D1.4 – Smart grid roll-out and access to metering data: state-of-the-art

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List of Abbreviations

Abbreviation	Description
WP	Work Package
Partner Abb.	Description
VUB-IES	Vrije Universiteit Brussel – Institute for European Studies
BLP	Blue Planet AC
UU	Universiteit Utrecht
RES	Resourcefully
SVT	University of Bergen, Centre for the Study of the Sciences and the Humanities
ENR	Enerbyte

1. Introduction

The European Union (EU) has set ambitious energy policy objectives to achieve by 2020; such as reducing carbon footprint, increasing energy efficiency, high penetration of renewable energy sources, among others (COMMISSION, 2010). Essential to the achievement of those targets is the transformation of Europe's conventional electricity grids into the so-called "smart grids" that ensure a bidirectional flow of electricity and information between power plants and end-consumers, and all points in between (Farhangi, 2010). This move will strongly aid the achievement of the EU's energy objectives and bring us into a more sustainable and competitive energy future.

Roll out of smart metering systems is at the core of this transformation since smart meters play an important role in monitoring the performance and the energy usage characteristics of the load on the grid, and have the potential to empower consumers to take a more active part in the energy system (Farhangi, 2010). Under the EU Third Internal Energy Market package (Council, 2009), adopted in 2009, at least 80% of customers should be equipped with smart meters by 2020, unless a different decision is taken by a member state based on the results of a Cost-Benefit Analysis (CBA). This will essentially lead to an active participation of end-consumers in the electricity market beyond existing liberalisation of suppliers to households.

Smart meters provide more information than conventional meters. They are capable of measuring energy consumption, as well as transmitting and receiving data using a form of electronic communication (EU, 2012). Smart metering systems allow end consumers to be energy efficient users by providing them with accurate and more frequent information on their own electricity consumption. Consumers can adjust their habits to use more electricity during off-peak hours in order to lower their electric bills. Smart metering systems can also provide benefits to utilities through an automated and remote meter reading. When smart meters are implemented in a particular environment, they may account for reduction of the distribution network operation and maintenance costs, while effectively integrating distributed generation, electric vehicles and energy storage (Farhangi, 2010; Barai, Krishnan, & Venkatesh, 2015).

Concerns about the development of smart metering systems are not new. Several regulations, directives and recommendations have been issued at a national and international level with the aim of modernizing the measurement of consumption and power generation. For instance, the directive 2009/72/EC states that consumers should be given access to their consumption data and the electricity pricing tariffs without any additional cost (Council, 2009). In fact, the main concern is regarding the handling of the large quantities of consumers' energy consumption data becoming available through the uptake of smart meters. Directive 2012/27/EU states that smart metering systems must comply with the applicable safety standards related to data transmission equipment and systems, as well as with requirements connected with the privacy of end users (EU, 2012). This requires proper regulation of the access to electricity consumption data (who can access it, what costs are associated with it, and so on) and its exchange between agents (who owns the data, who is obliged to share it and who should not be given access it, how the privacy of users can be protected, etc.) (Leiva, Palacios, & Aguado, 2016). In addition to those regulations, the type of information accessible and the frequency with which it is provided should be standardized (Reddy, Kumar, Mallick, Sharon, & Lokeswaran, 2014). The increased data flow means more opportunity to make use of data, opening the door for new products and services, and creating a new framework for competitiveness and business models for customers, resellers, demand and generation consolidators, etc.

The EU-funded project PARENT (PARENT, 2016) aims at using the energy consumption data gathered by smart meters to answer the pressing needs of more efficient energy management. The project expands an innovative participatory energy management platform, targeting home electricity consumption in four targeted cities: Amsterdam, Bergen, Barcelona and Brussels. The platform is built on an existing software-based solution that has been developed by a project partner Enerbyte (Salas-Prat, Zelco, Carrasco, & Segura, 2014) and it will be enhanced into an open, extensible, reusable, socially acceptable and marketable platform, incorporating real-time energy information, novel gaming and other reward mechanisms to achieve energy efficiency through stimulating behavioural change. It is expected that this project will provide a set of practical recommendations on how such a platform would contribute to the increase of energy efficiency at local, regional, national and European levels.

To help PARENT achieve its goals, it is fundamental to study the current status of smart metering systems roll-out and metering data access models in Europe, mainly in the four targeted countries, focusing on how a third party platform will be integrated in the current systems deployed and highlighting the main barriers and directions for further steps.

In this study, we start by providing an overview on smart electricity metering systems, the main applications and advantages, and the critical challenges that are facing their deployment in Section 2. After that, the roll-out of smart electricity meters in Europe is investigated in Section 3. Particularly, the roll-out of smart meters in the four European countries participating in the PARENT project is surveyed. Then, we study the smart metering data management and data access models in Europe focusing and comparing the status in the four targeted countries in Section 4. Section 5 concludes the report and provides directions for future steps.

2. Smart Metering Systems

2.1. SYSTEM ARCHITECTURE

A smart metering system typically includes a smart meter, communication infrastructure, and control devices. A smart meter is an advanced digital electric meter that measures and collects the consumption of electric energy and other related information from a consumer in intervals of an hour or less, and communicates that to the utility company for monitoring and billing. Consumers can know in real time (i.e., via an in-home display connected locally to the smart meter) how much and how the energy is being used. This feature makes decision-making most simple and intuitive. A smart meter provides utilities with a two-way communication system, as well as the ability to modify customers' service-level parameters. Through smart meters, utilities can meet their basic targets for load management and revenue protection. They can not only get near-instantaneous information about individual and aggregated demand, but they can also impose certain caps on consumption, as well as enact various revenue models to control their costs (Farhangi, 2010).

Smart meters incorporate detailed energy measurement functions with integrated communications. For instance, they can be used to monitor and control all home appliances and devices at the customer's premises. They can also collect diagnostic information about the distribution grid and communicate with other meters in their reach. Smart meters can be programmed such that, only power consumed from the utility grid is billed while the power consumed from, for instance, the distributed generation sources or storage devices owned by the customers are not billed (Depuru, Wang, & Devabhaktuni, 2011). In the following section, we will present in more details the main applications and advantages of smart meters.

2.2. APPLICATIONS AND ADVANTAGES:

According to the smart metering roll-out plans of the EU Member States, it can be observed that the implementation of smart metering systems will provide a number of benefits to the consumer, the utility and to the society as a whole. In this section we will present the main applications and advantages of smart electricity meters, which are also depicted in Figure 2.1.

2.2.1. Appliances scheduling

Smart meters can be used to monitor and control all households' appliances and electric devices including light, heat, air conditioning, washing machine, among others. They can be programmed to maintain a schedule for their and possibly find the best schedule that benefits the households; such as to achieve cost savings, to work on renewable energy sources and storage units, among others. A smart meter could be programmed by the household and/or it can be connected to a central control station at the utility company that directs the smart meter to control the households' appliances based on the preselected schedule for operation. Moreover, in demand dispatch systems (Brooks, Lu, Reicher, Spirakis, & Weihl, 2010), consumers can define their demand flexibilities and submit them to the utility side which in turn maintains an execution schedule, under consideration of the most beneficial exertion of the demand flexibilities.

The availability of the detailed consumption data will create significant new opportunities to companies in offering services and products on appliance diagnostics, more refined automation of heating and hot water controls and the analysis of heating patterns (Covrig, et al., 2014).

2.2.2. Detection of frauds

Electricity theft severely affects genuine customers and utility companies. The integration of smart meters helps utility companies in detecting unauthorized consumption and electricity theft, not only for the billing issues but also for improving the distribution efficiency and power quality. Smart meters can be designed such that they can control illegal consumers from bypassing or tampering with the meter (Depuru, Wang, & Devabhaktuni, 2010). Moreover, the two-way communication can allow utilities to remotely disconnect meters not only in cases of fraud or unpaid bills but also in emergency situations (e.g. risk of a black-out) (Depuru, Wang, & Devabhaktuni, 2011).

2.2.3. Efficient metering data collection

The two-way communication enables automatic, remote (instead of manual) meter readings for utilities. This saves the tedious and expensive manual reading efforts in conventional metering system, and enables utilities to send regular accurate bills based on actual consumption.

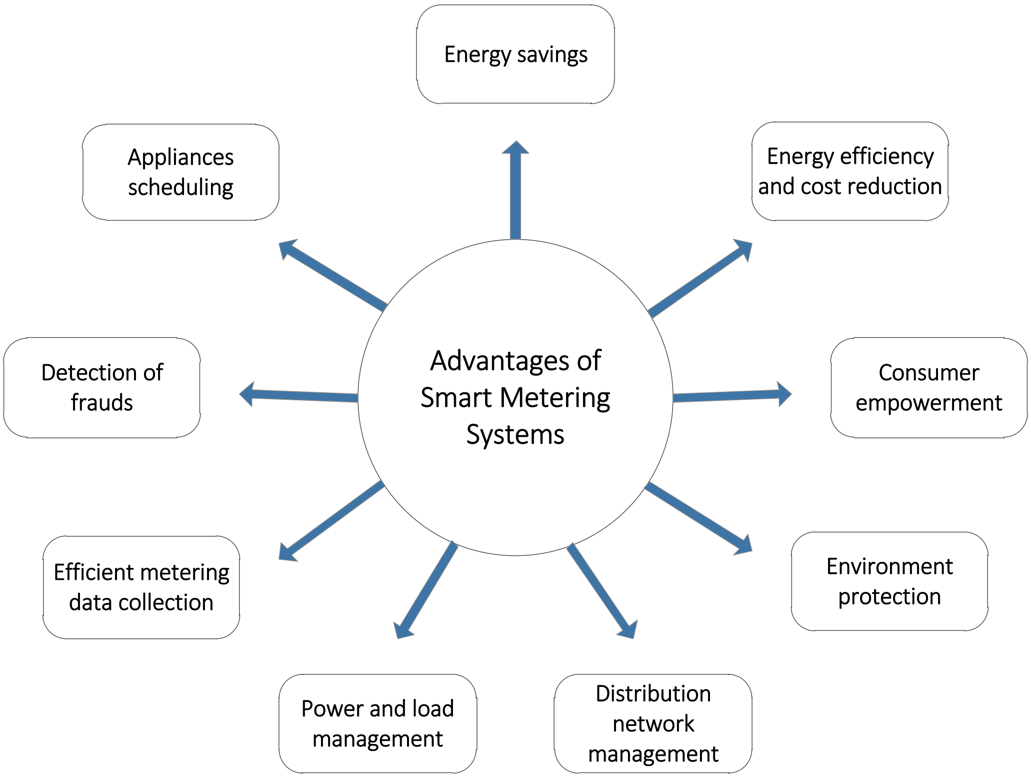

Figure 2.1: The advantages of smart metering systems.

2.2.4. Energy savings

In most of the EU Member States, the energy saving potential has been one of the strongest drivers towards adoption of smart metering systems (Covrig, et al., 2014). Deployment of smart metering systems does not automatically lead to energy savings; nevertheless, effective use of smart meters by consumers could bring fundamental benefits. The frequency at which consumption data can be updated and made available, will support advanced pricing schemes and enable consumers to make informed choices on their consumption patterns. The consumption data can be displayed locally using in-home displays, or via internet portals or mobile apps that help consumers to identify energy saving potentials. The ways the data are presented to the consumers have significant impact on the energy savings potential. In this context, the national smart metering roll-out of Netherlands, for instance, assumes 3.2 % of energy savings with indirect and 6.4 % with direct feedback (e.g., using an in-home display) (Covrig, et al., 2014). Moreover, including gamfication techniques can increase consumers' engagement in energy saving strategies. This includes understanding and motivating the consumers with provision of clear and

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easily accessible information about their electricity consumption (e.g. indirect/direct feedback, incentive-based mechanisms, pro-environmental behaviour, personalized advice, social connection and competition, among others). This will be one of the main objectives of the EU-funded project PARENT.

2.2.5. Energy efficiency and cost reduction

Inducing energy efficient behaviour is another relevant aspect of the electricity consumer engagement process. Smart metering systems may lead to an energy-aware consumer both in the way the electricity is used (i.e., usage behaviour) and in the purchase of more energy efficient appliances (i.e., purchase behaviour) (Covrig, et al., 2014).

On the same note, implementation of smart meters enables the utility companies to introduce new distribution network tariffs (e.g., ranging from time-variable rates to dynamic rates and event rates) that reflect real network conditions. This would enable the possibility for innovative services, such as home energy management, demand response and peak load shifting, and will account for benefits both for the consumer (e.g., electricity cost reduction) and for the utilities (e.g., network operation costs).

2.2.6. Consumer empowerment

The introduction of smart metering systems will have considerable impact on the energy supply retail market competition. Increased consumer awareness on the time and amount of electricity consumption on one hand side and provision of accurate and reliable data flows on the other would enable easier and quicker switch between suppliers for both, the consumers and the suppliers. This enables the consumers to choose from different offers that better adapt to their consumption patterns and therefore drive prices down (Covrig, et al., 2014). This may also result in empowering the customer in choosing different power sources that better serves its intentions (e.g., self-consumption from distributed generation and electric vehicles).

2.2.7. Environment protection

Effective deployment and use of the smart metering systems will add additional value to the consumers and society in general, leading to a reduced amount of CO_2 emissions (i.e., a main energy policy objective of the EU). This can be achieved as a result of energy savings and more efficient use of electric energy, and a higher electricity network operational efficiency. Smart metering systems also help foster the diffusion of distributed generation at consumers' side (e.g. solar photovoltaic) and Plug-in Electric Vehicles (PEVs) making the consumers more aware of the CO_2 associated to the electricity they consume (Covrig, et al., 2014).

2.2.8. Power and load management

Smart meters can analyse and control fluctuations in low voltage grids caused by unbalanced load. Information about the load at the customer side and control of the maximum load demand helps utility companies in maintaining a flat voltage profile on the power supplied and improve system stability. For instance, using the data obtained from the meters, smart inverters can be triggered to compensate reactive energy and voltage drops instantaneously. Moreover, using smart meters the maximum load demand of a customer during peak load can also be controlled.

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2.2.9. Distribution network management

Smart meters can provide a number of important opportunities for Distribution System Operators (DSOs) to manage and plan low-voltage networks and reduce electricity network losses. Moreover, smart metering data helps to identify more profitable customers to provide optional value added services. However, this imposes many challenges in collecting, managing and analysing large quantity of real-time smart metering data. Those challenges and other challenges related to the smart metering systems roll-out will be explained in the following section.

2.3. ISSUES AND CHALLENGES:

In spite of the perceived benefits smart meters provide to most interest groups, the roll-out of smart metering systems involves many issues and challenges. Those challenges are related to the design, operation and maintenance of the smart metering system and impose fundamental responsibilities on governments, DSOs, consumers and market parties. In this section, we address the most critical challenges pertain to the roll-out of smart metering systems. Some of those challenges are presented in Figure 2.2.

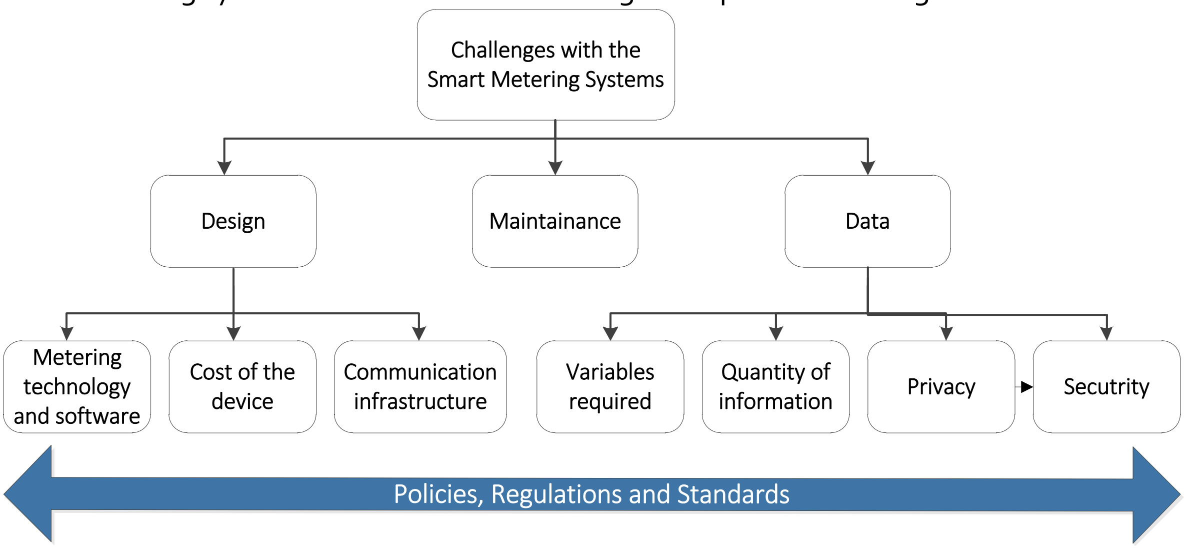

Figure 2.2: Challenges with the smart metering systems.

First of all, the implementation of smart metering systems in the distribution system involves several billion dollars of investment for deployment and maintenance of the network. In addition, managing public reaction and social acceptance of the new technology and transition may be challenging in some places.

Second of all, the collection and transmission of energy consumption data is a continuous process that is typically done automatically. Although the increased data flow means more opportunity to make use of data, but at the same time it requires a development of new and flexible technical solutions to manage these larger quantities of data, while guaranteeing data security and consumers' privacy. Managing and analysing a huge amount of collected data efficiently is a complex process and might not be possible using the conventional data management and analysis tools.

Third of all, smart meters might essentially create some privacy risks of consumers' personal data and signals being transmitted. This data might reveal information about the occupancy patterns in households and their daily energy consumption behaviour and appliances usage. In view of this, some customers might be unwilling to communicate their energy consumption data with their neighbouring household's meter or they may even refuse to send their data to the utility company, or a third party, in real time. Fundamentally, it would be an issue about the choice of parameters to be transmitted and administrator authentication to access that information. However, even if consumers accept communicating their data in a timely manner, there might be some barriers imposed by the responsible party on that data. In fact, the access and exchange of electricity consumption data differs between Member States (e.g., the ownership of data, who can access to data, how frequent the data are provided, max delay between consumption data and data access, among others). This point will be given more attention in the following sections.

Finally, even though several devices can be integrated with the smart metering system, they can be used to their fullest extent only when all the appliances and devices in the distribution and metering network are included in the communication network.

To conclude, future of smart metering systems depends on the policies of utility companies and respective governments. In the following sections, we will present and discuss the roll-out status of smart metering systems, and smart metering data management and access models in the Europe focusing on the four targeted countries, namely Netherlands, Spain, Norway and Belgium.

3. Smart Electricity Metering Systems Roll-out in Europe

The several regulations and directives released by the EU in the electricity sector during the past few years show a strong commitment to the implementation of smart grids and smart metering systems. The first reference, Directive 2009/72/EC (Council, 2009), sets common rules for the internal electricity market to deliver real choices for all consumers of the EU (i.e., citizens or businesses) and new business opportunities in order to achieve efficiency gains, competitive prices and more secure and sustainable supply. The directive mentions that smart metering systems are essential to assist the active participation of consumers in the electricity supply market. However, it also states that the implementation of those metering systems may be subject to an economic assessment of all the long-term CBA, to the market and the individual consumer, and all countries are required to conduct a CBA for smart meters roll-out (Council, 2009).

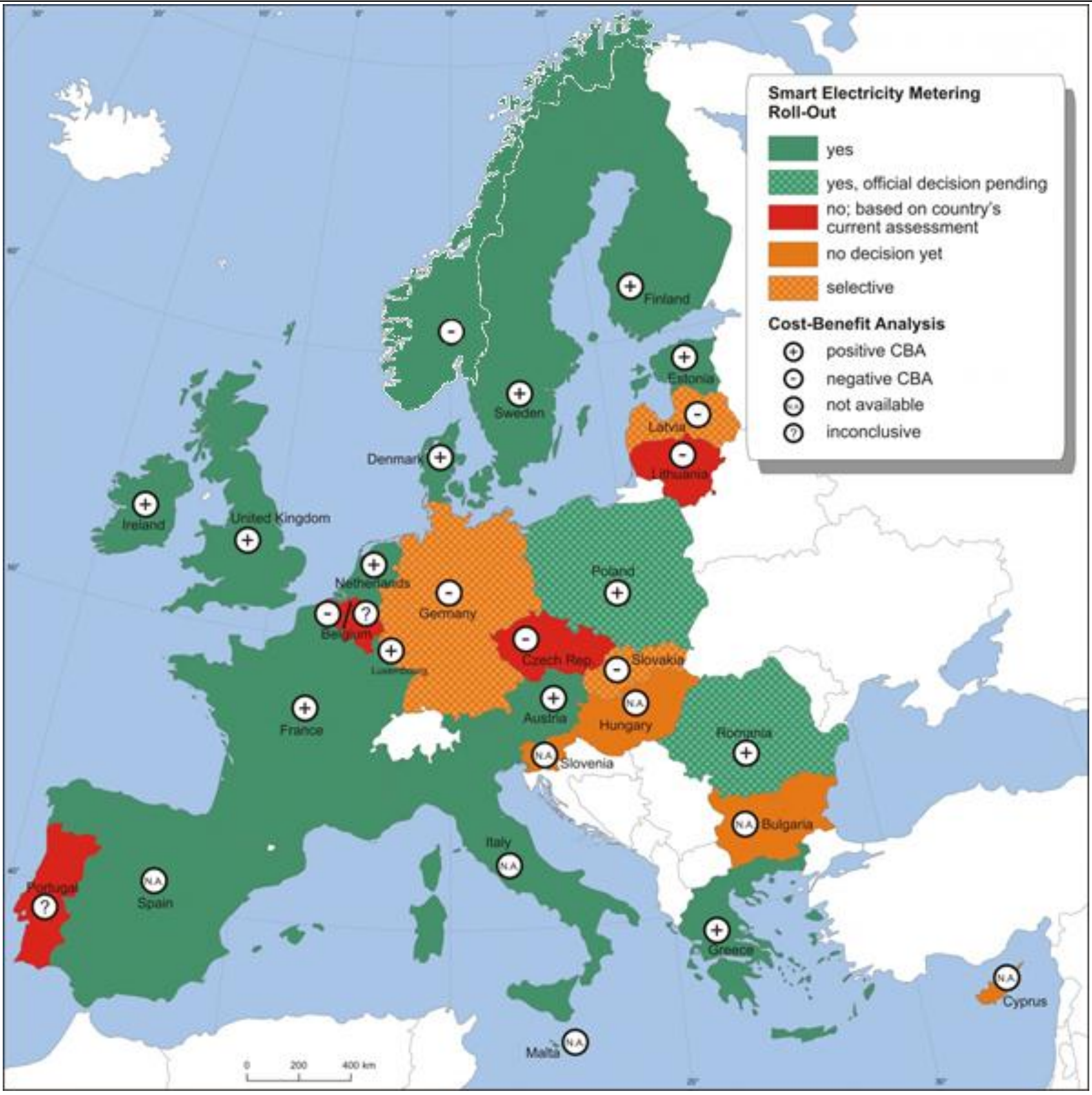

Figure 3.1: Smart electricity metering systems roll-out status in the EU countries and Norway until 2016 (source: http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/files/electricity.jpg).

In the case of a positive CBA, 80% of electricity meters in European households will be replaced by smart meters by 2020. It is expected that nearly 200 million ~~of~~ electricity smart meters will be rolled out in the EU by that time (Union, 2012). However, only few countries have achieved this target so far. Italy was the first country to roll-out smart meters in 2001, even before the EU set its goals. Sweden followed with its roll-out between 2003 and 2009. Malta and Finland have finalized their roll-outs in 2013. Austria, Denmark, Norway, Estonia, France, Greece, Ireland, Luxemburg, Malta, Netherlands, Poland, Romania, Spain and UK have set targets for the implementation of smart meters, but have not finalized the roll-out yet analysis. Other countries like Germany, Latvia and Slovakia are opting for a selective smart metering roll-out, economically justified for a specific group of customers. The installation of smart meters in those countries is limited in new or renovated houses/buildings, prosumers, and high-consumption households (Edelmann & Kästner, 2013). Belgium, Czech Republic and Lithuania, have decided against smart meters roll-out, at least for the time being and under current conditions, based on a negative CBA outcome. Portugal has reported an inconclusive CBA. The intention is to conduct a re-evaluation of the CBA based on updated assumptions and taking into consideration the current economic context and constraints. Finally, no CBA or concrete national roll-out plan has been available for Bulgaria, Cyprus, Hungary, and Slovenia (Giordano, et al., 2011; Covrig, et al., 2014). The smart electricity metering systems roll-out status in the EU countries and Norway until 2016 is presented in Figure 3.1.

Typically, national regulation makes the DSOs responsible for metering and consequently also for the roll-out of smart meters. In Germany, what is called a metering point operator is the responsible party for smart metering implementation, which can be the DSO or a third party chosen by the consumer (SWD(2014)188, 2014). In exceptional cases, such as the UK, the retailer is responsible for metering. Within the limits of government mandates, DSOs (or retailers) have to determine the technical (e.g. architectures, technologies and communication protocols) and non-technical (e.g. security, privacy, ownership of data) requirements for smart metering systems. Those requirements depend among others on the country and the targeted use cases (Erlinghagen, Lichtensteiger, & Markard, 2015).

In the following section, we present the status of smart metering systems roll-out in the four targeted European countries, where the PARENT project is involved, namely: the Netherlands, Spain, Norway and Belgium. The wide scale smart roll-out details by 2020 is summarized in Table 3.1.

3.1. The Netherlands

The long-term CBA conducted in 2005 and revised in 2010 for the roll-out of electricity and gas smart metering systems in the Netherlands resulted in a positive net present value (NPV) of 770 million euros. The revised CBA considers different aspects such as: energy efficiency, data protection/security measures, additional functional requirements, among other benefits for the consumer. The highest benefits appear to go to the consumer, as the advantages of energy savings and efficiency improvements in the market largely benefit the consumer. The metering company will also benefit due to an increased efficiency in the meter data collection (SWD(2014)188, 2014).

The Dutch electricity and gas market is competitive, with sixty-four suppliers, twenty-eight balance responsible parties (BRPs), two TSOs, eight DSOs, thirteen metering companies, eight big generators and more than ten thousand small generating installations. The metering activity is regulated, and the DSO has the responsibility to implement the smart metering systems. Currently 1.5 million households have smart meters. The expected diffusion rate of smart metering in the Netherlands by 2020 is 100% which accounts for 7.6 million smart electricity and gas meters. The roll-out in the Netherlands is governed by the Dutch Electricity Act and the Gas Act and the financing is through network tariffs. The roll-out period started in 2012 until 2020 and the roll-out strategy is mandatory with the possibility to opt-out. In fact, consumers have been granted the possibility to refuse the smart meter or to opt using one, under one of the three settings (SWD(2014)188, 2014; SWD(2014)189, 2014):

- Administrative off: which means that no information on the electricity consumption data has been exchanged with the DSO or any third party; but the consumer himself can still have access to his metering data via the consumer port.
- Standard reading (bi-monthly reading).
- Detailed reading.

The net metering scheme in the Netherlands is considered as a major driving force for the growth of solar power installations in the residential sector. Under this model, consumers with self-generation are using the grid to artificially store electricity produced at one point of time to consume it at another point of time, without reflecting the value of electricity which may vary substantially between the time periods. In the Netherlands, yearly-based net-metering is allowed for 'small users'. This applies to systems up to 15kWp with a grid connection limited to 80A in three phases, but compensation is received for only a maximum of 5000 kWh (SWD(2015)141, 2015). Currently, there are about 300,000 PV system owners in the Netherlands (mainly households and also SMEs). The National Action Plan on Solar Power (NAZ) denoted that the growth scenario for solar power is developing towards an accelerated scenario of no less than 10 GWp in 2023 (which accounts for 2.5 million Dutch households) (GL, 2016).

3.2. Spain

The five main DSOs in Spain (Endesa, Iberdrola, Gas Natural-Fenosa, EDP-Hidrocantábrico, and E.ON) have conducted a CBA for an electricity smart metering roll-out in Spain, but the outcome of this CBA has not been announced on a national public scale. However, the country has decided to proceed with a full roll-out. The roll-out covers 100% of 27.8 million meters and is intended to run from 2011 till 2018. (SWD(2014)188, 2014). Order IET/290/2012 (Spain, 2012) sets out the details for the effective implementation of smart metering systems in Spain, where all meters for supplies of up to 15 kW have to be replaced by new smart devices before 31st December 2018. The roll-out of smart meters in Spain is DSO~~s~~-led and the deployment programmes vary in smart meters capabilities. The order IET/290/2012 (Spain, 2012) states that 35% of meters must be replaced by 1st January 2015, 70% by 1st January 2017, and 100% by 1st January 2019, whilst any meter that is installed today must of course be ready for integration into the eventual relevant smart metering systems (Leiva, Palacios, & Aguado, 2016). The choice for the customer to either accept a rented meter by the DSO at a regulated monthly fee or install his own meter is a legal right in Spain. The financing of the roll-out is through network tariffs and smart metering rental fees (SWD(2014)188, 2014). Practically, the rental fee is included in the network tariff (around 0.92 euro/month + taxes). However, the consumer can buy and install his own smart meter (the cost of the meter is around 100 euro + installation costs). In this case, the consumer is responsible for the smart meter maintenance and upgrade.

3.3. Belgium

In Belgium the competence on energy policy is shared between the federal and the regional administrations. The central government deals with issues pertaining to electricity

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transmission and distribution networks from 70kV up, while the section of the network below this threshold is under the supervision of regional administrations. Accordingly, no legal framework in place for rolling out smart meters, but the three Belgian regions (Flanders, Brussels-Capital, and Wallonia) have been in charge of their region-specific CBA for the smart metering systems roll-out. In fact, the outcome of the CBA for a wide-scale roll-out was negative, but different CBAs were conducted in each region, which will support a selective smart meters roll-out (SWD(2014)188, 2014). Energy consumption tariffs in Belgium differ according to a legal social classification system. A segmented smart metering systems roll-out would likely target those of higher tariffs who can benefit more financially from smart meters. Till this moment, smart meters have been deployed only in pilot projects. So far, approx. 50.000 smart meters have been installed in some pilot projects by Eandis and Infrax (Eandis/Infrax, 2014).

In the current market model, metering is one of the responsibilities of the DSOs. DSOs buy, install and maintain the sub-meters. DSOs in Belgium tend to work together and this cooperation resulted in the founding of 'working companies' through which working orders and metering activities from different DSOs are bundled. As a result, a handful of 'working companies' populate the Belgian DSO landscape (CEER C. o., 2012).

3.4. Norway

Norway is a member of the European Economic Area (EEA) but not the EU, and is obliged to adopt EEA-relevant EU legislation such as the Energy Efficiency Directive. Regulation by the Norwegian Water Resources and Energy Directorate (NVE) mandates a 100% smart meter roll-out by 2019 which accounts for 2.8 million smart metering points (Venjum & Hagen, 2015). The introduction process is governed by a regulatory framework determined by the national regulator (NVE). The roll-out of smart meters will be done by the DSOs, which constitute a regulated monopoly. Although the CBA for rolling out smart meters to the household level in Norway was negative due to large uncertainties, Norwegian authorities nevertheless chose to implement smart meter devices in all households (Ballo, 2015). Consumers can only opt out if they have a small and predictable consumption and if the metering can be shown to cause a significant and documentable disadvantage for the customer. In fact, the amount of consumers making use of this option is very small (i.e., estimated 0.3% of the total). The current roll-out plan is 20% by end of 2016, 65% by end of 2017, 100% by end of 2018. The investment cost for the smart meter roll-out is a number with large uncertainties, but is estimated to be about 10 billion NOK (Venjum & Hagen, 2015). The cost of the smart meter investment will be paid by the consumers, through an increase in what is called the transmission tariff; a fee paid to the DSO by the end-users. This tariff is set by each individual DSO, but has to stay within limits determined by the national regulator (Ballo, 2015). There are several pilot programmes running, including a demonstration project on different types of feedback solutions, for which science software company Onzo has been selected by energy supplier Fjordkraft. A competition for energy suppliers who want to do pilots on technologies, services and business models for feedback solutions was announced on May 1, 2015, rewarding seven-winners with partial financing for pilot projects (enova, 2015). Previous pilot projects have focused on communication infrastructure and data management. Some of the ca. 130 DSOs had started the roll-out at the end of 2013, but most have planned to start the main roll-out in 2016 (about 75% of the meters will be installed in 2017-2018).

Table 3.1: Smart metering systems roll-out details by 2020 in the four targeted countries.

Country	Belgium	Netherlands	Norway	Spain
CBA completed	Yes	Yes	Yes	Completed by five main DSOs, not publicly available
CBA outcome	Negative	Positive	Negative	Not available
Expected Diffusion rate by 2020 (%)	No wide scale roll-out of SM by 2020	100	100	100
Smart metering points implemented	NA	1500000	265000	18500000
Smart metering points to be installed by 2020	NA	7600000	2800000	27768258
Roll-out period Start Date	NA	2012	2013	2011
Roll-out period End Date	NA	2020	2019	2018
Responsible party implementation and ownership	DSO	DSO	DSO	DSO
Financing	NA	Network Tariffs	Network Tariffs	Network Tariffs

4. Smart metering data management and access models

The large quantities of data generated by the progressive roll-out of smart meters should be managed in a secure and efficient way. Gathering all the data from the electricity meters, storing it, and granting interested parties access to it can be achieved in different ways. There are three data management models have been discussed within the EG3 Smart Grids Task Force, which are defined as follows:

- The DSO model: in which the DSO plays central roles by operating a data hub and providing data to the market through this hub.
- The CDH model: in which the previous tasks are performed by an independent party operating a central data hub (CDH).
- The DAM model: in this model no official data hub exists, but one or more data access-point managers (DAMs) guarantee data access at each metering point.

In the first two models the central actors are regulated as a natural monopoly. In the third model, the DAMs can be any certified commercial company (van den Oosterkamp, et al., 23 April 2014). The main advantages and disadvantages of the three models are presented in Table 4.1.

Table 4.1: Advantages and disadvantages of the three data management models.

	Advantages	Disadvantages	Countries
The DSO model	the most efficient model in data handling	less transparency in data handling than the CDH-model	Currently: Spain, Belgium, Norway
The CDH model	the most guarantees for transparent, non-discriminatory and neutral data handling	increased regulatory and administrative costs due to setting up a new regulated agent who should cooperate with DSOs	Currently: Netherlands In 2017: Norway (Elhub) In 2018: Belgium (Atria)
The DAM model	provide a high level of innovation	required regulation of the metering companies and risks of limited access of other market actors and DSOs to smart metering data	

In most of the Member States the metering sector is considered part of the DSO, being both the owner and the responsible party for smart meters roll-out and granting access to metering data, since the DSOs have a long experience in data collection, management and validation (SWD(2014)189, 2014). The choice of DSOs as responsible party has also been the favourite route for many of the Member States who have not decided yet for a large-scale roll-out plan: Belgium, Cyprus, the Czech Republic, Lithuania, Latvia, Portugal, and Slovakia. In Germany, the DSOs are the responsible party for the roll-out, as long as the respective consumer does not choose a third party as meter operator (SWD(2014)189, 2014). For granting access to metering data, there is a balanced tendency between using the DSO model and the CDH model. In the DSO model, the non-discriminatory third party access to consumers' consumption data is not always guaranteed. Therefore, some European countries (e.g., Denmark, Netherlands, Czech Republic, Norway, among others) exercise the possibility of having a separate CDH entity responsible for providing access of metering data. In such a deployment set-up, consumers' data are stored on the smart meter installed at their premises and the CDH is then responsible for routing the data to energy suppliers, DSOs, and other third parties with appropriate access permissions according with privacy legislation. One of the key reasons behind this choice is that centralised communications, particularly in competitive electricity retail market, could lead to improved supplier competition as a result of enabling easier switching between suppliers (SWD(2014)189, 2014; van den Oosterkamp, et al., 23 April 2014).

The ever increasing data flow requires the DSOs to develop new and flexible technical solutions to manage these larger quantities of data, while guaranteeing data security and consumers' privacy. Consumers' data stored in databases at the operator's premises are treated as sensitive information. It is typically protected with advanced cyber-solutions and legally protected by related privacy and confidentiality policies.

Regarding the private and secure access to consumer metering data, the CEER public consultation document (C13-RMF-57-04) sets out draft advice on how consumer metering data management in the retail market should be developed (CEER, 2014). CEER believes that efficient, safe and secure data exchange between stakeholders is vital for retail market functioning and customer protection. For consumers, a key consideration is which parties

have access to their data and for what purpose. The availability of data is also crucial to the operation of effective competition regardless of the specific form of the data management model.
Figure 4.1 shows the third party smart metering data access in EU countries and Norway. The smart metering data access models in the four participating countries in the PARENT project are presented in the following sections and further summarized in Table 4.2.

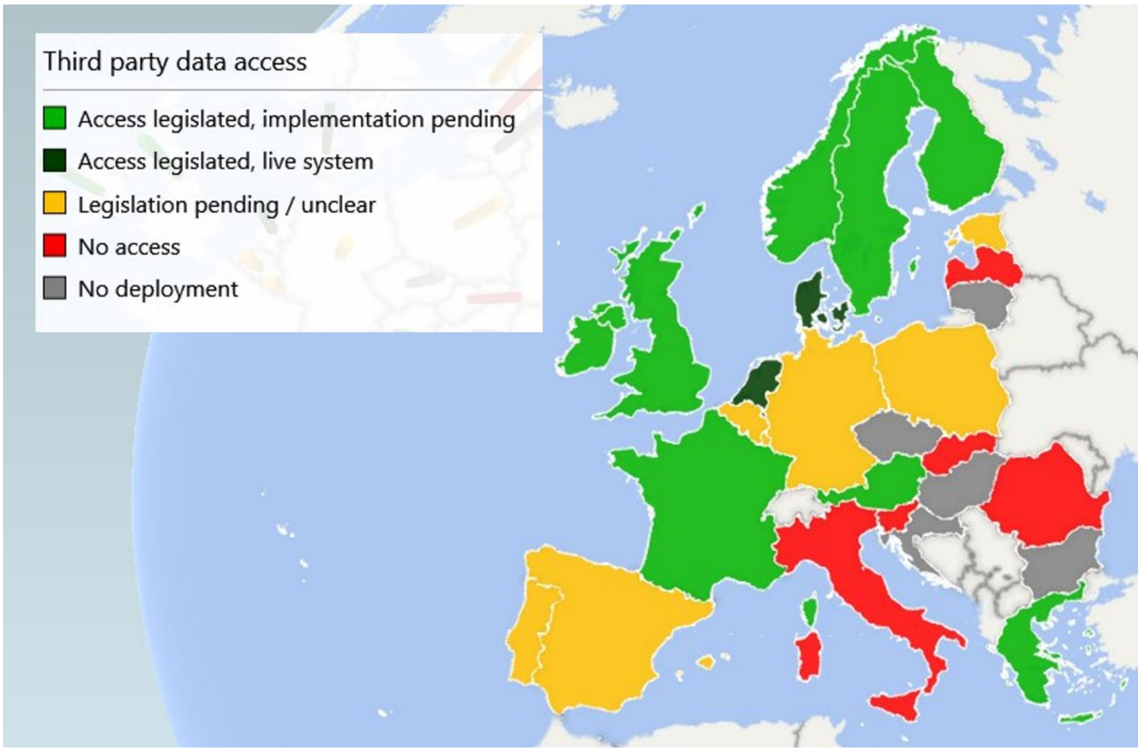

Figure 4.1: Third party smart metering data access in the EU countries and Norway taken from **(Beviz, 2016)**.

4.1. The Netherlands

In the Netherlands, consumers can access their consumption data via the DSO web portal, with quarter hourly readings available one day after consumption. The smart meters are equipped with four interfaces that allow different data access settings (see Figure 4.2). Consumption data is stored locally in households and consumers can purchase additional hardware to access real time metering data via the P1 meter interface.
The P2 meter interface is designated to connect to other available product meters (e.g., gas and water meters). P3 allows communication between the smart meter and the central access server (CAS), run by the DSO to read and manage all smart meters. If a consumer accepts a smart meter but takes no further action, the default is that the P3 gate will send consumption data to the DSO six times per year for billing purposes.
Suppliers and third parties can access metering data through the P4 gate, with consent from the consumer, via the CAS.
Providing meter data based energy services is considered a market responsibility, and is not mandated for utilities. There are government resources to assist consumers in finding

energy service providers, and several suppliers provide processed meter data through apps and other channels for their consumers. Energy service providers can connect to smart meters either directly through the P1 interface or indirectly through the P4 interface. The available energy service providers in the Netherlands can be listed in a database targeted at consumers, which is run by Milieu Centraal, a public energy advice service, and Netherlands Enterprise Agency (RVO). Milieu Centraal (Centraal, 2016) website provides energy saving advice and resources. Consumers are directed in this website to a database of energy management tools, where they can search for energy management services based on their capabilities and interests.

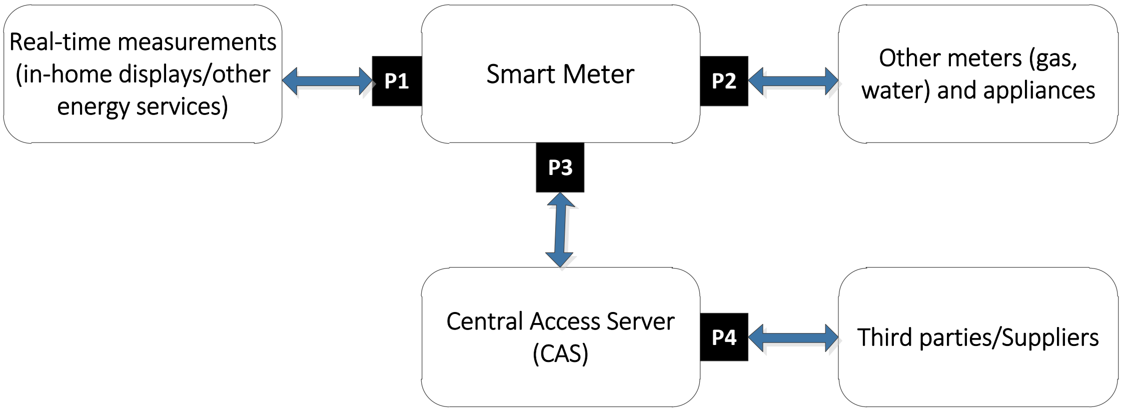

Figure 4.2: Smart meters communication interfaces in the Netherands.

4.2. Spain

DSOs are responsible for capturing, validating and making available, in a standardised way, the hourly consumption data needed by the suppliers and the system operators. In practice, DSOs provide secure access to servers, where each supplier can download data from its clients, with a maximum delay of seven working days, and keep a two-year record of hourly consumption data. Electricity consumers in Spain can access their hourly consumption data free of charge through web portals run by DSOs. Utility companies are responsible on informing consumers on their bills about how they can access their data. In addition to graphs and figures, designed to help analyse and improve consumption habits, the customer will also be able to download the validated hourly consumption data used for billing to an excel file. Since the deployment programmes in Spain vary in smart meters capabilities, not all consumers are able to access their smart metering data in real time through in-home displays. Third parties can access the hourly consumption data in CVS or Excel format with permission from consumers via the DSO web portals. Again the consumption data is one week delayed. Regarding the energy management services, energy service companies need to be registered as or associated with retailers.

4.3. Belgium

As mentioned previously, the DSOs in Belgium are responsible for the installation, maintenance and reading of sub-meters. Managing and validating electricity measurement data are also the responsibilities of every individual DSO. The DSO makes the consumption data available to energy suppliers, which in turn make the data available to their customers. Most energy suppliers have web portals providing an overview of invoices and annual consumption data. Only the corresponding DSO has a metering data access directly from the meter, then it communicates it to the supplier for billing purposes for free. Regarding third parties data access to sub-metering data, it is not possible to get the data from all customers. The Flemish DSO Eandis, for instance, informed that currently third parties cannot access the sub-metering data, although it is possible to release certain data for research purposes after aggregation.

In the currently deployed pilot projects, DSOs read electricity smart meters every 15 minutes. The smart metering data is typically not communicated to consumers. Consumers can read their consumption data by consulting an in-home display connected to the smart meter (Eandis/Infrax, 2014).

In view of the possible introduction of a larger number of smart meters, market processes in Belgium will most likely change. In this respect, one central access register (i.e., a CDH), where there are now as many access registers as there are DSOs, could be made. It is still the individual DSO who will hold a database with the detailed metering data. The DSOs have to give the data that is necessary to the CDH (Atrias) who will have the access register. One single access register will largely simplify procedures to make new products and services possible in the future when smart metering data is available. The intention is that Atrias will receive all the quarterly reads (i.e., 15 min read) for electricity smart meters and will give the data to the market parties with respect to the legislation (i.e. if a customer has to be given monthly consumption information, Atrias will give this information once a month to his supplier) (CEER C. o., 2012). Third parties access to smart metering data will also depend on legislation updates and it is very likely an agreement with the DSO will be needed.

4.4. Norway

Currently DSOs provide smart metering data to suppliers, and most utilities allow consumers to access their hourly metering data via web portals. The data is available one day after consumption. In the future, system to go live in February 2017, consumption data will be reported into a central data centre "Elhub" (i.e., a CDH model). The consumers will access their consumption data in the central Elhub through their supplier's webpage (Elhub, 2016). An in-home display in every household is not part of the roll-out, but DSOs have to provide an open meter interface to ensure that third parties can provide feedback solutions (Inderberg, 2015). Utilities are obliged to provide consumers with information that enables them to compare consumption, prices and costs over time (Energy, 2010). Hourly data will be stored for a minimum of 3 months and a maximum of 15 months, and monthly and yearly data for 3 years. The meters will include functionality for 15-minute measurements, and a future move from hourly measurements to 15-minute measurements is envisioned. Third parties will be able to access consumption data from consumers who have given their permission to such third-party access via the Elhub, which is due to go live in 2017. Elhub will provide access for all market players (DSO, retailers, and energy service companies)

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with permission from the consumer. Consumers will access their data in the Elhub and control who gets access to the data via electricity supplier websites.

Table 4.2: Summary of smart metering data management and access for countries.

Country	Metering data management (responsible party)	Metering Data Management Model	Frequency of metering readings	Max. delay between consumption and data access	Metering data access
Belgium	Regulated monopoly (DSOs) (in future: independent CDH Atrias)	Currently: Decentralised access and data storage (DSOs). In future: Centralised service hub and decentralised storage	Sub-meters: Once per year in the residential sector Smart meters: Regional variations. Mainly, there will be 15 minutes reading for smart electricity meters	NA	The sub-metering data are held by every individual DSO, which provide the data to energy suppliers. Most energy suppliers have web portals providing the annual metering data to their customers In Future: consumers will be able to access their own data via the CDH Atria when it goes live in 2018 Third party: Currently: they cannot access the sub-metering data of all customers In Future: access will depend on legislation updates (most likely an agreement with the DSO is needed)
Netherlands	Regulated (DSOs, with data stored at metering points)	Centralised service hub and decentralised data storage	10 seconds real-time/15 min reading	1 day	Consumers: from the CDH through their supplier's web portal Third parties: via the CDH with the consent of consumers
Norway	Regulated (TSO)	Currently: Decentralised access and data storage (DSOs). In future (2017): Centralised access and centralised data storage	Hourly. Future: 15 min reading	1 day	Consumers: Currently: From the DSOs through their supplier's web portal In future (2017): from the CDH Elhub through their suppliers' web portal Third parties: Via the Elhub with the consent of consumers
Spain	Regulated (DSOs)	Decentralised access and data storage (DSOs)	Hourly	1 week	Consumers: through a web portal provided by the DSO Third parties: through an agreement with the retailer and with the consent of the consumer

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5. Conclusions and guidelines

The purpose of this study is to provide an overview of the smart electricity metering systems roll-out in Europe and how the metering data can be accessed in different European countries. The study starts by reviewing the applications, advantages and challenges of smart metering systems in general. After that, it takes a closer look at the state of the art of smart metering systems roll-out and smart metering data access models in four European countries, participating in the EU-funded project "PARENT", namely the Netherlands, Spain, Belgium and Norway. The study aims at providing a guideline to different players in the energy market including third parties interested in playing an integral role in the energy reduction targets in the residential sector. The study shows that the roll-out status of smart meters in Europe varies between countries and that not all European countries have deployed smart meters yet due to the results of their CBA performed, which may make the mission of helping consumers in reducing their electricity consumption through energy advisory platforms more challenging for third parties. Apart from getting the authorization from electricity consumers to allow third parties to access their consumption data, smart metering data access also strongly depends on the regulations and the data access model deployed in each country. It has been shown through this study that some countries in Europe have decided to adopt, or have already adopted, a separate CDH entity responsible for providing access of metering data, due to its advantages represented by the transparency, non-discriminatory and neutral data handling. In other data access model, it is expected that in some places the process will be more complex, taking into account the agreements that need to be done, the frequency of meter reading, the max delay between consumption and data access, the data privacy guarantee, among others. We hope that this study will help in paving the way for future steps in the EU-funded project PARENT and giving pointers about the challenges that it might be encountered in the pilot installations where the virtual energy advisor EnerByte, as a third party, is going to be deployed.

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