandates network operators to offer a smart meter to all small customers (households and small businesses). Customers have a legal choice to refuse or accept the smart meter. When accepting a smart meter, the customer has to authorise the network operator to collect and use the meter data for specific purposes such as annual billing, switching supplier and moving home. The energy suppliers are mandated to provide the customers with bimonthly consumption and cost statements based on minimum information requirements. Providing customers with more real-time consumption and cost information is considered to be a market responsibility. The customer will choose and authorise a commercial service provider to use (real-time) data beyond the minimum regulated level for the specific purposes for which the customer has given their consent.	The first phase of the rollout of smart meters in the Netherlands took place from 2012 until 2014 as a small-scale rollout for experience purposes. During the trial period s the Authority for Consumers & Markets (ACM) and Netherlands Enterprise Agency (RVO.nl) conducted research into the rollout, customer satisfaction and energy savings. From these evaluations, the Minister of Economic Affairs decided to accelerate the rollout, aiming to have a smart meter fitted in at least 80% of households and small businesses in 2020. The large scale roll-out of the smart meters in The Netherlands started in 2015, with 3.0 million Dutch households having one by now. The number of smart gas and electricity meters is predicted to exceed eight million households by 2020. Both the grid operators as well as the government have high hopes for this technology, because it promises more accurate insights into the energy use for the consumer, as well as flexible energy tariffs. However, reluctant market developments since the start of the rollout are mounting over how well the smart meters rollout will lead to quick high level market penetrations of associated smart energy management services to meet the energy saving expectations.
Norway	Regulation provided in 2011 demands a 100 % roll-out of smart meters by the beginning of 2019. Exceptions are allowed for certain customers. Benefits for consumers include advanced consumption information, more accurate meter reading and billing and opportunities to engage in demand response. Functional requirements include hourly metering and supporting 15 min frequency, measuring both output and input energy, disconnecting or limiting power output, two-way communication, connection to other metering equipment (gas, heat, water) and a standardized interface for communication with external equipment. The measured consumption values should be made available to the customer and electricity supplier on the next day by the DSO. With the consent of the customer, also other parties can access the data. The information should enable comparing consumption, prices and costs over time. The consumption values have to be offeredto the customer free of charge via online service, with local access via in-home display (no obligation for provision) or mobile solution.Suppliers should be able to send price information andDSOs network tariff information to the customer's display.	The DSOs are responsible for installing smart meters. Several demonstration and pilot projects have been carried out, dealing mostly with communication and meter data management. Also different displays and tariffs have been tested. Most DSOs have started their roll-out before the end of 2015. Approximately 2,7 million meters need to be replaced and the bulk of the roll-out sis expected to come in 2017 and 2018. DSOs and third parties are expected to offer consumers services that go beyond the basic regulatory requirements. Some retailers offer hourly spot price contracts, as well as displays and demand response services as an additional service. In 2016, supported by Enova and The Water Resources and Energy Directorate NVE seven six-year pilot projects involving a total of 25,000 households were started by the power industry to test how different solutions for offering smart metering information affect energy consumption.NVE is also looking for opportunities to use market mechanisms for demand response to deal with network capacity constraints. NVE has commissioned the TSO Statnett to create a central datahub (Elhub) for metering data exchange and market processes in the Norwegian electricity market, which will start its operation in 2017.

Member state	Legal and regulatory status	Implementation status
Poland	Poland's Energy Law as amended in 2013 made the installation of smart meters eligible but not mandatory. The amendment introduced into Poland's law all the relevant provisions on smart metering of the 2009/72/EU directive. The amendment opened way for DSOs to start pilot projects but did not force them to make more ambitious plans of massive roll-out. The President of the Energy Regulatory Office (ERO), the energy regulator, initiated the process of smart meter installation in 2009 – the first platform of main stakeholders, including customer associations was established. Then, some other platforms embracing DSOs, financing institutions, industry, research and academic institutions were founded. At present the platforms conduct their activities but not very intensively. In years 2010-2014 the efforts of the ERO concentrated mainly on setting requirements for minimal smart meter technical standards. Interoperability was the issue of special concern. Afterwards ERO activities faded and his role as a leader in invigorating the market by providing incentives for DSOs to get more involved were rather weak. Substantial step in legislation governing development of smart meters is expected with the long awaited new act, so called Meter Act. Preparation of the act started as early as in 2010 but then in 2014 the project was dropped. New proposal is due by the end of 2016. The act will regulate the procedures of gathering and processing date from smart metering in a way securing privacy and data safety. To facilitate the duties a new body will be established, namely the Operator of Measuring Information, as a daughter-company of the TSO. It expected that the act will make installation of smart meters in at least 80% of end users a legally binding target for all DSOs.	The cost benefits analysis carried out by the DSOs revealed that replacement of traditional meters by smart meters is economically viable for a vast majority of end users. This conclusion enabled to undertaking smart meters deployment by DSOs as the expenditures are eligible costs of their operation and may be included into energy tariffs. It can be estimated that the total number of smart meters installed by all DSOs up to mid-2016 amounts to 500 000. It is approximately 3% of all end users. Government's analyse made in 2014 predicted rather modest impact of smart meters on energy savings in households since reduction of only 1% of electric energy consumption in 2021 as compared to 2015 use is projected in governmental energy forecasts. This estimation takes into account two opposite trends: increase in consumption caused by higher living standard and consumption reduction due to energy saving measures, including smart meters. Ongoing pilot projects do not entail development of energy services that at least theoretically should follow smart meter deployment. Information on the energy savings attained in the pilot projects due to smart meters is rather scarcely and not well promoted among the end users participated in the projects. In 2014 the government drafted the schedule of smart meter deployment – at least 5% in 2015, with final target set for 80% in 2020. It is envisaged that the new Meter Act will also introduce new schedule of meeting the targets of the smart meter deployment. Since the current plans of reaching 80% of end-users equipped with smart meters in 2020 are rather unrealistic it is expected that the target year will be shifted to 2024.
Portugal	No legal framework for a mandatory rollout, but EDP has decided to start the installation of smart meters, which will gain speed in 2016. In 2007, the regulator presented a meter substitution plan for the period 2010–2015 and a list of functional requirements. That plan is co-ordinated with Spain. The target would be to reach 80% of smart meters installed by 2020 if the Cost-Benefit is positive. There is a decision process for a Cost-Benefit analysis which has not been finished yet. The massive installation of smart meters hasn't started.	The national meter replacement plan started with a pilot phase in 2010. A consortium led by EDP Distribuição started the InovGrid project with the InovCity of Évora as a key location, including 30,000 meters, where customers receive near real-time consumption information. In 2012-2013 another 100.000 meters were installed in 7 other Portuguese regions as part of the Inovgrid project. Guimarâes, S. João Madeira, Lamego, Marinha Grande, Batalha, Alcochete and Ilhas Barreira. The latest information indicates that a total of 200.000 more meters should be installed by the end of 2016, but the massive rollout date is to be defined for the overall 6 Million homes

Member state	Legal and regulatory status	Implementation status
		with electricity meters. Some innovations for end-users are available, as real time information in consumption and production, real time billing, control on energy costs, value added services and innovative tariffs.
Romania	Romania presented a positive CBA. In December 2013 was approved the ANRE Order no. 91/2013 on the implementation of smart metering systems for electricity. ANRE is the regulatory agency responsible for the legislation in the energy sector. In compliance with the Order No. 91/2013 (the "Order"), the intelligent electricity measurement systems are electronic systems measuring electricity consumption, ensuring the secure two-directional transmission of information to the end consumer, providing more information than a conventional meter, using electronic means of communication and include the following: • measurement subsystems containing at least the meter, the measurement transformers and the equipment for secure access to the meter; • subsystems for information transmission; • subsystems for the management of information contained by meters;	The distribution networks in Romania were splitted into 8 subsidiaries administrated by Electrica, the nation-wide distribution company; 5 of the 8 distribution subsidiaries were privatized, with over 50% of that participation coming from 3 foreign companies (ENEL-Italy, EoN-Germany and CEZ-Czech Republic). In 2014, the DSOs implement new pilot projects previously endorsed by ANRE, to establish the conditions for intelligent measurement systems and in order to evaluate the implementation plans for 2015-2020. The target is to reach 80% of end consumers (9 million) until 2020. At the end of 2013. EoN had already installed about 36,900 smart meters A local Romanian subsidiary of ENEL installed smart meters for more than 30,000 clients by 2015. Enel is said to have plans to install similar meters for all 2.7 million clients in Romania, paving the way for larger smart cities and infrastructure.
Slovakia	After a negative but selective result of a cost-benefit analysis for Slovakia in 2015 the government approved a national rollout plan for selected groups of consumers. Separated into three phases consumers with a minimum consumption of 15 MWh per year and maximum reserved capacity of more than 30 kW have to participate in the rollout till December 31, 2015. The second phase which runs till December 31, 2016 includes all consumers with a minimum consumption of 4 MWh per year and maximum reserved capacity of more than 30 kW. Finally the third phase including consumers with a minimum consumption of 4 MWh per year and maximum reserved capacity of 30 kW ending on December 31, 2020.	30,000 devices have been installed at the end of 2015. The numbers shall rise according to two big DSOs. ZápadoslovenskáDistribučná (ZSD) plans to install more than 190,000 meters by 2020 and additionally VýchodoslovenskáDistribučná (VSDS), which already installed 10,500 meters in 2015, aims a number of 100,000 meters by the end of 2020. The goal until 2020 is a total number of approximately 600,000 installed intelligent with consumption of electric energy at the LV voltage level.
Slovenia	CBA of advanced (smart) metering of gas and electricity was carried out in 2014 with positive net benefits shown for roll-out of electricity smart metering. At the end of 2015, the Government adopted the Regulation on measures and procedures for the introduction and interoperability of advanced electric power metering systems, which imposes on the DSO the implementation of unified advanced metering system for all electricity consum-	Notwithstanding the Regulation and the Plan, the deployment of advanced metering infrastructure at consumers has been going on for many years, and Slovenia ranks at the top among the Member States in relation to the degree of replacement conventional metering devices with advanced ones. The share of smart (electricity) meters by individual electricity distribution areas and for (the entire) Slovenia is currently approximately 50% of the 700.000 homes.

Member state	Legal and regulatory status	Implementation status
	ers in Slovenia. In accordance with mentioned Regulation DSO prepared a Plan for the Slovenian Advanced Metering Infrastructure implementation which sets the timeline by which smart meters should be deployed at all consumers by 2025. Minimum functional requirements considered in the CBAare generally in line with „A joint contribution of DG ENER and DG INFSO towardsDigital Agenda, Action 73: Set of common functional requirements of the SMART METER (October 2011)" and should be legally set in the System Operation Guide of the DSO (in preparation).	
Spain	In February 2012 the national roll-out plan was reviewed, and established the requirement of having 35% smart meters installed by the end of 2014, 70% by end of 2016 and 100% by 2018. DSOs are responsible for the substitution of traditional meters by new smart meters. A set of functional requirements is available for the smart meters. A public cost-benefit-analysis for electric smart meters has not been performed yet, even when the 5 main utilities, serving over 4/5 of the total consumers in the country, have provided detailed data to the national regulator to estimate the cost of the smart meter installation, based on the requested characteristics. Then, a national CBA based on the impact on the 5 main utilities data, but not public, was carried out. In 2014 the new regulation Royal Decree 216/2014 has been published, establishing a mandatory requirement for distributors to provide hourly energy consumption data. Where a smart meter with full telemanagement has been installed consumers can choose an energy cost based on their real hourly consumption data. In those homes where there is not a smart meter installed, the invoice will be based on the average national hourly curve cost, with variable prices. An alternative offer is mandatory to be available in both situations (with or without smart meter) from the suppliers, for homes with <10kW power contracted. This will be a fixed price for one year for the energy consumption (like the traditional situation). A recent document published by the national regulator (CNMC) indicates the need of a new regulation to establish how the data should be exchanged among the different agents (distributor, supplier, consumer…), protecting the information of	The five main companies in Spain (ENDESA, IBERDROLA, GAS NATURAL FENOSA, EDP-HIDROCANTABRICO and VIESGO) are leading the installation of the new smart meters with AMI capacities. There are two main protocols in development, the PRIME /DLMS, leaded by IBERDROLA and involving a number of other utilities as GAS NATURAL FENOSA and EDP-HIDROCANTABRICO, and the Meters and More, leaded by ENEL-ENDESA and with participation of EON Spain. The massive installation is currently in progress with hundreds of thousands of units per month. Communications and data bases are also in progress to allow full AMI. The national regulatory body (CNMC) has published in 2016 their report on smart meter rollout follow up as to end of 2015. According to it, 14,5 m smart meters were already installed in Spain from the 28m existing, which constituted over 50%. According to the latest information collected as to September 2016, IBERDROLA communicated the installation of over 8m smart meters (accumulated), over 76% of their total electric meters. ENDESA also informed on the installation of over 8m smart meters, and expect to have 9,2m by the end 2016. GAS NATURAL FENOSA installed over 2,7m smart meters (>72%) of their 3,7m. VIESGO installed overall 670.000 smart meters, over 97% of their total customers. EDP-HIDROCANTABRICO installed over 450.000 units.

Member state	Legal and regulatory status	Implementation status
	consumers with a smart meter. A cost-benefit analysis has been developed for gas meters in 2013 with negative results for a rollout and which proposes that there is a for further analysis.	
Sweden	Sweden was the first country to fully roll-out remotely readable meters, mainly to improve billing processes. In 2003, new regulation was adopted requiring monthly electricity consumption metering for small customers (fuse size less than 63 A) by 1st July 2009. Hourly metering was required for larger customers. Metering of output energy is not a general requirement for installed smart meters in Sweden. The DSOs are responsible for metering. On October 2012, new regulation came into force requiring that small customers subscribing to hourly-priced electricity tariff can have hourly metering from the DSO free of charge. In 2015, the Swedish energy market authority Ei developed recommendations for functional requirements of smart meters. Detailed regulation is expected during 2016 and the implementation of the 2nd generation of smart meters is expected to take place between 2017 and 2025. In 2015, the Swedish government gave TSO SvenskaKraftnät (SvK) the task to develop and run a national datahub for centralized metering data exchange and key market processes, estimated to be operational in Q4 2020.	Since 2009, nearly all end customers have had remotely readable electricity meters with monthly reading. Of the installed meters, ca. 90 % are capable of hourly metering. Of the metering systems installed, 50 % are capable and used to provide hourly meter data and almost 90 % of these update the information every 24h.Web-based solutions are used to deliver the consumption data for over 90 % of the customers. Around 30 % of the installed meters are equipped with a Home Area Networkport. Consumers have access to consumption data through bills and websites with monthly, hourly or daily consumption values depending on the data availability. Few suppliers offer additional services for monitoring real-time and appliance specific consumption and monitoring variable electricity prices. DSOs are switching to deliver hourly consumption data as consumers subscribe to hourly-priced tariffs. Also, some utilities have already started to roll-out the 2nd generation smart meters complying with the latest functional requirements. However, hourly based contracts are not offered actively and by all suppliers. The adoption of hourly-priced tariffs is still rather low and very few suppliers are offering additional services facilitating smarter use of energy.
UK	In March 2011, the Government set out the rollout strategy and policy design for smart meters. The Smart Metering Implementation Programme has been revised significantly since its inception in 2011. The updated delivery plan expects the roll out to start in late 2016 and be completed by 2020. The roll out is lead by the Department for Energy and Industrial Strategy (DBEIS). (It was formerly facilitated by the Department of Energy and Climate Change until July 2016). Key players in the roll out include: Energy suppliers – supplying and installing smart meters and In Home Displays (IHDs) Smart Data Communications Company (DCC) – communications infrastructure for smart meter data Ofgem – the national energy regulator to ensure consumer protection, adherence to	In the early foundation phase, the UK's largest smart metering trial Energy Demand Research Project (EDRP), with around 58,000 households, was finalised in 2011 with four suppliers (EDF, SSE, Scottish Power and E.ON) installing smart meters, in-home displays and trialled feedback mechanisms, financial incentives and ToU tariffs. A variety of small scale trials testing specific incentives have followed. Nearly 6% of British households now have a smart meter (2.75 million meters installed by June 2016). Technical specifications for smart meters were changed in 2014, with full functionality of smart meters dependent on the DCC communications system. There have been significant delays to the DCC Go Live date, and as a result many suppliers have not commenced roll out. It could prove more costly to them to have to install a second smart meter which

Member state	Legal and regulatory status	Implementation status
	codes of practice for meter installation and data sharing, and regulation of the DCC DNOs – respond to network –related issues during the smart meter roll out Smart Energy GB – not for profit national marketing and engagement campaign. The DCC communications system will ensure consistent operation of meters irrespective of supplier, and the potential for consumers to allow third parties to access their smart meter data to provide them with additional services. The Smart Energy Code sets out the rules, rights and obligations for this new metering system, and is a multiparty contract that determines the DCC service provision. It is self-regulated by a panel of its members, and regulated by Ofgem. The Smart Meter Installation Code of Practice regulates the training of meter installers, and the meter installation process and provision of energy efficiency guidance by energy suppliers. It includes but does not specify the need for additional support for vulnerable customers in use of their smart meter. For domestic consumers, smart meters are free and optional, and all households must be offered an IHD for energy efficiency. The British Cost Benefit Analysis attributed a significant £5.69 billion of consumer benefit to this. Many suppliers will/are also offering free online and phone app options for energy management. Trials are currently underway to assess whether these options provide an equivalent ability for consumers to achieve energy reductions in the home as the IHD and whether they could be given as an alternative, rather than in addition to a display. Smart Energy GB has been successful at increasing consumer awareness of smart metering. 30% of British households know about smart meters and 21% want to upgrade or already have a smart meter. Smart Energy GB is also facilitating community-led smart meter awareness raising and provision of IHD-related and other energy efficiency advice by small local organisations and networks for specific vulnerable consumers groups.	meets the new technical specifications in the near future. Consumers can register their interest for a smart meter already with many suppliers. Once the DCC is live, 70% of households can be fitted with smart meters. However technical challenges still exist for installation in blocks of flats (about 27% of homes, to be facilitated later in on the roll out using dual band communications that utilises two radio wave frequencies). Another solution is still sought for the 3.5% of properties (rural, some flats) where dual band won't work. Some suppliers, particularly those that focus on smart prepay, have successfully installed smart meters with the original specification. Multiple advantages for consumers exist with smart prepay – such as ease of topping up - so these meters are appealing as they meet a need. One smart prepay supplier also offers a smart Economy 7 meter, something the majority of suppliers are leaving for later in the roll out. One supplier trialled smart PAYG in 2015, offering a reduced tariff on evenings and weekends. Another supplier currently offers a Time of Use tariff, with free off peak electricity for one day of the weekend. A significant body of research is available on consumer attitudes to smart meters and what works in terms of IHD use, energy monitoring and behaviour change.

2.3. Recent progresses in European legal framework

This section summarizes the main documents related to the legal framework and regulation for smart metering and consumers.

The Energy Efficiency Directive 2012 (and Guidance note 2013)

The Energy Efficiency Directive (the "EED") was published in the Official Journal on 14 November 2012, and entered enter into force on 4 December 2012. Member States will have to transpose it by 5 June 2014, with exceptions. The EED puts forward legally binding measures to step up Member States' efforts to use energy more efficiently at all stages of the energy chain – from the transformation of energy and its distribution to its final consumption. Related to metering and billing information, Articles 9-11 provide the rules on what devices, invoices and information should be provided to end-users.

> ***Article 9*** *requires that final customers for electricity, natural gas, district heating, district cooling and hot water should have a competitively priced individual meter that accurately reflects their energy consumption and provides information on the time of their energy use (with exceptions based on technical and financial grounds). This is mandatory for connections in a new building and in major renovations.*

The provisions of the EED on metering and billing information take over and make more effective some of the provisions of the earlier Directive 2006/32/EC on energy end-use efficiency and energy services (most of which will be repealed by the EED on 5 June 2014). From 31 December 2016, the requirement for the provision of individual consumption meters to final customers of heating and cooling will extend to multi-apartment and multi-purpose buildings with a central heating/cooling source or supplied from a central source serving multiple buildings (with exceptions based on technical and financial grounds).

The guidance note makes it clear that Article 9 does not require the introduction of smart metering systems but rather clarifies that if Member States introduce intelligent metering systems and smart metering (this is dealt with in the Third Package Directives: 2009/72/EC and 2009/73/EC), various obligations then apply under Article 9(2), such as that the smart meters must be able to measure electricity supplied to the grid from the customer's premises. It also sets out the assessment that "final customer" could include not just the person who uses the energy but also a person or organisation such as cooperative of owners in a multi-apartment building, which collectively buys energy.

It is specified that, when introducing the intelligent metering systems for natural gas and or electricity:

- The metering systems must provide final customers with information on actual time of use

- Objectives of energy efficiency and benefits for final customers must be fully taken into account when establishing the minimum functionalities of the meters and the obligations imposed on market participants
- The smart meters and data communication must be secure and the privacy of final customers must be in compliance with relevant Union data protection and privacy legislation
- In the case of electricity and at the request of the final customer, meter operators must be required to ensure that the meter can account for electricity put into the grid from the final customer's premises
- If final customers request it, metering data on their electricity input and offtake must be made available to them or to a third party acting on behalf of the final customer (e.g. an energy services company (ESCO) or energy aggregator) in an easily understandable format that they can use to compare deals on a likefor-like basis
- At the time of installation of smart meters, appropriate advice and information must be given to final customers in particular about the meters' full potential with regard to the monitoring of energy consumption.

As regards metering of the use of heating, cooling and domestic hot water:

- Buildings supplied from a district heating/cooling network or a central source servicing multiple buildings must be equipped with a central heat or hot water meter installed at the heating exchanger or point of delivery
- As regards final customers residing in multi-apartment or multi-purpose buildings, whether such buildings are supplied from an external source or a common source within such buildings, individual heat or hot water meters for each apartment or unit in such buildings must be provided by 31 December 2016. However, in buildings where the use of heat meters is not technically feasible or cost-efficient, individual heat cost allocators must instead be installed on each radiator in the individual apartments/units of those buildings. Finally, where this solution is not cost-effective, alternative methods of heat consumption measurement may be considered.

Article 10 *requires that final customers with traditional individual meters (not smart) should normally be told at least every 6 months how much they will be billed for the energy they used in the last period – every 3 months if they ask for it or are billed electronically. They must be provided with billing information as from 31 December 2014 that is accurate and based on actual consumption.*

Where smart electricity/gas meters are available, this article gives final customers a right to detailed information on their energy consumption under their present supply contract for the previous two years and (with exceptions) to a comparison with the consumption of a typical user. The smart meters must enable accurate billing based on actual consumption, and Member States are obliged to ensure that final customers have the possibility of

easy access to complementary information on their own historical consumption. This must include at least the following information:

- Cumulative consumption data corresponding to the intervals for which frequent billing information based on actual consumption has been produced. Such data should be made available for at least the three previous years or the period since the start of the supply contract, if this is shorter.
- Detailed consumption data according to the time of use for any day, week, month and year. Such data should be made available to the final customer for the period of at least 24 months or the period since the start of the supply contract if this is shorter.

> ***Article 11*** *gives a right for final customers to receive bills and billing information for their energy consumption free of charge and in an appropriate way. It should be recalled that Member States are required to lay down rules on effective, proportionate and dissuasive penalties applicable in case of non-compliance with the national provisions adopted pursuant to Articles 9 to 11 (Article 13 EED)*

Notwithstanding with the previous information, the distribution of costs of billing information for the individual consumption of heating and cooling in multi-apartment and multi-purpose buildings pursuant to Article 9(3) shall be carried out on a non-profit basis. Costs resulting from the assignment of this task to a third party, such as a service provider or the local energy supplier, covering the measuring, allocation and accounting for actual individual consumption in such buildings, may be passed onto the final customers to the extent that such costs are reasonable.

> ***Article 12*** *refers to consumer information and empowering programmes, and describes that Member States shall take appropriate measures to promote and facilitate an efficient use of energy by small energy customers, including domestic customers. These measures may be part of a national strategy.*

These measures shall include one or more of the following elements: (i) fiscal incentives; (ii) access to finance, grants or subsidies; (iii) information provision; (iv) exemplary projects; (v) workplace activities;

The ways and means to engage consumers and consumer organisations during the possible roll-out of smart meters would be made through communication of: (i) cost-effective and easy-to-achieve changes in energy use; (ii) information on energy efficiency measures.

The effective implementation of the Directive on Energy Efficiency (2012/27/EU) in all EU Member States as well as Norway is still partial.

The Third Energy Package (Directives: 2009/72/EC and 2009/73/EC)

> *Member States are required to ensure the implementation of smart metering under EU energy market legislation in the Third Energy Package. This implementation may be subject to a long-term cost-benefit analysis (CBA). In cases where the CBA is positive, there is a roll-out target of at least 80% market penetration for electricity by 2020.*

The Directives on the Internal Market for Electricity and Gas (Directives 2009/72/EC and 2009/73/EC) require Member States to ensure the implementation of intelligent metering systems to assist the active participation of consumers in the electricity and gas supply markets.

As regards electricity, where an economic assessment of the long-term costs and benefits has been made, at least 80% of those consumers who have been assessed positively have to be equipped with intelligent metering systems for electricity by 2020. Where no economic assessment of the long-term costs and benefits is made, at least 80 % of all consumers have to be equipped with intelligent metering systems by 2020 (Annex I(2) of the Electricity Directive).

As regards natural gas, no deadline is given but the preparation of a timetable is required, subject to an assessment of long-term costs and benefit (Annex I(2) of the Gas Directive). These Directives also state that final customers must be properly informed of actual electricity/gas consumption and costs frequently enough to enable them to regulate their own consumption.

The Directive on internal markets (2009/72/EC), demands in Art. 3(11) that, in order to promote energy efficiency, Member States or regulatory authorities shall strongly recommend that electricity undertakings optimise electricity use by, for example, introducing intelligent metering systems or smart grids.

Annex I(1)(i) states that customers must be properly informed about actual electricity consumption and costs frequently enough to enable them to regulate their own electricity consumption. Moreover, Member States shall ensure the implementation of intelligent metering systems. The implementation of those metering systems “may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual customer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution.” The later EED provided more specifications on this issue.

The Directive obliges Member States to produce cost-benefit assessments for the rollout of smart metering before 3 September 2012. Subject to that assessment, a timetable with a target of up to 10 years for the implementation of smart meters shall be prepared. Some countries have found barriers on developing positive cost-benefit analysis at a first

stage, and are adjusting the methods and information to the current situation due to different options existing in the market.

As regards to retail markets, Art. 41 indicates that in order to facilitate the emergence of well functioning and transparent retail markets in the Community, Member States shall ensure that the roles and responsibilities of transmission system operators, distribution system operators, supply undertakings and customers and if necessary other market participants are defined with respect to contractual arrangements, commitment to customers, data exchange and settlement rules, data ownership and metering responsibility. Those rules shall be made public, be designed with the aim to facilitate customers' and suppliers' access to networks, and they shall be subject to review by the regulatory authorities or other relevant national authorities.

In the Annex I of the Directive, there are defined the *Measures on Consumer Protection*. Without prejudice to Community rules on consumer protection, in particular Directive 97/7/EC of the European Parliament and of the Council of 20 May 1997 on the protection of consumers in respect of distance contracts and council Directive 93/13/EEC of 5 April 1993 on unfair terms in consumer contracts, regulation ensures that:

- ✓ *Customers have at their disposal their consumption data, and shall be able to, by explicit agreement and free of charge, give any registered supply undertaking access to its metering data. The party responsible for data management shall be obliged to give those data to the undertaking. Member States shall define a format for the data and a procedure for suppliers and consumers to have access to the data. No additional costs shall be charged to the consumer for that service*

- ✓ *Customers are properly informed of actual electricity consumption and costs frequently enough to enable them to regulate their own electricity consumption. That information shall be given by using a sufficient time frame, which takes account of the capability of customer's metering equipment and the electricity product in question. Due account shall be taken of the cost-efficiency of such measures. No additional costs shall be charged to the consumer for that service*

- ✓ *Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the electricity supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs*

> *and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution.*

Recast of Building Directive EPBD 2010/31/EU

> *Additionally, the recast of the Energy Performance of Buildings directive (2010/31/EU, EPBD) includes a provision on the introduction of intelligent metering systems. Art. 8(2) specifies that Member States shall encourage the introduction of intelligent metering systems whenever a building is constructed or undergoes major renovation. Additionally, Member States may encourage the installation of active control systems such as automation, control and monitoring systems that aim to save energy.*

A push has been provided through the Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements, not directly related to smart metering.

3. Services for EU consumers based on Smart Metering

3.1. Introduction

Overview

Only during the last few years there have been considerable developments in smart metering technology and consumer oriented services, highlighting the feedback tools like information displays in the home, websites, information on moving devices – smart phones and tables -, informative bills and others. At the same time, innovative tariffs, with dynamic prices directly related to the current demand or prices fixed for specific periods of the day (eg. different prices for night and day) have entered into the market.

The arrival to the market of these services aimed at residential consumers are directly related to the smart meters rollouts, the interest by energy companies in providing better services to their customers and the regulatory requirements.

The publication of and the start of transposition of the internal market package for electricity and natural gas (Directives 2009/72/EC and 2009/73/EC) started a growing confidence in the market opportunity of smart metering services.

The European Commission commits Member States to rollout smart meters to at least 80% of customers by 2020 that are deemed to have a positive cost/benefit ratio. In many EU Member States this energy market package is the major driver for infrastructure pilots, cost-benefit analyses and the development of new businesses for smart metering services.

The developments within the metering service market have the potential to bring actual energy savings. Even while it is still under debate as to what extent these services will in fact achieve energy savings, it is at the same time clear that **without services based on frequent or real time information and their feedback there is no benefit for the end customer**.

It will be difficult to convince customers of the added value of new metering technology and the modernisation of the European electricity grids, if metering data is only of use for operational changes within utilities (to reduce non-technical losses, for remote reading and switching or the simplification of billing procedures, etc.). This is particularly important because the real advantages of smart metering will and have to be compared with the related costs that will be borne by customers (in monetary terms, but also in terms of privacy intervention and other non-monetary issues). Only efficient services based on frequent and real smart meter data will benefit the consumer and result in energy savings.

Besides feedback tools that enable customers to regulate their energy consumption, a number of utilities test and operate **demand response programmes** in order to limit the peak load that has to be provided in the market. Nordic, as well as several other countries, have piloted and put into the market market-based tariffs and demand response services that provide with accurate information, innovative tariffs and other economic incentives aiming to achieve certain customer behaviours or apply direct load curtailment within the contractual framework, showing promising results.

This section gives an overview of available services based on smart metering technologies and data in EU Member States. **It is by no means a complete picture of all the different technologies available at the moment.** This section should rather be a starting point for interested stakeholders to learn and replicate from services that are in use in EU member states and Norway, including real developments, pilots and innovative services.

Services for household sector have been classified in three groups:

- Frequent information to consumer and feedback
- Real-time information to consumer and feedback
- Demand response

Type of service	Frequent information to consumer and feedback
Description	Provides historical and recent information (not real-time) about the home energy usage, benchmark with others, comparisons with the own previous consumption or with average consumption data for the same segment, provides tips on energy efficiency (more effective if based on own and real information), and might establish targets for the month or year
Delivery of the service	By informative billing, on-line services – including Internet on the computer or moving devices as smart phones and tablets-, energy efficiency advice
Origin of the data	It requires using information from databases which has been analysed and put into figures/graphics/images. It does not provide real-time information, but requires a system able to manage a great amount of data, with hourly minimum frequency.
Main targets	Energy saving at home, create awareness, educate, create active consumers

Type of service	Real time information to consumer and feedback
Description	Provides information in real time when directly connected to the meter at home or almost real time when it is returned by the Telemanagement system, both aiming at a fast consumer response.
Delivery of the service	Energy display, internet-based services through computers, tablet/smart phone, television.
Origin of the data	The aim is to use information directly available from the smart meter (directly from an existing port or LED indicator pulse in the smart meter), electricity feed phases or smart plugs, or from a Telemanagement system which provides information which can change the behaviour of the consumer in few minutes or hours
Main targets	In a first stage, it allows a fast detection of equipment and systems energy consumption to gain awareness on how much these affect overall consumption, and helps to reduce unnecessary consumption without affecting the consumer comfort (e.g. removing equipments from the plug, turn off lights, switch off stand-by, etc.). Also, these services support the consumer in selecting the time of the day and length in which he/she uses the appliances/systems, benefitting from variable tariffs, resulting in demand response based instantaneous behaviour change. In a second stage it helps maintaining the awareness and behaviour change, thus sustaining or increasing the energy savings

Type of service	Demand response
Description	Changes in electricity (or heat) usage by end-use customers compared to their normal consumption patterns in response to: a) changes in the price of electricity over time, or b) to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when production or distribution system reliability is jeopardized

Delivery of the service	a) Dynamic load control by utility (direct) and home or appliances automation. b) Different pricing incentives, such as dynamic pricing, hourly tariffs, compensations A demand response service usually includes both above mentioned components, whereas a) delivers the needed automation and means to function according to the variable price or compensation terms, and b) delivers the financial reward needed to motivate the activity. b) can be also used without a) and the actual change in the consumption pattern is based on a behaviour change (induced by the incentives), instead of automated activity.
Origin of the data (and load control functionalities)	At least hourly data provided by the smart meter to the utility database system, is needed to enable new variable or dynamic tariffs or compensation arrangements. Automated load control can be delivered via smart meters or separate building automation. The control signal can come directly from the utility/demand response service provider or via receiving price information, to the building automation.
Main targets	The main aim is to shift usage from on-peak to off-peak. The consumer uses the energy at the time of the day when it is cheaper, helping to reduce and flatten the national energy consumption wave decrease electricity consumption curve. Additionally, it might help to decrease the average consumption itself.

Table 3: Types of Household Sector Services from Smart Meter Data

3.2. Services provided at full or very large scale

100koll EON Smart Electricity Meter | Sweden

Type of supply:	Electricity
Number of households involved	First started as a pilot including 10.000 residential customers, now available as a product for E.ON residential customers.
Type of services provided	Monitoring real-time total electricity and appliance consumption and controlling appliances (with smart plugs) through a mobile application.
Years of execution and aim	The pilot was completed in 2013, and now the 100koll is available as a product for residential customers

Target group: Households, with primary focus on detached houses.

Description and aim of the services: the 100Koll started as Sweden's largest energy saving experiment exploring how visualising real-time electricity consumption through online and mobile apps can result in behavioural changes in energy consumption and how much households can save electricity through this. The one-year piloted tested the concept “100Koll” and included 10.000 residential customers located all over Sweden. Their consumption was visualised in five different ways, to see what would make them save the most. Also a PR campaign was launched to help spreading wider awareness. The pilot was completed in 2013.

Now E.ON Sweden offers 100Koll to all their electricity customers. The package costs 495 SEK, with a one-time invoice fee of 35 SEK and monthly fee of 19 SEK. The package includes one optical eye and one smart plug. The 100Koll reads real-time electricity consumption from the electricity meter and smart plugs andvisualises the data through a mobile application, through which home appliances equipped with smart plug(s) can be controlled. The platform can be extended with new smartplugs, and more features is said to be added over time.

http://www.eon.se/100koll

Figure 2: EON: real-time information in Sweden

Data requirements: Access to the electricity meter with a LED pulse is needed for monitoring the real time total electricity consumption of a household. For customers that do not have access to electricity meter, the 100Koll is supplied with 2 smart plugs.

Customer response and results: The pilot resulted in electricity savings up to 15 %, with the average of in 12 %.There are no publicly available studies on the current version of the service.

Your assessment of the service: The real-time information andclear visualisations on the level and trends of home electricity consumption coupled with appliance specific monitoring and control possibilities provide a good platform to increase awareness and change behaviour. Acquiring and installing the service is relatively easy and the app seems to be developing over time. As the service has already been offered for several years, it clearly contributes positively to the utility's image and customer satisfaction and acquisition in a market where smart metering with hourly information and feedback is not yet available for every consumer

Asema E Smart Home System | Finland

Type of supply:	Electricity
Number of house-holds involved	Available to all consumers in Finland, primary focus on detached houses.
Type of services provided	Appliance specific real-time electricity consumption feedback, smart home automation and appliance control to increase home energy efficiency and enable demand response.
Years of execution and aim	Available to consumers since 2009

Target group: Households, with primary focus on detached houses.

Description and aim of the services:

Asema E Electricity Saver combines information, control and automation to increase home energy efficiency and enable demand response. The system consists of Asema E touch-screen display, operating as a smart home central unit, coupled with adapters, switches, modules, and sensors that connect to the central unit.

The system enables real-time monitoring of home electricity consumption and costs both through a smart meter and with independent sensors. With wireless switches, one can monitor appliance specific consumption, and connected appliances can be controlled and programmed to automatically react to changes in electricity price. Tariff controls can use data from utilities or directly from Nord Pool Spot.

In addition, The Asema E Electricity Saver offers energy saving tips, consumption alerts and extended energy saving and other applications over the internet (e.g. home consumption comparisons to similar users as well as different appliances comparisons). Through the use of customizable applications called screenlets, the system can also function as a direct in-home communication channel between the utility and the user.

Asema E has mobile phone, tablet, PC and Internet access built in, expanding the interfaces and mobility to monitor and control home energy use. More information can be found from the website www.asema.com

Data requirements: The system uses real-time data from a direct local connection to the smart meter and switches connected to appliances. The smart meter is usually provided by the utility, as the Finnish regulation demands.

Customer response and results: According to a recent pilot, consumers find the functionalities of the system valuable. To reach the highest potential value for home owners and builders, the energy efficiency aspects should be complemented with other smart home functionalities such as better home and indoor climate control, safety, weather etc.

Based on general pilots, by combining smart meters with smart home automation in existing homes, householders can realistically expect to reduce their electricity consumption by tens of percent, depending on the nature of the technology used and the consumer's own consumption behaviour.

Generally the greatest savings are possible at peak price times, through the use hourly spot or 'critical-peak' pricing in combination with the use of home automation and appliance controlling.

Your assessment of the services: The appliance specific real-time information coupled with control and automation possibilities of the system provides a large potential for energy saving and demand response, especially in electricity heated houses. The system extensibility and usability is good through applications, different interfaces and remote operability.

The capability to include other functionalities and information besides energy (such as news and weather forecasts) is likely to increase the use of the central display unit and consumer engagement. Price wise, the system is most suitable for consumers with rather large electricity consumption, such as households with electricity heating. Thus the system is not so easily adopted by masses, although still very good potential to reach a wide group of heavy electricity consumers and smart home builders.

Energy Watch and Smart Plugs from Vattenfall | Finland and Sweden

Type of supply:	Electricity
Number of household involved	Available to all household customers in Finland and Sweden
Type of services provided	Visualising real-time electricity consumption, monitoring and controlling appliance consumption via computer and smart phones.
Years of execution and aim	EnergyWatch and SmartPlugs are available to consumers continuously

Target group: Available to household customers in Finland and Sweden.

Description and aim of the services:

The aim of EnergyWatch is to help utility customers to gain awareness, change behaviour and reduce their energy consumption and bills. EnergyWatch visualises real-time electricity consumption and appliance consumption and costs through computers and smart phones. The programme recognises recurring changes and patterns of electricity consumption and deduces the consumption of different appliances, enabling to break down the total consumption to home appliances, heating and hot water.

The service:

- Shows electricity consumption and costs in real time, from different perspectives
- Analyzes how electricity consumption is affected by appliances that never turn off
- Analyzes how much of your electricity consumption goes into household electricity and heating and hot water
- Saves electricity consumption history enabling comparisons between different times
- Shows the instant effects of turning on/off appliances and energy saving measures

Vattenfall also offers Smart Plugs that use the EnergyWatch application and extend its features to monitoring the energy consumption of appliances (sockets), and controlling and scheduling their use through a smart phone. The Smart Plugs can also be used individually without buying the EnergyWatch product.

Data requirements: An electricity meter with a LED pulse is needed. The EnergyWatch system reads real-time data from the electricity meter LED pulse and smart plugs.

Customer response and results: There are no publicly available customer study results. According to Vattenfall, up to 20 % energy savings are possible with EnergyWatch, but the utility does not guarantee this. According to Swedish customer testimonials, the system is easy to install and it has helped in identifying where electricity is consumed in the household and relevant energy saving measures.

Your assessment of the services: The real-time information enhanced with appliance specific monitoring and control possibilities provides a good platform to increase awareness and change behaviour. The costs of the system and smart plugs are reasonable.

Eesti Energia Consumption Monitoring Services | Estonia

Type of supply:	Electricity
Number of households involved	Available to Eesti Energia customers with smart meters in Estonia
Type of services provided	Consumption information and feedback
Years of execution and aim	The services have been available from 2014 for the smart metered customers, the smart meter roll-out is completed by 2017.

Target group: EestiEnergia customers with smart meters in Estonia.

Description and aim of the services:

As a part of their smart metering roll-out, Eesti Energia provides to its customers both online service and mobile application for monitoring consumption and saving electricity.

The online service displays customer's electricity consumption of the past year on a graphand enables monitoring and comparing different consumption points (if more than one) and comparing different periods of consumption. The service also includes weighted consumption to match consumption with e.g. the number of residents and adding events affecting consumption, helping to analyze the consumption graphs more accurately.

The Eesti Energiamobile app allows customers to monitor monthly, weekly, daily or hourly electricity consumption, including consumption in the current month and previous month. The app can send notifications about the market price and information on the cheaper and more expensive price periods during the next day. The app also includes electricity contract and invoice information, possibility to pay invoices, submitting meter readings, having notifications on bills, due payments and consumption as well as special offers for EestiEnergia customers. According to EestiEnergia nearly 30,000 customers are already using the app. In their website, EestiEnergia also has "Test your consumption" page informing customers on how much energy they can save by monitoring their consumption using the app.

Data requirements: Hourly smart metering is rolled out to all the customers.

Customer response and results: There are no publicly available customer studies available. According to academic studies and pilots, the energy savings from indirect (non-real time) consumption feedback services usually range from 1 % to 5 %.

Your assessment of the service: Interpreting hourly consumption data and understanding its connection to one's own behaviour and saving possibilities can be challenging for most consumers. In indirect feedback services, the key issue is the proper design and choice of channels of the feedback to gain maximum and long lasting consumer engagement leading to behavioural changes towards energy saving. The strength of EestiEnergia's approach is that, in addition to the on-line service, they offer a mobile app with a good variety of key functionalities which supports engaging the customers in using the consumption feedback. Further features such as normative comparisons, goal settings and tracking, innovative visualisations, as well as energy advice and consumption explanations integrated directly into the reporting system could enhance the energy savings. Also providing real-time and appliance specific data as well as solutions for appliance control and demand response would most likely increase the energy saving and efficiency effects.

Fortum Fiksu - Demand Response System for Houses | Finland

Type of supply:	Electricity (also oil heating systems)
Number of house-holds involved	Available for all households with direct electric heating, electric boiler and oil heating (over 700 000 households in Finland)
Type of services provided	Demand response through controlling electric or oil/electric heating; real-time information and heating system optimisation
Years of execution and aim	Since 2012

Target group: The system is available for households with direct electric heating, electric boiler and oil heating, which covers over 700 000 households in Finland. In Nordic countries Finland, Sweden and Norway, the potential electric heating systems include c.a. 2 million households.

Description and aim of the services: Nordic energy company Fortum was the first utility to launch a commercial demand response system for Finnish consumers in October 2012. Based on Home Energy Management system developed by There Corporation, the system is said to be the first fully commercial market based demand response consumer product in the world.

The FortumFiksu ("FortumSmart") system for houses with electric heatingfeatures an automatic control for electric boilers and direct electric heating to operate on the cheapest hours ofelectricity price (including Nord Pool spotprice and network tariffs). For oil heated houses, the system compares the oilprice defined by the userwithcustomer's hourly electricity price (Nord Pool Spot and network tariff), and automatically switches heating to the cheapest alternative. Through these features, the service can offer cost savings in the range of 15 - 20 % of heating costs. The system can also bring energy savings by optimizing heating more accurately considering the indoor temperature and heating need of the house.

The basic package consists of the central control system and a spot-priced electricity contract. The control system automatically fetches the current Nord Pool Spot and network tariff prices for electricity and a local weather forecast. Based on this data and other site specific parameters, the system calculates the optimal hours and controls the heating accordingly. The system can also utilize feedback from the household's main electricity meter to further improve its accuracy. In principle, the system is totally automatic and no user interaction is necessary.

The system includes a web interface that enables monitoring and controlling heating system as well as monitoring real-time electricity (and oil) consumption, accumulated savings, Nord Pool Spot prices and receiving price alerts. The interface can be used

throughcomputer or smart phone. Furthermore, the system has wideupscale possibilities within energy, security,homeautomation and health services. The energy management systems developed by There Corporation also include solutions for optimizing comfort and energy costs in houses and holiday homes, optimising photovoltaic systems with home energy consumption and controlling heat pumps.

More info at:http://smarthomepartnering.com/en/node/151, www.fortum.fi/fiksu, www.there.fi/solutions

Figure 3: Fortum Fiksu

Data requirements: Hourly smart metering is needed to enable spot priced electricity contract.

Customer response and results: The system is easy to install and its use is automatic and effortless for the customer while delivering costs savings and possibilities for remote monitoring and control of heating. According to monitored customers, the system can deliver 15 – 20 % energy cost savings.

Your assessment of the service: The service has a wide potential among consumer segments that use a lot of electricity. On the national system level, if widely implemented the service has potential to cut electricity peak consumption and emissions, contribute in reducing the stress on electricity production systems and to some extent lowering the electricity system price.

When comparing the costs and benefits, the system provides positive value. The price of the installed system is ca. 750 € for electric boiler heating and 850 € for oil heating, with a monthly service fee of 9,90 €. When the cost savings of 15 -20 % are assumed, the annual monetary cost savings are in the range of 300 - 500 € in a typical one-family house with electric or oil heating. This results in roughly 2 - 4 year investment payback times. Remote monitoring and control possibilities provide extra benefit in addition to monetary savings. The system can be also extended to include other smart home functionalities related to security and home management, which further increase the range of expected benefits.

Gas Natural Fenosa TuLuz | Spain

Type of supply:	Electricity
Number of house-holds involved	Available to all citizens in Spain (website) and to Gas Natural Fenosa / Unión Fenosa Distribuión customers (mobil App)
Type of services provided	Web service available to all citizens in Spain (information on incidences in the distribution network) and to Gas Natural Fenosa / Unión Fenosa Distribuión customers (mobil App with incidences and consumption information)
Years of execution and aim	Available to consumers continuously Inform consumers on incidences (any consumer in Spain) Inform GNF/UF Distribución customers on incidendes and energy consumption by mobil App

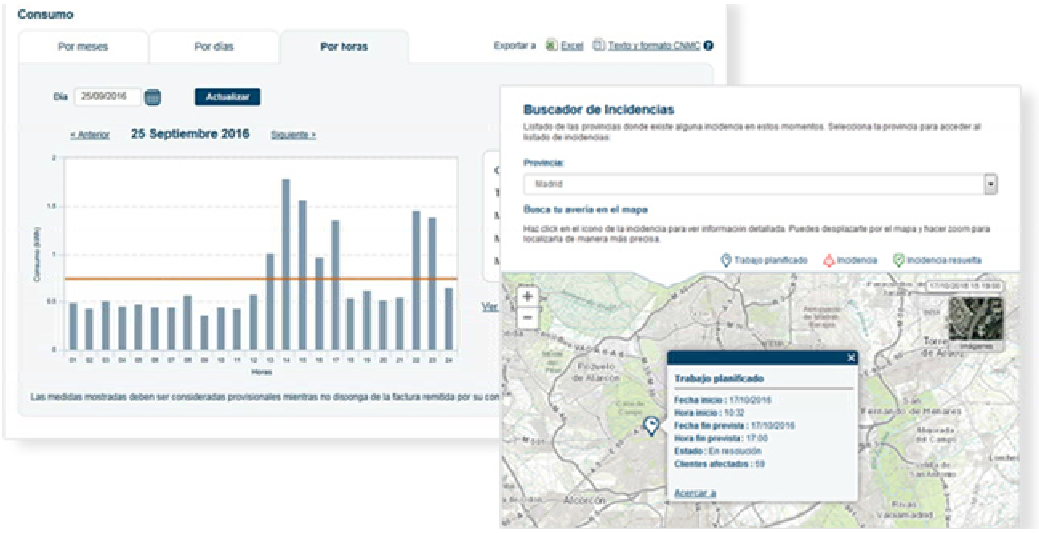
Target group: Available to household customers in Spain.

Description and aim of the services:

The aim of TuLuz is double. On one side, any Spanish consumer can look at the website www.unionfenosadistribucion.com and check the incidences happening in the distribution network in real time, as well as the starting and ending time of the works to solve it. On the other side there is an App (mobil) to help utility customers to gain awareness, change behaviour and reduce their energy consumption and bills by providing the hourly consumption curve.

The service:

- Shows the incidences in the distribution network, indicating the location affected, number of customers, date/hour incidence detection and date/hour estimated for fixing the problem
- Provides the hourly curve for each GNF / Unión Fenosa Distribución customer, based on their smart meter data.
- Provides daily and monthly consumptions
- Saves electricity consumption data for two years, and allows customer to read the historical consumption
- Customer can download the above mentioned data in several formats to manage the consumption



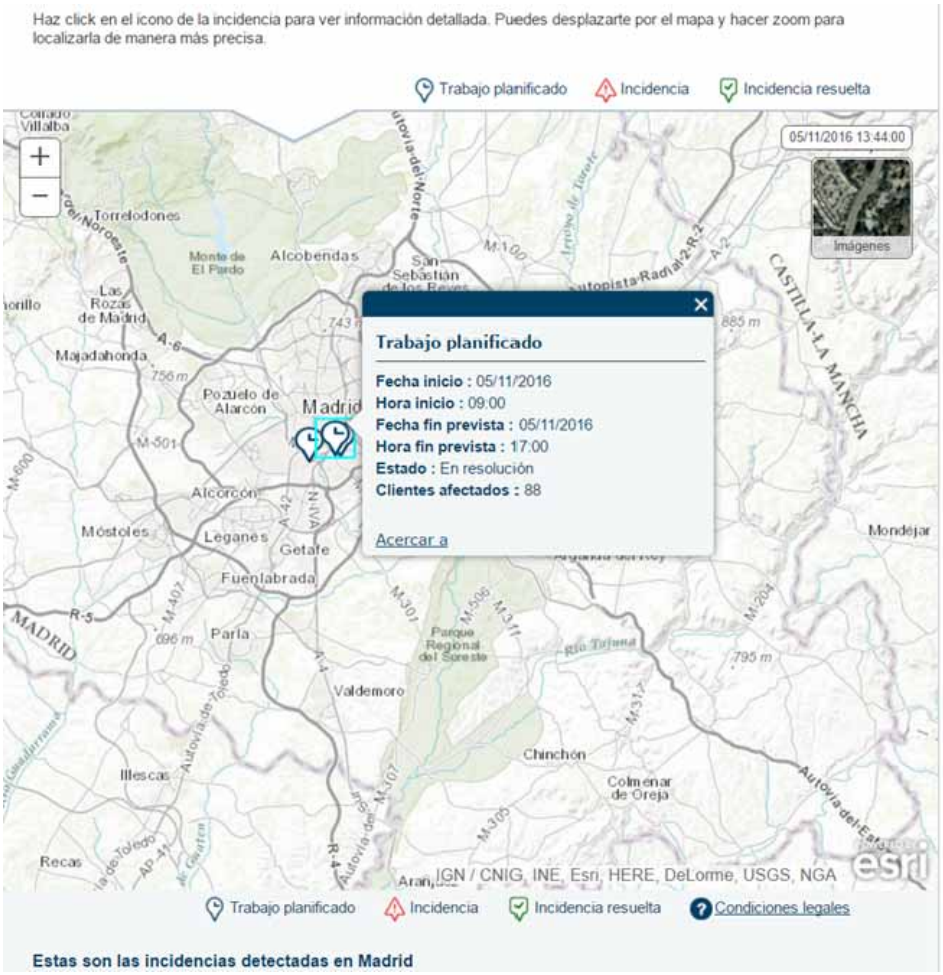


Figure 4: Gas Natural Fenosa / Union Fenosa Distribución Tuluz service

Data requirements: smart meter managed by Gas Natural Fenosa / Unión Fenosa Distribución

Customer response and results: There are no results from a wide sample yet as the service was started recently in October 2016.

Your assessment of the services: The system is automatically available for any consumer in Spain, which provides transparency to the utility distribution system performance in almost real time. It provides dates and hours for incidences in the network and fixing. The App also provides hourly curves and historical information, as well as monthly and daily figures, helping consumers to manage their own data to better decide how to manage their energy and select the best retailer offer.

Iberdrola Distribución information system | Spain

Type of supply:	Electricity
Number of house-holds involved	+8.000.000 (September, 2016)
Type of services provided	Frequent information to consumer and feedback in web platform
Years of execution and aim	Currently existing and will progress until the end of the period for the full rollout

Target group: there are currently over 8 million consumers with the services from all segments in Spain. The target would be the almost 11 Million households with Iberdrola smart meters by 2018. This service is provided by the distribution company.

Description and aim of the services:

This information and feedback services are provided to all customers with smart meter installed, since 2014. The consumers can join a portal where information on their consumption can be obtained.

The main services include:

- Hourly energy consumption
- Daily energy consumption
- Monthly energy consumption
- Power consumed
- kWh consumed versus similar consumers
- Access to the invoice based on real information of the energy consumption

The information and feedback services are provided through an innovative web service with access through a computer.

Figure 5: Hourly real energy consumption curves by Iberdrola Distribución

Data requirements: the data are provided from the smart through the smart grid (PRIME Protocol) to provide the services: as the energy data, status of the equipment, energy unitary cost.

Customer response and results:

At the moment 8 million Iberdrola distribution consumers can access the innovative service provided at the time they get their smart meter installed and connected to the smart grid system with full functionalities.

As the service is relatively new, there is still no enough data to evaluate the results. During this year and 2015 some results might arise.

Your assessment of the services: the innovative service developed by Iberdrola, which will be available for millions of consumers, is an example of how real energy data from the smart meter can be provided to the consumer in a simple way to benefit them and save money, without any additional cost (the service is provided for free.

The service provides clear information to the consumers without cost (free for a consumer in the distribution area). The web platform allows to understand the hourly, daily and monthly consumption profile, and compare to others to check your position in the segment. Also, you can check the power consumed and adjust the contract. The project will allow the approximately 11 million customers to use the service by 2019.

Inovgrid | Portugal

Type of supply:	Electricity
Number of house-holds involved	130.000 (2014)
Type of services provided	Real time information to consumer and feedback, and frequent information to consumer and feedback
Years of execution and aim	Since 2010, currently existing and will progress in the coming years to the new InnovGrid developments in Portugal

Target group: at present 130.000 consumers from all segments in Portugal. The target would be the 6 Million households with smart meters by 2020. The InnovGrid will also apply to tertiary buildings and other installations integrated into the smart grid.

Description and aim of the services:

The information and feedback services have been provided to the customers inside the InnovGrid project since 2010, when the project started at the Évora InnovCity, with 30.000 smart meters.

The services include:

- Real time monitoring of the energy consumption and production
- Real time information on billing
- Real time control (switch on/off, increase/decrease)
- Monitoring and control of energy costs
- Added value service, as information on energy efficiency, alerts, reports
- Access to new tariffs and price plans

The information and feedback services are provided through innovative web services and applications on computer, smart phone or tablet. A test group was provided with display systems.

Figure 6: EDP Box services in InnovGrid

Data requirements: the data are provided from the smart meter (EDP Box) through the smart grid to provide the services: as the energy data, status of the equipment, energy unitary cost.

Customer response and results:

More than 130.000 consumers can use the innovative services provided by EDP by the time the get their smart meter installed and connected to the smart grid system with full functionalities.

- The Évora population were provided with invoices based on real consumption, permanent access to historical consumption in the EDP online portal and energy efficiency recommendations. A study carried out during March 2011 and February 2013 resulted in a 3,9% reduction in energy consumption compared to a control group, and they seem to be sustainable.
- A Test Group was provided with New Products and Services as alerts, reports and some special tariffs. They showed a 5,3% energy savings.
- Another Test Group was provided also with display system to monitor their consumption, reaching energy savings of 6,6%.

Your assessment of the services: the InvoGrid project developed by EDP and the associated services have shown interesting energy savings associated with the smart meter services rollout. The reduction in the energy consumption varies from 3,9 to 6,6%, which at the same time seems a sustainable result. The project will progress to reach the 6 million customers by 2020, optimizing the overall system.

Linky meters and services | France

Type of supply:	Electricity
Number of house-holds involved	300.000
Type of services provided	Frequent information to consumer and feedback: on-line consumption historic data comparison, thresholds, SMS notifications on consumption.
Years of execution and aim	2010-2012, pilot in rural and urban area to test the smart meters, their functionalities and the services to consumers

Target group: the pilot project was aimed at 300.000 consumers from two areas in France, one rural and the other one urban. The target was to test the performance o fthe smart meters functionalities and some services for the consumers. The positive result will allow to deploy the 25 million households with smart meters by 2018.

Description and aim of the services: The smart metering pilot, which included 300.000 meters and 7.000 concentrators in total, was carried out in order to validate the technical performance of the smart metering solution and the smart Linky-meters provided by several suppliers especially for ERDF (e.g. Landis and Gyr).

Installation, logistics and rollout management practices were tested and verified. The benefits in terms of distribution quality, customer satisfaction. The total investment of 4.4 billion Euro was financed by ERDF, while no additional costs will be allocated to the French consumers.

The pilot took place in the Tours region, a rural area, and Lyon, an urban area. By focusing on these two diverse regions, the widest possible variety of installation requirements could be tested. ERDF and meter solution providers evaluated physical meter installation as well as all the associated logistics. The partners took a careful look at production, warehousing, distribution and installation. They also ran tests on data collection and collating within the central system.

The smart meters enabled new services to the consumers based on their real consumption and with reasonable frequency to take better decisions.

Data requirements: Linky is a smart electricity meter, developed especially for ERDF, according to their specifications. It includes a breaker for remote power disconnection and connection, advanced tariff management possibilities, and a two-way PLC communication modem, based on IEC61334 S-FSK profile. The future PLC-G3 OFDM standards have also been considered in the meter design.

The system reads the data through concentrators and a GSM interface. In the pilot-phase, ERDF used the networks of the three main telco operators for better coverage.

Customer response and results:

The over 300.000 consumers have been provided with the Linky system and can use the innovative services provided by ERDF

The meters are supplied to customers free of charge, with the additional costs of the deployment expected to be offset by the productivity gains ERDF will achieve. Since 2013, the consumer benefits from new services, including invoices based on actual consumption, which will eliminate one main cause of customer complaints.

In addition, customers have access to up to two years of consumption history online and are able to set consumption targets. In case they exceed their self-imposed thresholds, they will receive notification via SMS. The system also enables flexible tariffs and de-mand response. Thus, the end consumers can decrease their energy costs by adapting the timing of their consumption and the utility has powerful tools to cut off peak loads.

No specific results in terms of energy savings have been provided related to this project. ADEME, the National Energy Agency, developed an study where indicates that 4,5 to 11% energy savings can be reached if specific information based on the real consump-tion is provided to the customers.

Your assessment of the services: the smart metering project based on Linky has shown that a wider deployment of smart metering and the associated services to domes-tic consumers will be reasonable in France. The project led by ERDF, with the coopera-tion of some major international providers (LANDIS and GYR, ITRON, etc.) should bring interesting benefits for the electric system and the consumers. Nevertheless, there is still need to start the massive rollout to confirm the results found so far.

"Muehlheim zaehlt" by RWE AG | Germany

Type of supply:	Electricity
Number of house-holds involved	around 100,000
Type of services provided	Frequent information to consumer and feedback, real-time information to consumer and feedback, smart home application
Years of execution and aim	2008 - 2012

Target Group: Residents of the city of Muehlheim, regardless of whether they are a RWE customer or not.

Description and aim of the services: The smart meter solutions of RWE's pilot „Muelheim zaehlt" consist of two components: the smart meter and an additional information / communication module. This module can be read remotely and will also be applicable to gas, water and heat meters in future.

The data transmission is done via "Powerline" (electric cable) or via mobile communications networks. In the pilot, different devices and communication concepts were tested and further developed. An accompanying research project examined the question, whether households with smart meters will have higher energy savings than households without.

The supplied smart meters can also be upgraded with *Smart Home Power Control*, which allows customers an overview of the consumption data for the past three days of his electrical appliances. The data can be displayed as charts and diagrams. With the aid of the *Power Control Basic App* customers can remotely turn of and on their electrical appliances (RWE, n.d.).

Data requirements: The consumption values are read out only once per month. The data transfer routine complies with the current data protection requirements of Germany, which are among the most strict in the world. The transmission of consumption data is

encrypted.

Customer response and Results: The accompanying research project found an average of 2.8 percent energy savings in the test group in the period between 2010 and 2011, compared to the control group outside Muelheim, with no installed smart meters.

Furthermore, the analysis showed particularly high savings, when participants changed their consumption behaviour actively (e.g. exchange of equipment with low energy efficiency). The smart meter customers found it particularly helpful to constantly obtain a current consumption overview with *Smart Home Power Control*. The possibility to compare the consumption for individual days or weeks was also evaluated to be helpful (RWE, n.d.).

Your assessment of services: This large-scale pilot is well suited to evaluate a comprehensive rollout of smart meters due to its size. Especially the development of concepts is important for future distribution. The project shows the potential to conveniently reduce power consumption and increase the costumer awareness of electricity consumption. The frequent comparison of individual consumptions might foster something like a “competition” for energy savings. The upgrade with the *Power Control* devices is a first starting point for smart home solutions, which will help the costumer to reduce their consumption even further.

OptiWatti–Smart Automation Service for Electrically Heated Houses | Finland

Type of supply:	Electricity
Number of house-holds involved	The service is available for all households withdirect electric heating (ca.500 000 households in Finland)
Type of services provided	Accurate and real-time heating optimisation, demand response according to hourly electricity price and providing real-time information on indoor temperatures and heating electricity use.
Years of execution and aim	Available from 2014 -

Target group: Consumers living in buildings or holiday homes with direct electric heating (radiators, roof and floor heating).

Description and aim of the services:

OptiWatti automation service enables accurate and real-time indoor temperature controlling for each room or space, as well as setting heating schedules and profiles for different times during the day. The timing of heating can be optimized according to outside temperature, weather forecast and the price of electricity, enabling customers to effectively use hourly tariffs and demand response.

OptiWatti can be used with computer, tablet or smartphone through easy-to-use visual, allowing remote access to control homes from anywhere. The service also provides real-time information on indoor temperatures, heating electricity consumption and indoor humidity for each room, making it easier to recognize saving opportunities.

Users can effectively save energy by decreasing temperature, for example while away and at night. The system features home-away switch to easily switch between different preferences of heating and indoor temperature. More accurate control also prevents overheating of rooms, which is usually the case in households with less accurate heating control systems. The system learns how different rooms react to temperature adjustments, providing more accurate control of heating and room temperatures.

Installation of the system is easy as the system is wireless and no major changes are needed to current heating system. Installation is done by an authorized electrician. The installation includes room sensors, heating element controlling devices and OptiWatti Central Unit.

Sources:www.optiwatti.fi/english

Pictures: www.optiwatti.fi

Figure 7: Optiwatti smart automation service

Data requirements: The system includes all the needed sensors and devices.For optimising heating according to hourly spot market tariffs, hourly priced electricity contract and a utility smart meter is needed to provide the hourly consumption data for billing.

Customer response and results: According to the published customer responses, the system has helped saving energy while increasing comfort due to better indoor temperature control.Compared to existing systems with several room thermostats, adjusting heating is easier when centralised to one system and interface which also enables remote use. Once set the system automatically controls heating and customers have achieved significant savings, averagely 30-40 % of heating costs. According to customer reviews, the system pays itself in a couple of years.

Your assessment of the service: TheOptiWatti system can be acquired by any household with direct electric heating, which presents a large potential group for new home energy management services in the Nordic countries. It provides very accurate control and monitoringof heating, indoor temperatures and real-time energy use wherever and whenever, coupled with user friendly mobile-based interface, which are nowadays must for modern home energy management systems. All in all, the system provides good value for the investment, coupling significant energy savings and efficient use of hourly tariffs and demand response with increased comfort and remote controlling.

RWE SmartHome Power Control | Germany

Type of supply:	Electricity and Heating
Number of house-holds involved	All households in Germany possible (appr. 6-digit-number of households involved)
Type of services provided	RWE SmartHome is home automation for every household. It enables the modern house a wireless control of electrical and heating appliances.
Years of execution and aim	Since 2013 RWE SmartHome Power Control allows - in connection with the RWE SmartHome central control unit - the reading of meter data from electricity meters (EDL21).

Target group: No limitation to the target group because just a connection to the electricity meter is needed. Therefore all households can be seen as the target group.

Description and aim of the services: In order to use the RWE Power Control for intelligent consumption control, a digital meter (EDL21), the intelligent home control RWE SmartHome central control unit and a device driver is required.

The RWE SmartHome Power Control readout unit is used for reading of electronic household meters (EDL21) and transmits power (W) and meter reading (kWh) of one- and two-tariff meters to the RWE SmartHomePowercontrol receiving unit.

The RWE SmartHome central is the control unit for all RWE SmartHome devices and the interface to the RWE SmartHome Backend. About the central all settings, profiles and timings are regulated.

The device driver can either be displayed on tha power control based app or the Premium app. The Basic App is freely available in the Smart Home AppStore. In the Basic App energy consumption in kilowatt hours and the power in watts of the last three days can be dis-

played. The consumption data can be displayed in the RWE SmartHome user interface as graphics - and the app also enables the control of electrical appliances

In the liable to pay cost premium app, values for energy consumption in euro can be found, provided that the information of the individual tariff has been deposited. Moreover, not only information of the last three days can be stored but daily, monthly and annual values can be displayed and compared with eachother.

Features and benefits at a glance

• Graphic display of consumption and power values

• Consumption overview by daily, monthly or yearly values

• Comparison of individual consumption periods

• Cost summary in euro

• efficient control of electrical equipment (remote access possible)

• easy installation and expansion

• intuitive usability at home and away

• readout and receiver unit communicate via an encrypted wireless standard at the highest level (128-bit AES, wireless MBus)

Data requirements: Due to the fact that all components interact with each other no data requirements exist for the system.

Customer response and results: Thefavorable entry into house control systems, the simple setup, the comprehensible web interface, flexible configuration and the opportunity to quickly expand the system are valued positively.

On the other hand the aspect that many services cost extra and are only available on subscription, the limited and poorly operable mobile app and the proprietary radio standard are valued negatively.

Your assessment of the service: With its smart home products RWE offers a variety of intelligent sensors, actuators, instrumentation and display options. The system is, according to customer reviews, easy to install and expand. Only temporal aspects of loading the app and clarity can be negatively valued. RWE is currently working on the integration of other companies (Miele, Phillips, etc.) in the Smart Home project. In a separate store RWE provides packages and individual items for purchase, but these can also be purchased on the open market on more favorable terms.

Smart Metering Based Information and Feedback Services | Finland

Type of supply:	Electricity (also district heat for larger suppliers)
Number of households involved	All households in Finland (c.a 3,2 million, smart metering coverage 97 % of consumers)
Type of services provided	Frequent information and feedback to consumers;optional services also: real-time information and feedback (display, apps), demand response and hourly tariffs based onspot price.
Years of execution and aim	Smart meter roll out ready from the beginning of 2014, with information and feedback services available for the customers

Target group: DSOs and retailers offer information and feedback services for their customers, covering all electricity consumers in Finland.The regulation demands smart meters for at least 80% of customers, but in practice the coverage is estimated to be 97 %.

Description and aim of the services: The aim of the Finnish smart metering roll-out is to deliver better tools for households to increase energy efficiency and to enable demand response through new tariffs and load control services.

DSOs are responsible for the roll-out, reading the meters, and reporting and forwarding the meter data. Both DSOs and electricity retailers offer information and feedback services to their customers. The hourly electricity consumption data is made available on the next day to the consumer through on-line energy reporting services. The data is also made available to the electricity supplier for hourly balance settlement and billing, and if authorised by the customer,to a 3rd party to enable new energy efficiency services.

The energy reportingservicesfor consumers differ between DSOs and retailers. Most of the services include the following features:

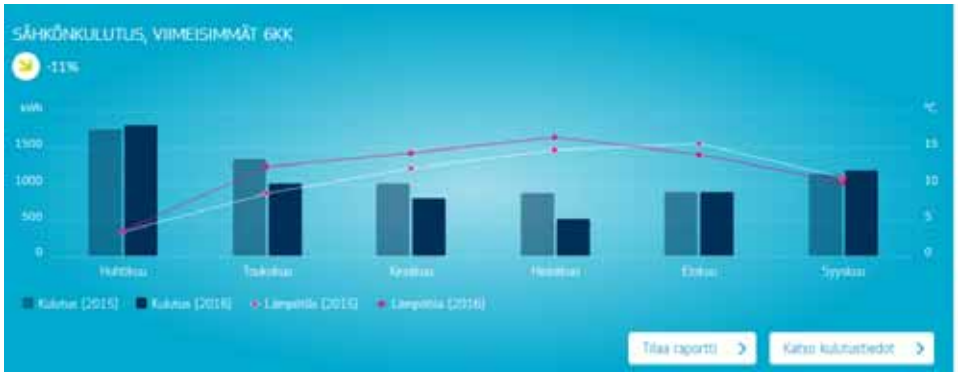
- Monitoring energy consumption from one hour to years in different time scales, usually visualized in bar charts, in kWh and Euros. The information updates once in a day.
- Daily energy use broken down to night and daytime electricity (when 2-time tariff is used)
- Monetary costs broken down to energy, distribution and taxes.
- Hourly or daily outdoor temperature data
- Comparisons toown historic useand other similar users

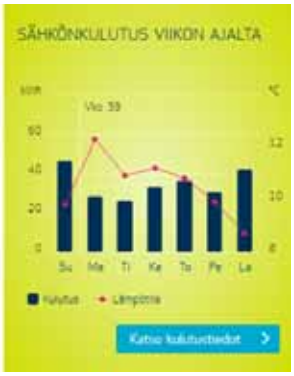
More extensive energy reporting services can also include the following:

- Graphic viewsindicating whether the level of consumption and emissionsare high orlow (e.g. “speedometer”), based on own previous consumption or other similar consumers
- Forecasts of consumption and energy bills, planning own energy goals and tracking them
- Virtual testing how turning on different home appliances or installing a heat pump affects consumption (virtually)
- Calendar marksto mark down actions affecting energy use,
- Tips and advice how to save energy.
- Electricity spot price (when applying hourly tariffs)
- Comparing the prices of different retailers (service implemented by a DSO)

For district heat, several suppliers have smart metering available and provide on-line energy reporting services for their small consumers. Depending on the supplier, services can include the following features:

- Monitoring energy consumption and costs from one hour to years, depending on the availability of data
- Monthly and annual average outside temperatures
- Comparisons to other similar users and own historic use
- A graphic view indicating the consumption and emission levels
- District heat costs, and forecasts own consumption and bills
- Information on how the heating system is functioning (cooling of district heat water based on coming and leaving watertemperatures)and improvement recommendations





Picture: Elenia (DSO) online energy reporting service and mobile app

Picture: Helsingin Energia energy reporting service for electricity

Picture: Helsingin Energia energy reporting service for district heat

Figure 8: Smart metering and feedback services in Finland

Data requirements: The electricity consumption data utilised is hourly-based and read once a day, as demanded by the regulation. For district heat, the utilised consumption data ranges from hourly to monthly depending on the supplier. The quality of data is also important in order to create reliable services from the huge amount of data.

Customer response and results: No extensive publicly available research on customer response has been done. Many utilities have perceived that at first the user numbers peak at high level and start to decline as the novelty value starts to decrease. When customers use the service for monitoring e.g. summer house (whether electricity is on, how the heating is working), higher level of interest remains at longer term. According to academic studies and pilots, the energy savings from indirect (non-real time) consumption feedback services usually range from 1 % to 5 %.

Your assessment of the service: The reporting servicesprovided by utilities to fulfil the Finnish regulatory demands usually include the basic hourly data provision through visualisationand outdoor temperature, with varying added featuressuch as showing monetary costs and comparisons to own previous use and other similar users. For regular small consumers, interpreting the consumption data and understanding their meaning and saving possibilities is usually challenging.

Designing the main features well and adding further functionalities, such as easy-to-understand consumption data explanations and analyses,goal settings and tracking, innovative visualisationsand energy advice,integrated directly into the reporting service-can significantly enhance the consumer engagement and energy saving effect.

Also, making the consumption data more visibly available and integrated to everyday life through a channel preferred by consumers, such as a mobile app with relevant reports and notifications, can clearly contribute to this. Generally consumers prefer real time and appliance specific data over indirect feedback and thus providing these can potentially increase the energy saving effects.

Smart Metering Services – Non real time | Netherlands

Type of supply:	Electricity and Gas
Number of households involved	All households by 2020.
Type of services provided	Bi-monthly home energy reports from the energy provider (regulated, standard feedback for all smart metered consumers). Additional indirect and direct (real-time) smart metering services on request of the consumer, to be provided by market.
Years of execution and aim	Large scale rollout from 2015 to 2020. Smart meter offered to all households by 2020.

Target group: Households.

Description and aim of the services in The Netherlands:

Smart Metering Trials in The Netherlands (both non-real and real time)

The Dutch Government's objective is for all residential and small business customers to have the next generation of electricity and gas meters offered to them by the end of 2020. It was agreed in the Dutch Parliament that smart meters would be introduced according to a two-phased rollout-approach, to begin on a small scale in 2012 and 2013. The purpose of the small-scale rollout was to gain experience and signal possible problems at an early stage, in order to take additional measures in time for the second phase, the large-scale rollout.

Following similar national customer trial programs in the UK (EDRP) and Ireland (CBT), the Netherlands performed a series of smart metering services trials in 2012 and 2013 to deliver evidence for the energy efficiency potential of smart metering and to contribute to balanced decisions on the large scale rollout of smart meters from 2015.

Durable average savings of around 3% are achievable for both electricity and gas, especially in combination with displays, as can be seen from recent trials in UK, Ireland and the Netherlands. The 3% figure is consistent with the findings of the Energy Demand Research Project carried out by four energy suppliers in the UK between 2009 and 2011. The comparable headline figures from the more complicated EDRP trials in Great Britain showed that a combination of smart meters and displays gave persistent energy savings

of around 3% against controls, for both gas and electricity. The EDRP trials showed that a combination of 'generic advice' (normally in leaflet form) and consumption feedback did not always show an effect but, when there was one, savings of up to 5% were achieved. This is in line with expectations from previous research.

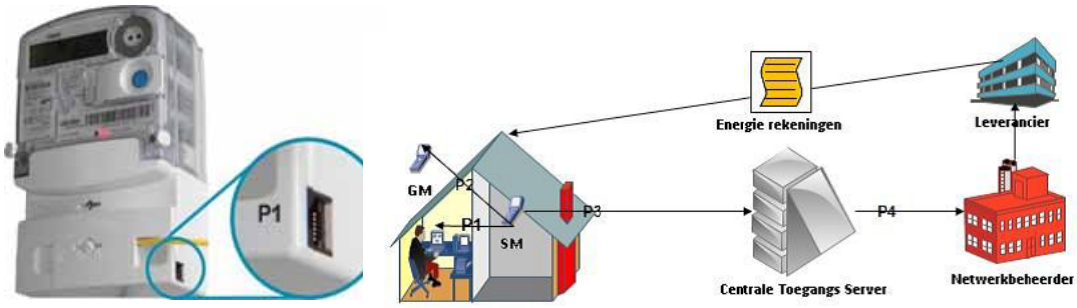
The Irish smart meter trials, in which a thousand representative participants had smart meters, with or without different forms of feedback and time-of-use tariffs, reported average electricity savings of 2.5% relative to a control group, at the end of a year of TOU tariffs and improved feedback, with the figure rising to 3.7% when customers had a bimonthly bill and an IHD. Comparable figures for peak-time savings were 8.8% and 11.3%. For gas, savings at the end of a year were 3% from smart metering (and the associated more accurate bills), rising to 3.6% for those with bimonthly bills, an IHD and a seasonal tariff. Three quarters of participants were still using their displays at the end of the year, and two-thirds said that it was helping them.

The recently-completed Dutch trials found electricity savings of <1% from smart metering plus a bimonthly energy statement (though many customers did not realize the statement was there for them), and 3-4% if this was supplemented by an IHD. Smart meters with dedicated real-time feedback are most consistent in achieving savings. In-home displays often appear to be the more important factor and a crucial first step to activate consumer interest and engagement in accessing real-time energy information. Sophisticated real-time web-based services on PCs, tablets and smart phones are potentially powerful to help reduce energy demand, but more so with already committed subsets of the population who are actively looking to further reduce their energy use.

From this (inter)national evidence base, in March 2014 the Dutch parliament approved additional implementing regulation for the large scale rollout of smart meters from 2015 until 2020.

The current smart metering services in the Netherlands can best be presented by way of differentiation between the two communication channels along which metering data can be read from the smart meter:

1. Non real-time meter readings through the so-called P3/P4 port, designed for the grid operator;
2. Real-time meter readings through the so-called P1 port, designed for the consumer.



Description of the non real-time smart metering services:

The smart metering services provided by Dutch suppliers in this category (pictured below) all offer free or low-cost web tools for viewing and analyzing energy use and energy costs, delayed by at least one day. Through a secured and personalized web page on a PC, laptop, tablet or smart phone, customers can monitor the electricity and gas consumption, in some cases also feed in electricity of own generation via solar panels. Most systems also allow programming of consumption targets, benchmarking with other (participating) households and the provision of energy saving tips as well as tariff- and consumption costs. Some systems use colourful graphic presentations for quick indication of energy spilling (red), average energy use (orange), small energy savings (green) and large energy savings (blue). Admission fees and/or subscription charges are generally low, varying from free services to admission fees up to € 20 and/or annual subscription fees up to € 20.

		
EnergyMonitor – Oxxio Only for Oxxio customers Subscription: not needed	**Enelogoic Basis – Enelogic** Admission fee: not needed Subscription: not needed	**Slimmeme-teruitlezen.nl - Enepa** Admission fee: not needed Subscription: € 20 / year

		
Energiemanager online – E.O. VOF Admission fee: € 7.50 Subscription: € 12 / year	**i-Care Advanced – EnerGQ** Admission fee: not needed Subscription: € 20 / year	**Slimme meter portal – Energy Alert** Admission fee: not needed Subscription: not needed
		
Meter-Online – Meter-Online Admission fee: not needed Subscription: € 19 / year	**Basis portal – Watch E** Admission fee: not needed Subscription: € 24 / year	**Slimme meter Lezer** Admission fee: € 1.79 Subscription: not needed
		
Het Slimmer Collectief-Uitlezen Admission fee: not needed Subscription: not needed	**Mijn Energieinzicht** Admission fee: not needed Subscription: not needed	**Nieuwe Stroom** Only for energy customers Subscription: not needed

Figure 9: Frequent information in The Netherlands

Data requirements: Participating customers authorise the network operator to forward the daily collected metering data from their smart meter (15 minute readings for electricity and hourly values for gas) to the chosen service provider (energy supplier or other market player).

Customer response and results: Not known yet for most feedback systems presented here. Notable exception is the Energy Monitor of energy supplier Oxxio. Scientific research in 2011 amongst appr. 2,500 of Oxxio's clients for a period of two years, pointed out that clients who used the web application, consumed on average 1.5 % less electricity and 1.8 % less gas compared to other Oxxio clients with a smart meter, but without using the website. Three-quarters of the examined group still visited their personal area on the website after a year to obtain insight into their in-home changes in consumption. The researchers assumed that the savings with new smart meter users would potentially be higher, since the clients that were studied also had a smart meter for a longer period of time, and likely formed part of a select group interested in energy savings.

Assessment of these services:

The 'P4 port' is the standard communication channel for the grid operator. Metering data from the smart meter is sent to a Central Access Server for specific network operations. This port will only be activated for licensed duties and, subject to data protection requirements, specific opportunities, such as for annual billing, the bi-monthly home energy reports and in case of switching supplier or moving house.

The consumer may also choose to have the meter readings forwarded on a daily basis via the grid operator to the energy supplier or an independent service provider for energy management purposes through a personal and secure internet page on the commercial (energy) supplier's website. This type of energy management is only legal if the consumer has signed a contract with the supplying party for the use of metering data. The smart metering services via the P4-port are restricted to deliver indirect feedback by definition, since the metering data are provided to the consumer afterwards (a delay of at least one day).

Smart Metering Services – Real time | Netherlands

Type of supply:	Electricity and Gas
Number of house-holds involved	Not provided. Available in the whole country.
Type of services provided	Several, real time, based on internet gateway devices that forward meter readings in real-time either directly to an in-home display or via the internet-router to a web-based application on PC, tablet or smartphone.
Years of execution and aim	Currently available

Target group: Households.

Description and aim of the services: The smart metering services in this category (pictured below) are based on internet gateway devices, also called 'bridges', that are connected to the P1-port of the smart meter and forward meter readings in real-time either directly to an in-home display or via the internet-router to a web-based application on PC, tablet or smartphone. Most smart metering services represent online energy management systems and offer real-time consumption data as well as additional analysis and graphical presentation options and tailored advice. Apart from visualization of the (real-time) consumption, customized graphical consumption analyses and comparisons to neighbors or other (participating) consumers (benchmarking) are also possible. A contract with the service provider is generally needed for this. Some energy management systems also provide additional (non-energy related) services via the internet, such as weather forecast and remote control for central heating. The consumer interface for such a system could be an in-home display or thermostat (Toon® by Eneco, for example), but in most cases, is a PC, tablet or smart phone.

Toon® - Eneco
Purchase price: € 0 with 4 year contract (else : up to € 275)
Subscription: € 42 / year

E.On EnergieAssistent
Purchase price: € 0 with 3 year contract
Subscription: € 174 / year for non customers

Smile P1 – Plugwise
Purchase price: € 109.95
Subscription: € 12

		
Internet gateway – BeNext Purchase price: € 135 Subscription: -	**Enelogic P1 – Enelogic** Purchase price: € 99 Subscription: € 19 / year	**Delta Comfort Wijzer** Purchase price: € 99 only with Delta contract Subscription: -
		
Aurum Energy App Purchase price: € 199,95 Subscription: -	**Future Power P1 Monitor** Purchase price: € 62,90 Subscription: € 12,10 / year	**Home Wizzard Energy Link** Purchase price: € 319 Subscription: -

		
i-Care Premium – EnerGQ Purchase price: € 79.95 Subscription: € 35 / year	**I-CE - iNRG** Purchase price: € 179 Subscription: -	**iungo - Iungo** Purchase price: € 160 Subscription: -

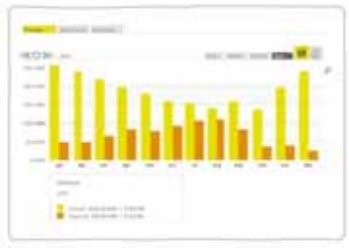
		
SmartBridge - NET2GRID Purchase price: € 49.95 Subscription: € 30 / year	**Qurrent Qbox - Qurrent** Purchase price: € 90 Subscription: -	**Watch-E Portal – Watch-E** Purchase price: € 98.50 Subscription: € 30

Figure 10: Real time services in the Netherlands

Data requirements: Consumers can also directly retrieve meter readings from their smart meter at any time via the P1 port. Metering data is forwarded through the P1 port to an in-home device or web-based application at an interval of once every 10 seconds for electricity and every hour for gas. Smart metering feedback services via the P1 consumer port are direct or (near) real-time feedback, because of the high update frequency for electricity, in particular.

Customer response and results: Not yet known or considered commercially sensitive information for the feedback systems presented here.

Assessment of these services:

A review of the current market supply of real-time smart metring services shows that simpler in-home displays are not yet or hardly being offered. For the time being, most solutions pictured above are aimed at 'high-end' solutions: advanced management systems with detailed analysis and comprehensive graphic presentation options for the most committed consumers. Simpler yet appealing in-home displays for electricity and gas, as a 'stepping stone' channel for less motivated or skilled consumers, are almost absent on the market as yet. Especially less capable consumers might therefore not profit immediately from the smart meter offer. These consumers are generally those in low-income groups, those with minimal education and low levels of numeracy and elderly. These consumers might prefer a simpler local energy monitor as an initial step, in order to be able to save on energy costs successfully. It is therefore important that the market also provides products for low-income groups and consumers who aren't internet skilled.

Smart Metering Services – Real time | UK

Type of supply:	Electricity and Gas
Number of households involved	2 million households to date
Type of services provided	In Home Display communicating directly with smart meter hubs to provide real time and historical consumption data. Different models provided by each energy retailer on point of installation of smart meter.
Years of execution and aim	All consumers with a smart meter installed since 2013

Target group: Households.

Description and aim of the services: As part of the smart metering roll out regulations in the UK every supplier is required to provide the householder with a free In Home Display (IHD) at the same time as smart meters are installed. Each supplier is free to procure their own model and supply a branded product but there is a requirement that all equipment will work with alternative retail supplies in the future. Although the design and display screens vary the information provided must include real time consumption data in both kWh and in monetary terms for electricity consumption and where mains gas is metered updated consumption data every 30 minutes. In addition there is a requirement for views of historical energy use and a facility for budget/target setting. Where consumers are on a pay-as-you-go tariff the IHD will also display credit balances, debts outstanding and status of any emergency credit used.

Installers are expected to demonstrate the IHD to householders as part of the smart meter installation process and provide energy efficiency advice to help consumers reduce bills. The provision of the IHD was included as part of the UK cost benefit analysis with expected energy savings realised by consumers being more knowledgeable and in control of their energy use contributing substantially to the benefits side of the equation.

Figure 11: Real time services in the UK

Data requirements: Real time consumption data in both kWh and in monetary terms for electricity consumption and where mains gas is metered updated consumption data every 30 minutes. This is facilitated by a 'smart hub' usually incorporated within the electricity smart meter this communicates directly with the gas meter, the IHD and is responsible for sending data to the energy supplier. Feedback to the IHD is near instantaneous enabling consumers to see an immediate impact of individual appliances as they are turned on or off.

Customer response and results: recent trail evaluations indicated that energy savings are in the region of 2-3%. Research by Smart Energy GB reports that 80% ofpeople with asmart meter have taken at least onestep to reduceenergy use

Your assessment of the services:

The provision of a free IHD ensures that every household has the opportunity to access smart meter data that can help them to control energy use. The provision of real time information means that feedback is immediate enabling consumers to quickly understand where there are opportunities for energy reduction. Unlike online or phone apps the IHD is available to view by all members of the family not just the named account holder and by displaying in a prominent place the display acts as a constant reminder. Consumers with less technical knowledge and lower numeracy skills may still find interpreting the data challenging but with guidance available at installation it is likely that every household will find at least once screen that they will look at and find useful.

Social Tariff for vulnerable consumers | Spain

Type of supply:	Electricity
Number of house-holds involved	around 2,5 Million
Type of services provided	Demand response and energy efficiency information: special reduced tariff for vulnerable consumers that contract low power (less 3 kW). Saving of 25% compared to the average energy price. Both for smart meter and non smart meter customers.
Years of execution and aim	Currently existing. Aimed at protecting vulnerable consumers and reducing their energy consumption and bill.

Target group: around 2,5 Million households with or without smart meters. The Social Tariff is aimed at vulnerable consumers who can select to consume less power and then receive an incentive of 25% in their energy bills.

The Government requests information to assure that the vulnerable consumer fulfils the requirements and can obtain this service for two years. The consumer has to repeat the procedure to obtain the service after this time.

Description and aim of the services:

The service was established as an innovative tariff in 2014, although it follows the previous "social bonus" which had a similar aim. With the new regulation based on smart metering and hourly energy prices, this service has been created.

The result is that the vulnerable consumer can obtain a 25% saving on their bill if they fulfil the requirements of maximum power installed (lower than 3kW) as well as other situations related to low incomes or families with a big number of members.

The vulnerable consumers, as well as any other consumer, can use also the informative services provided by the national government and energy agency (IDAE), as the "Citizen information service for energy efficiency and renewable energies" to obtain additional information on how they can save more energy.

These information services are announced frequently on their bills through several campaigns (efficient bulbs, efficient appliances, etc.). All available tariffs can be checked to select the most profitable for the consumer at the CNMC website: http://comparadorofertasenergia.cnmc.es/

Figure 12: Electricity and gas tariffs comparison tool in Spain

Data requirements: the main data required is the contracted power and personal details to assure the vulnerable situation of the family living in that specific home. In the case of smart meters, the power should be limited to 3 kW.

Customer response and results:

More than 2,5 million consumers use the social benefits for tariffs, and as it needs to be renewed every two years, that means that an average of 1,25 million customers request it every year.

Considering the conditions for the new social tariff, the benefits will be a 25% reduction on the energy part of the bill, plus additional benefits due to energy consumption reduction by the information provided thought the information systems. Those customers with smart meter will have additional information to better use their energy.

Your assessment of the services: this new commercial tariff allows vulnerable consumers with or without smart meters to pay less. It increases the awareness of how to better use energy; this is a necessary expense for all consumers, and more relevant for the vulnerable ones. As it is supported by the national government, it seems that it will be sustainable in the medium and long term. Additional information for energy saving, using the specific consumer data provided by the smart meters will help to provide better information and tools to save more energy.

The success on the smart metering | Poland

Type of supply:	Electricity
Number of house-holds involved	around 800.000
Type of services provided	Energa-OPERATOR completed the first phase of building the smart metering system. The company is currently conducting a massive meter exchange in all areas of its operation.
Years of execution and aim	2013 - 2014

Target group: The measurement data of more than 800.000 meters are regularly transmitted to a computer system. The company is currently conducting a massive meter exchange in all areas of its operation.

Energa-OPERATOR and its customers are already using the opportunities brought the new smart metering system. In locations where smart meters are installed meter readings, for instance on change of electricity tariff no longer requires a visit by a company representative . Remote procedures for arming and disconnect the meter have also implemented. . Some new tools for customers who already have the new meters installed are activated eg. portal and mobile applications allow for checking daily energy consumption. Furthermore, the system allows checking of the energy consumption of every appliance in the home at any time of the month. This functionality is already available in Kalisz and will be gradually launched in other areas of implementation.

Description and aim of the services:

In the finishing stage of the pilot project, in addition to the meter exchange, more than 1,550 power cabinets have been upgraded and the new data technology (PLC LV and 3GPP / CDMA) has been established and an information system to handle and manage the data from meters was also built from scratch. As the result it is one of the most technologically advanced solutions in Europe in the field of smart metering infrastructure.

An information system built by the Energa Operator company complies with the all requirements of the Polish Energy Regulatory Office and can make energy readings at 15 minute intervals. For the meters used for during testing the data necessary for billing customers are remotely transmitted to the system with the efficiency level of 99%. Initially,

we assumed that system would be considered successful if a 95% effective readings were achieved[1]

The data sent over the meter are encrypted, like bank details and stored in accordance with the Act on the Protection of Personal Data. Access to them is strictly recorded, to make sure that they are used as intended. These data are needed to bill for the actual energy consumption of each customer and to work out individual tariffs and offers, through which customers will be able to save on electricity bills by analysing them.

The energy consumption meters are the property of the ENERGA- OPERATOR. They are part of the infrastructure that allows companies to supply electricity to customers. The exchange of the meters includes all clients. The new tools and services for customers are under development.

Data requirements:

Due to the importance and complexity of the infrastructure and remote meter reading, the standard technical requirements were analysed by the Polish Energy Regulatory Office. The requirements were published, after public discussion.

The elaborated standard technical requirements are thus in effect of a common vision of the Polish Regulator, Operators of the Electricity Distribution System (OSD E), sellers of energy, technology providers and energy consumers . to achieve an effective balance of interests which are sometimes contradictory.

Customer response and results:

The research conducted by the Energa-OPERATOR SA clearly indicates considerable potential for reducing technical and commercial losses through smart grid and smart metering solutions. The company studied the possibility of limiting the amount of the difference in Kalisz and the reduction of technical losses on the Hel Peninsula.

The research carried out in Kalisz 12 months after installation and covering the year 2013 indicates a 10-percent reduction in the ability to balance differences in relation to the year 2012.

This amount it is the sum of the difference of technical losses, resulting from a physical phenomenon accompanying the flow of the energy through the network or mains voltage and commercial losses. The reduction of the balance difference in Kalisz depends on a number of factors, among others, reduction of illegal consumption of the energy, reducing the amount of energy consumed by the measurement system, growth effectively obtained the correct meter readings and the reduction of technical losses. In parallel with the experience of the city Kalisz Energa-Operator also examined the possibility of reducing

[1] interview of Rafał Czyzewski, CEO of Energa-Operator

technical losses themselves on the Hel Peninsula. The pilot project was installed in the area of smart grids solutions. In addition to the meter system (AMI approx. 5000 devices) it was installed here on a remotes power grid monitoring and measurement of the medium and low voltage system. Also a system to manage the operation of the distribution network DMS (Distribution Management System) was fitted.

At the peak load period (summer) the research indicated the possibility of reducing technical losses by up to 9% just by optimizing the layout of the network.

The meters using technology "smart metering" provide to customers, in a clear and legible way, a full range of information about energy consumption and above all how much the used energy will cost. This means that when we have installed the meter at home, we can keep track of how the various domestic appliances affect energy consumption. If we want to consciously manage the energy in your home or apartment we have to know what really uses the most energy- and it will show galloping digits on the meter, eg. after switching on the washing machine or dishwasher or even quietly changing the number of devices in standby mode. "Smart" meter can show us how much we have to pay today and to the end of the month, if there is no change in their behaviour. Smart meters do not save the energy for us, but teach us to be aware of managing our energy and how much we are spending. Having accurate and current information from the meters we have a chance to change our habits.

Your assessment of the services:

The counters based on the technology of "smart metering", enable the payment of the energy consumption in both credit (traditional) and prepayment method. The ability to change the mode of payment without having to replace the meter is a new in the Polish market. For the individual a particularly important role is in the control of energy consumption in a prepayment system (www.licznikiprzedpłatowe.pl), which allows shaping of future energy costs. It give the ability to purchase the energy at any time and any amount.

3.3. Services provided at medium and large scale

"EnergieSpar-Helfer" by EON AG | Germany

Type of supply:	Electricity and gas
Number of house-holds involved	10,000 (9,000 electricity; 1,000 electricity and gas)
Type of services provided	Frequent information to consumer and feedback (historic, benchmark, efficiency information, CO_2 emissions), visualization of key consumption data, real-time information to consumer (In-home Solutions), demand response
Years of execution and aim	2008 - 2010

Target Group: For acquisition purposes it was decided to lower participation barriers for customers, so that willing participants do not have to the change to a specific smart meter tariff. Moreover, the project was subdivided into two parts, a concentrated use in the town of Bad Staffelstein as a simulation for a full rollout (about 5000 PLC based smart meters) and a scattered use in the rest of the network area of E.On Bayern (about 5000 mobile communication based smart meters) (E.On, 2011).

Description and aim of the services: The main tasks and objectives of the 10,000 smart meter program were:

- Evaluation and testing of available smart meters for electricity and gas.
- Conceptual development of the IT landscape for future smart meters systems.
- Implementation and practical testing of IT systems and the integration into the existing system.
- Development and testing of customer service processes.
- Development of smart meter products and service offerings. This includes energy products, but also related services, such as a web portal for the convenient presentation of consumption and cost data, as well as highly sophisticated in-home solutions for consumption transparency.
- Conducting market research studies in order to evaluate customer acceptance and the willingness to pay for the development of new product ideas and benchmarking.
- Evaluation of the impact of smart meter offerings on customer loyalty and brand perception.
- Evaluation of the results and recommendations for future implementations (Achiele, 2013).

The *EnergieSpar-Portal* is an online application, where the customer can log in and track statistics on their total consumption, current and past electricity consumption, cost structure of consumption and their personal CO_2 emission. The smart meter data is transmitted and updated in 15-minute intervals. The application allows customers to view different statistics in the form of tables and charts along various time dimensions. The visualisation of the 15-minute values can be displayed in days, weeks, months and years.
The main challenge of the web portal was the development of a free personalized smart meter application that enables customers to display and track consumption and cost data. The functions included, among other features, the display and visualization of the following values:

- consumption in kWh
- cost/price in Euro,
- CO_2 emission in gram,
- current tariff of the customer

The in-home solution was developed as a pure offline solution with direct access to the smart meters. Thus, it always provides real-time data. There are two variants:

- The *Inhome-PC*: the smart meter data is transmitted wirelessly to the customer's computer and imported by software based on the web portal.
- The *Inhome-Display*: the display device uses the same wireless technology as the PC solution. It indicates consumption and cost data, and is particularly interesting for customers, who do not use a PC. In addition, the display provides information on weather.

The requirements of the in-home solution were defined as follows:

- display of actual power in watt (electricity only)
- display of consumption in kWh (electricity and natural gas),
- presentation of cost in cents / euro (electricity and natural gas),
- presentation of CO_2 emissions (electricity and natural gas),
- presentation of total, average, maximum and minimum values of the above listed measures for different time dimensions (electricity and gas),
- presentation of forecast values, based on existing standard load profiles (electricity only) (Achiele, 2013).

Data requirements: The *EnergieSpar-Portal* uses metering data in 15-minute intervals. The *Inhome PC-Solution* and *Inhome-Display* use real-time metering data for certain functions, transmitted either directly via the customer's home network or by radio communication.

Customer response and Results: The motivation of costumers using the smart meter system are in line with expectations: improve consumption transparency, identify energy-intensive equipment, achieve energy savings. The reasoning against participation were

diverse. A strong argument is the fear that private information could leak out. Therefore, the privacy issue is to be taken very seriously in future implementation.

Also, only a small fraction of customers showed a willingness to pay for the services offered. Therefore, product packages, with integrated smart metering services, are promising. Smart metering should be offered in exclusive product bundles, not as an option to conventional products. The billing of smart meter tariffs should be based on the actual monthly consumption, instead of (prepayments based on) the annual consumption. This way, costumers get a quick and reliable feedback on their current cost development. The number of tariffs and tariff variations should be limited (Achiele, 2013).

95% of participants have an interest in continuing to use smart meter services and expect an offer from their suppliers. Of all respondents, 36.1% say, that they have changed their consumption behaviour strongly and 41.8% say they have changed at least slightly. Overall, participants stated that their power consumption could be significantly reduced by smart meter services (E.On, 2011).

Your assessment of the services: The real-time information and clearly displayed consumption data have a large potential for energy saving. The data accessibility offered by the web-interface, the in-home PC applications, and the in-home display is helpful. Supplementary, value-adding services such as weather forecasts are likely to increase the attractiveness of in-home display units and customer's involvement.

Isernia Project by ENEL | Italy

Type of supply:	Electricity
Number of house-holds involved	around 8.000
Type of services provided	Display the instantaneous power, the tariff band in place and the total energy drawn; display graphs of historical consumption; view the daily and weekly consumption projections; set of personalized consumption thresholds and receive alerts when they reach; alerts; access to administrative data relating to the supply contract; calculate the power draw from any of the devices connected to your home network; receive warnings by the distributor
Years of execution and aim	Smart Info - and dedicated data display interfaces (Smart Kit info) - was delivered to about 6000 BT users of Isernia and 18 municipalities of the province, involved in a pilot project for energy efficiency. Customers have actively participated in the trial, through the community created for the project and the statistical surveys in which they were involved.

Target group:

Consumers and BT customers

Description and aim of the services:

Smart Info works very simply: you can just plug it into any electrical switch in the house. Once inserted and activated, the device is able to communicate with the electronic meter of the house and to download all the data for electricity consumption.

The consumption data, and production at presence of a photovoltaic system, have been made available to the users who participated in the trial of Isernia through different display interfaces (display, PC). The service includes:

- display the instantaneous power, the tariff band in place and the total energy drawn;
- display graphs of historical consumption by day, week, month, two months, and years;
- view the daily and weekly consumption projections estimated about their habits;

- set of personalized consumption thresholds and receive alerts when they reach;
- receive the alert in case of exceeding the contractual power;
- access to administrative data relating to the supply contract;
- calculate the power draw from any of the devices connected to your home network;
- receive any warnings by the distributor;
- display additional information (date, time).

They also had access to more data by some software applications.

- carry out a breakdown of the consumption curves;
- compare the recorded consumption in different time periods;
- export reports in Office format;
- check the average consumption profile;
- receive tips to consume less;
- view the production data and compare them with those of consumption.

Figure 13: Smart Info+ Kit: Enel Smart Info+ Display, Enel Smart Info+ App, Enel Smart Info+ personal web page

Data requirements:

Personal data and the technical characteristics of the provision are requested. The consumption habits are calculated on historical consumption. The average electricity consumption for each day of the week, are displayed using as reference the last 10 days of the same type (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday and holidays). The display stores the data of the last 36 months.

Customer response and results:

Isernia project

Smart Info - and dedicated data display interfaces (Smart Kit info) - was delivered to about 6000 BT users of Isernia and 18 municipalities of the province, involved in a pilot project for energy efficiency. Customers have actively participated in the trial, through the community created for the project and the statistical surveys in which they were involved.

The results obtained from a comparison of consumption of the experimenters (post smart info) with themselves (pre smart info) show that home users have reduced their consumption by an average of 5%, this percentage was higher (8%) in case contractual powers higher than 3 kW. Comparing these variations with those of a control group of households that have not adhered to the experimentation, it appears that the net reduction due to the use of smart Info varies in a range between 2% and 6%. Even in the case of utilities related to small businesses, small and medium enterprises, public buildings for administration, education etc. there has been a decrease in consumption, which on average is equal to 8%. From the comparison with the control group the net reduction values amounted in a range between 2% and 6%.

The telephone survey results conducted to evaluate the popularity of the kit and the effects of the energy awareness kits were satisfactory: a high percentage of the investigators said they better understand their consumption and how they are distributed in the tariff bands (95%), he has given a positive assessment of the kit (95%) expressed satisfaction with the project (89%) declaring himself willing to repeat the experience and stated that the participation would recommend to their friends and acquaintances (93%). 66% of respondents said they continue to use the kit at least once a week even after 6 months of its receipt. The ability to view power consumption in graphical form, to display the breakdown at the times and knowing the instantaneous power were the most appreciated features. Much interest has also been aimed at a passing rate alarms.

About 61% of respondents said they had consumed less by the use of the kit and you change the usage habits of home appliances, while 6% have replaced inefficient appliances.

The results obtained from a comparison of consumption of the experimenters (post smart info) with themselves (pre smart info) show that home users have reduced their consumption by an average of 5%, this percentage was higher (8%) in case contractual powers higher than 3 kW. Comparing these variations with those of a control group of households that have not adhered to the experimentation, it appears that the net

reduction due to the use of smart Info varies in a range between 2% and 6%. Even in the case of utilities related to small businesses, small and medium enterprises, public buildings for administration, education etc. there has been a decrease in consumption, which on average is equal to 8%. From the comparison with the control group the net reduction values amounted in a range between 2% and 6%.

The telephone survey results conducted to evaluate the popularity of the kit and the effects of the energy awareness kits were satisfactory: a high percentage of the investigators said they better understand their consumption and how they are distributed in the tariff bands (95%), he has given a positive assessment of the kit (95%) expressed satisfaction with the project (89%) declaring himself willing to repeat the experience and stated that the participation would recommend to their friends and acquaintances (93%). 66% of respondents said they continue to use the kit at least once a week even after 6 months of its receipt. The ability to view power consumption in graphical form, to display the breakdown at the times and knowing the instantaneous power were the most appreciated features. Much interest has also been aimed at a passing rate alarms.

About 61% of respondents said they had consumed less by the use of the kit and you change the usage habits of home appliances, while 6% have replaced inefficient appliances.

Your assessment of the services:

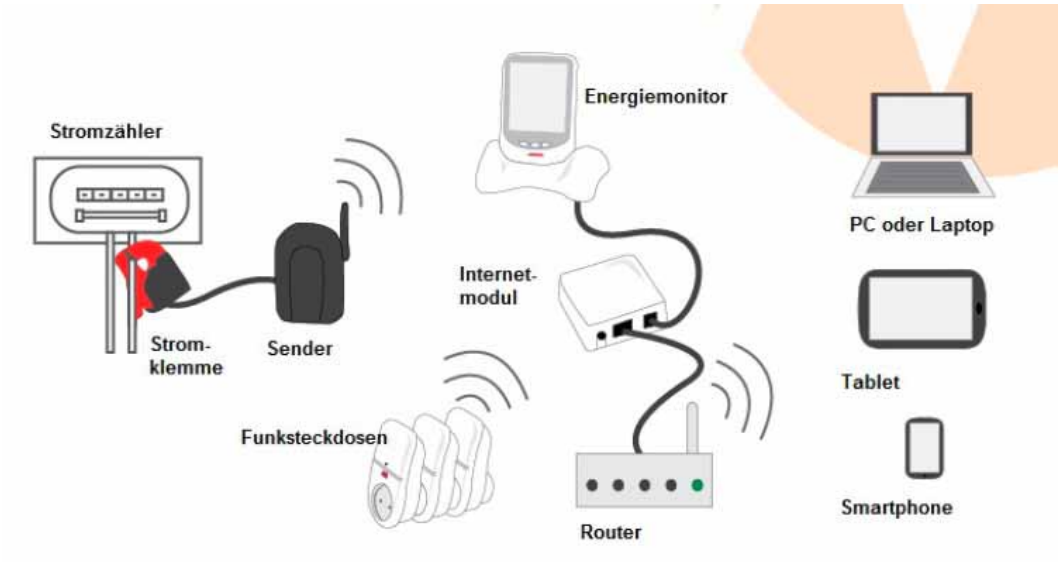
Enel Info+ kit allows you to learn about their habits and understand how to save energy. The in-home display and the apps for smart phones are popular and effective, They have a huge potential, in particular regarding the development of custom services offered by energy suppliers.

Smart Cost Envir Energy Monitor | Germany

Type of supply:	Electricity
Number of house-holds involved	All households in Germany possible (no number of households involved available)
Type of services provided	The Energy Monitor by the company Smart cost allows the reading and visualization of consumption data. For this purpose, the data is either picked up by a current clamp for the Ferraris meter or an optical sensor, which is compatible with the new digital electricity meters. This way the current consumption is sent to the power monitor.
Years of execution and aim	Since 2011 The Energy Monitor shall help consumer to actively manage their energy consumption and thus reduce energy costs sustainably.

Target group: No limitation to the target group because just a connection to the electricity meter is needed. Therefore all households can be seen as the target group.

Description and aim of the services: The current clamp is either clamped to the cable or an optical sensor is adhered to the digital counter and determines the power consumption by the current pulses per kWh which flash on the LED. The optical sensor intercepts the energy consumption data based on the current pulses per kWh and then sends it to the energymonitor.



Features and benefits of the Smart Cost Envir Energy Monitor at a glance

• detection and monitoring of the current energy consumption with cost indication

• Easy to install, but also partner companies handle the installation

• Tracing consumption intensive devices

• With different channels and radio outlets up to 10 measuring points on a single monitor to monitor (total consumption, individual floors and rooms, electrical appliances such as washing machine, refrigerator, etc., heat pumps, cogeneration, supplying the photovoltaic system and much more.)

• Energeniaal software (monitoring of current energy consumption, the temperature and the time by the minute)

- Display of the energy data at the following intervals:
  - o the energy consumption in kWh the previous 30 days in a 2 hour interval
  - o daily reminder of the energy consumption in kWh the last 3 months
  - o monthly display of energy consumption in kWh of the last 84 month

• ELink 2.3 Software:

- presentation and comparison of consumption data
- alarming when reaching set peaks
- Simulation of a two-tariff system and the shift of load peaks

Figure 14: elink: energy monitor in Germany

Data requirements: The requirements for the Wattcher are marginal. The Wattcher consists of three parts: a sensor, a transmitting unit and the display. The sensor and the transmitting unit is attached to the meter. From there a wireless signal to the display is sent to any socket in the household.

Customer response and results: Especially the easy installation process was positively valued by the customer. The public knowledge of the product is rather small which might be linked to the fact that Smart Cost is tending towards industrial consumer. The manufacturer promises energy savings of up to 15%, which cannot yet be proven in practice.

Your assessment of the service: In addition to household products, industrial products are offered by Smart Cost for industrial operations. They should help to raise costumer's awareness for their own consumption and to simplify energy audit according to DIN EN 16247-1.

Energy monitoring systems are available in smart cost shops starting at 70 €. However, the system is not suitable for all users. The existing electricity meter should be checked in advance. Here it should be ensured that the installation of the current clamp is possible.

The product demonstrates very well the own consumption of electricity and if necessary the specific power consumption of individual devices. The switching off of devices is not provided here. The product is mainly used to visualize the power consumption. Positive feature of the energy monitor is the possible export of data as a csv file. Thus an individual data processing and visualization is possible.

Wattcher | Germany

Type of supply:	Electricity
Number of households involved	All households in Germany possible (no number of involved households available)
Type of services provided	With the Wattcher it is possible to check and reduce the power consumption in the household. By identifying the energy inefficient devices, they may be replaced by more efficient equipment.
Years of execution and aim	Since 2009 The Wattcher ensures a better energy awareness by visualizing live data and statistics on energy consumption.

Target group: No limitation to the target group because just a wall socket is needed. So all households can be seen as the target group.

Description and aim of the services: With a small handle a sensor is attached to the electricity meter, which measures the revolutions of the meter and sends it wirelessly to the Wattcher, which is plugged in any socket. Immediately thereafter, the Wattcher shows the current power consumption in real time.

The Wattcher consists of a sensor, a transmission device and a display. Sensor and transmitter are attached to the electricity meter. The display is plugged into anwall socket. The distance from the electricity meter to the apartment should not be further than from the basement to the 3rd floor.

The Wattcher display shows directly what amount of energy is consumed in the entire household at the moment. The display is plugged into an available power outlet and displays the current power consumption.

Source: https://www.wattcher.nl/de/

The display pulsates slowly when the power consumption is low and faster when consumption increases.

The Wattcherdatalogger is part of the energy monitoring and the management of energy data. If the dataloggeris connected to an

internet modem, via Wattcher Online and Mobile Wattcher detailed energy patternscan be seen and for a long time it can be tracked whether savings occur.

Wattcher Online is a supportive online savings program. Here the data is managed and displayed in detailed graphics. Here you will receive a phased program with savings tips and experiences of other users.

Figure 15: Wattcher: frequent information in Germany

In addition to the online version for the PC, there is also the Wattcher Mobile. For all popular smartphone operating systems there is a mobile web page. Positioned in the Center the weekly consumption is displayed, which can be compared to the desired and set consumption.

The Wattcher provides the following functions:

• Current consumption: presentation of the current power consumption in watts

• Daily consumption: display of total consumption of the last 24 hours

• Average daily consumption: Displays the average daily output last 2 months

• Annual savings in euros: Calculates the expected savings from the previous year

• Annual savings in percent: Comparing the average daily consumption with the consumption of last year

Data requirements: The requirements for the Wattcher are marginal. The Wattcher consists of three parts: a sensor, a transmitting unit and the display. The sensor and the transmitting unit is attached to the meter. From there a wireless signal to the display is sent to any socket in the household.

Customer response and results: The Wattchersenjoys customer popularity particular due to the end-customer friendly design and simple handling. Through Wattcher saving energy is a playful experience and tangible by means of visual representation. The manufacturer promises energy savings of up to 30%, which cannot yet be proven in practice.

Your assessment of the service: Wattcher is a very easy-to-install intelligent electricity measuring device which makes it simple for households to measure their electricity consumption in the house or in the apartment. It helps to meet individual electricity consumption goals and helps to reduce by up to 30%.

The Wattcher is currently available for about 90 euros in various shops.

3.4. Services provided to a lower number of consumers and smaller pilots

EnBW Cockpit by EnBW AG | Germany

Type of supply:	Electricity
Number of house-holds involved	around 1,000
Type of services provided	Frequent information to consumer and feedback (historic, benchmark, efficiency information, carbon footprint), real-time information to consumer and feedback (display)
Years of execution and aim	available since 2008

Target Group: The EnBW *Cockpit, iCockpit/DruidCockpit* and *StromRadar* are designed for private customers and are offered as part of a product bundle ("Intelligenter Stromzähler®") in combination with a variable tariff and a smart meter. The product bundle has been available since 2008 in EnBW's supply areas.

Description and aim of the services: *EnBW Cockpit* is an online application, where the customer can log in and track statistics on total consumption, current and past electricity consumption, cost structures for usage, and their personal carbon footprint. The smart meter data is transmitted and updated in 15-minute intervals. The application allows customers to view different statistics in the form of tables and charts, as well as comparing the consumption from different time periods. The visualisation of the 15-minute values can be displayed in days, weeks, months and years. A "bullseye" function allows a comparison of the current day's consumption in reference to the price levels. All data can also be exported to a CSV data file for further analysis. The data for the online application is transmitted from the smart meter to the central EnBW server via the customer's DSL router. In addition to viewing consumption data on the Cockpit, the customer can set reminders and alarms in the form of text messages and e-mails.

StromRadar is a stand-alone software tool that can be installed on the customer's home PC. The software analyses data transmitted from the smart meter directly through the

local network. The data can therefore be transmitted in one-second intervals and analysed almost instantaneously. The *StromRadar* allows customers to recognise the consumption of different appliances, calculate costs and estimate annual consumption. It can be downloaded by “Intelligenter Stromzähler®” customers from the *EnBW Cockpit.*

The *iCockpit* is available for free from the iTunes store and the *DruidCockpit* is available from Google Play Store also for free for customers with the “Intelligenter Stromzähler®” tariff. Both Apps include several functions provided by the afore-mentioned systems, but have the advantage of being available for mobile devices.

Figure 16: EnBW Cockpit and StromRadar: frequent and real-time information in Germany

Source: EnBW Cockpit and DruidCockpit (EnBW 2013)

Data requirements: The *EnBW Cockpit* uses metering data in 15-minute intervals, provided by the EnBW smart meter device. The *StromRadar* and *iCockpit* and the *Druid-Cockpit* use almost real-time metering data for certain functions, transmitted directly through the customer's home network and not recorded or received by the utility.

Customer response and results: The three systems described above are expected to contribute to, both, energy saving (the real-time function is intended to help customers identify appliances with a high consumption) and load-shifting (the feedback systems are only available in combination with a variable tariff).

EnBW AG carried out a smart meter pilot with 1,000 customers, using smart meters and the three systems described above. Results on the load-shifting and reduction that took place were not published, but feedback from the participants showed a high level of satisfaction. Individual participants explained that they were able to identify appliances with a high consumption as well as recognising times of high consumption in the household.

Assessment of services: The EnBW AG services provide customers with detailed information in a simple and understandable layout. The possibility of viewing consumption in terms of cost and carbon emissions is important factors, which will lead to the customer adjusting consumption on the long-term.

The options of sending text messages and e-mails or of accessing data using a smart phone also contribute to the sustainability of the system. There is still room for improvement. However, - the services are currently only offered in combination with a variable tariff with just two price categories.

"eWave" in-home display pilots | Norway

Type of supply:	Electricity
Number of households involved	91 households in Follo (Eastern Norway) and Askøy (Western Norway)
Type of services provided	Piloting new Norwegian in-home display "eWave"
Years of execution and aim	The pilot started in 2010 and was completed at the end of 2012.

Target group: Households, with primary focus on detached houses.

Description and aim of the services:

The goal of the pilot was to identify ways of increasing customer awareness of their own electricity consumption, and to thereby encourage them to reduce their consumption.

A new prototype of the new Norwegian in-home display "eWave" was tested in the pilot. eWave offers different dis-play options (e.g. graphs or a speedometer) to present electricity consumption and energy costs. The display communicates wirelessly with a pulse meter connected to the electricity meter. A smart meter is not required. The display is connected with the internet using the household Wi-Fi (WLAN) network. This allows the service provider to send messages to the customer via the in-home display.

Some technical start-up problems were experienced, but have since been resolved. A new version of the display will be released in 2013. The in-home displays were offered by the power retailer (Fredrikstad Energi/Askøy Energi) in combination with an energy contract. The power retailer paid for the in-home displays used in the pilot.

91 displays were installed in customer households for the pilot study: 47 in Askøy and 44 in Follo. Three customer surveys were carried out during the one-year test period. The surveys were distributed to the participating customers before the installation of the in-home display, then three months after the installation, and finally at the end of the pilot. An additional two surveys were carried out with a control group of 42 households.

Data requirements: An electricity meter with a LED pulse.

Customer response and results: The participants saw the displays positively and not as a disturbing factor in their day-to-day lives. This is presented in Figure with a large part of agreed or strongly agreed regarding the help from the display related to making environmental considerations, saving money and saving electricity. A large part disagreed or

strongly disagreed with the statement that the display was a disturbing factor during the day.

In all three surveys the participants answered questions on their electricity consumption habits (see Figure 2). A large share of the households turned appliances and lights off when not using them or if they were not present. A smaller proportion of households reduced the indoor temperature when going out or during the night. This indicates that the customers were more focused on “visible” consumption, despite more electricity is used for heating.

The changes in the electricity consumption in the pilot study, compared to historical consumption, are presented in Figure 3. The curves represent maximum and minimum consumption for the different periods. The columns represent the average consumption for all the customers included. Since some problems were experiences related to the displays, only customers with a well-functioned display for a longer period have been selected. The figures present the results from 19 households with a working display for 6 months and 11 households with working displays for 8-13 months. Compared to the same periods in the years before the pilot, the reduction was 7.5% for 19 households for 6 months and 5.9% for 11 households for 8-13 months. The results include households from both Askøy and Follo. The results are corrected for different temperatures and locations. There is already a reduction for the two previous years, so it is an uncertainty related to how this descending trend would have been without the display.

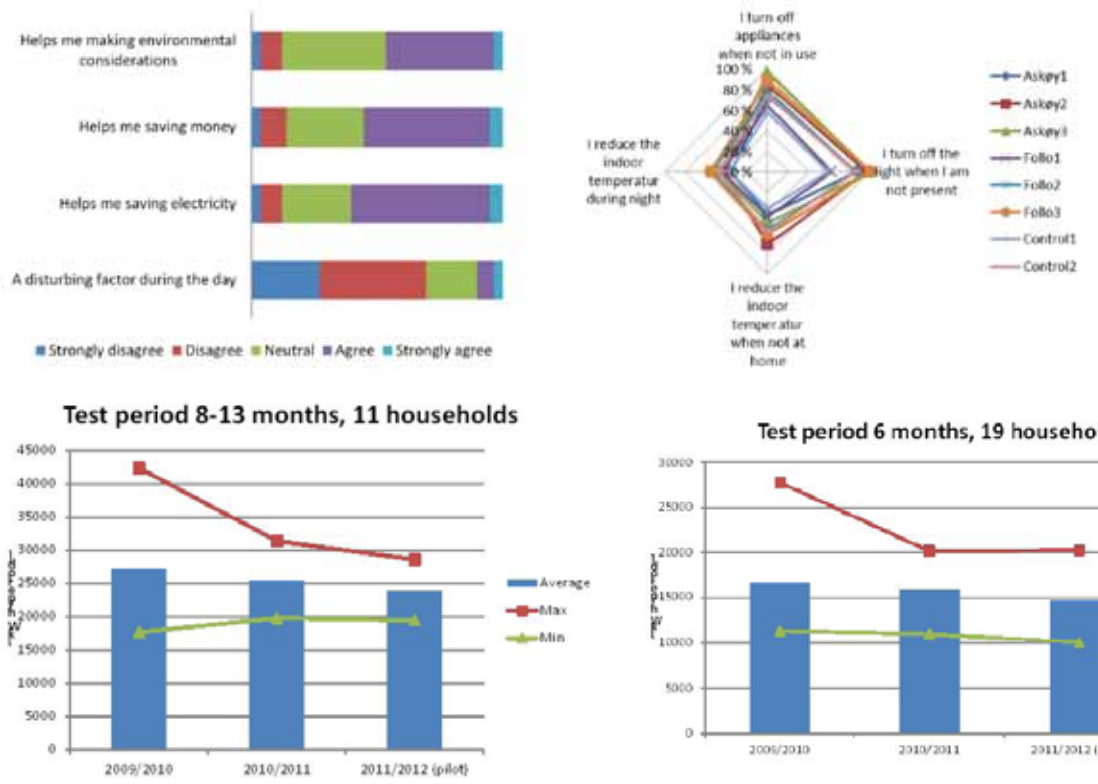


Figure 17: eWave in-home display real time information: results in Sweden

MoMa – Modellstadt Mannheim by MVV | Germany

Type of supply:	Electricity
Number of house-holds involved	1,500
Type of services provided	Frequent information to consumer and feedback, real-time information to consumer, demand response: flexible tariff choice, smart home application
Years of execution and aim	2009 - 2012

Target Group: Customers of the MVV Energie AG in Mannheim. In the third part of the MoMa-project residents of Mannheim were selected, who produce energy themselves.

Description and aim of the service: The MoMa project consists of major three parts:

Part 1 Intelligenter Stromzähler (October 2009 to September 2010): The aim of the first practical tests was to improve the technical stability of the system, the installation and the operating procedures in respect to the following field tests. The first test also gave a first idea of consumption and behavioral changes in response to increased information and transparency levels (MVV, 2013).

Part 2 Flexibler Stromtarif (October 2010 to July 2011): In the second Part, more than 200 households were equipped with a Smart Meter that enabled their inhabitants to easily track the consumption data of their home. Later *Energiebutler* were installed in more than 100 households in order to establish a secure connection between consumers and network operators. In addition, the use of a special MoMa Bonus Tariff was tested. The intention is to give customers an incentive to shift their use of electricity to off-peak periods (MVV, 2013).

Part 3 „SmarTest Energiebutler" (Mars 2012 to October 2012): The aim of the third part was to obtain knowledge about the extent, to which customers can help increasing energy efficiency and integrating renewable energies into the grid. For this purpose, smart meters and *Energiebutlers* were installed in about 700 households with renewable energy systems. Furthermore, a flexible tariff model was introduced, which allowed costumers to shift from one tariff to another depending on their current consumption. A website provided, inter alia, detailed information on power consumption and the current tariff and thus, ensured a high cost transparency. The *Energiebutler* supported the participants by starting electronic devices automatically, if the price of electricity is low (MVV, 2013).

Data requirements: The smart meter data is updated every 7.5 minutes. From the received data a 15-minute value is calculated. This is done by means of a linear interpolation. In addition, a value per hour is stored with the corresponding time stamp.

Customer response and results: The participating households responded to the variable electricity prices. The power consumption was not only lower but also shifted to periods, where the price of electricity was below average. The prime motivation of the participants was the prospect of cost savings. Other motivational factors were the contribution to climate protection and the expansion of renewable energy sources.

Assessment of service: The combination of a flexible, daily changing tariff and an assistance system for consumption control has a great potential for energy saving. The ability to integrate self-generated energy in the system is of great importance in terms of future smart grid systems. Of particular advantage is the simple overview of the current consumption of individual devices and the display of the current and future tariff. The MoMa project is primarily designed to develop a smart grid that integrates renewable energy in a decentralized system. The project itself, therefore, goes far beyond the use of smart meter systems.

Personal EnergyTM in Rubí Brilla Community | Spain

Type of supply:	Electricity
Number of households involved	150
Type of services provided	Frequent information to consumer and feedback (historic, benchmark, efficiency information, targets), real-time information to consumer and feedback (display and consumption curves), notifications and weekly reports with energy related content (change of tariffs, recipes to cook without using energy, recommendations…), gamification tools including common causes, medals and points.
Years of execution and aim	2013-2014. Pilot project to test the Personal Energy™ service, which is aimed to use the information provided by the smart meters

Target group: Rubí households. The Project *Rubí Brilla Domèstic* aims to improve and meet the European Energy target of the 20/20/20 in the residential sector. The main action has been the implementation of a pilot project in order to understand the energy behaviour of its households and develop an energy map of the city to tailor energy savings measures and recommendations. This pilot project is based in the installation of an energy monitor provided by Cliensol-Current Cost in each of the 150 households and the access of each user to the multiplatform Personal Energy™ provided by Enerbyte.

Description and aim of the services:

Personal Energy™ aims to reduce energy consumption in the household sector by 10%. There are several reasons to trigger a change of behaviour for a better consumption of resources and the solution aims to find out which are the motivations of each consumer to promote a better energy usage in the residential sector by driving pro-saving behaviours.

Personal Energy™ is a multiplatform cloud based product composed by Web, App, online and off-line reports and Newsletters has been chosen in order to reach all the possible user's profile to different extents.

Business intelligence and data analysis allows to personalize and improve the users engagement accompanying the user in his/her way towards an energy efficiency behaviour. Last, but not least, some algorithms provides useful insights about how the energy is consumed that priorizes the different type of energy saving measures.

The main services provided by Personal Energy can be summarized as:

- Energy efficiency advice and other energy related content in order to empower the consumer in his/her path towards the energy efficiency.
- Historic energy consumption information (such as comparison of energy consumption with earlier periods).
- Benchmarking of the customer's consumption against the consumption of households with similar characteristics in order to apply peer-pressure strategies.
- Disaggregation of the consumption in different types of usages (appliances, cooking, lighting…) in order to better understand where consumers can improve and tailor recommendations and messages.
- Customer engagement using targets to reduce the electricity usage (both individual and cooperative) and gamification tools (badges and points)
- A section to ask, answer and comment any energy consumption doubt in order to trigger the use of Personal Energy™ and to give a social perspective to the understanding of the energy consumption and the topics related to it.
- Obtaining different clusters of users in order to better tailor the advices, notifications and improving the understanding of the residential electricity consumers.
- Real-time display (RTD) curve which shows the energy use by days, months and;years, maximum and minimum values and forecast the energy consumption at the end of the period.
- Internal temperature shown in the consumption curve in order to relate the cooling and heating consumption to the electricity usage when possible.

Figure 18: Personal Energy™ reports and energy saving plans

Data requirements: the electricity consumption from each household is needed in order to offer the best possible services and an energy monitor (Envir from Current Cost) was installed in the households participating in the project in order to obtain data from the electricity usage every five minutes.

The service is prepared to use the hourly information from the smart meters.

Figure 19: Personal Energy™ in the web, tablet and smart phone

Customer response and results: During the project implementation, a difference between users who used the multiplatform Personal Energy™ (Active users) and households who did not use the multiplatform (Passive users) was detected. Therefore the saving and analysis of the results are differentiated between this two kind of users.

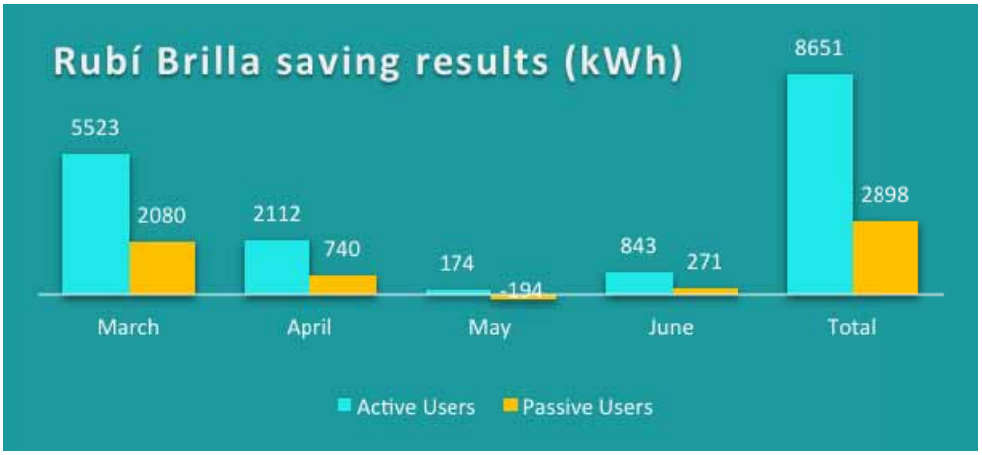
- **Saving results for active and passive users.** Active and Passive Users statistics are presented in the table below. Subjects from the sample due to incomplete

historical data (necessary to quantify the saving level) and corrupted data received from the monitoring device have been discarded.

Number of users	Active Users	Passive users	Total	Population
March	42	40	82	106
April	51	36	87	113
May	48	34	82	116
June	48	35	83	145

Energy savings	Active Users	Passive users
March	23%	5%
April	13%	8%
May	1%	-2%
June	6%	3%

Table 4: "Rubí Brilla project: number of users involved and energy savings compared to the previous year



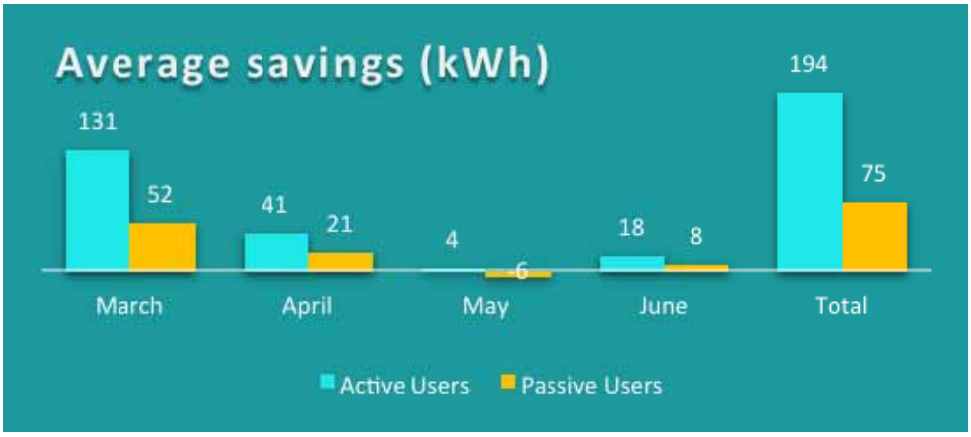


Figure 20: "Rubí Brilla" savings results

- **Statistics of use**

  Average of people accessing the web more than twice a month: 57%

  Average Newsletter open rate: 67%

  Actions that require less proactive behavioural response, e.g. reading the newsletter, have proved to be effective in reducing access barriers to information, reaching an average ratio of 67% in channel impact, higher than the web access average.

- **Community engaging level.** In the period range from March to June, there were 738 interactions with community (visits, questions, responses and comments and votes).

Your assessment of the service: Personal Energy™ is a cost-effective solution to achieve energy efficiency in the residential electricity sector. The importance of the data usage raises the need to involve utilities in providing the own energy consumption data to consumers, preferably from their smart meters. If an energy monitor (display) is required in each household, the large scale implementation of solutions like Personal Energy™ has got drawbacks and the economic feasibility of the Project is not so clear. Therefore, the data requirements should be fulfilled by the European smart meter roll-out which is taking place in most of the countries and in this scenario, the solution Personal Energy™ can be easily scaled and extended to a great share of the European residential electricity consumers.

Smart Metering Trials | Netherlands

Type of supply:	Electricity and Gas
Number of house-holds involved	5.000
Type of services provided	Several. Frequent information to consumer and indirect feed-back via bi-monthly home energy reports, provided by the energy suppliers. Real-time feedback systems provided by other service providers in the market.
Years of execution and aim	2012 to 2013, pilots to deliver evidence for the energy effi-ciency potential of smart metering and balanced decisions on the actual rollout of smart meters.

Target group: The target group are consumers.

Description and aim of the services: Following similar national customer trial programs in the UK (EDRP) and Ireland (CBT) as described in the previous sections, the Nether-lands performed a series of smart metering services trials in 2012 and 2013 to deliver evidence for the energy efficiency potential of smart metering and to contribute to bal-anced decisions on the actual rollout of smart meters. The monitoring programme re-ported on the actual energy savings of households with a smart meter and a bi-monthly home energy report provided by the suppliers on the one hand and the potential energy savings of households using alternative feedback interventions with the smart meter on the other hand.

Data requirements: not provided.

Customer response and results: Quantitative research pointed out that a representa-tive selection of approx. 750 households with smart meters and bi-monthly home energy reports used 0.9 % less gas (significant at the 95% level) and 0.6 % less electricity (non-significant) after a full consumption year, compared to a control group of 50,000 house-holds without a smart meter. It was noted with this consumption change effect that the households in the experimental group did not yet have access to the final intended home energy report, in which a historic cost comparison to the same consumption period in the previous year is presented. Therefore, a conclusive evaluation regarding the actual effectiveness of savings was not possible at that time.

Based on literature reviews and a suit of trials to investigate consumers' response to improved energy feedback via smart meters, it has been concluded that smart metering in combination with direct feed-back, in particular, can lead to a considerable household energy reduction.

Scientific pilot research by network operator Liander, with an energy management app for smart phones amongst home-owners, showed average savings of 3 % for electricity and 4 % for gas.

Another trial by network operator Stedin, housing corporation Woonbron and the City of Rotterdam, testing the consumption effect of an in-home energy dashboard amongst households in the low rental segment, delivered average savings of 5.6 % for electricity and 6.9 % for gas. Whether households with smart meters and direct feedback interventions will be able to meet the average savings of 6.4 % for electricity and 5.1 % for gas as mentioned in the national cost-benefit analysis, deserves a cautious answer of 'yes, on condition that...'

The smart meter can provide better information with direct and personal feedback, in particular, and this information can result in similar savings to those expected. However, the pilots also indicate that the savings are only persistent if the feedback medium matches the user's practical preference, and if the functionality and data presentation are tailored to the consumer's interests and capability for reinforcement and habit formation with the feedback system (i.e. daily bedtime check). For this reason, more sophisticated web-based services may stand a better chance of succeeding amongst a subset of consumers who are already committed to energy saving and are technology-oriented. The extensive data analysis and graphic presentation options, in combination with the ease of use associated with online media such as PCs, tablets or smart phones, provide the required added value for persistent use of the web tool. However, consumers with less commitment or less technology-orientation, more often experience such systems as too complex or too demanding for reinforcement and routine use. These consumers actually prefer the accessibility of a simple yet visually appealing physical in-home display. In fact, for older people, those with minimal education and low levels of numeracy and computer illiterates, for example, an in-home display will be a crucial first step to achieve consumer interest and engagement in accessing energy information from the smart meter. The interface design and the interaction within the household also play an important role in reinforcement and habit formation with the monitor.

Assessment of service: The Netherlands Enterprise Agency oversaw the pilot programme on behalf of the Ministry of Economic Affairs. As part of this work, NLA was also responsible for monitoring market developments of smart metering services.

Trio smartbox Display by EWE AG | Germany

Type of supply:	Electricity and Gas
Number of house-holds involved	n/a
Type of services provided	Frequent information to consumer and feedback, visualization of key consumption data, real-time information to consumer
Years of execution and aim	since 2011

Target group: The *trio smartbox* display was developed by EWE and has been available for purchase since February 2011. The target group are private customers.

Description and aim of the services: The display is part of a product bundle, including a smart meter, an internet portal and a variable tariff with two price categories. It is marketed as increasing the transparency of household energy consumption.

The product bundle is available in two variations – a bundle for electricity tariffs and a bundle for electricity and gas combined. The *trio smartbox* display has a colour screen with 320*240 pixel resolution and integrated system software (EWE, 2014).

It communicates with the gateway via M-Bus. The display can visualise the load in watts as well as the energy consumed within the last 15 minutes in kWh. It also shows the real-time consumption, the costs of energy consumption and CO_2 emissions for hourly, daily or monthly periods.

The consumption data is visualised using a bar chart, subdivided by the different price levels. The daily average consumption and the average weekly consumption can also be viewed.

A separate online portal allows customers to compare annual consumption data with reference households or previous values.

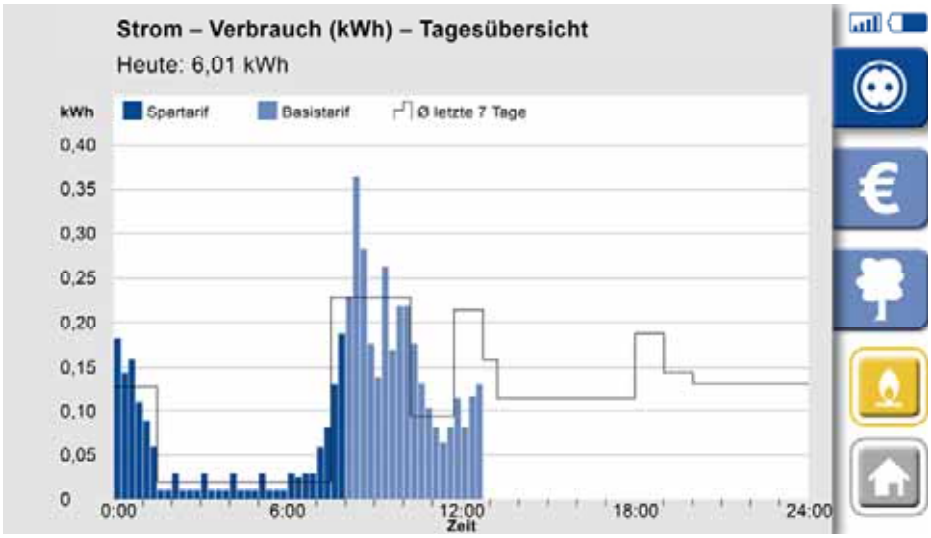


Figure 21: Trio smartbox Display for frequent and real-time information by EWE AG in Germany

Source: Trio smartbox (EWE, 2014)

Data requirements: The *trio smartbox* is provided together with a smart meter, which provides real-time data for electricity and hourly data for gas.

Customer response and results: The customer can respond to feedback from the display by shifting (the costs for the relevant time category are illustrated on the display) or reducing (the real-time feedback allows users to identify appliances with high levels of consumption) loads.

Before the product was released, EWE carried out a field test with 400 households. According to EWE, the increased transparency of the electricity and gas consumption led to a 10% reduction in consumption on average.

Assessment of service: The *trio smartbox* is an easy to use display offering many possible ways of analysing energy consumption. It does not only cover electricity consumption, but also accounts for gas consumption. Therefore, it seems to provide strong incentives to save energy or to shift loads. The portable display would seem to lend the product particular additional sustainability and serve as a more present reminder to customers to shift or reduce loads. The disadvantage of the *trio smartbox* would appear to be the price (the display costs €79 and the installation of the smart meter costs €99), which could be a reason why only about 200 customers ordered the product in its first year on the market.

4. List of References

Estonia:

- EUROPEAN COMMISSION: https://webgate.ec.europa.eu/fpfis/mwikis/essnetbigdata/index.php/WP3_Minutes_1
- ENERGIA: https://www.energia.ee/en/avaleht
- ELERING: http://elering.ee/estonian-data-hub/
- ENERGIA: https://www.energia.ee/en/elektripaketid

Finland:

- ASEMA: www.asema.com
- Vattenfall: http://www.vattenfall.fi/fi/energywatch.htm, http://www.vattenfall.fi/fi/smart-plug.htm
- Fortum Fiksu: http://smarthomepartnering.com/en/node/151

General:

- EY*:* http://www.ey.com/Publication/vwLUAssets/ey-electric-smart-metering-market-overview/$FILE/ey-mai-2016-etude-compteurs-intelligents.pdf

Italy:

- ENEL: http://www.enel.it/it-IT/reti/smart_info/progetto/
- ENEL: http://www.enel.it/it-IT/reti/smart_info/
- AUTORITA ENERGIA: http://www.autorita.energia.it/it/operatori/smartgrid.htm
- AUTORITA ENERGIA: http://www.autorita.energia.it/allegati/operatori/elettricita/smartgrid/Enel_finale.pdf

Nordic countries:

- ENERGIMARKNADSINSPEKTIONEN: http://www.energimarknadsinspektionen.se/Documents/Publikationer/nordisk_slutkundsmarknad/THEMA_R-2015-03_Framework_for_DR_and_MP.pdf
- NORDIC REGULATORS: http://www.nordicenergyregulators.org/wp-content/uploads/2013/02/Common-Nordic-Metering-Methods.pdf
- NORDIC REGULATORS: http://www.nordicenergyregulators.org/wp-content/uploads/2015/03/NordREG-Status-report-to-EMG-2015.pdf

- NORDIC REGULATORS: http://www.nordicenergyregulators.org/wp-content/uploads/2016/02/NordREG-Discussion-of-different-arrangements-for-aggregation-of-demand-response-in-the-Nordic-market.pdf
- NORDIC REGULATORS: http://www.nordicenergyregulators.org/wp-content/uploads/2016/07/NordREG-Status-report-to-the-EMG-2016.pdf

Norway:

- NVE: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/ny-teknologi-og-forbrukerfleksibilitet/
- NVE: http://smarthomepartnering.com/en/node/151https://www.nve.no/electricity-market-and-regulation/retail-market/smart-metering-ams/

Portugal:

- InnovGrid: http://www.edpdistribuicao.pt/pt/rede/InovGrid/Pages/InovGrid.aspx

Spain:

- CNE, Social Tariff: http://www.cne.es/cne/contenido.jsp?id_nodo=407&&&keyword=&auditoria=F
- Gas Natural Fenosa: www.unionfenosadistribucion.com
- Iberdrola distribution: www.iberdroladistribucionelectrica.com

Sweden:

- MDPI: http://www.mdpi.com/2079-9276/5/1/3/pdf
- EON: https://www.eon.se/privat/for-hemmet/100koll.html
- SWEDISH SMART GRID: http://swedishsmartgrid.se/wp-content/uploads/2016/04/swe-day-smart-city-week-23-okt-k-widegren.pdf

5. List of figures

6. List of tables

7. Abbreviations

AEA	Austrian Energy Agency
AISFOR	Agenzia per l'Innovazione, lo Sviluppo e la Formazione
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
AMM	Automatic Meter Management
CBA	Cost Benefit Analysis
CFEA	Benet Oy / Keski-Suomen Energiatomimisto
CSE	Centre for Sustainable Energy
DSO	Distribution System Operator
EED	Energy Efficiency Directive
ESCAN	Escan,s.l.
EV	Electrical Vehicles
EPBD	Energy Performance of Buildings Directive
GSM	Global System for Mobile Communication
HV	High Voltage
IEE	Intelligent Energy Europe
IHD	In-Home Displays
KAPE	Krajowa Agencja Poszanowania Energii S.A.
LV	Low Voltage
PLC	Power Line Carrier
MV	Medium Voltage
REEM	REE Management GmbH
RES	Renewable Energy Sources
RVO	The Netherlands Enterprise Agency
TSO	Transmission System Operator
USMARTCONSUMER	You are a Smart Consumer Project