European smart metering benchmark

European Commission DG Energy
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>1G</td>
<td>1st generation</td>
</tr>
<tr>
<td>2G</td>
<td>2nd generation</td>
</tr>
<tr>
<td>ANEC</td>
<td>The European consumer voice in standardisation</td>
</tr>
<tr>
<td>CAPEX</td>
<td>Capital expenditure</td>
</tr>
<tr>
<td>CBA</td>
<td>Cost Benefit Analysis</td>
</tr>
<tr>
<td>CEN</td>
<td>European Committee for Standardisation</td>
</tr>
<tr>
<td>CENELEC</td>
<td>European Committee for Electrotechnical Standardisation</td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>DSO</td>
<td>Distribution System Operator</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EG</td>
<td>European Committee for electro</td>
</tr>
<tr>
<td>ESO</td>
<td>European standards organisation</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EV</td>
<td>Electric vehicles</td>
</tr>
<tr>
<td>ICT</td>
<td>Information &amp; communication technology</td>
</tr>
<tr>
<td>IOT</td>
<td>Internet of things</td>
</tr>
<tr>
<td>IT</td>
<td>Information technology</td>
</tr>
<tr>
<td>KPI</td>
<td>Key performance indicator</td>
</tr>
<tr>
<td>MS</td>
<td>Member State</td>
</tr>
<tr>
<td>N/A</td>
<td>Not available</td>
</tr>
<tr>
<td>NRA</td>
<td>National Regulation Authority</td>
</tr>
<tr>
<td>OPEX</td>
<td>Operational expenditure</td>
</tr>
<tr>
<td>PLC</td>
<td>Powerline communication</td>
</tr>
<tr>
<td>SM-CG</td>
<td>Smart Meter Coordination Group</td>
</tr>
<tr>
<td>SME</td>
<td>Small &amp; medium enterprise</td>
</tr>
<tr>
<td>TOTEX</td>
<td>Total expenditure</td>
</tr>
</tbody>
</table>
1 EXECUTIVE SUMMARY

As Miguel Arias Cañete, the EU Commissioner for Climate and Energy stated, the European Union has already started the modernization and transformation towards a climate neutral economy. And today, we are stepping up our efforts as we propose a strategy for Europe to become the world’s first major economy to go climate neutral by 2050.²

To foster the transition of its economy from a centralized, rigid, fossil fuel-based energy system towards a flexible, decentralized, decarbonized energy system, the European Union has been adapting its policy and regulatory framework continuously. The Clean Energy Package has thus been conceived as the central pillar of the Energy Union strategy for the forthcoming decades.

With digitalisation being a main enabler for the rise of a resilient and secure grid of the future, the recently updated European Union regulatory instruments stress more than ever the need for a large-scale roll-out of smart energy meters. Despite the current advanced stage of smart electricity and gas meter deployment in some Member States, others they are still at the very beginning of this process. Yet, the objectives of the European Union in terms of energy transition will not be reached if all European citizens do not find themselves on the same page. Thus a harmonization effort is required and guidance must be provided to stakeholders in order to observe consistent application of smart meters’ provisions across Member States. The European Commission is therefore calling for a fit for purpose deployment of smart metering systems across the Energy Union.

The adoption of the 2009/72/EC Electricity Directive and the 2009/73/EC Gas Directive has triggered the necessity to conduct a cost benefits analysis (CBA) on the deployment of smart metering systems in each Member States. In 2014, a first benchmarking report was presented by the European Commission, presenting the CBAs’ outcome.

The aim of the present report is to update the information from that first benchmarking report, gauge progress with smart metering since then, and even go one step further and gather the returns of experience and lessons learned from previously initiated large scale smart meters roll-out. This will help provide insights and guidelines for Member States currently planning their deployment strategy.

The report considers for the 28 EU Member States, the regulatory framework implemented at national level, the data management system architecture chosen, the functional and technical specification of smart meters as well as whether consumer benefits are incorporated into the roll-out strategy. Furthermore, the current roll-out state of play is described and results of updated CBAs are analysed.

The data collection and validation methodology has been carried out by directly engaging with National authorities – NRAs and Energy ministries – to collect relevant information in a systematic manner. A standard questionnaire has been sent to NRAs (or the entitled body for smart meters roll-out planning), to capture the state of play of smart metering deployment in each Member State. Based on the answers received to the questionnaire, country fiches have been elaborated and shared for early feedback. The next phase consisted of the validation of the findings coming from the consolidated analysis against the data gathered at Member States level. To this end, an informal consultation with relevant stakeholders permitted to gather views and insights on the recommendations that were preliminary drawn, following the consolidated analysis.

- **From planning to realisation...**

The Third Energy Package required Member States to conduct a CBA for smart metering deployment, and to roll-out, for the case of electricity, at least 80% by 2020, of the positively assessed cases. Yet, the purpose of this report is to assess how far the Member States have come in their national deployment plans with this obligation. The first aspect to consider is the development of implementation laws that will enable a roll-out strategy and detailed specifications to be put in place at national level.

The picture appears to be quite different when assessing the situation for gas and electricity smart meters. While three quarters of Member States have adopted specific legal provisions for the roll-out of electricity smart meters, only a quarter of them has done so for the roll-out of gas smart meters.

As of July 2018 all but two Member States have conducted at least one CBA for a large-scale rollout of electricity smart meters to at least 80% by 2020, with the results for most of these being positive. This can be seen in Figure 1. Regarding gas smart meters, the majority of Member States either did not conduct a CBA or did not specify whether the CBA conducted was for gas as well as electricity. But for those Member States that did perform a CBA for the roll-out of gas smart meters, the results were most of the time negative.
Taking a closer look at the CBA performed for electricity smart metering, more specifically the cost items considered by Member States (see Figure 2), the capital costs associated with smart meters themselves and the IT infrastructure was considered by approximately 90% of the Member States. Other cost items considered by Member States are the operation expenses linked to meter readings, IT maintenance, telecommunications and network management, being considered by 85% of the Member States when conducting their respective CBAs.
The most common benefits taking into account in the CBA for electricity smart metering are related to DSOs, and are the operational savings that can be achieved through remote meter readings and the reduction of non-technical losses. 75% of Member States have also considered the consumer’s bill reduction as a result of increased energy efficiency. Table 1 summarizes key electricity CBA parameters.

<table>
<thead>
<tr>
<th>Range of value</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lifetime</strong></td>
<td>8 to 50 years 16 ± 8 years (71%)²</td>
</tr>
<tr>
<td><strong>Evaluation period</strong></td>
<td>8 to 50 years 22 ± 13 years (60%)</td>
</tr>
<tr>
<td><strong>Costs per metering points</strong></td>
<td>€38 to €546  €211 ± €117 (57%)</td>
</tr>
<tr>
<td><strong>Benefits per metering points</strong></td>
<td>€19 to €493  €216 ± €150 (46%)</td>
</tr>
<tr>
<td><strong>Energy savings</strong>³</td>
<td>5.42% - 7.85%⁴ N/A</td>
</tr>
</tbody>
</table>

Table 1: Key electricity CBA parameters

As of 2018, 33.83% of all electricity metering points were equipped with a smart meter (ca. 99,080,000 smart meters). Taken separately, households electricity metering points and SMEs metering points were equipped at 34.5% and 27.52%, respectively. By 2020, based on the originally announced rollout plans 127,593,300 additional smart meters were to be installed within the EU-28 (setting the total number of smart meters to ca. 226 million). That would correspond to a penetration ratio of electricity smart meters of ca. 78%.

However, given the speed of deployment observed in 2017, we estimate⁵ that only 24 million additional smart meters will be installed by 2020, setting the total number of electricity smart meters to 123 million, which would correspond to a 42.5% penetration rate. With a weighted average cost per electricity smart meter of 153,300€⁶, the deployment of these 123 million smart meters would have required an aggregated investment of €18.8 billion.

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² This percentage relates to the number of measurements that fall within the range of the average value quoted ± the standard deviation given.


⁴ The first figure relates to energy savings induced by non-real-time up to daily feedback on electricity consumption, while the second relates to energy savings induced by real-time feedback on electricity consumption.

⁵ These estimations are based on the observed rate of deployment of electricity smart meters in 2017.

⁶ The computation of this weighted average includes Austria, Denmark, Estonia, Finland, France, Italy, Luxembourg, Malta, the Netherlands, Spain, Sweden, United Kingdom, Greece, Ireland, Latvia, Poland, Romania and Slovenia.
Extrapolating from the current pace of deployment of electricity smart meters in Member States that have completed, or are currently proceeding to a large-scale rollout of electricity smart meters, we expect that 243 million smart meters will be installed in 2024 (corresponding to a 83.97% penetration rate), which will represent an aggregated investment of €37.3 billion. By 2030, we expect that 266 million smart meters will be installed (corresponding to a 91.57% penetration rate), which will represent an total aggregated investment of €40.7 billion.

<table>
<thead>
<tr>
<th>Number of electricity smart meters installed (in thousands)</th>
<th>Penetration rate at EU level (%)</th>
<th>Induced overall investment (€ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Announced 2020 State of play</td>
<td>226,673</td>
<td>78.16</td>
</tr>
<tr>
<td>Estimated 2020 State of play</td>
<td>123,213</td>
<td>42.49</td>
</tr>
<tr>
<td>Estimated 2024 State of play</td>
<td>243,510</td>
<td>83.97</td>
</tr>
<tr>
<td>Estimated 2030 State of play</td>
<td>265,562</td>
<td>91.57</td>
</tr>
</tbody>
</table>

Table 2: Key figures for different electricity smart meters deployment state of play scenarios

Currently, more than half of the Member States have reached a 10% installation rate for electricity smart meters, meaning a significant step in completing their large-scale roll-out targets. Seven have already reached 80% (Denmark), or even finished their large-scale electricity smart metering roll-out like Estonia (>98% in 2017), Finland (100% 2013), Italy (95% by 2011), Malta (80-85)% by 2014), Spain (93% end of 2017) and Sweden (100% by 2009). Some of them are already proceeding with the second generation rollout, like Italy, or planning this (for instance, Finland, Sweden). Nevertheless, only few from those remaining Member States that had committed to do so are still on track to reach the 80% deployment rate target by 2020; some of them are now setting this target as late as 2030. One of the reasons for smart metering deployment delays relates to consumer acceptance, an issue that is herein further investigated. As described in the relevant chapter (Consumer outcomes) Member States have taken counter-measures to address these challenges and gain trust toward smart metering.
To this day, 19 Member States conducted at least one CBA for gas smart metering deployment, and high variability of CBAs’ outcome can be observed. The Table 3 presents the key parameters of gas CBAs.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range of value</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime</td>
<td>8 to 20 years</td>
<td>15 ± 3 years (29%)²</td>
</tr>
<tr>
<td>Evaluation period</td>
<td>9 to 50 years</td>
<td>24 ± 10 years (36%)</td>
</tr>
<tr>
<td>Costs per metering points</td>
<td>€38 to €380</td>
<td>€183 ± €97 (26%)</td>
</tr>
<tr>
<td>Benefits per metering points</td>
<td>€19 to €352</td>
<td>€139 ± €110 (18%)</td>
</tr>
<tr>
<td>Energy savings</td>
<td>1.83% - 9.63%³</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 3: Key gas CBA parameters


³ The first figure relates to energy savings induced by non-real-time feedback on gas consumption, while the second relates to energy savings induced by real-time feedback on gas consumption.
At the first January 2018 – according to the available data – 10.57% of all gas metering points were equipped with smart meters, which represents ca. 12,146,000 gas smart meters. Among the 7 Member States having adopted an implementation strategy for gas smart metering rollout - namely Austria, France, Ireland, Italy, Luxembourg, the Netherlands and the United Kingdom - the Netherlands is the only one that is on track to reach as they originally intended their 80 % roll-out target by 2020. Figure 4 depicts the target period for gas smart meters large-scale rollout for the concerned Member States.

By 2024\(^9\), based on the announces made by the NRAs of Member States rolling out smart gas smart meters, the penetration ratio of gas smart meters should approximate **52% with 60 million of gas smart meters installed in 5 years**. With a weighted average cost per gas metering point\(^10\) of **210.95€**, this would represent an aggregated investment of €12.66 billion.

Nevertheless, considering the current pace of deployment of gas smart meters, our previsions are less optimistic. We estimate\(^11\) that **in 2020, 27 million of smart meters will be in place**, accounting for **23.5% of all gas metering point**, which will represent an aggregated investment of **€5.69 billion**. By 2024, we estimate that **51 million of smart meters will be in place**, accounting for **44.6% of all gas metering point**. The deployment of these 51 million gas smart meters would have trigger a total investment of **€10.76 billion**. By 2024 only Italy, Luxembourg and the Netherlands would have completed their large-scale rollout of gas smart meters.

<table>
<thead>
<tr>
<th>Announced 2024 State of play</th>
<th>Number of gas smart meters installed (in thousands)</th>
<th>Penetration rate at EU level (%)</th>
<th>Induced overall investment (€ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60,071</td>
<td>52.26</td>
<td>12,657</td>
</tr>
</tbody>
</table>

\(^9\) 2024 is the latest targeted period within the group of MS currently planning a large-scale rollout of gas smart meters.

\(^10\) The calculation of this weighted average included all Member States rolling out gas smart meters, except Italy for which data on costs and benefits per gas metering point was not available. The Member States included in this calculation are thus Austria, France, Ireland, Luxembourg, the Netherlands and United Kingdom.

\(^11\) These estimations are based on the observed rate of deployment of gas smart meters in 2017.
• A secure and enhanced smart metering system

The energy sector is a particularly interconnected industry and whilst the digitalization is driving growth and innovation, it also increases the need to secure the smart grid. The European Commission therefore mandated CEN, CENELEC and ETSI to develop an open architecture for utility meters (mandate M/441) involving communication protocols enabling interoperability and cyber-resilience. As a follow-up to that successfully completed mandate, that led to the development of standards including a common set of security requirements, a Protection Profile for smart meters was also developed that could bring a positive contribution to the security certification of smart meters in Europe.

Currently, there are two main approaches for the management of smart metering data. Whilst some Member States seem to have opted for a centralised data hub, others prefer a more decentralized system where data activities are split amongst a greater number of players acting as metering responsible parties.

In our understanding, a central data hub is likely to deliver benefits of increased competition by lowering transaction costs for commercial parties whose business model heavily relies on access to metering data. However, putting in place a simplified – low cost – access point for market players does not necessarily imply that all metering activities are to be centralized within the central data hub. Next to access, other metering data activities, like sourcing, processing and validation could remain in the scope of local actors that are also the preferred contact point for consumers when it comes to smart metering deployment.

The Commission Recommendation 2012/148/EU on the preparation for the rollout of smart metering systems identified 10 common minimum functionalities relevant for different market actors. We observed that 80% of Member States plan to have all ten functionalities available for their electricity consumers, and 50% of Member States aim to do that free of charge. Furthermore, all Member states that provided information about functionalities of their smart metering systems intend to enable smart metering systems (1) to provide direct reading to consumers and third parties of their choice, (2) to upgrade readings frequently enough to use energy saving schemes and (3) to support advanced tariff systems.

• Consumers benefits

Given that smart metering could bring numerous value propositions to consumers, Member States should consider under which conditions consumers can actually reap benefits from it. There is a clear trend within the EU-28 letting consumers compare their energy consumption based on historical data. Dynamic energy pricing and the integration of prosumers in the market are respectively the second and third most offered service to allow consumers benefit from smart meters.

<table>
<thead>
<tr>
<th>Estimated 2020 State of play</th>
<th>27,025</th>
<th>23.51</th>
<th>5,695</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated 2024 State of play</td>
<td>51,287</td>
<td>44.62</td>
<td>10,758</td>
</tr>
</tbody>
</table>

Table 4: Key figures for different gas smart meters deployment state of play scenarios
But it must be understood that those value propositions can only benefit consumers if they carry motivations and abilities to do so. With regards to these considerations it should be noted that concerns about smart meters have been expressed in almost all Member States; more specifically the accuracy of the smart meter, the electromagnetic radiation they produce and privacy related issues being the main concerns. Communication campaigns launched have a tendency to focus more on the installation and the advantages of smart meters, but failed to address these concerns expressed by European citizens. NRAs (or smart metering deployment responsible parties) should proceed to the ex-post assessment of their communication campaigns’ outcomes in order to track the key messages that have been successfully delivered to consumers. Probably more important, in a context of diversification of consumers (prosumers) behaviours, they should consider systematically tailoring their communication channels to a specifically targeted audience.

We conclude that smart metering system deployment should not constitute for Member States a missed opportunity to enable the grid digitalization and to foster the integration of European energy markets.

The level of progress of the legal and regulatory framework at national level shows a contrasted picture. This fragmentation preclude service providers from reaching economies of scale, which limits the upscaling of services offered to consumers.

The CBA, as performed by many Member States does not fully capture the full range of benefits enabled by smart metering. We recommend to national authorities to use the Cost Benefit Assessment to investigate how to best meet consumer needs and monitor the actual delivery of benefits, not to justify political choices.

When designing their data management system, Member States must fully integrate considerations regarding the resilience of the system to cyber-attack, black-out recovery capability as well as the feasibility of a system replacement if better options can be considered. A significant proportion of smart meters installed in Europe today still have a limited data storage capacity, which make it difficult to implement some value propositions enabled by smart meters (e.g. hourly dynamic pricing) while being fully compliant with the Measuring Instrument Directive12 (MID) requirements. A way around this could be to make the whole smart metering system, and not just the smart meter device, MID-compliant. That could be rather complicated though and cost-prohibitive for some Member States. To help address this issue, the Commission could potentially consider, always with due respect to accuracy and transparency of measurements, a more inclusive interpretation, or even an update, of the MID requirements. This is to ensure that those pioneers who deployed the earlier smart metering set-ups in Europe are not punished having their customers deprived from access to novel energy services and products.

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A better communication campaign and training of personnel to properly inform customers on smart meters is required to enhance their acceptance and their ability to reap benefit from it. The communications should also be broader (multi-channel), more consumer-clusters specific and not time-consuming\textsuperscript{13}.

\textsuperscript{13} Among other positive examples, a dedicated website relative to smart metering has been created in UK (weblink: https://www.smartenergygb.org/en ) destined to address all consumers’ concerns, from request for installation, safety and data privacy to smart metering benefits.
2 BACKGROUND

2.1 Context

The European Commission presented in its 2014 benchmarking report the state of play of smart metering deployment in the European Union. This benchmarking report intended to provide an overview of the national cost benefit analyses (CBA) that Member States (MS) were invited to conduct following the adoption of the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC.

The Electricity and Gas Directives promoted the wider user of smart metering systems as a key enabler to allow active participation of consumers in the internal electricity and gas markets, and to contribute to a secure, competitive and sustainable supply of energy for Europe. According to these directives it is the Member States that decide whether they will proceed with smart metering and the deployment target, usually on the basis of an economic assessment of long-term costs and benefits to the market and the individual consumer. Where the roll-out of smart meters is assessed positive, at least 80% of consumers are expected to be equipped with smart meters by 2020, in accordance with the aforementioned Directives.

The current document comes to update the information presented in that earlier benchmarking report regarding the implementation of smart metering in EU Member States. Moreover, it aims to help put into light lessons learned from the field and early returns of experience that might prove useful for others rolling out smart meters or planning to do so in the near future and are looking for guidance.

2.2 Objectives

The objectives of this report, entitled “Benchmarking smart metering deployment in the EU-28”, are to assess the current progress of smart metering deployment in the EU-28 against the objectives of the Third Energy Package adopted in 2009, consisting of the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC. The scope of this study includes both electricity and gas smart meters.

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This report also considers the latest policy initiatives undertaken by the European Commission, especially the new provisions related to smart metering of the recast Electricity Directive (Directive (EU) 2019/944) that has been recently adopted and which further paves the way for smart metering deployment. Those provisions include, amongst other topics of interest, smart metering system interoperability and support of new services to deliver benefits and ultimately satisfaction to consumers.

The analysis of the updated information collected during this exercise will provide an overall assessment of the smart metering landscape in Europe in a comprehensive and consistent manner as well as its future outlook.

2.3 This report

This draft final report, as submitted to the European Commission, includes a detailed description of the work performed, the information collected, the results as well as the analyses performed for the different tasks, and principal conclusions and recommendations.

3 EUROPEAN LEGISLATIVE FRAMEWORK RELATED TO SMART METERING

The development of smart metering systems has been carried out gradually through the adoption of numerous legislative measures during the last decades (see Figure 1). Originally introduced in the frame of end-use energy savings, the deployment of smart metering systems was expected to contribute to the end consumers understanding of their actual energy consumption hence creating stronger incentives on the demand-side for energy efficiency. Pursuing the liberalization process of energy markets and the constitution of a single European market, the European Commission has also considered the smart metering systems as an effective tool to increase transparency and competition on retail markets for electricity.

The booming of the digital economy and the proliferation of data, now considered as economic and strategic assets, led the European institutions to take unprecedented measures for the personal data protection of its citizens and table an overarching comprehensive legislative framework for this. This framework applies also to the collection, processing and overall management of smart metering data when personal data is concerned. In the case of non-personal data, non-discriminatory and transparent access to it by eligible parties, and irrespectively of the data management model used, is ensured through specific provisions and rules set in the recast Electricity Directive.

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3.1 Institutional background

Directive 2006/32/EC\(^{20}\) on energy end-use efficiency and energy services prescribes the use of cost-effective technological innovations such as “electronic metering” in order to reach its energy saving target of 9\% over the next nine years. Article 13 of this Directive, entitled “Metering and informative billing of energy consumption”, provides that end-consumers for electricity, natural gas, district heating and cooling and domestic water should be provided with competitively priced individual meters that reflect their actual consumption with information on actual time of use. Appropriate billing information should be provided to consumers in order to enable them to regulate their energy consumption. In particular, this information consists in the current actual price and actual consumption of energy, the comparison with the consumption for the same period in the previous year, and when possible, comparison with an average normalized user of energy in the same user category. This Directive constitutes the first step of making customers active by the use of metering.

Directive 2009/72/EC\(^{21}\) and Directive 2009/73/EC\(^{22}\), forming part of the so-called Third Energy Package, provide in Article 3.11 that Member States and regulatory authorities should recommend energy undertakings to optimise energy use via, amongst others, introducing intelligent metering systems or smart grids where appropriate. Annex I of the Directives provide instructions on the economic assessment of long-term costs and benefits to the market and the consumers, which had to be performed by 3 September 2012, and on the implementation of smart metering systems. Annex I, in the case of electricity, specifically states that: “Where roll-out of smart meters is assessed positively, at least 80 \% of consumers shall be equipped with intelligent metering systems by 2020”.

In the context of the smart grids development, the Commission Recommendation 2012/148/EU\(^{23}\) on the preparation for the roll-out of smart metering systems of 9 March 2012 defines a smart metering system as follows: “an electronic system that can measure energy consumption, adding more information than a conventional meter, and that can transmit and receive data using a form of electronic communication”. The Recommendation provides guidance to Member States on the design of smart metering systems to ensure the protection of personal data and recommend Member States to include a data protection impact assessment in the design of smart grids and smart metering systems. This Recommendation also provides guidelines on the methodology for the economic assessment of the roll-out of smart metering, in accordance with Annex I of Directives 2009/72/EC and 2009/73/EC. Finally, this Recommendation lists a set of common minimum functional requirements for smart metering systems for electricity, stemming from standards and experiences from earlier deployments, in order to make them fit for purpose and help secure consumer benefits and increases in energy efficiency.

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\(^{21}\) https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A3A32009L0072

\(^{22}\) https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A3A32009L0073

Directive 2012/27/EU on energy efficiency which updates the energy saving target to 20% by 2020, in its introductory remarks, takes note of the limited effects of the provisions on metering and billing in Directives 2006/32/EC, 2009/72/EC and 2009/73/EC on energy savings, and states that: “it is important that the requirements of Union law in this area be made clearer”. Article 9 is dedicated to metering and provides additional instructions on the deployment and on the minimum common features of smart metering systems as well as on data protection and privacy of final customers. These functional requirements for the case of electricity are later on consolidated within Article 20 of the recast Electricity Directive under the Clean Energy Package, and the Energy Efficiency Directive is accordingly amended.

Apart from the aforementioned provisions in energy-specific legislation, smart metering systems need to comply, being measuring instruments, also to Directive 2014/32/EU. This Directive harmonises the national laws for making available on the market measuring instruments and came to repeal the earlier Directive 2004/22/EC which aimed at establishing the requirements that measuring instruments must satisfy in order to be made available on the market. To ensure that a legal methodological control on these instruments would not lead to barriers to their free movement, the Measuring Instruments Directive (MID) provides that these essential requirements should be in conformity with harmonized standards. Regulation (EU) No 1025/2012 on European standardization designates the International Organisation for Standardisation (ISO), the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU) as legitimate bodies to adopt international standards, and designates the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC) and the European Telecommunications Standards Institute (ETSI) as legitimate bodies to adopt EU-wide standards.

The MID applies to ten different type of measuring instruments and notably gas meters and electrical energy meters. Requirements for measuring instruments are updated again in this Directive which provides the essential requirements common to all measuring instrument in its Annex I, while Annex IV and Annex V respectively concern gas meters and volume conversion devices, and active electrical energy meters.

In order to ensure that the provisions of Recommendation 2012/148/EU were followed consistently across Member States, a template for conducting data protection impact assessment has been developed at Union level. Commission Recommendation 2014/724/EU on the data protection impact assessment template for smart grid and smart metering systems provides guidance to Member States on the use of this Data Protection Impact Assessment Template (called the “DPIA Template”) “to help ensure the fundamental rights to protection of personal data and to privacy in the deployment of smart grid applications and systems and smart metering roll-out” (Article 1).

29 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L.2014.300.01.0063.01.ENG
The Directive 2014/94/EU on the deployment of alternative fuels infrastructures establishes a common framework of measures for the deployment of alternative fuels infrastructures in order to minimise dependence on oil of transport. In Article 7, the Directive states: “The recharging of electric vehicles at recharging points accessible to the public shall, if technically feasible and economically reasonable, make use of intelligent metering systems as defined in point (28) of Article 2 of Directive 2012/27/EU and shall comply with the requirements laid down in Article 9(2) of that Directive”. This provision is directed by the opportunity given by smart metering systems which allow electric vehicles to be recharged during off-peak periods and which would also enable, in the long-run, these vehicles to feed power from the batteries back into the grid at times of high general electricity demand.

3.2 Clean energy package and recast of Internal Electricity Market Directive

The integration of the energy transition at the core of European Union political ambition has led the European Commission to present in November 2016 a package of measures called the Clean Energy Package (see Table 5). The 26 March 2019 the European Parliament, and later on the 22 May 2019 the Council, adopted one of these legislative texts called the Directive on common rules for the internal market for electricity (the recast ‘Electricity Directive’ or Directive (EU) 2019/944) which updates the common rules for the generation, transmission, distribution, energy storage and supply of electricity. Specific provisions related to smart metering systems are included from Article 19 to Article 21, and Annex II.

Article 19 recalls the provision under which Member States shall recommend electricity market undertakings to implement smart metering systems, and specifically states that:

- The deployment of smart metering systems should follow a cost-benefits assessment, which shall be undertaken in accordance with the Commission Recommendation 2012/148/EU;

• Member States should publish the minimum functional and technical requirement for these systems which should be in accordance with those mandated in the Directive and in the spirit of the Commission Recommendation 2012/148/EU;
• Member States should ensure the interoperability of the smart metering systems and their ability to provide output for consumer energy management systems;
• Final customers should contribute to the associated cost of deployment of smart metering systems, in a transparent and non-discriminatory manner, while taking into account the long-term benefits to the whole value chain;
• When the deployment of smart metering systems is negatively assessed, Member States should revise this assessment at least every four year;
• Smart metering systems should be in accordance with applicable Union data protection rules.

Article 20 provides that Member States should ensure that the deployed smart metering systems are in accordance with European standards, the Commission Recommendation 2012/148/EU, and with other specific requirements coming from Article 9 of the Energy Efficiency Directive 2012/27/EU concerning:

• the type of data provided to customers;
• security of data and data communications;
• the availability of these data for the customers;
• the appropriate advice and information that should be given to final customers prior to or at the time of installation of smart meters;

Article 21 provides that customers be entitled to a smart meter, even where the deployment of smart metering systems has been negatively assessed. In such case, customers should bear the associated costs of deployment, under fair, reasonable and cost-effective conditions.

Thereby, the new Electricity Directive updates and puts forward the following provisions that are of direct relevance to smart metering and its use as a tool for demand-side management and flexibility (see Figure 6: Smart meter provisions):

• Establishment of a level playing field for demand response with independent aggregator (Article 17)
• Entitlement to smart meter: consumers entitle to smart meter and how to exercise this right (Article 21)
• Network tariffs: as a general principle of network charges, tariffs paid by customers should fairly reflect the cost they impose on the network operator. This should also be reflected on network charges related to smart metering deployment (full or segmented roll out) (Article 19)
• Consumer Outcomes: consumers directly benefitting from smart meter to promote acceptance and satisfaction, but also to ensure that deployment does not fall short of expectations (of customers but also vis-à-vis the original cost-benefit analysis, e.g. estimated energy savings) (Article 19)
• Data protection and security: follow applicable Union rules; use and adoption of Data Protection Impact Assessment (Article 20, Annex II)
• Citizen engagement: wider use of data brings opportunities, but also poses new challenges for effective competition in retail markets (Article 20)
• Cost benefit assessment: periodic CBA updates every 4 years in case of negative CBA result (Article 19)
Furthermore, Annex II “Smart Metering systems” of the recast Electricity Directive provides, with respect to the aforementioned CBA, that:

“Subject to that assessment, Member States or, where a Member State has so provided, the designated competent authority, shall prepare a timetable with a target of up to ten years for the deployment of smart metering systems.

Where the deployment of smart metering systems is assessed positively, at least 80% of final customers shall be equipped with smart meters either within seven years of the date of the positive assessment or by 2024 for those Member States that have initiated the systematic deployment of smart metering systems before the date of entry into force of this Directive.”
4 DATA COLLECTION AND VALIDATION METHODOLOGY

The objective is to provide a comprehensive and updated overview of the current status of smart metering roll-out, both for electricity and gas. A key challenge is to achieve a consistent and complete view of smart metering deployment in the EU-28. The following figure represents the data collection and validation methodology used for this study.

![Figure 7: Data collection & validation methodology.](image)

### 4.1 Data collection at national level

A standard questionnaire was drafted and used to capture the state of play of smart meter deployment in each Member State. The targeted interlocutor for the questionnaire were the National Regulatory Authorities (NRAs). This was adapted for some Member States, where for instance the subject was under the perimeter of a national Ministry. The questionnaire was structured as to cover all following 8 parts:

1. Regulatory framework  
2. Cost benefit analysis  
3. Roll-out state of play  
4. Functional specifications

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5. Technical specifications
6. Access to data and data management
7. Consumer outcomes
8. Data privacy / security

For each Member State, a dedicated country fiche is compiled based on the answers received from the NRA and other publicly available data sources. The structure of the country fiche follows the structure used in the questionnaire. Additional insights have also been integrated in the fiches regarding smart meter deployment financing, and the use of best available techniques for privacy and information security, including the data protection impact assessment.

Table 6 lists the status of the data collection based on the following legend:

1. Country fiche realised based on NRA (or responsible national authority) feedback and validated by project consortium (through an internal review process in which country fiches completed by a partner were reviewed by another partner).

2. Country fiche realised based on other sources (DSO if the NRA did not provide an answer) and validated by the consortium (similar to point 1).

<table>
<thead>
<tr>
<th>Country</th>
<th>Code</th>
<th>Status</th>
<th>Country</th>
<th>Code</th>
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<td>Latvia (LV)</td>
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<td></td>
<td>United Kingdom 33 (UK)</td>
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</tr>
</tbody>
</table>

Table 6: Status of data collection at national level

32 Given the individual and region-specific data in Belgium, it is rather difficult to determine a single, country-representative value for the parameters considered in the CBA. Data from the regions are available in the respective country fiche document.

33 Throughout the report, the data on the United Kingdom (UK), Great Britain (UK-GB) is discussed as representative of the UK. The region of Northern Ireland (NI) represents a very small proportion of the overall UK figures in terms of overall metering points, i.e. 1.5 % of the total UK number. Therefore, it is not reflective of the MS position as a whole. Furthermore, there are varying methodologies as well as differences in the energy markets between NI and UK-GB.
4.2 Data consolidation at European level

Based on the data collected from the 28 Member States, a consolidated analysis, covering both electricity and gas, has been carried out which details the most relevant facts, and draws out recommendations. At this stage we have also investigated the data comparability of collected information at national level. In this respect, most information has been gathered using pre-selected answers and options from closed lists of propositions. However, we have witnessed significant challenges to compare data and some information might require additional treatment to allow a sensible benchmark, especially economic outputs coming from the national cost benefit assessment and more advanced topics like consumer outcomes and data management.

4.3 Stakeholders engagement activities

In order to deliver strong and undisputed recommendations, a workshop was organised to test ideas and share the preliminary results with the target audience (NRAs) and other relevant stakeholders. The workshop also triggered an informal consultation that allowed stakeholders to express their views à posteriori on the material shared and the views expressed during this interactive event.

5 BENCHMARKING

The aim of this study is to assess the current progress of smart metering deployment in the EU-28 against the objectives of the Third Energy Package adopted in 2009, taking also into consideration the latest policy initiatives undertaken by the European Commission, especially the new provisions related to smart metering under the recast Electricity Directive that has been recently adopted by the co-legislators and which further paves the way for smart metering deployment.

Those provisions include, amongst other topics of interest, smart metering system interoperability and support of new services to deliver benefits and ultimately satisfaction to consumers.

The analysis of the data collected and herein presented provides an overall assessment of the smart metering landscape in the EU-28, in a comprehensive and consistent manner, as well as its outlook. Based upon this analysis, and consolidating our fact-finding exercise, clear and strong recommendations will be framed on the way forward, at both national and European level, towards a successful smart metering deployment in Europe.
5.1 Electricity smart meters

5.1.1 Regulatory framework

This section provides an overview of the regulatory framework for smart metering deployment in all EU-28 Member States. Table 7 gives a comprehensive and updated review of the main legal and regulatory provisions related to electricity smart metering, that have come into force in each Member State. It is noted that, Member States have to transpose the aforementioned EU Directives into national law, and it is only if the CBA shows a positive case for a (wide-scale or partial) roll out of smart meters that they detail rules on smart metering, and those rules would then need to be adopted (see related information included in the tables below).

Whilst some MS have done so when transposing the Third Energy Package, others have not adopted a national specific law for smart metering yet, even though they have also started to roll-out their smart meters following in most cases a positive CBA.

<table>
<thead>
<tr>
<th>Country</th>
<th>Relevant legislation for electricity smart metering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>The primary law is ‘EIWOG 2010’. Delegated laws that further implement smart metering deployment are ‘IME-VO’ for the implementation plan, ‘IMA-VO’ for the functional scope, and ‘DAVID-VO’ for the requirements concerning data availability and presentation to the customer.</td>
</tr>
</tbody>
</table>
| Belgium       | The primary law that enables smart metering for electricity in the Brussels Capital Region is the ‘Ordonnance du 19 juillet 2001 relative à l’organisation du marché de l’électricité en Région de Bruxelles-Capitale’  
The primary law that enables smart metering for electricity in Wallonia is the ‘Décret du 19 juillet 2018 modifiant les décrets du 12 avril 2001 relatif à l’organisation du marché régional de l’électricité et du 19 janvier 2017 relatif à la méthodologie tarifaire applicable aux gestionnaires de réseau de distribution de gaz et d’électricité’.  
In Flanders, the primary law that enables smart metering for electricity is the ‘Energieedecreet’. |
| Bulgaria      | No specific laws have been adopted to frame the deployment of smart metering. |
| Croatia       | The Croatian primary law that enables both smart electricity and gas metering is the ‘Energy Act’. |
| Cyprus        | The primary law that enables CERA to ensure the implementation of smart metering for electricity is the ‘Regulation of the Electricity Market Act3’. It was introduced and amended as follows: 239(I)/2004, 143(I)/2005, 173(I)/2006, 92(I)/2008, 211(I)/2012 and 206(I)/2015. |
| Czech Republic| ‘Act No. 458/2000, Coll. on Business Conditions and Public Administration in the Energy Sectors and on Amendment Other Laws (Energy Act)’. |
| Denmark       | The primary law that enables smart metering for electricity is the ‘Danish Electricity Supply Act’ which were revised 2019. Other relevant regulations are:  
• ‘Forskrifter, som implementerer EU direktiv 32009L0072’  
• ‘Forskrifter, som implementerer EU direktiv 32012L0027’  
• ‘Alle cirkulærer, vejledninger m.v. til denne bekendtgørelse’  
• ‘Afgørelser truffet i henhold til denne retsforskrift’  
• ‘Beretninger fra ombudsmanden, der anvender denne retsforskrift’ |
<p>| Estonia       | The primary law that enables smart metering for electricity is the ‘Grid code (Võrgueseskiri) under Eletricity Market Act’, which was revised in July 2010. |
| Finland       | The primary law that enables smart metering for electricity is ‘Decree of the State Council (66/2009)’. |</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>The primary law that enables smart metering for electricity is the 'Law n° 2005-781' of 13th of July 2005 providing energy policy guidelines, that has been incorporated into the 'Energy Code (art. L.341-4)'.</td>
</tr>
<tr>
<td>Germany</td>
<td>The primary law that enables smart metering for both electricity and gas is 'Gesetz zur Digitalisierung der Energiwende'. The delegated law that further implements smart metering deployment for electricity is 'Messstellenbetriebsgesetz'.</td>
</tr>
<tr>
<td>Greece</td>
<td>The primary law that enables smart metering for electricity is 'Law 3855/2010'. This law is still to be revised. The purpose of this law is to enable to replace 80% of the conventional meters with smart meters until 2020.</td>
</tr>
<tr>
<td>Hungary</td>
<td>The primary laws that enable smart metering for electricity is the 'Electricity Act LXXXVI' of 2007. The 'Government Decree No. 26/2016' is currently the delegated law that further implements smart metering deployment for both smart electricity and gas meters.</td>
</tr>
<tr>
<td>Ireland</td>
<td>The primary law introduced by the Department of Communications, 'Climate Action and Environment in 2014 that enables smart metering for electricity and gas meters is the 'Statutory Instrument 426', transposed into Irish law by way of secondary legislation based on the obligations under the Third Directive.</td>
</tr>
<tr>
<td>Italy</td>
<td>The primary law enabling smart metering for electricity in Italy is the 'Legislative Decree 102/20143', approved on 4th July 2014, which transposes the EU Directive on Energy Efficiency (EED 2012/27/EU).</td>
</tr>
<tr>
<td>Latvia</td>
<td>There is no specific law framing the smart metering deployment for electricity.</td>
</tr>
<tr>
<td>Lithuania</td>
<td>The general principles of implementation of the Lithuanian energy sector vision are approved in the National Strategy for Energy Independence. The latest version of the strategy was approved by the Parliament of the Republic of Lithuania in June 21st, 2018 ‘Resolution No. XIII-1288’ (hereinafter referred to as NENS). The approved NENS envisages that the development of the Lithuanian energy sector must be based on smart technologies and digitalization of energy (Article 19.8). They are set out in the General Regulations for the Installation of Electrical Equipment, approved by the Minister for Energy in January 13th, 2017 (‘Order No 1-9’). These requirements are based on the implementation of the Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (i.e. Article 9 (2) (a), (b), (c) and (d), and Article 10 (2) and (3) (a) and (e)).</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>The primary law that enables smart metering for electricity is 'Loi modifiée du 1er août 2007 relative à l'organisation du marché de l'électricité (Art 29)'. This law was last revised in 2015. This revision introduced the mandate to roll out Smart Meters. Next revision was submitted to parliament on 19/03/2018, this time no changes were made to the Smart Meter paragraphs.</td>
</tr>
<tr>
<td>Malta</td>
<td>The primary laws that enable smart metering for electricity are the Subsidiary Legislation 545.01 on Electricity Supply Regulations (S.L. 545.13) and the 'Subsidiary Legislation 545.01 on Electricity Supply Regulations (S.L. 545.01)'.</td>
</tr>
</tbody>
</table>
| The Netherlands | The primary laws that enables smart metering for electricity and gas are:  
- 'Wet implementatie EG-richtlijnen energie-efficiëntie'  
- 'Wijziging van de Elektriciteitswet 1998'  
- 'Gaswet ter verbetering van de werking van de elektriciteits- en gasmarkt (31374)' These laws are currently under revision. A delegated law that further implements smart metering deployment for electricity is the 'Besluit op afstand uit te lezen meetinrichtingen ten behoeve van de grootschalige uitrol van de slimme meter'. |
| Poland | The primary law that enables smart metering for electricity and gas is the 'Energy Law'. |
| Portugal | The primary laws that enable smart metering for electricity and gas are 'Decreto-Lei n° 215-A/2012' (October 8) and 'Decreto-Lei n° 231/2012' (October 26), which have been both revised. The delegated law that further implements smart metering deployment for electricity is 'Portaria n° 231/2013' (July 22). |
Romania  The primary law that enabled smart metering for electricity is the 'Law on Electricity and Natural Gas No. 123/2012', put in place in 2012 and revised in 2018 with 'Law no. 167/2018'.

Slovakia  The Slovak primary law that enables smart metering is 'Act on Energy No. 251/2012'. The 'Decree No. 358/2013' of the Ministry of Economy of the Slovak Republic is currently the delegated law laying down the procedure and conditions for the introduction and operation of smart metering systems in the electricity sector.

Slovenia  The 'Energy Act' is currently the primary law that enables electricity and gas smart metering in Slovenia, as it includes Articles 49 addressing "Intelligent metering systems" for the electricity sector. In 2015, as set out by the Energy Act (see Paragraph 2.1.1), the "Decree on Measures and Procedures for the Establishment and Connectivity of Advanced Measuring Systems for Electricity" ("Uredba o ukrepih in postopkih za uvedbo in povezljivost naprednih merilnih sistemov električne energije (Uradni list RS, št. 79/15)") was adopted.

Spain  The primary law that enables smart metering for electricity is the 'Royal Decree 1110/2007', of August 24th. The order 'ITC/3860/2007' (1st additional provision) reviews the electricity tariffs and further sets the implementation of smart metering deployment for electricity. While order 'IET/290/2012' also reviews the latter to include various modifications.

Sweden  The primary law that enables smart metering for electricity is the ‘Electricity Act 2012’ which has been revised. A further revision is expected at the end of 2018.

United Kingdom  The primary law that enables smart metering for electricity is the ‘Smart Meters Act 2018’, which in part amends existing smart metering powers in the ‘Energy Act 2008’.

Table 7: National legislation for the deployment of electricity smart meters

Figure 8 provides an overview on the status of smart meter related legislation for electricity.

It can be observed that approximately three quarters of Member States have implementation strategies in place with specific legal provisions for the deployment of smart meters. For instance, in Germany, deployment and operation of smart metering system is a legal obligation of the Metering Point Operator (MPO). This specific legal status has been created by ‘Messstellenbetriebsgesetz’ (the “Act on the Opening of Metering Systems for Electricity and Gas”) that fully liberalised metering point operation and metering services.

Therefore, Member States show a variable progress in the redefinition or refinement of their legal framework devoted to prevent and accommodate smart metering challenges. It is noted that our perspective was to assess here if MS had taken steps further, namely defining a deployment strategy (high level objectives and key changes to the market model to be implemented) and eventually the implementation laws that will accompany the day-to-day deployment of smart metering, such as priority targets, channels for communication and dispute resolution, tariffs,… etc.

An interesting development we have witnessed in several Member States is the progress achieved by grid operators to deploy and install smart metering system, while the complete legal package is still to be adopted by National Authorities. For instance, Flanders lacks the political decision to roll out even though significant progress has been realized by local grid operators, in terms of smart meter penetration rate as well as the preparatory steps to enable a consistent value chain as a prerequisite to deliver benefits to consumers. Moreover, Croatia, Slovenia are very active on smart grids even though the local operators are facing similarly a lagging legal framework.
5.1.2 Cost benefit analysis

This section provides an overview of the timing and the result of the latest national cost benefit assessment (hereafter CBAs) performed for the deployment of smart meters by each Member State. For many of the Member States the initial CBA was carried out on the back of pilot projects, in order to integrate the experiences from those projects. Whereas the revised CBAs focus more on the actual scale and timing of the rollout.

First, the status and outcome of the latest national CBAs for electricity smart meters are described in subsection 5.1.2.1. In a second step (subsection 5.1.2.2), the CBA analysis is detailed with a focus on the cost, benefits and market roles considered in the CBA analysis for each Member State.
### Status of Most Recent CBA

For electricity smart meters, most Member States have performed at least one CBA, except for Spain. As it can be observed in Table 8, for many Member States the result of the CBA have remained unchanged compared to the initial benchmarking exercise carried out in 2013. In some cases the CBA results have changed, going from negative or non-conclusive to positive in the case of electricity smart meters; like in Latvia and Portugal.

On the other hand, in Ireland the result of the CBA has gone from positive (in 2013) to negative (in 2018). The new Electricity Directive[18] under the “Clean Energy Package” indicates that Member States having obtained a negative CBA result must regularly revise their CBA, at least every 4 years, in response to significant changes in their assumptions and to technological and markets developments. Once the result of the CBA is positive, at least 80% of final customers for electricity shall be equipped with smart metering systems within 7 years from the date of the positive assessment.

<table>
<thead>
<tr>
<th></th>
<th>Initial CBA result 34 (as of July 2013)</th>
<th>Revised CBA result 35 (as of July 2018)</th>
<th>Latest CBA conducted (as of July 2018)</th>
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<td>Austria</td>
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<tr>
<td>Belgium</td>
<td>Negative/Inconclusive</td>
<td>Positive/Inconclusive</td>
<td>2017</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>N/A</td>
<td>Negative</td>
<td>2013</td>
</tr>
<tr>
<td>Croatia</td>
<td>N/A</td>
<td>Positive</td>
<td>2017</td>
</tr>
<tr>
<td>Cyprus</td>
<td>N/A</td>
<td>Inconclusive</td>
<td>2014</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Negative</td>
<td>Negative</td>
<td>2016</td>
</tr>
<tr>
<td>Denmark</td>
<td>Positive</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Estonia</td>
<td>Positive</td>
<td>Positive</td>
<td>2011</td>
</tr>
<tr>
<td>Finland</td>
<td>Positive</td>
<td>Positive</td>
<td>2008</td>
</tr>
<tr>
<td>France</td>
<td>Positive</td>
<td>Positive</td>
<td>2013</td>
</tr>
<tr>
<td>Germany</td>
<td>Negative 36</td>
<td>Negative</td>
<td>2013</td>
</tr>
<tr>
<td>Greece</td>
<td>Positive</td>
<td>Positive</td>
<td>2012</td>
</tr>
<tr>
<td>Hungary</td>
<td>Inconclusive</td>
<td>Pending</td>
<td>2018</td>
</tr>
<tr>
<td>Ireland</td>
<td>Positive</td>
<td>Positive</td>
<td>2017</td>
</tr>
<tr>
<td>Italy</td>
<td>N/A</td>
<td>Positive</td>
<td>2014</td>
</tr>
<tr>
<td>Latvia</td>
<td>Negative</td>
<td>Positive</td>
<td>2017</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Negative</td>
<td>Inconclusive</td>
<td>2018</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Positive</td>
<td>Negative</td>
<td>2016</td>
</tr>
<tr>
<td>Malta</td>
<td>NO CBA</td>
<td>NO CBA</td>
<td>NO CBA</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Positive</td>
<td>Positive</td>
<td>2010</td>
</tr>
</tbody>
</table>

34 The conditions of the initial CBA results (as of July 2013) were a large-scale roll-out covering at least 80% of the consumers by 2020.

35 The conditions of the revised CBA results (if applicable) were a large-scale roll-out covering at least 80% of the consumers by 2020.

36 Positive CBA for a segmented rollout only, for Germany, Slovakia, and originally also for Latvia.
Figure 9 provides a graphical overview of the most recent CBA results (as of July 2018) for the deployment of electricity smart meters.

![Revised CBA results for electricity smart meters](image)

Figure 9: Revised CBA results electricity smart meters, considering a large-scale rollout to at least 80% by 2020 (as of July 2018).

### Table 8: Status of last CBA for electricity smart meters conducted as of the previous and current study, including the outcome of the CBA(s) already conducted

<table>
<thead>
<tr>
<th>Country</th>
<th>Previous CBA</th>
<th>Current CBA</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poland</td>
<td>Positive</td>
<td>Positive</td>
<td>2014</td>
</tr>
<tr>
<td>Portugal</td>
<td>Inconclusive</td>
<td>Positive</td>
<td>2015</td>
</tr>
<tr>
<td>Romania</td>
<td>Positive</td>
<td>Positive</td>
<td>2012</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Negative</td>
<td>Inconclusive</td>
<td>2013</td>
</tr>
<tr>
<td>Slovenia</td>
<td>N/A</td>
<td>Positive</td>
<td>2014</td>
</tr>
<tr>
<td>Spain</td>
<td>NO CBA</td>
<td>NO CBA</td>
<td>2015</td>
</tr>
<tr>
<td>Sweden</td>
<td>Positive</td>
<td>Positive</td>
<td>2015</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Positive</td>
<td>Positive</td>
<td>2016</td>
</tr>
</tbody>
</table>

---

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5.1.2.2 CBA ANALYSIS

Key cost and benefit items were defined in the Recommendation 2012/148/EU, inviting Member States to use the same structure for their CBA. This subsection presents all costs, benefits and market actors considered in the CBA for each Member State. As indicated in Figure 10, the functionalities foreseen will create benefits for the different actors (e.g. consumers, grid operators, etc.), while the assets involve capital (CAPEX) and operational expenditures (OPEX). These costs and benefits serve as input for the Cost Benefit Analysis.

![Diagram of CBA Analysis](image)

**Figure 10: Basic steps for a cost benefit analysis.**

**Costs considered in the electricity CBA**

Table 9 provides an overview of the cost items considered by each Member State in their latest CBA, both for electricity and gas smart metering deployment. The most common cost items considered by the Member States while conducting their CBA can be observed in Figure 11. The capital investment linked to the smart meters themselves and the IT infrastructure are the cost items most selected by Member States. These are followed closely by operational expenses linked to meter readings, IT maintenance, telecom and network management.

Despite the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC promoting the wider use of smart metering systems as a key enabler to allow active participation of consumers in the internal electricity and gas markets and to contribute to a secure, competitive and sustainable supply of energy for Europe, only few (6 out of 28) Member States are considering investment expenditures in in-home-displays and operational expenditures for active customer engagement while carrying out their assessment.
### Benchmarking Smart Metering deployment in the EU-28

#### CAPEX
- Investment in smart meter
- Investment in IT
- Investment in Telecom
- Investment in In-home display
- Sunk cost of conventional meters

#### OPEX
- IT maintenance
- Network management and front end
- Telecom
- Change management
- Unplanned renewal and failures of smart meter
- Revenue reduction
- Meter reading
- Call center and customer service
- Consumer engagement programme
- Other
Benefits considered in the electricity CBA

Table 10 provides an overview of the various benefit items considered by each Member State when performing the CBA.

Consumers will have **direct benefits** from bill reductions, as a result of:

- Increased energy efficiency as smart meters will allow them to get insight into their energy consumption. These insights may result in a reduction of energy consumption inducing reduced electricity and gas energy bills.

- A reduced bill due to dynamic pricing, i.e. a price defined the day before or near real time and shared with the consumer. A dynamic pricing profile will allow the consumer to shift their energy consumption in time (e.g. white goods) allowing them to reduce their energy bill.

Moreover, consumers will **benefit indirectly from potential cost savings that other market actors** can benefit from as a result of several other technical and non-technical benefits.
• Smart meters will allow automated meter reading resulting in operational savings (vs. manual reading by for instance the DSO). The automated reading will also allow reduce other non-technical losses. For instance, meter readings will be less sensitive to administrative errors, energy offtake is less sensitive to fraud, technical losses or fraud can be much faster identified with regular meter reading (e.g., near real-time).

• Consumers and other actors may offer flexibility services, which allows different actors (e.g., grid operators, supply chain and generators) to more optimally operate and maintain their assets. Therefore, they may incur reduced technical losses, additional assets/capacity may be deferred, etc. This can lead to cost savings for the market actors which may ultimately result in a reduced energy bill for consumers.

Figure 12 presents the ranking of the consolidated results of the considered benefits across the EU-28. The most common benefit considered by Member States is linked to the operational savings that can be achieved through remote meter readings. The reduction of non-technical losses (e.g. administrative or fraud), and the consumer’s bill reduction as a result of increased energy efficiency are the next two main benefits considered.

Despite the smart metering roll-out being in nearly all Member States DSO-led, the main benefits considered related to the DSO is the meter reading & operation savings and non-technical losses (incl. for instance fraud), while on the other hand distribution capacity deferral, O&M of assets, outage management and reduction of technical losses are less considered as benefits while conducting the CBAs.

Benefits that focus on the potential services that could be offered to consumers through smart meters (e.g. optimisation of auto-consumption through access to solar PV installations) as well as flexibility services have been considered by a small number of Member States.
Table 10: Considered benefits in the CBA for each Member State (legend: green = considered, blank = not considered; grey = data not available).
### Market actors considered in the electricity CBA

The various market actors considered by each Member State when carrying out the CBA can be observed in Table 12; a consolidated ranking is presented in Figure 13.

With no real surprise, the most common actor is the distribution system operator (DSO), who in many countries is responsible for metering installation, meter reading, and grid operations. Apart from UK where the smart meter ownership and installation is supplier-led, in all Member States the smart metering is DSO-led. Many technical benefits (see Section 0) are directly related to the DSO, such as meter reading & operations savings, technical operational & maintenance benefits, etc.

Table 11 demonstrates which market actor (i) owns the smart meter and which market actor (ii) is responsible for the installation of the smart meter in each Member State.

<table>
<thead>
<tr>
<th>Country</th>
<th>Meter ownership</th>
<th>Meter installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>BE (BR)</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>BE (FL)</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>BE (WA)</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>BG</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>HR</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>CY</td>
<td>Distribution system owner</td>
<td>Distribution system owner</td>
</tr>
<tr>
<td>CZ</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>DK</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>EE</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>FI</td>
<td>DSO</td>
<td>DSO</td>
</tr>
<tr>
<td>FR</td>
<td>DSO&lt;sup&gt;37&lt;/sup&gt;</td>
<td>DSO&lt;sup&gt;37&lt;/sup&gt;</td>
</tr>
<tr>
<td>DE</td>
<td>DSO or 3&lt;sup&gt;rd&lt;/sup&gt; party meter operator</td>
<td>DSO or 3&lt;sup&gt;rd&lt;/sup&gt; party meter operator</td>
</tr>
<tr>
<td>GR</td>
<td>DSO</td>
<td>DSO</td>
</tr>
</tbody>
</table>

<sup>37</sup> In France meters ownership is retained by local municipalities while the DSO operates them under a multi-annual concession.
Table 11: Meter ownership & installation in Member States for both electricity and gas smart metering

Other important market actors are the energy supplier who collects metering data, e.g. to send the energy bill to the consumer, and the consumers.

Actors such as the transmission system operator (TSO), balance responsible parties (BRP), producers, state/society (e.g. less tax incomes due to energy efficiency) and NRAs are considered to some extent, as they are mainly actors which will benefit from smart metering data, but are less involved in the smart metering roll-out (from a cost-perspective). Service providers like telecom companies and aggregators are the least considered actors in the assessment.
Table 12: Considered market actors in the CBA for each Member State (legend: green = considered, blank = not considered; grey = data not available).

Figure 13: Ranking of the considered market actors in the CBA.
5.1.2.3 NORMALISED COST AND BENEFIT PER METERING POINT FOR ELECTRICITY

The normalised cost and benefit per metering point for each Member State can be seen in Table 13. It is important to note that two methods were proposed for the computation of normalised cost and benefit per metering point in the data collection exercise. These were:

1. Direct computation of key indicators (cost and benefit per installed meter) by the NRA (or other entity in charge)
2. The providing of yearly estimates on OPEX, CAPEX, benefits, number of meters in order to estimate the cost and benefit over the given period

All responding Member States in the current investigation have chosen the first method. As highlighted in the following table, the collected data shows a high level of inconsistency between initial and updated CBAs outcomes. During the earlier benchmarking exercise of 2013/2014, national regulatory authorities had at their disposal, and made available, recent cost/benefit data coming from their CBAs that were meant to be conducted, in accordance with the 2009/72 Electricity Directive, by September 2012 – an option that most Member States decided to take. In this updated benchmarking, we gathered the latest information where available, with the following outcome:

- 2 Member States did not perform a CBA or were unable to provide the suggested information to compute comparable indicators, namely Bulgaria and Hungary, neither in 2014 nor in 2018.
- 8 Member States did not update their initial CBA: Denmark, France, Germany, Netherland, Malta, Romania, Slovakia and Sweden.
- 4 Member States have performed their first CBA that occurred after the publication of the first benchmarking report (2014): Croatia and Cyprus show a positive result, while costs took over benefits in Slovenia and Spain.
- Member States that have updated their CBA may have found different results than the initial one: in Latvia and Lithuania, the new CBA produced a positive result; while the contrary happened in Austria and Luxembourg (for both countries the estimated benefits in the updated CBA accounted for only ca. 10% of the benefits estimated in the initial CBA). In spite of the negative outcome of their revised CBA, these two Member States are still pursuing the smart meters deployment process.
- In Czech Republic and Belgium, an updated CBA has confirmed the initial negative result, while the remaining 8 Member States (Estonia, Finland, Greece, Ireland, Italy, Poland, Portugal, UK) confirmed their initial positive assessment of smart metering deployment.

<table>
<thead>
<tr>
<th></th>
<th>TOTEX (€/meter) 2018</th>
<th>TOTEX (€/meter) 2013</th>
<th>Benefit (€/meter) 2018</th>
<th>Benefit (€/meter) 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>332.00 €</td>
<td>590.00 €</td>
<td>70.00 €</td>
<td>654.00 €</td>
</tr>
<tr>
<td>Belgium</td>
<td>340.00 €</td>
<td>340.00 €</td>
<td>316.00 €</td>
<td>316.00 €</td>
</tr>
<tr>
<td>Bulgaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Croatia</td>
<td>272.40 €</td>
<td>353.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>275.80 €</td>
<td>969.00 €</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 13: Normalised costs and benefits per metering point, for the case of electricity, for each Member State (Legend: blank = data not available).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>766.00 €</td>
<td>766.00 €</td>
<td>499.00 €</td>
<td>499.00 €</td>
</tr>
<tr>
<td>Belgium</td>
<td>350.33 €</td>
<td>766.00 €</td>
<td>100.82 €</td>
<td>499.00 €</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>125.00 €</td>
<td>225.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Croatia</td>
<td>225.00 €</td>
<td>233.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cyprus</td>
<td>233.00 €</td>
<td>233.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>233.00 €</td>
<td>233.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Denmark</td>
<td>233.00 €</td>
<td>233.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estonia</td>
<td>233.00 €</td>
<td>233.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Finland</td>
<td>269.00 €</td>
<td>269.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>269.00 €</td>
<td>269.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>269.00 €</td>
<td>269.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Greece</td>
<td>269.00 €</td>
<td>269.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hungary</td>
<td>269.00 €</td>
<td>269.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ireland</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Latvia</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lithuania</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Malta</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Netherlands</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Poland</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Portugal</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Romania</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Slovakia</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Slovenia</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sweden</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>176.00 €</td>
<td>176.00 €</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 14: Comparison on normalised costs and benefits per metering point for each Member States between the previous (2014) and current benchmarking report (2018).
Figure 15: Comparison on normalised costs and benefits per metering point for each Member States between the previous (2014) and current benchmarking report (2018)

Figure 14 and Figure 15 bring out the high variability in some of the results compared to the earlier data (comparing the 2013 and 2018 CBA results). As an example, five out of the ten countries (namely Austria, Czech Republic, Ireland, Luxembourg and Poland) exhibit lower costs and benefits in the 2018 CBA compared to the previous one, two of them (Lithuania and Portugal) exhibit higher costs and benefits, whilst irregular variation levels can be observed for the others (Estonia, Greece, Italy, Latvia and United Kingdom).

What can be seen from Table 9 - Table 12 is that there is high variation between the market actors, cost and benefit items considered by each Member State and as a result, there will be a high variation between the normalised cost and benefit per metering point. This is also reflected in Figure 16.
Those statistics show, on average, that both costs and benefits have decreased since the first benchmark. New cost estimates show less variation amongst member states than for the previous exercise. However, benefits estimate still vary greatly between member states, the latest statistics showing a higher variation of benefit estimates than previously.

<table>
<thead>
<tr>
<th>€/metering point</th>
<th>TOTEX 2018</th>
<th>TOTEX 2013</th>
<th>Benefit 2018</th>
<th>Benefit 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>213</td>
<td>256</td>
<td>258</td>
<td>286</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>117</td>
<td>181</td>
<td>212</td>
<td>172</td>
</tr>
</tbody>
</table>

Table 14 - Average and standard deviation for cost and benefit per metering point, in the case of electricity smart meters and considering data from all EU-28 countries

In order to refine this analysis, we have separated Member States into 4 groups\textsuperscript{38}, depending on their actual penetration level and their commitment to deploy. Group 1 includes countries that have more than 75% of smart meters, group 2 targets countries that had a positive CBA, and took a commitment to deploy 80% in 2020 but do not exceed 75% of deployment. The third group gathers countries with less than 10% of smart meters, while the last fourth group focus on countries that have a significant penetration of smart meter but that did not commit to the 80% target in 2020.

\textsuperscript{38} Group 1 includes Denmark, Estonia, Finland, Italy, Malta, Spain and Sweden. Group 2 includes Austria, France, Luxembourg, The Netherlands and United Kingdom. Group 3 includes Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Germany, Greece, Hungary, Ireland, Lithuania, Poland, Romania and Slovakia. Group 4 includes Latvia, Portugal and Slovenia.
The results are detailed in the Table 15 and Figure 17.

<table>
<thead>
<tr>
<th></th>
<th>€/metering point</th>
<th>TOTEX 2018</th>
<th>TOTEX 2013</th>
<th>Benefit 2018</th>
<th>Benefit 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Average</td>
<td>213</td>
<td>256</td>
<td>258</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>117</td>
<td>181</td>
<td>212</td>
<td>172</td>
</tr>
<tr>
<td>Group 1</td>
<td>Average</td>
<td>156</td>
<td>165</td>
<td>218</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>72</td>
<td>78</td>
<td>84</td>
<td>61</td>
</tr>
<tr>
<td>Group 2</td>
<td>Average</td>
<td>214</td>
<td>246</td>
<td>189</td>
<td>339</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>66</td>
<td>158</td>
<td>125</td>
<td>172</td>
</tr>
<tr>
<td>Group 3</td>
<td>Average</td>
<td>253</td>
<td>326</td>
<td>326</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>138</td>
<td>218</td>
<td>253</td>
<td>184</td>
</tr>
<tr>
<td>Group 4</td>
<td>Average</td>
<td>172</td>
<td>201</td>
<td>179</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>122</td>
<td>102</td>
<td>204</td>
<td>92</td>
</tr>
</tbody>
</table>

Table 15 - Statistical outcomes of cost and benefit per metering point for different groups of Member States depending on their level of smart metering deployment

The first group (Denmark, Estonia, Finland, Italy, Malta, Spain and Sweden) shows a significantly lower variation in their assessment between the 2013 and the 2018 data, which is partly explained but the lack of an updated CBA but also on a better knowledge of economic outcomes and expenses of smart metering systems potentially due to access to relevant field data.
The second group (Austria, France, Luxembourg, The Netherlands and United Kingdom) shows a common pattern, namely that cost and benefits have both declined, but initial benefits seem to have been significantly overestimated since their decrease is much more important. The decrease in variation depicts an increased maturity and knowledge of benefits and costs, using pilot project and early waves of deployment as a source of feedback for the economic assessment.

The third group (Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Germany, Greece, Hungary, Ireland, Lithuania, Poland, Romania and Slovakia), characterized by a lower commitment level towards smart metering deployment, has witnessed a significant decrease in capital and operating expenses for smart metering assessment. Their standard deviation remains very large though for both costs and benefits indicating a different degree of commitment to continue pursuing a wider range deployment.

Finally the last group (Latvia, Portugal and Slovenia) has demonstrated some sort of ambiguity towards smart metering by deploying them without taking any formal commitment for the target to reach. A simultaneous decrease in costs and increase in benefits has triggered a wave of new commitment for smart metering, even though the full roll out will require more than the business as usual to be completed within the next 10 years.

5.1.3 Deployment state of play

A detailed analysis has been performed on the progress and the current deployment rate of the smart metering deployment across the EU-28, for each Member State.

5.1.3.1 MARKET DRIVERS FOR SMART METER ROLL-OUT

6 primary market drivers were identified for the deployment of smart meters:

- Enabling dynamic tariffs for households and SMEs;
- Digitalization of the distribution grid and optimization of the network operations;
- Digitalization of the retail market to foster innovation and new services by private actors;
- Integrating decentralized energy resources with flexible access, such as load shedding or infeed curtailment;
- Supporting actions for tackling fuel poverty;
- Supporting energy efficiency.

The primary drivers for the deployment of smart meters in each Member State can be observed in Table 16. Figure 18 consolidates this information to visualize the ranking of these market drivers across the EU-28.

The key driver to roll-out smart meters is the ‘digitalization of the distribution grid to allow optimization of the network operations’, providing direct value for grid and generation operators to optimize the operation and usage of their existing assets. This may defer additional grid capacity (investments), leading to indirect benefits for the consumer. For instance, the German legislator has conceived smart metering systems as a digital infrastructure for the energy transition.
Dynamic pricing for households and SMEs is the second ranked key driver for the deployment of smart meters, providing value for multiple actors (e.g. flexibility for grid operators and reduced energy bills for customers).

On the other hand, tackling issues like fuel poverty or supporting energy efficiency are rarely seen as a main drivers for the deployment of smart meters by most Member States, except for some countries where the risk of fuel poverty recently stood at worrying level (e.g. Romania).

<table>
<thead>
<tr>
<th></th>
<th>Enable dynamic tariffs for households and SMEs</th>
<th>Digitalize distribution grid and optimize network operations</th>
<th>Digitalize retail market to foster innovation and new services by private actors</th>
<th>Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)</th>
<th>Support actions tackling fuel poverty</th>
<th>Support energy efficiency</th>
</tr>
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<tr>
<td>Austria</td>
<td></td>
<td></td>
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<tr>
<td>Belgium (BR)</td>
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<tr>
<td>Belgium (FL)</td>
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<td>Belgium (WL)</td>
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<td>Cyprus</td>
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<td>Czech Republic</td>
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<td>Denmark</td>
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<td>Estonia</td>
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<td>Finland</td>
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<td>Germany</td>
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<td>Greece</td>
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<td>Hungary</td>
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<td>Ireland</td>
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<td>Italy</td>
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<td>Latvia</td>
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<td>Lithuania</td>
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<tr>
<td>Luxembourg</td>
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<td>Malta</td>
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<tr>
<td>Netherlands</td>
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<tr>
<td>Poland</td>
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<tr>
<td>Portugal</td>
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</tr>
</tbody>
</table>
5.1.3.2 ELECTRICITY SMART METERING LARGE-SCALE ROLLOUT IN MEMBER STATES

The targets for reaching wide scale rollout (i.e. to at least 80% of consumers) for electricity smart meters for each Member State can be observed in Figure 19. Only a few countries – namely Sweden, Finland, Italy, Estonia, Malta, Spain and Denmark – have already a wide-scale roll-out for electricity in place today. Most countries will reach such a wide-scale roll-out (to at least 80% of the consumers) in the period 2020-2025. About one third of the Member States will roll-out smart meters by 2030 or later, as their latest CBA is still negative. According to the recast Electricity Directive18, these Member States will have to perform a CBA every 4 years. Once the result of the CBA is positive, at least 80% of the final consumers shall be equipped with smart metering systems within 7 years from the date of the positive assessment.
Final Report Benchmarking Smart Metering deployment in the EU-28

Figure 19: Overview of target period for the completion of a wide-scale rollout of electricity smart meters with at least 80% of all consumers for each Member State.

Figure 20 shows the estimated target date for completion of a wide scale rollout of smart meters (at least 80% of consumers) as of 2018, and its comparison with the original estimations from 2013. It can be seen that compared to the initial targets, fewer Member States are in line to reach the deployment rate of at least 80% by 2020. Furthermore, some Member States that had no targets or targets beyond 2030, are putting steps in place to achieve mass rollout of smart meters by 2030, following a positive CBA.

Figure 20: Overview (aggregated) of target period for a wide-scale rollout of electricity smart meters with at least 80% of all consumers (study 2018), compared to the initial targets set in the previous study (data as of 2013).
Figure 21 shows the evolution of the target period for a large-scale rollout for each Member State. As an example, Slovenia that had a target for wide scale rollout of beyond 2030 (or defined), has now put measure in place to ensure a wide scale rollout of 80 % by 2020 and 100 % by 2025.

Another example is Poland which has initially planned to reach a wide scale rollout by 2020 following the CBA carried out in 2012. However, the initial primary law that enables smart metering, did not made it mandatory. A draft legislation, which is currently under public consultation, will oblige DSOs to install electricity smart meters in at least 80 % of the consumers’ premises. According to latest estimates, Poland is now on track to reach a wide scale rollout by 2026.

By the time this report is being elaborated, it can be foreseen that some target periods for a electricity smart metering large-scale rollout may be missed. Among other examples, Greece planning to complete its large-scale rollout by 2020 should install ca. 7,000,000 smart meters within 6 month, which is already a challenge to complete their procurement process; and United Kingdom which set his large-scale rollout target to 2020 exhibited in January 2018 an electricity smart meter penetration rate of only 19.9%.

To conclude, Figure 22 presents the official deployment strategy per Member State to reach their 80% target on the roll-out of electricity smart meters. Other countries that are already rolling out smart meters include Slovakia, with a target of about 10 % roll-out by 2020, Germany with a selective roll-out, and Portugal whose electricity smart meters have reached a 20.5% penetration rate.
<table>
<thead>
<tr>
<th>Country</th>
<th>Start Year</th>
<th>End Year</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>2003</td>
<td>2008</td>
<td>Completed</td>
</tr>
<tr>
<td>Italy</td>
<td>2001</td>
<td>2012</td>
<td>Completed</td>
</tr>
<tr>
<td>Finland</td>
<td>2008</td>
<td>2011</td>
<td>Completed</td>
</tr>
<tr>
<td>Malta</td>
<td>2008</td>
<td>2014</td>
<td>Completed</td>
</tr>
<tr>
<td>Spain</td>
<td>2011</td>
<td>2018</td>
<td>Completed</td>
</tr>
<tr>
<td>Austria</td>
<td>2011</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2011</td>
<td>2020</td>
<td>100%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>2012</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>Poland</td>
<td>2012</td>
<td>2024</td>
<td>80%</td>
</tr>
<tr>
<td>Estonia</td>
<td>2011</td>
<td>2017</td>
<td>2014</td>
</tr>
<tr>
<td>Romania</td>
<td>2011</td>
<td>2021</td>
<td>Completed</td>
</tr>
<tr>
<td>Greece</td>
<td>2014</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>2014</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>Denmark</td>
<td>2014</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>France</td>
<td>2014</td>
<td>2020</td>
<td>80%</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>2017</td>
<td>2019</td>
<td>95%</td>
</tr>
<tr>
<td>Ireland</td>
<td>2009</td>
<td>2024</td>
<td>100%</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2009</td>
<td>2024</td>
<td>N/A</td>
</tr>
<tr>
<td>Latvia</td>
<td>2014</td>
<td>2022</td>
<td>N/A</td>
</tr>
<tr>
<td>Lithuania</td>
<td>2020</td>
<td>2023</td>
<td>N/A</td>
</tr>
<tr>
<td>Croatia</td>
<td>2014</td>
<td>2026</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Figure 22: Official deployment strategy per Member State on the large-scale roll-out (80% or higher coverage) of smart electricity meters.

In order to have a second source of information and check the consistency of the collected data, key manufacturer data has been used, as shown in Figure 23.

---

39 For Latvia and Croatia, the starting year of the large-scale roll-out has not been communicated.
Those data show a high degree of consistency even though for some countries, the figures seem to be higher. In our understanding, these statistics represent market expectations; we have a more conservative view, which reflects the commitment made by NRAs.

5.1.3.3 CURRENT STATUS ON SMART METER DEPLOYMENT RATE

This subsection provides insight into the state of play of electricity smart meter deployment rate in all Member States as of 31/12/2017.

Table 17 presents the total number of metering points and the total number of smart meters installed (cumulative and in 2017), from which the overall penetration rate of smart meters per Member State can be defined. The number of smart meters installed in 2017 has also been provided as an indication of the rhythm in which each Member State is deploying smart meters.

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41 The total number of metering points includes household and SME metering points.

42 However, no instalment rate curve is available.
In January 2018, 33.83% of all electricity metering points in the EU-28 were equipped with a smart meter (ca. 99,080,000 smart meters). Taken separately, households electricity metering points and SMEs metering points were equipped at 34.5% and 27.52% respectively.

It should be noted that some Member States did not provide differentiated data on metering points for households and metering points for SMEs, nor differentiated data on whether smart meters were installed for households metering point or for SMEs metering points. For those Member States, we used Eurostat data\(^43\) to find out the number of SMEs for each country and estimate the number of metering points for SMEs. We followed a simple yet realistic hypothesis under which each SME accounts for one metering point. We were then able to differentiate between households and SMEs metering points. To estimate the number of smart meters installed for households metering points and the number of smart meters installed for SMEs, we applied the ratio of SMEs metering points over the total number of metering points in the country to the total number of smart meters installed. The underlying hypothesis is that Member States did not favour a specific segment while rolling out their smart meters. We then just had to subtract the total number of smart meter installed by the number of smart meters installed for SMEs to obtain the number of smart meters installed for households.

In order to provide even more accurate, yet less inclusive statistics, we computed the penetration rates for households smart meters and SMEs smart meters separately, including only MS which provided differentiated data for smart meters installed\(^44\). In this scenario, the penetration rate for households smart meters is equal to 23.69% and the penetration rate for SMEs smart meters is equal to 13.19%.

By 2020, based on the originally announced rollout plans 127,593,300 additional smart meters were to be installed within the EU-28 (setting the total number of smart meters to ca. 226 million). That would correspond to a penetration ratio of electricity smart meters of ca. 78%.

However, given the speed of deployment observed in 2017, we estimate\(^45\) that only 24 million additional smart meters will be installed by 2020, setting the total number of electricity smart meters to 123 million, which would correspond to a 42.5% penetration rate. With a weighted average cost per electricity smart meter of 153,30\(\)\(\)€\(^46\), the deployment of these 123 million smart meters would have required an aggregated investment of €18.8 billion.


\(^44\) These MS are Austria, Denmark, Italy, Luxembourg, Portugal, Slovakia and Sweden.

\(^45\) These estimations are based on the observed rate of deployment of electricity smart meters in 2017.

\(^46\) The computation of this weighted average includes Austria, Denmark, Estonia, Finland, France, Italy, Luxembourg, Malta, the Netherlands, Spain, Sweden, United Kingdom, Greece, Ireland, Latvia, Poland, Romania and Slovenia.
Extrapolating from the current pace of deployment of electricity smart meters in Member States that have completed, or are currently proceeding to a large-scale rollout of electricity smart meters, we expect that **243 million smart meters will be installed in 2024** (corresponding to a **83.97% penetration rate**), which will represent an aggregated investment of **€37.3 billion**. By **2030**, we expect that **266 million smart meters will be installed** (corresponding to a **91.57% penetration rate**), which will represent an total aggregated investment of **€40.7 billion**.

<table>
<thead>
<tr>
<th>Country</th>
<th>Actual number of existing metering points</th>
<th>Total Smart Meters installed in 2018</th>
<th>Total Smart Meters installed in 2017</th>
<th>Total smart meter penetration rate (as of 2018)</th>
<th>Total smart meters installed in 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>6,148,094</td>
<td>728,477</td>
<td>214,671</td>
<td>11.8%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Belgium</td>
<td>5,975,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>4,700,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Croatia</td>
<td>2,424,060</td>
<td>55,000</td>
<td>23,000</td>
<td>2.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Cyprus</td>
<td>546,500</td>
<td>0</td>
<td>0</td>
<td>0%</td>
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</tr>
<tr>
<td>Czech Republic</td>
<td>5,712,550</td>
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</tr>
<tr>
<td>Denmark</td>
<td>3,361,816</td>
<td>2,324,439</td>
<td>2,324,439</td>
<td>69.1%</td>
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<td>Estonia</td>
<td>707,900</td>
<td>700,000</td>
<td>5,752</td>
<td>98.9%</td>
<td>0.8%</td>
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<td>Finland</td>
<td>3,557,500</td>
<td>3,551,500</td>
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<td>France</td>
<td>40,743,844</td>
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<td>6,257,000</td>
<td>22.2%</td>
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<td>Germany</td>
<td>50,700,000</td>
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<td>Greece</td>
<td>7,485,000</td>
<td>195,000</td>
<td>50,000</td>
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<td>Hungary</td>
<td>7,500,000</td>
<td>75,000</td>
<td>0</td>
<td>1.0%</td>
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<td>Ireland</td>
<td>2,200,000</td>
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<tr>
<td>Italy</td>
<td>36,789,000</td>
<td>36,237,165</td>
<td>0</td>
<td>98.5%</td>
<td>-</td>
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<tr>
<td>Latvia</td>
<td>981,633</td>
<td>356,358</td>
<td>112,430</td>
<td>36.3%</td>
<td>11.5%</td>
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<tr>
<td>Lithuania</td>
<td>1,722,925</td>
<td>40,687</td>
<td>3,915</td>
<td>2.4%</td>
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</tr>
<tr>
<td>Luxembourg</td>
<td>300,499</td>
<td>75,847</td>
<td>75,847</td>
<td>25.2%</td>
<td>25.2%</td>
</tr>
<tr>
<td>Malta</td>
<td>317,747</td>
<td>309,287</td>
<td>15,634</td>
<td>97.3%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>8,600,000</td>
<td>4,000,000</td>
<td>1,114,000</td>
<td>46.5%</td>
<td>13%</td>
</tr>
<tr>
<td>Poland</td>
<td>17,719,000</td>
<td>1,469,661</td>
<td>62,800</td>
<td>8.3%</td>
<td>0.4%</td>
</tr>
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<td>Portugal</td>
<td>6,000,000</td>
<td>1,500,000</td>
<td>600,000</td>
<td>25.0%</td>
<td>10%</td>
</tr>
<tr>
<td>Romania</td>
<td>9,237,788</td>
<td>442,206</td>
<td>159,618</td>
<td>4.8%</td>
<td>1.7%</td>
</tr>
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<td>Slovakia</td>
<td>2,513,743</td>
<td>127,325</td>
<td>50,458</td>
<td>5.1%</td>
<td>2.0%</td>
</tr>
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<td>Slovenia</td>
<td>935,333</td>
<td>544,332</td>
<td>65,028</td>
<td>58.2%</td>
<td>7.0%</td>
</tr>
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<td>Spain</td>
<td>28,000,000</td>
<td>26,067,500</td>
<td>5,000,000</td>
<td>93.1%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Sweden</td>
<td>5,300,000</td>
<td>5,300,000</td>
<td>0</td>
<td>100.0%</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>29,807,531</td>
<td>9,355,202</td>
<td>2,759,082</td>
<td>19.9%</td>
<td>9.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>289,987,463</strong></td>
<td><strong>99,079,986</strong></td>
<td><strong>18,893,674</strong></td>
<td><strong>34.2%</strong></td>
<td><strong>6.5%</strong></td>
</tr>
</tbody>
</table>

47 The ‘Actual number of existing metering points’ in Belgium and Ireland are based on the previous Benchmarking report.14
Table 17: Number of electricity metering points by 2020, and total number of smart meters installed today by Member State (legend: grey = data not available).

Table 17: Number of electricity metering points by 2020, and total number of smart meters installed today by Member State (legend: grey = data not available).

Figure 24 represents the information about smart metering deployment) for each Member State and shows two sets of information:

1. The overall penetration of electricity smart meters in each Member State which is represented by the overall bar (a combination of blue and orange).
2. The percentage of electricity smart meters that was installed in 2017, which is represented by the orange bar.

As indicated in Section 5.1.2, many Member States obtained a positive CBA result for electricity smart meters. Six countries have already finished their large-scale electricity smart meter rollout, namely Estonia (2017), Finland (2013), Italy (2011), Malta (2014), Spain (93% end of 2017) and Sweden (2009). Moreover, Denmark reached by the end of 2017 a smart metering penetration rate of nearly 80%, meaning that it is on track to reach its 100 % roll-out target by 2020. So, in total seven Member States had reached or well surpassed the 80% penetration rate by end of 2017.

Different Member States reached in 2017 an installation rate for electricity smart meters of more than 10% of the total number of metering points within the country, meaning a significant step in meeting their large-scale roll-out targets. France can reach the 80 % roll-out target by 2021 and only needs to slightly increase its installation rate (compared to 2017) to reach its 90 % target in 2021 (+ 1 %pt per year). Latvia has a current electricity smart meters penetration rate of 36 % and is on track to reach its 100 % roll-out by 2022. Luxembourg reached a 25 % penetration rate in only 1 year, therefore it is likely this Member State will reach its 95 % roll-out by 2019 (or at least 80 %). The Netherlands is as well on track to reach the 80 % rollout by 2020, but it will need to increase its installation rate if this Member State wants to reach its 100 % roll-out target by 2020. To conclude, Portugal will – at its current installation rate – be able to reach an 80 % roll-out by 2022-2023.

While 3 Member States (Austria, Greece and United Kingdom) are not on track to reach their large-scale rollout by 2020, many Member States are in the initial phase of their massive rollout. Cyprus, Germany and Slovakia have currently a selective rollout planned. Another example is Ireland which is setting up a deployment plan that will be carried out in three phases. Phase One (2019-2020) will be based on voluntary take-up of smart meters and also on asset replacement requirement. The Phase Two (2021-2022) and Phase Three (2023-2024) will be based on a national rollout.
Figure 24: Overall electricity smart meter penetration by Member State

Figure 25 allows to compare the 2018 actual penetration rate, the 2020 expected one as of 2013 and the new expected 2020 penetration rate as of 2018. While we observe discrepancies (in value) in the evolution of the originally foreseen penetration rate, a general trend can be drawn among the Member States that have not met yet a significantly large portion of metering points equipped with smart meters: most of these countries have softened their expectations.

Considering the significant gap between current penetration rate and the announced penetration rate in 2020 for many countries, we estimated the penetration rate by 2020, based on the current pace deployment of smart meters. Figure 26 allows to compare the current penetration rate and the expected 2020 penetration rate based on our estimates.
A breakdown of installed electricity smart meters can be observed in Table 18. The table comprises the total electricity smart meters in households and SMEs, the electricity smart meters installed in 2017 for households and SMEs, as well as the overall number of electricity metering points for these two segments.

![Graph showing penetration rate comparison between 2018 and estimated 2020 rate](graph.png)

Figure 26: Comparison of penetration rate as of 2018 and estimated penetration rate by 2020
5.1.4 Functional specifications

The Commission Recommendation 2012/148/EU defines 10 common minimum functionalities for smart metering systems, mainly applicable for electricity, which are relevant for different market actors (see Figure 27), namely:

- a) Provide readings directly to consumer and/or any 3rd party
- b) Upgrade readings frequently enough to use energy saving schemes
- c) Allow remote reading by the operator
- d) Provide 2-way communication for maintenance and control
- e) Allow frequent enough readings for network planning
- f) Support advanced tariff systems
- g) Remote ON/OFF control of the supply AND/OR flow or power limitation
- h) Provide secure data communications
- i) Fraud prevention and detection
- j) Provide import/export and reactive metering

These recommendations have been drawn in close consultation with National Regulatory Authorities, especially from Member States with significant experience with their rollout, and are aligned with those developed by the standardisation mandate M44148. The most important functionalities related to engagement of consumers are functionalities a, b, and f, and are also included in the list of smart metering functionalities mandated in the recast Electricity Directive.

---

Based on the data collected during this study, and as shown in Table 19 the majority of the EU-28 Member States foresees to have all ten smart metering functionalities available to their electricity consumers, except for Germany, Lithuania, The Netherlands, Slovenia and Sweden. Many of the functionalities will be activated by default (see Table 20 and Table 19) and will be free of charge for the consumer (see Table 21). For instance, Croatia is one of the Member States where all the ten functionalities recommended by the European Commission will be made available, activated by default and free of charge (regarding electricity smart meters).

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Austria</th>
<th>Belgium (BR)</th>
<th>Belgium (FL)</th>
<th>Belgium (WL)</th>
<th>Bulgaria</th>
</tr>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>b) Update readings frequently enough to use energy saving schemes</td>
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<td>c) Allow remote reading by the operator</td>
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<td>d) Provide 2-way communication for maintenance and control</td>
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<td>e) Allow frequent enough readings for networking</td>
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<td>f) Support advanced tariff system</td>
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<td>g) Remote ON/OFF control supply and/or flow or power limitation</td>
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<td>h) Provide secure data communications</td>
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<td>i) Fraud prevention and detection</td>
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<td>j) Provide import/export and reactive metering</td>
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Table 19: Overview of all smart metering functionalities for electricity that are foreseen or are already available by each Member State (legend: green = foreseen, blank = not foreseen, grey = data not available).
<table>
<thead>
<tr>
<th>Country</th>
<th>Provide readings directly to consumer and/or any 3rd party</th>
<th>Upgrade readings frequently enough to use energy saving schemes</th>
<th>Allow remote reading by the operator</th>
<th>Provide 2-way communication for maintenance and control</th>
<th>Allow frequent enough readings for network planning</th>
<th>Support advanced tariff systems</th>
<th>Remote ON/OFF control of the supply AND/OR flow or power limitation</th>
<th>Provide secure data communications</th>
<th>Fraud prevention and detection</th>
<th>Provide import/export and reactive metering</th>
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</table>

Table 20: Overview of all smart metering functionalities for electricity that are activated by default by each Member State (legend: green = foreseen, blank = not foreseen, grey = data not available).
Table 21: Overview of all smart metering functionalities for electricity by each Member State that are free of charge (legend: green = foreseen, blank = not foreseen, grey = data not available, orange = data history is subject to a charge).

When it comes to the frequency at which data is updated and provided to consumers, it is recommended that this be done close to real time or at least every 15 minutes to support advanced (dynamic) tariffs for demand response programmes or even account settling.
<table>
<thead>
<tr>
<th>Country</th>
<th>(a) Provide readings directly to consumer and/or 3rd party</th>
<th>(b) Upgrade readings frequently enough to use energy saving schemes</th>
<th>Frequency at which consumption data is updated</th>
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Table 22: Frequency of data update intervals (implemented or foreseen) for electricity smart meters
5.2 Gas smart meters

5.2.1 Regulatory framework

This section provides an overview of the regulatory framework for gas smart metering deployment in all EU-28 Member States. Table 23 gives a comprehensive and updated review of the main legal and regulatory provisions related to gas smart metering that have come into force in each Member State. It is noted that, Member States have to transpose the aforementioned EU Directives (see European legislative framework related to smart metering) into national law, and it is only if the CBA shows a positive case for a (wide-scale or partial) rollout of smart meters that they detail rules on smart metering, and those rules would then need to be adopted (see related information included in below).

Whilst some MS have done so when transposing the Third Energy Package, others have not adopted national specific law for smart metering yet, even though they have also started to roll-out their smart meters following a positive CBA.

<table>
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<th>Country</th>
<th>Relevant legislation for gas smart metering</th>
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<tr>
<td>Austria</td>
<td>The primary law is ‘GWG2011’. The status of this law is also nearly unchanged since implementation. A delegated law that further implement smart metering deployment is ‘G-IMA-VO’ which contains functional requirements for Gas Meters.</td>
</tr>
<tr>
<td>Belgium</td>
<td>The primary law that enables smart metering for gas in the Brussels Capital Region is the ‘l’ordonnance du 1er avril 2004 relative à l’organisation du marché du gaz en Région de Bruxelles-Capitale’. At this stage there are no laws that enable smart metering for gas in Wallonia. In Flanders, The primary law that enables smart metering for electricity and gas is the ‘Energiedecreet’.</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>No specific laws have been adopted to frame the deployment of smart metering.</td>
</tr>
<tr>
<td>Croatia</td>
<td>The Croatian primary law that enables both smart electricity and gas metering is the ‘Energy Act’.</td>
</tr>
<tr>
<td>Cyprus</td>
<td>The ‘Regulation of the Gas Market Act4’ enables the CERA to ensure the implementation of smart meters, but it will have to be revised.</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>‘Act No. 458/2000, Coll. on Business Conditions and Public Administration in the Energy Sectors and on Amendment Other Laws (Energy Act).’</td>
</tr>
<tr>
<td>Denmark</td>
<td>No specific laws have been adopted to frame the deployment of smart metering.</td>
</tr>
<tr>
<td>Estonia</td>
<td>The primary law that enables smart metering for gas is the 'Natural Gas Act', which was revised and valid as of June 2017.</td>
</tr>
<tr>
<td>Finland</td>
<td>Information regarding national law relevant for gas smart metering has not been provided by the NRA.</td>
</tr>
<tr>
<td>France</td>
<td>A framework similar to that of the electricity market has been adopted.</td>
</tr>
<tr>
<td>Germany</td>
<td>The primary law that enables smart metering for both electricity and gas is ‘Gesetz zur Digitalisierung der Energiewende’.</td>
</tr>
<tr>
<td>Greece</td>
<td>Information regarding national law relevant for gas smart metering has not been provided by the NRA.</td>
</tr>
<tr>
<td>Hungary</td>
<td>The primary laws that enable smart metering for gas is the ‘Natural Gas Act XL of 2008’. The ‘Government Decree No. 26/2016’ is currently the delegated law that further implements smart metering deployment for both smart electricity and gas meters.</td>
</tr>
<tr>
<td>Ireland</td>
<td>The primary law introduced by the Department of Communications, Climate Action and Environment in 2014 that enables smart metering for electricity and gas meters is the ‘Statutory Instrument 426’, transposed into Irish law by way of secondary legislation based on the obligations under the Third Directive.</td>
</tr>
</tbody>
</table>
Italy

Although a first legislative mandate was laid down in ‘Law 99/2009’, the primary law enabling smart metering for gas in Italy is the ‘Legislative Decree 102/2014’ (same as for electricity).

Latvia

There is no specific law framing the deployment of smart metering for natural gas.

Lithuania

No specific laws have been adopted to frame the deployment of smart metering.

Luxembourg

The primary law that enables smart metering for gas is ‘Loi modifiée du 1er août 2007 relative à l’organisation du marché du gaz naturel’. The last revision of this law was in 2015.

Malta

There is no gas market in Malta.

The Netherlands

The primary laws that enables smart metering for electricity and gas are:

• ‘Wet implementatie EG-richtlijnen energie-efficiëntie’
• ‘Wijziging van de Elektriciteitswet 1998’
• ‘Gaswet ter verbetering van de werking van de elektriciteits- en gasmarkt (31374)’

These laws are currently under revision.

Poland

The primary law that enables smart metering for electricity and gas is the ‘Energy Law’.

Portugal

The primary laws that enable smart metering for electricity and gas are ‘Decreto-Lei n° 215-A/2012’ (October 8) and ‘Decreto-Lei n° 231/2012’ (October 26), which have been both revised.

Concerning gas smart metering, at present, there is no delegated law to further implement its deployment.

Romania

There is currently no specific law framing the deployment of smart metering for natural gas.

Slovakia

No Decree is in place for the implementation of gas smart meters.

Slovenia

The ‘Energy Act’ is currently the primary law that enables electricity and gas smart metering in Slovenia, as it includes Articles 174 addressing “Intelligent metering systems” for the gas sector.

Spain

There is no specific law in place framing the deployment of smart metering for gas.

Sweden

Information regarding national law relevant for gas smart metering has not been provided by the NRA

United Kingdom

A framework similar to that of the electricity market has been adopted.

Table 23: National legislation for the deployment of gas smart meters

Figure 28 provides an overview on the status of smart meter related legislation for gas.

Approximately a quarter of Member States have implementation strategies in place with specific legal provisions for the deployment of gas smart meters. It can be observed that most of these Member States have replicated the legal framework they have adopted for electricity smart meters for the implementation of gas smart meters, or have adopted implementation laws dedicated to both electricity and gas smart meters.

Generally, Member States are still at an early stage of the definition or refinement of their legal framework devoted to address and accommodate smart metering gas-specific challenges when compared to electricity. However, one should carefully notice that the average ratio of gas meters over electricity meters within the EU is ca. 29%, and some Member States do not host any gas market (e.g. Malta). This can be a beginning of explanation for this delay in the adoption of a legal framework for gas metering system deployment.
It is noted that our perspective was to assess here if MS had taken steps further, namely defining a deployment strategy (high level objectives and key changes to the market model to be implemented) and eventually the implementation laws that will accompany the day-to-day deployment of smart metering, such as priority targets, channels for communication and dispute resolution, tariffs, etc.

Figure 28: Overview of MS which have an implementation strategy in place with specific legal provisions for the deployment of gas smart meters. N/A stands for data not made available in the course of the project by the relevant national authorities.

5.2.2 Cost benefit analysis

This section provides an overview of the timing and the result of the latest national cost benefit assessment (hereafter CBAs) performed for the deployment of gas smart meters by each Member State. For many of the Member States the initial CBA was carried out on the back of pilot projects, in order to integrate the experiences from those projects. Whereas the revised CBAs focus more on the actual scale and timing of the rollout.

First, the status and outcome of the latest national CBAs for gas smart meters are described in subsection 5.1.2.1. In a second step (subsection 5.1.2.2), the CBA analysis is detailed with a focus on the cost, benefits and market roles considered in the CBA analysis for each Member State.

5.2.2.1 STATUS OF MOST RECENT CBA

Table 24 gives an overview of when the latest CBA was carried out back for gas smart meters, including the result of the CBAs conducted. Compared to electricity smart meters, less Member States have already conducted a CBA for gas smart meters. Where CBAs have been conducted, nearly 40% of these have a negative outcome.
For a number of Member States, no new information has been provided by the NRA (or associated body) on the timing and result of the CBA conducted for gas smart meters. In some cases, it has not been specified if the information provided extends beyond electricity, and whether it is applicable also to gas smart meters. These Member States have been marked with a (*) in the table below.

<table>
<thead>
<tr>
<th>Country</th>
<th>Initial CBA result (as of July 2013)</th>
<th>Revised CBA result (as of July 2018)</th>
<th>Latest CBA conducted (as of July 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Positive</td>
<td>Negative</td>
<td>2010</td>
</tr>
<tr>
<td>Belgium</td>
<td>Negative</td>
<td>Negative / Positive / Inconclusive</td>
<td>2017</td>
</tr>
<tr>
<td>Bulgaria*</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Croatia</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>2017</td>
</tr>
<tr>
<td>Cyprus</td>
<td>No natural gas network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Denmark*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Estonia*</td>
<td>No gas CBA</td>
<td>No gas CBA</td>
<td>NO CBA</td>
</tr>
<tr>
<td>Finland*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>France</td>
<td>Positive</td>
<td>Positive</td>
<td>2013</td>
</tr>
<tr>
<td>Germany*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Greece*</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Hungary*</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Ireland</td>
<td>Positive</td>
<td>Positive</td>
<td>2017</td>
</tr>
<tr>
<td>Italy</td>
<td>Positive</td>
<td>Positive</td>
<td>2008</td>
</tr>
<tr>
<td>Latvia</td>
<td>Negative</td>
<td>Positive</td>
<td>2017</td>
</tr>
<tr>
<td>Lithuania</td>
<td>N/A</td>
<td>Inconclusive</td>
<td>2018</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Positive</td>
<td>Negative</td>
<td>2016</td>
</tr>
<tr>
<td>Malta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>Positive</td>
<td>Positive</td>
<td>2010</td>
</tr>
<tr>
<td>Poland*</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Portugal*</td>
<td>N/A</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Romania*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Negative</td>
<td>Negative</td>
<td>2012</td>
</tr>
<tr>
<td>Slovenia</td>
<td>N/A</td>
<td>Negative</td>
<td>2014</td>
</tr>
<tr>
<td>Spain</td>
<td>Negative</td>
<td>Negative</td>
<td>2011</td>
</tr>
<tr>
<td>Sweden*</td>
<td>Negative</td>
<td>No gas CBA</td>
<td>N/A</td>
</tr>
</tbody>
</table>

49 The conditions of the initial CBA results (as of July 2013) were a large-scale roll-out covering at least 80% of the consumers by 2020 (even though there is no such target in the gas legislation).

50 The conditions of the revised CBA results (if applicable) were a large-scale roll-out covering at least 80% of the consumers by 2020 (even though there is no such target in the gas legislation).

51 In Belgium the following can be observed: the latest CBA performed in the Brussels Capital region was in 2011 and the result was negative. In Wallonia, the latest CBA was performed in 2017 and the result was inconclusive. In Flanders, the latest CBA was performed in 2017 and the result of the assessment was positive.
Table 24: Status of last CBA for gas smart meters conducted as of the previous and current study, including the outcome of the CBA(s) already conducted (Legend: (*) = No new information was provided or it was not mentioned if CBA results extended beyond electric)

Figure 29 provides a graphical overview of the most recent CBA results (as of July 2018) for the deployment of gas smart meters. It can be observed that for the majority of the Member States the information has not been provided.

As of 2018, four groups of Member States can be identified regarding CBA for gas smart meters deployment:

- A first group of nine Member States did not conduct any gas smart meters CBA. These Member States are Bulgaria, Croatia, Estonia, Greece, Hungary, Poland and Portugal. Cyprus and Malta do not host any natural gas network and as a consequence did not perform a gas CBA.
- Nine Member States conducted one CBA before 2013: Czech Republic, Denmark, Finland, Germany, Italy, Romania, the Netherlands, Spain and Sweden.
- Lithuania and Slovenia only conducted one CBA after 2013.
- Eight Member States conducted two gas CBA, namely Austria, Belgium, France, Ireland, Latvia, Luxembourg, Slovakia and the United Kingdom.
5.2.2.2 CBA ANALYSIS

Key cost and benefit items were defined in the Recommendation 2012/148/EU, inviting Member States to use the same structure for their CBA. This section presents all costs, benefits and market actors considered in the gas CBA for each Member State. As indicated in Figure 10, the functionalities foreseen will create benefits for the different actors (e.g. consumers, grid operators, etc.), while the assets involve capital (CAPEX) and operational expenditures (OPEX). These costs and benefits serve as input for the Cost Benefit Analysis.

Costs considered in the gas CBA

Table 25 provides an overview of the cost items considered by the 13 Member States that revised their gas CBA for gas smart metering deployment. The most common cost items considered by the Member States while conducting their CBA can be observed in Figure 30. The capital investment linked to the smart meters themselves and the IT infrastructure are the cost items most selected by Member States. These are followed closely by operational expenses linked to meter readings, IT maintenance, telecom and network management.

Despite the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC promoting the wider use of smart metering systems as a key enabler to allow active participation of consumers in the internal electricity and gas markets and to contribute to a secure, competitive and sustainable supply of energy for Europe, only few Member States (Luxembourg, Slovenia and United Kingdom) are considering investment expenditures in in-home-displays and operational expenditures for active customer engagement while carrying out their assessment.
Benefits considered in the gas CBA

Table 26 provides an overview of the various benefit items considered by each Member State when performing the CBA.

Consumers will have **direct benefits** from bill reductions, as a result of:

- Increased energy efficiency as smart meters will allow them to get insight into their energy consumption.
- A reduced bill due a reduction of energy consumption.
Moreover, consumers will benefit indirectly from potential cost savings that other market actors can benefit from as a result of several other technical and non-technical benefits.

Smart meters will allow automated meter reading resulting in operational savings (vs. manual reading by for instance the DSO). The automated reading will also allow reduce other non-technical losses. For instance, meter readings will be less sensitive to administrative errors, energy offtake is less sensitive to fraud, technical losses or fraud can be much faster identified with regular meter reading (e.g., near real-time).

Figure 31 presents the ranking of the consolidated results of the considered benefits across the EU-28. The most common benefit considered by Member States is linked to the operational savings that can be achieved through remote meter readings and the consumer’s bill reduction as a result of increased energy efficiency. Tackling of non-technical losses (e.g. administrative or fraud) is the next main benefit considered.

Despite the smart metering roll-out being in nearly all Member States DSO-led, the main benefits considered related to the DSO is the meter reading & operation savings, while on the other hand, outage management and increased competition are less considered as benefits while conducting the CBAs.
Market actors considered in the gas CBA

The various market actors considered by each Member State when carrying out the CBA can be observed in Table 27; a consolidated ranking is presented in Figure 32.

With no real surprise, the most common actor is the distribution system operator (DSO), who in many countries is responsible for metering installation, meter reading, and grid operations. Apart from UK where the smart meter ownership and installation is supplier-led, in all Member States the smart metering is DSO-led. Many technical are directly related to the DSO, such as meter reading & operations savings, technical operational & maintenance benefits, etc. The consumer is also a main market actor considered in most of the CBAs, as he will directly benefit from energy bill reduction.

Table 11 demonstrates which market actor (i) owns the smart meter and which market actor (ii) is responsible for the installation of the smart meter in each Member State.

Another important market actor is the energy supplier who collects metering data, e.g. to send the energy bill to the consumer.
Table 27: Considered market actors in the CBA for each Member State (legend: green = considered, blank = not considered; grey = data not available).

Figure 32: Ranking of the considered market actors in the gas CBA
5.2.2.3 NORMALISED COST AND BENEFIT PER METERING POINT FOR GAS

The normalised cost and benefit per metering point for each Member State can be seen in Table 28. This table only includes Member States that already conducted at least one CBA for gas smart meters deployment.

It is important to note that two methods were proposed for the computation of normalised cost and benefit per metering point in the data collection exercise. These were:

1. Direct computation of key indicators (cost and benefit per installed meter) by the NRA (or other entity in charge)
2. The providing of yearly estimates on OPEX, CAPEX, benefits, number of meters in order estimate the cost and benefit over the given period

All the information collected in 2018 was done so using method 1. It must be highlighted that the variation and level of consistency of the information provided makes it difficult to provide an accurate benchmark.

For the Member States marked with a (*) in the following table, a joint CBA for electricity and gas has been conducted, hence no separate calculation of costs and benefits per metering points for electricity and for gas was available.

<table>
<thead>
<tr>
<th></th>
<th>TOTEX (€/meter) 2018</th>
<th>TOTEX (€/meter) 2013</th>
<th>Benefit (€/meter) 2018</th>
<th>Benefit (€/meter) 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria*</td>
<td>332</td>
<td>239</td>
<td>70</td>
<td>952</td>
</tr>
<tr>
<td>Belgium*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>826</td>
<td>-</td>
<td>329</td>
<td>-</td>
</tr>
<tr>
<td>Denmark</td>
<td>268</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Finland</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>France*</td>
<td>135</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>-</td>
<td>546</td>
<td>-</td>
<td>493</td>
</tr>
<tr>
<td>Ireland*</td>
<td>380</td>
<td>233</td>
<td>448</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Latvia*</td>
<td>38.18</td>
<td>2113</td>
<td>43.64</td>
<td>-</td>
</tr>
<tr>
<td>Lithuania*</td>
<td>169.6</td>
<td>-</td>
<td>185.9</td>
<td>-</td>
</tr>
<tr>
<td>Luxembourg*</td>
<td>139</td>
<td>150</td>
<td>19</td>
<td>181</td>
</tr>
<tr>
<td>Netherlands*</td>
<td>-</td>
<td>220</td>
<td>-</td>
<td>270</td>
</tr>
<tr>
<td>Romania</td>
<td>-</td>
<td>145</td>
<td>-</td>
<td>151</td>
</tr>
<tr>
<td>Slovakia</td>
<td>-</td>
<td>160</td>
<td>-</td>
<td>184</td>
</tr>
<tr>
<td>Slovenia*</td>
<td>145.5</td>
<td>-</td>
<td>25.5</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>-</td>
<td>120</td>
<td>-</td>
<td>105</td>
</tr>
<tr>
<td>Sweden</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom*</td>
<td>232</td>
<td>-</td>
<td>352</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 28: Normalised costs and benefits per metering point, for Member States that proceeded to at least one gas CBA (Legend: blank = no CBA conducted; "-" = data not available).
The unavailability of data does not allow us to provide a detail benchmark of costs and benefits per gas metering point. Nevertheless the quoted figures in the previous table depict significant variation of results. Indeed the average costs per gas metering point for the Member States included in the table (taking into account the most recent figures for each country) equal €257 with a standard deviation of €194, while the average benefits equal €206 with a standard deviation of €154.

What can be seen from Table 25 - Table 27 is that there is high variation between the market actors, cost and benefit items considered by each Member State and as a result, there is a high variation between the normalised cost and benefit per metering point. This can be seen in Figure 33.

![Figure 33: Normalised costs vs. benefits per metering point, for the case gas.](image)

5.2.3 Deployment state of play

A detailed analysis has been performed on the progress and the current deployment rate of the smart metering deployment across the EU-28, for each Member State.

5.2.3.1 MARKET DRIVERS FOR GAS SMART METER ROLL-OUT

4 primary market drivers were identified for the deployment of smart meters:

- Digitalization of the distribution grid and optimization of the network operations;
- Digitalization of the retail market to foster innovation and new services by private actors;
- Supporting actions for tackling fuel poverty;
- Supporting energy efficiency.
The primary drivers for the deployment of gas smart meters in each Member State can be observed in Table 29. Figure 34 consolidates this information to visualize the ranking of these market drivers across the EU-28.

<table>
<thead>
<tr>
<th>Country</th>
<th>Digitalize distribution grid and optimize network operations</th>
<th>Digitalize retail market to foster innovation and new services by private actors</th>
<th>Support actions tackling fuel poverty</th>
<th>Support energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium (BR)</td>
<td></td>
<td></td>
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<tr>
<td>Belgium (FL)</td>
<td></td>
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<tr>
<td>Belgium (WL)</td>
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<tr>
<td>Bulgaria</td>
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<td>Croatia</td>
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<td>Cyprus</td>
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<td>Czech Republic</td>
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<td>Denmark</td>
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<td>Estonia</td>
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<td>Finland</td>
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<td>France</td>
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<td>Germany</td>
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<td>Greece</td>
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<td>Hungary</td>
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<td>Ireland</td>
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<td>Italy</td>
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<td>Latvia</td>
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<td>Lithuania</td>
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<td>Luxembourg</td>
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<td>Malta</td>
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<td>Netherlands</td>
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<td>Poland</td>
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<td>Portugal</td>
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<td>Romania</td>
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<td>Slovakia</td>
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<tr>
<td>Spain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The key driver to roll-out gas smart meters is the ‘digitalization of the distribution grid to allow optimization of the network operations’, providing direct value for grid and generation operators to optimize the operation and usage of their existing assets. This may defer additional grid capacity (investments), leading to indirect benefits for the consumer.

Supporting energy efficiency is not a main driver for the deployment of gas smart meters, excepted for some countries where the risk of fuel poverty recently stood at worrying level (e.g. Romania).

It should also be noticed that even though biogas injection in the distribution grid has become a reality in some Member States, it is not considered as a significant driver for gas smart metering rollout.

5.2.3.2 GAS SMART METER LARGE-SCALE ROLLOUT IN MEMBER STATES

Whilst Directive 2009/73/EC requires that Member States should proceed, usually subject to a CBA, with the deployment of smart metering for gas, and consecutively draw up an implementation strategy, these provisions are less restrictive than the ones of the mirror Directive for electricity since no deployment target for gas smart meters is set.

Consequently, as of 2018, only seven Member States have decided to proceed to a large-scale rollout of gas smart meters. These Member States – namely Austria, France, Ireland, Italy, Luxembourg, the Netherland and UK - account for 58% of all gas metering points within the Union.

Figure 35 shows the estimated target date for completion of a wide scale rollout of gas smart meters as of 2018 and its comparison with the original estimations from 2013. It can be seen that the large majority of Member States has not yet defined a target period.

Table 29: Market drivers for gas smart meter rollout (legend: green = considered, blank = not considered; grey = data not available).
Figure 35: Overview (aggregated) of target period for gas smart meters (study 2018), compared to the initial targets set in the previous study (2013).

Figure 36 proposes a detailed view on the target period for a large-scale rollout of gas smart meters for the Member States having set up an implementation strategy.

One should notice that these 7 Member States are still at an early stage of their gas smart metering system deployment, except for the Netherlands. Within this group of countries, the penetration rate at the first January 2018 varied from close to 0% for Austria to 46.6% for the Netherland, with an average of 11.69%.

To conclude, Figure 37 presents the official deployment strategy per Member State to reach their respective target on the roll-out of gas smart meters.
Among those countries that took the decision to proceed to a large-scale rollout of gas smart meters, only three (France, Ireland and Italy) out of seven revised their target period for the completion of the process. Among the four others, which kept 2020 as target period for the completion of the rollout, only the Netherlands might be able to reach its 80% penetration rate by 2020.

5.2.3.3 CURRENT STATUS ON SMART METER DEPLOYMENT RATE

This subsection provides insights into the state of play of gas smart meter deployment rate in all Member States as of 31/12/2017.

Table 30 presents the total number of existing gas metering points and the total number of gas smart meters installed, from which the overall penetration rate of smart meters per Member State can be calculated (as indicated in the final column). Similar as for electricity smart meters, Figure 38 shows:

1. The overall penetration of gas smart meters in each Member State which is represented by the overall bar (a combination of blue and orange).
2. The percentage of gas smart meters that was installed in 2017, which is represented by the orange bar.

Based on the data collected from National Authorities it can be observed that the deployment of gas smart meters is still rather immature and much less advanced than that for electricity smart meters. Nearly all existing gas smart meters are installed in France, Italy, The Netherlands and United Kingdom.

From Figure 38 it can also be observed that most of existing gas smart meters – around 61% of all existing gas smart meters as of 2018 – were installed throughout 2017. Apart from The Netherlands, Member States planning to rollout their gas metering system by 2020 are not on track to reach their original roll-out target.

At the first January 2018 – according to the available data – 10.57% of all gas metering points were equipped with smart meters, which represents ca. 12,146,000 gas smart meters.
By 2024, based on the announcements made by the NRAs of Member States rolling out smart gas smart meters, the penetration ratio of gas smart meters should approximate 52% with 60 million of gas smart meters installed in 5 years. With a weighted average cost per gas metering point of 210.95€, this would represent an aggregated investment of €12.66 billion.

Nevertheless, considering the current pace of deployment of gas smart meters, our previsions are less optimistic. We estimate that in 2020, 27 million of smart meters will be in place, accounting for 23.5% of all gas metering point, which will represent an aggregated investment of €5.69 billion. By 2024, we estimate that 51 million of smart meters will be in place, accounting for 44.6% of all gas metering point. The deployment of these 51 million gas smart meters would have triggered a total investment of €10.76 billion. By 2024 only Italy, Luxembourg and the Netherlands would have completed their large-scale rollout of gas smart meters.

### Actual number of existing metering points

<table>
<thead>
<tr>
<th>Country</th>
<th>Actual number of existing metering points</th>
<th>Total Smart Meters installed (as of 2018)</th>
<th>Total Smart Meters installed in 2017</th>
<th>Total smart meter penetration rate (as of 2018)</th>
<th>Total smart meters installed in 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1,473,684</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>2,970,208</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>180,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Croatia</td>
<td>647,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2,870,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>410,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>43,000</td>
<td>5,000</td>
<td>5,000</td>
<td>11.6%</td>
<td>11.6%</td>
</tr>
<tr>
<td>Finland</td>
<td>37,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>10,960,000</td>
<td>818,000</td>
<td>609,900</td>
<td>7.5%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Germany</td>
<td>14,000,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>287,938</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>7,000,000</td>
<td>11,584</td>
<td>6,492</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ireland</td>
<td>600,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>22,200,000</td>
<td>3,700,000</td>
<td>3,700,000</td>
<td>16.7%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Latvia</td>
<td>2,200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>582,058</td>
<td>1,258</td>
<td>46</td>
<td>0.2%</td>
<td></td>
</tr>
</tbody>
</table>

---

52 2024 is the latest targeted period within the group of MS currently planning a large-scale rollout of gas smart meters.

53 The calculation of this weighted average included all Member States rolling out gas smart meters, except Italy for which data on costs and benefits per gas metering point was not available. The Member States included in this calculation are thus Austria, France, Ireland, Luxembourg, the Netherlands and United Kingdom.

54 These estimations are based on the observed rate of deployment of gas smart meters in 2017.

55 For Italy, only the number of installed gas smart meters in 2017 were communicated. Therefore, the total number of gas smart meters is considered to be at least 3,700,000.
 Luxembourg | 88,527  | 14,723  | 14,723  | 16.6%  | 16.6%  
 Maltese | 0  | 0  | 0  | 0%  | 0%  
 Netherlands | 7,300,000  | 3,400,000  | 947,000  | 46.6%  | 13.0%  
 Poland | 7,349,885  | 94,266  | 21,443  | 1.3%  | 0.3%  
 Portugal | 1,251,000  | 0  | 0  | 0%  | 0%  
 Romania | 2,800,000  | 0  | 0  | 0%  | 0%  
 Slovakia | 805,000  | 0  | 0  | 0%  | 0%  
 Slovenia | 133,630  | 165  | 0  | 0.1%  | 0.1%  
 Spain | 7,500,000  | 0  | 0  | 0%  | 0%  
 Sweden | 37,000  | 0  | 0  | 0%  | 0%  
 United Kingdom | 23,417,428  | 4,101,072  | 2,134,983  | 17.5%  | 9.1%  
 Total | 114,945,558  | 12,146,068  | 7,439,587  | 10.6%  | 6.5%  

Table 30: Number of gas metering points by 2020, and total number of smart meters installed today by Member State (Legend: Blank = data not available).

A breakdown of installed gas smart meters can be observed in Table 31. The table comprises of the total gas smart meters in households and SMEs, the gas smart meters in households and SMEs installed in 2017, as well as the overall gas metering points for these two segments.
5.2.4 Functional specifications

As mentioned in the section 5.1 related to electricity smart meters, the Commission Recommendation 2012/148/EU defines 10 common minimum functionalities for smart metering systems, among which 9 are relevant to gas smart metering. These functionalities are:

a) Provide readings directly to consumer and/or any 3rd party
b) Upgrade readings frequently enough to use energy saving schemes
c) Allow remote reading by the operator
d) Provide 2-way communication for maintenance and control
e) Allow frequent enough readings for network planning
f) Support advanced tariff systems
g) Remote ON/OFF control of the supply AND/OR flow or power limitation
h) Provide secure data communications
i) Fraud prevention and detection
These recommendations have been drawn in close consultation with National Regulatory Authorities, especially from Member States with significant experience with their rollout, and are aligned with those developed by the standardisation mandate M441\textsuperscript{56}. The most important functionalities related to engagement of consumers are functionalities a, b, and f.

It has to be noticed that we considered in this subsection the Member States that have adopted an implementation strategy for the rollout of gas smart meters.

Based on the data collected during this study, and as showed in Table 32 the majority of the 7 Member States proceeding to a large-scale rollout of gas smart meters foresees to have all nine smart metering functionalities available to their electricity consumers. Many of the functionalities will be activated by default (see Table 33) and will be free of charge for the consumer (see Table 34). For instance, France is one of the Member States rolling out gas smart meters where all the nine functionalities recommended by the European Commission will be made available, activated by default and free of charge.

<table>
<thead>
<tr>
<th>Austria</th>
<th>France</th>
<th>Ireland</th>
<th>Italy</th>
<th>Luxembourg</th>
<th>Netherlands</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
<td>e</td>
<td>f</td>
<td>g</td>
</tr>
</tbody>
</table>
| ![Table 32: Overview of all smart metering functionalities for gas that are foreseen or are already available by Member State (legend: green = foreseen, blank = not foreseen, grey = data not available).](image)

\textsuperscript{56} “Functional reference architecture for communications in smart metering systems” (CEN-CLC-ETSI TR 50572:2011).
Table 33: Overview of all smart metering functionalities for gas that are activated by default by Member State (legend: green = foreseen, blank = not foreseen, grey = data not available).

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Austria</th>
<th>France</th>
<th>Ireland</th>
<th>Italy</th>
<th>Luxembourg</th>
<th>Netherlands</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide readings directly to consumer and/or any 3rd party</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Upgrade readings frequently enough to use energy saving schemes</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Allow remote reading by the operator</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Provide 2-way communication for maintenance and control</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Allow frequent enough readings for network planning</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Support advanced tariff systems</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Remote ON/OFF control of the supply AND/OR flow or power limitation</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Provide secure data communications</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Fraud prevention and detection</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
When it comes to the frequency at which data is updated and provided to consumers, it is recommended that this be done close to real time or at least every 15 minutes to support advanced tariffs for demand response programmes or even account settling.

<table>
<thead>
<tr>
<th></th>
<th>(c) Provide readings directly to consumer and/or 3rd party</th>
<th>(d) Upgrade readings frequently enough to use energy saving schemes</th>
<th>Frequency at which consumption data is updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>YES</td>
<td>YES</td>
<td>15’</td>
</tr>
<tr>
<td>France</td>
<td>YES</td>
<td>YES</td>
<td>N/A</td>
</tr>
<tr>
<td>Ireland</td>
<td>YES</td>
<td>YES</td>
<td>Daily</td>
</tr>
<tr>
<td>Italy</td>
<td>YES</td>
<td>YES</td>
<td>Near real-time (through continuous update)</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>YES</td>
<td>YES</td>
<td>10’</td>
</tr>
<tr>
<td>Netherlands</td>
<td>YES</td>
<td>YES</td>
<td>Not specified</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>YES</td>
<td>YES</td>
<td>30’</td>
</tr>
</tbody>
</table>

Table 35: Frequency of data update intervals (implemented or foreseen) for gas smart meters

It should be noticed that among these seven Member States, only United Kingdom provided differentiated data consumption’s frequency update for electricity and gas.

5.3 Cross-cutting considerations

5.3.1 Technical specifications

This section, applicable to both electricity and gas smart meters, will go beyond the mere update of the data information on smart metering system specifications and the status of interoperability of the smart metering architecture on local interfaces and interoperability of those interfaces.

Figure 39 represents the smart meter environment, which is based on the reference architecture for smart metering communications of the Smart Metering Coordination Group, in the framework of the smart grids M/490 mandate and that for smart meters M/441 mandate (CEN/CLC/ETSI/TR 50572, 2011). The smart meter is usually composed of 2 elements:

- the smart itself (with metrology functions and other functionalities), and
- a smart meter gateway for communication, also called the local network access point (LNAP).

To enable communication between the network components, interfaces are required.
- The **H1 interface** connects the smart meter system to an external display, via one-way communication. The external display is not uniquely designed. For instance, information may be provided only visually, or be available for downloading. The so-called « P1 » implemented in the Netherlands, Luxemburg or Austria is one example of an H1 interface.

- The **H2 interface** connects the smart meter system with the Home Area Network (HAN). The HAN interconnects smart home devices for energy management purposes. The H2 provides a two-way communication, i.e. the HAN can send information on individual devices back to the smart meter system.

- Data from the smart meter is shared externally with the meter data management system (a central communication system). This system communicates with meters either directly through the Wide Area Network (WAN) and enabled by the **G1 interface**, or via a data concentrator where information from several meters in a neighborhood is concentrated (Neighborhood Network Access Points, NNAP).

- The NNAP may also have an **H3 interface** to the HAN. It seems, however, that H3 is currently not implemented or planned in Europe.

Note that the **Meter Data Management System** is represented in a very simplified way: in practice, the way consumption data is collected, validated and stored is organized differently. Some countries have opted for centralized systems where an independent third party is responsible, other countries have opted for a decentralized system (where DSOs or suppliers are responsible), or a combination. It provides validated historical and usually non-validated near-real time consumption data that is used by different data users for several purposes: DSOs and suppliers for traditional activities (for switching and billing purposes for instance), suppliers and third parties for emerging energy and flexibility services.

To this end, consumption data might be combined with wholesale market data, or transmission and distribution grid data to deliver services to DSOs/TSOs. Finally, suppliers and third parties may also have direct access to the smart meter (not shown in Figure 39)
Table 36 gives an overview of the preferred communication technologies for the different interfaces H1-H3, G1-G2 and C, based on Member States’ feedback. More than two thirds of the Member States have already defined the preferred communication technologies (Power line communication or other wireless technologies) for the different interfaces. Depending on the Member State, one specific technology is preferred for each interface, or a set of technologies is given. Only two countries (Hungary and Italy) have today defined different preferred technologies for electricity and gas smart meters.

<table>
<thead>
<tr>
<th>Member State</th>
<th>Choice of communication technology for H1, H2, H3, C, G1, G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>The interfaces are open to the decision of the DSO. Due to the fact that few DSOs have started their rollout yet, the information is not complete. H1: IDIS CII, IR according to IEC 62056-23, MEP (Multipurpose Expansion Port), Plug AV (IEEE 802.2), ZigBee, Wireless, MBUS; protocols according OSGP specifications H2: OMS (Specification Volume 2, primary communication issue 3.0.1 mit wired Mbus nach EN 13757-1 bis EN 13757-3, MEP (Multipurpose Expansion Port), Plug AV (IEEE 802.2), ZigBee, Wireless ; H3: MEP (Multipurpose Expansion Port), Plug AV (IEEE 802.2), ZigBee, Wireless</td>
</tr>
<tr>
<td>Belgium (Brussels)</td>
<td>Not available</td>
</tr>
<tr>
<td>Belgium (Flanders)</td>
<td>H1: DSMR P1 V5.0 G1: GSM (NB-IoT)</td>
</tr>
<tr>
<td>Belgium (Wallonia)</td>
<td>Not available</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>C: GPRS / PLC</td>
</tr>
<tr>
<td>Croatia</td>
<td>Not available</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Not available</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Not available</td>
</tr>
<tr>
<td>Denmark</td>
<td>Not available</td>
</tr>
<tr>
<td>Estonia</td>
<td>C: PLC G1: GSM G2: GSM</td>
</tr>
</tbody>
</table>
The standards that have been adopted to support the chosen communication technology are GSM, GPRS, 3G, 4G, PLC. The following gives an overview of the implementation of the different interfaces with regards to the implementation and the technology used.

<table>
<thead>
<tr>
<th>Country</th>
<th>Interface Implementation Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>H1: Activated upon customer explicit request</td>
</tr>
<tr>
<td></td>
<td>H3: No Powerline Cable</td>
</tr>
<tr>
<td></td>
<td>G1: Implemented by default GSM</td>
</tr>
<tr>
<td></td>
<td>G2: No GSM</td>
</tr>
<tr>
<td>France</td>
<td>STEP 1 (2.5 million meters)</td>
</tr>
<tr>
<td></td>
<td>H1: TIC Wire Interface</td>
</tr>
<tr>
<td></td>
<td>H3: PLC</td>
</tr>
<tr>
<td></td>
<td>G1: PLC</td>
</tr>
<tr>
<td></td>
<td>STEP 2 (32 million meters)</td>
</tr>
<tr>
<td></td>
<td>G3: PLC</td>
</tr>
<tr>
<td></td>
<td>H1: WPAN</td>
</tr>
<tr>
<td></td>
<td>H2: WPAN</td>
</tr>
<tr>
<td></td>
<td>G1: GSM and Long-Range Radio</td>
</tr>
<tr>
<td>Germany</td>
<td>Not available</td>
</tr>
<tr>
<td>Greece</td>
<td>The following gives an overview of the implementation of the different interfaces with regards to the</td>
</tr>
<tr>
<td></td>
<td>implementation and the technology used.</td>
</tr>
<tr>
<td></td>
<td>H1: Activated upon customer explicit request</td>
</tr>
<tr>
<td></td>
<td>H2: Activated upon customer explicit request</td>
</tr>
<tr>
<td></td>
<td>H3: No</td>
</tr>
<tr>
<td></td>
<td>C: No Powerline Cable</td>
</tr>
<tr>
<td></td>
<td>G1: Implemented by default GSM</td>
</tr>
<tr>
<td></td>
<td>G2: No GSM</td>
</tr>
<tr>
<td>Hungary</td>
<td>C: Power Line Carrier (electricity smart meter) &amp; Wireless technology (gas smart meter)</td>
</tr>
<tr>
<td></td>
<td>G1: GSM</td>
</tr>
<tr>
<td></td>
<td>G2: GSM</td>
</tr>
<tr>
<td>Ireland</td>
<td>Today, it cannot be confirmed which technologies will be adopted and which standards will be</td>
</tr>
<tr>
<td></td>
<td>applicable. This decision depends on the DSO’s procurement process which is currently ongoing. The</td>
</tr>
<tr>
<td></td>
<td>DSO, ESBN, will make overall decisions on the design, functionality and customer interaction</td>
</tr>
<tr>
<td></td>
<td>procedures. It is expected that the procurement process will be finalized by the end of 2018. In 2019</td>
</tr>
<tr>
<td></td>
<td>the chosen technology will be known, once ESBN completes its procurement activities.</td>
</tr>
<tr>
<td></td>
<td>In terms of communication standards adopted, it seems that an open standard solution will be</td>
</tr>
<tr>
<td></td>
<td>chosen for the only implemented interface, H2.</td>
</tr>
<tr>
<td>Italy</td>
<td>1G Electricity smart meters</td>
</tr>
<tr>
<td></td>
<td>H1: PLC (activated upon customer explicit request)</td>
</tr>
<tr>
<td></td>
<td>H2: PLC (activated upon customer explicit request)</td>
</tr>
<tr>
<td></td>
<td>H3: not implemented</td>
</tr>
<tr>
<td></td>
<td>C: PLC (implemented by default)</td>
</tr>
<tr>
<td></td>
<td>G1: GSM (implemented by default only for MV/HV)</td>
</tr>
<tr>
<td></td>
<td>G2: GSM (implemented by default);</td>
</tr>
<tr>
<td></td>
<td>2G Electricity smart meters: more advanced solutions such as the Universal Mobile</td>
</tr>
<tr>
<td></td>
<td>Telecommunications System (UMTS) and its LTE (Long-Term Evolution) will be</td>
</tr>
<tr>
<td></td>
<td>implemented on G2 interface.</td>
</tr>
<tr>
<td></td>
<td>In addition to the PLC channel, a second communication radio channel (RF 169 MHz) from the 2G</td>
</tr>
<tr>
<td></td>
<td>meters to the 2G data concentrator will be implemented on C interface. This channel will be used as a</td>
</tr>
<tr>
<td></td>
<td>back-up of the primary PLC channel and for the reception of real-time voltage interruption coming from</td>
</tr>
<tr>
<td></td>
<td>2G meters.</td>
</tr>
<tr>
<td></td>
<td>While 1G smart electricity meters have only one communication channel, new 2G meters can rely on two</td>
</tr>
<tr>
<td></td>
<td>separate communication channels: one with the central distribution system (Chain 1) and the other</td>
</tr>
<tr>
<td></td>
<td>towards any consumer energy management systems, i.e. the In-home or smart and portable devices (Chain</td>
</tr>
<tr>
<td></td>
<td>2). The combination of the following technologies achieve performance levels consistent with those</td>
</tr>
<tr>
<td></td>
<td>indicated for 2G meters in Resolution 87/2016/R/el:</td>
</tr>
<tr>
<td></td>
<td>Chain 1: A-band Power Line Carrier (A-PLC) combined with RF 169 MHz (back-up);</td>
</tr>
<tr>
<td></td>
<td>Chain 2: C-band Power line Carrier (C-PLC); a possible second channel for Chain 2 is</td>
</tr>
</tbody>
</table>
under investigation (see consultation paper n. 245/2018); a decision is expected by mid-2019.

The two communication channels on power-line (Band A and Band C according to Cenelec technical standards) respectively used in Chain 1 and 2 are independent each other, thus avoiding interferences between them.

For Gas smart meters:

- **H1**: Logical Port (>G6)
- **H2**: under consideration
- **H3**: not implemented
- **C**: 169 MHz
- **G1**: GSM
- **G2**: GSM

The architecture of smart metering gas systems can be either point-to-point (generally with communication on public telecommunication network) or point-multipoint, with concentrator. In these cases, the communication on radio frequency at 169 MHz is adopted (C interface).

The interoperability and interchangeability technical standards have been set by CIG (Comitato Italiano Gas) and can be updated according to technical innovation.

<table>
<thead>
<tr>
<th>Country</th>
<th>H1</th>
<th>H2</th>
<th>C</th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latvia</td>
<td>Wire</td>
<td>Wire</td>
<td>PLC</td>
<td>GSM</td>
<td>GSM</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Wire</td>
<td>Wire</td>
<td>PLC</td>
<td>GSM</td>
<td>GSM</td>
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<tr>
<td>Luxembourg</td>
<td></td>
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<td></td>
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<tr>
<td>Malta</td>
<td>PLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>P1</td>
<td>P2</td>
<td>P3</td>
<td>P4</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>PLC</td>
<td>G1 &amp; G2: GSM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>H2</td>
<td></td>
<td>H1 implemented by default</td>
<td>H2 activated upon customer explicit request, relying on Wi-Fi Technology</td>
<td>C, G1, G2 implemented by default and they rely on PLC</td>
</tr>
<tr>
<td>Romania</td>
<td>PLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.3.2 Information security & Data management

5.3.2.1 CONTEXT

Thanks to information and communication technologies, the grid of the future (i.e. smart grid) becomes smarter so as to improve the reliability, security, and efficiency of the energy system through information exchange, distributed generation, storage sources, and the active participation of the end consumer. Internet of Things (IoT) communication networks are already in use and enable modern energy services provided by grid operators and energy service companies. Therefore, digitalization is driving growth and innovation in the electricity and gas industry.

Traditionally, risk management dealt with issues such as component failure via robust mitigation and recovery plans. The electricity system has always been a complex and heavily interconnected system. The digitalization has increased this level of interconnectivity and introduced a new cyber risk dimension. With this increasingly connected environment comes the risk of vulnerabilities, which could affect the reliability of the energy system and the trust of consumers. Therefore, securing the smart grid and the related communications systems between all actors using cyber resilience strategies is essential for a successful energy transition.57

As shown in Figure 40, the electricity ecosystem consists of many interdependent relationships between numerous stakeholders, relying on providing business-critical components and services. The mapping of the stakeholder consists of the core value chain with generation, transmission and distribution operators and the customer, extending to the business and extended ecosystem. All stakeholders are interconnected through physical, network and strategic relations. The complexity of the network layer continues to grow as the electricity system further digitalizes and therefore forms the challenge to secure the cyber resilience.

The previous figure, published by the World Economic Forum in the context of its report “Cyber resilience in the Electricity Ecosystem: Principles and guidance for the board”, illustrates the main topics at the heart of the Forum approach for cyber resilience in the power industry.

First, it needs to be recognized that the electricity system is a highly interdependent and complex ecosystem. Delivering energy in a secure and resilient way implies the close collaboration of all stakeholders active in the value chain. Digitalization further extends the cyber-attack surface for malicious actors to exploit.

It is also pointed out that cyber resilience can no longer be perceived as an IT-only issue and no longer be managed in isolation. It needs to be integrated with business risks and owned by all parts of the organization and ecosystem.
Finally WEF experts pointed out the unavoidable gap between regulatory safeguards and technology evolution. Even tough significant efforts have been devoted in the world to deliver future-proof, digital-savy regulation for protecting the power system against cyber-attacks, it is not reasonable to expect those regulations to keep pace with the newest cyber risks, meaning that compliance will not necessarily ensure being effectively secure. It is therefore necessary to develop and promote a resilience mindset and take a strategic and holistic approach to manage cyber risks.

In addition to the general principles, boards in the electricity industry are invited to adopt seven-specific principles to advance systemic cyber resilience\(^{58}\), as illustrated by the following figure.

5.3.2.2 DEVELOPMENT OF AN OPEN ARCHITECTURE FOR SMART METERING

To address those challenges, the European Commission initiated specific actions in 2009 and mandated CEN, CENELEC and ETSI (Mandate M/441) to develop an open architecture for utility meters involving communication protocols enabling interoperability (i.e. smart metering). In response to Mandate M/441, the European Standardization Organizations (ESOs), CEN, CENELEC and ETSI decided to combine their expertise and resources by establishing the Smart Meters Coordination Group (SM-CG). This group is a joint advisory body that provides a focal point concerning smart metering standardization issues.

The work under the M/441 mandate has been successfully completed, while the Smart Meters Coordination Group continues, as it is the norm in standardization, to follow up developments and provides input for the maintenance of new and existing standards related to advanced metering.

In a first phase of Mandate M/441, the different functional entities and interfaces that the communications standards should address were identified, with the intention to support the development of software and hardware architecture and related standards.

The second phase of Mandate M/441 (starting in 2013) focused on the development of European standards containing harmonized solutions for additional functionalities within interoperable frameworks. First, a common set of security requirements for smart meters on European level were developed. Based on this common set of requirements and in line with the provisions of the “Cyber Security Act” – adopted by the EU in 2018, the coordination group and ESMIG developed a Protection Profile for Smart Meters. This Protection Profile could be a positive contribution towards the security certification of smart meters in Europe and the enabling of the mutual recognition of certificates by multiple EU Member States. To this respect, it could help (i) avoid further fragmentation of the certification approaches across Europe, (ii) reduce the certification cost, and (iii) increase the security level of smart grids.

Parallel to these mandates, the EC had launched the dedicated experts’ platform of the Smart Grid Task Force, to offer its advice on related policy issues in order to help accelerate the deployment of the smart energy grid solutions and therefore also of smart metering, mainly concentrating on:

- **EG1**: Smart grid standards and interoperability
- **EG2**: Regulatory recommendations for privacy, data protection and cybersecurity in the smart grid environment
- **EG3**: Regulatory recommendations for smart grid deployment
- **EG4**: Smart grid infrastructure deployment
- **EG5**: Implementation of smart grid industrial policy

The Smart Grids Task Force latest assignment was to help prepare, through the work of its ad-hoc expert working groups, the background for secondary legislation under the Clean Energy Package, on access to data and interoperability, demand side flexibility and on energy-specific issues for cybersecurity.

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59 https://www.cencenelec.eu/standards/Sectorsold/SustainableEnergy/SmartMeters/Pages/default.aspx

In parallel to those initiatives that are specific to the energy sector, the European Commission has also progressively adopted a comprehensive legislative framework to cope with the broader challenge of digitalisation.

The framework builds on the EU Cybersecurity strategy (JOIN (2013)01 final) and the Directive on Security of Network and Information Systems (the NIS Directive) (EU) 2016/1148 and has been reinforced by the Cybersecurity Package (JOIN (2017) 450 final) from September 2017, which also includes the Cybersecurity Act.

An energy sector specific guidance has recently (April 2019) been issued by the European Commission (recommendation C(2019)240 final and staff working document SWD(2019)1240 final) to implement horizontal cybersecurity rules. This guidance aims to increase awareness and preparedness in the energy sector, tackling cybersecurity challenges while taking into account the specificities of the energy sector:

- **Real-time requirements** - some energy systems need to react so fast that standard security measures such as authentication of a command or verification of a digital signature can simply not be introduced due to the delay these measures impose.
- **Cascading effects** - electricity grids and gas pipelines are strongly interconnected across Europe and well beyond the EU. An outage in one country might trigger blackouts or shortages of supply in other areas and countries.
Combined legacy systems with new technologies - many elements of the energy system were designed and built well before cybersecurity considerations came into play. This legacy now needs to interact with the most recent state-of-the-art equipment for automation and control, such as smart meters or connected appliances, and devices from the Internet of Things without being exposed to cyber-threats.

Member States are expected to provide information regarding the state of implementation of this Recommendation by April 2020.

5.3.2.3 DATA MANAGEMENT – TYPES & PROCESSES IN THE ELECTRICITY MARKET MODEL

Smart metering data to ensure different processes, among which retail/wholesale functionalities, energy services, grid functionalities, etc., is not just about metered data of physical flows, but also includes other types of data, such as market data and grid data to ensure an optimal integration between data and processes (see Figure 43). With increasing data volumes and data sources, data integrity, availability and confidentiality are becoming more and more complex to ensure.

Data management can be done through different technical solutions, such as decentralized or centralized data hubs, with the majority of the Member States having already deployed or intending to deploy a data hub. Some countries have opted for centralized systems where an independent third party is responsible for managing the data and the respective flows (e.g. United Kingdom, Estonia), whereas others have opted for a decentralized system (where DSOs or suppliers are responsible), or a combination.

Whatever the solution chosen, the key requirement remains efficient and secure data access and exchange, as also instructed in the recast Electricity Directive. According to Article 20 and Article 23 of the new Electricity Directive, the following criteria are to be assessed regarding data management:

- Availability of metering data and settlement at the same time resolution as the national imbalance settlement period.
- Access to (and exchange of) data for the customer and eligible third parties. For this purpose, data is understood to include metering and consumption data as well as data required for customer switching, demand response and other services.
- Interoperability to allow for access and exchange of data (e.g. standardized processes, data formats and communication protocols).

Moreover, easy and secure access for the consumer to their non-validated near real time data, as well as to their validated data (that is used for billing) irrespectively of frequency of readings, is required. This must also be in accordance with the Measuring Instruments Directive (MID) and WELMEC guide requiring the ability to directly read from the meter all the data used for billing, which may be challenging in terms of easy access.

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61 An eligible third party for instance needs the explicit consent of the consumer to access their data.
visualization, storage capacity and the amount of data in function of the time resolution (e.g. consumption data, dynamic prices, etc.).

![Diagram of data types & processes for an electricity market model](image)

**Figure 43:** Overview on data types & processes for an electricity market model.\(^\text{64}\)

## 5.3.3 Consumer outcomes

A major aim of the European legislation when it comes to smart metering, is to empower final customers and to assist their active participation in the energy market. To this end, Article 19 of the recast Electricity Directive provides that Member States should regularly monitor the deployment of smart metering in order “to track the delivery of benefits to consumers”. Hence consumers’ outcomes should be systematically considered when framing the deployment of smart metering, and accordingly monitored to ascertain the success of the deployment from this point of view.

To be able to assess consumer benefits from smart metering deployment and use in the European Union, the following approach proposed in a recent report\(^\text{65}\) is the starting point in this study (see Figure 44):

- **Supply side**, i.e. the potential value propositions related to smart meters, delivering benefits to consumers
- Demand side, i.e. the characterization of the interests, needs and concerns of consumers, and their segmentation according to socio-demographic characteristics
- **Matching ‘supply/demand’,** i.e. looking under which conditions consumers can actually reap benefits from the value propositions enabled by smart meters. These conditions include:
  - the characteristics of the ‘context’ of a given MS (e.g., information campaign in place, regulatory framework, development of energy market.)

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64 M. Sánchez-Jiménez (European Commission 2018), “Overall DSOs’ tasks and functions under the CEP framework”, GEODE Spring Seminar, Brussels, 29/05/2018.

- the socio-demographic characteristics of consumers

This framework developed in the previous investigation was applied there only to few Member States, while in this study we capitalize on this methodology to help assess the potential consumer outcomes from the smart metering deployment in Member States.

5.3.3.1 POTENTIAL VALUE PROPOSITIONS AND BENEFITS FOR THE CONSUMER ENABLED BY SMART METERS

The potential value propositions enabled by smart meters are divided in two groups: standard and advanced/future value propositions. Smart meters can bring direct benefits to consumers, both in terms of monetary (e.g., bill reduction) and non-monetary value (e.g., reducing environmental footprint). However, it is important to note that these direct benefits are possible benefits will depend on the consumer’s motivations and abilities if he or she will benefit.
5.3.3.1.1 Standard value propositions

In the following we describe the set of most common value propositions enabled by smart meters (herein defined as “standard”) and the associated benefits for end-consumers (Figure 46). Each value proposition brings one or several benefits to the consumers. Basically, all standard value propositions allow consumers to better understand and control their energy consumption.

It is worth mentioning, that not all these “standard” value propositions have been considered in the CBAs carried out by Member States. The CBAs have mainly focused on real time consumption display, real-time cost display, prepayment and implicit demand response.

The following standard value propositions are considered:

- **Comparison with peer consumers**: Refers to the possibility to leverage smart meters’ data to allow consumers to compare their energy consumption with comparable peers.

- **Bill forecasting**: Refers to the possibility to use historic smart meter consumption data and on-going consumption level to forecast the amount of the bill at the end of the month. This can help consumers to better understand their bill and also energy consumption patterns.

- **Real-time consumption**: Relates to the possibility to make accessible to consumers energy consumption data in real-time. This can help reducing the energy consumption and the associated bill, and could increase consumers’ awareness over their energy consumption and possible actions to have it under control.

- **Real-time cost**: Displayed on a digital application or IHD can help the consumer reduce the electricity bill and also better understand the bill.

- **Unusual usage alert**: This service alerts the consumer when an unusual high consumption occurs during a longer time period. This can help reduce the energy consumption, and can also increase safety.

- **Historical consumption overview**: Can be helpful for comparing consumption during specific periods, which can help consumers understand and reduce their energy consumption.

- **Real-time carbon impact**: This value proposition consists in making the energy consumption CO\textsubscript{2} footprint, expressed in tCO\textsubscript{2} eq., available to the consumer, which helps understand the impact of their energy consumption on the environment.

- **Pre-payment**: Capability to display the credit balance to consumers who take a pay-as-you-go tariff.

- **Different tariffs (implicit demand response)**: Consumers with a smart meter and a time-of-use tariff can benefit from it as smart meters provide them with better information and enable them to react accordingly and to reduce their energy bill.
5.3.3.1.2 Advanced value propositions

The implementation of **advanced value proposition** (Figure 47) requires further developments in technologies (e.g., data analytics) and market/regulatory contexts (e.g., set-up of flexibility market; penetration of EVs, etc.). The following table provides the advanced value propositions:

- **Flexibility provision (through implicit demand response with dynamic pricing):** Consumers with a smart meter and a tariff with variable dynamic tariff (spot based, peak pricing, etc) can benefit since smart meters will provide them with better information and enable them to react accordingly.

- **Flexibility provision (through explicit demand response):** This value proposition has the ability to provide and valorise flexibility to the power markets, either through existing suppliers or by signing a new service agreement with a new and independent aggregator.

- **Fuel poverty detection:** Data analytics can be used to detect fuel poverty (deprivation) for households who have not yet applied for help or do not have access to social protection. This can increase safety for vulnerable consumers.

- **Energy sharing:** The implementation of smart meters has an enabling role for the local energy communities value propositions, like virtual metering and collective self-consumption.

- **Smart meter to integrate prosumers in the market:** The smart meter can be used either as a prerequisite to install decentralised generation or as a way to introduce new tariffs, for instance to promote self-consumption, reduce network usage or provide economic signals that are consistent with energy markets. These economic signals can be price signals of the energy market, that can push for more self-consumption or the opposite, selling the produced PV energy on the market.

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66 Virtual metering is a bill crediting system for community solar. The solar production is not used onsite but is installed at a distance, where there is a better yield or/and more area available. The solar energy is then shared amongst its subscribers. The subscribers receive credits on the electricity bill.

Collective self-consumption is the transfer of any production surplus, meaning that besides individual self-consumption, the surplus can be used in by members of the same legal entity, which includes various participants, energy producers and end users.
- **Smart meter to facilitate smart charging of electric vehicles at home**: depending on the local regulation a smart meter can reduce the system impact of EV charging by enabling smart charging schemes that take market and grid constraints into account, possibly lowering the cost of charging.

- **Smart meters to facilitate smart charging of batteries**: The smart meter could also be used to in the same way as the smart charging of electric vehicles, but for batteries. This can optimise the battery charging based on grid constraints, tariff prices or roof PV production.

<table>
<thead>
<tr>
<th>Advanced value propositions</th>
<th>Achieved benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bill reduction</td>
</tr>
<tr>
<td>Implicit DR (Spot pricing)</td>
<td>✓</td>
</tr>
<tr>
<td>Flexibility provision (implicit DR)</td>
<td>✓</td>
</tr>
<tr>
<td>Fuel poverty detection</td>
<td>✓</td>
</tr>
<tr>
<td>Energy sharing</td>
<td>✓</td>
</tr>
<tr>
<td>Smart meter to integrate prosumers in the market</td>
<td>✓</td>
</tr>
<tr>
<td>Smart meter to wake charging of EV at home</td>
<td>✓</td>
</tr>
</tbody>
</table>

Figure 47: The consumer benefits related to the smart meter and its enabling “advanced value propositions” (source: ASSET study⁶⁵)

Table 37 and Figure 48 highlight the available services & value propositions enabled by smart meters and made available for the consumers in each Member State. These services & value propositions could materialize into direct benefits for the consumers, that Member States are considering nowadays or for the near future.

There is a clear convergence within EU-28 to let consumers **compare their energy consumption (weekly, monthly, yearly, etc.) based on historical consumption data.** Integrating and visualising **dynamic energy tariffs** (e.g., hourly varying electricity price in function of technical/market boundary conditions) is the 2nd most offered service and allows consumers to better plan the operation of certain (smart) appliances (e.g., washing machines, dryers or dishwashers) to minimize their total energy cost. The 3rd most popular service is the **integration of prosumers in the market.**
<table>
<thead>
<tr>
<th>Country</th>
<th>Comparison of energy consumption with similar peers</th>
<th>Bill forecasting</th>
<th>Real-time consumption data</th>
<th>Real-time carbon impact</th>
<th>Unusual usage alert</th>
<th>Fuel poverty detection</th>
<th>Historical consumption to compare weekly/monthly consumption</th>
<th>Dynamic tariffs (implicit demand response)</th>
<th>Flexibility provisions (explicit demand response)</th>
<th>Pre-payment (pay-as-you-go) system displaying credit balance</th>
<th>Energy sharing in local energy communities</th>
<th>Integration of prosumers in the market</th>
<th>Ease of smart charging of electric vehicles at home</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
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<td>✔</td>
<td>✔</td>
<td>✹</td>
<td>✔</td>
<td>✹</td>
</tr>
<tr>
<td>AT</td>
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<td>✔</td>
<td>✹</td>
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<td>✹</td>
</tr>
</tbody>
</table>

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5.3.3.2 CONSUMER CONCERNS, MOTIVATIONS AND ABILITIES TO BENEFIT

According to the ASSET findings\(^6\), consumers’ ability to reap benefits from smart meter deployment is determined by:

- **Motivations and abilities to effectively benefit from smart meter.** Consumer motivations can be mapped on three dimensions: economic, behavioural and innovation (see Figure 49).

### Figure 49: Interests and needs of the consumer

<table>
<thead>
<tr>
<th>Economic</th>
<th>Behavioural</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Direct savings: By reducing your energy consumption or comparing tariffs and choosing the optimal one. The benefit of direct savings is often emphasised in brochures for smart meters.</td>
<td>• Conformity of society: consumers like to do what rest of society is doing, the norms of the society</td>
<td>• Motivation and ability to learn, understand and use new products and services</td>
</tr>
<tr>
<td>• Indirect savings: Savings made by DSO since he can run his network more efficiently. In France, the economic success of the deployment only relies on indirect economical savings</td>
<td>• Green aspect: consumers who value environment. Suppliers of smart meters can implement services which emphasise the green aspect of the meter</td>
<td>• Importance of interoperability and portability of data and access to data from third parties</td>
</tr>
</tbody>
</table>

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**Table 37:** Services & value propositions available for the consumers in each Member State (legend: green = considered, blank = not considered; grey = data not available).
• **Perceived risks, fears and concerns** related to the deployment of smart meters (Figure 50) which may prevent certain smart meter benefits to be materialized. To have a successful deployment, Member States need to carefully consider and properly address related consumer concerns at the earliest stage of deployment as a prerequisite for further engagement.

The **accuracy of the smart meter**, the **electromagnetic radiation** and **privacy** are the main concerns within the EU-28 (see Table 38 and Figure 51). The measures taken by the Member States therefore also mainly focus on the same concerns expressed by the consumers (see Figure 52).

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**Figure 50: Perceived concerns of the consumers (source: ASSET study)***

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<table>
<thead>
<tr>
<th>Privacy</th>
<th>Cybersecurity</th>
<th>Electromagnetic radiation</th>
<th>Accuracy of meters</th>
<th>Price of meters</th>
<th>Installation barriers</th>
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<tbody>
<tr>
<td>Austria</td>
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<tr>
<td>Belgium (Brussels)</td>
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<td>Belgium (Flanders)</td>
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<td>Belgium (Wallonia)</td>
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<td>Bulgaria</td>
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<td>Germany</td>
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<td>Greece</td>
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<td>Hungary</td>
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<td>Ireland</td>
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<tr>
<td>Italy</td>
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</tr>
</tbody>
</table>

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*This document is the property of Tractebel Impact Belgium S.A. Any duplication or transmission to third parties is forbidden without prior written approval.*
Table 38: Perceived concerns of the consumer in each Member State (legend: green = considered; blank = not considered; grey = data not available).

Figure 51: Ranking of perceived concerns of the consumer in EU-28.

Figure 52: Ranking of focus on measures to counteract on the perceived concerns by consumers in the EU-28.
The context factors influencing the consumers’ ability to benefit from smart meters mainly depend on:

- the set-up of a **suitable communication campaign about the installations and advantages of a smart meter** to raise awareness about the potential value of smart meters for consumers. In the EU-28, communication campaigns are mainly conducted through a website, advertisement and dedicated letters to the consumer (see Figure 53). Exemplary communication campaigns are shown in Figure 54.

- the existence of a **suitable regulatory framework** that can address consumers’ concerns regarding smart meters at the earliest stage of deployment as a prerequisite for further engagement. Exemplary communication campaigns are shown in Figure 55.

- the **market conditions** enabling market actors to develop value propositions.

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**Figure 53: Most used communication campaigns used within the EU-28.**

**Communication campaign example (source: ASSET study**

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Regarding research on consumers benefits, in Lithuania for instance, extensive research and evaluations have been carried out. In 2016 and 2017, interviews were conducted before and after the start of a smart meter pilot. The majority of the respondents considered the advantage of basic intelligent accounting and about half of the respondents indicated the advantages of being able to pay bills automatically and tracking online electricity consumption.

5.3.3 TRANSITION AND CONSUMER KPIS FOR MEASURING SUCCESS OF SMART METERING DEPLOYMENT FROM A CONSUMER PERSPECTIVE

A set of KPIs (non-exhaustive) has been defined in the ASSET study in an attempt to provide guidance to Member States in systematically and transparently monitor progress and impact from a consumer perspective as to ultimately assess the success of smart metering deployment in the EU. These KPIs (see Table 39) are based upon the four dimensions suggested by the European Consumer Organisation ANEC, further refined into Transition KPI – depending on the national context – and Consumer KPI – depending on how consumers have been embracing the new smart energy system put at their disposal.

These four different dimensions/levels can be compared with the pyramid of Maslow, which depicts the hierarchy of human needs and their motivation.

- First, the consumer needs to be made aware of the smart meter deployment, its value propositions and benefits.
- Second, the customer satisfaction regarding the Smart Meter rollout becomes of importance, where the consumer may have concerns regarding his privacy, health and other. To have a successful deployment, Member States need to carefully consider and properly address related consumer concerns at the earliest stage of deployment as a prerequisite for further engagement.
- Next, the active engagement of the consumer becomes important. The consumer will feel empowered. Of course, for this to occur, the regulation and market need to be well developed.

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Maslow’s hierarchy of needs is a theory in psychology proposed by Abraham Maslow in 1943 in his paper ‘A Theory of Human Motivation’.
Finally, the consumer should be able to **benefit from the smart meter** thanks to the available value propositions.

<table>
<thead>
<tr>
<th>Domain</th>
<th>1. Transition KPI</th>
<th>2. Consumer KPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Consumer awareness</td>
<td>• Communication campaign level</td>
<td>• Awareness of installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Awareness of available value propositions</td>
</tr>
<tr>
<td>2 Consumer satisfaction</td>
<td>• Response to consumer concerns</td>
<td>• Ratio of complaints</td>
</tr>
<tr>
<td></td>
<td>• % bills based on actual meter readings</td>
<td>• Deactivation ratio</td>
</tr>
<tr>
<td>3 Active engagement</td>
<td>• Maximum allowable switching time</td>
<td>• Switching rate</td>
</tr>
<tr>
<td></td>
<td>• Availability of detailed load curve</td>
<td>• Number of consumers changing to different tariff</td>
</tr>
<tr>
<td>4 Benefit realisation</td>
<td>• Available value propositions</td>
<td>• Energy consumption reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peak demand reduction</td>
</tr>
</tbody>
</table>

Table 39: Transition and Consumer KPIs to systematically and transparently monitor progress and impact from a consumer perspective as to ultimately assess the success of smart metering deployment in the EU (source: ASSET study65)

In this chapter we investigated what consumer outcomes smart metering was likely to deliver. Obviously, a key success factor identified is the ability to deliver direct benefits to consumers. We also highlighted that a few pre-requisites have to be met to reach this point: consumers have to be informed about smart metering, they have to accept the installation of the smart meter itself and to choose a relevant value proposition for them.

Since the last benchmarking report, the good news is that a lot of innovation occurred within retail markets (gas and electricity). A diversity of value proposition is now offered by market actors, so the next challenge is to facilitate customer choice. On the one hand we recommend NRAs and national authorities to put in place legal safeguards and didactic tools to help them make the appropriate retail choice (e.g. price comparison tool set up by a neutral party). On the other hand, it is fair to expect that those value propositions will mature over time depending on the actual successes and failures triggered by market competition.

In the context of this report, our concern is to transfer lessons learnt and avoid design failures that were already identified as such in the past. Since most of the value propositions depend on the legal framework set up at national level, the relevant markets for the diffusion of innovation are the national ones. Our purpose is to share the return of experience among national stakeholders and to contribute to the diffusion of innovation within the Energy Union. Our proposition is therefore to use the KPIs in order: (1) as a practical tool to help fulfil requirements under the EU Directives and keep track of the benefits and (2) to transfer the lessons learnt and success factors as experienced by early smart metering adopters as further guidance for others proceeding with the rollout.

We invite all national authorities to take inspiration from our work, and suggest ACER and CEER to take a leading role in the definition of a common methodology to compute KPIs and ultimately to contribute to a collective regulatory intelligence.
6 DEEP DIVES

The information collected at national level has been consolidated and is presented as well as the findings out of our initial analysis (covering tasks 1 to 3). The consolidation exercise will be further continued during the coming weeks for the remaining tasks.

This calls for two comments:

- Comparability issues will be dealt with, especially regarding the results of the cost benefit assessments (task 2).
- The content of the most advanced tasks related to data management (task 6) and consumer outcomes (task 7) show a high variability from country to country. Consolidating information might therefore not be the best way to show the relevant results of our investigation, and we recommend to add a few deep dives in the final report that focus on the most interesting countries where there is already some activity regarding emerging services from the deployment of smart meters.

Three smart meter case studies\(^6\) across Europe are described below to illustrate the Smart meter advancements achieved so far:

- The roll out of the 2\(^{nd}\) generation of smart meters in Italy;
- The digital transformation in Estonia;
- Advanced consumer services in The Netherlands.

6.1 Roll out of the 2\(^{nd}\) generation of smart electricity meters in Italy

Italy is a frontrunner of smart metering deployment in the EU, as it was the first European country to introduce a large-scale deployment of remotely-read, advanced electricity meters for low-voltage end-users and is the world’s first country in terms of number of installed smart meters in operation (over 35 million).

As not fully compliant with the subsequent functional requirements by the EC, the first generation (1G) of smart meters would not have allowed the development of additional and advanced services (Table 40 and Figure 56). Therefore, Italy has introduced the second generation (2G) of smart meters that are able to deliver near-real time information to consumers and third parties of their choice via a separate communication channel, and therefore making it possible to offer advanced and customer-centric services, at the same cost of 1G smart meters. The 2G smart meter will introduce extra benefits for the consumer and other market parties (Figure 56).

\(^6\) The country selection was the responsibility of the consortium partners and achieves a balance between the level of access to information about the national deployment plan and the representativeness of contrasted implementation strategies. It has come to our knowledge that the three selected countries have adopted a centralized data management model, nevertheless it is not our intention to favour one model compared to another.
Table 40: Functional comparison of 1G and 2G meters on remote reading and management (source: ARERA, 2018)

<table>
<thead>
<tr>
<th>Features</th>
<th>1G smart meter</th>
<th>2G smart meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote readings</td>
<td>✔ Monitoring of energy and peak consumption</td>
<td>✔ Increased efficiency of remote reading</td>
</tr>
<tr>
<td></td>
<td>✔ Monitoring of the correct functioning of the meter</td>
<td>✔ Higher granularity</td>
</tr>
<tr>
<td></td>
<td>✔ Increase of the number of clients with hourly readings</td>
<td>✔ Readings and hourly based values available within 24h to the retailer via SII</td>
</tr>
<tr>
<td>Remote management</td>
<td>✔ Remote commercial operations</td>
<td>✔ Increased efficiency of remote management</td>
</tr>
<tr>
<td></td>
<td>✔ Remote activation and deactivation of the meter</td>
<td>✔ Additional functionalities available</td>
</tr>
<tr>
<td></td>
<td>✘ Reconfiguration of the setup of the meter at large scale</td>
<td>✔ 2 Channels available</td>
</tr>
</tbody>
</table>

Figure 56: Overview of main features and benefits of the 2G smart meter (source: ARERA, 2018)
6.1.1 Regulatory framework

The deployment of the 1G smart electricity meters started as early as 2001 as a voluntary initiative by ENEL Distribuzione (today: e-distribuzione). In 2006, recognizing the benefits of implementing smart metering, the Authority (ARERA) set a mandatory installation of 1G smart meters to all low-voltage metering points with Deliberation 292/061, so that a mandatory smart metering rollout was extended to all Italian DSOs. This allowed Italy to meet the EU target (i.e. 80 % of all households equipped with smart meters by 2020) by reaching a 95 % penetration rate in 2011.

The primary law enabling smart metering for electricity in Italy is the Legislative Decree 102/2014, approved in July 2014, which transposes the EU Directive on Energy Efficiency (EED 2012/27/EU). The Decree assigned the Authority the duty of defining the functional and performance specifications of the 2G smart meters. In 2016, ARERA issued two resolutions on 2G smart electricity metering rollout: 87/2016/R/eel\(^4\) and 646/2016/R/eel\(^5\):

- Resolution 87/2016/R/eel\(^4\) includes the definition of the functional specifications and performance levels expected for 2G smart meters.
- Resolution 646/2016/R/eel\(^5\) includes the tariff regulation setting the criteria for the recognition of capital costs for smart metering systems complying with the functional requirements and performance levels defined by Resolution 87/2016/R/eel.

With Resolution 222/2017/R/eel\(^6\), ARERA approved the 2G smart metering rollout plan for E-distribuzione, starting in 2017. E-distribuzione’s deployment plan develops over a period of 15 years (2017-2031) and sets out the nationwide substitution of its 31.8 million 1G meters with 2G meters, reaching an 80 % penetration rate by 2022. As of November 2017, E-distribuzione has already installed almost 1.4 million of 2G meters across the country (see Figure 58).
6.1.2 Features and benefits of the 2G smart meter

Most of the 10 key functionalities recommended by the EC (2012/148/EU) are available and activated by default on the 1G smart electricity meters. More advanced technological solutions are now adopted for the 2G smart meters that are currently being deployed, in order to respond to the need for functional and performance evolution induced by the ever-growing computational requirements and higher volumes of data to be transmitted. Figure 59 depicts the system architecture of the 2G smart meters.

While 1G smart electricity meters have only one communication channel, new 2G meters can rely on two separate communication channels:

1. Communication with the central distribution system (Chain 1: “from the meter to the customer through the supplier”)
2. Communication with any customer energy management systems, e.g., the In-home display (Chain 2: “from the meter directly to the customer (or designated third parties)”).

The first chain will provide data that are validated by the DSO and that the supplier can use for billing, while the second chain will provide non-validated data. The supplier (or third parties designated by the customer) can use such non-validated data for energy efficiency goals, and for the development of new commercial offers integrated with other services.

The combination of the following communication technologies allow to achieve performance levels consistent with those indicated for 2G meters in Resolution 87/2016/R/ee and avoiding data interferences between both chains:

- Chain 1: A-band Power Line Carrier (A-PLC) combined with RF 169 MHz;
- Chain 2: C-band Power line Carrier (C-PLC).

Suppliers have the right to access energy consumption data for billing and other regulated purposes without specific. Only the consumer, who is the owner of data, can provide third parties the access to their consumption data.
6.2 Digital transformation in Estonia

Smart metering was deployed in Estonia by 2017 to all customers (~700,000), and a central data hub is already in use. According to the national Electricity Market Act and Natural Gas Act all smart meters were to be installed by 1st of January 2017, and 1st of January 2020 for electricity and gas, respectively. The deployment is mandatory for all consumers (for gas if consumption is higher than 750 m³/yr).

6.2.1 Estonia, is one of the world’s most advanced digital nations

When it comes to the level of maturity of government services ("eGovernement"), Estonia is considered as leading in the field (see Figure 60). This high level of IT maturity in the country has been one of the key success parameters in the smart metering and central data hub design and deployment.

Estonia is a frontrunner in both digitisation and penetration of its public services (e.g., e-Governance, e-Tax, e-Voting, Digital ID, etc.) and also scores high technologically, due to its, amongst others:

- Highly developed telecommunications and IT infrastructure;
- Digital networks providing wireless internet (400 Mbps with 4G connections);
- Fiber optic backbone network throughout the country;
- Two competing 10 Gbps optical networks (being built & among the first in Europe);
- Providing 10 Gbps to at least 40 % of the households in Estonia within the next few years.

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In Figure 60, “Penetration” captures the extent to which use of the online channel is widespread among users of government services and stems from Eurostat data. Digitisation is a proxy for the Digitisation level of the back- and front-office of Public Administration and its source is the eGovernment benchmark indicators.\(^70\)

6.2.2 Central data hub

A central data hub (see Figure 61), administered by Elering as an independent transmission system operator, is in operation in Estonia:

- To manage the central exchange of electricity metering data between market participants;

to support the process of changing electricity suppliers in the market;
- to archive the metering data of electricity consumption

The Estonian Data Hub system is a software/hardware solution managed by the DSO. User access to the Estonian Data Hub is granted to grid operators, open suppliers and line operators operating in Estonia. Market participants are encoded, as well as measuring points measuring electricity flows between participants. Encoding defines the market participants’ rights, as well as the supply chains.

Through the data hub web portal, all parties have access to their own consumption volume measurement data (remotely readable in one-hour increments). The data hub system ensures principles of equal treatment. The network operator must ensure measurement, collection, control and accuracy of measurement data.

![Estonian data hub](source: Ennomotive)

**Figure 61: Estonian data hub – an example of a centralised data management system**

### 6.3 Advanced consumer services in The Netherlands

By the end of 2017, smart metering systems have been rolled out (on the basis of the original timeline 2015 – 2020) to over 50% of all users. Only 11% of the users have declined the smart meter, while 2% asked to deactivate the communication. Around 18% of the consumers with a smart meter also have an energy consumption manager, such as a smart thermostat, which offers direct feedback to allow energy consumption reductions. Smart meters are one part in the smart grid strategy (see Figure 62), among digital operation, intelligent substations (low and medium voltage), flexible grid structures and telecom.
Figure 62: For grid operators, smart meters are one part of the smart grid strategy (source: Liander, DSO)

In The Netherlands, the DSOs are responsible for the roll out (see Figure 63 for DSO Enexis) and communication with the smart meter (see Figure 64). Consumers with a smart meter installed, will receive a bi-monthly energy bill.

Figure 63: Smart meters installed and planned in the south of The Netherlands (DSO: Enexis) Legend: green (installed); yellow (roll out started); blue/purple (roll out planned); grey (roll out not planned)
6.3.1 Case study – Dynamic energy pricing

During the last decade, several pilot projects have been executed in the scope of smart grids as preparation for the scale up of smart metering roll out. One pilot project “Your Energy Moment” (Jouw Energy Moment) was conducted between 2012 – 2015 to gain experience with technical, economic and social options to create flexibility and increase sustainability in the energy consumption of consumers\(^{71,72}\) and help answer questions like:

- How can consumers become actively involved in a smart grid system? How will they change their behavior?
- Which technical and social options can unburden the energy grid?
- How can supply and demand be better aligned, in order to use available renewable energy efficiently?

The participants of the pilot project are equipped with a smart meter, a photovoltaic system, smart appliances (e.g., washing machine and dryers), and a “Home Energy Management System” (HEMS). The HEMS can be used to consult interactive information of their energy use, local energy production and energy prices. Based on this information, users can insert their preferences to plan the operation of their smart appliances and other “dumb” appliances. The dynamic price information – based on the available grid capacity, local electricity production and APX (day-ahead) prices – is communicated to the consumer 24 h through a central ICT system (CEMS) (see Figure 65 and Figure 66).

\(^{71}\) Eindrapportage (report) Jouw Energiemoment Zwolle, November 2014.

\(^{72}\) A second phase of the project has been executed to assess new scalable business models for flexible tariffs to avoid peak loads on the energy system. In 1/3 of the houses, a battery and heat pump were installed which was automatically turned on and off.

The outcome of the first pilot project is that dynamic energy tariffs are a reason for energy consumers to change their consumption behavior and move their consumption to periods with low energy prices. Among the appliances, the dishwasher, washing and drying machine are for consumers the most popular appliances to shift their energy demand.
7 RECOMMENDATIONS FOR NATIONAL AUTHORITIES

7.1 Purpose

In this chapter, we present a set of recommendations to national stakeholders, especially lawmakers and regulatory agencies but also for industry and consumer representatives active at European level. Our initial views were confronted with those of the relevant stakeholders, to finally converge to the final recommendations. Those recommendations were elaborated by analysing the extensive data received and consolidated as detailed previously in this benchmarking report.

As explained in the introduction of this report, our goal is to assess smart metering deployment in the light of the European legal framework. And it comes with a vision – as reflected in the Clean Energy for all Europeans - and a target to reach – that is the 2030 climate goals - and an ambition to realize – secure, clean and affordable energy for all Europeans. Our recommendations have the ambition to serve that vision, but it is neither our purpose to promote smart meters themselves nor to assess any form of legal compliance of national authorities with respect to the European regulatory framework.

We first forget for a while our strict European mandate and take a look at smart metering as an industrial opportunity, a trade gateway for growth and external sales of goods and services. Then we go through each of the specific areas that have structured our analysis, from the legal framework to consumer outcomes.

7.2 Recommendations

7.2.1 Global context

7.2.1.1 HIGH POTENTIAL FOR SMART METERING TECHNOLOGIES AND APPLICATIONS

The smart metering technologies and applications create a whole new range of business models for all actors across the power and gas value chain. Given the scale of the energy system, the potential market for these technologies and applications is very large.

The stakeholders all recognise the disruptive impact of smart metering technologies and applications on the energy system. The future energy system will look substantially different from today, if there is a widespread implementation of these technologies and applications.

The energy system will be more decarbonized, digitalized and decentralised. Energy flows will be increasingly bidirectional, thereby making the notion of producers following consumers less relevant. This will create a need for a higher level of engagement of the end users, compared to the situation today.
SMART METERING ACTIVITIES OUTSIDE EUROPE

Many innovative and mass-scale smart metering projects and commercial implementations are taking place outside Europe. The Middle-East, Asia-Pacific, and North-America are three key non-EU regions where a high level of activity is observed.

From a world trade perspective, several European companies are active in these non-EU countries, especially for aspects that are not highly region-specific, such as ICT-aspects. Non-EU companies are also very active in these regions, and they have the advantage of operating in their domestic market.

Thus, the prospect of smart metering deployment should be considered globally, with competition pressures from industrial actors that can rely on a strong domestic market. Within such an environment, a substantial level of activity in the EU might effectively support the EU industry, by creating a substantial domestic market for smart metering-related goods and services.

This all points out to smart metering as an opportunity Europe should not miss. How could we possibly sustain our leadership role in climate action if we are to rely on an old-dated, non-digital metering layer in the Energy Union? The following page take a deeper look to try an give a correct answer to this question.

Legal framework

Even though all MS have successfully transposed the smart metering related provisions from the current EU legislation, the level of progress of the legal and regulatory framework on this very subject shows a contrasted picture. Starting from the strict transposition, national authorities have progressively and diversely adopted general provisions related to the design of smart metering systems: allocation of roles and responsibilities to the different actors, principles for funding and cost recovery, eventually definition of a more advanced set of functionalities. These next steps are usually focused on the actual implementation and transition towards the new metering paradigm. Some key topics to consider are specific rules for the deployment modalities, such as refusing the installation or allowing for the lesser use of metering data (opt out and default provisions for data access), as well as for the implementation phase, such as the definition of dedicated tariffs scheme for grid users equipped with smart meters.

From a service provider perspective, the regulatory framework for smart metering applications is fragmented across the member states, e.g. the regulation concerning access to consumer data. Due to this fragmentation, some economies of scale cannot be achieved, which limits/slows down the upscaling of European companies that can offer smart metering technologies/applications.

Simultaneously, the upscaling is taking place in some non-EU regions, which accelerates the domestic players in those regions. Examples here are the initiatives taken by cross-state ISOs in the USA to allow for residential demand response to participate in the electricity markets. This allows for the industrialisation of North-American demand response aggregators.
7.2.3 Cost benefit assessment

In this broader context of competitive digitalization, national authorities should also take into account the missed opportunities of having a lagging smart metering deployment.

While the Third Energy Package put “smart meter” in the spotlight as a driver for innovation and competition in the retail energy markets, the time has come to refer to “smart metering” as a system whose ultimate goal is to address consumers – or citizens – needs. And those needs are real, as experienced in various ways by national stakeholders.

From energy communities and collective self-consumption to dynamic electricity prices and flexibility aggregation, smart metering should not become the missing link in the new digital value chain.

In this respect, we fear that the cost benefit assessment, as generally defined in the EU legal framework and in some cases not comprehensively performed by Member States, does not fully capture the range of benefits enabled by smart metering. Due to the lack of consistency between members states’ CBAs, no reliable quantitative analysis could be performed during our investigation for this study. However, major trends were identified, where the cost benefit assessment meets different needs. As detailed in the following table, we found out that, depending on the actual level of progress of smart metering deployment, national authorities will use the cost benefit assessment for very different motivations.

<table>
<thead>
<tr>
<th>Motivation for performing CBA</th>
<th>Actual level of progress of smart metering deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early adopters</td>
<td>Upgrade of first generation</td>
</tr>
<tr>
<td>Promoters</td>
<td>Keep track of benefits delivered</td>
</tr>
<tr>
<td>Newcomers</td>
<td>Support communication during deployment campaign</td>
</tr>
<tr>
<td>Waverers</td>
<td>Justify segmented vs massive roll out and avoid binding target</td>
</tr>
</tbody>
</table>

Table 41: A simplistic typology of Member States use of the Cost Benefit Assessment

For those early adopters that are now investigating a wider range of services and benefits thanks to a more versatile smart metering system, smart metering is able to support the adoption of innovative, inclusive and citizens-centred energy policies and support schemes. CBA is not an embedded tool for monitoring and benchmarking in those countries – the deployment debate has been done for years there – which is a missed opportunity for other Member States to learn from their more experienced colleagues.
Promoters of smart metering system are using the CBA in the most interesting manner, namely to keep track of benefits. However, as was mentioned by several stakeholders during the course of this project, those countries using CBA as a monitoring tool and making efforts for greater consumer engagement are also the ones that took the most optimistic assumptions for computing smart metering benefits. In our opinion, using CBA for reacting to a growing discrepancy between initial assumptions and actual realization of benefits is perfectly fit, since it demonstrates accountability and transparency that are prerequisites for consumers to trust smart metering.

For Member States that have less experience of large scale deployment of smart metering systems, CBAs are used in much more conservative and less transparent way. The economic assessment is not designed to be debated in public – due to its inner complexity and somewhat conflicting objectives in certain cases. Our perception is that national authorities, generally the regulatory authority in charge of setting and controlling the grid tariffs that will be used in most countries to finance the deployment, have been trying to build a solid business case based on value pockets located within the DSO regulated perimeter of activities. While this approach is robust and reliable, since it is based on partially controllable expenses, it is also conservative in that sense that it fails to capture the potential for smart metering benefits for market participants, consumers and the broader economy.

The new electricity Directive turns the Cost Benefit Assessment into a periodic process, with the binding target of 80% (originally set in 2020 by the Third Energy Package) becoming a moving – 7 years (from a positive cost-benefit assessment) – target. We have identified lessons learned, return of experience from large scale deployment and best practices that could lead a more favourable economic assessment of smart metering deployment for those member states that are still assessing the economic relevance of a digital (!) energy system. However, those authorities are accountable for the costs they approve. It is therefore their duty to define a consistent vision for their domestic energy system that support the Clean Energy Package and makes use of the many degrees of freedom that national authorities have left at their disposal to sustain a clean, affordable and secure energy for their citizens.

Our recommendation to those national authorities is to use the Cost Benefit Assessment to investigate how to best meet consumer needs and monitor the actual delivery of benefits, not to justify political choices.

7.2.4 State of play

Whilst the recast of the Electricity Directive has updated the required functionalities of smart meters, a significant number of countries have already rolled out their metering system. According to article 20 of the Directive, countries whose smart metering systems do not meet the new requirements have up to 12 years to update their system. Thus we can be concerned that a critical proportion of citizens from those countries may be stuck for at least 12 years with outdated, limited-functionality smart meters. Indeed, the development of new businesses and services will be significantly slowed down if not completely impeded thus precluding end-users to fully benefits from the grid digitalisation. Hence, a national-scaled updating process of software and hardware composing the smart metering systems will be required in those countries.
In the meantime one should consider that the countries which have already rolled out their metering system are among the ones with the higher degree of acceptance of smart meters and are also the ones who had best integrated the potential benefits of smart metering system in their network development framework. Hence, whilst the updating of the smart metering systems will require additional investment, which might slower the process, the risk that those countries do not launch such update before 12 years is unlikely to realise.

Today, the main obstacle to the digitalisation of the European grid, taken as a whole, is probably the limitation in the functionalities imposed by MS. Although EU manufacturers claim to be able to deliver all functionalities, those are limited inconsistently across MS. This choice, whatever the reason, and beyond the missed benefits for consumers, engender undesired consequences for the European energy market.

First, those differences significantly impede the interoperability of smart metering systems among MS which might create, or at least do not remove, barriers to entry in national metering systems market. In such a configuration, where smart metering systems must be differently adapted to each national market, we are short of reaching an internal energy market. Then, the fact that European manufacturer are limited by national constraint with regards to smart meter functionalities might also slower the pace of improvement of smart metering systems, in terms of accuracy, safety and cost-efficiency, as well as the development of related services. Considering the arising competitive pressure for smart meter provision, particularly from the US and China, MS and European institutions should be particularly cautious at ensuring that European manufacturers will not be suffering from a significant competitive disadvantage in the forthcoming years.

7.2.5 Functional and technical specifications

Smart metering business models rely heavily on communication functionality. There are some barriers that are specifically related to the communication part in the business models.

**Gaps in standards and protocols** – For upscaling smart energy grid solutions, it is necessary to connect all types of appliances, such as cars or smart assets with all other types of smart infrastructure, such as for instance (public) chargers. For smart charging for instance, this includes roaming between different national and international networks. On a local level, a standardised type of connection facilitates interconnectivity, relevant for IT/OT integration. It is important that standards and protocols are agreed upon that make these smart solutions possible across the entire EU.
Economic lifetime mismatch between energy and ICT/Telecom – The economic lifetime of ICT infrastructure and commercial telecommunications is very short compared to the long lifespan of energy infrastructure. Telecom and ICT undergo rapid innovation and development pressured by the public want for better, faster performance and increased functionality. In order to keep tariffs low, the energy infrastructure has an economic lifespan that range from decades to over half a century. While this already proves a challenge to smart grid business cases and investments, there is a risk of technology or supplier lock-in, when large parts of the consumer ICT and telecom market and technology have moved away from the legacy technology.

Telecom frequencies are regularly reallocated – Related to the previously described risk, most commercial telecom frequencies are periodically reallocated by means of a government auction. For energy infrastructure such an auction may provide a risk of losing connectivity, while not having earned back the smart grid investments. Some market actors advocate the allocation of a dedicated band for utility communication, that is exempted from the auctions and provides long-term investment stability. To guarantee resilience, DSOs mention that it would be more efficient to have a specific spectrum, and some countries are already allocating specific spectra (Poland and Germany).

Leverage the synergies with the ICT Industry

Electricity and communication grids can be unified. The ICT industry is capable of building a more flexible, less capital intensive layer on top of the physical grid infrastructure, for instance by using broadband power lines. These are much more cost effective than conventional telecommunication solutions as they use the grid infrastructure itself to transfer communication signals on top of electricity flows.
7.2.6 Data management

7.2.6.1 GENERAL CONSIDERATIONS

The new Electricity Directive made access to data and exchange of data the cornerstone of smart metering data management. Different technical solutions are used by MS, from centralized data hub to decentralized system and, during the present investigation we gathered evidences of efficient data management systems, considering cost efficiency and data security, both in de-centralized and centralized environments. Assessing the suitability and the best option for data management systems architectures is not an easy task and, in any case, is not in the scope of this study. When designing their data management system, MS must fully integrate considerations regarding the resilience of the system to cyber-attack, black-out recovery capability as well as the feasibility of a system replacement if better options can be considered. MS should also integrate requirements stemming from the GDPR such as data minimisation, proportionality to purpose and risk mitigation. Last but not least, MS should ensure an effective mitigation of the market power de facto acquired by the data management responsible party.

Still, access to and exchange of data, where data is understood as metering and consumption data as well as data required for customer switching, demand response and other services, is the key for consumers and eligible 3rd parties to enjoy those retail/wholesale functionalities and new energy services that are of interest and benefit to them.

Thus, smart meters must be able to support the delivery of the full range of near real time data as well as validated data of actual consumption/generation (even at frequent intervals), in order to comply with the Measuring Instruments Directive (MID) and the WELMEC guide. These require that customers are able to directly read data used for billing from their smart meters data. Whilst new smart meters seem to be able to provide all these data, it appears that not all installed smart meters in EU are able to do this for the required data frequency (e.g. due to storage limitations, etc).

This calls for promptly implementable solutions without waiting for smart meters upgrades. One possible option to investigate could be to use another channel than the smart meter itself to provide feedback to consumers and inform them appropriately with timely information.

In any case, parties responsible for smart meters deployment and/or data management should focus on digitalisation of their systems. In that context, new services such as price signal for switching or for flexibility provisions, have to be taken into account. With regard to near real-time data provision and the tremendous amount of data that has to be collected, data managing parties should not fixate on smart meter only but should also consider cost effective channels that can complement each other to provide a reliable and timely information to consumers. In conclusion, we do not favour one-solution-fits-all approach for handling the data management challenges. Metrology experts need to design flexible solutions that are cost effective and inclusive. Pioneers should not be punished but practical accommodations need to be implemented that do not jeopardize consumer’s trust: deploying smart meters should not prevent consumers to use their metering data to check their consumption and the accuracy of their energy bills.
Considering the accelerating pace of technological evolutions, the MID should be adapted and become more inclusive of new realities where data are always moving faster and the digitalisation is way more anchored in citizens’ life that it was years ago when the MID related provisions were last revised.

In the following paragraphs, we focus on two specific but promising advanced services that have the potential to directly benefit consumers and therefore to promote smart metering acceptance by its users, presenting services based market and grid drivers respectively. In both cases, smart metering is a prerequisite in order to differentiate the individual consumption profile that can be translated into direct monetary benefits. Without smart metering, any effort to incentivize consumers to adopt a more favourable behaviour will not induce direct benefits, but will rather be spread over the system users.

7.2.6.2 VARIABLE RETAIL ELECTRICITY PRICES

Various business models build on a lower energy bill for the electricity user by allowing them to use the variable retail electricity prices. For instance, in advanced services like smart charging, vehicle to grid and energy management systems, flexibility is used to purchase electricity more cheaply by taking advantage of its wholesale price volatility.

**Flexible tariffs are not always allowed or feasible for small end users** – To protect residential customers from price risk, some member states have taken specific provisions that prevent consumers from fully benefitting from their active participation in the electricity market. In those countries that have chosen to implement a form of price regulation, it is not always allowed to charge flexible tariffs.

As also described in the report *Regulatory Recommendations for the Deployment of Flexibility*, the ability of consumers to offer their demand side flexibility to be used in the capacity, forward, day ahead, intraday and balancing markets, is limited. Industrial consumers and generators with their own bi-lateral power purchasing agreements can participate. Smaller industrial, commercial or domestic consumer access to flexibility services varies in Member States but tend to be limited. The result is that not all of the demand side flexibility which could be provided by motivated and willing consumers is accessed. This barrier makes it impossible to pass on the benefit of demand shifting to the consumers.

To enable companies to use prosumers and electric vehicles to access the flexibility market will require careful design of the flexibility market. A first step is to accept flexibility as a resource in the full range of energy markets.

**Smart meters are not installed** – To confirm that demand shift has taken place, hourly or even quarter-hourly metering must be in place at the end consumer. These costs might be prohibitive for the entrepreneur to carry, while the benefits of the smart meters are broader than for the specific business models. Different consumer products exist that bypass the need for a smart meter, e.g. by offering a similar functionality as an integrated or modular part of an energy management system.

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73 Regulatory recommendations for the deployment of flexibility, EG3 Smart grid task force, European Commission, 2015.
**Allocation does not take place based on smart meter data** – For the supplier to be rewarded for the demand shift, it must be possible to allocate it to that specific supplier. At the moment, even while smart meters are installed, the allocation of hourly electricity flows are still based on predefined synthetic load profiles. This means that individual profiles are aggregated and can no longer be allocated to the BRP.

**Aggregation for ancillary services** – To be eligible for providing ancillary services, TSOs often fix sources of a minimum size. This has historically grown as providers have always been medium to large generators. They also demand regular test running of specific installations. These requirements are impossible to meet with a portfolio of EVs or smart prosumers.

### 7.2.6.3 CONGESTION MANAGEMENT USE

Electricity market is one possible value stream for active participation of consumers, but it would also be possible to get value from flexibility put at DSOs disposal to alleviate congestion and by reducing peak demand. The main difference with the previous is the way demand side management is incentivised. For these “grid-focused” business models the following additional barriers can be identified:

**There is no remuneration for providing local flexibility products** – For the business model to work there must be a revenue stream that originates from DSOs. DSOs in turn can finance these stream from lower investments. For a number of reasons these revenues do not exist:

**DSOs are not allowed to apply congestion management** – In many countries DSOs are obliged to always allow customers to use their full capacity, and make sure the grid can facilitate this. Congestion management is considered a limitation on the freedom of the end user to access the grid at any time. Similar consideration is that in many countries DSOs are not allowed to diversify tariffs based on capacity requirements.

**DSOs are not allowed to include costs related to congestion management in their tariffs** – As a rule, DSO tariffs are regulated. In many cases the tariff structure does not allow including costs not related to physical infrastructure in their tariffs. This means costs related to local flexibility and congestion management cannot be recuperated and constitute a loss from the perspective of the DSO.

**Net metering is a disincentive for prosumers to maximise true self consumption** – In many countries net metering is in place. This means that prosumers have no incentive to use the electricity they produce simultaneous to their production. Abolishing net metering would give an incentive for prosumers to shift their demand to moments of production. This would provide an additional revenue for business models that are based on increasing flexibility behind the meter. Self-consumption can be synergetic with the needs of the DSOs – it can be combined, without additional costs, with congestion management.

**Supplier blocking aggregators from approaching their customers** – Suppliers do not like third party aggregators to change the demand behaviour of their consumers. This might cause imbalance in their portfolio. For this reason, they are reluctant to allow aggregators to approach their customers and supply them with the information that is required to perform their operations.
Those two examples show that smart metering is a prerequisite to be able to provide benefits and value to the end users. It also shows that the whole value chain has to adjust to the new digital reality: from predefined (also called synthetic) to real load profiles, from yearly net metering to incentives for real time self-consumption, the same question comes again: what is the best balance between protecting the consumers and providing them with appropriate incentives and economic signals?

7.2.7 Consumer satisfaction

In spite of all the efforts exerted by MS and NRA to turn out the smart metering deployment into a social welfare enhancement, only an insufficient share of its potential benefits will be realised if European consumers do not properly use their smart meters. To make it happen, a process which informs customers about the smart meters deployment, its value propositions and benefits, accurately addresses their concerns and provides them with incentives to become active participants of energy markets has to be implemented. MS have launched communication campaign about smart meters roll-out, with more or less success. Opt-out and refusal rates, if the legal framework allows this possibility and the information is monitored, provide useful insights into the level of acceptance of smart metering. This kind of information is key to be able to enhance consumer engagement initiatives.

The main concerns expressed by consumers, when it comes to smart meters being installed in their premises, relate to electromagnetic radiation and the broader impact of smart meters on health, and to data privacy. Regarding the first of these concerns, smart meters – like any electronic device – have to comply with European safety and quality standards and are subject to laboratory tests to demonstrate their compliance. But information related to those tests (process and results) have not always been appropriately communicated by grid operators, which constitutes a missing opportunity to reassure consumers about the health effects of meters and to increase the acceptance of these meters. With regards to consumers concerns relating to data privacy, a focus on GDPR provisions - whose extensive communication campaign at the Union scale has effectively comforted Europeans about protection of their data - should be put forward when communicating about collection and management of smart meters data.

Smart meters bring a wide range of value propositions for customers, creating stronger incentives for demand-side efficiency, or enabling flexibility provision, energy sharing, etc. Consumers just have to be accurately informed of all these possibilities to become active participants in energy markets.

Hence there is a need for better communication campaigns and training of personnel to properly inform customers on smart meters and their potential. The communications should also be broader (multi-channel) and facilitated for the consumer and not time-consuming. These are mandatory measures to lay the foundation for consumer’s trust and acceptance of smart meters.
8 CONCLUSION

The European Commission presented in its 2014 benchmarking report the state of play of smart metering deployment in the European Union. It provided an overview of the national cost benefit analyses (CBA) that Member States (MS) were invited to conduct following the adoption of the Electricity Directive 2009/72/EC and Gas Directive 2009/73/EC.

The present document constitutes an updated benchmarking report for smart metering deployment in the EU-28. It has built upon the initial benchmarking report but it further investigated areas of interest that have been demonstrated as key by MS that have already experienced significant difficulties to make smart meter actually deliver the business case, including direct benefits to the consumers.

This report also considered the latest policy initiatives undertaken by the European Commission, especially the new provisions of the recast Electricity Directive that further paves the way for smart metering, like, among other topics, system interoperability and support of new services to deliver benefits and ultimately satisfaction to consumers.

Next to the reminder of the specific background of our report, the European regulatory and legal framework related to smart metering has been presented in detail.

After this reminder on the European framework, the report presents how data was collected and validated to feed the analysis and proceed with relevant recommendations. Data was effectively collected and validated in each of the EU-28 member states, that allowed to have access to the most consistent and complete view on smart metering in the EU-28 that was reasonably possible to achieve.

National regulatory authorities and energy ministries across the EU-28 have been closely involved in the course of producing this benchmarking report. Comments and expectations expressed during the initial 2014 benchmarking report have fed our approach for stakeholders engagement from the very start of the project.

We committed to engage with national authorities and did actually embark them on our benchmarking journey. From the initial questionnaire and additional Q&A that followed, we engaged in bilateral activities to come with a refined overview of the country at hand, using a country fiche put at NRA scrutiny, to later invite those national authorities and other relevant stakeholders to a dedicated interactive seminar.

During this event, we tested our recommendations and gathered feedback and comments on the consolidated data been shared. Finally this report will be put at their disposal to further react and provide any final reaction before finalizing this report.

From the 2014 initial report, a mind shift progressively occurred. It was not about economic assessment of a new (regulated) asset, it is now about defining a consistent value chain to deliver benefit and usage to end consumers and citizens.

The analysis, made of a comprehensive data collection and consolidation exercise throughout the EU-28, translated national insights into European-wide recommendations to further strengthen the deployment of smart metering system at the benefits of European consumers and citizens. Each of the specific area/domain of knowledge has been analysed, summarized and finally assessed.
Our key message is that smart metering represents an opportunity Europe should not miss. Smart metering should not become the missing link in the new digital value chain. We also call National Authorities to embrace the opportunity offered by the Cost Benefit Assessment as institutionalized in the European regulatory framework and implement an efficient and consistent monitoring tool for smart metering deployment. Early adopters of smart metering systems have gathered a precious return of experience, and the smartest have learned from their mistakes. We believe it is now time for the rest of the Energy Union to be even wiser and learn from the earlier mishaps and success stories of others.
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