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Benchmarking smart metering deployment in the EU-28

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Benchmarking smart metering deployment in the EU-28

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Directorate-General for Energy

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Moreover, we would like to note that these individuals were not asked to endorse the conclusions and/or recommendations. Responsibility for the final content of this report rests entirely with the authors.

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This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Austria.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

1.1. Legal and Regulatory Framework

1.1.1. Market model

In Austria, the Federal Ministry for Sustainability and Tourism is legally entitled to define deployment targets and conditions for smart meters for electricity and gas.

The provisions that are made will mostly apply to Distribution Grid Operates (DSOs) as they are in charge of almost all market roles, except for in-home display ownership and installation. The market roles include:

- Meter ownership
- Meter Installation
- Metering data collection
- Metering data storage
- Metering data transmission to third parties
- Metering data protection officer (Art.37 GDPR)
- Buyer compensation for technical & administrative losses

For the roles 'metering data transmission to third parties' and 'buyer compensation for technical and administrative losses' there is a convergence towards a single entity, which is also the DSO.

1.1.2. Legal grounds

The primary law that enables smart metering for electricity is ElWOG 2010. The status of this law is nearly unchanged since implementation.

Delegated laws that further implement smart metering deployment for electricity are IME-VO (issued by Federal Ministry for Sustainability and Tourism), IMA-VO (issued by E-Control) and DAVID-VO (issued by E-Control). The functions of these laws are:

- IME-VO: the implementation plan
- IMA-VO: functional scope
- DAVID-VO: requirements concerning data availability and data presentation to the customer

The primary law that enables smart metering for gas is GWG 2011. The status of this law is also nearly unchanged since implementation.

A delegated law that further implement smart metering deployment for gas is IGMA-VO 2012 which contains functional requirements for Gas Meters.

At the moment, there is no implementation plan foreseen for the gas sector in Austria.

1.1.3. Primary drivers

The primary drivers for smart metering deployment in Austria are:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)

1.1.4. Smart metering programme financing

In Austria, the DSOs have invested in the rollout of smart meters. The item charges for metering services or the so-called metering price in the electricity bill comes directly to the grid operator to cover its costs for installation and operation of counters and electricity meters, as well as its calibration and data readout. In general, a basic flat rate of € 28.80 per year is charged, which is independent of providers and consumption. In Vienna, on the other hand, this flat rate amounts to € 26.16 per year under the same conditions. Depending on the network operator or on request of the customer, this lump sum can also be paid in monthly instalments.

1.1.5. Recent publications by the NRA

Information on the smart meter rollout can be found on the website of E-control, the Austrian regulator.[1]

[1] https://www.e-control.at/en/konsumenten/energie-sparen/smart-metering/rechtlicher-rahmen

1.2. Cost benefit analysis

1.2.1. Relevant study

Following a public tender, E-Control commissioned consultancy PricewaterhouseCoopers with a study on smart meter roll-out in Austria. It analyses all relevant aspects of blanket rollout of smart meters for electricity and gas throughout Austria and evaluates them.

A cost-benefit analysis was conducted to assess the effects on market players. In addition, macroeconomic analyses provided information on the effect of the Austrian economy as a whole (e.g. on employment, GDP). The exercise included effects for consumers (households, small businesses, and agriculture for electricity), system operators and suppliers. Impact on the market model and on competition was also considered.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2010[2]	Consultant	NRA	Positive Net Present Value	Define ideal target and planning
2010	Government	Government	Positive Net Present Value	Comply with Dir. 2009/72

1.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were considered in the cost-benefit assessment, namely DSO, Supplier, Consumer and State/society, TSO, Producer and Telecom service provider, as well as multiple scenarios.

Key parameters for the assessment	
evaluation period of the CBA [Years]	2011-2020
billing and metering frequency in the reference case for electricity [times/year]	Billing Yearly, Metering information monthly; metering frequency 15 min intervals (opt-out option possible)
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	4,4%
What is the electricity losses unit cost? [€/MWh]	Not available
What is the economic lifetime of electricity smart meters? [Years]	15

[2] Studie zur Analyse der Kosten Nutzen einer österreichweiten Einführung von Smart Metering, PWC/E-control, 2010

What is the economic lifetime of gas smart meters? [Years]	12
What is the value of the lost load? [€/MWh]	Not available
What is the cost reduction rate due to technological maturity? [%/year]	Not available

1.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (see Recommendation 2012/148/EU), with four exemptions.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management
☐ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call center and customer service
☒ OPEX - Consumer engagement programme

Furthermore, also most benefits recommended, were considered:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
☒ Provision of explicit flexibility services (rather based on a request than a price signal)
☒ Increased competition in retail market
☐ Easier access to photovoltaic production
☒ Meter reading & operation savings
☒ Operation & maintenance of assets
☒ Distribution capacity deferral
☒ Transmission capacity deferral
☒ Generation capacity deferral
☒ Technical losses reduction
☐ Non-technical (administrative, including fraud) losses
☐ Outage management (based on societal value of lost load)
☐ Outage management (based on reduced customer indemnification)
☒ CO2
☐ Air pollution (particulate matters, NOx, SO_2,...)

1.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	5.730.000
actualised CAPEX for the whole evaluation period	€845.785.000,00
actualised OPEX for the whole evaluation period	€964.348.000,00
actualised benefits for the whole evaluation period	€381.739.000,00

The resulting ratios have been computed per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- OPEX per meter: €168
- CAPEX per meter: €148
- Benefit per meter: €67

1.2.5. Deployment strategy and latest statistics

The Federal Ministry for Sustainability and Tourism is overseeing the rollout which is being delivered by the DSO. Concerning smart meters for electricity there is the original target of 80% until 2020, followed by a target of 95% for 2022. There is no mandatory deployment target for gas meters.

The rollout of electricity smart meters is mandatory regarding electricity for all meters with a load higher than 50kW and a consumption higher than 100.000kWh.

The following tables highlights the latest statistics, respectively an "instant picture" of smart deployment in the mid of the year 2019 and the outcomes of the installation programme as of 31/12/2018.

In Austria there is no distinction made between small/medium enterprises and households. Furthermore, since there is no target for smart meters for gas, this is not included in the tables.

State of play of smart metering deployment in AT as of Q2 2019	Electricity households and Electricity SME
Number of smart meters	1.310.783
Number of connection points equipped with smart meters	953.302
Total number of meters	6.199.303
Total number of connection points	6.069.683

Number of smart meters that does not communicate (de-activated upon specific consumer request)	16.250
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	
Number of smart meters that does communicate default metering data	
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	42.750

Deployment outcomes in 2018	**Electricity households and Electricity SME**
Yearly installation target	1.269.442
Number of visits to consumer premises	
Number of installed smart meters	239.685
Number of deactivated smart meters	
Number of refusals	6.515

1.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (in Recommendation 2012/148/EU) are implemented, with the clear intent to maximise smart metering deployment benefits. However, customers can opt out from the functionalities of the smart meter. In this case the data will not be stored in the meter, but only send to the network operator.

Two functionalities are not activated by default:

- e) Allow readings to be taken frequently enough for the information to be used for network planning
- f) Support advanced tariff system

In addition, all functionalities are free of charge for the costumer.

In the following table, information is given about the period the data can be stored, the granularity and the frequency that the consumption data is updated.

Level of the…	**History**	**Granularity**	**Frequency of consumption data update**

DSO	according to legal requirements	1 day	1 day
Supplier	according to legal requirements	1 day	1 day
Central data hub	according to legal requirements	1 day	1 day
Smart meter	60 days	15 minutes	15 minutes

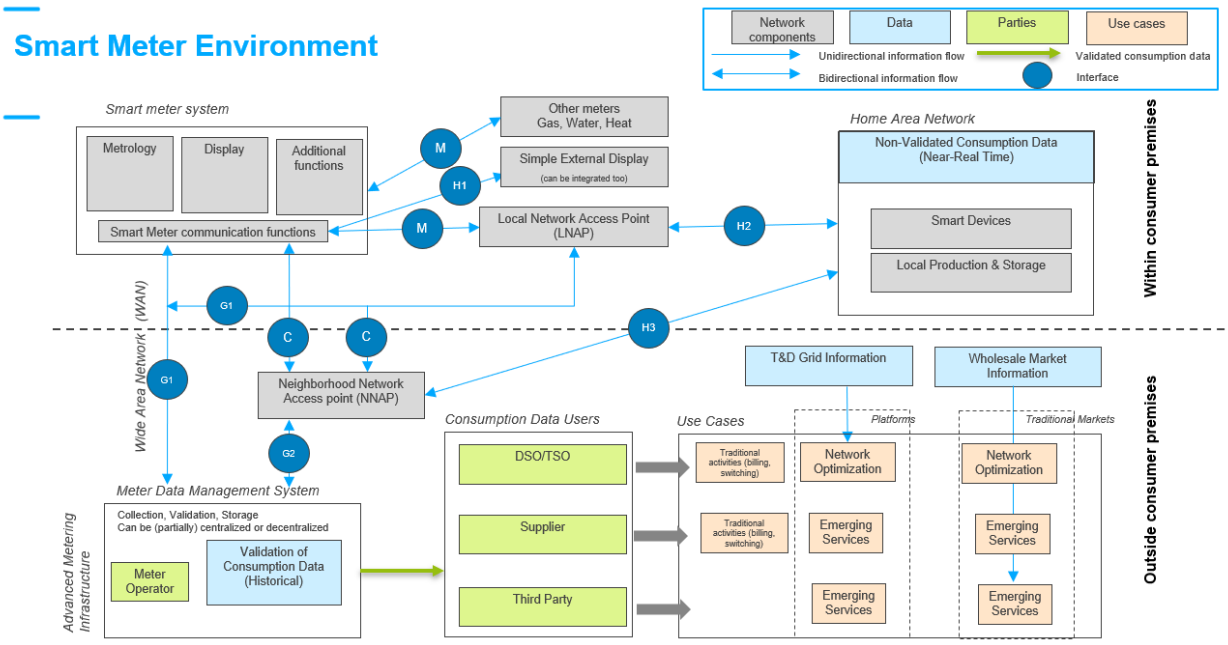
The data must be provided free of charge and must be made available to the consumer either via a DSO web portal, a supplier web portal or via the smart meter itself.

In principle, a third party does not have access to the data of the smart meter. This will only be given after the customer has given approval.

1.4. Technical specifications

In respect to the following figure, that is a schematic representation of the functional architecture in a smart metering environment, 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. Below an overview is given of the standards that are currently being used.

- 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



1.5. Data management

1.5.1. Data access and privacy framework

Third parties and suppliers need an explicit consent from the customers to access their metering data.

Customers can give access to their metering data by a written approval, communicated to and validated by the DSO or a central party. In addition, there is also a specific app or website with secured access.

Network operators performed a Data Protection Impact Assessment DPIA, organized by *Oesterreichs Energie* and published 2017[3]

1.5.2. Provisions to provide and revoke access to data

To revoke access to metering data, the customer can go to a specific app or website with secured access.

1.6. Consumer impact

1.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No

[3] Oesterreichs Energie, Data Protection Impact Assessment / Datenschutz-Folgenabschätzung für den Smart Meter Einsatz, 2017

Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

1.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	general public resistance to smart metering but lack of objective grounds	yes - publication of the test results and methods
Electromagnetic radiation	general public resistance to smart metering but lack of objective grounds	yes - publication of the test results and methods

Accuracy of meters	general public resistance to smart metering but lack of objective grounds	yes - publication of the test results and methods
Price of meters	general public resistance to smart metering but lack of objective grounds	no
Installation barriers	feedback from pilots	no

1.6.3. Research on consumer benefits

Austria has conducted research on consumer benefits; details of the research have not been shared by the regulator.

1.6.4. Communication campaign

The regulator had arranged meetings with relevant stakeholders to keep them informed. In addition, a Smart Meter Information Flyer was produced and distributed to create awareness about the rollout of smart meters. Furthermore, some DSOs launched information campaigns.

1.6.5. Advanced consumer services

Smart Meters are generally seen in Austria thanks to their features as useful tools enabling suppliers to offer new services and products, new pricing models, like for instance differentiating between periods of use. There are already some possibilities today, e.g. many suppliers offer pricing models with different rates for day/night hours, separate rates for heating or generally dual rate models. To distinguish between the time windows, an additional meter or a particular type of meter is necessary, which usually means more costs for consumers or additional equipment in the consumer's home. In future, smart meters would even enable pricing models with more than two different rates.

1.7. Conclusions

In Austria, the Federal Ministry for Sustainability and Tourism is legally entitled to define deployment targets and conditions for smart meters for electricity and gas.

The respective provisions will mostly apply to Distribution Grid Operates (DSOs) as they are in charge of almost all market roles, except for home display ownership and installation.

For the roles 'metering data transmission to third parties' and 'buyer compensation for technical and administrative losses' there is a convergence towards a single entity, which is a cooperation between DSOs.

The primary law that enables smart metering for electricity is ElWOG 2010. The status of this law is nearly unchanged since implementation.

Primary drivers for smart meter deployment and opportunities for digitization of the energy grid and market. In addition, enabling dynamic tariffs and integration of decentralised renewable

energy are mentioned as opportunities. Smart meters are also contributing to efficiency and optimisation of business processes of the DSOs.

In Austria, the DSOs have invested in the rollout of smart meters. The item charges for metering services or the so-called metering price in the electricity bill comes directly to the grid operator to cover its costs for installation and operation of counters and electricity meters, as well as its calibration and data readout.

A cost-benefit analysis was conducted to assess the effects on market players. In addition, macroeconomic analyses provide information on the effect of the Austrian economy as a whole (e.g. on employment, GDP). The exercise included effects for consumers (households, small businesses, and agriculture for electricity), system operators and suppliers. Impact on the market model and on competition was also considered. The CBA resulted in a positive net present value.

The Federal Ministry for Sustainability and Tourism is overseeing the rollout which is being delivered by the DSOs. Concerning smart meters for electricity there is a target of 80% until 2020, followed by a target of 95% for 2022. There is no mandatory deployment target for gas meters.

All 10 key functionalities recommended by the European Commission are implemented, with the clear intent to maximise smart metering deployment benefits. However, customers can opt out from the functionalities of the smart meter. In this case the data will not be stored in the meter, but only send to the network operator. The data must be provided free of charge and must be made available to the consumer either via a DSO web portal, a supplier web portal or via the smart meter itself.

In principle, a third party does not have access to the data of the smart meter. This will only be given after the customer has given approval. To revoke access to metering data, the customer can go to a specific app or website with secured access.

When it comes to technical specifications, the choice for interfaces is open to the decision of the DSO. Due to the fact that few DSOs have started their rollout yet, the information is not complete.

Austria has conducted research on consumer benefits; however, the details of the research have not been shared by the regulator.

Smart Meters, thanks to their features, are generally seen in Austria as useful tools enabling suppliers to offer new services and products, as well as new pricing models, for instance differentiating between periods of use. There are already some possibilities today, e.g. many suppliers offer pricing models with different rates for day/night hours, separate rates for heating or generally dual rate models. To distinguish between the time windows, an additional meter or a particular type of meter is necessary, which usually means more costs for consumers or additional equipment in the consumer's home. In future, smart meters would even enable pricing models with more than two different rates.

1.8. References

Id	Reference description
1	Studie zur Analyse der KostenNutzen einer österreichweiten Einführung von Smart Metering, E-Control, 2017

2	Oesterreichs Energie, Data Protection Impact Assessment / Datenschutz-Folgenabschätzung für den Smart Meter Einsatz, 2017

2. BELGIUM

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Belgium.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

2.1. Legal and Regulatory Framework

2.1.1. Market model

In the Brussels Capital Region, it is the local authorities that are legally entitled to define deployment targets and conditions for smart electricity and gas meters.

In Brussels the following roles are the responsibility of the DSO:

- Meter ownership
- Meter installation
- Metering data collection
- Metering data storage
- Metering data transmission to 3rd parties
- Metering data protection (Art. 37 GDPR) - also the responsibility of the energy supplier and
- Buyer compensation for technical and administrative losses,

whereas the responsibility for installation and ownership of in-home display devices lies with consumers themselves.

In Wallonia it is the Walloon Parliament that is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Similar to the Brussels Capital Region, meter ownership, meter installation, metering data collection, storage, transmission to 3rd parties and protection (Art. 37 GDPR) and buyer compensation for technical and administrative losses are the responsibility of the DSO.

In-home display installation and ownership are the responsibility of the supplier and consumer.

In Flanders, it is the Flemish government that is legally entitled to define deployment targets for smart electricity and gas meters.

In Flanders, the roles and responsibilities of various actors differ slightly to the Brussels Capital Region and Wallonia.

The DSO in Flanders is not only responsible for meter ownership and meter installation, but also for the ownership and installation of the in-home displays as well as the green sub-meter (connecting small-scale production units, like PV, to the private installation of the network user). Buyer compensation for technical and administrative losses is also the responsibility of the DSO.

All elements linked to metering data (metering data collection, storage, transmission to third parties and protection (Art. 37 GDPR)) are the responsibility of a common entity owned by Flemish DSO, Fluvius, which is responsible for managing smart metering data.

2.1.2. Legal grounds

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'. A modification of the ordonnance has been voted during the summer of 2018.

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'. This ordonnance was, at the moment of data collection for this report, under revision.

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'. As indicated above, this is a revision of the first law from 2001. Delegated laws that further implement smart metering for electricity are foreseen but not yet published.

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 'Decreet van 8 mei 2009 houdende algemene bepalingen betreffende het energiebeleid'. The law was, at the moment of data collection for this report, under revision; the revised legislation will facilitate the rollout of smart meters (expected to begin in January 2019).

The 'Energiebesluit' are delegated laws put in place to enable further implementation of electricity and gas smart metering in Flanders, as well as fine-tune the functional scope and revise the timing of deployment.

2.1.3. Primary drivers

No views on this issue were shared for Brussels Capital Region.

The key drivers for the deployment of smart meters in Wallonia are:

- Enable dynamic tariffs for households and SMEs
- Digitalise distribution grid and optimise network operations
- Digitalise retail market to foster innovation and new services by private actors
- Integrate decentralised energy resources with flexible access (load shedding, infeed curtailment)
- Address fuel poverty (by replacing budget meters)

The key drivers for the rollout of smart meters in Flanders are the following:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalise retail market to foster innovation and new services by private actors
- Address fuel poverty (by replacing budget meters)
- Improve energy efficiency

2.1.4. Smart metering programme financing

Most DSOs have followed a similar scheme to secure smart metering financing, namely creating additional debt to self-finance the rollout. Talks are ongoing at political level to assess the relevance of regions financing smart metering rollout from the public budget, but no concrete commitment has been secured yet.

2.1.5. Recent publications by the NRA

The CBA conducted for the Brussels Capital Region is publicly available and can be found at the following link:

(https://www.brugel.brussels/publication/document/etudes/2011/fr/etude-20110531-03.pdf)

In Wallonia, the most recent publications issued by the implementation body were the following:

- 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 en vue du déploiement des compteurs intelligents et de la flexibilité (available here : http://www.ejustice.just.fgov.be/cgi/article_body.pl?language=fr&caller=summary&pub_date=2018-09-06&numac=2018204390)
- "Actualisation de l'étude sur les compteurs intelligents" – published by the CWaPE on 21st of December 2017 (available here : https://www.cwape.be/docs/?doc=3426)

In Flanders, the most recent relevant publication was the CBA which was carried out in 2017 and aimed to define ideal deployment targets and planning as well as integrate the return of experiences from pilot projects.

2.2. Cost benefit analysis

2.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
May 2011	(Brussels Capital)	Capgemini Consulting (contracted by Brugel)	Negative Net Present Value	
2012	(Wallonia)	Consultant (contracted by the NRA)	Negative Net Present Value	Compliance with Dir. 2009/72
2017	(Wallonia)	NRA (contracted by the NRA)	Inconclusive	Refine deployment scenario
2017 (CBA 1)	(Flanders)	NRA	Positive Net Present Value (full rollout 2019-2029)	Define ideal deployment targets and planning, integrate the return of experiences from pilot projects
2017 (CBA 2)	(Flanders)	NRA	Positive Net Present Value (full rollout 2019-2039)	Define ideal deployment targets and planning, integrate the return of experiences from pilot projects

2.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the cost-benefit assessment for Brussels Capital Region: DSO, Supplier, NRA, Consumer and State/society.

Key parameters for the assessment	
evaluation period of the CBA [Years]	20
billing and metering frequency in the reference case for electricity [times/year]	12
Does this also apply for gas?	yes

What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	3.3% of total supply at low voltage
What is the electricity losses unit cost? [€/MWh]	variable
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	variable
What is the cost reduction rate due to technological maturity? [%/year]	N/A

In Wallonia, the only actor considered in the assessment is the DSO.

The CBA has been carried out for the two main DSOs in the Wallonia region. The key parameters and assumptions differ depending on the DSO.

Key parameters for the assessment	
evaluation period of the CBA [Years]	30
billing and metering frequency in the reference case for electricity [times/year]	Once per year
Does this also apply for gas?	DSO 1: yes DSO 2: No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A
What is the electricity losses unit cost? [€/MWh]	variable
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	DSO 1: 15 years DSO 2: N/A
What is the value of the lost load? [€/MWh]	variable
What is the cost reduction rate due to technological maturity? [%/year]	0%

In Flanders, the following actors were considered in the assessment: DSO, supplier, consumer, State / society, TSO, BROP and producer

Key parameters for the assessment	
evaluation period of the CBA [Years]	30
billing and metering frequency in the reference case for electricity [times/year]	2
Does this also apply for gas?	yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	1,33%
What is the electricity losses unit cost? [€/MWh]	307
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	317
What is the cost reduction rate due to technological maturity? [%/year]	N/A

2.2.3. Main cost and benefit items

The cost items considered in the analysis for the Brussels Capital region have been listed below:

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☐ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☐ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme
☒ Other cost items (please specify) OPEX training, pilot studies and program management

The main benefit items considered in the analysis for Brussel Capital Region can be found below:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☐ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☐ Operation & maintenance of assets

☒ Distribution capacity deferral

☐ Transmission capacity deferral

☐ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☐ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☒ CO2

☐ Air pollution (particulate matters, NOx, SO_2,...)

☒ Other (please specify): peak shaving

The cost items considered in the analysis for Wallonia are marked below:

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☐ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

The main benefit items considered in the analysis for Wallonia can be found below:

☐ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☒ Provision of explicit flexibility services (rather based on a request than a price signal)

☐ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☐ Operation & maintenance of assets

☐ Distribution capacity deferral

☐ Transmission capacity deferral

☐ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☐ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☐ CO2

☐ Air pollution (particulate matters, NOx, SO_2,...)

☒ Other (please specify): cost of the public service obligation related to budget meters

The cost items considered in the analysis for Flanders are marked below:

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☐ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☐ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
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☒ OPEX - Change management
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☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

The main benefit items considered in the analysis for Flanders can be found below:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☒ Provision of explicit flexibility services (rather based on a request than a price signal)

☒ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☐ Operation & maintenance of assets

☒ Distribution capacity deferral

☐ Transmission capacity deferral

☐ Generation capacity deferral

☐ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☒ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☒ CO2

☐ Air pollution (particulate matters, NOx, SO_2,...)

2.2.4. CBA results

For the Brussels Capital Region the number of actualised meters installed for the whole evaluation period is 413,000 (with an annual increase of 0.8%) for gas and 619,000 for electricity (with an annual increase of 0.9%).

In terms of the actualised costs (CAPEX and OPEX) and benefits for the evaluation period, this will vary according to the 4 different type of meter models considered in the analysis.

No information has been provided by the NRA regarding the CBA results in Wallonia.

In Flanders, the latest CBA provided a positive outcome with a NPV of above €440 million. The number of actualised meters installed for the evaluation period are as follows:

- For CBA 1:
  - 3,831,202 electricity meters
  - 2,323,411 gas meters
- For CBA 2:
  - 3,835,810 electricity meters
  - 2,324,408 gas meters

2.2.5. Deployment strategy and latest statistics

Limited information has been shared regarding the deployment strategy as well as the latest statistics for the three regions in Belgium.

Deployment up to the moment of data collection for this report has been limited to a number of pilot projects.

State of play of smart metering deployment in Brussels Capital Region as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	0	0	0	0
Number of connection points equipped with smart meters	0	0	0	0
Total number of meters	650,000	N/A	429,000	N/A
Total number of connection points	N/A	N/A	N/A	N/A
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	N/A	0	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	N/A	0	N/A
Number of smart meters that does communicate default metering data	0	N/A	0	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	N/A	0	N/A

Deployment outcomes in 2017 for Brussels Capital Region	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	N/A	N/A	N/A	N/A
Number of visits to consumer premises	N/A	N/A	N/A	N/A
Number of installed smart meters	N/A	N/A	N/A	N/A
Number of deactivated smart meters	N/A	N/A	N/A	N/A
Number of refusals	N/A	N/A	N/A	N/A

In Wallonia a segmented rollout (target of 80% of the concerned segments by 2029) is foreseen and will focus on customers with an annual consumption above 6,000 kWh, prosumers with an installed capacity of at least 5 kW, and for charging points open to the public. No information was shared by the Walloon authorities regarding the current statistics.

State of play of smart metering deployment in Wallonia as of 1/1/2018	Electricity	Gas
Number of smart meters	N/A	N/A
Number of connection points equipped with smart meters	N/A	828.661
Total number of meters	N/A	808.910
Total number of connection points	N/A	N/A

Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A	N/A
Number of smart meters that does communicate default metering data	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A

Deployment outcomes in 2017 for Wallonia	**Electricity**	**Gas**
Yearly installation target	N/A	N/A
Number of visits to consumer premises	N/A	N/A
Number of installed smart meters	N/A	N/A

Number of deactivated smart meters	N/A	N/A
Number of refusals	N/A	N/A

No information was shared by the Flemish authorities regarding the current statistics. The only information that was transmitted is the number of smart meters installed as part of pilot projects, which is in the region of 28,500 electricity smart meters and 16,500 gas smart meters.

On the basis of its positive CBA (2018), Flanders will undertake the mandatory installation of smart meters in case of building construction and renovation, meters' renewals as well as for prosumers, while other market segments' customers will be entitled to have a smart meter installed on demand.

Full rollout of electrcity and gas smart meters is expected to begin in July 2019 in Flanders.

State of play of smart metering deployment in Flanders as of 1/1/2018	**Electricity**	**Gas**
Number of smart meters	N/A	N/A
Number of connection points equipped with smart meters	N/A	N/A
Total number of meters	N/A	N/A
Total number of connection points	N/A	2.175.690
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	N/A

Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A	N/A
Number of smart meters that does communicate default metering data	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A

Deployment outcomes in 2017 for Flanders	**Electricity**	**Gas**
Yearly installation target	N/A	N/A
Number of visits to consumer premises	N/A	N/A
Number of installed smart meters	N/A	N/A
Number of deactivated smart meters	N/A	N/A
Number of refusals	N/A	N/A

2.3. Functional specificiations

Given that the legal framework is not yet fixed in the Brussels Capital Region, no answers were provided regarding the functionalities of smart meters.

For Wallonia, all 10 key functionalities recommended by the European Commission (in its Recommendation 2012/148/EU) have been foreseen. As a reminder, these are:

A. Provide readings directly to the customer and any third party designated by the consumer
B. Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings
C. Allow remote reading of meters by the operator
D. Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system
E. Allow readings to be taken frequently enough for the information to be used for network planning
F. Support advanced tariff system
G. Allow 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

All these functionalities will be free of charge and activated by default.

In Wallonia, the storage of consumption data at the following level (DSO, supplier, central data hub and smart meter is as follows:

	History	Granularity
DSO	≤ 5 years	15 minutes
Supplier	≤ 5 years	Default: 1 year User's choice: 15 minutes
Central Data Hub	≤ 5 years	Default: 1 year User's choice: 15 minutes
Smart Meter	Daily index per timeframe and per direction: 40 days; Monthly index per timeframe and per direction: 13 lasts months.	Daily index per timeframe and per direction: 40 days; Monthly index per timeframe and per direction: 13 last months.

Concerning the functionalities of smart meters for the Walloon region, further information has been provided:

- Regarding functionality A and customer access to consumption data, this will be possible through local access to smart meters (via H1 or H2), the DSO web portal and the Supplier web portal.
- Regarding functionality A and 3rd party access to consumption data, this will be possible through local access to smart meters (via H1 or H2) and the DSO web portal
- Regarding functionality A and 3rd party access to consumption data for emerging services, this will be possible through local access to smart meters (via H1 or H2) and the DSO web portal
- Regarding functionality F and advanced tariff system possibilities, pre-payment schemes and Time of Use tariffs will be possible.
- Regarding functionality J, the smart meter will be able to measure grid injection and withdrawals separately.

In Flanders, the aforementioned 10 key functionalities recommended by the European Commission have been foreseen. All these functionalities will be free of charge and activated by default. In Flanders, the storage of consumption data at different levels (DSO, supplier, central data hub and smart meter) is as follows:

	History	Granularity
DSO	Days	15 minutes
Supplier	Years	15 minutes
Central Data Hub	Years	15 minutes
Smart Meter	Days	15 minutes

The frequency of which consumption data will be updated in Flanders can be seen in the table below:

	Frequency
DSO	Daily
Supplier	Monthly
Central Data Hub	Daily
Smart Meter	Every second

Concerning the functionalities of smart meters for the Flemish region, further information has been provided:

- Regarding functionality A and customer access to consumption data, this will be possible through local access to smart meters (via H1 or H2) and the Supplier web portal.
- Regarding functionality A and 3rd party access to consumption data, this will be possible through local access to smart meters (via H1 or H2) and the central data hub web portal.
- Regarding functionality A and 3rd party access to consumption data for emerging services:

	History	**Granularity**
Meter data management system	Months	Quarter of an hour
Direct access to the smart meter	No history	1 second

- Regarding functionality C and remote reading by the operator, the information will be pulled (on-demand by the operator).
- Regarding functionality F and advanced tariff system possibilities, pre-payment schemes, time of use tariffs and linkage with wholesale market data will be possible.
- Regarding functionality J, the smart meter will be able to measure grid injection and withdrawals separately, and will be able to measure reactive power

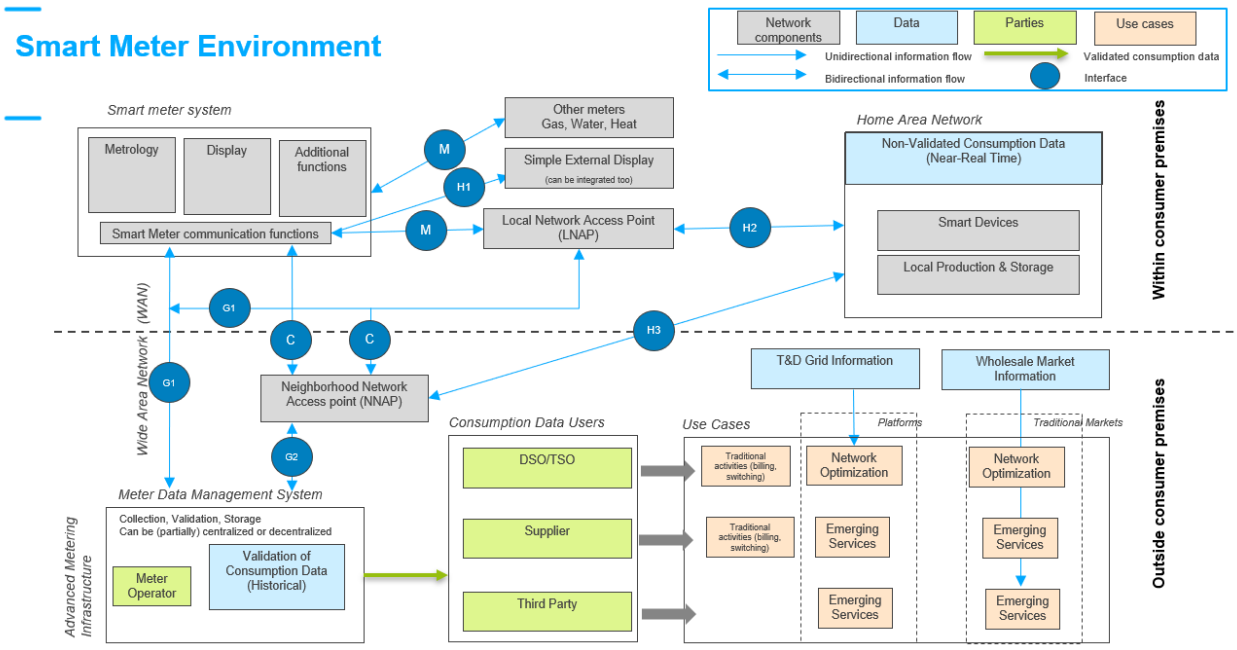
2.4. Technical specifications

No views were shared regarding the technical specifications of smart meters in the Brussels Capital Region. However, local conditions, like the presence of 3x400V+N or the location of the main protection fuse are local specificities that will need to be tackled in the future.

The technical specifications are up to the DSO in Wallonia. The deployment has not yet started and as a result, no views were shared on the subject.

In Flanders, with respect to the following figure, which is a schematic representation of the functional architecture in a smart metering environment, Serial Line (DSMR P1 V5.0) is the chosen technology for the H1 interface. DSMR P1 is identical to the standard used in the Netherlands.

For G1, the technology chosen is GSM (more specifically NB-IoT), as it is not only cost effective but also, understood to be the best fit (conclusion from numerous pilot projects) for the type of rollout planned in Flanders.



2.5. Data management

2.5.1. Data access and privacy framework

No information has been provided by for this section for Brussels Capital Region.

In Wallonia, 3rd party actors and energy suppliers will need an explicit consent from the customers to access metering data.

A data protection impact assessment (recommended by the European Commission) was performed in December 2015 for Wallonia. This assessment has not been made publicly available.

In Flanders, similar to Wallonia, an explicit consent from customers is necessary in order for 3rd party actors and energy suppliers to access smart metering data.

The data protection impact assessment has not yet been performed in Flanders. When the time comes, this will be done by the data manager 'databeheerder' (the party responsible for managing the meter data).

2.5.2. Provisions to provide and revoke access to data

It is yet to be defined how customers can give / revoke access to metering data in Brussels Capital Region and in Wallonia.

In Flanders, customers can give / revoke access to metering data via one of two methods:

- Delegated to a third party or a supplier as part of a service contract (no independent party to double check, the DSO will simply execute the request for metering data)
- Specific app or website with secured access

2.6. Consumer impact

2.6.1. Available services

As the deployment has not started yet in the Brussels Capital Region, no services have been made available at this point in time.

The situation in Wallonia is similar to Brussels Capital Region, where no services have yet been made available given that the deployment has not yet started.

As the rollout in Flanders starts in July 2019, most services are not available yet but will be operational and widely spread within the horizon 2021.

2.6.2. Consumer concerns

No information has been provided for this section for Brussels Capital Region.

In Wallonia, the following concerns have been expressed by consumers:

- Privacy
- Cybersecurity
- Electromagnetic radiation
- Accuracy of meters
- Price of meters
- Installation barriers

For information on these concerns can be found in the table below:

Concern expressed by consumers in Wallonia	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Electromagnetic radiation	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework

Accuracy of meters	general public resistance to smart metering but lack of objective grounds	yes – proven compliance to existing standards
Price of meters	general public resistance to smart metering but lack of objective grounds	yes – prices will be challenged through the DSO tariff proposals
Installation barriers	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework

In Flanders, the following concerns have been expressed by consumers:

- Privacy
- Electromagnetic radiation
- Installation barriers

Information on these can be found in the table below:

Concern expressed by consumers in Wallonia	**Nature of the concern**	**Counter measure adopted?**
Privacy	Freely accessible P1 port can be used to detect user presence or can be used for profiling	H1 (=P1) interface to be closed by default
Electromagnetic radiation	Meter is source of radiation, possible impacting electrosensitive people	No counter measures
Installation barriers	Reception of GSM signal required	Rollout delayed on locations without GSM reception

2.6.3. Research on consumer benefits

No information has been provided for Brussels Capital Region.

In Wallonia, the hope is that the pilot projects (currently in progress) will reveal some findings on consumer benefits.

For the Flemish region, there has been a study on behalf of the government and executed by Energyville which will be used as input for governmental measures.

2.6.4. Communication campaign

No information has been provided for Brussels Capital Region.

Given that in Wallonia the rollout hasn't begun yet, no communication campaign has been launched or is planned for the foreseeable future. This is also the case for Flanders, at least at the moment of data collection for the present report.

2.6.5. Advanced consumer services

No information has been provided by any of the three regions in Belgium for this section.

2.7. References

Id	Reference description
1	Ordonnance du 19 juillet 2001 relative à l'organisation du marché de l'électricité en Région de Bruxelles-Capitale
2	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
3	Decreet van 8 mei 2009 houdende algemene bepalingen betreffende het energiebeleid
4	Actualisation de l'étude sur les compteurs intelligents - CWaPE

3. BULGARIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Bulgaria.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

3.1. Legal and Regulatory Framework

3.1.1. Market model

In Bulgaria, the Government is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to DSOs as they are the entities in charge of meter ownership, installation and data collection. The territory is served by three utilities with territorial scope as indicated in Figure 1. The approximate number of electricity meters is CEZ 2,0 million, EVN 1,5 million, Energo – Pro 1,2 million.

However, since the cost benefit analysis realized in line with the provisions of the Electricity Directive 2009/72/EU, the Bulgarian authorities (government and regulation agency) decided to not impose smart metering deployment and left the decision to utilities' discretion.

There are no apparent synergies between gas, water and electricity, given that they are managed by separate entities and there is no plan to further integrate those regulated entities. One exception is related to district heating. EVN owns the district heating network (32,000 customers) in the second biggest city of Bulgaria (Plovdiv) and makes use of the M-bus of the electricity advanced metering infrastructure to collect data from the district heating network.

Figure 1 Territorial scope of Bulgarian electricity distribution companies

3.1.2. Legal grounds

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

3.1.3. Primary drivers

As explained above, the main driver is to optimize the internal costs and benefits for the DSO, which is mainly from reduction of operational costs related with meter reading (according to the regulations, monthly meter reading is required) and reducing losses (technical – by rebalancing phase loading, and commercial – by fraud detection features of the system as well as speeding up the disconnection process triggered by non-payment of electricity bills).

3.1.4. Smart metering programme financing

Smart metering costs are borne by DSOs as part of the normal regulated activities. Deployment of smart meters is allowed on the condition that it will not trigger tariff increase.

3.1.5. Recent publications by the NRA

The most recent publication is a decision to entitle utilities to deploy smart metering under the condition that it would not lead to a tariff increase. It was issued by the Water and Energy Regulatory Commission at 31 July 2013 (Decision N ИС – 1 / 31.07.2013 г[4]). The conclusions in the decision are as follows:

[4] Link to the SWERC decision http://www.dker.bg/files/DOWNLOAD/res-is1-07-13.pdf

"1. From the analysis carried out, on the basis of the information provided by the distribution system operators, no clear assessment can be made as to the economic feasibility of introducing smart metering systems;

2. Recommends the installation of intelligent electricity metering systems up to 20% but not less than 10% by 2020, with the introduction of public funding under European programs that will not lead to an increase in the prices of the final customers."

3.2. Cost benefit analysis

3.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
31 July 2013	Regulator		Negative	Comply with 2009/72

3.2.2. Market roles and key parameters

In coherence with the regulator decision described above, the only market role considered in the assessment was the DSO.

3.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with the only exception of consumer service and call centre costs.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☐ OPEX - Call center and customer service
☐ OPEX - Consumer engagement programme

Benefits focus on the utility side to optimize its legal duties like loss reduction, meter reading and disconnection of customers and management of bad debt (which are closely related). If the consumer chooses for a competitive supply offer, smart metering can provide a better service (access to metering data history, tailor-made offers that help share the benefits of having a better view on the balancing needs).

3.2.4. CBA results

No information was provided on associated costs (CAPEX, OPEX) and benefits for the whole evaluation period, nor per metering point.

3.2.5. Deployment strategy and latest statistics

The following tables highlights the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Bulgaria as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	Not available			
Number of connection points equipped with smart meters	Not available			
Total number of meters	4 700 000			
Total number of connection points	4 700 000			
Number of smart meters that does not communicate (de-activated upon specific consumer request)	Not applicable			
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	Not applicable			
Number of smart meters that does communicate default metering data	The same as number of smart meters			
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	The same as number of smart meters			

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME

Yearly installation target	Not applicable			
Number of visits to consumer premises	1.05[5]			
Number of installed smart meters	Not available			
Number of deactivated smart meters	Not applicable			
Number of refusals	Not applicable			

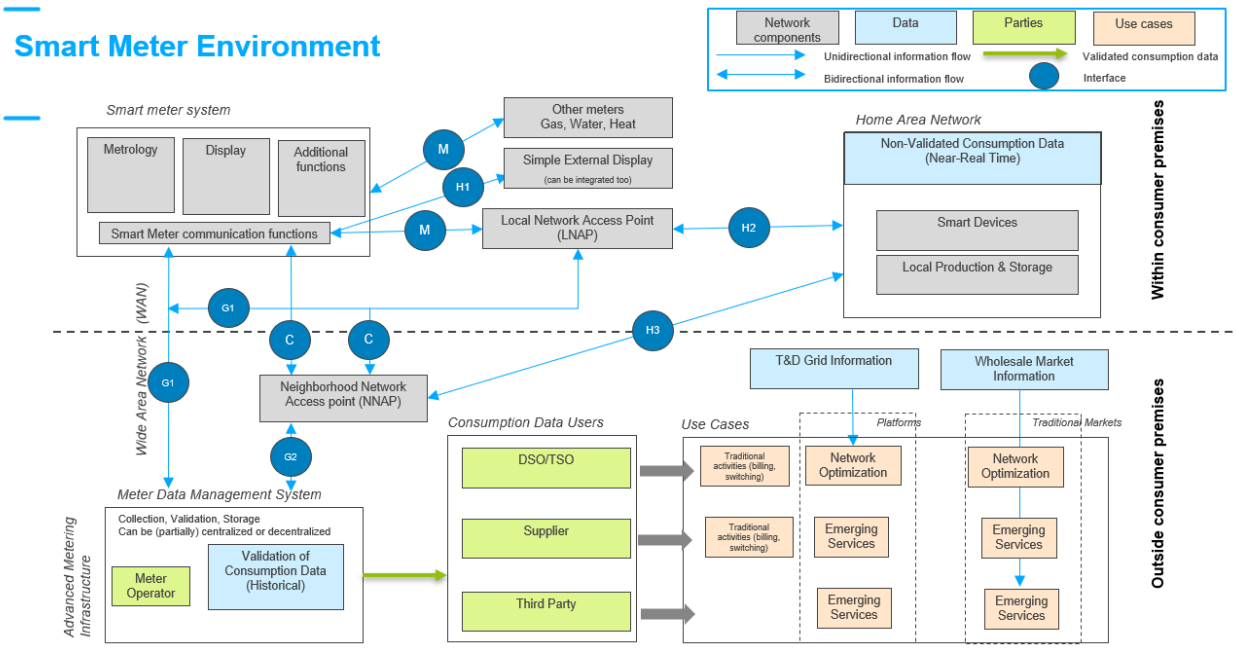
3.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (in its Recommendation 2012/148/EU) are foreseen to be implemented and activated by default, but at the moment access to more granular validated data is subject to a specific charge.

3.4. Technical specifications

In respect to the following figure, which is a schematic representation of the functional architecture in a smart metering environment, GPRS is the chosen technology for C interfaces leveraging on combination with PLC communication. Communications do not go beyond utilities data centres.

[5] To describe that the utility has access to the meters which are outside or inside with a key for the door.



3.5. Data management

3.5.1. Data access and privacy framework

There are no specific regulations related with data obtained by the smart metering system. This data is subject of general data access and privacy framework of the country.

3.5.2. Provisions to provide and revoke access to data

According to the regulations, the data is stored by the DSOs. Finer granularity (hourly) validated historical data is currently provided at a charge (app. 34 € per month of history) for the consumer.

3.6. Consumer impact

3.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No[6]

[6] To explain that this is classified as personal data

Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes, via home monitor device[7]
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes, via home monitor device
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

3.6.2. Consumer concerns

[7] Device is not provided for free

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	The topic is not sensitive in the country	Feedback from DSOs
Cybersecurity	The topic is not sensitive in the country	Feedback from DSOs
Electromagnetic radiation	No system complaints by customers	Feedback from DSOs
Accuracy of meters	The accuracy of the meters is the same as conventional. Hourly data supports easy solving of disputes between DSO and customer related with consumption	Feedback from DSOs
Price of meters	Not applicable, as the meter is paid and belong to the DSO	Not applicable
Installation barriers	Access to the meter	Feedback from DSOs activities

3.6.3. Research on consumer benefits

Utilities perform their own CBA in order to identify areas for implementation of smart metering. Their CBAs are mostly based on improvement of grid losses and (technical and non-technical) as well as optimization of meter reading disconnection and re-connection costs.

3.6.4. Communication campaign

Not available

3.6.5. Advanced consumer services

Not available

3.7. Recommendations

Regulated tariffs for residential consumers are rather low, prepayment could be of interest to a number of customers; consumer access to more granular validated data is at the moment not freely provided.

Removing such regulatory barriers could help make smart meter pave the way for innovative services by competing players.

3.8. References

Id	Reference description
1	Decision N ИС – 1 / 31.07.2013 г - Water and Energy Regulatory Commission

4. CROATIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Croatia.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

4.1. Legal and Regulatory Framework

4.1.1. Market model

The Croatian Energy Regulatory Agency (HERA), established in 2004, is the entity responsible for energy regulation in Croatia, while *Hrvatska elektroprivreda* (HEP) is the incumbent national energy company charged with production, transmission and distribution of electricity.

The Croatian electricity and gas Transmission System Operators (TSOs) are HOPS Ltd and Plinacro Ltd respectively.

Croatia has one electricity Distribution System Operator (DSOs), HEP-DSO (*HEP ODS d.o.o*), being distributor to both industry and households.

Gas is distributed by 36 companies, which operate at local level, 13 of which have unbundled their supply and distribution operations. The remaining DSOs serve less than 100,000 customers and are exempted from the unbundling rules.

The Croatian Ministry of Environmental Protection and Energy is legally entitled to define deployment targets and conditions for smart electricity meters[1].

Concerning the introduction of advanced metering devices (smart meters), HEP ODS d.o.o. establishes the technical requirements and costs, the Croatian Energy Regulatory Agency conducts costs benefit analyses and the Minister establishes the plan and programme of measurements on the subject.

Ownership and installation of meters belong to the Croatian electricity and gas DSOs. Metering data collection, validation, storage and transmission to third parties are in charge of the DSOs, which are also responsible for metering data protection, in compliance with the General Data Protection Regulation (GDPR) and the duty to compensate the buyer in case of technical and administrative losses.

4.1.2. Legal grounds

On 1st July 2013 Croatia became a member of the European Union and joined the EU energy market. One of Croatia's obligations as part of its accession process was the incorporation of the EU Third Energy Package. Thus, in 2012 and 2013, new legislation was adopted governing the electricity sector, later amended in line with EU legislation: the Energy Act (Official Gazette No. 120/12, 14/14, 95/15, 102/15, 68/18), the Energy Activities Regulations Act (Official Gazette No. 120/12, 68/18) and the Electricity Market Act (Official Gazette No. 22/13, 102/15, 68/18, 52/19). These acts incorporate respective EU directives, in particular Directive 2009/72/EC, 2009/28/EC and 2005/89/EC and a number of EU regulations. Since 2006, Croatia has been a party to the Energy Community Treaty (Official Gazette International Treaty No. 6/06). According to the Croatian Constitution, international agreements take priority over domestic laws and form an integral part of Croatian legislation.

Actually, the Croatian primary law that enables both smart electricity and gas metering is the Energy Act, of which there has been no revision yet.

4.1.3. Primary drivers

The following actions have been identified as the main drivers for smart metering deployment in Croatia:

- Tool for reducing non-technical losses
- Make easier the switching of energy supplier
- Control of energy usage
- Digitalize metering assets and optimize network operations
- Enable dynamic tariffs for households and SMEs
- Integrate decentralised energy resources with flexible access and curtailment
- Enforce security and data privacy rights
- Address fuel poverty
- Develop a digital playground for private actors

4.1.4. Smart metering programme financing

There is no official programme, but the intention is to finance smart metering roll out from distribution tariffs. Recent publications by the Ministry of Environment and Energy.

4.1.5. Recent publication by the NRA

The most relevant official document that is available is the 4th National Energy Efficiency Action Plan (NEEAP 2017)[2], which was prepared in compliance with the Energy Efficiency Directive (EED, 2012/27/EU), but no information about deployment of smart meters is included in it.

4.2. Cost benefit analysis

4.2.1. Relevant study

A Cost-Benefit Analysis for electricity has been conducted in recent years in Croatia.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation	Publicly available
2017	Consulting Company	NRA	Positive Net Present Value	N/A	N/A

4.2.2. Market roles and key parameters

In the economic assessment, the DSO, Supplier, Consumer, State/Society and TSO market roles have been considered supporting direct cost and benefits.

Key parameters for the assessment	
Evaluation period of the CBA [Years]	16 years
Billing and metering frequency in the reference case for electricity [times/year]	2
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	7.96%
What is the electricity losses unit cost? [€/MWh]	38.37 €/MWh
What is the economic lifetime of electricity smart meters? [Years]	16 years
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	N/A
What is the discount rate taken into account? [%]	5.94%
What is the inflation rate taken into account? [%]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A
What is the installation success rate (installation/visits)? [%]	100%
What is the refusal rate (refusals/visits)? [%]	0
What is the deactivation rate (deactivations/installations)? [%]	100%
What is the carbon price taken into account? [€/t + reference year]	25 €/t

4.2.3. Main cost and benefit items

The following cost items among those suggested by the European Commission (Recommendations 2012/148/EU) have been taken into account in the electricity CBA:

☒ CAPEX - Investment in smart meter

☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom

☐ CAPEX - Investment in In-home display

☐ CAPEX - Sunk cost of conventional meters

☒ OPEX - IT maintenance

☒ OPEX - Network management and front end

☒ OPEX - Telecom

☒ OPEX - Change management

☐ OPEX - Unplanned renewal and failures of smart meter

☐ OPEX - Revenue reduction

☒ OPEX - Meter reading

☐ OPEX - Call center and customer service

☒ OPEX - Consumer engagement programme

And the following main benefit items have been considered:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☒ Increased competition in retail market

☒ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☒ Distribution capacity deferral

☒ Transmission capacity deferral

☒ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☐ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☒ CO2

☒ Air pollution (particulate matters, NOx, SO2, etc...)

☐ Other: demand response solutions can be used to provide ancillary services

4.2.4. CBA results

Two different scenarios (Scenario 1 and 2) have been considered in the electricity CBA, with two different periods of evaluation (4 and 11 years), so that the CBA main results can be summarised as follows:

Key outcomes of the assessment (actualised values, referring to the whole evaluation period)	Scenario 1 (4 years)	Scenario 2 (11 years)
Number of meters installed [n° of meters]	2,351,892	2,351,877
CAPEX [€]	320,864,845	315,471,816
OPEX [€]	114,627,821	325,252,265
Benefits	902,854,641	830,359,286

4.2.5. Deployment strategy and latest statistics

While smart electricity meters have been progressively implemented in the last years, no smart gas meters are currently installed in Croatia.

The results of smart electricity meter deployment for households and Small-Medium Enterprises (SMEs) are resumed in the following table:

State of play of smart metering deployment in Croatia as of 1/1/2018	Electricity households	Electricity SMEs
Number of smart meters	15,000	40,000
Number of connection points equipped with smart meters	15,000	40,000
Total number of meters	2,187,648	236,412
Total number of connection points	2,187,648	236,412
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A	N/A

Number of smart meters that does communicate default metering data	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A

Currently (as of 1/1/2018), less than 1% of the 2,187,648 electricity meters supplying households have been replaced with smart meters. In the case of SMEs, the percentage of smart meters is higher, being of 17% out of 236,412 active electricity meters.

Globally (for electricity households and SMEs) there are 55,000 smart meters out of 2,424,060 meters installed. Electricity smart metering has hence an overall degree of penetration of only 2.3% in the country.

In particular, the following results in terms of smart electricity meters annual deployment were achieved in 2017:

Deployment outcomes in 2017	**Electricity households**	**Electricity SMEs**
Yearly installation target	8,000	15,000
Number of visits to consumer premises	8,000	15,000
Number of installed smart meters	8,000	15,000
Number of deactivated smart meters	N/A	N/A
Number of refusals	N/A	N/A

According with the table above, the 2017 yearly installation targets related to electricity smart metering have been fulfilled for both households and SMEs in Croatia.

Concerning future planning for deployment, there is a smart meter rollout programme, which states that every consumer will be equipped with smart meter by the end of 2030.

The goal set by the Croatian authority for 2020 is to install 450,000 smart meters, while by the end of 2030 smart meters should be installed on all connection points.

4.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (2012/148/EU) are available and free of charge for the Customer in Croatia in the case of smart metering for electricity.

FUNCTIONALITIES	**Foreseen and available (but not necessarily activated)**	**Activated by default**	**Free of charge for the customer**

FUNCTIONALITY A: Provide readings directly to the customer and any third party designated by the consumer	☒	☒	☒
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings	☒	☒	☒
FUNCTIONALITY C: Allow remote reading of meters by the operator	☒	☒	☒
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☒	☒
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☒	☒
FUNCTIONALITY F: Support advanced tariff system	☒	☒	☒
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☒	☒	☒
FUNCTIONALITY H: Provide secure data communications	☒	☒	☒
FUNCTIONALITY I: Fraud prevention and detection	☒	☒	☒
FUNCTIONALITY J: Provide import/export and reactive metering	☒	☒	☒

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated in the case of electricity have been provided and are as follows:

	History (Historical data)	**Granularity (Historical data)**	**Frequency (Readings)**
DSO	N/A	N/A	Hourly
Supplier	N/A	N/A	Hourly
Central Data Hub	N/A	N/A	Hourly
Smart Meter	Days	Hourly	Hourly

Electricity customers can access their consumption data only by direct local access to smart meters and third parties' access to consumption data and/or to consumption data for emerging services (Functionality A).

Croatian operators have implemented push (automatic) remote reading of smart meters (Functionality C).

Among advanced tariff system possibilities, it is foreseen to use time-of-use tariffs and linkage with wholesale market data (Functionality F).

Smart meters are able to measure the net injected energy into the grid and they measure grid injection separately from withdrawals (Functionality J).

In Croatia, smart metering is not foreseen to be used in community-based distribution systems for now, and an impact assessment on the topic has not yet been performed.

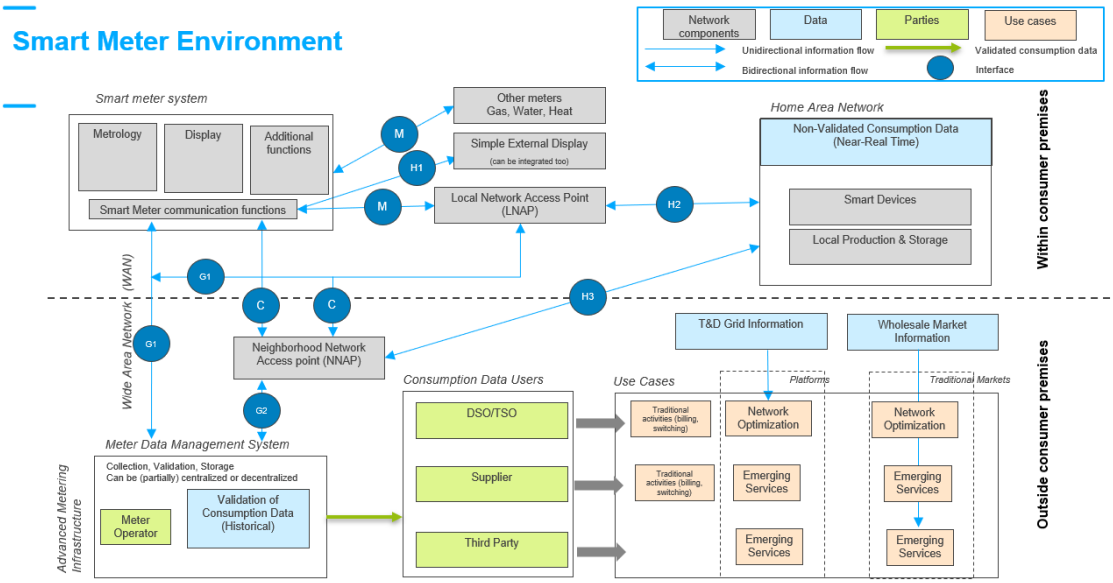
4.4. Technical specifications

In a smart metering system (see figure below), interfaces enable the interaction between the different components that are part of it, namely:

- the electricity smart meter
- the data management system
- other communicating devices including gas meter, water meter, local production, stationary batteries or electric vehicle charging stations linked to a dedicated "box" or energy management system

Interfaces are all characterized by specific technologies and standards (with known advantages and disadvantages). While enabling access and sharing of smart meter data, they also represent possible vulnerabilities in terms of cyber security.

Referring to the figure below, the following six interfaces can be found in a smart meter environment: H1, H2, H3, C, G1, G2.



No information regarding technical specifications and functional architecture of the smart metering systems deployed in Croatia has been made available at the moment of writing of this report.

4.5. Data management

4.5.1. Data access and privacy framework

Suppliers and Third Parties need explicit consent from the Customer to access his/her metering data.

4.5.2. Provisions to provide and revoke access to data

Access to Customers' data is delegated to a Third party or a Supplier as part of the service contract (there is no independent party to double check, the DSO simply executes the request for metering data).

The Customer can revoke access to his/her data via a written form communicated to and validated by the DSO or a central party.

4.6. Consumer impact

4.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Croatian market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes

Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

It can be noticed from the table that, in Croatia, smart meters can provide two (out of six) advanced services: dynamic tariffs and possibility to ease charging of Electric vehicles.

4.6.2. Consumer concerns

Consumer organizations expressed concerns about the impact of smart metering roll out on distribution charges. No concerns on privacy, cybersecurity, electromagnetic radiation, smart meters pricing and installation barriers have been raised yet.

4.6.3. Research on consumer benefits

In Croatia, a research on consumers' ability to realize the smart metering benefits has not been conducted so far.

4.6.4. Communication campaign

A dedicated communication campaign has not been launched in Croatia during the rollout of smart meters.

4.6.5. Advanced consumer services

At present, there are no plans or initiatives leveraging smart meters integration with distributed energy resources (distributed generation, storage, e-mobility, demand response, etc…), but there might be in the future.

4.7. Conclusions

Croatia became member of the European Union and joined the EU energy market in 2013. As a part of the access process, the Croatian authority had to incorporate the EU Third Energy Package in the national legislation with the Energy Act and other Acts. Currently, the Energy Act is the primary law that enables both smart electricity and gas metering.

Up to 1/1/2018, electricity smart metering has reached a low degree of penetration in the country with only 2.3% of traditional meters replaced with smart meters. Concerning gas, no smart meters are currently installed in Croatia.

The Croatian authority set a target for the future development of smart meters in the Country: 450,000 smart meters for electricity will be installed by the end of 2030.

Croatia is working on the deployment of smart metering systems for electricity principally in order to reduce non-technical losses, make easier the switching of energy supplier, digitalise metering assets and develop a digital playground, enable dynamic tariffs for households and SMEs, integrate the decentralized energy resources with flexible access (load shedding, infeed curtailment) , optimise the network operations and enforce the security and data privacy rights. Further primary drivers have been taken into account such as addressing fuel poverty and developing a digital playground for private actors.

In 2017, the Croatian NRA commissioned the drafting of the first CBA on smart metering deployment for electricity. Two different scenarios have been considered in the CBA, with two different periods of evaluation (4 and 11 years). In both cases, the result of the CBAs is positive with benefits that overcome costs as of 1.3 times in the least favourable scenario.

Almost all cost and benefit items suggested by the European Commission (Recommendations 2012/148/EU) have been taken into account in the electricity CBA. The only costs that have not been considered are investment in in-home display and sunk cost of conventional meters (CAPEX), unplanned renewal and failures of smart meters, revenue reduction and call centre and customer service (OPEX). Regarding benefits, only bill reduction due to dynamic pricing, provision of explicit flexibility services and outage management based on societal value of lost load and on reduced customer indemnification have not been considered.

Privacy and data protection matters related to smart meters are at a very early stage of discussion in Croatia. There is no clearly defined data management strategy at this point in time and main risks have not been identified yet. The role of the Data Protection Officer, as defined in the GDPR, is bestowed to the DSO; a Data Protection Impact Assessment has not been performed yet.

As for access to final customers' data, the third party and suppliers need an explicit consent from the customer and such a customer can then revoke this access via written form validated by the DSO.

All 10 key functionalities recommended by the European Commission (2012/148/EU) are available and free of charge for the electricity customer in Croatia.

Finally, in Croatia, consumer organizations expressed concerns about the impact of smart metering roll out on distribution charges. Therefore, it is recommended to organise a tailor-made communication campaign to explain the added value of smart metering for consumers and the system as a whole and mitigate those concerns. Moreover, the project promoters and the competent authorities should ensure that all necessary measures are taken to safeguard data privacy and security in line with the EU law and in compliance with existing standards.

4.8. References

Id	Reference description
1	General conditions for network use electric energy supply, Article 110 - https://www.hera.hr/hr/docs/2014/Prijedlog_2014-12-24_02.pdf https://narodne-novine.nn.hr/clanci/sluzbeni/2015_08_85_1666.html
2	4th NEEAP 2017 - https://ec.europa.eu/energy/sites/ener/files/hr_neeap_2017_en.pdf

5. CYPRUS

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Cyprus.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

5.1. Legal and Regulatory Framework

5.1.1. Market model

The Cyprus Energy Regulatory Authority (CERA) is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

The CERA[1] has been established in 2003 in accordance with the European Union directives. According to the responsibilities and the authorization given by the law, it is the National Independent Regulatory Authority for Energy that is able to oversee and regulate the electricity and gas market, ensure effective and fair competition, protect the interest of the consumers, ensure safety, quality, competence, continuity and reliability in the energy supply, as well as encouraging the use of RES.

In Cyprus, the Law for Regulating the Natural Gas Market is fully harmonized with the European Directive 2009/73/EC concerning the common rules for the internal natural gas market (Gas Directive). The market is currently qualified to be characterized as an Isolated natural gas market and efforts are been made in order to import Liquefied Natural Gas to Cyprus by the end of year 2021 and characterise the market as an Emergent market. The main aim, in accordance with the National Law for the Regulation of the Gas Market, is the development of an organized market on the model of the best practises adopted by the European Natural Gas Industry.

Regarding the electricity market and according with the Regulatory Decisions of the CERA, which implement the corresponding provisions of the EU, the Electricity Authority of Cyprus (EAC) has carried out Accounting and Functional Unbundling. These decisions set the basis for the unbundling of the four regulated activities of generation, transmission, distribution and supply and the non-regulated activities of the EAC. Distribution[2], as one of the four Core Regulated Activities (CRAs), incorporates both the Distribution System Owner (DAO) and the Distribution System Operator (DSO). In this context, the DAO is in charge of meter ownership and installation, while the DSO is the responsible party for metering data collection, storage, transmission to third parties and it is the metering data protection officer, in compliance with the General Data Protection Regulation (GDPR).

Both suppliers and consumers could have the ownership of the in-home display and their installation. In case of technical and/or administrative losses, the responsibility is always of the supplier.

5.1.2. Legal grounds

The primary law that enables CERA to ensure the implementation of smart metering for electricity is the Regulation of the Electricity Market Act[3]. It was introduced and amended as follows: 239(I)/2004, 143(I)/2005, 173(I)/2006, 92(I)/2008, 211(I)/2012, 206(I)/2015, 18(I)/2017 and 145(I)/2018. This law will be revised in order to incorporate the new Electricity Directive (EU) 2019/944 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast).

Furthermore, the CERA has issued a draft Regulatory Decision 02/2018 regarding a full roll out timeline. After public consultation, the CERA issued the final Regulatory Decision 02/2018 (Act 259/2018) where it instructed the DSO to proceed with the appropriate actions to initiate the required procedures for the complete and massive installation of smart metering systems by setting the date of commencement of operations the 1 January 2019 and completion within eight (8) years, which includes individual actions with the ultimate goal of installing 400,000 smart meters for electricity. The Regulatory Decision after public consultation has become a secondary legislation.

As already described above, the Natural Gas Market in Cyprus is under development. The Regulation of the Gas Market Act[4] enables the CERA to ensure the implementation of smart meters, but it will have to be revised.

5.1.3. Primary drivers

The main drivers for smart metering deployment in Cyprus in the case of electricity are related to:

- enabling of dynamic tariffs for household and SMEs in order to optimize consumptions in an efficient way;
- digitalization of distribution grid and the optimization of network operations;
- digitalization of retail market with the aim to foster innovation and new services by private actors; and
- decentralized integration of energy resources with flexible access (load shedding, infeed curtailment).

As a matter of fact, the final goal of the Cypriot smart metering deployment is to put consumers in control of their energy use and to enhance the distribution system with digitalization that will allow to manage efficiently and in a flexible way the energy fluxes in the network.

5.1.4. Smart metering programme financing

Based on the provisions of the Regulatory Decision 02/2018, CERA issued the Decision 231/2018 where it states that 50% of the total cost for the implementation of the full roll out for electricity will be covered by the DSO reserves.

5.1.5. Recent publications by the NRA

The most recent publication issued by the National Regulatory Authority is the Regulatory Decision 02/2018 as described above. The decision defines specific timelines for the installation and operation of advanced metering infrastructure (AMI).

It is noted that the latest relevant publication which is the 4th National Energy Efficiency Action Plan (NEEAP)[5] that was prepared in compliance with the Energy Efficiency Directive (EED, 2012/27/EU), contains no further information on the deployment of smart meters.

5.2. Cost benefit analysis

5.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2014	Consulting Company	DSO	Inconclusive	Comply with Dir. 2009/72/EC

The last CBA for rolling out smart metering in electricity was drafted in 2014, and its outcome was inconclusive. This analysis is not publicly available.

5.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the aforementioned assessment: DSO, DAO, Suppliers and Consumers.

Key parameters for the assessment	
Evaluation period of the CBA [Years]	50
Billing and metering frequency in the reference case for electricity [times/year]	6
Does this also apply for gas?	no
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	T&D Technical losses 4.3%
What is the electricity losses unit cost? [€/MWh]	Not assigned
What is the economic lifetime of electricity smart meters? [Years]	50
What is the economic lifetime of gas smart meters? [Years]	N/A

What is the value of the lost load? [€/MWh]	No VoLL has been assumed for the study
What is the discount rate taken into account? [%/year]	6,00%

5.2.3. Main cost and benefit items

As detailed in the following list, few cost items have been taken into account from those recommended in the guidance issued by the European Commission (see Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter

☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom

☐ CAPEX - Investment in In-home display

☐ CAPEX - Sunk cost of conventional meters

☐ OPEX - IT maintenance

☐ OPEX - Network management and front end

☐ OPEX - Telecom

☐ OPEX - Change management

☐ OPEX - Unplanned renewal and failures of smart meter

☐ OPEX - Revenue reduction

☒ OPEX - Meter reading

☒ OPEX - Call center and customer service

☐ OPEX - Consumer engagement programme

Benefits focus on bill reduction due to energy efficiency (based on volume rather than unit price), savings in meter readings and operations, non-technical losses (administrative, including fraud), outage management (based on societal value of lost load) and finally CO_2.

5.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for the smart metering rollout in the case of electricity:

Key outcomes of the assessment (actualised values, referring to the whole evaluation period)	**Number**
Number of meters installed [n° of meters]	543,910

CAPEX [€]	150 € million of additional investments compared to the situation of conventional meters
OPEX [€]	Not mentioned
Benefits	527 € million but with large deviations during the sensitivity analysis

5.2.5. Deployment strategy and latest statistics

According with the Regulatory Decision 02/2018, the implementation of a timeline of smart meters' full rollout will start in 2019. The aim is to install, at first, 57,143 smart meters by January 2021. At the moment, there is only a pilot programme running involving 3,000 meters.

State of play of smart metering deployment in Cyprus as of 1/1/2018	Electricity households	Electricity SMEs
Number of smart meters	0	0
Number of connection points equipped with smart meters	0	0
Total number of meters	437,500	109,000
Total number of connection points	N/A	N/A
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	0
Number of smart meters that does communicate default metering data	0	0
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	0

As reported in the table above, currently no smart meters have been installed. Concerning the 109,000 SMEs meters, the number refers to cases where the customers pay commercial and industrial tariffs and the vast majority of them fall under the definition of a SME.

5.3. Functional and technical specificiations

As described above, the Regulatory Decision 02/2018 mandates the DSO to do a full rollout of electricity smart meters. The final target of the Regulatory Decision is that until 2027 all consumers have smart meters installed at their premises.

The national authorities overseeing the operation intend to carefully consider, along with the DSO bestowed with the task, the Commission recommendations of the 2012/148/EU when deciding the smart metering technical and functional specifications.

5.4. Data management

5.4.1. Data access and privacy framework

Third parties do need explicit consent from the customer to access his/her metering data.

In Cyprus, nothing else has been defined yet, concerning customer data management and thus the processes by which data is sourced, validated, stored, protected and the basis on which it can be accessed. Furthermore, CERA with its Regulatory Decision No. 05/2017, dated 6th of October 2017, decided the immediate implementation of a binding timetable by the DSO, to strictly implement a schedule for full installation and operation of the software MDMS (Meter Data Management System), with a binding target on 1 April 2019. Due to delays in the tendering process, the expected date for the implementation of the MDMS is in 2020.

5.4.2. Provisions to provide and revoke access to data

The option for costumers to provide and revoke access to data has not been defined yet.

5.5. Consumer impact

5.5.1. Available services

No further services have been defined yet.

5.5.2. Consumer concerns

At present, no study about consumer concerns has been officially performed in Cyprus.

5.5.3. Research on consumer benefits

A specific research on consumers' ability to realize the smart metering benefits has not been conducted so far.

5.5.4. Communication campaign

No communication campaign has been conducted so far.

5.6. Conclusions

In Cyprus, the gas market has not been developed yet and the Ministry of Energy, Commerce and Industry, the Natural Gas Public Company (DEFA) and CERA are currently involved in its development.

Regarding the deployment of electricity smart meters, the implementation of a timeline of smart meters' full rollout starts in 2019. The Regulatory Decision 02/2018 aims at installing 57,143 smart meters by January 2021. Therefore, on the cut-off date (1/1/2018) for data collection for the present report, the Cypriot penetration rate of electricity smart meters is 0%.

Cyprus intends to rollout smart metering systems in order to enable dynamic tariffs for households and SMEs, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment) and to digitalize the distribution grid and the retail market. The final goal of this deployment is to put consumers in control of their energy use and to enhance the distribution system with digitalization that will allow efficient and flexible management of the energy fluxes in the network.

In Cyprus, a CBA for the smart metering rollout for electricity was drafted in 2014 and it is not publicly available. Although the foreseen benefits are estimated to be much higher than costs (by almost 3.5 times), the NRA has considered the CBA inconclusive.

It is noted that in the aforementioned economic assessment, only few costs have been taken into account. They included smart meters, IT and Telecom costs, as well as operational costs such as meter reading, call centre and customer service. On the other hand, benefits focused on bill reduction due to energy efficiency (based on volume rather than unit price), savings in meter readings and operations, and from non-technical losses (administrative, including fraud), outage management (based on societal value of lost load) and finally CO_2. However, these benefits are found to be subjected to large deviations in the sensitivity analysis.

Concerning privacy and data protection in Cyprus, the DSO was appointed as the Data Protection Officer. A Data Protection Impact Assessment has not been finalized yet (at the moment of writing of this report), and no general Standard Operating Procedure has been designed to enhance information and transparency regarding the data protection and security topic.

According to the Regulatory Decision 02/2018, the implementation of a timeline of smart meters' full rollout was to start in 2019. There is no information yet on the definition of functional specifications, nor of services' costs or communication campaign to the customer.

5.7. References

Id	Reference description
1	The Cyprus Energy Regulatory Authority (CERA) - https://www.cera.org.cy/en-gb/raek
2	The Operational Unbundling – https://www.eac.com.cy/EN/EAC/Operations/Pages/dianomi.aspx
3	The Regulation of the Electricity Market Act - https://www.cera.org.cy/en-gb/nomothesia/details/hlektrismos-nomos
4	The Regulation of the Gas Market Act - https://www.cera.org.cy/en-gb/nomothesia/details/fysiko-aerio-nomos
5	4th National Energy Efficiency Action Plan - https://ec.europa.eu/energy/sites/ener/files/documents/cy_neeap_2017_en.pdf

6. CZECH REPUBLIC

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Czech Republic.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

6.1. Legal and Regulatory Framework

6.1.1. Market model

In the Czech Republic, the Energy Act defines the following electricity market actors:

- Electricity generators
- Transmission system operator (TSO)
- Distribution system operators (DSO)
- Market operator
- Energy suppliers
- Electricity traders
- Customers

The DSO is responsible for installation and operation of metering devices in its distribution area, as well as metering itself and the transfer of metering data to the market operators with the highest amount of security, in order to reduce the risk of potential abuse or loss of customer data. Market operators are responsible for the later processing of submitted customer data.

6.1.2. Legal grounds

The basic legislative norm that sets up rules for undertaking in the Czech Republic energy sector is the Act No. 458/2000, Coll. on Business Conditions and Public Administration in the Energy Sectors and on Amendment Other Laws (Energy Act) as amended by later legislation. The Energy Act has implemented into the Czech Republic legislation the Electricity Directive 2009/72/EC, which calls on Member States to ensure implementation of smart metering which supports customers' active participation in the electricity market.

No specific legislation has been adopted to define a specific target in time for the deployment of smart meters and there is no explicit definition of priority customer segments that should be equipped with smart meters.

6.1.3. Recent publications by the NRA

The most relevant document issued by the authorities in the Czech Republic is the economic assessment of all long-term costs and benefits for the market and the individual customer through application of smart metering systems in the Czech power and gas sector.

The CBA has been updated in 2016.

6.2. Cost benefit analysis

6.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
November 2016	Ministry of Industry & Trade		Negative Net Present Value	Legal obligation
September 2012	Ministry of Industry & Trade		Negative Net Present Value	Legal obligation

The motivations behind this exercise was to be compliant with the European Directives 2009/72/EC and 2009/73/EC.

6.2.2. Market roles and key parameters

Some of the key parameters considered for the 2016 CBA for electricity can be found in the table below:

Key parameters for the assessment	
evaluation period of the CBA [Years]	19
billing and metering frequency in the reference case for electricity [times/year]	1 (yearly)
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	5,5%
What is the electricity losses unit cost? [€/MWh]	1,500 CZK/MWh (58 EUR/MWh)

What is the economic lifetime of electricity smart meters? [Years]	12
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A

6.2.3. Main cost and benefit items

The main cost items considered in the analysis are as follows:

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☐ OPEX - Meter reading
☐ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

The main benefit items considered in the analysis are:

☐ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☐ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☐ Distribution capacity deferral

☐ Transmission capacity deferral

☐ Generation capacity deferral

☐ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☐ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☐ CO2

☐ Air pollution (particulate matters, NOx, SO2)

No consumption reduction benefit is considered in the CBA. The exclusion has been justified on the grounds that the HDO system in place already maintains the consumptions patterns at their optimum levels[8].

6.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment:

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	5,712,550
Actualised CAPEX for the whole evaluation period	€1,073,000,000
Actualised OPEX for the whole evaluation period	€927,000,000
Actualised benefits for the whole evaluation period	€575,940,000

The resulting ratio has been computed per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- OPEX per meter: 162.38 €
- CAPEX per meter: 187.95 €
- Benefit per meter: 100,82 €

6.2.5. Deployment strategy and latest statistics

The deployment of smart meters is not expected to begin before 2019 and is set to be completed by 2026.

On the other hand, details of certain pilot projects can be seen below[9]:

- E.ON Ceska Republika installed 4,000 smart meters in South Moravia in 2006
- PRE completed a project in Prague with 3,000 meters
- CEZ installed 2,000 meters in East Bohemia as part of FUTUR/E/MOTION, a smart grid project with 32,000 meters.

[8] ttps://ec.europa.eu/energy/sites/ener/files/documents/AF%20Mercados%20NTUA%20CBA%20Final%20Report%20June%2015.pdf

[9] http://www.escansa.es/usmartconsumer/documentos/USmartConsumer_European_Landscape_Report_2016_web.pdf?_sm_au_=iVVMF0wVSRf2wJZQ

6.3. Functionalities and consumer impact

No publicly available information could be used to provide more explanation on the scope of functional and technical specifications.

Regarding consumer engagement, no specific action has been taken to ensure a smooth adoption of smart metering system, even though the market players are investigating implementation options by conducting pilot projects and trials.

6.4. Conclusions

Although the Czech Republic is one of the leading countries within the new Member States to have established a strategy for smart grid testing and implementation[10], this interest has not translated into smart meters.

The result of the CBA (which had a negative NPV) is one of the main reasons for the lack of willingness in the deployment of smart meters. However, it is considered that should the Czech Republic review some of the key elements of the CBA (i.e. cost of smart meters themselves, the proposed IT infrastructures, along with the benefits), its CBA could have a different outcome.

6.5. References

Id	Reference description
1	Economic assessment of all the long-term costs and benefits for the market and the individual costumer through application of smart metering systems in the Czech Republic power sector (2016)
2	SG and SM in the Czech Republic (2015)
3	Study on cost benefit analysis of smart metering systems (2015)
4	http://www.escansa.es/usmartconsumer/documentos/USmartConsumer_European_Landscape_Report_2016_web.pdf?_sm_au_=iVVMF0wVSRf2wJZQ

[10] http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/u24/2014/report/ld-na-26609-en-n_smart_grid_projects_outlook_2014_-_online.pdf

7. DENMARK

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Denmark.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

7.1. Legal and Regulatory Framework

7.1.1. Market model

In Denmark, the DSOs are legally entitled to define deployment targets and conditions for smart electricity[11] to ensure that replacement deadlines from the legislation are met. Regarding gas meters, there is no incentives for smart metering deployment and there are no smart meters for gas installed today. The DSOs are the parties responsible for meter ownership and installation as well as metering data collection and storage. Usually the DSOs use third parties for mass replacement of new meters such as the smart metering deployment.

In 2013, the first version of a central data hub where meter readings are stored was implemented in Denmark by the TSO, and in 2016 the electricity market shifted to a supplier-centric model. A supplier-centric model means that the supplier is the single point of contact for the customer with the electricity market. EnergiNet, the Danish TSO, is responsible for operating the central data hub which also includes arrangements for ensuring data protection with respect to GDPR[12] and other related legislation. Accordingly, as regards metering data in the DSOs' databases and/or local hubs, the DSO is responsible for its protection in line with the GDPR; the same applies for the suppliers. Below is a picture describing the data responsibility shared between the TSO, DSO and supplier:

[11] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

[12] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

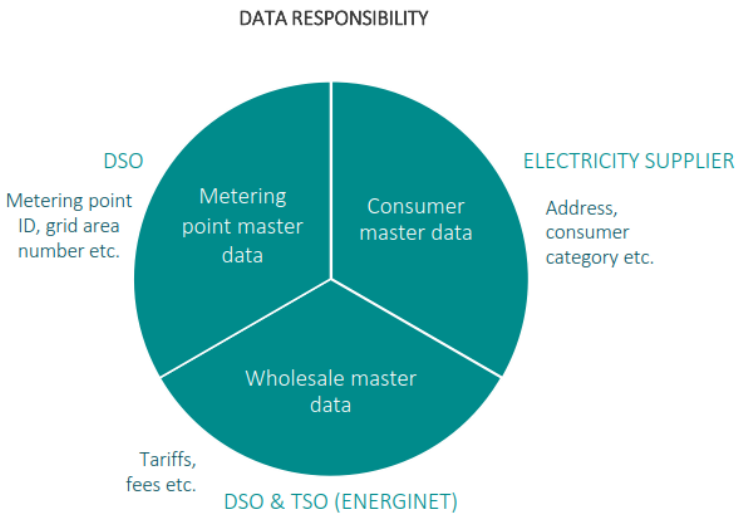


Figure 2: *Taken from EnergiNet report "The Danish Electricity retail market"*[13]

From the central data hub, meter readings, when requested by eligible parties, are transmitted to them.

It is up to the customer to decide if he or she wants to buy and install an in-home display. The in-home display is provided by other actors who can also help with the installation.

In Denmark, there is no intention to deploy smart meters for gas since gas installations are slowly being phased-out. Highly more relevant is heat and cooling meters, where a large number of Danish heat utilities have installed smart meters at their customer connection points during the last 20 years; the same applies to water meters.

7.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Danish Electricity Supply Act which were revised 2019[14]. 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

[13] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

[14] https://www.retsinformation.dk/Forms/R0710.aspx?id=206623

7.1.3. Primary drivers

The primary drivers for smart metering deployment in Denmark are linked to increasing competition on the electricity market, enabling the consumers free supplier choice and the possibility for them to contract green electricity and thus support increased production of renewable energy. Following the full cabling of the Danish distribution grid, all grid components have been digitalized and net assessments carried out have focussed on optimization of the grid operations i.e. following asset management according to ISO 55000. Enabling dynamic tariffs for households and SMEs is also promoted, in line with the energy agreement 2018, but it is not being put forward as an argument for smart metering implementation.

7.1.4. Smart metering programme financing

Smart metering costs are borne by the DSOs. To this respect, the Danish NRA has defined a revenue cap (per meter category). The respective costs for deployment are covered under an overall four-year revenue cap and are financed by tariffs paid by the customers.

7.1.5. Recent publications by the NRA

The most recent publications issued by the national regulatory authorities is the yearly energy efficiency benchmark report for 2017, published 2019[15].

7.2. Cost benefit analysis

During our investigation, we found no information about a cost benefit analysis for the smart metering deployment in Denmark.

According to energy experts in Sweco Denmark, meter reading and operations savings as well as the potential increased competition in the retail market are most likely the main benefits. However, so far (and probably until a mass rollout of heat pumps and electric vehicles) electricity customers' switching, which could be considered as an indicator of an active, competitive retail market, is low (less than 1% a year). Furthermore, in Denmark a number of retailers are selling electricity already to industries and private households irrespectively of the presence of smart meters at the distribution point. With regards to Photovoltaic production, a large number of households has already (and for more than 10 years) installed PV solutions in combination with grid connection and sell/purchase electricity. Smart metering deployment will not increase this market share. Finally, the electricity bill might be rising as a result of the costs for the smart metering installation.

7.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
Not available	Not available		100%	Not available

[15] http://forsyningstilsynet.dk/tool-menu/kontakt-og-presseinfo/el-rapporter-og-analyser/

7.2.2. Market roles and key parameters

Not available.

7.2.3. Main cost and benefit items

Not available.

7.2.4. CBA results

Not available.

7.2.5. Deployment strategy and latest statistics

The Danish Government have imposed on all DSOs that by end 2020 all meters used for measuring consumers must be smart meters and remotely read. By the end of 2017 2 324 439 smart meters were installed of a total of 3 361 816 electricity meters in Denmark[16]. There are sufficient plans and progress for the different DSOs to meet the target.

7.3. Functional specifications

No information has been found during our investigation. Nevertheless, the European Smart Grids Task Force Expert Group 1 report on "Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering" provided information regarding the implementation of functionalities (a), (b) and (f). Functionality (a) is partly implemented (only for meters after 2011). Functionality (b) and functionality (f) are also implemented. The provision of information is free of charge and the frequency of data consumption update is 1 hour and 15 minutes for the smart meters installed after 2011.

7.4. Technical specifications

The Danish DSOs and Dansk Energi (a business and interest organization for energy companies in Denmark) have produced technical guidelines for the smart metering rollout. Furthermore, there is a working group under Dansk Energi laying out the standard for smart meters, which the DSOs have followed.

The interfaces H1 and H2 are used to support functionalities (a) and (b) for the smart meter installed after 2011. No specific standard has been chosen for interface H1, but open standards will be required, and this interface will probably use DLMS/COSEM data model. For the interface H2 the selected standards are open standards wired (RS-485) or wireless (wM-Bus), and DLMS[17].

[16] Email from Michael Søgaard Schrøder at Forsyningstilsynet, Danish NRA.

[17] The information presented in this paragraph has been provided by European Smart Grids Task Force Expert Group 1 report on "Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering" https://ec.europa.eu/energy/sites/ener/files/documents/EG1_Final%20Report_SM%20Interop%20Standards%20Function.pdf

7.5. Data management

7.5.1. Data access and privacy framework

Danish consumers can access their own data in the data hub through a website developed by the Danish TSO. The granularity of the meter readings differs depending on which DSO the customer has, and can be either on an annual, monthly or hourly level. The central data hub is updated with data every 24 hours, but not all data is updated.

7.5.2. Provisions to provide and revoke access to data

Danish consumers maintain ownership of their own data and third parties and suppliers need an explicit consent from the customers to access their metering data. For suppliers, access is given to data for a specific customer and a specified connection point through the central data hub when the contract is signed. This access right is revoked automatically when the contract changes, due to customer moving from that connection point or changing supplier. For third parties, access to data is given for a specific customer and connection point through an explicit permission granted by the customer and can be withdrawn at any time. The third-parties access data through a secure access-solution provided by Energinet. Only electricity agents, energy consultants or other market participants that are authorised by Energinet to collect data, are permitted to submit access requests.

The central data hub also delivers data for research purposes and open access data for statistics and market reports. This data is aggregated and anonymised.[18]

7.6. Consumer impact

7.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No

[18] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes. More precisely, in Denmark it has been custom for decades to forecast the bill for next month/quarter/year and having the customers to pay based on this forecasting, which is based on previous 2-4 years consumption. At year end adjustment payment is made.
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	N/A
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No, but is reflected to some degree in the price fluctuations.
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No. Has been pilot tested >10 years ago but require approval by each customer/ household.
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	N/A
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No, but has been discussed in the new energy agreement of 2018 on trial basis.
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	N/A
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	N/A
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	N/A

Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	N/A. A relevant category for Denmark.
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	N/A. A relevant category for Denmark.

7.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	-	-
Cybersecurity	-	-
Electromagnetic radiation	Concerns regarding health issues related to the radiation of remotely read electricity meters.[19]	Yes, the Danish Health Authority has given their recommendation and published test results and research on the subject.[20]
Accuracy of meters	-	-
Price of meters	-	-
Installation barriers	-	-

Regarding accuracy of meters, Danish Safety Technology Authority is an authority in Denmark with responsibility to make sure that rules and requirements applied to regulated meter technology are closely followed. This is done through supervision, approval of companies allowed to check accuracy of meters etc and market check.

[19] http://www.stopsmartmeter.dk/?fbclid=IwAR3apzunqStgNuEoTC5r2TdYo2rMe_f5Uw9tixRx0K918xLPLDW9SrAtU

[20] https://www.sst.dk/da/straalebeskyttelse/mobiltelefoni,-traadloese-netvaerk-med-mere/anvendelser/smart-meters

7.6.3. Research on consumer benefits

Our research has shown that customer switching, which could be an indication of an active retail market, is extremely low in Denmark. This leads some to believe that there will be few opportunities, under the current conditions, and therefore few benefits for consumers, from the smart metering deployment. Over the last 15 years a number of test/pilot projects undertaken in Denmark have investigated customer switching and the interest in getting smart metering benefits. Their results are not encouraging regarding the size of smart metering benefits that could be realised by consumers. Having amongst the lowest electricity production prices in Europe, Danish electricity customers are instead more interested of buying green energy and for this the consumers are prepared to pay more.

The new market design following the supplier-centric model, is enabled technically through the central data hub and the deployment of smart meters. The new market model makes it easier for the customer to integrate with the electricity market: the customer has the electrical supplier as single point of contact to the electricity market and he/she receives one single bill for electricity which includes costs for energy, network, taxes and levies.[21]

7.6.4. Communication campaign

The DSOs communicate with their customers when they undertake the rollout and installation of the next generation of smart meters. Different channels are used and one of them is a written letter[22]. Information regarding the functionalities and requirements from the NRA are publicly available.

Concerning communication on electricity prices, there are different communication platforms used for that, as well as the daily evening news.

7.6.5. Advanced consumer services

When 100 % of the metering points in Denmark have smart meters installed, hourly meter readings will be applied even for small consumers. "Hourly settlement meter readings together with price signals from the wholesale market that reflect the real cost of energy is expected to increase consumer incentive to adjust consumption accordingly". This will require "that new and existing market participants offer services or products for consumers that make this consumer experience possible".[23] At the same time the prices the customers pay today depend on the contract they sign with the DSO. The customer can get hourly values, but the benefits are very small as the electricity generation and transmission/distribution only reflects about 1/3 of the energy prices, whereas 2/3 of the bill is taxes and levies. In principle, a consumer can save at most 5% on 1/3 of the bill and then receive two bills in parallel – one from the DSO and one from the electricity retailer.

[21] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

[22] https://radiuselnet.dk/Elkunder/Fjernaflaeste-maalere/Udskiftning

[23] The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model

7.7. Conclusions

In Denmark the smart metering rollout is ongoing and will be completed in 2020. There is a central data hub already in use for the Danish electricity market actors. All consumers in Denmark have the option to access their own data in DataHub through Eloverblik.dk, a public website developed by Energinet.

Eloverblik.dk is a simple web interface, where consumers can access all data registered from all of their metering points in DataHub – both master data and meter data, change of supplier etc.

The customer can get hourly values, but the benefits are very small as the electricity generation and transmission/distribution only reflects about 1/3 of the energy prices. 2/3 of the bill is taxes and levies. In principle, a consumer can save at most 5% on 1/3 of the bill and then receive two bills in parallel – one from the DSO and one from the el-retailer.

7.8. References

Id	Reference description
1	Information about the Danish Central Hub: The Danish Electricity Retail Market – Introduction to DataHub and the Danish supplier-centric model
2	Danish laws for enabling smart metering: https://www.retsinformation.dk/Forms/R0710.aspx?id=206623
3	http://forsyningstilsynet.dk/tool-menu/kontakt-og-presseinfo/el-rapporter-og-analyser/
4	Email from Michael Søgaard Schrøder at Forsyningstilsynet, Danish NRA
5	Website with listed reasons to stop smart metering in Denmark: http://www.stopsmartmeter.dk/?fbclid=IwAR3apzunqStgNuEoTC5r2TdYo2rMe_f5Uw9tixRx0K918xLPLDW9SrAtU
6	Information from the Danish Health Authority about smart metering: https://www.sst.dk/da/straalebeskyttelse/mobiltelefoni,-traadloese-netvaerk-med-mere/anvendelser/smart-meters
7	Communication from one of the largest Danish DSO's about smart metering rollout: https://radiuselnet.dk/Elkunder/Fjernaflaeste-maalere/Udskiftning

8. ESTONIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Estonia.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

8.1. Legal and Regulatory Framework

8.1.1. Market model

In Estonia, the Government is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to the DSOs that are the parties in charge of meter ownership, installation and data collection, as well as in-home display ownership and installation. Metering data is also collected to a Central Data Hub where meter readings are stored and if requested transmitted to third parties. The Central Data Hub also fulfils the duties of metering data protection officer.

8.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Grid code (Võrgueeskiri) under Electricity Market Act, which was revised in July 2010. There are no other laws that further implement smart metering deployment for electricity. This law has a functional scope.

The corresponding law for gas is the Natural Gas Act, which was revised and valid as of June 2017.

8.1.3. Primary drivers

The primary drivers for smart metering deployment in Estonia are to:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations

- Digitalize retail market to foster innovation and new services by private actors, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)

8.1.4. Smart metering programme financing

The smart metering programme is financed through the network charges paid by the end-customer.

8.1.5. Recent publications by the NRA

At the moment, there are no recent related publications by the implementation body.

8.2. Cost benefit analysis

8.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2011	DSO		Not available	Set the scene. The CBA is not publicly available.

8.2.2. Market roles and key parameters

In coherence with the national market model described above, the market role taken into account in the assessment was the DSO. There is no information regarding the key parameters in the cost-benefit assessment conducted for the case of the large-scale smart metering rollout.

Key parameters for the assessment	
evaluation period of the CBA [Years]	Not available
billing and metering frequency in the reference case for electricity [times/year]	Not available
Does this also apply for gas?	Not available
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	Not available
What is the electricity losses unit cost? [€/MWh]	Not available
What is the economic lifetime of electricity smart meters? [Years]	Not available

What is the economic lifetime of gas smart meters? [Years]	Not available
What is the value of the lost load? [€/MWh]	Not available
What is the cost reduction rate due to technological maturity? [%/year]	Not available

8.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☐ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☐ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call center and customer service
☐ OPEX - Consumer engagement programme

Benefits focus on meter reading and operative savings, operation and maintenance of assets and non-technical losses such as administration.

8.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for electricity rollout:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	700 000
actualised CAPEX for the whole evaluation period	Approx. 103 M€
actualised OPEX for the whole evaluation period	N/A

actualised benefits for the whole evaluation period	The 10 recommended functionalities by the European Commission

8.2.5. Deployment strategy and latest statistics

According to the Electricity Market Act all smart meters were installed by 1st of January 2017 and the deployment was mandatory for all customer. According to the Natural Gas Act, smart meters shall be installed by the 1st of January 2020 and is mandatory consumers over 750 m3/year. For both electricity and gas there is no exception to the mandatory installation. Technical constraints by smart meter data communication exists, but they shall be solved by using alternative technical solutions (GSM, fiber, LAN etc).

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017. There are no disaggregated statistics concerning metering points in households and SMEs, therefore the numbers in the table below include both.

State of play of smart metering deployment in UK-GB as of 1/1/2018	**Electricity**	**Electricity SME**	**Gas**	**Gas SME**
Number of smart meters	700 000	Not available	5000	Not available
Number of connection points equipped with smart meters	700 000	Not available	3000	Not available
Total number of meters	707 900	Not available	43 000	Not available
Total number of connection points	707 900	Not available	43 000	Not available
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	Not available	0	Not available
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	11 600	Not available	Ca 10	Not available

Number of smart meters that does communicate default metering data	688 400	Not available	Not available	Not available
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	Not available	Not available	Not available	Not available

Deployment outcomes in 2017	Electricity	Electricity SME	Gas	Gas SME
Yearly installation target	N/A. Mass installation was completed in 2016. There was no planned number for 2017.	Not available	7000	Not available
Number of visits to consumer premises	4153	Not available	1	Not available
Number of installed smart meters	5752	Not available	8000	Not available
Number of deactivated smart meters	358	Not available	0	Not available
Number of refusals	17	Not available	0	Not available

8.3. Functional specificiations

All 10 key functionalities recommended by the European Commission in its Recommendation 2012/148/EU, especially for electricity, are implemented and activated by default. About half of the functionalities are free of charge for the customer such as provision of readings directly to customer and updating of these readings frequently enough, allowing remote reading of meters by the operator, supporting pricing and prevention and detection of fraud.

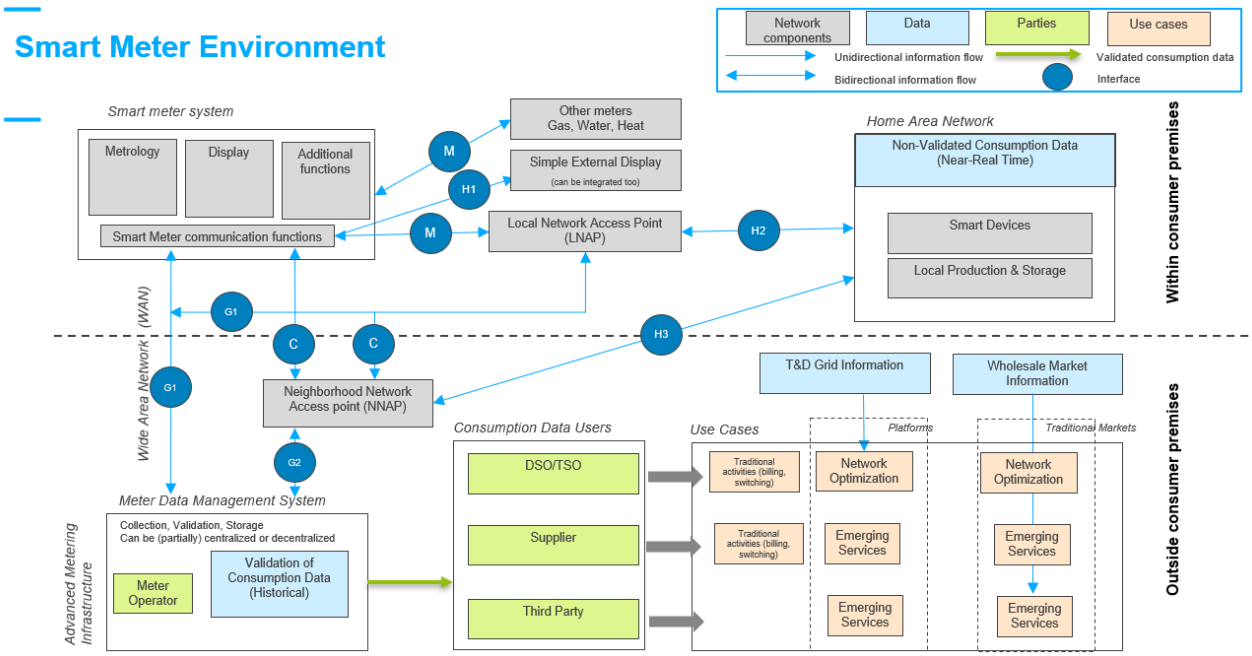
Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	No	N/A
H2 Interface (Smart Devices)	No	N/A
Compulsory DSO website	7 years of hourly consumption data.	Hourly
Compulsory Supplier website	Not available	N/A
Compulsory Third Party website	Not available	N/A

The smart metering systems installed could also be used in community-based distribution systems.

Remote reading by the operator is made by both push (automatic) and Pull (on demand by the operator). Advanced tariff system possibilities are foreseen for time-of-use tariffs. The smart metering systems measure grid injection and withdrawals separately; they measure the net injected energy into the grid and are able to measure reactive power.

8.4. Technical specifications

In respect to the following figure, that gives a schematic representation of the functional architecture in a smart metering environment, interface to C, G1 and G2 are implemented by default. Technology chosen for C is PLC because it is easy to install in existing electrical cable networks and it is economical. Regarding G1 and G2, GSM will be used for meters where the PLC installation price is too high (smart meter and data concentrator). No standard was adopted, at the moment of data collection for this report, to support the chosen communication technology.



8.5. Data management

8.5.1. Data access and privacy framework

To access metering data, third parties and suppliers need an explicit consent from the customer. A Data Protection Impact Assessment recommended by the European Commission was performed in the second quarter of 2018; this is not publicly available. The main risk identified is data leakage to unwanted third parties.

8.5.2. Provisions to provide and revoke access to data

Access is given and revoked through written approval communicated to and validated by the DSO or through a specific app or website with secured access.

8.6. Consumer impact

8.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the electricity market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?

Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing.) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

There is no consumer segmentation and no legal obligation for prepayment.

8.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	General public resistance to smart metering but lack of objective grounds	Yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	No concerns	N/A
Electromagnetic radiation	Tested in laboratory	Yes - proven compliance to existing standards
Accuracy of meters	Tested in laboratory	Yes - publication of the test results and methods
Price of meters	No concerns	N/A
Installation barriers	No concerns	N/A

8.6.3. Research on consumer benefits

No research been conducted about consumers and their ability to realize the smart metering benefits.

8.6.4. Communication campaign

There was no specific communication campaign before and during the installation of smart meters, but several institutions, namely the Estonian Competition Authority, Ministry of Economic Affairs and Communications, Consumer Protection Authority, Technical Regulatory Authority etc., published several related articles. Channels that were used for communication were: website and meetings with representatives of consumers.

8.6.5. Advanced consumer services

There are plans and initiatives that leverage smart metering to integrate distributed energy resources; these include advanced consumer services to support distributed generation and demand response.

8.7. Conclusions

Smart metering was deployed in 2017 in Estonia and a central data hub is already in use. There is a high level of IT maturity; this served well the smart metering deployment as well as the central data hub design and overall the deregulation of the electricity market. This forms the foundation on which new companies and start-ups can grow and develop and facilitates competition in the retail market and the engagement of the end customer via novel smart energy services and products.

A number of lessons learned by the Estonian NRA regarding smart metering deployment is shared below.

- Smart meters are more convenient for end users since they do not have to inform the DSO about their meter readings.
- They are also convenient for DSOs, since they have better overview about hourly consumption in network, which enables better network planning.
- Moreover, DSOs, can have, thanks to smart meters, better overview of their network losses (as confirmed in the Estonian distribution network: from 5,7% losses recorded in 2012, down to 4,1% in 2017).
- In addition, DSOs, can easily detect with the help of smart meters illegal electricity consumption (theft).
- Finally, smart metering supports the implementation of demand response.

8.8. References

Id	Reference description
1	Electricity Market Act
2	Natural Gas Act

9. FINLAND

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Finland.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

9.1. Legal and Regulatory Framework

9.1.1. Market model

In Finland, the Ministry of Economic Affairs and Employment is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to the DSOs as they are the parties in charge of meter ownership and installation, metering data collection and storage as well as acting as the metering data protection officer (Art. 37 GDPR). In-home display ownership and installation could be with the supplier, the customer or other actors.

Some of the roles mentioned here will belong in the future to the datahub, such as metering data storage, metering data transmission to third parties and metering data protection officer (Art.37 GDPR).

9.1.2. Legal grounds

The primary law that enables smart metering for electricity is Decree of the State Council (66/2009) which has a functional scope. This was revised and adopted in 2009 since the roll out of smart meters started that year.

9.1.3. Primary drivers

Drivers for smart metering deployment in Finland is to:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations

- Digitalize retail market to foster innovation and new services by private actors, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)

9.1.4. Smart metering programme financing

Smart metering costs are borne by the DSOs and there has a defined cap (per meter category) by the Finish NRA. The costs are financed by tariffs paid by the customer.

9.1.5. Recent publications by the NRA

The next generation of smart meters, i.e. first was rolled out 2013, will be rolled out in the near future in Finland; respective requirements have not been set yet. Since Finland is not in an implementation phase, there are no related recent publications.

9.2. Cost benefit analysis

9.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2008	Government		Positive	Demand side management, DSO cost reduction, electricity trade and new services

A gas smart meters rollout CBA was carried out at the same time as for electricity (2008) and was negative. The main reasons for this outcome were that gas is used for heating only in a handful of households (only few thousands) and there is no supply competition in Finland.

9.2.2. Market roles and key parameters

The key parameters considered in the electricity CBA conducted can be seen below.

Key parameters for the assessment	
evaluation period of the CBA [Years]	15
billing and metering frequency in the reference case for electricity [times/year]	N/A
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A
What is the electricity losses unit cost? [€/MWh]	N/A
What is the economic lifetime of electricity smart meters? [Years]	15-25

What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A

9.2.3. Main cost and benefit items

The economic evaluation of long-term costs and benefits was carried out in 2008. The evaluation was mainly focused on finding the prerequisites for demand side response and therefore a comprehensive analysis of benefits of smart meters was not carried out.

Therefore, information for the detailed list below is not available.

- ☐ CAPEX - Investment in smart meter
- ☐ CAPEX - Investment in IT
- ☐ CAPEX - Investment in Telecom
- ☐ CAPEX - Investment in In-home display
- ☐ CAPEX - Sunk cost of conventional meters
- ☐ OPEX - IT maintenance
- ☐ OPEX - Network management and front end
- ☐ OPEX - Telecom
- ☐ OPEX - Change management
- ☐ OPEX - Unplanned renewal and failures of smart meter
- ☐ OPEX - Revenue reduction
- ☐ OPEX - Meter reading
- ☐ OPEX - Call center and customer service
- ☐ OPEX - Consumer engagement programme

9.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for electricity:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	3,3 million
actualised CAPEX for the whole evaluation period	N/A
actualised OPEX for the whole evaluation period	N/A
actualised benefits for the whole evaluation period	N/A

The actualised cost, CAPEX+OPEX, for the evaluation period is 692 million €.

9.2.5. Deployment strategy and latest statistics

As owner of the meter and responsible of installation the DSOs in Finland are responsible for each deployment strategy. The first smart metering rollout was completed in 2013.

All consumption points with main fuse over 3x63 A were equipped with smart meter already in 2011 and with main fuse max. 3x63 A by the end of 2013.

Regarding smart meters for gas, the Finnish gas market will be opened for competition in 2020 so there were no targets for gas meters in 2017.

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Finland as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	3 469 000	Ca 82 500	N/A	N/A
Number of connection points equipped with smart meters	Not available	Not available	Not available	Not available
Total number of meters	3 475 000	Ca 82 500	N/A	N/A
Total number of connection points	Not available	Not available	Not available	Not available
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	N/A	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	0	N/A	N/A
Number of smart meters that does communicate default metering data	3 469 000	Ca 82 500	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A	N/A	N/A

Some comments on the statistics: In Finland, information is collected on consumption points equipped with a smart meter; there may be several consumption points equipped with a smart meter inside a connection point. Also, there is no information on connection points disaggregated per customer category – namely households and enterprises.

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	N/A	N/A	N/A	N/A
Number of visits to consumer premises	N/A	N/A	N/A	N/A
Number of installed smart meters	N/A	N/A	N/A	N/A
Number of deactivated smart meters	N/A	N/A	N/A	N/A
Number of refusals	N/A	N/A	N/A	N/A

9.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (in Recommendation 2012/148/EU) are implemented, being activated by default and free of charge for the customer.

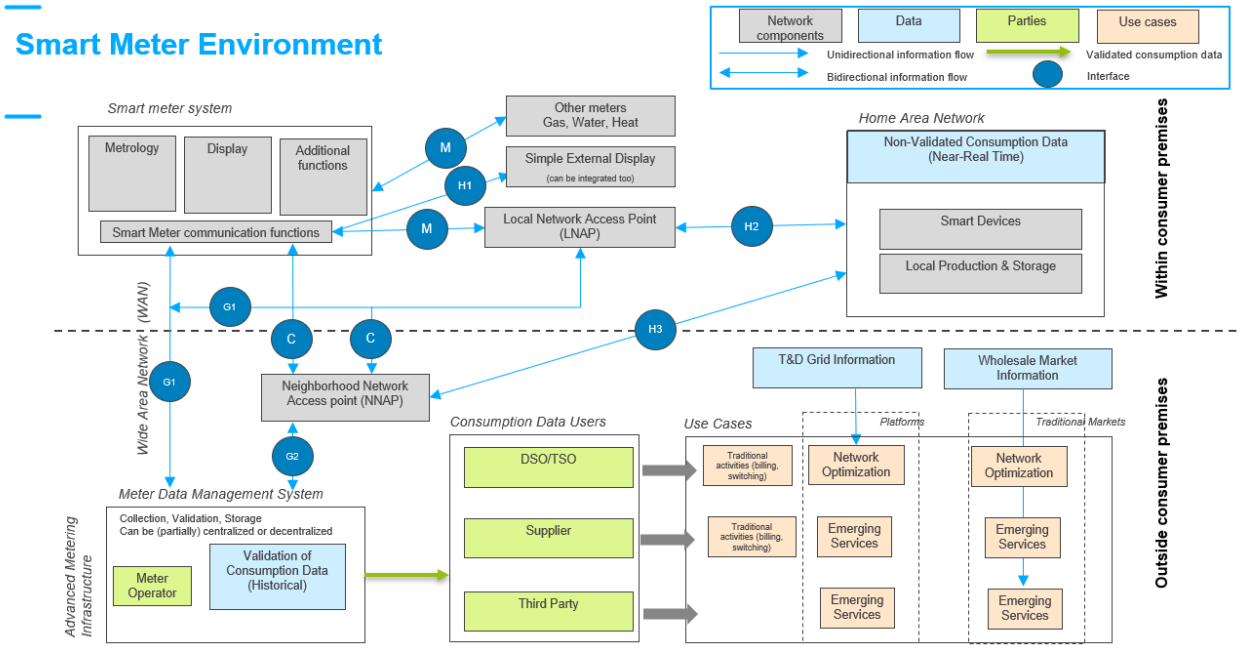
Meter data is collected daily by the DSO and sent on a daily basis to the supplier.

No decision has been made regarding the use of smart metering systems to also serve community-based distribution systems.

Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	The customer will have local access to smart meter. This function will be activated by customer explicit request.	Near real-time
H2 Interface (Smart Devices)	The customer will have local access to smart meter. This function will be activated by customer explicit request.	Near real-time
Compulsory DSO website	Yes. Storage of 6 years of hourly consumption data	Daily
Compulsory Supplier website	Yes. Storage of 6 years of hourly consumption data	Daily
Compulsory Third Party website	N/A	N/A

9.4. Technical specifications

In respect to the following figure, that gives a schematic representation of the functional architecture in a smart metering environment and the related communication/connectivity, no specific standard has been decided at national level as it is not under the Finish NRA's jurisdiction. Regarding the standardised interface G1, PLC-, GPRS and RF-technology is used.



9.5. Data management

9.5.1. Data access and privacy framework

Third parties need an explicit consent from the customer to access their metering data. This is not the case for suppliers.

9.5.2. Provisions to provide and revoke access to data

The customer gives and revokes access to third parties through a written approval which is communicated and validated by the DSO. Regarding access and revoked access for the supplier it is a part of the service contract between the customer and supplier and the DSO will execute the request for metering data.

9.6. Consumer impact

9.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available or foreseen in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No

Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

9.6.2. Consumer concerns

No specifics concerns have been expressed by consumers group and representatives.

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	No	No
Cybersecurity	No	No
Electromagnetic radiation	No	No
Accuracy of meters	No	No
Price of meters	No	No
Installation barriers	No	No

9.6.3. Research on consumer benefits

The consumer segment identified as having a higher level of sensitivity regarding new services enabled by smart meters is the households with electricity heating and opportunities for demand response.

9.6.4. Communication campaign

Since the DSOs are the owner of the meters and responsible for installation, they are also the ones dedicated to launching communication campaigns before and during installation. It is up to them to also decide upon communication channels to use.

9.6.5. Advanced consumer services

The smart grid working group set up by the ministry has discussed on matters related to smart metering requirements, demand response, energy communes etc. and gives its recommendations. However, no related decisions have yet been made.

9.7. Conclusions

Finland is working on setting up functional requirements for the next generation of smart meters; the first one was completed in 2013. Finland, as well as Sweden and the other Nordic countries, are working towards implementing a new energy market hub, that will support the development of the electricity market as well as third party development of new services, for example demand response and energy efficiency. The DSO in Finland appears to have already significant capabilities regarding monitoring of the metering values, alarms and power flows.

The national authorities believe that deregulation and the smart metering deployment form the foundation on which new companies and start-ups can grow and develop and help enhance the competition in the retail market and the opportunities for the active participation and empowerment of the final customers.

9.8. References

Id	Reference description
1	Decree of the State Council 66/2009

10. FRANCE

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in France.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

10.1. Legal and Regulatory Framework

In France, the National Regulatory Authority CRE (Commission de regulation de l'énergie) is legally entitled to define deployment targets and conditions for smart electricity meters. This responsibility is shared with the authority for gas smart meters.

10.1.1. Market model

Smart metering provisions will mostly apply to distribution system operators, DSOs, as they are the parties in charge of meter ownership, installation and data collection, including its storage and transmission to third parties.

In France, a common entity has been put in place to centralize the access of third parties to smart metering data, the "Agence ORE",

10.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Law n° 2005-781 of 13th of July 2005 providing energy policy guidelines, which have been incorporated into the Energy Code (art. L.341-4). Numerous implementation laws have consequently been adopted, amongst others:

- Regarding the deployment target and conditions: Decree 31/08/10 - n° 2010-1022
- Regarding smart meter functionalities and specifications: Implementation law 04/01/12
- Regarding smart meter capabilities and functionalities: Regulator decision of 7th July 2011 regarding the feedback from early trials of ERDF for the Linky smart meter

- Regarding DSO incentive regulation: Regulator decision of 17th of July 2014 regarding incentive regulation of ERDF duties in advanced metering systems (for consumers connection below or equal to 36kV)

A similar framework has been adopted for gas.

Recent legislative and regulatory initiatives have been taken to implement smart meter-related provisions of the law 2015-992 on energy transition and sustainable growth (*Transition énergétique et croissance verte*). Those initiatives intend to facilitate access to smart metering data for the following parties: public and local authorities, households that are likely to suffer from fuel poverty, building tenants; end users, and more generally the open data philosophy underlying the law mentioned above.

Finally, an interesting development is the adoption of a community-based incentive scheme for self-consumption (auto-consummation collective) for which smart meter acts as an enabling tool.

10.1.3. Primary drivers

In France, the smart metering system is perceived as an enabler for future innovative developments. Initially, the focus lied in optimizing DSO regulated activities but the setup of open platform for the provision of smart meter data – as triggered by the legal framework described above – will enable all actors and stakeholders to benefit from smart meters in the following ways:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrate decentralized energy resources with power fed into the grid and flexible access (load shedding, infeed curtailment)

10.1.4. Smart metering programme financing

Smart metering costs are borne by DSOs who have the right to integrate those expenses in their tariffs. A significant part of those expenses is considered as controllable expenses and DSOs are therefore expected to optimize them, using an incentivizing regulation.

10.1.5. Recent publications by the NRA

The most recent publications issued by the national regulatory authorities relate to the adoption of the deployment framework for smaller DSOs (others than the dominant ones Enedis and GRDF).

10.2. Cost benefit analysis

10.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2011	Consultant	NRA	Positive NPV	Set the scene for electricity
2013	NRA	NRA	Positive NPV	Refine deployment scenario for electricity
2011	Consultant	NRA	NA	Set the scene for gas
2013	Consultant	NRA	NA	Refine deployment scenario for gas

10.2.2. Market roles and key parameters

The following market roles were taken into account in the assessment: DSO, Consumer, Producer and State/society.

10.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (under Recommendation 2012/148/EU), with the sole exception of in-home display expenses (no mandatory roll out in France).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call center and customer service
☒ OPEX - Consumer engagement programme

Benefits focus on bill reduction due to energy efficiency (based on volume rather than unit price), enhanced operations in distribution grids (including losses reduction, savings in meter readings and optimized maintenance of grid assets) and distribution grid capacity deferral.

10.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for a large-scale smart metering rollout in the case of electricity:

Key outcomes of the assessment	Number
Non actualised number of meters installed for the whole evaluation period [Number of meters]	35 million
actualised CAPEX for 2014-2012 period	€4,5 billion
actualised OPEX for 2014-2012 period	€1 billion
actualised benefits for 2014-2012 period	€7,7 billion

The ratio per meter has not been computed since the number of meters and the total expenses and benefits were not computed on the same evaluation period (2014-2034 for the number of meters, 2014-2021 for the expenses & benefits).

10.2.5. Deployment strategy and latest statistics

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

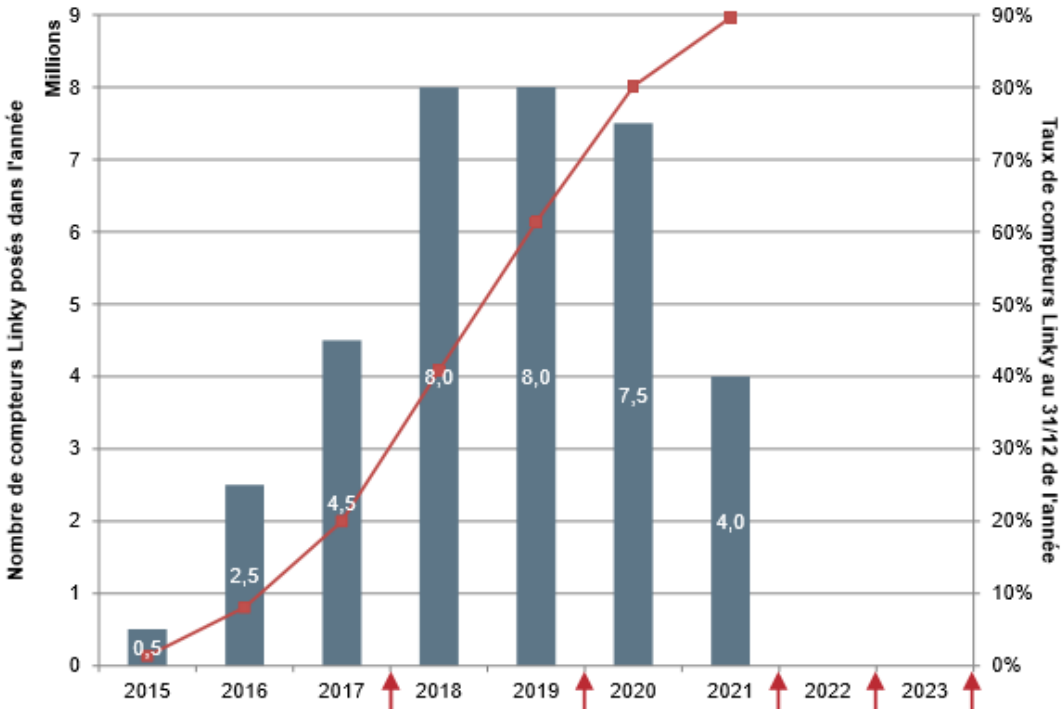
State of play of smart metering deployment in France as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas B2B
Number of smart meters	8045000	1000000	685500	132500
Number of connection points equipped with smart meters	8045000	1000000	683500	132500
Total number of meters (<36kW)	36364294	4379550	10560000	400000
Total number of connection points	36364294	4379550	10560000	400000

Number of smart meters that does not communicate (de-activated upon specific consumer request)	Not applicable	Not applicable	Not available	Not available
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	< 3% after 6 months	< 3% after 6 months	221800	Not available
Number of smart meters that does communicate default metering data	6390000	750000	461700	Not available
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	Not available	Not available	Not available	Not available

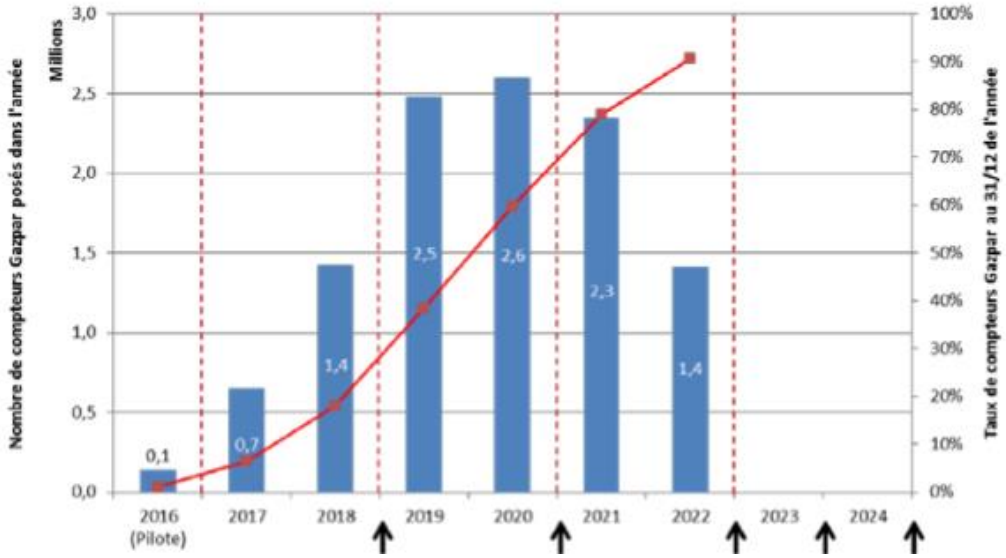
Deployment outcomes in 2017	**Electricity households**	**Electricity SME**	**Gas households**	**Gas SME**
Yearly installation target	8000000	No target	568000	
Number of visits to consumer premises	Not available	Not available	Not available	Not available
Number of installed smart meters	5557000	700000	585500	24400
Number of deactivated smart meters	Not available	Not available	Not available	Not available
Number of refusals	Not available	Not available	Not available	Not available

The French NRA has implemented a dedicated regulatory framework for smart metering deployment for gas and electricity. Given the magnitude of the smart metering investment borne by the DSOs, the CRE has turned the one-time CBA into an institutionalized process that has been translated into the adoption of yearly installation targets and a close monitoring of the associated expenses (see the figures below).

Electricity: 2015 – 2021 [source: CRE 2018]



Gas: 2016-2022 [source: CRE 2018]



A significant constraint when deploying the French smart meter, using power line carrier technology, is to achieve a minimum level of penetration to ensure effective and reliable communications at the local level (per distribution transformer).

10.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (in its Recommendation 2012/148/EU) are implemented, being activated by default (at the only exception of functionality J) and free of charge for the consumer, with the clear intent to maximise smart metering deployment benefits.

The default setting does not preclude consumers to exercise their privacy rights, as their consent is required to disclose detailed (>monthly) metering data.

The key functional features are summarized in the table below.

Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	Not deployed (yet)	Not deployed (yet)
H2 Interface (Smart Devices)	Not applicable	Not applicable
Compulsory DSO website	Daily with 36 months history, monthly with 60 months history	
Compulsory Supplier website	On demand + monthly update	30 min with 2-month history
Compulsory Third Party website	N/A	N/A

The electricity smart meter has also been introduced to provide new services to end consumers. Multiple initiatives have now been introduced in the French electricity market, including:

- Transmission system operator RTE is progressively extending the provision of ancillary services to demand response at lower voltage levels

- Distribution system operator ENEDIS is also offering advanced distribution network services:
    - Local opportunities to valorise storage flexibility
    - Legal framework to support local energy communities (auto-consommation collective)
    - Support for RES hosting capacity (quicker, cheaper connection charges): distributed generation grid connection fee is reduced for consumer due to implementation of smart meter
    - Flexibility services procurement for DSO: an incentive framework for CAPEX reduction is under evaluation

The CRE has also introduced in the distribution tariffs (TURPE) a revised tariff structure that allows consumers to take benefits from demand response during peak times. In comparison with the previous scheme (constant and predefined day/night timeframes), a mobile peak timeframe is proposed.

10.4. Technical specifications

Regarding technical specifications set in the smart metering environment as represented in the functional architecture schematic shown below, the H1 is using TIC wire interface that relies on the international standard CEI 62056-7-2 CEI:2012: One-way communication profile using 56-3-1.

The H3 interface is the PLC link which enables the communication between the DC and the meter on the Low Voltage network. Two PLC technologies have been chosen by ERDF for the national large-scale smart metering rollout:

- At first, for more than 2,5 million meters, the G1 PLC technology will be used. The G1-PLC metering profile relies on different international telecom standards described as below:

  On applicative layer, this is the DLMS/COSEM standard which is used and commonly implemented for few decades by many manufacturers and utilities in their electricity meters[24].

  These G1 meters will be deployed from December 2015 to end of 2016.

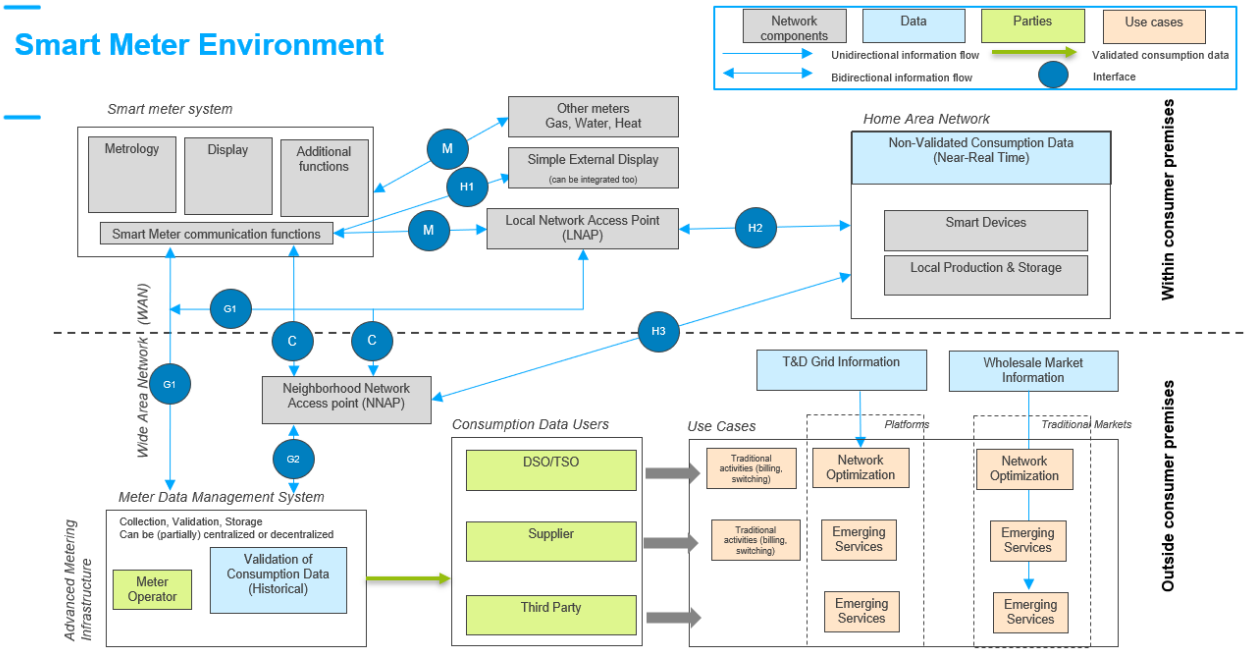
- In a second step, for the main part of the rollout that means more than 32 million meters, the G3-PLC will be used. The G3-PLC specifications have been standardized in ITU[25].

  The G3-PLC meters started to be deployed at the beginning of 2016 for a large-scale field test, and then the wide-scale rollout was accelerated in 2017.

  WPAN is the chosen technology for H1 and H2 interfaces leveraging on its low power and meshed network characteristics, while G1 relies on GSM and Long-Range Radio. GSM was chosen because of the prevalence of the existing infrastructure, the extended network capacity and its more robust economic case. Long range radio was chosen due to geographic and population concentration issues within relevant territory.

[24] NF EN 62056-3-1 May 2014 Electricity metering data exchange – The DLMS/COSEM suite – Part 3-1: DLMS/COSEM Use of local area networks on twisted pair with carrier signaling, NF EN 62056-5-3 May 2014 Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer, NF EN 62056-6-1 December 2013 Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1 DLMS/COSEM Object Identification System (OBIS), NF EN 62056-6-2 December 2013 ELECTRICITY METERING Electricity metering data exchange – The DLMS/COSEM suite – PART 6-2 DLMS/COSEM Interface classes

[25] International Telecommunication Union) as ITU-T G.9903. The standard has been released in April 2014 and is available for free on the ITU website (www.itu.int/rec/T-REC-G.9903



Related standards to consider, whose proper use is a key element to assess information security, are Zigbee smart energy and DLMS/COSEM for H interfaces. That includes the cryptographic standards that UK-GB have outlined in the Great Britain Companion Specification (GBCS).

G interface standards depend on the communication service provider and are not stipulated by the authorities in charge of the smart metering programme.

10.5. Data management

10.5.1. Data access and privacy framework

A dedicated analysis of privacy risks has been performed by the electricity DSO following the eBIOS methodology for the French data protection authority ANSSI. The scope of this analysis was not dedicated to smart meters but included them. The eBIOS methodology was used at the very foundation of the DPIA (Data Protection Impact Assessment) design drawn in line with the Commission Recommendation 2014/724/EU, as a primary source of inspiration.

10.5.2. Provisions to provide and revoke access to data

Unlike the DSO, third parties and suppliers need an explicit consent from the consumers to access their metering data. The following means can be used to provide and revoke access:

- written approval communicated to and validated by the DSO or a central party
- delegated to a third party or a supplier as part of a service contract (no independent party to double check, the DSO will simply execute the request for metering data)
- specific app or website with secured access

10.6. Consumer impact

10.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes

Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

10.6.2. Consumer concerns

There follows a list with the main concerns expressed by the consumers regarding the smart metering rollout and counter measures that have been adopted to address them.

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - proven compliance to existing standards
Cybersecurity		yes - proven compliance to existing standards
Electromagnetic radiation		yes - publication of the test results and methods
Accuracy of meters		No
Price of meters		no

10.6.3. Research on consumer benefits

No research and evaluation have been carried out with a single focus on consumer benefits but, as explained previously, a dedicated regulatory framework has been put in place that tracks the effective realization of those benefits, as part of the tariff-setting scheme.

10.7. Conclusions

- A strongly regulated deployment of smart meters, with yearly installation targets
- Consumers cannot refuse the smart meter installation. Moreover, they do not have access to In-Home Displays, but plans exist for the future for their deployment in electricity (especially for consumer with social tariffs)
- Deployment is still a challenge for the DSOs from a consumer acceptance perspective as well as for technical reasons (critical penetration of PLC meters to enable effective communications)
- The rollout has been accompanied with the introduction of a wide range of services, some of them being at forefront of innovative models to engage with consumers (dynamic peak timeframe, collective self-consumption)
- The progressive use of those services by consumers in combination with the extended coverage of France with smart meters planned in 2021 should allow realize the potential of smart metering, making the deployment cost-effective and opening new opportunities for the market players in the years to come.

10.8. References

Id	Reference description
1	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)
2	Decree 31/08/10 - n° 2010-1022
3	Implementation law 04/01/12
4	Regulator decision of 7th July 2011 regarding the feedback from early trials of ERDF for the Linky smart meter
5	Regulator decision of 17th of July 2014 regarding incentive regulation of ERDF duties in advanced metering systems

11. GERMANY

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Germany.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

11.1. Legal and Regulatory Framework

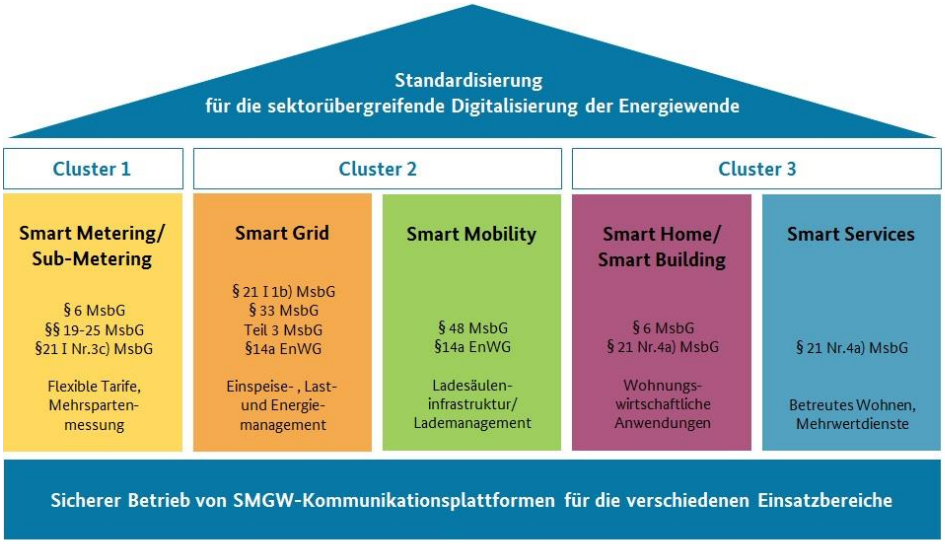
11.1.1. Market model

In Germany, the legal framework, including market roles, the deployment targets and the overall system design are defined by parliament (Deutscher Bundestag and Bundesrat) as the legislator.

Under the legal framework in Germany, deployment and operation of smart metering systems is a legal obligation of the Metering Point Operator ("Messstellenbetreiber", MPO). Notwithstanding the unbundling of MPO and DSO, the default MPO is the DSO, however consumers can also choose a third party for this. Moreover, the MPO in charge can commission a third party contractor with metering point operation in order to raise efficiency. The market roles considered for the MPO are:

- Meter ownership
- Meter Installation
- In home display ownership
- In home display installation
- Metering data processing
- Metering data storage
- Metering data transmission to third parties
- Metering data protection officer

The German legislator notes to have conceived smart metering systems as a digital infrastructure for the energy transition. As such, it is designed as a platform for *all* relevant use cases as shown in the three clusters below. For all these applications, the Smart Meter Gateway is meant to provide a secure, interoperable communications infrastructure:



The key idea is to help maximise the benefits for consumers, grid operators and all other stakeholders alike, taking account of the energy transition as a whole. Accordingly, the platform is not limited to electricity, but can be used as well for gas, water and heat metering and for other appliances within the Smart Grid and Smart Home

The intelligent metering system pursues the idea of an open infrastructure platform, which provides TSO/DSO and the suppliers as well as additionally contracted smart service providers with the data they require.

11.1.2. Legal grounds

The primary law that enables smart metering for electricity and gas as well as heat and water is 'Gesetz zur Digitalisierung der Energiewende' (Act on the Digitalization of Energy Transition, GDEW) which was adopted in September 2016. This law is currently in force. As the core part of GDEW, the detailed provisions on smart metering systems deployment are stipulated by the 'Messstellenbetriebsgesetz' (Metering Point Operation Act, MsbG).

The primary drivers for smart metering deployment in Germany are:

- Digitalization as prerequisite for a successful energy transition.
- Providing a decentralized, secure and interoperable communication infrastructure as a platform for metering of different commodities (electricity, gas, water, heat) and for sector coupling.
- In particular, grid integration of electric mobility requires a smart grid
- Enable dynamic tariffs for households and businesses
- Digitalize distribution grid and optimize network operations (→ Smart Grid)
- Integrate decentralized energy resources with flexible access (demand side management, infeed curtailment)
- Ensuring consumer acceptance
- Data security and data protection "by design", which are ensured by technical guidelines and a protection profile based on the Common Criteria.

11.1.3. Smart metering programme financing

As is already the case with conventional meters, the costs are normally to be borne by the consumer or the operator of the generating plant. The new aspect is the protection the consumers/operators will enjoy. There are individual price caps which must be kept to when the equipment is installed and operated, although additional services for remuneration can be offered. At present, the costs of metering point operation and metering via electronic meters are approx. €20 p.a. for consumers. This is also the upper price limit for "modern metering devices" (Moderne Messeinrichtung, i.e. electronic meters which can be integrated into a smart metering system through a smart meter gateway). For small-scale consumers, the charge for metering point operation is currently approx. €30 p.a.

Funding via the grid charges would make it more difficult to prescribe individual price caps and reduce the resulting cost transparency. Also, funding via the grid charges would only be available for the grid operators and would therefore impede market access for third-party metering point operators.

11.1.4. Recent publications

The most recent publication of the Messstellenbetriebsgesetz is that of 2016, namely the 'Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen (Messstellenbetriebsgesetz - MsbG)[26]'. The 29 January 2019, the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Office for Information Security (BSI) published the standardization roadmap which specifies the work programme to further develop the technical standards needed in the different sectors (see illustration above).[27]

The digitalization progress of the competent authorities as well as relevant businesses is monitored by consultants commissioned by the Federal Ministry for Economic Affairs and Energy (BMWi) in annual status reports. The first report submitted by EY for 2018 was published on 30 January 2019.[28]

On 31 January 2019, BSI published the first market analysis in accordance with the MsbG. The market analysis records the status of implementation of the BSI standards as well as the legal requirements for calibration in the field of smart metering.

Figures on deployment of smart meters are published in the NRA monitoring reports for 2017 and 2018.[29]

[27] Standardisierungsstrategie zur sektorübergreifenden Digitalisierung nach dem Gesetz zur Digitalisierung der Energiewende 2019, https://www.bmwi.de/Redaktion/DE/Downloads/S-T/standardisierungsstrategie.pdf?__blob=publicationFile&v=4.

[28] Barometer Digitalisierung der Energiewende 2018, https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/barometer-digitalisierung-der-energiewende.pdf?__blob=publicationFile&v=20

[29] Bundesnetzagentur, Monitoring Report 2017 & Monitoringbericht 2018

11.2. Cost benefit analysis

11.2.1. Relevant study

There follows the information regarding the cost-benefit analysis conducted for the specific case of smart metering deployment for electricity.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2013 [30]	Consultant	Ministry for Economic Affairs and Energy	negative	Comply with Dir. 2009/72
2014 [31]	Consultant	Ministry for Economic Affairs and Energy		

The latest assessment is a sensitivity analysis in response to political discussion.

11.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were considered in the aforementioned assessment: MPO/DSO, Supplier, Consumer, BRP, and Producer.

Key parameters for the assessment	
evaluation period of the CBA [Years]	2012-2032
billing and metering frequency in the reference case for electricity [times/year]	1
Does this also apply for gas?	Gas is not explicitly considered
What % do electricity losses (technical & non-technical) represent? [% of total supply DE low voltage]	4%
What is the electricity losses unit cost? [€/MWh]	50 €/MWh (peak), 60 €/MWh (off-peak)

[30] Kosten-Nutzen: Analyse für einen flächendeckenden Einstatz intelligenter Zähler, EY, 2013 https://www.ey.com/Publication/vwLUAssets/Kosten-Nutzen-Analyse_Roll-out_Smart_Meter/$FILE/BMWI-Endbericht-KNA-Smart-Metering-2013.pdf, https://www.ey.com/Publication/vwLUAssets/Kosten-Nutzen-Analyse_Roll-out_Smart_Meter/$FILE/BMWI-Endbericht-KNA-Smart-Metering-2013.pdf

[31] Variantenrechnungen von in Diskussion befindlichen Rollout-Strategien – Ergänzungen zur KNA vom Juli 2013, EY, 2014 https://www.bmwi.de/Redaktion/DE/Downloads/Studien/variantenrechnungen-von-in-diskussion-befindlichen-rollout-strategien.pdf?__blob=publicationFile&v=1

What is the economic lifetime of electricity smart meters? [Years]	13
What is the economic lifetime of gas smart meters? [Years]	13
What is the value of the lost load? [€/MWh]	10.000 €/MWh
What is the cost reduction rate due to technological maturity? [%/year]	2% p.a.

11.2.3. Main cost and benefit items

As detailed in the list below, most cost items have been taken into account in the CBA performed, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with two though exemptions.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☒ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☒ OPEX - Consumer engagement programme

Furthermore, half of the benefits have been considered. In the following list, an overview of the benefits, as described by the European Commission in their Recommendation, is given.

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
☐ Provision of explicit flexibility services (rather based on a request than a price signal)
☐ Increased competition in retail market
☐ Easier access to photovoltaic production
☒ Meter reading & operation savings
X Operation & maintenance of assets
☒ Distribution capacity deferral
☒ Transmission capacity deferral
☒ Generation capacity deferral
X Technical losses reduction
☒ Non-technical (administrative, including fraud) losses
☐ Outage management (based on societal value of lost load)
X Outage management (based on reduced customer indemnification)

☒ CO2
☐ Air pollution (particulate matters, NOx, SO_2,...)

11.2.4. CBA results

Unlike other EU member states, in 2011 Germany planned to not oblige the installation of smart meters for electricity. While the metering business, unlike in other countries, is liberalized, the competent authorities continued to analyse approaches and experiences of other EU member states.

In 2011, during the reform of the Energy Industry Act, the focus on data security and privacy increased. As further technological developments were required in order to guarantee data protection and to meet the complex demands of an intelligent energy supply system, it was not yet possible to start the nation-wide rollout of smart meters. Cyber security and data protection requirements have been published in the "BSI Protection Profile[32]" and the Technical Guidelines, in order to counteract the threats a smart grid is exposed to.

Different scenarios and methods for a smart-meter rollout have been examined. Parameters such as the number of meters, the success percentage, CAPEX and OPEX vary in these different scenarios.

In the most optimistic scenario, the legislator aims for installations where smart metering systems could either relieve the energy supply system or significantly reduce energy demand or shift energy demand. This scenario leads to overall economic benefits of up to €1.6 billion until 2032. However, if done under the required timeline and consumer group of as set by the EU (80% by the target date though of 2022), this would lead to a negative net present value.

11.2.5. Deployment strategy and latest statistics

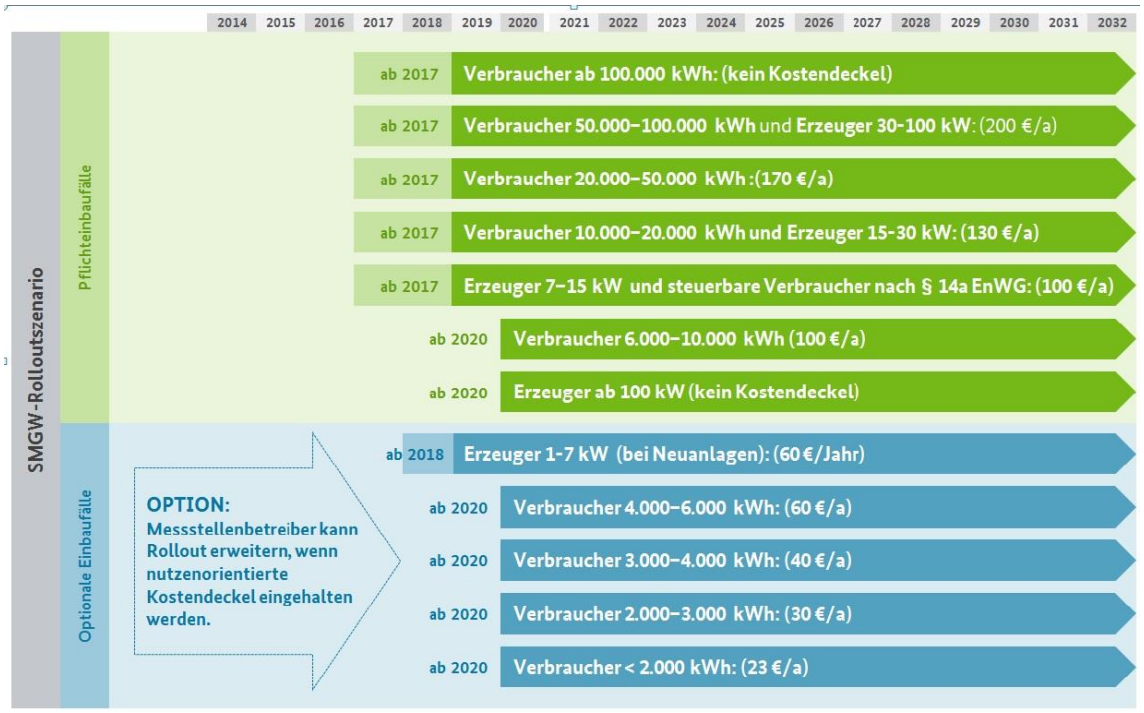
As a consequence of the CBA results, Germany has adopted a differentiated deployment strategy.

Only consumers with annual power consumption over 6000 kWh and producers with power systems >7kW have to be equipped with a smart metering system. Smaller consumers are to be provided with a digital meter which can be "upgraded" to a smart metering system when connected to a Smart Meter Gateway. MPOs are also free to install a smart metering system on a voluntary basis with the consent of the consumer. The deployment of smart metering systems begins as soon as three independent smart meter gateway producers have been certified by BSI, and the meter operator must equip 10 percent of those measuring/connecting points.

Given their critical infrastructure quality, smart meters have to undergo certification by the Federal Office for Information Security (BSI). The first certificate was issued in December 2018. Mandatory deployment will commence with the certification of three smart meters of independent manufacturers. At the moment of data collection for this report, eight manufacturers were in the process of certification and at least two more certifications were to follow in the course of 2019. At the same time, technical standards were being extended so as to realize the full scope of application for the smart meter communication infrastructure.

The following illustration depicts the deployment plan laid down by the GDEW, as well as the individual price caps for each group:

[32] Federal Office for Information Security Germany (Bundesamt für Sicherheit in der informationstechnik, BSI)



Although the mandatory rollout of smart metering systems has not started yet, the first MPOs have commenced voluntary deployment of the first certified devices in late 2018.

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment DE 1/1/2018 and the outcome of the installation programme during the year 2017.

State of play of smart metering deployment in DE as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	0	0	0	0
Number of connection points equipped with smart meters	0	0	0	0
Total number of meters	0	0	0	0
Total number of connection points	47,6 million	3,1 million	12,4 million	2,0 million
Number of smart meters that does not communicate (de-activated upon specific consumer request)	n/A	n/A	n/A	n/A

Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	0	0	0
Number of smart meters that does communicate default metering data	0	0	0	0
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	0	0	0

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	Minimum of 10% within 3 years	Minimum of 10% within 3 years	No target	No target
Number of visits to consumer premises	no data	no data	no data	no data
Number of installed smart meters	0	0	0	0
Number of deactivated smart meters	n/A	n/A	n/A	n/A
Number of refusals	no data	no data	No data	No data

11.3. Functional specifications

German law (MsbG) defines minimum functional specifications leaving freedom for MPOs to offer further functions and services. Almost all 10 key functionalities recommended by the European Commission are covered by these minimum requirements for electricity smart meters, with the only exemption of functionality g, 'allow remote on/off control of the supply and/or flow or power limitation'.

Beyond the Commission's recommendations, Smart Meter Gateways in Germany are not limited to electricity but can also integrate gas, water and heat meters.

In the following table, information is given about the period the data can be stored, the granularity and the frequency that the consumption data is updated.

Level of the…	History	Granularity	Frequency of consumption data update
DSO	As long as they need them	15-Minutes up to yearly, depends on consumption and type / use of data	Daily/monthly/yearly under regulation of the MsbG
Supplier	As long as they need them	15-Minutes up to yearly, depends on consumption and the tariff	Daily/yearly under regulation of the MsbG
Central data hub	-	-	-
Smart meter	At least 2 years	At least 15 minutes for consumption data	At least every 15 minutes, depending on tariff

To allow customers to access their data, the supplier and the metering operator have to offer either an online service with a protected individual account or access through a local interface.

11.4. Technical specifications

The intelligent metering system consists of several parts:

- Smart-Meter-Gateway (SMGW): central data processing and communication hub,
- Administrator: Services for the administration of the SMGW,
- SM-PKI: Secure and authenticated communication via a Public-Key-Infrastructure.

The Cybersecurity is addressed by two Protection Profiles: One for the Secure Module inside the SMGW (BSI-CC-PP-0077) and on for the SMGW itself (BSI-CC-PP-0077). The SMGW and the Secure Module are certified under Common Criteria.

The following technical specifications are published by the BSI:

- The technical specifications and minimum functionalities of the SMGW are described in Technische Richtlinie BSI TR-03109-1[33]. Equally the Technische Richtlinie BSI TR-03109-1 defines the technical requirements for the Secure Module.

[33] Technische Richtlinie BSI TR-03109-1, Anforderungen an die Interoperabilität der Kommunikationseinheit eines intelligenten Messsystems, Bundesambt fur sicherheit in der Informationstechnik, 2013, https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/TechnischeRichtlinien/TR03109/TR03109-1.pdf?__blob=publicationFile&v=1

- Several cryptographic requirements for the intelligent metering systems are defined by the Technische Richtlinie BSI TR-03109-3.
- The requirements on the Smart-Meter Public-Key-Infrastructure are described in the Technische Richtlinie BSI TR-03109-4.
- The requirements on the Administrator of a SMGW are defined in the Technische Richtlinie BSI TR-03109-6.

In the recent market analysis published at the end of January 2019, the BSI stated a sufficient broad range of service providers for the administrative service. Also, the SM-PKI is operating and sub-certificate authorities (Sub-CA) issue certificates for the SM-PKI.

11.5. Data management

11.5.1. Data access and privacy framework

German law requires that smart metering devices ensure privacy and security "by design". In addition, the MsbG contains detailed provisions which specify which data may be used by whom and for which purpose. These provisions were developed in line with Regulation 2016/679 ("GDPR") and in close consultation with the Federal Data Protection Commissioner. It does not restrict end-users' right to consenting that third parties access their information.

The consumer can access his historic consumption values locally at a dedicated interface or via an online portal. Regulatory measures have been implemented to limit data misuse. Only entitled subjects will receive consumption data on a time basis, to which the consumer consents.

11.5.2. Provisions to provide and revoke access to data

Where consent is necessary for the access to customers' information, the general provisions on consent and its revocation apply as provided by the national Data Protection Act (BDSG) and the GDPR.

11.6. Consumer impact

11.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

It is noted that in Germany the first smart metering systems have been deployed voluntarily since the end of 2018. Therefore, services are still emerging in the market at this moment.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No

Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill DE the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** DE home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging DE lowest costs. It also could be used to charge more rapidly DE home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

11.6.2. Consumer concerns

At the moment of data collection for writing this report, no information was available with the NRA regarding consumer concerns for smart meters.

11.6.3. Research on consumer benefits

Germany conducted a cost-benefit analysis in line with Directives 2009/72/EC and 2009/73/EC which extensively considered consumer benefits.

Gaining practical insights, including on consumer benefits and experiences with smart metering, is an integral part of the Smart Energy Showcases programme (SINTEG) initiated by the Federal Government.[34]

Under the Barometer project commissioned by the Federal Ministry for Economic Affairs and Energy (see above), three separate studies on key topics are being prepared. One study entitled "Consumers, Digitisation, Business Models" focuses extensively on the consumer perspective and new services and benefits.

11.6.4. Communication campaign

The smart metering deployment is accompanied by dedicated communication, including on consumer benefits. Moreover, the MPOs communicate the process to their customers.

11.6.5. Advanced consumer services

There are plans for better integration of distributed generation and demand response.

The law defines mandatory standard services which must be offered without extra charge. It allows MPOs to offer customers additional services.

11.7. Conclusions

In Germany, the deployment targets for smart metering are defined by parliament.

The provisions made by the legislator will mostly apply to the Metering Point Operator (MPO) as they are responsible for all market roles. The MPO is usually the DSO, however consumers can also choose a third party for this.

The primary law that enables smart metering for both electricity and gas is 'Gesetz zur Digitailiserung der Energiwende'. This law is currently in force. The delegated law that further implements smart metering deployment for electricity is 'Messstellenbetriebsgesetz'. The purpose of this law is a cost benefit assessment.

Primary drivers for smart meter deployment and opportunities for digitization of the energy grid and dynamic energy tariffs. In addition, renewable energy integration is mentioned as opportunity.

Already in 2011, Germany planned to not oblige the installation of smart meters. The national metering business is liberalized, yet approaches and experiences from other EU member states with different metering landscapes were also analysed. During the reform of the Energy Industry Act, the focus on data security and privacy increased. As further technological developments were required to guarantee data protection and to meet the complex demands of an intelligent energy supply system, it was not yet possible to start the nation-wide rollout of smart meters. In addition, the CBA that was performed in Germany in 2013 resulted in a negative business case, largely because of the EU requirement to install smart meters for 80% of the users within a specified timeline, resulting in a large number of uneconomical meters.

[34] In detail: See https://www.sinteg.de/fileadmin/media/Publikationen/SINTEG_broschuere_2018_EN__bf_web.pdf

Under the current deployment programme, only consumers with annual power consumption over 6000 kWh and producers with power systems >7kW have to be equipped with a smart meter. Smaller consumers are to be provided with a digital meter which can be "upgraded" to a smart metering system when connected to a Smart Meter Gateway. Although the mandatory rollout of smart metering systems has not started yet, the first MPOs have commenced voluntary deployment of the first certified devices in late 2018.

The national authorities state that they have chosen a so-called holistic approach for the digitalization of the energy and gas grid that encompasses metering as well as grid functionality. The threats to smart grid components are considered high and could cause severe damage in case of hacking of the smart grid. Therefore, the chosen smart metering set-up is designed to address these issues with a high quality product assurance (under the Common Criteria methodology) of the Smart-Meter-Gateway, certified Administrators and secure and authenticated communication.

Due to privacy concerns, a decentralized data management of the consumption data is implemented.

Almost all 10 key functionalities recommended by the European Commission for smart metering are being implemented, with the exemption to the functionality that allows remote on/off control of the supply and/or flow or power limitation. Customers can access their historic consumption data via an online service of the MPO. Alternatively, they can also retrieve their data locally at a dedicated interface of the SMGW. The smart metering deployment is being accompanied by dedicated communication, including on consumer benefits. Moreover, the MPOs communicate the process to their customers.

11.8. References

Id	Reference description
1	Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen (Messstellenbetriebsgesetz - MsbG) , 2016
2	Stellungnahme der Bundesnetzagentur zum „Gesetz zur Digitalisierung der Energiewende" (BT-Drs. 18/7555), 2016
3	Kosten-Nutzen: Analyse für einen flächendeckenden Einstatz intelligenter Zähler, EY, 2013
4	Variantenrechnungen von in Diskussion befindlichen Rollout-Strategien – Ergänzungen zur KNA vom Juli 2013, EY, 2014
5	Technische Richtlinie BSI TR-03109-1, Anforderungen an die Interoperabilität der Kommunikationseinheit eines intelligenten Messsystems, Bundesambt fur sicherheit in der Informationstechnik, 2013,
6	Bundesnetzagentur, Monitoring Report 2017
7	Bundesnetzagentur, Monitoringbericht 2018
8	Federal Ministry for Economic Affairs and Energy, SINTEG - Smart energy showcases, 2018

12. GREECE

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Greece.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

12.1. Legal and Regulatory Framework

12.1.1. Market model

In Greece, the deployment targets are defined by the Ministry of Environment & Energy.

Those provisions will mostly apply to the Distribution Grid Operator (DSO) who is in charge of the related market roles, except for the in-home display ownership and installation. The aforementioned market roles that fall within the DSO responsibility include:

- Meter ownership
- Meter Installation
- Metering data collection
- Metering data storage
- Metering data transmission to third parties
- Metering data protection officer
- Buyer compensation for technical & administrative losses (the supplier is also responsible for this role).

Greece has a single DSO, HEDNO, whose responsibilities are covering the entire nation.

12.1.2. Legal grounds

The national primary law that enables smart metering for electricity is 'Law 3855/2010'. This law is still to be revised. The respective legislative provisions enable the replacement of 80% of the conventional meters nation-wide with smart meters, originally until 2020.

There is no specific law regarding the implementation of smart metering for gas.

The primary drivers for smart metering deployment in Greece are:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Address fuel poverty
- Efficient monitoring of the grid

12.1.3. Smart metering programme financing

Until now, no decision is made on the smart metering programme financing.

12.1.4. Recent publications by the NRA

The most recent publication by the NRA is the Law 4342/2015.

12.2. Cost benefit analysis

12.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2010	Consultant (in cooperation with DSOs)	Other	Positive Net Present Value	Comply with Dir. 2009/72
2012	Consultant	Other	Positive Net Present Value	Comply with Dir. 2009/72

There is a difference between the two cost benefit analyses that were done for the case of electricity smart metering. The updated CBA (2012) considers the following:

- Update of discount rate,
- Benefits of reducing CO2 emissions
- Update of capital and operating costs for meters, in-home displays, and communication equipment, as well as labour and variable costs.

12.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were considered in the cost-benefit assessment: DSO, Supplier, NRA, Consumer, State/Society and Producer.

Key parameters for the assessment	
evaluation period of the CBA [Years]	25

billing and metering frequency in the reference case for electricity [times/year]	12
Does this also apply for gas?	N/A
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	3% and 4%, respectively
What is the electricity losses unit cost? [€/MWh]	
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	
What is the cost reduction rate due to technological maturity? [%/year]	8%

12.2.3. Main cost and benefit items

As detailed in the following list, various cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☒ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

As detailed in the following list, not all benefits have been taken into account from those proposed in the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☒ Increased competition in retail market
☒ Easier access to photovoltaic production
☒ Meter reading & operation savings
☒ Operation & maintenance of assets
☐ Distribution capacity deferral
☐ Transmission capacity deferral
☐ Generation capacity deferral
☒ Technical losses reduction
☒ Non-technical (administrative, including fraud) losses
☐ Outage management (based on societal value of lost load)
☐ Outage management (based on reduced customer indemnification)
☒ CO2
☒ Air pollution (particulate matters, NOx, SO_2,...)

12.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for a wide-scale smart metering rollout for electricity:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	7.500.000
actualised CAPEX for the whole evaluation period	€ 890.000.000
actualised OPEX for the whole evaluation period	€ 330.000.000
actualised benefits for the whole evaluation period	Benefits have not yet been evaluated to determine the CBA.

The resulting ratios have been computed in per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- OPEX per meter: 44 €
- CAPEX per meter: 118 €

12.2.5. Deployment strategy and latest statistics

The regulator will be overseeing the rollout (as provided by the legislation) which is to be delivered by the DSO. The target, as original set, is to have 7.500.000 smart meters installed by 2020.

The deployment is mandatory for all consumers.

The following tables highlight the latest statistics per customer segment (households and SMEs considered), giving respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in at as of 1/1/2018	Electricity households	Electricity SME
Number of smart meters	35000	160.000
Number of connection points equipped with smart meters	35000	160.000
Total number of meters	5815000	1670000
Total number of connection points	5815000	1670000
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	0
Number of smart meters that does communicate default metering data	0	70000
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	0

Deployment outcomes in 2017	Electricity households	Electricity SME
Yearly installation target	25000	25000

Number of visits to consumer premises	25000	25000
Number of installed smart meters	25000	25000
Number of deactivated smart meters	0	0
Number of refusals	0	0

12.3. Functional specificiations

Almost all 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are implemented, being activated by default and free of charge for the consumer. The only exemption from this are two functionalities that are not activated by default, namely:

a) Provide readings directly to the customer and any third party designated by the consumer

b) Update the readings referred to in point (a) frequently enough to allow the information to be used to achieve energy savings

Level of the…	History	Granularity	Frequency of consumption update
DSO	5 years	15-min intervals	24 hours
Supplier		15-min intervals	1 month
Central data hub	5 years	15-min intervals	24 hours
Smart meter	60 days	15-min intervals	1 second

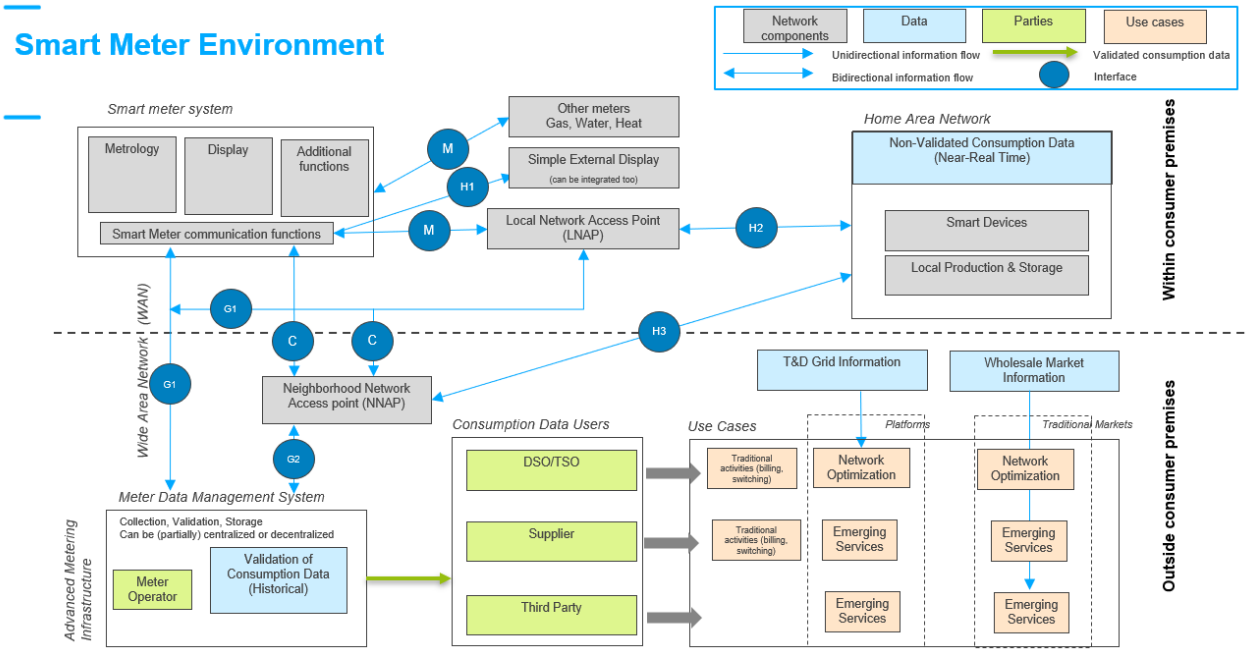
The smart metering data must be made available to the consumer via a web portal of the DSO or via the smart meter itself.

12.4. Technical specifications

The standards that have been adopted to support the chosen communication technology are GSM, GPRS, 3G, 4G, PLC.

The following table gives an overview of the implementation of the different interfaces (as indicated in the functional architecture diagram below) for communication/connectivity in and within the smart metering environment, and with regards to the implementation and the technology used.

Interface	Implementation	Technology
H1	Activated upon customer explicit request	
H2	Activated upon customer explicit request	
H3	No	
C	No	Powerline Cable
G1	Implemented by default	GSM
G2	No	GSM



12.5. Data management

12.5.1. Data access and privacy framework

Third parties and suppliers need an explicit consent from the customer to access his metering data.

A customer can give access to his metering data by delegating this to a third party or a supplier as part of a service contract.

12.5.2. Provisions to provide and revoke access to data

The process to revoke access to metering data is similar to the process to give assess to the metering data, namely by delegating it to a third party or a supplier as part of a service contract.

12.6. Consumer impact

12.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes

Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

12.6.2. Consumer concerns

The table below presents the main consumer concerns regarding smart meters and the measures adopted in order to address them.

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy		
Cybersecurity		
Electromagnetic radiation	General public resistance to smart metering but lack of objective grounds	yes - proven compliance to existing standards
Accuracy of meters		
Price of meters		
Installation barriers		

12.6.3. Research on consumer benefits

Greece did not conduct research about customers and their ability to realize the smart metering benefits.

12.6.4. Communication campaign

HEDNO has provided information on their website and has sent letters to consumers, attached to the electricity invoice, about the replacement of their meter with electronic hourly meter.

12.6.5. Advanced consumer services

Greece has made some plans that leverage smart metering to integrate distributed energy resources:

- Development of "Smart Islands", Pilot project and promotion for its extension
- Telemetering of LV customers, Pilot project and promotion for its extension
- Kick starting the E-mobility market

12.7. Conclusions

Greece has a single DSO, HEDNO, that covers the entire territory. The metering-related DSO responsibilities cover meter ownership and installation and data collection, storage, protection and transmission to third parties. The DSO and the suppliers are responsible for buyer compensation and for technical and administrative losses.

The primary law that enables smart metering for electricity is 'Law 3855/2010'. This law is still to be revised. The respective legislative provisions enable the replacement nation-wide of 80% of the conventional meters with smart meters until, as originally set, 2020. There is no specific legislation for gas smart metering.

The main drivers for the deployment in Greece are the opportunities that smart metering supports, namely: the digitization of the energy grids and markets, the introduction of dynamic tariffs, addressing fuel poverty, more efficient grid monitoring and cost-effective integration of ever-increasing decentralised energy resources.

Most cost elements that were provided in the guidance by the European Commission (Recommendation 2012/148/EU) have been taken into account in the CBA conducted. Despite the fact that almost half of the benefits from this guidance were considered, the two CBAs that were developed both yielded positive results for a large-scale rollout in the case of electricity. No decision has been made yet on the smart metering programme financing.

The installation of smart meters for electricity is mandatory for all consumers. For both households and SMEs, the target is to have 7.500.000 smart meters installed by 2020. Currently about 2.5% of all meters are smart meters.

Almost all 10 key functionalities recommended by the European Commission are implemented, being activated by default and free of charge for the consumer. The only exemptions being two functionalities that are not activated by default, namely:

> a) Provide readings directly to the customer and any third party designated by the consumer
>
> b) Update the readings referred to in point (a) frequently enough to allow the information to be used to achieve energy savings

The smart metering data must be made available to the consumer via a web portal of the DSO or via the smart meter itself. Third parties and suppliers need an explicit consent from the customer to access his metering data. A customer can give access to his metering data by delegating it to a third party or a supplier as part of a service contract.

Smart meter services that are currently available in the market are limited to monitoring historic consumption data and integration of prosumers.

Greece did not conduct research about customers and their ability to realize the smart metering benefits. A dedicated consumer engagement programme was also not considered in the national CBA. Public concerns that have been identified are related to electromagnetic radiation from smart meters.

12.8. References

Id	Reference description

1	Law 3855/2010'
2	LAW4342/2015

13. HUNGARY

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Hungary.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

13.1. Legal and Regulatory Framework

13.1.1. Market model

The Ministry for Innovation and Technology is the competent governmental body responsible for all policies relating to the electricity sector. The Hungarian Energy and Public Utility Regulatory Authority (HEPURA) is an independent authority charged with the supervision of sectors deemed to be of strategic importance, including the electricity and natural gas sectors. HEPURA's responsibilities include licensing, supervision, price regulation and network tariffing[2].

MAVIR Zrt. is the state-owned electricity Transmission System Operator (TSO) that manages the transmission network. Six electricity Distribution System Operators (DSOs), owned by three investor groups, have a licence for distribution activities from the regulator HEPURA and are hence responsible for the regional distribution networks[2].

FGSZ, owned by MOL (Hungarian Oil and Gas Plc), is the holder of a natural gas Transmission System Operator licence, so that it is responsible for the operation of the natural gas system and the transmission network[2]. There are ten gas Distribution System Operator (DSO) companies operating in the country, five of which are major regional companies with more than 100.000 consumers each[2].

Concerning smart meters, the Hungarian Parliament is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

According to the Electricity Act LXXXVI of 2007, the DSO is the owner of meters and responsible for their installation. It is the party in charge of the metering data collection, storage and transmission to third parties as well. These last three roles are actually under an evaluation process in order to study the possibility of their convergence towards a common platform, based on the ongoing KOM Pilot Project. Furthermore, the DSO is responsible for the data protection, in compliance with the General Data Protection Regulation (GDPR) and has the duty to compensate the buyer in case of technical and administrative losses (justified DSO tariff item, approved by NRA). Currently, there are no in-home displays installed.

13.1.2. Legal grounds

The primary laws that enable smart metering for electricity and gas are respectively the Electricity Act LXXXVI of 2007 and the Natural Gas Act XL of 2008. Both laws have to be reviewed based on the results from a Pilot Project (KOM Project). Independently from this Pilot, remote reading has been made mandatory for those electricity metering points where connection capacity equals or exceeds 3×80A and those natural gas metering points where connection capacity exceeds 10 m^3/h.

The Government Decree No. 26/2016 is currently the delegated law that creates suitable regulatory environment for a key smart metering pilot project. The main purpose is to have the authorization for the delivery of the national Intelligent Smart Grid Pilot Project (KOM project), in cooperation with the DSOs.

13.1.3. Primary drivers

Digitalizing the distribution grid, optimizing the network operations and integrating decentralized energy resources with flexible access (load shedding, infeed curtailment) are the main drivers for smart metering deployment in Hungary.

Based on the above-mentioned drivers, the Hungarian smart metering deployment aims at enhancing the distribution system with digitalization, which will allow manage efficiently and in a flexible way the energy fluxes in the network.

13.1.4. Smart metering programme financing

As described later, there is no decision on the national smart metering rollout programme yet, thus the financing structure is also pending. Regarding the currently deployed smart meters (electricity metering points equal or above 3×80A and natural gas metering points above 10 m^3/h capacity), the costs are borne by the DSOs.

13.1.5. Recent publications by the NRA

The 4th National Energy Efficiency Action Plan (NEEAP)[1] that was prepared in compliance the Directive 2012/27/EU has been recently published but has no information about deployment of smart meters.

The Hungarian NRA does not appear to have issued any related publications on smart metering. General publications are available here[2].

13.2. Cost benefit analysis

13.2.1. Relevant study

Since 2010, three Cost-Benefit Analyses (CBA) have been implemented in Hungary, the most recent one (2018) is currently in progress.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2010	Consulting Company	NRA	Inconclusive	Set the scene
2012	Consulting Company	NRA	Inconclusive	Comply with Dir. 2009/72
2018	Consulting Company	KOM Ltd./NRA	Under review	Define ideal target and planning

The 2012 CBA was based on estimations and benchmark studies, and not on real-life experiences that reflect the Hungarian business environment. Although the result was Positive NPV, it was considered not robust and reliable enough to provide solid background for a go/no go decision.

13.2.2. Market roles and key parameters

In the Hungarian economic assessment, the following market roles supporting direct cost and benefits have been taken into account: DSO, Supplier, Consumer, Independent aggregator and Telecom service provider.

Investment (CAPEX) has been accounted as zero, given that the telecommunication services are considered to arise as external costs (OPEX). This is equivalent to the annual fee to be paid for the telco service providers and considered as one of the most relevant direct costs.

Producers and State/society have been considered in the assessment, but no cost/benefit was monetarily attributed to them.

The TSO has been identified as a possible beneficiary of ancillary services provided by demand-side response (DSR) solutions.

Key parameters for the assessment	
Evaluation period of the CBA [Years]	10 years
Billing and metering frequency in the reference case for electricity [times/year]	Billing: 12 Metering: 35,040
Does this also apply for gas?	No, in case of gas 365 meter reading is assumed
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	ca. 7%

What is the electricity losses unit cost? [€/MWh]	around 50 €/MWh (without network fee)
What is the economic lifetime of electricity smart meters? [Years]	10 years
What is the economic lifetime of gas smart meters? [Years]	10 years
What is the value of the lost load? [€/MWh]	N/A
What is the discount rate taken into account? [%]	5.67%
What is the inflation rate taken into account? [%]	3% (as forecasted by MNB – Central Bank of Hungary)
What is the cost reduction rate due to technological maturity? [%/year]	5% after the 5th year (an indicative proposal was used for meter CAPEX which proposed fixed price for 5 years)
What is the installation success rate (installation/visits)? [%]	It was not considered. Installation process of the DSOs were used, which includes more visits if needed (e.g. in case of unsuccessful installation)
What is the refusal rate (refusals/visits)? [%]	0 (according to the pilot project, there is no customer resistance)
What is the deactivation rate (deactivations/installations)? [%]	0 (according to the pilot project, there is no customer resistance)
What is the carbon price taken into account? [€/t + reference year]	N/A (the carbon price is considered as part of the electricity price)

13.2.3. Main cost and benefit items

As detailed in the following list, the majority of cost items suggested by the European Commission (Recommendation 2012/148/EU) have been taken into account:

☒ CAPEX - Investment in smart meter

☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom

☐ CAPEX - Investment in In-home display

☒ CAPEX - Sunk cost of conventional meters

☒ OPEX - IT maintenance

☒ OPEX - Network management and front end

☒ OPEX - Telecom

☐ OPEX - Change management

☐ OPEX - Unplanned renewal and failures of smart meter

☒ OPEX - Revenue reduction

☒ OPEX - Meter reading

☒ OPEX - Call center and customer service

☒ OPEX - Consumer engagement programme

In particular, the investment in telecommunications has been evaluated zero, as already mentioned, given that it is accounted as an external cost (annual telco fees cover both CAPEX and OPEX). Costs related to network management and front end have been considered as part of IT maintenance.

Sunk costs of conventional meters have been considered only in specific cases, as they do not emerge in each scenario. For example, in a rollout scenario, where smart meters may be installed at the end of the lifetime of the conventional meters, no sunk costs have been considered.

Cost items that have not been taken into account in the analysis are investments in in-home displays (since they are not going to be installed) and costs associated to change management, unplanned renewal and failures of smart meters, as they are not considered as material costs.

The main benefit items considered in the analysis have been the following:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☒ Provision of explicit flexibility services (rather based on a request than a price signal)

☐ Increased competition in retail market

☒ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☐ Distribution capacity deferral

☐ Transmission capacity deferral

☐ Generation capacity deferral

☐ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☒ Outage management (based on societal value of lost load)

☒ Outage management (based on reduced customer indemnification)

☒ CO2

☒ Air pollution (particulate matters, NOx, SO2, etc...)

☒ Other: demand response solutions can be used to provide ancillary services

Concerning the bill reduction benefit due to dynamic pricing, two prices (peak and off-peak) have been assumed as time-of-use tariff, thus leading to some peak load transfer.

The benefit related to easier access to photovoltaic production has been indirectly considered. The benefits associated to O&M of assets and outage management based on both societal value of lost load and reduced customer identification, have been considered as zero.

Since the air pollution benefit is not a material benefit, it has been put equal to zero in the analysis, while the CO_2 related benefit has been considered as part of electricity market price.

The generation, transmission and distribution benefits, along with technical losses reduction benefits have been taken into account only indirectly in the CBA. For example, in the case of energy savings, the full fee was considered, including the network fee, thus monetizing the long-term effects of the capacity deferral savings as well.

13.2.4. CBA results

The cost benefit assessment is under review at the moment of writing this report, so that, at this time, no results can be provided.

13.2.5. Deployment strategy and latest statistics

For the time being, there has been no wide-scale smart metering deployment in Hungary and there is no dedicated legislation in force setting up the requirements for a smart metering rollout, nor a defined target for 2020 or later. The deployment of smart meters is not mandatory for consumers and no technical constraints shaping the deployment policy have been identified so far. Nevertheless, DSOs are obliged to equip large customers with Automatic Reading Meters (AMR). In particular, customers equipped with AMR meters are those with a connection capacity of above 3x80A for electricity and of above 20 m^3/h for natural gas (this threshold has been reduced to 10 m^3/h from the 1st October 2018).

There have been several Pilot Projects analysing the benefits of smart metering in Hungary. The HEPURA oversaw a Smart Metering Working Committee in 2013, which involved all stakeholders. The DSOs in turn implemented smart metering pilot projects in 2013 and 2014, which were completed by the end of 2014. The focus of the smart grid pilot projects was to establish functions for the electricity and gas networks by creating and testing measurement solutions, data collection and other smart grid applications. As a result, some DSOs started implementing smart meters in some special cases (e.g. household-scale PVs and prepaid customers)[2].

Currently, there is an ongoing smart grid Pilot Project managed by KOM Central Smart Metering Ltd. (affiliate of MAVIR Zrt), which will be considered during the decision phase for the national rollout. KOM Ltd. (affiliate of MAVIR Zrt) started such a multi-utility pilot project (electricity, natural gas, water and district heating), involving altogether about 20,000 endpoints, on the 4th March 2016 and has been mandated by the Government Decree N°26/2016 to finalize the Pilot Project until the 4th March 2018[2].

The Final Report of the KOM Pilot Project (incl. CBA and suggestion on the national smart metering rollout) was submitted in September 2018. Evaluation and verification of the Final report and the CBA was under progress at the moment of collecting data for this report. The negotiation process on the future of smart metering in Hungary is expected to speed up by Q1-Q2, 2019[2].

The current (as of 1/1/2018) state of play of smart electricity and gas meter deployment is resumed in the following table, where the indicated values for electricity households and SMEs are comprised of specific use cases of the earlier Pilot Projects (2013-2014) and the Pilot Project delivered by KOM Ltd.

State of play of smart metering deployment in Hungary as of 1/1/2019	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	70,000	25,000	5,700	5,900
Number of connection points equipped with smart meters	70,000	25,000	5,700	5,000
Total number of meters	6,500,000	1,000,000	3,500,000	3,500,000
Total number of connection points	5,200,000	900,000	3,500,000	3,500,000
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	close to 0	close to 0	close to 0	close to 0
Number of smart meters that does communicate default metering data	n/a	n/a	n/a	n/a
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	n/a	n/a	n/a	n/a

The difference between the total number of electricity meters and connection points both in households and SMEs is equal to the number of night "B" tariff meters.

In Hungary there are around 1.5 million customers using electricity for space heating and/or water heating (mainly households and a few SMEs). Similarly, to several countries, those customers are equipped with two meters: one for regular consumption and one for special purposes (heating and water heating). As the special purpose meters are remote controlled via AFRC (audio frequency ripple control) or RRC devices (Radio Ripple Control) devices, heating and water heating consumption is active mainly in the night hours when the electricity is much cheaper. Therefore, there is a separate tariff for this purpose (so-called B tariff) and this consumption is metered separately.

Concerning the gas sector, all remotely read (AMR) meters have been accounted as smart meters in the data presented above.

Therefore, electricity and gas smart metering have respectively a 1%, and less than 1%, percentage points of penetration in the country; these numbers refer to smart meters that are still in a pilot phase.

The following results in terms of smart meters' annual deployment were achieved in 2017:

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME

Yearly installation target	No rollout decision	No rollout decision	4,560	2,226
Number of visits to consumer premises	No rollout decision	No rollout decision	4,560	2,226
Number of installed smart meters	No rollout decision	No rollout decision	4,326	2,166
Number of deactivated smart meters	No rollout decision	No rollout decision	0	3
Number of refusals	No rollout decision	No rollout decision	234	57

13.3. Functional specificiations

The 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) have not been defined yet. In any case, the Hungarian NRA has provided some information and data based on the pilot projects and the smart meters currently installed for the specific use cases.

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated has also been provided:

	History (Historical data)	**Granularity* (Historical data)**	**Frequency* (Readings)**
DSO	Usually 5 years or more	1 year	Usually yearly (monthly for large customers)
Supplier	Usually 5 years or more	1 year	Usually yearly (monthly for large customers)
Central Data Hub	N/A	N/A	N/A
Smart Meter	Depends on the DSO: they usually store it since the implementation of the smart metering systems, then they will delete it once they run out of the data storage (ca. 6 years)	15 min (refers to smart and Automatic Meter Reading (AMR) meters; higher resolution (5 to 1 min) in large customers)	Monthly or daily (it is also possible to do it in every 15 mins)

*Refers to conventional meters, which are read manually, usually once a year and in some cases every month.

Customers can access their consumption data only on the DSO web portal, while Third Parties are not allowed to access consumption data in any way, even for emerging services.

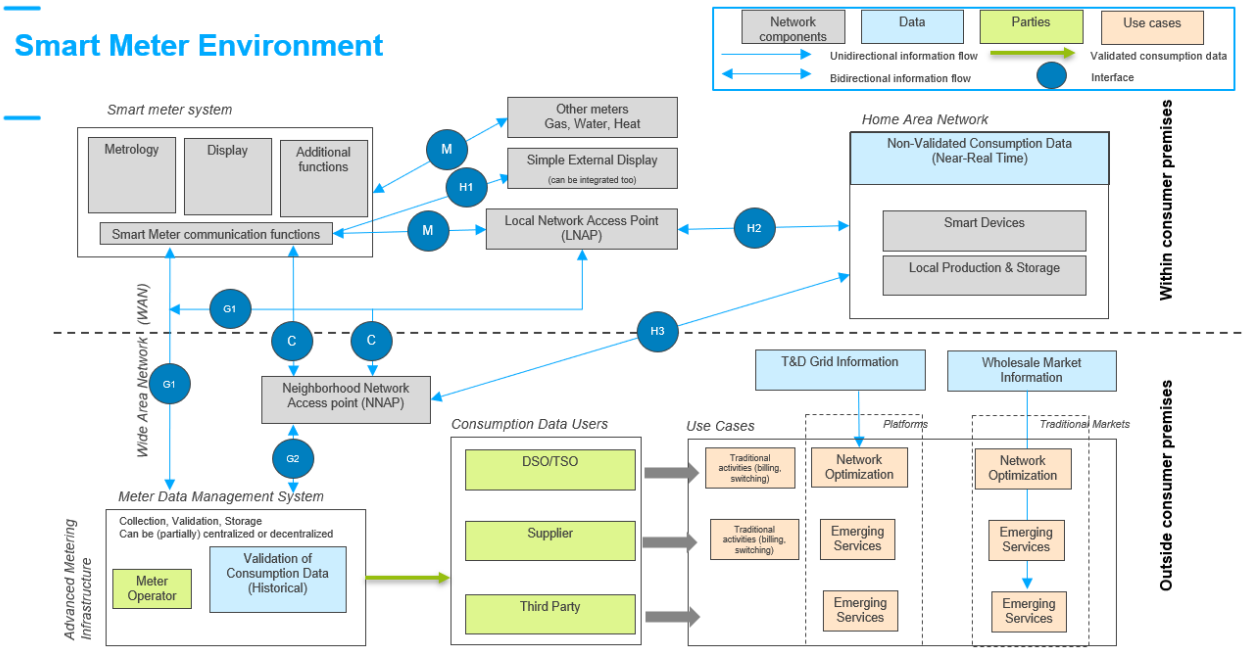
In Hungary both push (automatic) and pull (on demand) remote reading has been implemented.

Advanced tariff systems are currently technically available for both conventional and smart meters, in the form of pre-payment schemes or a simplified time-of-use tariffs. In particular, concerning the latter, although no linkage with wholesale market data has been found, A1/A2 tariffs (peak and off-peak) are already in use, not just for smart meters. It should be noted that this tariff is not popular and it is not an extensively used solution.

Smart meters are able to measure the net injected energy into the grid and they measure both the net injected energy and grid injection separately from withdrawals, with the sole exception of household-scale production (mostly PVs), which only measures net grid injection and not withdrawals.

Finally, although compulsory websites available to customers for accessing their data have been implemented in the relevant pilot projects, the legislator so far has taken no rollout decision on other initiatives aiming at providing customers with access to their data.

13.4. Technical specifications



In Hungary, only C, G1 and G2 interfaces have been implemented on smart meters. These interfaces are indicated in the schematic diagram shown above that represents the functional architecture used in and within a smart metering environment.

In case of electricity, Power Line Carrier (PLC) is the chosen technology for C interface, while both G1 and G2 interfaces rely on Global System Mobile (GSM) communication technology. In case of natural gas, usually wireless technologies are used for C interface.

13.5. Data management

13.5.1. Data access and privacy framework

Suppliers do not need explicit consent to access customers' metering data, while Third Parties do. Nevertheless, usually Third Parties do not have access to Customers' metering data. It is noted that, apart from the Pilot Projects, these metering data are produced by conventional meters and not by smart meters.

13.5.2. Provisions to provide and revoke access to data

At present, only DSOs and Suppliers have access to the metering data. It is based on the customer's contract with the DSO and the Supplier.

When changing suppliers, customers consent for access to their metering data by the former supplier, is automatically revoked.

13.6. Consumer impact

13.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Hungarian market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?	Additional Comments
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No	
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes	The service is available in the case of conventional meters as well
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes	Service available only for the participants of Pilot Projects
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	Yes	Service available only for the participants of Pilot Projects
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	N/A	No information
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No	

Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes	Service available only for the participants of Pilot Projects
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No	Only two tariffs used as of now: A1 and A2
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No	
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No	The service is currently available as well, but it is not advanced
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No	
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No	
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No	

13.6.2. Consumer concerns

At the current stage, there has been no significant consumer or civil society resistance experienced during the Pilot Projects.

13.6.3. Research on consumer benefits

Research on consumers' ability to realize the smart metering benefits has been conducted in the Pilot Projects, but no details about it have been provided.

13.6.4. Communication campaign

A dedicated communication campaign was launched for the earlier Pilot Projects delivered by the DSOs. Direct marketing tools were used, e.g. leaflet delivered by postal services, Facebook campaign and pre-made contracts. Online tools, such as tariff calculation, were also made available.

13.6.5. Advanced consumer services

Hungary is seriously considering the option of defining new initiatives and plans that could leverage smart metering to integrate distributed energy resources (distributed generation, storage, e-mobility, demand response, etc…) as part of the ongoing CBA.

13.7. Conclusions

For the time being, there has been no wide-scale smart metering deployment in Hungary and there is no specific legislation in force mandating a smart metering rollout. Since 2013, there have been several Pilot Projects analysing the benefits of smart metering for the electricity and gas networks in Hungary. As a result, some DSOs started implementing smart meters, but only in some very specific cases.

Currently, there is an ongoing smart grid Pilot Project managed by KOM Ltd., which is expected to serve as a basis for the decision of the national smart metering rollout (evaluation under progress). Therefore, the negotiation process on the future of smart metering in Hungary is expected to speed up by Q1-Q2, 2019.

The Hungarian smart meters deployment strategy is under progress and the 2020 target must still be defined. Currently (as of 1/1/2018), smart metering has a very low degree of penetration in the country, with less than 1% of traditional meters replaced with smart meters, where this value refers to smart electricity meters that are still in a pilot phase and to AMR gas meters (taken as smart meters).

Since 2010, Hungary performed three Cost-Benefit Analyses (CBAs) on smart metering deployment. The first two CBAs (2010 and 2012) gave positive results, while the latest (2018) is currently in progress. KOM Ltd. is conducting this last economic assessment to define the ideal target and potentially help plan the deployment of smart metering systems. The final outcomes are not yet known (at least at the moment of collecting information for this report) but are expected to boost smart metering development in the country in the next years.

Almost all cost and benefit items suggested by the European Commission (Recommendation 2012/148/EU) have been taken into account in the Hungarian CBA. Concerning costs, investment in telecommunications (CAPEX) has been considered as an external cost and thus evaluated as zero; while costs related to network management and front end have been considered as part of IT maintenance (OPEX). Cost associated to change management and unplanned renewal and failure of smart meters (OPEX) are considered as material costs and thus have not been taken into account in the assessment. With regard to benefits, they have been all taken into account, with the sole exception of generation, transmission and distribution benefits, along with technical losses reduction benefits, which have been considered only indirectly in the CBA.

Privacy and data protection matters related to smart meters are at a very early stage of reflection in Hungary. There is no clearly defined data management strategy yet, nor risk assessment. A Data Protection Impact Assessment has not been performed and a Data Protection Officer is still to be appointed.

In Hungary, the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) have not been considered yet in the field, since there has been no rollout decision made and no technical/functional specifications set. At present, there are information and data coming only from pilot projects and the smart meters that are currently installed to serve specific use cases.

Besides the functionalities, smart meters of Pilot Projects can enable different services in the Hungarian market, such as:

- **Bill forecasting**: using historical smart meter consumption data and on-going consumption level to forecast the bill at the end of the month (service available for conventional meters as well)
- **Real-time consumption and carbon impact**: real-time data on consumption (€) and carbon impact (tCO_2 eq.) are made accessible to customers
- **Historical consumption**: provide access to historical data for consumption in order to compare weekly or monthly consumption over time
- **Pre-payment** (not advanced): pay-as-you-go tariff used in combination with an interface device displaying to consumers their credit balance that is still available, their outstanding debts and status of emergency credit

Moreover, the national authorities have noted that Hungary did an intensive and wide-scale communication campaign for the earlier Pilot Projects delivered by the DSO, aimed at facilitating consumers' engagement and promoting behavioural change.

13.8. References

Id	Reference description
1	4th National Energy Efficiency Action Plan - https://ec.europa.eu/energy/sites/ener/files/documents/hu_neeap_2017_en.pdf
2	Hungarian Energy and Public Utility Regulatory Authority – publications http://www.mekh.hu/publications
3	Energy Policies of IEA Countries – Hungary 2017 Review - https://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesHungary2017Review.pdf

14. IRELAND

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Ireland.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

14.1. Legal and Regulatory Framework

14.1.1. Market model

In Ireland, the Commission for Regulation of Utilities, Water and Energy (CRU) is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Regarding the market roles, there is a shared responsibility between the energy network operator and the energy suppliers. The DSO is responsible for the deployment and installation of smart meters and the energy supplier is responsible for the services made available with smart meters. More specifically the energy network operator is responsible for the meter and in-home display ownership and installation, metering data collection and storage, data transmission to third parties and metering data protection. Energy suppliers are responsible for the services provided by the in-home display, data collection, storage, data transmission and protection.

In Ireland, there is a convergence towards a single entity for almost all market roles except for the buyer's compensation for technical and administrative losses. It will be the DSO the entity in charge of leading and overseeing the different roles mentioned above.

Regarding data privacy, all entities will have to comply with the General Data Protection Regulation (GDPR).

14.1.2. Legal grounds

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 Energy Package.

The Statutory Instrument 426 grants CRU the responsibility for ensuring the provision of smart metering systems in the electricity and natural gas retail market. CRU may take all reasonable steps to discharge its functions in accordance with the Directive, the Electricity Market Directive and the Natural Gas Market Directive. This law covers the functional scope and cost benefit assessment of electricity and gas smart metering in Ireland.

14.1.3. Primary drivers

The main drivers for smart metering deployment in Ireland have been defined as:

- Digitalizing retail markets with the aim to foster innovation and create the enabling framework to deliver new services
- Digitalizing the distribution grid and optimizing network operations and enabling dynamic tariffs for households and small medium sized enterprises

14.1.4. Smart metering programme financing

Smart metering costs are to be borne by the DSO, who will charge consumers an additional yearly tariff of around 6 EUR during the lifetime of the device.

14.1.5. Recent publications by the NRA

The most recent publication issued by CRU, at the moment of writing this report, dates from September 2017 and relates to the smart metering upgrade delivery plan[35]: a three-phased approach starting in 2019 and ending in 2024.

14.2. Cost benefit analysis

14.2.1. Relevant study

In Ireland, several CBAs were conducted, at first to integrate the experience from pilot projects and later to determine the final scope, scale and timing of the rollout plan and to ensure the benefits are transferred to the consumer.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2011	NRA		Positive Net Present Value	Integrate return of experience from pilots
2014	NRA		Negative Net Present Value	Define ideal target and planning
2017	NRA		Positive Net Present Value	Define ideal target and planning

[35] Smart metering upgrade update report from the CRU in 2017: https://www.cru.ie/wp-content/uploads/2016/11/CER17279-NSMP-Info-Note.pdf

14.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the assessment: DSO, Supplier, Consumer and State/society.

Key parameters for the assessment	
evaluation period of the CBA [Years]	20
billing and metering frequency in the reference case for electricity [times/year]	4
Does this also apply for gas?	yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A
What is the electricity losses unit cost? [€/MWh]	N/A
What is the economic lifetime of electricity smart meters? [Years]	20
What is the economic lifetime of gas smart meters? [Years]	20
What is the value of the lost load? [€/MWh]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A

14.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with the only exception of the consumer engagement programme expenses. In particular, the investment in smart meters and IT, and IT maintenance turned out to be the most significant costs.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☒ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

Regarding the benefit items, almost all benefits have been taken into account in the analysis except for the impact on air pollution. More specifically, the following benefits were defined as significant:

- Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
- Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
- Meter reading & operation savings
- Generation capacity deferral
- Non-technical losses (administrative, including fraud)

14.2.4. CBA results

The main outcome of the last CBA[36] is that the NPV for electricity smart metering in aggregate is negative €36 million. Nonetheless, given that a number of unquantifiable benefits remined unconsidered in the calculation and that smart meters are considered to play a key role in the attainment of national energy policy objectives, the result is interpreted as broadly neutral.

14.2.5. Deployment strategy and latest statistics

The CRU will oversee the implementation phase and have a coordinating role, while the electricity and gas DSOs, ESB Networks (ESBN) first and later GNI, will lead the actual rollout. Governance arrangements and work plans are, at the moment of writing this report, being recalibrated to reflect the phased delivery and the move to the implementation stage of the project. The CRU has stated that they look forward to working closely with all stakeholders during the duration of this national rollout.

Deployment will be carried out in three phases. Phase One (2019-2020) is based on voluntary take-up of smart meters and also on asset replacement requirement. Phase Two (2021-2022) and Phase Three (2023-2024) will be based on a national rollout. There are no exceptions to the mandatory installation. The plan is to replace all meter stock with smart electricity and gas meters.

The rollout of electricity smart meters will commence in 2019 with a target of 250,000 smart meters installed by the end of 2020. Electricity meters and its smart services will, however, not be activated until Q4 2020. With regards to gas smart meters, the gas DSO, GNI, has been replacing old gas meters with new smart ready meters in homes. However, these meters are currently operated in non-smart mode and still have to be paired with the electricity meter.

Phase Two will see an additional 1 million electricity meters rolled out with an additional functionality layered in: smart prepayment, by Q4 2022.

Finally, Phase Three will commence in 2023 with the deployment of 1 million additional meters. A Home Area Network (HAN) will also be made available by ESBN in Q4 2024 allowing consumers to access real-time data on their household energy usage via a device in their home. The activation of the in-home channel by ESBN will make it possible to pair gas smart meters to electricity smart meters.

Furthermore, there seem to be no major technical constraints shaping the deployment policy. These are limited to the central IT and back-office systems that cater for smart metering.

[36] Smart Metering Cost Benefit Analysis from CRU in 2017: https://www.cru.ie/wp-content/uploads/2017/11/CRU17324-Smart-Meter-Upgrade-Cost-Benefit-Analysis-Information-Paper.pdf

The following tables highlight the latest statistics, an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017, respectively.

State of play of smart metering deployment in Ireland as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	0	0	Approximately 350 000	0
Number of connection points equipped with smart meters	0	0	350 000	0
Total number of meters	0	0	Approximately 350 000	0
Total number of connection points	0	0	n/a	0
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	0	0	Approximately 350 000	0
Number of smart meters that does communicate default metering data	0	0	0	0
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	0	0	0

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	0	0	0	0
Number of visits to consumer premises	0	0	0	0
Number of installed smart meters	0	0	0	0
Number of deactivated smart meters	0	0	0	0

Number of refusals	0	0	0	0

14.3. Functional specifications

All 10 key functionalities recommended by the European Commission (in Recommendation 2012/148/EU) are foreseen and are free of charge for the consumer. However, not all of them are activated by default. Allowing remote on/off control of the supply and/or flow or power limitation and providing import/export and reactive metering, are not activated by default.

To ensure that consumers have access to their detailed energy consumption information, the DSO and the energy supplier are required to provide, on request, up to 2 years of consumption data with a granularity of 30 minutes. The smart meter should be able to store up to 3 months data with a granularity of 30 minutes.

With regards to the frequency update of data, the regulation states that the consumption data must be available on demand and be demonstrably current and could not be considered out of date. The DSO and the supplier need to refresh the data regularly. If the consumer requests data, it should not be delayed, and data of the past 2 years up until 1 or 2 days before request should be provided. On the other hand, the smart meter pulls data every 30 minutes; data is also pulled by the DSO daily at midnight.

Level of the...	History	Granularity	Frequency of consumption data update
DSO	2 years	30 minutes	Demonstrably current data available on demand
Supplier	2 years	30 minutes	Demonstrably current data available on demand
Central data hub	N/A	N/A	N/A
Smart meter	3 months	30 minutes	Near real time

With regards to the implementation of the interfaces in and within the smart metering infrastructure, only H2 interface (shown in the figure below) will be implemented and it will be done by default.

Customer access to consumption data will be made available through the following channels:

- DSO web portal
- Supplier web portal
- Locally through the in-home display via the Home Area Network (HAN)

Both the DSO and energy suppliers will be obligated to make available 24 months' worth of historical consumption data to the customer in half-hourly intervals. It is envisioned that this will be in the form of a csv file.

Third party access to consumption data will be made available through the DSO web portal, only if the consumer gives his/her consent. The DSO should then transfer this consumer's information to the third party or make arrangements for the third party to access the information.

On the other hand, there is no decision made on any type of third party access to consumption data for emerging services in the meter data management system (MDMS) nor in the smart meter. It is unclear whether any mechanism will be put in place for this.

Remote reading by the operator, both push (automatic) and pull (on demand by the operator), will be possible. Moreover, advanced tariff system possibilities like pre-payment schemes, time-of-use tariffs and linkage to wholesale market prices are foreseen to be implemented.

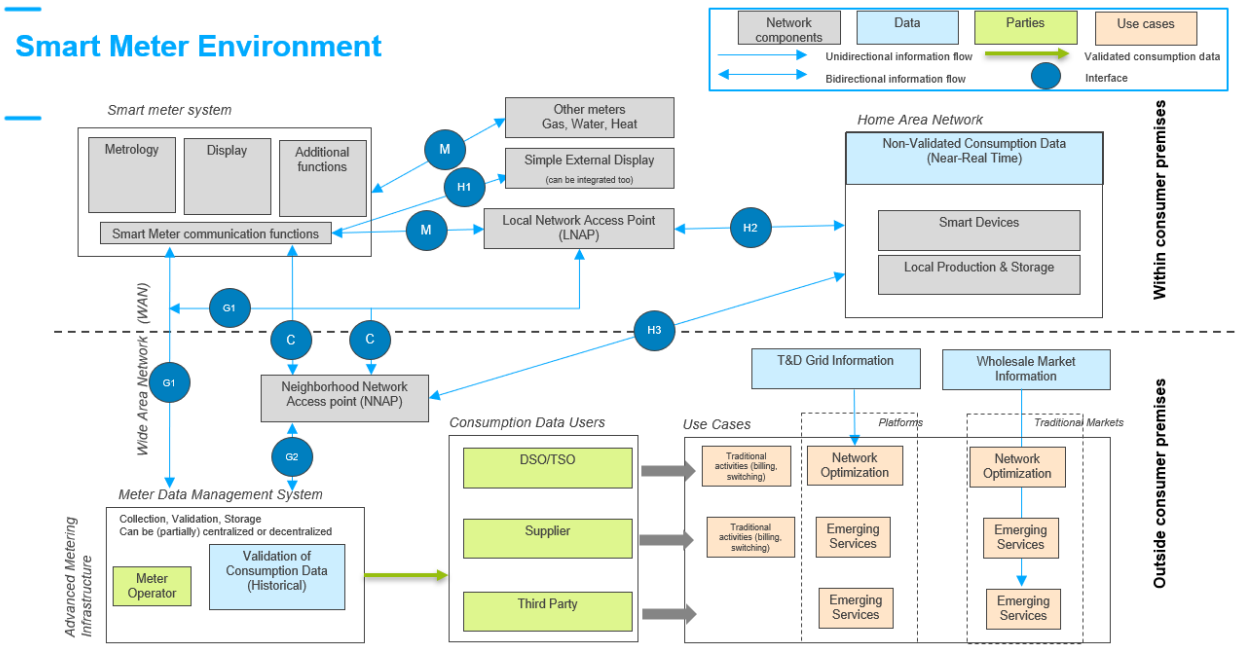
The smart meter will also be able to measure the net injected energy into the grid, including reactive power, and it will be able to measure grid injection and withdrawals separately.

Currently, it is not clear whether it is intended to use the smart meter in community-based distribution metering systems in which metering data is aggregated between multiple users that are physically close to each other and use the same distribution infrastructure.

14.4. Technical specifications

In respect to the following figure (showing a schematic representation of the functional architecture in a smart metering environment), it cannot be confirmed which technologies will be adopted and which standards will be applicable. This decision depends on the DSO's procurement process which was, at the moment of data collection for this report, still ongoing. The DSO, ESBN, will make overall decisions on the design, functionality and customer interaction procedures. The expectation is that as soon as the procurement process is finalized, the technology will be selected in the course of 2019.

In terms of communication standards adopted, it seems that an open standard solution will be chosen for the only implemented interface, H2.



14.5. Data management

14.5.1. Data access and privacy framework

The CRU has stated that is considering the best way to ensure that consumers' energy consumption information is processed lawfully in accordance to the Data Protection Act 1988 and in a manner which both protects energy consumers and enables them to benefit from this service upgrade.

The CRU's assessment regarding data access and privacy commenced in July 2013. They have worked closely since then with the Data Protection Commissioner in developing an interim Privacy Impact Assessment and a review of EU and international best practice. They have conducted to date three Data Protection Impact Assessments: in 2013, 2015 and 2016. Extracts of the second assessment[37] performed in July 2015 have been published. Evidence was gathered to assess the case for providing this consumption data automatically to industry stakeholders.

Using the evidence adduced, and recognising international best practice, CRU has concluded that allowing customers' flexibility and choice as to share or not their data and obtaining their "consent" for doing so, is the preferred grounds on which granular consumption data is processed. This is in line with the Data Protection Commissioner's recommendations and best practice in Europe.

Some of the main risks identified were the absence of a coordinated approach to information and cyber security on the smart meter upgrade project, and the need to adopt a clear and transparent consumer engagement strategy in order to communicate to consumers their rights regarding data privacy and smart meters.

The measures taken to mitigate the potential impact of the above risks were the establishment of a security workstream on the smart meter upgrade project charged with running an end-to-end security risk assessment and drafting security mitigation measures. Moreover, the CRU, the DSO and suppliers have initiated a consumer engagement workstream to communicate data privacy rights to consumers.

14.5.2. Provisions to provide and revoke access to data

Third parties and suppliers will need an explicit consent from the consumer to access his/her metering data, however, the way the consumer will grant or revoke this consent is still under discussion between the DSO and the energy suppliers.

14.6. Consumer impact

14.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

[37] CRU National Smart Metering Programme – Information Paper on Data Access & Privacy, 2015: https://www.cru.ie/wp-content/uploads/2015/07/CER15139-Data-Access.pdf

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	Yes
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No - technically this could be accommodated however no arrangements are currently in place for this type of approach, but this could be developed in the future
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes

Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

In terms of detecting unusually high customer load (power usage) which might cause safety concerns, the meter will be capable of recording an event in its event logs if the customers' load rises above a set threshold for a set period of time. The threshold can be set to record an event for power load levels which are approaching the safe operation limits for the meter or electricity supply infrastructure. These events will be collected daily by ESBN and will be analysed – level of detail of the analysis is not yet decided. The meter does not provide any facility to share these events directly with customers locally.

Regarding the level of sensitivity in consumer segments towards the new services enabled by smart meters, the CRU has conducted extensive customer behaviour trials for electricity and gas customers using smart meters. Approximately 5,000 customers participated and there were little to no negative impacts on those participants from low-income households.

14.6.2. Consumer concerns

As the rollout will not commence until 2019, to date there have only been sporadic enquiries or issues raised regarding smart metering and impacts on privacy.

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Cybersecurity	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Electromagnetic radiation	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Accuracy of meters	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Price of meters	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Installation barriers	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns

To educate the public on issues regarding data privacy and smart metering, a dedicated communications campaign will be launched. The idea is to communicate the actions taken to date e.g. running of Privacy Impact Assessments and communicate to customers their rights regarding data protection.

Dedicated campaigns will be launched to communicate (i) the actions taken to date regarding cybersecurity such as the performance of risk assessments and implementation of mitigation measures; (ii) on the safety of smart meters and adherence to domestic and European safety standards and therefore address potential concerns on electromagnetic radiation.

14.6.3. Research on consumer benefits

The CRU has conducted extensive customer behaviour trials with approximately 5,000 domestic and small-medium sized enterprises, the results of which were made publicly available. The primary purpose of this programme of research has been to help ensure consumer benefits are realised among both domestic and non-domestic consumers.

14.6.4. Communication campaign

A dedicated communication campaign is currently being developed and will be launched in advance of the smart meter deployment based on current plans. This campaign will use a wide variety of approaches like consumer engagement through websites, social media, information notices e.g. pamphlets, leaflets, call-centres, etc.

14.6.5. Advanced consumer services

Currently, there are no plans or concrete initiatives that leverage smart metering to integrate distributed energy resources. The primary benefits for the Irish smart metering deployment focus on time-of-use and dynamic tariffs. However, the deployment may evolve to include other initiatives such as storage and demand response in the future.

14.7. Conclusions

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 Energy Package.

The Statutory Instrument 426 grants the Commission for Regulation of Utilities, Water and Energy (CRU) the responsibility for ensuring the provision of smart metering systems in the electricity and natural gas retail market. Moreover, the CRU may take all reasonable steps to discharge its functions in accordance with the Directive, the Electricity Market Directive and the Natural Gas Market Directive. CRU is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

This law also covers the functional scope and cost benefit assessment of electricity and gas smart metering in Ireland.

The main drivers for the deployment of smart meters in Ireland are the opportunities they offer in digitization of the energy grid and markets, enabling innovation, new energy services and the introduction of dynamic energy tariffs.

Most of the activities around smart meter deployment in Ireland will be the responsibility for the DSO and are structured in three phases, starting in 2019 and ending in 2024. The deployment phases will build on lessons learned in pilots and earlier phases. The continuous learning, from pilots and related experiences, has fed into and is accordingly incorporated in the development and refinement of the consecutive CBAs. The outcome of the CBA was positive, with a relatively large annual benefit per meter compared to other member states.

All 10 key functionalities recommended by the European Commission are foreseen and are to be offered free of charge for the consumer. However, not all of them will be activated by default. That will be the case for the remote on/off control of the supply and/or flow or power limitation, as well as for providing import/export and reactive metering.

Technical details and standards are still under consideration as part of the smart metering procurement process that is currently underway.

Over the past years the CRU has stated that they have conducted extensive pilots focused on consumers and SMEs to validate the smart meter benefits. These trials showed limited consumer issues with third party data access and privacy.

14.8. References

Id	Reference description
1	CRU - Smart metering upgrade update report, 2017
2	CRU - Smart Metering Cost Benefit Analysis Information paper, 2017
3	CRU National Smart Metering Programme – Information Paper on Data Access & Privacy, 2015

15. ITALY

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Italy.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

15.1. Legal and Regulatory Framework

15.1.1. Market model

In Italy, the Italian Regulatory Authority for Energy, Networks and the Environment (ARERA - *Autorità di Regolazione per Energia Reti e Ambiente*; formerly AEEG - *Autorità per l'energia elettrica e il gas* from 1997 to 2012 or AEEGSI - *Autorità per l'energia elettrica il gas e il sistema idrico* from 2012 to 2017) regulates the metering activity. DSOs are metering operators and therefore the responsible party for smart metering implementation and making data available to central data hub, where third-party access is then granted.

Terna is the national electricity transmission system operator (TSO) that owns over 98% of the Italian transmission grid and is responsible for planning, operating and maintaining the transmission system. "e-distribuzione S.p.A", belonging to ENEL Group, is the primary Italian Distribution System Operator (DSO), covering 86% of Italy's electricity final consumers. Besides e-distribuzione, approximately 130 DSOs operate the electricity distribution networks in Italy, with only 10 DSO with more than 100.000 final consumers and more than 50 DSOs having less than 1,000 consumers (ARERA, Annual report 2018[15]). The most important municipal DSOs are Unareti (belonging to A2A group), ARETI (belonging to Acea Group), IRETI (belonging to Iren Group), Deval (belonging to CVA Group), and Inreti (belonging to Hera. Group).

Snam Rete Gas, a subsidiary of the Italian natural gas infrastructure company Snam S.p.A., is the Italian gas TSO, which operates 90% of the infrastructure for the transmission of natural gas. The gas distribution network in Italy is highly fragmented: the distribution service is performed with more than 6,400 concessions in about 7,100 municipalities. There are about 210 active gas DSOs supplying approximately 23 million consumers in Italy (ARERA, Annual report 2018[15]).

Electricity smart metering

Italy was the first European country to introduce a large-scale deployment of smart electricity meters for low-voltage end-users and still is the world's first country in terms of number of installed smart meters in operation (over 35 million).

In Italy, the deployment of the "first generation" (1G) of smart electricity meters started as early as 2001 as a voluntary initiative by ENEL Distribuzione (nowadays, e-distribuzione) and was almost completed in 2006. A few years after, other large Italian DSOs operating at municipality, level (ACEA in Rome and ASM in Brescia) started a similar voluntary process.

In 2006, recognizing the benefits of implementing smart metering, the Authority (then AEEG, nowadays ARERA) set a mandatory installation of 1G smart meters to all low-voltage metering points with Deliberation 292/06[1], so that a mandatory smart metering roll-out was extended to all Italian DSOs (even the smallest ones).

As a result, the rollout of 1G smart meters for electricity has been deployed in two phases:

- First phase (2001-2006): voluntary phase started principally by Enel distribuzione, followed by ACEA (Rome) and ex ASM (Brescia);
- Second phase (2007-2011): mandatory for all DSOs (Deliberation 292/06), with a target of 95% of the low-voltage withdrawal points of each DSO to be equipped with 1G smart meters by December 2011.

Following the Legislative Decree 102/2014, that mandated the Authority to define the functional requirements for second-generation (2G) smart metering systems, ARERA issued decision n. 87/2016 that includes both functional requirements and performance expected levels for 2G smart metering systems. Afterward, with decision 646/2016 rules for approval of rollout plans and allowance of related costs (including efficiency incentives) were established. Each DSO is for the time being free to decide when to start the roll-out process for the substitution of its own 1G smart metering system with a 2G one, after regulatory approval on a submitted plan.

Gas smart metering

The replacement of traditional gas meters with smart meters was launched by the Authority in 2008 with decision 155/08, starting from the highest flow meters (class G40 and above) and progressively extended firstly to medium-size meters and then, from 2013, to the households gas meters of lower flow rate (G4-G6 class).

While the Authority defined the functional specifications with Resolution ARG/gas 155/08[2], the Italian Committee for technical standardization in the gas sector (CIG), on a mandate from the Authority, defined the technical specifications for gas smart metering systems. CIG paid particular attention to issues of interchangeability (i.e. the possibility for smart metering systems to work properly with devices produced by different manufacturers) and of interoperability, that is the ability of a system to exchange data with systems of other services.

The Authority has progressively updated the plan to replace gas meters, taking into account the implementation difficulties. At the moment of data collection of this report, a target of 50% G4-G6 smart gas meters in operation was set for 2018, having completed the installation of smart gas meters of the upper classes (above G6) for that date. Half of the total volume of gas supplied to final consumers through distribution networks is already smart metered in Italy.

Market roles

The market roles related to smart metering are defined in the integrated text of the provisions for the regulation of the electricity metering activity the *Testo Integrato Misura Elettrica* (TIME[9]).

DSOs are the parties in charge of meter installation and ownership and are responsible for buyer compensation for technical and administrative losses (Art. 6, TIME[9]). They are not in charge for In-Home Devices (IHDs) installation and ownership - these are property of Suppliers and/or designated Third parties or of the final Consumer. Such beyond-the-meter activities are left to the competitive market.

TIME identifies the DSO competent for the area in which the connection point is located as the responsible party for metering data collection of that point (Art. 10.1, TIME[9]). For generation points in medium and high voltage networks, the responsibility for the meter installation and maintenance is on the Supplier. In these cases, the DSO has to identify, within the contract relating to the metering service, the responsibilities and obligations of the same Supplier in order to guarantee the proper functionality of the metering system (Art. 10.2, TIME[9]).

Regarding data privacy, the DSOs are the Data Protection responsible (DPO) in line with the General Data Protection Regulation (GDPR).

In Italy, for both gas and electricity, data collection falls within the perimeter of the DSO, whereas a centralized data hub, known as the Integrated Information System (Sistema Informativo Integrato - SII) currently operates data storage. Indeed, in 2010 Law 129/2010 provided that Acquirente Unico (AU), a public and independent third party, develop a data hub that would become the official data repository for information concerning identity of end-consumers and points of delivery. Moreover, in 2012, Law 27/2012 extended the perimeter of SII to include storage of metering data and the exchange of data between DSOs and other parties (i.e. suppliers) that became mandatory according to a subsequent law (Law 205/2017). At the moment of writing this report, the creation of a web portal within SII that will allow end-clients to access, download their own energy consumption data, and share such data with third parties, was under development.

15.1.2. Legal grounds

Electricity smart metering

The national regulatory authority defined the legal framework for mandatory rollout of 1G smart meters to all DSOs in 2006 with Deliberation ARG/elt 292/06[1], which sets the directives for the installation of smart electricity meters for all low-voltage metering points.

The primary law enabling smart metering for electricity in Italy is the Legislative Decree 102/2014[3], approved on 4th July 2014, which transposes the EU Directive on Energy Efficiency (EED 2012/27/EU). The Decree assigns the Authority the duty of defining the functional specifications of the 2G smart meters (Art. 9, subsection 3), but it does not define a starting date for the obligation of the 2G smart metering systems commissioning. In particular, the Decree sets the "procedures with which DSOs, as metering operators, must supply their electricity, gas, district heating, district cooling and hot water for domestic use consumers with smart meters able to accurately reflect actual consumption and to provide information on the actual time of energy use and on the related time bands" (Art. 9, subsection 1a)[3]. Furthermore, the Decree disposes that the above-mentioned procedures must also be applied to "DSOs replacing the existing meters with new smart meters in the case of new buildings or which have undergone major renovations" (Art. 9, subsection 1b)[3].

Among the delegated laws that further implement smart metering deployment in Italy, ARERA issued the following resolutions on 2G smart electricity metering rollout: 87/2016/R/eel[4] and 646/2016/R/eel[5]. These are not ministerial regulations, as the competent body is the independent regulatory Authority (NRA).

In particular, with Decision 87/2016/R/eel[4], the NRA defines the functional specifications and performance levels expected for second-generation (2G) smart metering systems, replacing the first generation meters, which have reached the end of their expected service life for regulatory purposes. The regulatory decision, pursuant to the provisions of the Legislative Decree 102/2014, was issued following a consultation process (DCO 416/2015/R/eel), technical and in-depth meetings, both with parties from the energy sector as well as from the world of telecommunications, and the technical collaboration with the Italian regulatory authority for telecommunication (AGCOM).

With the Decision 646/2016/R/eel[5], the Authority has defined the tariff regulation for the second generation (2G) of low-voltage electricity smart metering systems and has laid down provisions on the commissioning of 2G smart metering systems. Decision 646/2016 also underwent an extensive consultation process (consultation papers No. 267/2016/R/eel and 457/2016/R/eel). It sets the criteria for the recognition of capital costs for smart metering systems complying with the functional requirements and performance levels defined by Decision 87/2016/R/eel. In particular, Decision 646/2016/R/eel requires DSOs with more than 100,000 metering points, that want to start the substitution of their 1G smart metering systems to define a rollout plan over the entire operational lifetime of meters (15-years). The plan must include a provision of meters volume and related expenses, distinguishing from a "massive phase" and a "consumer management phase". The NRA has to evaluate and approve the plan taking into account the considerations/comments of all stakeholders. The evaluation and approval process can follow two different paths depending on the DSO's provisions of its own expenditure:

- Preferential path ("fast track"): implicates a quick decision (within 90 days) for the plans presented by the DSOs that foresee an expense such as to guarantee a substantial invariance in the low-voltage electricity metering tariffs;
- Ordinary route ("standard track"), longer and more analytical, for all other cases.

For the time being, e-distribuzione is the only DSO to have initiated the 2G roll-out process (due to its frontrunner position in 2001 with 1G). ARERA, with Resolution 222/2017/R/eel[6], approved the 2G smart metering rollout plan for e-distribuzione, which actually started in 2017.

Gas smart metering

Although a first legislative mandate was laid down in Law 99/2009, the primary law enabling smart metering for gas in Italy refers to the Legislative Decree 102/2014[3] (as for the electricity case). In 2013, with 631/2013/R/gas[7], ARERA updated its first decision for smart gas meter deployment issued in 2008 (ARG/gas 155/08) and updated the gas smart metering targets.

Then, pursuant to the provisions of the Legislative Decree 102/2014, ARERA issued the Resolution 554/2015/R/gas[8], postponing until 2018 the obligations to put in operation gas smart meters, and establishing the penalties that the DSOs must pay for failure to comply with the installation and commissioning obligations.

15.1.3. Primary drivers

As detailed in the following list, many drivers have led, and continue to do so, smart metering deployment in Italy:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Address fuel poverty
- Foster competition (spot reading at switching)
- Improve quality of service (for instance remote reactivation after payment in case of deactivation for rearrangements)

- Reduce non-technical losses (fight against energy theft)
- Improve consumer awareness (through in-home devices) of his/her energy footprint
- Ensure certification for demand response.

15.1.4. Smart metering programme financing

Smart metering costs are borne by the DSOs, which are identified as metering operators and have the obligation to install the smart meters. The costs, sustained by DSOs, are financed by a tariff approved by ARERA and paid by consumers through distribution charges in energy bills.

15.1.5. Recent publications by the NRA

The most recent publications issued by the national regulatory authorities are collected on a dedicated web page- available here[10] (Italian only).

Furthermore, in 2015, ARERA performed a survey on metering with the aim to verify the conditions for the provision of the electricity metering service, whose results are in Resolution 413/2015/E/eel[11] "Closure of the survey on the provision of the electricity metering service".

15.2. Cost benefit analysis

15.2.1. Relevant study

In 2008, ARERA published the first CBA in order to evaluate the cost effectiveness of gas smart metering. In 2014, e-distribuzione, which was the committed company for the smart meters' deployment, implemented the ex-post calculation of cost and benefit for 1G electricity smart metering. Both the above-mentioned CBAs resulted positive and are publicly available. According with the list reported below, ARERA did a further economic assessment on smart electricity meters. In particular, this assessment aimed at planning the imminent roll out of 2G smart metering system, but it is more a benefits qualitative analysis rather than a costs analysis.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation	Publicly available
2008 (gas)	NRA	NRA	Positive Net Present Value (For Large DSOs and high consumption levels)	Evaluate the cost effectiveness of gas smart metering	Yes[12]
2014 (electricity)	DSO (ENEL Distribuzione)	DSO (ENEL Distribuzione)	Positive Net Present Value	Ex-post calculation of cost and benefit for 1G electricity smart metering	Yes[13]
2016 (electricity, 2nd generation)	NRA	NRA	N/A (only methodology)	Roll out of 2G smart metering project	Yes[14]

15.2.2. CBA results

In 2008, the Italian NRA (ARERA) performed a CBA for the implementation of remote management and remote reading on gas metering systems. The analysis was conducted in relation to the size of the distribution company (small, medium and large DSO), which is the entity that has to realize the investments and perform metering systems readings, as well as in relation to DSO consumers' annual gas consumption level. The CBA results were partially positive. In fact, for medium (50,000-500,000 consumers) and large (> 500,000 consumers) DSO companies, with a mix of consumers with medium-high annual consumption (>5,000 scm), the NPV was positive, while it resulted negative in the case of DSOs (both medium and large companies) serving only consumers with low annual consumption (< 5,000 scm).

In spite of the partial negative result of the CBA, even small consumers are to be equipped with smart gas meters thanks to the latest trends in Italy, if they are served by DSO of at least medium size (above 50.000 consumers). This ongoing result has been possible according to the latest acquisition of smaller distribution companies by large DSOs that has allowed having positive investment results, balancing the mix of consumers. A medium sized DSO acquiring a smaller one is compelled to install smart meters also to the consumers of the latter. In this way, the smart gas meter deployment is extended to a broader number of consumers as an effect of market consolidation.

Concerning smart electricity deployment, the largest Italian electricity DSO e-distribuzione (former Enel Distribuzione) carried out an internal CBA to assess long-term (2001-2011) costs and benefits before proceeding with the voluntary large-scale rollout of smart metering systems. The CBA outcome was positive, with 6,400 million € of benefits for the DSO only, against 3,400 million € of total investment costs (95% of CAPEX associated with the production and installation of smart meters and concentrators, while the remaining 5% to costs related to IT system development, R&D costs and other expenses).

Lastly, the 2016 economic assessment performed by ARERA, was not quantitative, but rather qualitative, providing a systematic overview of the potential impacts and benefits of the 2G smart metering system on the electricity sector at various levels. According to the Italian NRA, this represents a necessary step in order to identify not only next regulatory interventions, but also costs the electricity system should sustain to allow the materialization of such benefits.

The potential benefits introduced by 2G smart metering systems deployment for low-voltage consumers have been examined in the consultation document DCO 468/2016/R/eel[14]. The Resolution 646/2016/R/eel[5], after an extensive consultation process (DCO No. 267/2016/R/eel and 457/2016/R/eel), sets 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[4]. The Authority introduced this last regulation with the aim at balancing the need for the minimization of the total replacement cost charged to final consumers with wide benefits deriving from the 2G smart metering systems deployment.

The starting date for the obligation of the 2G smart metering systems commissioning has not been identified yet. Therefore, the Authority decided to develop a two-phase incentive approach *before* and *after* the 2G meters, commissioning obligation enters into force, as detailed below:

1) *Before*: DSOs intending to proceed with the replacement of their meter stock must define their own deployment plan demonstrating costs efficiency and benefits gain;
2) *After*: DSOs that have not already proceeded with the commissioning will be required to complete it within the time limits set by the Authority;

15.2.3. Deployment strategy and latest statistics

Smart electricity and gas metering have followed two distinct and very different deployment paths in Italy, as described below.

Electricity smart meters current and future deployment

Currently about 37 million smart electricity meters are installed in Italy, mainly as a result of the massive rollout plan for 1G meters developed by Enel Distribuzione S.p.A. in the 2002-2006 period and by all other DSOs starting from 2007, after the publication of the 1G Metering Directives (ARERA Resolution 292/06[1]).

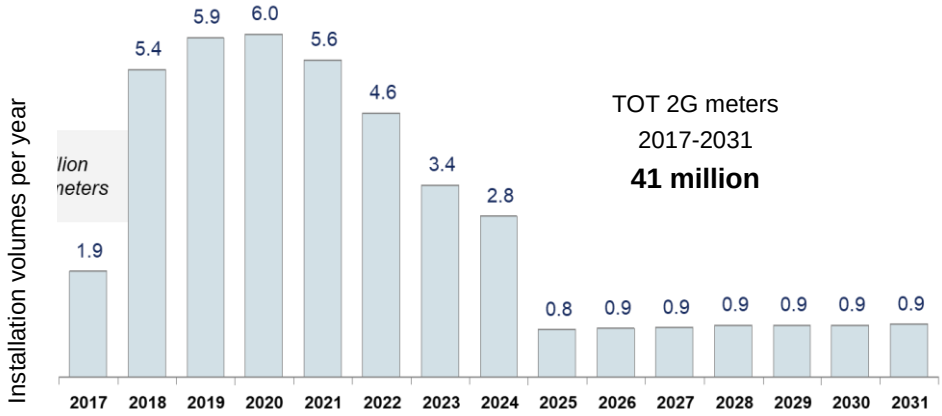
Enel Distribuzione S.p.A. has installed almost 23 million 1G smart meters before 2007, which are now reaching the end of their lifecycle, while during the 2007-2016 period it has installed just under 10 million 1G meters[15]. These installations were mostly due to new delivery points or substitution of meters for either verification/failure or following verified tampering by the consumer, as well as for switching from single-phase to three-phase meter due to power increase. Thanks to this large-scale deployment, smart meters reached 95% penetration rate in 2011. This allowed Italy to meet the EU target of at least 80% of households equipped with intelligent metering systems well ahead of 2020, as early as 2008.

Currently (as of 1/1/2018), the percentage of electricity delivery points equipped with smart meters is around 98.5%. There are 36,895,000 existing delivery points in Italy, of which 36,789,000 in Low Voltage (LV) (29,532,000 households and 7,257,000 non-households consumers) and almost 107,000 in Medium/High Voltage (MV/HV).

The Authority approved, with the Resolution 222/2017/R/eel[6,] the Commissioning Plan (PMS2) for the 2G smart metering system deployment and admitted to the tariff coverage the investments forecasted by e-distribuzione under the new specific regime according to Decision 646/2016/R/eel. E-distribuzione deployment plan develops over a period of 15 years (2017-2031, of which 6 years of massive substitution phase) and sets out the nationwide substitution of its 31.8 million 1G meters with "smarter" ones, the new generation (2G) meters, called Open Meters. According to the plan, almost 41 million 2G meters will be installed in the period 2017-2031.

As shown in the figure below, e-distribuzione provisions to carry out most of the activities in the initial phase of the plan and, in particular, to replace more than 80% of 1G meters in the first 6 years (2017-2022). Such massive phase will be completed (100% substitutions) by 2024 with 35.7 million of 2G smart meters installed. As of November 2017, e-distribuzione has already installed almost 1.4 million of 2G meters across the country.

Besides 1G meter replacement, e-distribuzione will proceed with the installation of 2G meters linked to consumer dynamics (new consumers, reactivation of ceased consumers, requests for commercial changes) or for substitutions due to failure and other causes.

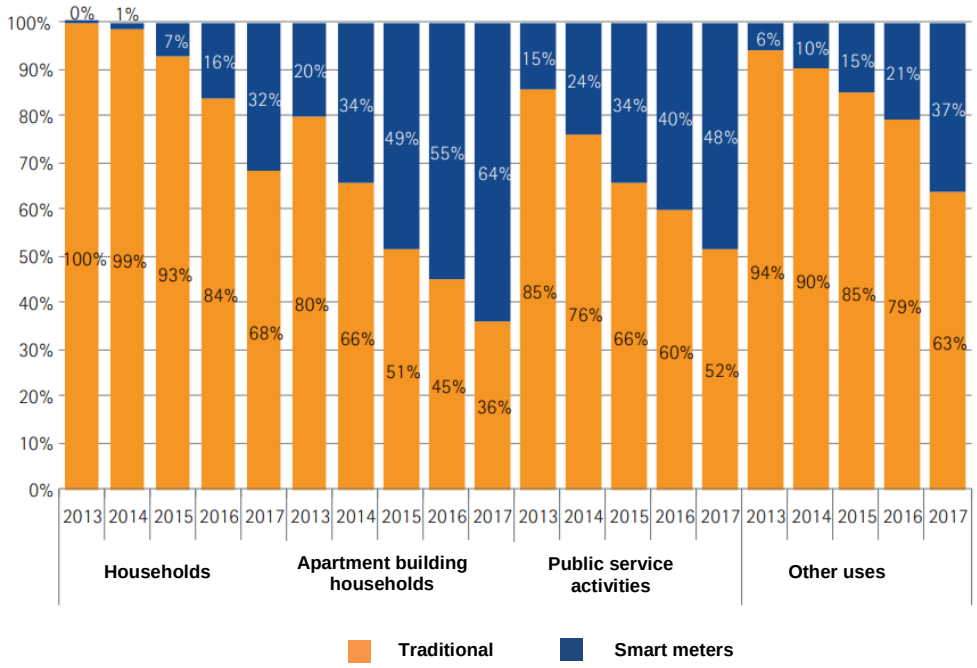


Furthermore, the e-distribuzione deployment plan, along with the installation of new generation (2G) smart meters, provisions the installation of secondary cabs for remote reading of new meters, concentrators (as central meters, which collect the consumption data from each smart meter) and the improvement of the central system.

Gas smart meters current and future deployment

The installation of smart gas meters proceeds and shows considerable growth, particularly in the sectors with the highest consumption: 92% of the highest flow metering systems (from G25 onwards) are "smart". Between 2016 and 2017, the number of smart meters in operation has doubled. In particular, in 2017, 3.7 million were installed, of which 98% of small size, i.e. metering systems up to class G6. As of January 2018, 7.7 million gas smart meters were installed in total.

As shown in the figure below, at the end of 2017, one-third (32%) of households consumers, two thirds (64%) of apartment building households, 48% of public service activities and 43% of consumers with other uses were equipped with a smart gas meter (ARERA, Annual report 2018[15]).



In Italy, a mandatory smart gas metering rollout program is currently in place, but it sets a target until 2018 and not over, according to the Authority Decision 631/2013/R/gas, which sets obligations for medium/large sized gas DSOs to install smart gas meters for all consumers, including G4-G6 class.

The Decision 554/2015/R/gas updated up to 2018 the obligations of smart gas metering systems commissioning and establishes the penalties for DSOs, if the plan is not respected by 2018. In particular, the 2018 targets vary for households and non-households consumers, so that the shares of existing delivery points to be replaced with smart gas meters are the following:

- Non-household consumers: 100%
- Household consumers: the number of delivery points varies with the DSO's company size, as follows
    - Large DSOs (> 200,000 costumers): 50%
    - Medium-large DSOs (100,000-200,000 costumers): 33%
    - Medium DSOs (50,000-100,000 costumers): 8%

- Small DSOs (< 50,000 costumers): currently there are no deployment plans, but they are expected to be updated with a resolution by the end of 2018

Italgas, the leading natural gas distribution operator in Italy, is planning to install 4 million smart meters in the retail gas market and 20,000 for large industrial consumers by 2020.

Recently, ARERA issued Decision 669/2018/R/gas setting final targets for all DSOs already involved in smart metering deployment. According to this regulatory decision, large and medium size DSOs have to commit smart meters for 85% of their consumers within the following years:

- By 2020, for large DSO (> 200,000 costumers);
- By 2021, for medium-large DSOs (100,000-200,000 costumers);
- By 2023, for medium size DSOs (50.000 – 100.000 consumers).

15.3. Functional requirements

Concerning smart meters functionalities, these have been set for both electricity and gas smart metering systems.

All 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) for electricity smart metering systems are available and activated by default on smart electricity meters, as well as free of charge for the consumer (see table below).

Functionalities for electricity smart meters	**Foreseen and available (but not necessarily activated)**	**Activated by default**	**Free of charge for the consumer**
FUNCTIONALITY A: Provide readings directly to the consumer and any third party designated by the consumer	☒	☒	☒
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings*	☒	☒	☒
FUNCTIONALITY C: Allow remote reading of meters by the operator	☒	☒	☒
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☒	☒
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☒	☒
FUNCTIONALITY F: Support advanced tariff system	☒	☒	☒
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☒	☒	☒

FUNCTIONALITY H: Provide secure data communications	☒	☒	☒
FUNCTIONALITY I: Fraud prevention and detection	☒	☒	☒
FUNCTIONALITY J: Provide import/export and reactive metering	☒	☒	☒

*this functionality refers only to the second generation (2G) meters and it can be activated on demand by the consumer

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated has been provided:

	History (Historical data)	**Granularity (Historical data)**	**Frequency (Readings)**
DSO	yes	1G: 3 time bands (below 55 kW; above 55 kW, 15 minutes) 2G; 15 minutes	1G: once a month 2G: once a day
Supplier	No (not mandatory)	as above	1G: once a month 2G: once a day
Central Data Hub	yes	as above	1G: once a month 2G: once a day (under development)
Smart Meter	6+1 months	as above	Continuous update (in order to be ready at any time when requested by concentrator)

Functionality A: The consultation document 865/2017/R/efr[16] describes consumers' access to their historical consumption data. Consumers can currently access their consumption data by direct request to supplier, or, at least partially, through local access to smart meter displays and on energy bills; in the near future (compulsory by Law 205/17) consumers will be able to access historical consumption data on a web portal, within the Central Data Hub *"Sistema Informativo Integrato (SII)"*. Also, under development is the consumer's right to share such data with third parties. The compulsory centralized data hub does not preclude network operators and second parties' rights to develop their own data service, not regulated by the NRA, such as E-distribuzione *"MieLetture"* web portal.

Functionality B: this functionality is not available in 1G smart meters since the beginning and was released with a proprietary device (called "SmartInfo") only in 2016, while it is fully enabled by 2G smart meters thanks to the implementation of a second communication channel (*Chain 2*). This second channel provides non-validated consumption data directly to the consumer, bypassing the DSO, so that consumers equipped with a third-party, interoperable IHD are able to learn about their consumption rates in real time (see section 2.4 of this document). This will enable real-time energy savings with a greater consumers' awareness of their consumption.

Functionality C: the Italian regulator has requested both push (automatic) and pull (on demand) remote reading on smart meters.

Functionality D: the functionality allows signals sent by the DSO or supplier to modify several configurable parameters, activate/deactivate contract and send messages to consumers.

Functionality E: this functionality is available on both 1G and 2G meters, on which it will be upgraded for both voltage levels and energy profiles.

Functionality F: among the advanced tariff system possibilities, time-of-use tariffs are currently mandatory for default supply regime (in 1G meters as well). Pre-payment schemes are not yet implemented, but their implementation is foreseen on 2G meters, as outlined in Chapter 6 of the consultation document 245/2018/R/eel[17].

Functionality G: power cut off and supply reactivation is foreseen and power limitation in case of delayed payment(s) is also available in both 1G and 2G meters.

Functionality H; secure data communication was ensured via a proprietary protocol on Chain 1 in 1G smart metering systems. For 2G systems, there is a regulatory requirement not only for authentication but also for encryption of messages.

Functionality I: anti tampering functionalities, i.e. specific seals, tamper-proof switch, and secure programming codes are embedded in 1G metering devices and system, whereas anti-fraud prevention measures are enforced in the 2G system, concerning both the device itself and the data collected. In both cases, the meter has the ability to signal physical tampering.

Functionality J: both 1G and 2G smart meters are able to measure reactive power and grid injection separately from withdrawals.

Concerning gas smart meters, the available functionalities are the following:

Functionalities for gas smart meters	**Foreseen and available (but not necessarily activated)**	**Activated by default**	**Free of charge for the consumer**
FUNCTIONALITY A: Provide readings directly to the consumer and any third party designated by the consumer	☒	☒	☒
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings*	☒	☒	☒
FUNCTIONALITY C: Allow remote reading of meters by the operator	☒	☒	☒
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☒	☒
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☐	☐	☐
FUNCTIONALITY F: Support advanced tariff system	☐	☐	☐
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☐	☐	☐

FUNCTIONALITY H: Provide secure data communications	☒	☒	☒
FUNCTIONALITY I: Fraud prevention and detection	☒	☒	☒

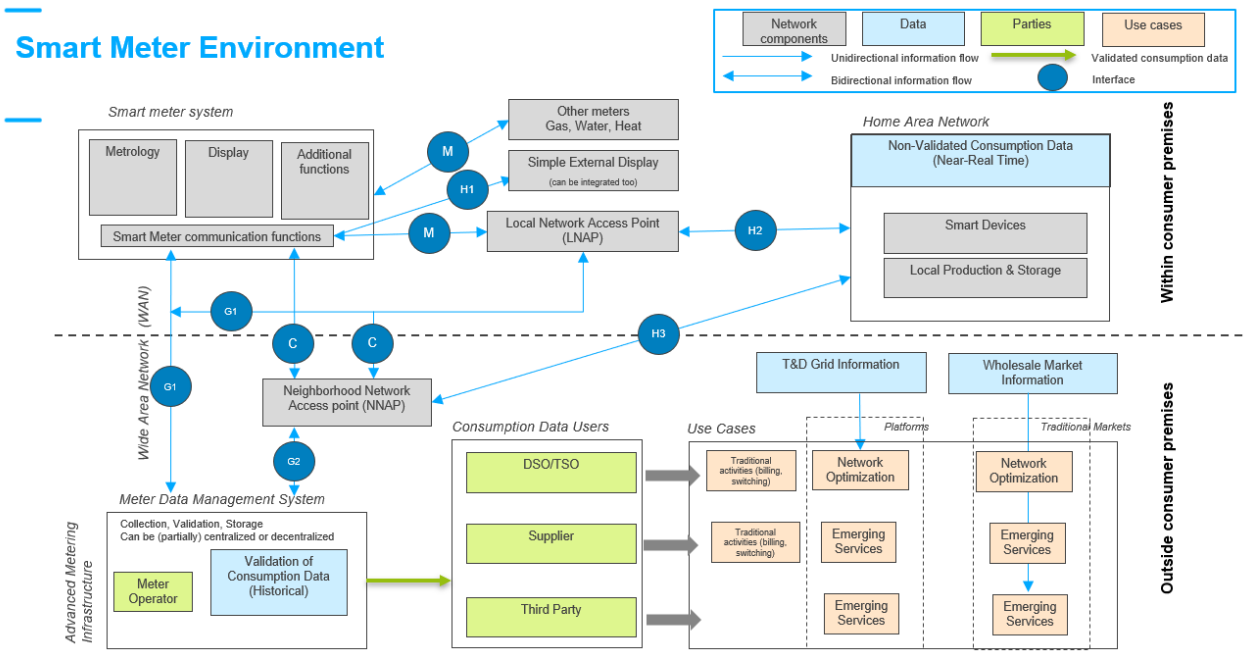
*This functionality refers only to the second generation (2G) meters and it can be activated on demand by the consumer

15.4. Technical specifications

In a smart metering system (see figure below that includes a schematic representation of the functional architecture in a smart metering environment), interfaces enable the interaction between the different components that are part of it, namely:

- the electricity smart meter
- the data management system
- other communicating devices including gas meter, water meter, local production, stationary batteries or electric vehicle charging stations linked to a dedicated "box" or energy management system

Interfaces are characterized by specific technologies and standards (with known advantages and disadvantages). While enabling access and sharing of smart meter data, they also represent possible vulnerabilities in terms of cyber security.



Different interfaces and technologies have been implemented on smart electricity and gas meters, as detailed below.

1G Electricity smart meters (LV)	Interface implementation	Technology
H1	activated upon consumer explicit request	PLC

H2	activated upon consumer explicit request	PLC
H3	No	Not implemented
C	implemented by default	PLC
G1	No (implemented by default only for MV/HV)	GSM
G2	implemented by default	GSM

In 1G smart electricity meters, H1 and H2 interface can be activated upon consumer explicit request, while H3 interface is not implemented. C, G1 and G2 interfaces are implemented by default, where G1 interface is implemented only in MV/HV applications.

Power Line Carrier (PLC) is the chosen communication technology for H1, H2 and C interfaces of 1G smart electricity meters, while GSM / GPRS technology is implemented on G1 and G2 interfaces (for 2G smart metering systems, interface G2 is now evolving towards LTE and/or fiber connection).

It is foreseen to adopt more advanced technological solutions in 2G smart meters in order to respond to the need for functional and performance evolution induced by the ever-growing computational requirements emerged in recent years. For example, GSM technology, which is currently supported by Telco infrastructures, might be not fully adequate to transmit growing volumes of data from the Data Concentrator to the Meter Data Management System (G2 interface). At present, GSM technology has the drawback of a reduced effective throughput (transmission capacity) and the need to establish the connection whenever communication is required. Inadequate coverage or insufficient availability of the GSM communication channel offered by Telco's public network are the cause of almost half of the failures of remote management activities. For these reasons, more advanced solutions such as the Universal Mobile Telecommunications System (UMTS) and its LTE (Long-Term Evolution) will be implemented on G2 interface of 2G smart metering systems.

In addition to the PLC channel, a second communication radio channel (RF 169 MHz) from the 2G meters to the 2G data concentrator will be implemented on C interface. This channel will be used as a back-up of the primary PLC channel and for the reception of real-time voltage interruption coming from 2G meters.

While 1G smart electricity meters have only one communication channel, new 2G meters can rely on two separate communication channels: one with the central distribution system (*Chain 1*) and the other towards any consumer energy management systems, i.e. the In-home or smart and portable devices (*Chain 2*). In particular, as shown in the figure below, the two channels go through the following steps:

- *Chain 1: "from the meter to the consumer through the supplier"*
  Meter > data concentrator > distributor > SII > supplier > consumer

- *Chain 2: "from the meter directly to the consumer (or designated third parties)"*
  Meter > In-home display (> energy services provider / > final devices)

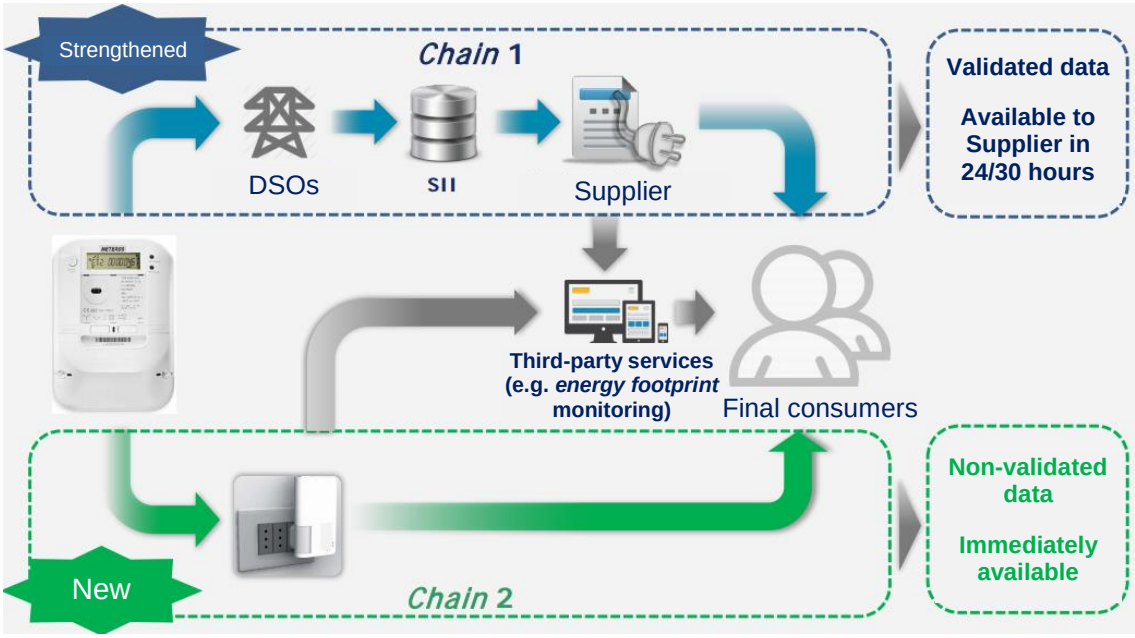
While *Chain 1* provides data validated by the DSO and that the Supplier can use for billing, *Chain 2* provides non-validated data. The Supplier (or Third parties designated by the consumer) can use such non-validated data for energy efficiency goals, such as "energy footprint" monitoring, and for the development of new commercial offers integrated with other services. Suppliers however may not use real time data provided through Chain 2 for billing because are not validated.

As mentioned in Section 2.1.2 of this country fiche, the Authority Resolution 87/2016/R/eel outlines functional specifications and performance levels expected for 2G smart meters, not establishing technical specifications, which have to be set by the DSO. However, the Authority has recently concluded a consultation (DCO 245/2018/R/eel[17]) to investigate further technologies for H1/H2 interfaces of 2G smart electricity meters.

The combination of the following technologies achieves performance levels consistent with those indicated for 2G meters in Resolution 87/2016/R/eel:

- *Chain 1*: A-band Power Line Carrier (A-PLC) combined with RF 169 MHz (back-up);
- *Chain 2*: C-band Power line Carrier (C-PLC); a possible second channel for Chain 2 is under investigation (see consultation paper n. 245/2018); a decision is expected by mid-2019.

The two communication channels on powerline (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.



The smart gas meters technical requirements are defined in the UNI/TS 11291; this document, issued by CIG (Comitato Italiano gas) is available upon payment of its cost.

Gas smart meters	Interface implementation	Technology
H1	implemented by default	Logical port (>G6)
H2	N/A	Under consideration

H3	No	Not implemented
C	implemented by default	169 MHz
G1	implemented by default	GSM
G2	implemented by default	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 GSM communication technology is implemented on G1 and G2 interfaces.

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

15.5. Data management

15.5.1. Data access and privacy framework

Suppliers have the right to access energy consumption data for billing and other regulated purposes without specific authorization (relevant authorization refers to general data protection laws) because of their market function and thanks to the fact that they have entered into a contract with the interested consumer that provides for such function.

In the future, consumers will be able to grant access to their own data to third parties to allow the development of innovative services. Provisions to provide and revoke access to data

Current regulation foresees the access to metering data to a specific set of actors, including the relevant TSO, DSO, supplier and the SII, necessary for the well-functioning of the energy system. This access, as explained above, is implicitly granted once a consumer enters into a supply contract. The possibility for consumers to revoke access to data while a contract is still in force is not foreseen, while supplier's access to metering data is revoked automatically at the date of termination of the supply contract (due either to switch or to physical disconnection). In the future regulation will also explicitly address aspects concerning consumer access to data on the mandatory web portal within SII as well as issues pertaining to the rights of consumers to grant and revoke access to third parties.

15.6. Consumer impact

15.6.1. Available services

The following table proposes an extended list of services enabled by smart meters and further details their availability in the Italian market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available or foreseen in the market?	Additional comments

Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No	Under development
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No	Under development
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes	
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No	
Unusual usage alert: alert the consumer when an unusual high consumption occurs. This may also include safety aspects if critical loads are providing health services	Yes – service provided by the meter itself (for electricity sector)	Significant performance improvements with 2G smart meters
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No	
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes	Under development
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes (for electricity sector)	Significant performance improvements with 2G smart meters
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No, but elec. 2G meter can already certify DR actions (15')	
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes	Under development
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This PV targets regulation on local energy communities, virtual net metering and collective self-consumption.	No, because the requirement is not yet clear	
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized generation or as a way to introduce new tariffs (for instance to promote self-consumption, reduce network usage or provide economic signal that are consistent with the balancing markets).	Yes (in the electricity sector)	, Chain 2 is already ready for advanced case uses for prosumers

Smart meter to ease charging of **Electric vehicles (EV)** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes (but prices must be conveyed via a different system)	

Where "under development" refers to the services that will be enabled in the electricity sector by 2G meters deployment in the near future.

It can be noticed from the table that, among the "advanced" services, 1G meters already enable dynamic tariffs use, integration of prosumer in the market and ease of EV charging at home, while 2G meters will enable the implementation of pre-payment tariffs and the integration of a growing number of prosumers in the market.

15.6.2. Consumer concerns

In Italy, consumer organisations and civil society have expressed concerns about privacy, electromagnetic radiation, accuracy and price of electricity smart meters. All these concerns are declared to have been mitigated, based on the feedback received from national authorities, by proving smart meters compliance to existing security standards. No concerns on cyber security have been raised; however, no objective grounds seem to have been presented so far.

	Concern expressed	**Based on proved facts or testimonies**	**Countermeasures adopted**
Privacy	Yes, limited	Limited resistance to smart metering but lack of objective grounds	Yes - Proven compliance to existing standards
Cybersecurity	No	No	No
Electromagnetic radiation	Yes, very limited	Extremely limited resistance to smart metering by specific associations of "electro-sensible" persons	Yes - Proven compliance to existing standards
Accuracy of meters (electricity)	Yes, very limited	Limited resistance to smart metering but lack of objective grounds	Yes - Proven compliance to existing legal standards (CoJ sentence)
Price of meters (electricity)	Yes, sporadic	Sporadic concern to smart metering but lack of objective grounds	Proven reduction of metering tariff
Installation barriers	N/A	N/A	N/A

15.6.3. Research on consumer benefits

A research on consumers' ability to realize the smart metering benefits has not been directly undertaken in Italy. However, some research papers have been published on these matters[19].

15.6.4. Communication campaign

E-distribuzione launched several communication campaigns to all stakeholders involved in the 2G smart meter deployment plan (for more details visit e-distribuzione web-site[18]).

E-distribuzione is reported to have launched a massive communication campaign to citizens and institutions/opinion leaders in order to promote the new 2G smart meter as enabler of an open, accessible, technologically advanced and sustainable energy concept. The campaign aimed to reach and involve the greatest number of people trying to convey a message of technological change through visual and informative messages, communications in the local press, with ads with "informative" content, billboards, banners and presentation events, etc...

In addition, E-distribuzione promoted a communication campaign to its clients with the aim of sponsoring its activities and creating a reference network for the consumer.

15.6.5. Advanced consumer services

The need for additional 2G meters functional specifications with respect to those already outlined in Resolution 87/2016/R/eel[4] has been recognized and examined in Resolution 245/2018/R/eel[20]. In particular, three further functional requirements have been detected: availability of 1G meter readings at the time of removal, demand-side response, thresholds management of the quantities processed by the 2G meter.

15.7. Conclusions

Italy is one of the first European countries, to start and complete a large-scale deployment of smart electricity meters; furthermore, it is the country with the highest number of installed smart meters in operation (37 million). E-distribuzione deployed the first generation (1G) of smart meters as a voluntary initiative, until 2006. Then, ARERA set a mandatory installation of 1G smart meters that ended in December 2011, when smart meters reached a 95% penetration rate. Currently, ARERA has defined, after wide consultation processes, functional requirements for the second generation (2G) smart metering systems. The substitution of 1G meters with 2G ones has been started by E-distribuzione; other DSOs are expected to follow in due time.

Concerning gas smart meters deployment, ARERA launched the replacement of traditional meters starting from the highest consumption (class G40 and above). From 2013, the target was progressively extended to households and low flow rate smart meters (G4-G6 class). In the end of 2017, 32% of household consumers, 64% of apartment building households, 48% of public service activities consumers and 43% of consumers with other uses were equipped with smart meters. ARERA has set a mandatory smart gas-metering target to be reached by 2018 and recently set target years to install smart meters for 85% of all consumers served by medium and large size gas DSOs.

Three Cost-Benefit Analyses (CBAs) on smart metering deployment have been conducted in Italy in 2008, 2014 and 2016. The first two CBAs concerned gas and electricity deployment respectively, and have provided positive net present values.

Regarding the last analysis, it was more a qualitative economic assessment rather than a quantitative assessment, providing a systematic overview of the potential impacts and benefits of the 2G smart metering system on the electricity sector at various levels. ARERA considered this analysis an essential step in order to identify regulatory next steps and main costs that should be considered for the materialization of benefits identified.

Concerning data protection, privacy, and security, the following actions have taken place. The DSOs have been appointed as the Data Protection Officer (DPO), in compliance with the General Data Protection Regulation (GDPR). Acquirente Unico (AU) as a third party, public and independent, is currently developing the Integrated Information System platform, as a common platform that will converge all the roles related to data collection, transmission to third parties and data protection. The Data Protection Impact assessment has been performed at least by E-distribuzione as a pilot.

In Italy, all 10 functionalities recommended by the European Commission (Recommendations 2012/148/EU) are available and activated by default on smart meters for electricity and are all free of charge for the consumer. Only functionality B ("update the readings frequently enough to allow the information to be used to achieve energy savings") was not available since the beginning in 1G smart meters. However, it has been introduced in 2016 for 1G (through a proprietary device) and will be further enabled with 2G smart meters. This is thanks to the implementation of the second communication channel (*Chain 2*) that is fully independent from the ordinary channel for remote reading and remote consumer management (*Chain 1*).

Indeed, new 2G meters will rely on two separate communication channels: one with the central distribution system (*Chain 1*) and the other towards any consumer energy management systems, i.e. the In-home display (*Chain 2*). Further, a 169 MHz channel will be used as a back-up of the primary PLC channel for Chain 1 and for the reception of real-time voltage interruption coming from 2G meters.

Besides these functionalities, smart meters enable different "standard" and "advanced" services in the Italian market, such as:

- **Real-time consumption:** make accessible to consumers energy consumption data in real-time (in physical units only, as smart meters don't have any price information);
- **Time-of-Use tariffs** (standard) **and dynamic prices** (advanced): consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly (implicit demand response)
- **Prosumers integration**: either as a prerequisite to install decentralized generation or as a way to introduce new tariffs
- **Electric vehicles charging at home** (advanced): the meter can enable a real-time communication with the "wall-box" of the consumer, while the Energy Management System allows easing the charging process by taking market and grid constraints into account, possibly charging at lower costs. It could also be used to charge more rapidly at home with a higher but non-firm connection capacity

Among "advanced" services, 1G meters already enable static Time-of-Use tariffs, integration of prosumer in the market, while 2G meters will enable the implementation of pre-payment tariffs, the integration of a growing number of prosumers and EVs in the market and certification of active demand response.

In Italy, consumer organisations and civil society have expressed rather few concerns about privacy, and electromagnetic radiation (very limited) and accuracy of smart meters. These concerns have been mitigated, according to the feedback received by the national authorities, by ensuring smart meters compliance to existing security and technical standards. No concerns on cyber security have been raised. Price concerns have been brought forward sporadically but were not substantiated. On the contrary, evidence so far shows that the electricity-metering tariff was reduced in real terms and that has been attributed to 1G smart metering.

To date, e-distribuzione has launched several communication campaigns to all stakeholders involved in the 2G smart meter deployment plan (more details can be found on the e-distribuzione web-site[18]), in order to promote the new 2G smart meter as enabler of an open, accessible, technologically advanced and sustainable energy concept.

15.8. References

Id	Reference description
1	ARERA Resolution ARG/elt 292/06 - https://www.arera.it/it/docs/06/292-06.htm
2	ARERA Resolution ARG/gas 155/08 - https://www.arera.it/allegati/docs/08/del.ARG-gas155-08.pdf
3	Legislative Decree102/2014 (4th July 2014) - http://www.normattiva.it/atto/caricaDettaglioAtto?atto.dataPubblicazioneGazzetta=2014-07-18&atto.codiceRedazionale=14G00113&queryString=%3FmeseProvvedimento%3D7%26formType%3Dricerca_semplice%26numeroArticolo%3D%26numeroProvvedimento%3D102%26testo%3D%26annoProvvedimento%3D2014%26giornoProvvedimento%3D4&currentPage=1
4	ARERA Resolution 87/2016/R/eel - https://www.arera.it/allegati/docs/16/087-16.pdf
5	ARERA Resolution 646/2016/R/eel - https://www.arera.it/allegati/docs/16/646-16.pdf
6	ARERA Resolution 222/2017/R/eel - https://www.arera.it/allegati/docs/17/222-17.pdf
7	ARERA Resolution 631/2013/R/gas - https://www.arera.it/allegati/docs/13/631-13.pdf
8	ARERA Resolution 554/2015/R/gas - https://www.arera.it/allegati/docs/15/554-15.pdf
9	ARERA - TIME (2016-2019) - https://www.arera.it/allegati/docs/15/TIME_654-15ti.pdf
10	https://www.arera.it/it/operatori/smartmetering.htm
11	ARERA Resolution 413/2015/E/eel - https://www.arera.it/allegati/docs/15/413-15all.pdf
12	ARERA Resolution ARG/gas 155/08 - https://www.arera.it/allegati/docs/08/155-08argrt.pdf
13	European Commission SWD(2014) 188 final Country Fiche Italy - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0188&from=en
14	ARERA DCO 468/2016/R/eel - https://www.arera.it/allegati/docs/16/468-16.pdf
15	ARERA Annual Report 2018 - https://www.arera.it/allegati/relaz_ann/18/RAvolumeI_2018.pdf
16	ARERA DCO 865/2017/R/efr - https://www.arera.it/allegati/docs/17/865-17.pdf

17	ARERA DCO 245/2018/R/eel - https://www.arera.it/allegati/docs/18/245-18.pdf
18	https://www.e-distribuzione.it/it/open-meter/open-meter--il-contatore-2-0.html
	http://www.cired.net/publications/cired2013/pdfs/CIRED2013_0320_final.pdf
20	ARERA Resolution 245/2018/R/eel - https://www.arera.it/allegati/docs/18/245-18.pdf

16. LATVIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Latvia.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

16.1. Legal and Regulatory Framework

16.1.1. Market model

In Latvia, the DSO, Sadales tīkls AS, is legally entitled to define deployment targets and conditions for smart electricity; for gas meters, it is the Latvian DSO GASO AS.

Those provisions will mostly apply to the DSO as the party in charge of meter ownership and installation as well as metering data collection and storage. The DSO is also metering data protection officer (Art. 37 GDPR) and in charge of metering data transmission to third parties.

Regarding in-home display ownership and installation, other actors are providing this service.

16.1.2. Legal grounds

According to the requirements of the national Energy Efficiency Law, the DSO shall be responsible for installing a smart meter and providing the energy users with information on the options of the meter reading management.

There is no specific or primary national law framing smart metering deployment for electricity. The DSO responsibility for installation of meters and methods for used energy accounting is stated in the Regulations Regarding the Trade and Use of Electricity.

The national Energy Efficiency Law defines that the DSO is responsible for rolling out appropriate smart meter functionality and should inform the end-user about it. The DSO is implementing smart meters in principle for supporting the electricity market, reducing operational costs and increasing internal efficiency.

Regarding gas, there are no laws in Latvia that oblige the DSO to install smart meters. There are not any specific nor primary laws that frame the smart metering deployment for gas. The DSO responsibility is for the installation of meters and for metering and energy accounting.

16.1.3. Primary drivers

Drivers for smart metering deployment is to:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Energy monitoring system

16.1.4. Smart metering programme financing

All investments in smart metering deployment are financed through network tariffs. System maintenance costs are directly included in the tariffs and yearly investment costs are included in next year tariffs.

16.1.5. Recent publications by the NRA

Recently there has not been any smart metering related publication by the DSO or the Public Utility Commission in Latvia.

16.2. Cost benefit analysis

16.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2012	Ministry of Economics	NRA	Negative	Comply with Dir. 2009/72. The CBA is not publicly available.
2017	DSO Sadales tīkls AS	NRA	Positive (76% in 2020, 100% in 2022)	DSO assessment to keep costs under control. The CBA is not publicly available.

This cost and benefit analysis presented above only concerns electricity.

Regarding the negative result of the original electricity CBA conducted in 2012, it is noted that only one scenario where smart meters are implemented for customers with annual energy consumption more than 2 500 kWh was positive. In this scenario, it was assumed that smart meters will be installed in 23% metering points nation-wide; meaning a segmented rollout.

Regarding the DSO of natural gas, there is no target set for switching entirely to smart meters. It is a free choice of the DSO.

16.2.2. Market roles and key parameters

In coherence with the national market model described above, the main market role taken into account in the assessment supporting direct costs and benefits was the DSO.

Key parameters for the assessment	
evaluation period of the CBA [Years]	18
billing and metering frequency in the reference case for electricity [times/year]	2
Does this also apply for gas?	yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A (fixed value)
What is the electricity losses unit cost? [€/MWh]	variable
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	variable
What is the cost reduction rate due to technological maturity? [%/year]	1,00%

Benefits considered in the analysis were meter reading and operation savings from better control and maintenance of assets, and from non-technical losses such as administration.

16.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with the exception of investment in telecommunications and in in-home display and programme for customer engagement.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☐ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call center and customer service
☐ OPEX - Consumer engagement programme.

16.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for the case of electricity:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	1,1 million
actualised CAPEX for the whole evaluation period	31 million € (net present value)
actualised OPEX for the whole evaluation period	11 million € (net present value)
actualised benefits for the whole evaluation period	48 million € (net present value)

16.2.5. Deployment strategy and latest statistics

During the next year, the DSO will make a detailed list of secondary substations and connected metering points where they will still install smart meters. The decision where to rollout is based on a number of criteria, e.g. annual total energy consumption in secondary substation level, available labour resources, network reconstruction plans, used communication technology (the DSO uses two technologies for meter reading - PLC and 2G/4G) etc. Before replacing smart meters, customers receive information, including short description about the smart meter functionality and benefits. Meters are installed for all connections in selected secondary substations, with no differentiation between households or SME connections.

The defined target is 100% smart meters nation-wide in 2022; as for 2020, 75% of smart meters should be already in place. Smart meters will be installed for all connection points. There is no exception to the mandatory installation and there are no technical constraints shaping the deployment policy.

At the moment, there is no defined plan for installation of smart meters in the case of gas.

The following tables highlight the latest statistics, presenting respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Latvia as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	356 358	Not available	10 (as a pilot)	652
Number of connection points equipped with smart meters	356 325	Not available	10	652

Total number of meters	981 633	Not available	Not available	413 886
Total number of connection points	981 561	Not available	Not available	413 886
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	Not available	0	0
Number of smart meters that does not communicate (due to technical problems)	5 120	Not available	0	0
Number of smart meters that does communicate default metering data	284 609	Not available	10	652
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	Not available	0	0

The largest Latvian DSO Sadales tīkls AS installs smart meters for all customers (including households and other customers like industrial customers, municipalities, services etc.). The data management systems of Sadales tīkls AS have no information about customer segmentation in small, medium and large enterprises. Thereof there is no information regarding exactly how many smart meters are already installed for small and medium enterprises. The total number of installed smart meters for non-household users the 1st January 2018 was 48 642 (44 406 of them have annual energy consumption under 10 000 MWh).

Deployment outcomes in 2017	**Electricity households**	**Electricity SME**	**Gas households**	**Gas SME**
Yearly installation target	130 000 (including both household and non-household customers)	Not available	Not available	200

Number of visits to consumer premises	119 292 (include visits for meter installation and visits to solve technical problems)	Not available	Not available	200
Number of installed smart meters	112 430	Not available	2 071 214	186 (totally 652 at the end of 2017)
Number of deactivated smart meters	0	Not available	Not available	2
Number of refusals	241	Not available	Not available	2

16.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (in Recommendation 2012/148/EU) are already implemented, being activated by default and free of charge for the consumer except for:

> *b) Update the readings referred to in point (a) frequently enough to allow the information to be used to achieve energy savings*

which is only activated on consumer request.

Additionally, functionality f) *Support advanced tariff system* is implemented but limited to four tariff zones.

Key functional features	**Functionality A: Customer access to consumption data**	**Functionality B: Frequency of consumption data update every…**
H1 Interface (IHD)	Only on consumer request (enabled by third party service)[38]	Daily

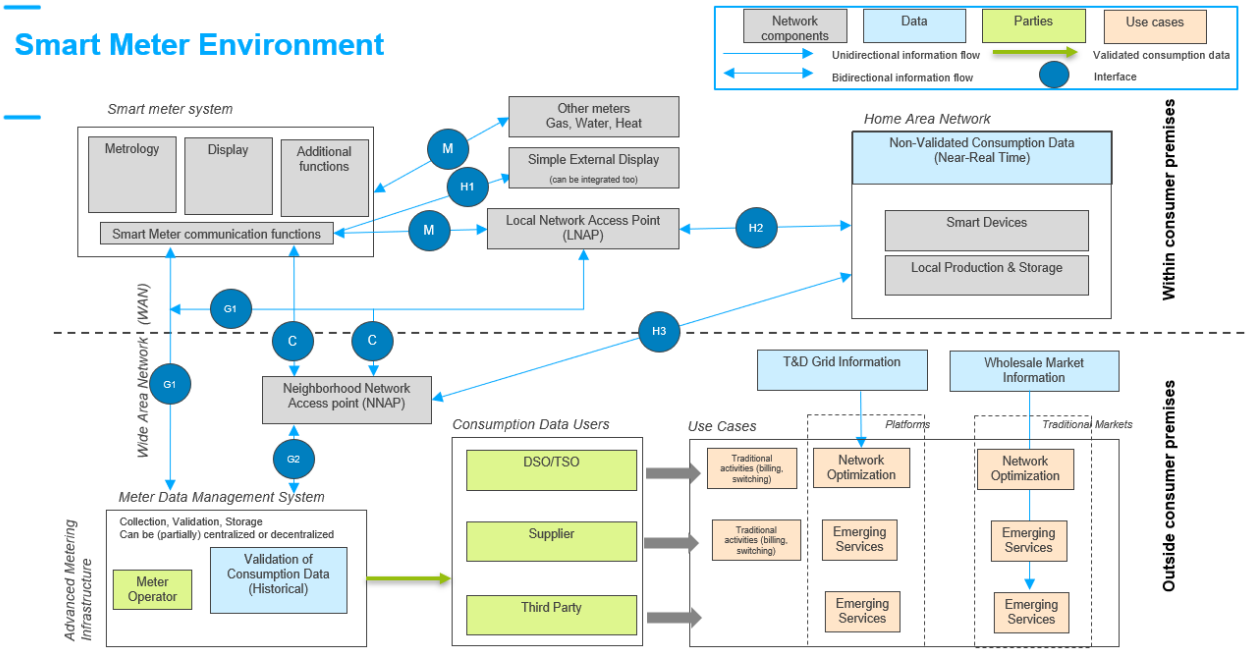
[38] Information provided by European Smart Grids Task Force Expert Group 1 report on "Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering" https://ec.europa.eu/energy/sites/ener/files/documents/EG1_Final%20Report_SM%20Interop%20Standards%20Function.pdf

H2 Interface (Smart Devices)	Only on consumer request (enabled by third party service)[39]	Daily
Compulsory DSO website	Yes	Daily
Compulsory Supplier website	Yes	Daily
Compulsory Third Party website	N/A	N/A

16.4. Technical specifications

For H1, H2 and H3, shown in the figure below that represents the functional architecture for communications in a smart metering environment, no technology has been communicated during the data collection phase. Regarding interface C, PLC has been chosen as a standard given that PLC technology is considered as well applicable for dense areas, DSO use their own infrastructure and follow up on the Service Level Agreement[40]. Also, CAPEX and OPEX is lower for PLC than for other technologies.

Latvia has good GSM network coverage; this technology is used for point-to-point meters, where PLC technology is not reasonable to use, and for reading data from PLC concentrators, which are installed in secondary substations. Therefore, GSM has been chosen as a standard for interfaces G1 and G2.



[39] See footnote 38

[40] A contractual document that highlight the performance target for the provision of a specific service. For instance, in the telecom industry, coverage and availably of the network are among the most common metrics used for the design of the service level agreement.

For PLC meters, G3 PLC technology is used; G3-PLC operating frequency band - FCC band plan 150-490 kHz.

For GSM technology, GSM modems are used based on 2G/3G/4G. Modem switches between the operating modes (2G, 3G and 4G) automatically relying on the good network coverage.

16.5. Data management

16.5.1. Data access and privacy framework

To access customer data, third parties need an explicit consent from the customer. When this is done, the third party has access to historical data on a granularity level of 1 hour. The customer can give and revoke access to metering data through a written approval or form communicated to and validated by the DSO. In Latvia, a Data Protection Impact Assessment as recommended by the European Commission (Recommendation 2014/724/EU) was performed in 2015. This assessment, as well as the main risks and the measures taken to mitigate their potential impact, is not publicly available.

16.5.2. Provisions to provide and revoke access to data

The customer can give and revoke access to metering data through a written approval or form communicated to and validated by the DSO.

16.6. Consumer impact

16.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No

Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

16.6.2. Consumer concerns

No specific research was done at national level regarding consumer concerns with smart metering and therefore there is no related information available as shown in the table below.

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	Not available	Not available
Cybersecurity	Not available	Not available
Electromagnetic radiation	Not available	Not available

Accuracy of meters	Not available	Not available
Price of meters	Not available	Not available
Installation barriers	Not available	Not available

16.6.3. Research on consumer benefits

No research has been performed to find out if there are any specific consumer segments that might have a higher level of sensitivity to new services enabled by smart meters. Customers who choose a market price and want to adjust their consumption to changes in prices, want current information about their loads and possibly manage their electrical equipment.

16.6.4. Communication campaign

A communication campaign has been launched before and during the installation through booklet and text messages, SMS.

16.6.5. Advanced consumer services

There are no specific plans or initiatives that leverage smart metering in support of advanced services such as for the integration of distributed energy resources. Load profile information coming from start meters could be used in such cases.

16.7. Conclusions

The goal is to have an almost 100% coverage of electricity smart metering nation-wide in 2022. Since 2015, Latvia is part of the Nordpool area (power market) and connected to NordBalt (high voltage cable) which facilitates power transmission between the Nordic countries and the Baltic. With smart meters deployed, it will be easier to communicate the price signals in the retail part to the final customers and could also help with the integration of distributed energy resources and the ever-increasing renewable energy production.

It appears that in Latvia, the approach to directly deliver smart metering benefits to the final customer has not been particularly pursued in their deployment programme. Moreover, there is no apparent research regarding customer concerns or expectations for the rollout, nor any material by the NRA that is publicly available.

One of the key lessons learnt by the Latvian DSO that is currently deploying, is that the smart meter project has decreased the operational costs (OPEX) for the network.

17. LITHUANIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Lithuania.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

17.1. Legal and Regulatory Framework

17.1.1. Market model

The organisation, coordination and implementation of the state policy in the energy sector is managed by the Ministry of Energy. In accordance with Paragraph 6 of Article 21 of the Law on Energy, the Ministry of Energy approves the development plans for smart grid and smart metering, or so-called intelligent energy accounting systems, and sets requirements for these networks and respective systems. It is noted that both plans and requirements can be set separately for each energy sector, if objective reasons exist.

In Lithuania, the DSO is responsible for meter ownership and installation, metering data collection and storage as well as metering data transmission to third parties. The DSO also has the responsibility of the metering data protection officer (Art. 37 GDPR). The customer buys and install in-home displays on their own choice. The DSO and the supplier have the role of buyer compensation for technical and administrative losses.

17.1.2. Legal grounds

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). To realize the above principles, it is planned to install smart meters and a common data placement and swap platform, or other analogous solutions based on innovative global solutions for good practice. If a cost-benefit analysis of intelligent electricity accounting systems appears to be positive, such systems should be implemented for all users by 2023 (according to Article 42.5.1).

Although there are no such specific terms for the gas sector, the strategy clearly states that innovation is related to the implementation of smart gas meters as well.

In order to effectively achieve the policy goals, the Ministry of Energy prepared a plan of measures to implement the NENS. The Government has approved this plan in December 5th, 2018.

Development plans for smart grids are not yet available nor indications were publicly given that the Ministry of Energy is currently, at least at the moment of writing this report, working on them. However, the Ministry of Energy has identified the basic functional requirements for smart metering systems for electricity. 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 Energy Efficiency Directive 2012/27/EU (i.e. Article 9 (2) (a), (b), (c) and (d), and Article 10 (2) and (3) (a) and (e)).

17.1.3. Primary drivers

Drivers for smart metering deployment in Lithuania is to:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Increase energy efficiency and lower energy consumption

17.1.4. Smart metering programme financing

The DSO in Lithuania is planning to apply for support from available European Union funds to finance the smart metering programme along with the distribution tariffs payed by the customers.

17.1.5. Recent publications by the NRA

The most recent publications by the NRA are the following:

- National Strategy for Energy Independence approved by the Parliament of the Republic of Lithuania in June 21st, 2018 Resolution No XIII-1288;
- A plan for the implementation of the National Strategy for Energy Independence approved by the Government of the Republic of Lithuania in 5th December, 2018 Resolution No. 1210;
- General Regulations for the Installation of Electrical Equipment, approved by the Minister for Energy in January 13th, 2017 (Order No 1-9).

17.2. Cost benefit analysis

17.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2012	DSO	NRA	Negative Net Present Value	Comply with Dir. 2009/72.
2014	NRA	NRA	Negative Net Present Value	Integrate return of experience from pilots.
2018	DSO	NRA	Inconclusive	Integrate return of experience from pilots.

The main benefit items considered in the analyses for rolling smart metering in the case of electricity was bill reduction due to energy efficiency, increasing competition in the retail market, meter reading and operation savings, operation and maintenance of assets, non-technical losses, outage management, CO2 and air pollution.

17.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the assessment: DSO, Supplier, NRA, Consumer and State/society.

Key parameters for the assessment	
evaluation period of the CBA [Years]	18
billing and metering frequency in the reference case for electricity [times/year]	12
Does this also apply for gas?	Yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	6 %
What is the electricity losses unit cost? [€/MWh]	38
What is the economic lifetime of electricity smart meters? [Years]	18
What is the economic lifetime of gas smart meters? [Years]	18
What is the value of the lost load? [€/MWh]	121 160
What is the cost reduction rate due to technological maturity? [%/year]	N/A

17.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☒ OPEX - Consumer engagement programme

17.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for a large-scale rollout of electricity smart meters:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	2,2 million
actualised CAPEX for the whole evaluation period	€ 287 million
actualised OPEX for the whole evaluation period	€ 86 million
actualised benefits for the whole evaluation period	€ 409 million

The resulting ratios have been computed in per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- Opex per meter: 39 €
- Capex per meter: 130 €
- Benefit per meter: 186 €

The following financial and social aspects have been evaluated:

Financial aspect:

- electricity losses reduction (+);
- less losses due to inappropriate use of investment (+);
- cost reduction of metrological revise (+);
- cost reduction of meter inspection (+);
- cost reduction of meter reading (+);
- cost reduction of consumer service (+);
- cost reduction of connection/disconnection (+);
- residual value (+);
- revenue of meter utilisation (+);

- cost reduction of billing (+);
- cost reduction of target meter exchange (+);
- cost reduction of deferred income (+);
- received income due to reduced interruptions (+);
- deferred investment in transmission assets due to income which is got from property (+);
- cost reduction of IT maintenance (+);
- cost reduction of outage in client network (+);
- electricity consumption used by meters (-)
- costs of data transmissions (-);
- profit tax (-);
- cost of solving outage (meters and other installation).

Social aspects:

- bill reduction due to energy efficiency;
- saved time value;
- air pollution (including CO_2);
- value of distribution service (reliability of distribution network);
- peak transfer

17.2.5. Deployment strategy and latest statistics

Based on available information, deployment of smart meters is actually planned from June 2020 to December 2023. The roll out will start in the biggest cities and when all meters are changed, the installation of smart meters continues in the other regions. According to the chosen strategy, the deployment starts in areas where density of meters is highest.

The target defined for 2020 is 280 000 meters; it is stated in the strategy that smart meters will be deployed for all customers. At the moment, no technical constraints have been identified since no solution or technology has yet been chosen. When a technology is chosen, the deployment strategy will be revised to reach the best results.

State of play of smart metering deployment in Lithuania as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	4 318	36 369	46	1 212
Number of connection points equipped with smart meters	4 318	36 369	46	1 212
Total number of meters	1 574 169	148 756	571 493	10 565
Total number of connection points	1 574 169	148 756	571 493	10 565

Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	2	330	8	6
Number of smart meters that does communicate default metering data	4 316	36 039	38	1 206
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	4 316	36 039	38	1 206

Deployment outcomes in 2017	**Electricity households**	**Electricity SME**	**Gas households**	**Gas SME**
Yearly installation target	46	3 218	46	0
Number of visits to consumer premises	1 049	2 867	46	0
Number of installed smart meters	1 049	2 866	46	0
Number of deactivated smart meters	0	0	0	0
Number of refusals	0	1	0	0

17.3. Functional specificiations

The intention is to implement almost all 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU). The exceptions made are for functionalities "*(g) allow remote on/off control of the supply and/or power limitation"* and "*(j) provide import/export and reactive metering"*. The following functionalities will be activated by default:

(b) Update the readings referred to in point (a) frequently enough to allow the information to be used to achieve energy savings

(c) Allow remote reading of meters by the operator

(d) Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system

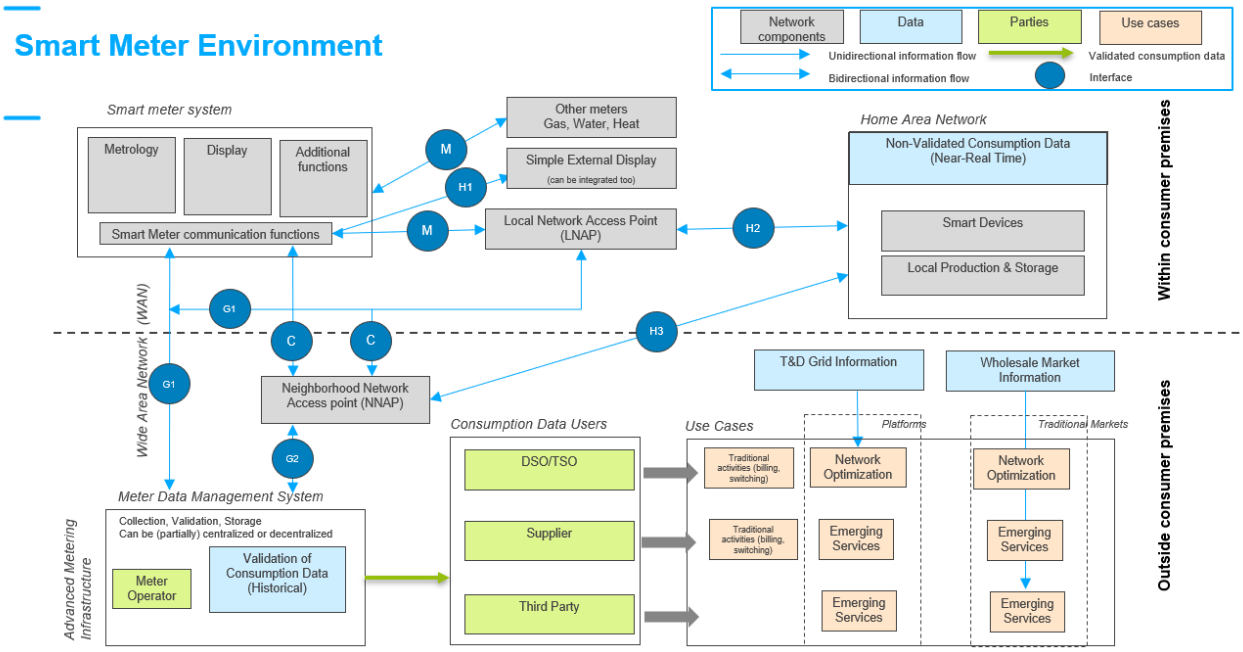
(h) Provide secure data communications

All implemented functionalities will be free of charge for the consumer.

Key functional features	**Functionality A: Customer access to consumption data**	**Functionality B: Frequency of consumption data update every…**
H1 Interface (IHD)	The customer will have access and it will be activated on customer explicit request. The granularity level is 1 hour, and meter readings will be stored for 2 months.	Real time consumption
H2 Interface (Smart Devices)	The customer will have access and it will be activated on customer explicit request. The granularity level is 1 hour, and meter readings will be stored for 2 months.	Real time consumption
Compulsory DSO website	There is a compulsory website foreseen by the legislator. Today the customer has access through a website. The DSO saves meter readings for 10 years and the granularity will be 1 hour.	Every hour
Compulsory Supplier website	Customer won't have access regarding electricity suppliers but will have access regarding gas.	Once a month
Compulsory Third Party website	N/A	N/A

17.4. Technical specifications

In respect to the following figure, that represents the functional architecture for communications/connectivity in a smart metering environment, wire is the chosen technology for H1 and H2 interfaces and will be activated on customer explicit request. G1 and G2 relies on GSM and is implemented by default as so is C. Regarding C, PLC technology is to be used. The interface H3 will not be implemented.



17.5. Data management

17.5.1. Data access and privacy framework

No Data Protection Impact Assessment had been performed in Lithuania, at the moment of data collection for this report. However, according to the original planning, this assessment is to be performed in May 2019 when relevant technical specifications are released, and certain issues related to the SMART-project are clarified.

17.5.2. Provisions to provide and revoke access to data

Third parties and suppliers need an explicit consent from the customer to access metering data. The customer gives access through written approval which is communicated to and validated by the DSO or a central party. The customer can also use a specific app or website with secured access. Access is revoked by a written form from the customer, communicated to the DSO.

17.6. Consumer impact

17.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No

Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

17.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Accuracy of meters	N/A	yes - a dedicated communication campaign has been launched to address those concerns

17.6.3. Research on consumer benefits

Extensive research and evaluation have been carried out in Lithuania in 2016 and 2017 with the following results:

2016 - research before the start of smart meters project

- The purpose of research: to determine the electricity usage patterns of electricity consumers, the approach to saving and the possible introduction of smart billing;
- 503 respondents were interviewed.

Conclusions:

- 52.5% respondents positively evaluated the proposal to introduce a new metering method at their home for an additional cost-free payment;
- 58.6% respondents said that it would be interesting for them to come up with such a system of metering to choose a new or different tariff plan that was used up to date, which would be more suitable for them;
- 40.4% respondents indicated that saving them most would encourage more information on possible ways to save money.

2017 - research after the start of smart meters project

- The purpose of research: to establish the opinion of smart meters' users about the implementation of this metering method, its advantages and disadvantages, electrical habits and the approach to saving;
- 495 respondents were interviewed

Conclusions:

- Respondents score an average of 9.5 points on the smart metering process
- The total score for the mastery of metering is 9.1 points;
- 93% of respondents didn't have any difficulty;

- 94% respondents considered the advantage of basic intelligent metering that there is no need to write off meter readings. Also, about half of the respondents indicated the advantages of being able to pay bills automatically and tracking online electricity consumption;
- 57% respondents said that a mobile phone devise be used to make even more use of the service.

17.6.4. Communication campaign

A communication campaign was held before the installation of smart meters rolled out during the pilot programme(s). Clients for the pilot project(s) were chosen randomly. During the execution of the programme, email, phone, leaflets, customer's service centres, direct telephone selling calls were used as communications channels.

17.6.5. Advanced consumer services

At the moment, there are no plans to rollout advanced consumer services leveraging the potential of smart metering.

17.7. Conclusions

The goal is to deploy 100% smart metering systems for electricity by 2023. Lithuania is part of the Nordpool area (power market) and with smart meters deployed, it will be easier to communicate the price signals in the retail part to the final customers and also support the integration of decentralised generation and the ever-increasing renewable energy production.

In Lithuania, there has been an elaborated approach to smart metering benefits for the final customer with pre- and after-interviews made in conjunction with a smart metering pilot. The majority of the respondents considered the advantage of basic smart metering that eliminates the need to take manual meter readings. Also, about half of the respondents indicated the advantages of being able to pay bills automatically and tracking online electricity consumption.

17.8. References

Id	Reference description
1	Law on Energy, Article 21
2	Resolution No. XIII-1288
3	General Regulations for the Installation of Electrical Equipment (Order No 1-9)
4	Resolution No. 1210

18. LUXEMBOURG

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Luxembourg.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

18.1. Legal and Regulatory Framework

18.1.1. Market model

In Luxembourg, the deployment targets are defined by the legislator.

Targets mostly apply to Distribution Grid Operators (DSOs) as they are in charge of all related market roles, except for in-home display ownership and installation. These market roles include:

- Meter ownership
- Meter Installation
- Metering data collection
- Metering data storage (Supplier is also responsible for this task)
- Metering data transmission to third parties (Supplier is also responsible for this task)
- Metering data protection officer (Art.37 GDPR; every entity that processes data has their own data protection officer)
- Buyer compensation for technical and administrative losses (the DSO buys energy for losses and this cost is covered through tariffs).

For metering data collection there is convergence towards a single entity. The common platform is Luxmetering GIE, a common "Groupement d'interêt economique" set up by all electricity and natural gas DSOs to manage the smart metering system.

18.1.2. Legal grounds

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. A following revision was submitted to parliament on 19/03/2018; this time no changes were made to the smart meter provisions.[41]

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. This revision introduced the mandate to roll out smart meters.

The two delegated laws that further implement smart metering deployment for electricity and gas are:

- Grand-Ducal regulation "Règlement grand-ducal du 27 août 2014 relatif aux modalités du comptage de l'énergie électrique et du gaz naturel", focused on scope of data content and transmission
- ILR Regulations "Règlement E16/38/ILR du 03 octobre 2016" & "Règlement E16/39/ILR du 03 octobre 2016", focused on technical specifications and organisational specifications.

The primary drivers for smart metering deployment in Luxembourg are:

- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Increase energy efficiency

18.1.3. Smart metering programme financing

The smart meter rollout is financed through the tariffs of the DSOs. The meter belongs to the network manager who charges, as before, a fee (rent) for the meter. The fee charged by the DSO will not increase compared to the current situation.

18.1.4. Recent publications by the NRA

One of the most recent publications of the NRA is a document on functional requirements of smart meters.[42]

18.2. Cost benefit analysis

18.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation

[41] PROJET DE LOI modifiant la loi modifiée du 1er août 2007 relative à l'organisation du marché de l'électricité, CHAMBRE DES DEPUTES, 2018

[42] De la consultation publique du 9 juin 2016 au 19 juillet 2016 sur les fonctionnalites, les specifications techniques et les specifications organisationelles du systeme de comptage intelligent, Institut Luxemburgeois de Regulation, 2016

2016	Consultant (in cooperation with DSOs)	NRA	Positive Net Present Value	Refine deployment scenario
2014	Consultant	Government	Positive Net Present Value	Refine deployment scenario
2011[43]	Consultant	Government	Positive Net Present Value	Comply with Dir. 2009/72

The assessment in 2014 was focused on the final customer perspective. In 2016, an update was made of the deployment cost.

18.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were considered in the assessment: DSO, Supplier, Consumer, BRP, and Producer.

Key parameters for the assessment	
evaluation period of the CBA [Years]	20
billing and metering frequency in the reference case for electricity [times/year]	1
Does this also apply for gas?	Yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A
What is the electricity losses unit cost? [€/MWh]	N/A (in these units). Savings through avoidance of non-technical losses are estimated at 3.6€/metering point, and savings through avoidance of technical losses through energy savings are estimated at 1.8€/metering point
What is the economic lifetime of electricity smart meters? [Years]	20
What is the economic lifetime of gas smart meters? [Years]	20

[43] Etude économique à long terme pour la mise en place de compteurs intelligents dans les réseaux électriques et gaziers au Luxembourg, Pol-Hervé Floch, Hervé Schwartz - Schwartz and Co S.A., 2011

What is the value of the lost load? [€/MWh]	Between 45 to 88 €/MWh, depending on whether it is base- or peak price and on the year.
What is the cost reduction rate due to technological maturity? [%/year]	N/A

18.2.3. Main cost and benefit items

As detailed in the following list, all cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☒ OPEX - Consumer engagement programme

Note that the Call Centre is not considered as a cost, but as a benefit by Luxembourg, assuming that more efficient client support leads to cost savings.

Furthermore, half of the benefits are considered. In the following list, an overview of the benefits as described by the European Commission (in its Recommendation 2012/148/EU) are given.

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
☐ Provision of explicit flexibility services (rather based on a request than a price signal)
☐ Increased competition in retail market
☐ Easier access to photovoltaic production
☒ Meter reading & operation savings
☒ Operation & maintenance of assets
☐ Distribution capacity deferral
☐ Transmission capacity deferral
☐ Generation capacity deferral
☒ Technical losses reduction
☒ Non-technical (administrative, including fraud) losses
☐ Outage management (based on societal value of lost load)
☐ Outage management (based on reduced customer indemnification)
☐ CO_2
☐ Air pollution (particulate matters, NOx, SO_2,...)

18.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for electricity and gas:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	263182(electricity) / 77727 (gas)
actualised CAPEX for the whole evaluation period	€41.261.941
actualised OPEX for the whole evaluation period	€6.257.836
Actualised net benefits for the whole evaluation period	€6.600.000 (incl. energy savings for customers

The resulting ratios have been computed in per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- CAPEX per meter: €121
- OPEX per meter: €18
- Net Benefits per meter: €158

18.2.5. Deployment strategy and latest statistics

The legislator foresees in his provisions the oversight of the rollout which is being delivered by the DSO. The target is to have 95% of the meters in electricity installed by 31 December 2019, and for the gas meters the installation should be completed with 90% by 31 December 2020.

The deployment is mandatory for all consumers. Replacement and installation of the new meter will be done free of charge for the customer. This installation is part of the costs of managing the network in the same way as all our work related to the modernization of our infrastructures.

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017. For Luxembourg there is no distinction made for the metering points between SMEs and households.

State of play of smart metering deployment in at as of 1/1/2018	Electricity households and Electricity SME	Gas households and Gas SME
Number of smart meters	75.847	14.723
Number of connection points equipped with smart meters	Not available	Not available
Total number of meters	300.499	88.527
Total number of connection points	168.620	89.130

Number of smart meters that does not communicate (de-activated upon specific consumer request)	0 (customer cannot request a deactivation of the communication)	0 (customer cannot request a deactivation of the communication)
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	33312 (only because they are not connected yet, they will start communicating when the rollout proceeds)	14.541
Number of smart meters that does communicate default metering data	42.535	182
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	Not available	Not available

Deployment outcomes in 2017	**Electricity households and Electricity SME**	**Gas households and Gas SME**
Yearly installation target		
Number of visits to consumer premises	76.670	14.865
Number of installed smart meters	75.847	14.723
Number of deactivated smart meters	0	
Number of refusals	206	13

18.3. Functional specificiations

Most of the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are implemented, being activated by default and free of charge for the consumer, with the only exemption of functionality 'a', that is 'provide readings directly to the customer and any third party designated by the consumer'.

These readings are only available to consumer on the on-meter screen and through the P1 port. The on-meter screen displays the most important values with a change every 5 seconds. In addition, customers can access the data available at the P1 port after receiving the encryption key from the DSO. This encryption key is free of charge, however there is a cost for the device that can read out this port. In addition, the readings can only be forwarded to a third party using the P1 interface.

The other functionalities are technically available; however, the market conditions for some functionalities are not in place yet.

In the following table, information is given about the period the data can be stored, the granularity and the frequency that the consumption data is updated.

Level of the…	History	Granularity	Frequency of consumption update
DSO	up to 15 years	15 min. (electricity) 1 h (natural gas)	24 hours
Supplier	up to 15 years	15 min. (electricity) 1 h (natural gas)	24 hours
Central data hub	N/A	N/A	N/A
Smart meter	up to 15 years	15 min. (electricity) 1 h (natural gas)	10 second (electricity) 1h (natural gas)

The smart metering data must be made available to the consumer either via the smart meter or via a supplier's web portal, if available.

Third parties can only get access to the smart meter data if the customer gives access to this data.

18.4. Technical specifications

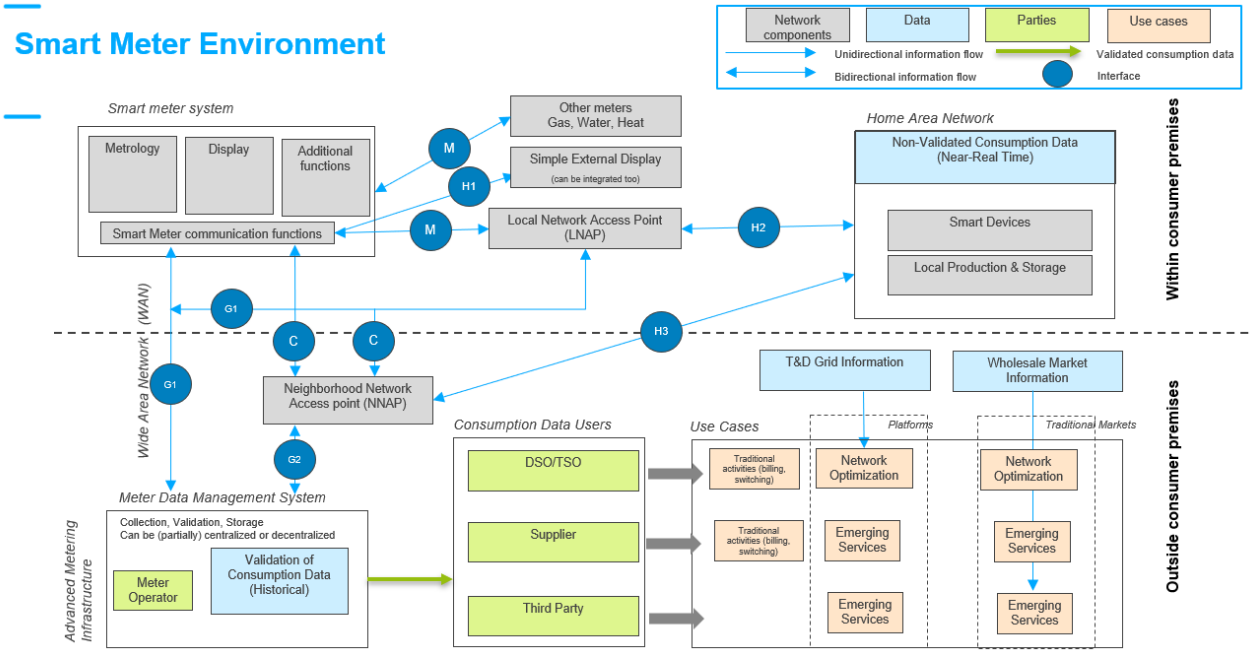
In respect to the following figure that gives a representation of the functional architecture for communications in a smart metering environment, the interfaces are open to the decision of the DSO.

The P1 port Interface is available on all the smart electricity meters in Luxembourg. Any In-home Display or Home Server solution which fulfils certain national specifications should be able to be interfaced with the E-Meter T210-D meters. The In-Home Display, according to these specifications, consist of a wireless or wired solution that supports the P1 Data Output communication protocol and format as specified in the "Dutch Smart Meter Requirements v5.0.2 Final P1". The solution deployed in Luxembourg includes an additional security layer standard that is conform to the IDIS package 2.0 requirement, which enables the maintainability of the solution.[44]

[44] P1 Port Specification for Luxembourg's electricity meter "Smarty", CREOS

The selected technologies for the different interfaces are as follow:

- G1: GPRS 2G/ LTE 4G between meter and central system. DLMS COSEM security suite 1.
- G2: GSM 2G/3G/LTE 4G or ethernet
- H1: based on Dutch standard DSMR 4.2.1. (based on IEC 62056-212). A companion profile for P1 (H1) is available for all DSO's.
- H2: LNAP implemented in e-meter
- C: PLC 3G to concentrator. DLMS COSEM security suite 1.
  H3: optional for DSO Smartgrid system feeding
  M: OMS 4.0.2 between e-meter and Mbus devices



18.5. Data management

18.5.1. Data access and privacy framework

Within Luxembourg the decision for smart metering deployment was already taken before the European Commission advised on a data protection impact assessment, therefore there is no privacy framework in place. However, the data protection commission did give an opinion on the Grand-Ducal regulation on metering.[45]

Third parties and suppliers need an explicit consent from the customers to access their metering data. A customer can give access to his metering data through a written approval or by delegating it to a third party or a supplier as part of a service contract (no independent party to double check, the DSO will simply execute the request for metering data)

[45] Avis de la commission nationale pour la protection de données relative au projet de règlement grand-ducal relatif aux modalités du comptage de l'énergie électrique et du gaz naturel, CNDP, 2013

18.5.2. Provisions to provide and revoke access to data

Only, the grid operator concerned, the customer's electricity or natural gas supplier and, if applicable, a service provider designated by the consumer have access to the customer's data. The authorised purposes for processing data are strictly defined by law, which also ensures that data cannot be forwarded to a third party without the prior agreement of the consumer. However, at the moment of collecting information for the present report, it appeared that no process was yet in place to revoke access to metering data. The supplier has access as long as they are the registered supplier of the point of delivery.

18.6. Consumer impact

18.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Please note that in Luxembourg the smart meters are not activated yet. The provision of load curves to suppliers is currently being tested (august 2018) and not yet operational for commercial purposes. Therefore, only a limited number of services is available in the market at this moment.

Description of service	Available or foreseen in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill LU the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	Yes
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes

Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

18.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	general public resistance to smart metering but lack of objective grounds	no
Electromagnetic radiation	general public resistance to smart metering but lack of objective grounds	yes - publication of the test results and methods
Accuracy of meters	general public resistance to smart metering but lack of objective grounds	No, the study that was published in the newspaper in Luxembourg was about a different smart meter than the one used in Luxembourg.
Price of meters		
Installation barriers		

18.6.3. Research on consumer benefits

Luxembourg has conducted research about customers and their ability to realize the smart metering benefits. No details of this investigation were provided when writing this report.

18.6.4. Communication campaign

A dedicated communication campaign has been developed by the DSOs. Leaflets are being handed out to consumers who receive a smart meter, and a website (www.smarty.lu) was set up.

18.6.5. Advanced consumer services

There is no information available on advanced consumer services.

18.7. Conclusions

In Luxembourg, the deployment targets are defined by the legislator. Targets mostly apply to Distribution Grid Operators (DSOs) as they are in charge of all related market roles, except for in-home display ownership and installation.

For metering data collection, there is convergence towards a single entity. The common platform is Luxmetering GIE, a common "Groupement d'interêt economique" set up by all electricity and natural gas DSOs to manage the smart metering system.

Primary drivers for smart metering deployment are the opportunities it presents for the digitization of the energy grid and market, as well as for supporting energy efficiency programmes.

Over the past years, three CBAs have been developed, all yielding a positive net present value. The assessment in 2014 was focused on the point of view of the final customer. In 2016, an update was made of the deployment cost.

The legislator has set up provisions to oversee the rollout which is being delivered by the DSO. The target is to have 95% of the meters in electricity installed by 31 December 2019, and for the gas meters the installation level should reach 90% by 31 December 2020.

The deployment is mandatory for all consumers. Replacement and installation of the new meter will be done free of charge for the customer. This installation is part of the costs of managing the network and in line with the work done for the modernization of the network infrastructure.

Most of the 10 key functionalities recommended by the European Commission are implemented, being activated by default and free of charge for the consumer, with the only exemption of functionality 'a', that is to 'provide readings directly to the customer and any third party designated by the consumer'.

The other functionalities are technically available; however, the market conditions are not yet in place to exploit some functionalities.

Technical specifications for all smart metering interfaces are open to the decision of the DSO.

Within Luxembourg the decision for smart metering deployment was already taken before the European Commission advised on a data protection impact assessment, therefore there is no specific privacy framework. Third parties and suppliers need an explicit consent from the customer to access its metering data. There is no apparent process foreseen, or already in place, at least based on the information available, to revoke access to metering data. The supplier has access as long as they are the registered supplier of the point of delivery.

The smart meters in Luxembourg have not been activated yet. The provision of load curves to suppliers is currently being tested (august 2018) and not yet operational for commercial purposes. Therefore, only a limited number of services is available in the market at this moment.

18.8. References

Id	Reference description
1	PROJET DE LOI modifiant la loi modifiée du 1er août 2007 relative à l'organisation du marché de l'électricité, CHAMBRE DES DEPUTES, 2018
2	De la consultation publique du 9 juin 2016 au 19 juillet 2016 sur les fonctionnalites, les specifications techniques et les specifications organisationelles du systeme de comptage intelligent, Institut Luxemburgeois de Regulation, 2016
3	Etude économique à long terme pour la mise en place de compteurs intelligents dans les réseaux électriques et gaziers au Luxembourg, Pol-Hervé Floch, Hervé Schwartz - Schwartz and Co S.A., 2011
4	P1 Port Specification for Luxembourg's electricity meter "Smarty", CREOS
5	Avis de la commission nationale pour la protection de données relative au projet de règlement grand-ducal relatif aux modalités du comptage de l'énergie électrique et du gaz naturel, CNDP, 2013

19. MALTA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Malta.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

19.1. Legal and Regulatory Framework

19.1.1. Market model

In Malta, there are no national network-based energy services other than electricity. In the absence of a natural gas network, the analysis has been carried out only concerning smart electricity meters deployment.

Regarding the electricity network, there is no transmission system in place and thus not even a Transmission System Operator (TSO). Enemalta Plc, as a vertically integrated power utility, is the single Distribution System Operator (DSO) and it is not subjected to unbundling. In fact, it performs the functions of the DSO and it is as well the sole supplier of electricity to final customers. Meter reading, billing and the handling of customer relations are performed by Automated Revenue Management Services (ARMS) Ltd., which is a subsidiary company owned and controlled by Enemalta plc and the Water Services Corporation. Therefore, the retail market is not open to competition and all customers remain on a regulated retail tariff.

The Regulator for Energy and Water Services Act entered into force on 31st July 2015. The Act provides for the establishment of a Regulator, known as the Regulator for Energy and Water Services (REWS) with the regulatory functions relating to energy and water services previously handled by the Malta Resources Authority (MRA). The Regulator's functions include the monitoring of the development of the distribution network through specific reports required by licence.

The Maltese Ministry, responsible for Enemalta Plc, is legally entitled to define deployment targets and conditions for the energy sector and thus for smart electricity meters as well.

Ownership and installation of meters and home displays belong to Enemalta Plc (DSO), as well as buyer compensation for technical and administrative losses. Metering data collection, storage and transmission to third parties are under the responsibility of both Enemalta Plc and ARMS Ltd. In particular, ARMS Ltd is the designated Data Processor for Enemalta Plc and performs meter reading, billing and the handling of customer relations. It is also responsible for the metering data protection, in compliance with the General Data Protection Regulation (GDPR).

19.1.2. Legal grounds

The primary laws that enable smart metering for electricity are the Subsidiary Legislation 545.13 on Electricity Market Regulations (S.L. 545.13) and the Subsidiary Legislation 545.01 on Electricity Supply Regulations (S.L. 545.01).

Regarding Electricity Market Regulations, the Legal Notice 166 of 2011 transposes the provisions of Directive 2009/72/EC (Article 3 (5) (b)). The Legal Notice 52 of 2010 amends the Electricity Supply Regulations, seeking to facilitate smart metering deployment, mainly with reference to access to customer premises.

The roles of the Regulator and the DSO in smart metering deployment are defined in the Electricity Market Regulations[1] (S.L. 545.13). The Regulator is responsible for the optimised use of electricity by also promoting energy efficiency through the adoption of related measures, including the introduction of *"intelligent metering systems"*. The DSO, according to the national legislation, should ensure the implementation of an *"intelligent metering system"* and assist the active participation of consumers in the electricity market. In addition, the DSO should ensure the interoperability of those metering systems and shall have due regard to the use of appropriate standards and best practice and the importance of the development of the internal market in electricity.

Furthermore, the S.L. 545.13 disposes that the implementation of those metering systems must be subjected to an economic assessment of all the long-term costs and benefits to the market and the individual consumer, which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution.

As of 1/1/2019, although an economic assessment has not yet been carried out, the following benefits deriving from smart meters implementation have been identified: remote reading exempt from the need to access customer premises, theft control, increased frequency of bills based on actual reading ensuring accuracy.

19.1.3. Primary drivers

Enabling dynamic tariffs for households and SMEs, integrating decentralized energy resources with flexible access (load shedding, infeed curtailment) and reducing the need of manual operation on sites, through remote activity to and from the smart meters are the main drivers for smart metering deployment in Malta.

19.1.4. Smart metering programme financing

There is no direct charge to customers for the smart metering rollout; the smart meters are financed through the electricity tariffs.

19.1.5. Recent publications by the NRA

The latest publication[2] on smart metering deployment is the "Malta's Report to the European Commission on the Implementation of Directive 2009/72/EC, Directive 2009/73/EC and Directive 2005/89/EC" published by the Maltese Regulator on 31st July 2018.

19.2. Cost benefit analysis

19.2.1. Relevant study

In Malta the investment decision was taken prior to 2009, and no Cost-Benefit Analysis (CBA) has been conducted since then.

19.2.2. Market roles and key parameters

No CBA conducted.

19.2.3. Main cost and benefit items

No CBA conducted.

19.2.4. CBA results

No CBA conducted.

19.2.5. Deployment strategy and latest statistics

Malta was one of the first Member States in the EU to proceed with the implementation of smart meters, even before the respective Directive was drafted, according to the national authorities[3].

The electricity meters replacement programme continued in 2017. The results of smart metering deployment in Malta for both households and Small-Medium Enterprises (SMEs), as of 1/1/2018, are resumed in the following table:

State of play of smart metering deployment in Malta as of 1/1/2018	Electricity households	Electricity SMEs
Number of smart meters	264,634	44,653
Number of connection points equipped with smart meters	243,508	43,361
Total number of meters	269,025	48,722
Total number of connection points	247,899	47,430
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	N/A

Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	52,155	13,420
Number of smart meters that does communicate default metering data	212,479	31,233
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	212,479	31,233

Therefore, globally, for electricity households and SMEs customers, there are 309,287 smart meters out of 317,747 meters installed and 286,869 connection points equipped with smart meters out of a total of 295,329 existing connection points in Malta. Electricity smart metering has hence reached a very high degree of penetration in the country, with 97% of traditional meters replaced with smart meters.

In particular, the following results in terms of smart meters annual deployment were achieved in 2017:

Deployment outcomes in 2017	**Electricity households**	**Electricity SMEs**
Yearly installation target	10,000	2,500
Number of visits to consumer premises	14,783	4,917
Number of installed smart meters	11,772	3,862
Number of deactivated smart meters	798	292
Number of refusals*	3,011	1,055

*Enemalta Plc refers to refusals as the number of operations that for one reason or another were not successfully completed (e.g. no access to the meter, closed premises, physical space constraint etc.). In 2017, there were 4,066 refusals in total.

As the table shows, the originally set 2017 yearly installation targets have been exceeded in Malta, with a total of 15,634 smart meters installed and 1,090 deactivated, in both households and SMEs.

A voluntary rollout for smart metering systems was launched by Enemalta Plc for the first time in 2009 and started with a pilot phase, followed by a mandatory rollout to all consumers (with no exceptions) in 2010, with the main aim to reduce the costs of bi-monthly billing and non-technical losses[5].

According to Malta's National Energy efficiency Action Plan (NEEAP 2017)[3], the rollout of smart meters for electricity is practically complete. The original target for Malta was to deploy 260,000 smart meters with an expected diffusion rate of 100% by 2020[4].

In general, households provided with an Advanced Meter Management (AMM) smart meter receive bills based on actual readings on a bi-monthly basis, while households not provided with a smart meter yet, receive bills calculated on actual consumption at least every six months. The frequency of actual bills for non-household consumers varies from one month to six months[2].

19.3. Functional specificiations

All but one key functionality recommended by the Commission (Recommendation 2012/148/EU) are currently available and foreseen in Malta, as reported in the table below:

FUNCTIONALITIES TABLE	Foreseen and available (but not necessarily activated)	Activated by default	Free of charge for the customer
FUNCTION A: Provide readings directly to the customer and any third party designated by the consumer	☐	☒	☒
FUNCTION B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings	☒	☐	☒
FUNCTION C: Allow remote reading of meters by the operator	☒	☐	☐
FUNCTION D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☐	☐
FUNCTION E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☐	☒
FUNCTION F: Support advanced tariff system	☒	☐	☐
FUNCTION G: Allow remote on/off control of the supply and/or flow or power limitation	☒	☐	☐
FUNCTION H: Provide secure data communications	☒	☐	☐

FUNCTION I: Fraud prevention and detection	☒	☒	☒
FUNCTION J: Provide import/export and reactive metering	☒	☒	☒

The only functionality that is activated by default is the one covering the provision of readings directly to the customer (Functionality A); this is free of charge for the customer. At present, customers may access consumption data from bills on the Enemalta Plc web portal, while third parties do not have any access to customers' consumption data.

In this regard, in order to help customers modulate their energy behaviour, which is currently seen as a great challenge for the smart metering deployment programme in Malta, the DSO Enemalta Plc, through its billing partner ARMS Ltd, is making efforts to provide relevant information to the customers via a web interface. The respective portal shall be known as "My Consumption". Regarding the target for energy efficiency improvement no savings are being attributed to this measure until a more robust assessment is carried out (NEEAP 2017)[3].

Concerning Functionality B, customers have access both to their historical consumption data (bills) and to real time consumption data via quarterly readings (15 min interval).

According with Functionality C that allows remote reading of meters by the operator, the meter can be read by the meter operator for regular billing. The Maltese operator has implemented a pull (on demand by the operator) remote reading on smart meters.

Being one of the most critical infrastructures, there is currently no link between the Smart Metering System and any other external network or system in Malta. The Automated Meter Management (AMM) System itself has its own diagnosis tools and reports that allow monitoring, maintenance and control (Functionality D).

Load profile data are updated every 15 minutes and used for network planning (Functionality E).

The smart electricity meters currently deployed around the island are capable to have configured different tariff schemes, billing periods, and dynamic time-of-use. Therefore, Functionality F is forseen but not activated yet.

The smart metering system allows for complete cut off and load limitation, if the consumer does not pay the bill (Functionality G).

Concerning fraud prevention and detection (Functionality I), smart meters are equipped with distinct sensing mechanisms that trigger alarms on the system for further action by Enemalta Plc. In particular cases, the meter is also programmed to switch-off when it senses tampering; this function is accordingly activated.

The smart meter can register imports and exports separately. Smart electricity meters are able to measure reactive power and grid injection separately from withdrawals (Functionality J).

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which they are updated has been provided and is as follows:

	History	Granularity	Frequency
DSO	2 years	15 minutes	10 minutes
Supplier	2 years	15 minutes	10 minutes
Central Data Hub	2 years	15 minutes	10 minutes
Smart Meter	28 days	15 minutes	10 minutes

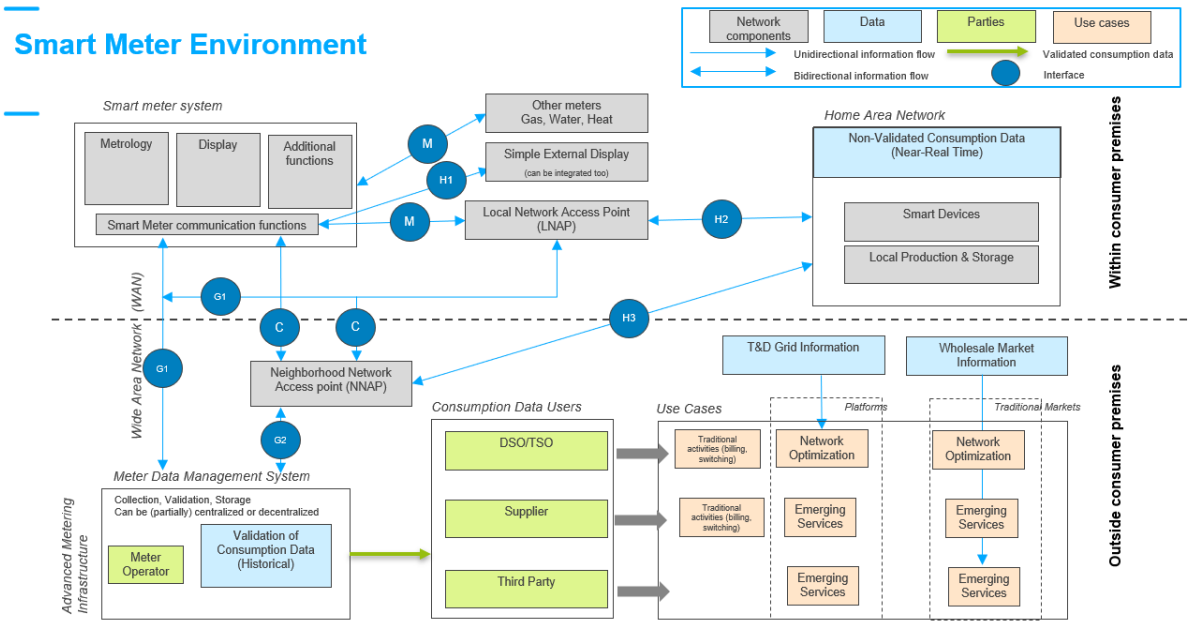
Whilst the Smart Meter itself can store 28 days' worth of load profile data, the DSO (Enemalta Plc, which is consistent with the Supplier) can access both historical and granular data from the Central Data Hub (Meter Data Management System) for a period of 2 years.

In Malta, each distribution infrastructure is and will have to be metered separately. Smart metering is thus not intended to be used in community-based distribution systems.

Finally, the main reason whereby a functionality could not be foreseen is due to the main drawback of the communication medium PLC, that is its noise on the grid. Indeed, in particular instances, this makes it difficult for the central system to connect to the meter.

19.4. Technical specifications

The figure below shows a schematic representation of the functional architecture and communications in a smart metering environment, where the differences interfaces are indicated.



The H2 interface is the only interface planned to be implemented on smart meters in Malta.

The standard adopted for Malta's Smart Metering System is Power Line Carrier (PLC), being the most widely adopted communication medium among utilities, at the time of proposal (2006-2009).

The major technological constraint shaping the deployment policy is related to PLC communication, which is susceptible to noise and impedance in the grid, making it a difficult task to model the physical channel and therefore choose the proper modulation technique. In various instances, Enemalta Plc had to deploy filtering techniques amongst other operations to safeguard the smooth operations of this medium.

Besides PLC-related problems, there are no other detected technical constraints, but rather actual physical issues posing difficulties in the smart meters deployment in Malta (e.g. challenges with storage space for more smart meters), which are strictly related to the relatively small geographical area of the island of Malta.

In addition to the PLC channel, a second communication radio channel (RF 169 MHz) from the 2nd Generation meters to the 2nd Generation data concentrator is being implemented on the C interface. This channel is used as a back-up of the primary PLC channel and for the acquisition of real-time supply interruptions. With this, Enel (and now Enemalta) are aiming to establish a communication channel with the metering units that up till now were not being reached via PLC.

The 2nd Generation of meters have now also a 2nd separate communication channel towards any consumer energy management system (i.e. in-house display systems, smart phones and other devices). The combinations of such technologies achieve performance levels consistent with those indicated for the 2nd Generation of Meters in resolution 87/2016/R/eel:

- A-band PLC combined with RF169 MHz (as a backup).

- C-band PLC, with an available second channel.

The two communication channels on PLC (bands A and C as per the CELENEC technical standard) used in the two chains are independent on each other, thus avoiding any possible cross-talking or interference between the two.

The 2nd Generation smart metering technology being installed in Malta is based on Enel's Telegestore Network.

19.5. Data management

19.5.1. Data access and privacy framework

Third parties do need explicit consent from the Customer to access his/her metering data.

Concerning privacy and data protection, a Data Protection Impact Assessment was finalized in October 2017, but it is not publicly available.

Enemalta Plc has appointed ARMS Ltd as full-time Data Protection Officer. The company informs that a general Standard Operating Procedure (SOP) has been designed to support employees working with data follow the new practices in line with applicable EU rules on data protection. This was also complemented by dedicated training given to all Enemalta personnel on GDPR and its core principles.

In order to avoid processing customer personal information, core systems are technically designed and configured in a way whereby all live data can be masked and mapped accordingly.

The following main risks associated to data management have been identified:

1. Data Retention Period
2. Internal practices concerning the management of data within the system

3. Data masking/mapping
4. IUBS – Integrated Utility Business Solution
5. Resistance to change

19.5.2. Provisions to provide and revoke access to data

The Customer can give and/or revoke access to his/her metering data by providing a written and signed consent to the DSO, which provides the data.

19.6. Consumer impact

19.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Maltese market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No

Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

19.6.2. Consumer concerns

At present, no study about consumer concerns has been officially performed in Malta.

19.6.3. Research on consumer benefits

A specific research on consumers' ability to realize the smart metering benefits has not been conducted so far.

19.6.4. Communication campaign

In Malta, different measures have been available over the last years to promote consumers' energy behavioural change ranging from financial incentives to information campaigns; the latter has been the main tool for encouraging energy efficiency among small energy consumers.

In particular, as for measures facilitating consumers' engagement during the rollout of smart meters, an information campaign, comprising billboards, explanatory leaflets, delivery of a 'smart meter manual' including guidelines for use, as well as specific instructions provided by the installer to the consumer, was conducted (NEEAP 2017)[3].

Details on smart metering and the related functions and benefits can also be found on the ARMS Ltd and Enemalta Plc websites. Furthermore, Enemalta Plc provides access to a freephone number in case of any queries.

19.6.5. Advanced consumer services

While distributed generators are already provided with a smart meter, no information about other initiatives leveraging smart metering to support advanced services such as the integration of other technologies are currently available.

19.7. Conclusions

In Malta, there is no natural gas network and the rollout of smart meters for electricity is practically complete. In fact, according to Malta's NEEAP, the set target is to deploy 100% smart meters nation-wide by 2020. On 1/1/2018, the electricity smart metering has already reached a very high degree of penetration in the country with 97% of traditional meters replaced with smart meters.

Malta is working on the deployment of smart metering systems principally in order to enable dynamic tariffs for households and SMEs, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment) and to reduce the need of manual operation on sites, through remote activity to and from the smart meters.

In the case of Malta, no CBA on smart metering implementation has been identified.

Concerning privacy and data protection, a Data Protection Impact Assessment was finalized in October 2017, but it is not publicly available. ARMS Ltd was appointed as the Data Protection Officer and a general Standard Operating Procedure (SOP) has been designed, aimed to support those working with energy data, and stay in line with the GDPR requirements. Furthermore, the Data Protection Officer has identified some risks related to data management, namely:

1. Data Retention Period
2. Internal practices concerning the management of data within the system
3. Data masking/mapping
4. IUBS – Integrated Utility Business Solution
5. Resistance to change

In Malta, all the minimum functionalities required are already in place for electricity smart meters. Besides those, the Maltese market provides further type of services, such as:

- **Bill forecasting:** use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month
- **Unusual usage alert:** alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services
- **Historical consumption:** Provide access to historical data consumption in order to compare weekly or monthly consumption over time.
- **Smart meter to ease charging of Electric vehicles at home (advanced)**: Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)

Maltese authorities report that they have undertaken an extensive communication campaign during the rollout of smart meters, aimed at facilitating consumers' engagement and promoting energy behavioural change.

19.8. References

Id	Reference description
1	Subsidiary Legislation 545.13 on Electricity Market Regulations - https://www.enemalta.com.mt/wp-content/uploads/2018/03/Electricity-Market-Regulations-.pdf
2	"Malta's Report to the European Commission on the Implementation of Directive 2009/72/EC, Directive 2009/73/EC and Directive 2005/89/EC" - https://www.ceer.eu/documents/104400/5988265/C17_NR_Malta-EN.pdf/e76e7c95-6822-7c2d-7ed8-a4f25fa9810b
3	Maltese National Energy efficiency Action Plan (NEEAP 2017) - https://ec.europa.eu/energy/sites/ener/files/documents/mt_neeap_2017.pdf
4	SWD(2014) 199 - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0189&from=EN
5	SWD(2014) 188 - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0188&from=en

20. THE NETHERLANDS

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in the Netherlands.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

20.1. Legal and Regulatory Framework

20.1.1. Market model

In the Netherlands, the Ministry of Economic Affairs and Climate Policy is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to distribution grid operators (DSOs) as they are in charge of meter ownership, installation and data collection and protection.

In the Netherlands, a Central Data Hub is responsible for the collection and storage of metering data. Currently this is the responsibility of NEDU/EDSN that is organised by the energy sector. Furthermore, the supplier is responsible for buyer compensation for technical and administrative losses, although legislation is currently, in 2018, being changed to allocate this to DSOs. The consumers are responsible for everything 'behind the meter'.

20.1.2. Legal grounds

The primary laws that frame the smart metering deployment 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 (in 2018) under revision.

A delegated law that further implements smart metering deployment for electricity is the 'Besluit op afstand uitleesbare meetinrichtingen ten behoeve van de grootschalige uitrol van de slimme meter' (translates to: Decision on remote readable metering devices for the large-scale roll-out of smart meters'). In this law, the responsibilities of parties, metering tariffs, functionalities, and consumer rights are described.

20.1.3. Primary drivers

There are five drivers for the smart metering deployment:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Increase energy efficiency

20.1.4. Smart metering programme financing

In January 2018, when the tariffs were regulated, customers started with paying a fee for the traditional meters. To avoid high cost changes, the Netherlands already calculated the cost of a smart meter in their pre-deployment prices. Therefore, customers do not have to pay a higher fee for their smart meter. They only pay the already existing annual fee. The fee is regulated by the Autoriteit Consument en Markt (ACM).

20.1.5. Recent publications by the NRA

The most recent document published by the NRA is a document about the pace of the smart meter rollout and the choice that consumers have for dynamic supply tariffs.[46]

20.2. Cost benefit analysis

20.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2010	Consultant	Government	Positive Net Present Value	Comply with Dir. 2009/72
2005	Consultant	Government	Positive Net Present Value	Comply with Dir. 2009/72

[46] Kamerbrief over tijdpad uitrol slimme meter en dynamisch leveringstarieven, Rijksoverheid, 2014 https://www.rijksoverheid.nl/onderwerpen/slimme-meter/documenten/kamerstukken/2016/03/04/kamerbrief-over-tijdpad-uitrol-slimme-meter-en-dynamische-leveringstarieven.

The methodology for the cost-benefit analysis in 2010 followed closely that of the 2005 study, while incorporating important interim changes, such as the options of refusing a smart meter or having it turned off administratively. The cost level has also been amended in line with later insights (including the costs for privacy and security). Moreover, the energy savings percentage has been substantiated in more detail and the possible contribution of a smart metering infrastructure to a future smart grid has been taken into consideration.[47]

20.2.2. Market roles and key parameters

In accordance with the national market model described above, the following market roles were considered in the assessment: DSO, Supplier, Consumer and State/society, TSO, Producer and Metering Company.

Key parameters for the assessment	
evaluation period of the CBA [Years]	50 years
billing and metering frequency in the reference case for electricity [times/year]	6
Does this also apply for gas?	yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	4%
What is the electricity losses unit cost? [€/MWh]	191
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	18.000
What is the cost reduction rate due to technological maturity? [%/year]	3,33%

20.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been considered, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with the only exception of unplanned renewal and failures of smart meter and of the customer engagement programme.

- ☒ CAPEX - Investment in smart meter
- ☒ CAPEX - Investment in IT
- ☒ CAPEX - Investment in Telecom
- ☒ CAPEX - Investment in In-home display
- ☒ CAPEX - Sunk cost of conventional meters
- ☒ OPEX - IT maintenance
- ☒ OPEX - Network management and front end

[47] Smart meters in the Netherlands Revised financial analysis and policy advice, KEMA 2010

☒ OPEX - Telecom
☒ OPEX - Change management
☐ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call center and customer service
☐ OPEX - Consumer engagement programme

Other costs that are considered are the cost of the time of consumer that is needed to install the smart meter, the OPEX of the installation and the cost of a higher frequency of billing by supplier.

Furthermore, most of the suggested benefits (Recommendation 2012/148/EU) are also considered. In the following list, an overview of the benefits as described by the European Commission are given.

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)
☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)
☒ Provision of explicit flexibility services (rather based on a request than a price signal)
☒ Increased competition in retail market
☐ Easier access to photovoltaic production
☒ Meter reading & operation savings
☒ Operation & maintenance of assets
☒ Distribution capacity deferral
☒ Transmission capacity deferral
☒ Generation capacity deferral
☒ Technical losses reduction
☒ Non-technical (administrative, including fraud) losses
☒ Outage management (based on societal value of lost load)
☒ Outage management (based on reduced customer indemnification)
☒ CO2
☐ Air pollution (particulate matters, NOx, SO2, ...)

In the 2010 version of the CBA, the benefits 'Provision of explicit flexibility services (rather based on a request than a price signal)', 'Distribution capacity deferral' and 'Transmission capacity deferral' were added. Additionally, an important change in policy compared to the first cost-benefit analysis is that a standard situation is assumed in which the meter can be read only to a limited extent and in which privacy aspects do not play an important role.

20.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment:

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	1213028
Actualised CAPEX for the whole evaluation period	N/A

Actualised OPEX for the whole evaluation period	N/A
Actualised benefits for the whole evaluation period	N/A

In the reference situation (which includes 100% acceptance of smart meters), a positive business case with a net present value of 770 million euros is calculated in the CBA. The primary benefits are energy savings, savings on call centre costs, and less costs per meter readings.

20.2.5. Deployment strategy and latest statistics

The Ministry of Economic Affairs and Climate policy is overseeing the rollout which is being delivered by the DSOs. The target is to complete the rollout by 2020. This means that every household and SME in the Netherlands must be offered a smart electricity and gas meter by then. However, since offering a smart meter is mandatory, but the acceptance is voluntary, the installation target is 80% or higher.

Residential and small business customers in the Netherlands are not obliged to accept a smart meter. Customers who object to the installation of the smart meter can either have the communication of the smart meter deactivated, or even refuse the installation of the smart meter. If the meter is administratively off (deactivated), the smart meter will function like a traditional meter. In case of refusal, the old electricity meter (and gas meter) will remain in place, and the meter reading will not be done remotely. In case of acceptance, the consumer will have the choice to have the smart meter read remotely at all times or in specific situations (for the annual bill and bi-monthly home energy reports, in case of switching supplier or when moving to a new house).

The definition of the target group who are offered smart meters, is: all customers with an active and measured connection point in the regulated market in the Netherlands (households and Small and Medium Enterprises). Therefore, connection points that are not active or not measured, are not in the target group.

No technical constraints have been observed that are fundamentally shaping the deployment policy.

The following tables highlight the latest statistics, showing respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in NL as of 1/1/2018	**Electricity households**	**Electricity SME**	**Gas households**	**Gas SME**
Number of smart meters	3,6 million	0,4 million	3,1 million	0,3 million
Number of connection points equipped with smart meters	3,6 million connection points	0,4 million	3,1 million	0,3 million

Total number of meters	7,7 million	0,9 million	6,6 million	0,7 million
Total number of connection points	7,7 million	0,9 million	6,6 million	0,7 million
Number of smart meters that does not communicate (de-activated upon specific consumer request)	43.000	5.000	37.000	4.000
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	33,000	4,000	28,000	3,000
Number of smart meters that does communicate default metering data	3,5 million	0,4 million	3,0 million	0,3 million
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0,6 million	0,1 million	0,5 million	0,1 million

Deployment outcomes in 2017	**Electricity households**	**Electricity SME**	**Gas households**	**Gas SME**

Yearly installation target	1,0 million	111.000	0,85 million	95.000
Number of visits to consumer premises	1,2 million	138.000	1,05 million	118.000
Number of installed smart meters	1,0 million	114.000	0,85 million	97.000
Number of deactivated smart meters	14.000	1.600	12.000	1.300
Number of refusals	110.000	12.000	94.000	10.000

To get to these numbers the following assumptions were made:

- The assumption that the rate of households versus small and medium enterprises is 90:10 (by type of connection points). In accordance with the market model in the Netherlands, it is the energy supplier that can accurately distinguish his customers as households or SMEs (on the basis of their contracts), whereas the grid operator only knows the type of connection points.
- The rate of smart meters vs connection points is 1:1 in the Netherlands
- In 2017, 18% of the customers with a smart meter had an 'energy consumption manager'. Note that in this study no distinction is made between Electricity (E) and Gas (G) meters, and households and SMEs.[48]
- The rate between E and G meters is 10:8,5
- Deployment numbers for 2017 are based on the Aanbiedmonitor[49]

20.3. Functional specificiations

In the Netherlands, not all 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are implemented, being activated by default and free of charge for the consumer with the clear intent to maximise smart metering deployment benefits.

Two of the functionalities are not available, namely:

- g) Allow remote on/off control of the supply and/or flow or power limitation
- i) Fraud prevention and detection

Other functionalities can only be activated if the consumer agrees or pays for them.

- c) Allow remote reading of meters by the operator - Only if the customer agrees with it

[48] Rijksdienst voor Ondernemend Nederland, Marktbarometer Aanbieding Slimme Meters - Voortgangsrapportage 2017, June 2018. https://zoek.officielebekendmakingen.nl/blg-847929

[49] Aanbiedmonitor 2017, Ministerie EZK GSA

- e) Allow readings to be taken frequently enough for the information to be used for network planning - Only if the customer agrees with it
- a) Provide readings directly to the customer and any third party designated by the consumer - This possibility comes with the smart meter, but the hard- and soft-ware needed to read out the meter has to be installed by the customer or a third party

In the Netherlands, a national companion specification has been defined and is supported by several manufacturers (DSMR[50]). In that context, the P1 port is covering the functional specification of interfaces H1 H2 and H3. The Dutch Smart Meter Architecture defines ports (P1 to P4) as a means on which communication takes place between two instances.

- P1 is used for connecting the smart meter to third party hard/software.
- P2 is used to connect to a gas or water meter.
- P3 connects (most commonly via GPRS) with the DSO.
- P4 is on the DSO's site and allows suppliers and/or third parties to connect to and to gather data from a customer.

In the following table, information is given about the period the data can be stored, the granularity and the frequency that the consumption data is updated.

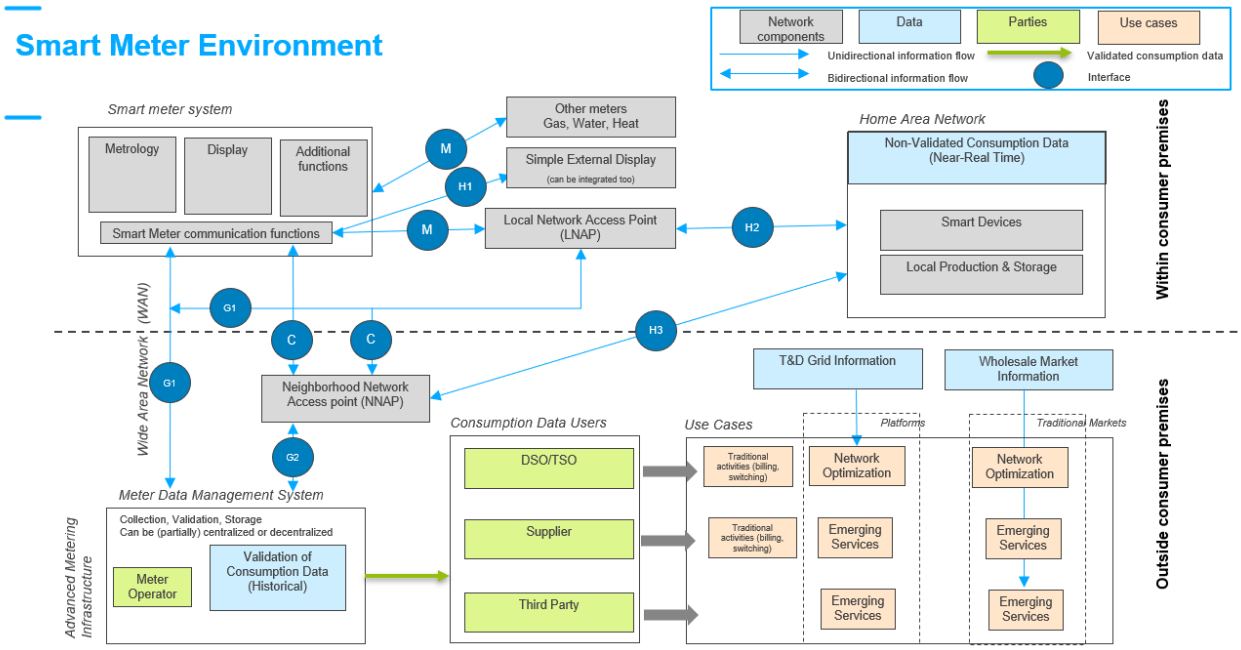
Level of the…	History	Granularity	Frequency of consumption data update
DSO	10 days 40 days 13 months	15 minutes Daily Monthly	
Supplier		2 months	
Central data hub			
Smart meter			Near real-time (electricity) / 5 minutes (gas)

Third parties and suppliers do allow customers to access their data, but this is not compulsory. The only thing that is compulsory is a letter from the supplier to the consumer every two months in which the consumer receives his/her latest meter readings, and one letter from the supplier every year in which the consumer receives his/her annual usage and costs.

20.4. Technical specifications

In respect to the following figure, that is a schematic representation of the functional architecture and communications in a smart metering environment, Serial protocol (115 kbaud) is the chosen technology for the interfaces. G1 relies on GSM and PLC. DSOs have defined the standards for H2 and were free to choose G1.

[50] https://www.netbeheernederland.nl/_upload/Files/Slimme_meter_15_91e8f3e526.pdf



20.5. Data management

20.5.1. Data access and privacy framework

By default, the smart meter is read by the supplier on a monthly basis; this is when only the actual meter value is read. For all more detailed metering data, both supplier and third party, need permission of the customer.

A customer gives access to his metering data by delegating it to a third party or a supplier as part of a service contract. The DSO will simply execute the request for metering data. In addition, the DSO should perform a sample inspection on a regular basis to check whether the third party or supplier indeed had the permission of the customer.

20.5.2. Provisions to provide and revoke access to data

In the Netherlands, the customer can either ask the DSO to switch off the possibility to read the meter remotely or can ask the supplier or third party to stop reading the detailed metering data.

20.6. Consumer impact

20.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

20.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	feedback from pilots	
Electromagnetic radiation		
Accuracy of meters	general public resistance to smart metering but lack of objective grounds	yes - a dedicated communication campaign has been launched to address those concerns
Price of meters		
Installation barriers		

20.6.3. Research on consumer benefits

The following studies investigated the benefits that smart meters can provide for consumers:

- 'Besparingseffecten van slimme meters met feedbacksystemen en slimme thermostaten' from ECN (translates to efficiency effects of smart meters with feedback systems and smart thermostats).[51]
  The goal of this research was to identify how many feedback systems and smart thermostats are needed to achieve 10 peta joule energy savings.
- 'Smart meter energy savings does not meet expectations' says PBL (the Netherlands Environmental Assessment Agency[52]). The expected energy savings from smart maters was 3,5%. However, a PBL study shows that savings are not as high as expected, not even 1%. In this letter, PBL mentions the importance of energy management system, such as in-home-displays.
- How to engage end-users in smart energy behaviour?[53]

[51] Besparingseffecten van slimme meters met feedbacksystemen en slimme thermostaten, ECN 2017, https://www.ecn.nl/publicaties/ECN-N--17-017

[52] Slimme meter energiebesparing blijft achter bij verwachting , PBL 2016, http://www.pbl.nl/nieuws/nieuwsberichten/2016/slimme-meter-energiebesparing-blijft-achter-bij-verwachting

[53] How to engage end-users in smart energy behavior, ECN 2014, https://www.ecn.nl/publicaties/ECN-W--14-049

Final customers are expected to play a crucial role in up-coming smart grids that aim to link end-users and energy providers in a better-balanced and more efficient electricity system. Within this context, this paper aims to deliver a coherent view on current good practice in end-user engagement in smart grid projects. It draws from a recent review of theoretical insights from sustainable consumption behaviour, social marketing and innovation systems and empirical insights from recent smart grid projects to create an inventory of common motivators, enablers and barriers of behavioural change, and the end-user engagement principles that can be derived from that. The authors conclude with identifying current research challenges as input for a research agenda on end-user engagement in smart grids.

20.6.4. Communication campaign

There was no dedicated communication campaign launched in the Netherlands. Information is given by the government (Consuwijzer) and by DSO's.

20.6.5. Advanced consumer services

There are some pilots with small groups of households, for example "Jouw Energiemoment "(http://www.jouwenergiemoment.nl/) and "Koplopers" (https://www.energiekoplopers.nl/) in which advanced consumer services are considered.

20.7. Conclusions

In the Netherlands, the Ministry of Economic Affairs and Climate Policy is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to distribution grid operators (DSOs) as they are in charge of meter ownership, installation and data collection and protection.

In the Netherlands, a Central Data Hub is responsible for the collection and storage of metering data. Currently, this is the responsibility of NEDU/EDSN that is organised by the energy sector. Furthermore, the supplier is responsible for buyer compensation for technical and administrative losses, although legislation is currently, in 2018, being changed to allocate this to DSOs. The consumers are responsible for everything 'behind the meter'.

Primary drivers for smart meter deployment are opportunities for digitization of the energy grid and market as well as for access to energy efficiency, dynamic tariffs and renewable energy sources integration.

Two CBAs have been developed over the past years, both yielding a positive result. Between the two CBAs some changes have been made to policies, resulting in differences in costs and benefits included in the CBAs.

The Ministry of Economic Affairs and Climate policy is overseeing the rollout which is being delivered by the DSOs. The target is to complete the rollout by 2020. This means that every household and SME in the Netherlands must be offered a smart electricity and gas meter by then. However, since offering a smart meter is mandatory, but the acceptance is voluntary, the installation target is 80% or higher.

Customers who object to the installation of the smart meter can either have the communication of the smart meter deactivated, or even refuse the installation of the smart meter. If the meter is administratively deactivated, the smart meter will function like a traditional meter. These options have been introduced both in the legal framework and deployment strategy to handle public concerns about data privacy and unwanted third party data access.

20.8. References

Id	Reference description
1	Kamerbrief over tijdpad uitrol slimme meter en dynamisch leveringstarieven, Rijksoverheid, 2014 https://www.rijksoverheid.nl/onderwerpen/slimme-meter/documenten/kamerstukken/2016/03/04/kamerbrief-over-tijdpad-uitrol-slimme-meter-en-dynamische-leveringstarieven.
2	Smart meters in the Netherlands Revised financial analysis and policy advice, KEMA 2010
3	Rijksdienst voor Ondernemend Nederland, Marktbarometer Aanbieding Slimme Meters - Voortgangsrapportage 2017, RVO, 2018 https://zoek.officielebekendmakingen.nl/blg-847929
4	Aanbiedmonitor 2017, Ministerie EZK, 2017
5	Besparingseffecten van slimme meters met feedbacksystemen en slimme thermostaten, ECN, 2017 https://www.ecn.nl/publicaties/ECN-N--17-017
6	Slimme meter energiebesparing blijft achter bij verwachting, PBL, 2016 http://www.pbl.nl/nieuws/nieuwsberichten/2016/slimme-meter-energiebesparing-blijft-achter-bij-verwachting
7	How to engage end-users in smart energy behaviour, ECN, 2014, https://www.ecn.nl/publicaties/ECN-W--14-049

21. POLAND

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Poland.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

21.1. Legal and Regulatory Framework

21.1.1. Market model

In Poland, the Ministry of Energy is the entity that is entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to DSOs as they are the parties in charge of meter ownership and meter installation. Furthermore, the DSOs shall facilitate installation of in-home displays and are responsible for the collection and storage of metering data.

Regarding data privacy, the DSOs are also the entities that have been appointed as the Data Protection Officer (DPO), in compliance with the General Data Protection Regulation (GDPR).

21.1.2. Legal grounds

The primary law that enables smart metering for electricity and gas is the Energy Law. Poland's Energy Law as amended in 2013 made the installation of smart meters eligible but not mandatory[54]. In 2014, the government drafted the schedule of smart metering deployment, with targets of 5% by 2015 and 80% by 2020 proposed.

There are currently (at least in 2018 at the moment of data collection for this report) no plans for the systematic deployment of smart meters at a large-scale.

[54] http://www.escansa.es/usmartconsumer/documentos/USmartConsumer_European_Landscape_Report_2016_web.pdf?_sm_au_=iVVMF0wVSRf2wJZQ

The Ministry of Energy has prepared a draft legislation (which is currently, in 2018, under public consultation[55]) obliging the DSOs to install a remote meter reading mechanism in combination with the metering system to at least 80% of final customers' properties connected to the electricity grid (of rated voltage below 1kV) by the end of 2028 in accordance with the schedule specified by the law. However, the detailed schedule is under discussion as the CBA is updated due to comments submitted by public and private partners with the view of reaching the compromise and making the deployment feasible for DSOs and beneficial for customers. The draft provisions were presented for public consultation in October 2018.

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

21.1.3. Primary drivers

The main drivers for the deployment of smart meters in Poland are linked to the conscious electricity consumption, possibility of switching supplier, reducing the time to issue an invoice, demand response, improvement of electricity consumption forecasting, reduction of financial support in the construction and maintenance of power stations, reduction of commercial and technical losses and above all reduction of reading costs and energy efficiency. Digitalisation of the distribution network and the retail market, as well as supporting energy efficiency are primary drivers for the deployment of smart meters.

21.1.4. Smart metering programme financing

In Poland, the DSOs are responsible for the deployment of smart meters and they will incur the costs related to it. These costs will be taken into account in the distribution tariff.

21.1.5. Recent publications by the NRA

The most relevant publications linked to the deployment of the smart meters in Poland were the CBAs that were carried out, with the most recent one performed in 2014.

21.2. Cost benefit analysis

21.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2014	Consultant	Government	Positive Net Present Value	Periodic regulatory assessment to keep costs under control
2013	Consultant	Government	Positive Net Present Value	Legal obligation
2012	Consultant	Other	Positive Net Present Value	Define ideal target and planning
2012	Consultant	Government	Positive Net Present Value	Legal obligation

[55] https://legislacja.rcl.gov.pl/projekt/12317354

The motivation behind the original exercise (apart from compliance with Dir. 2009/72) and the periodic regulatory assessments as follow-ups was to ensure costs are kept under control.

21.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the assessment: DSO, supplier, consumer, state/society, TSO, BRP, producer and independent aggregator.

Key parameters for the assessment	
evaluation period of the CBA [Years]	8
billing and metering frequency in the reference case for electricity [times/year]	12
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	6%
What is the electricity losses unit cost? [€/MWh]	55
What is the economic lifetime of electricity smart meters? [Years]	8
What is the economic lifetime of gas smart meters? [Years]	10
What is the value of the lost load? [€/MWh]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A

21.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management (Change management takes place in case of internal processes in DSOs. It should be marked as a CAPEX)
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading

☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme
☒ Other – Investment in electricity infrastructure

The main benefit items considered in the analysis are:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames) (although not introduced yet)

☐☒ Provision of explicit flexibility services (rather based on a request than a price signal)

☒ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☒ Distribution capacity deferral

☒ Transmission capacity deferral

☒ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☐ Outage management (based on societal value of lost load)

☐ Outage management (based on reduced customer indemnification)

☐ CO2

☐ Air pollution (particulate matters, NOx, SO2)

21.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for electricity:

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	14,692,000
Actualised CAPEX for the whole evaluation period	€1.07 billion
Actualised OPEX for the whole evaluation period	€79 million
Actualised benefits for the whole evaluation period	€1.285 billion

The resulting ratios, concerning electricity smart meters, have been computed in per unit, taking the number of installed meters as the reference denominator:

- Opex per meter: 5 €
- Capex per meter: 73 €
- Benefit per meter: 87 €

21.2.5. Deployment strategy and latest statistics

In Poland, the draft law foresees a deployment rate of 80% to be reached by 2028. For 2020, 1.5 million installations have been targeted (including SMEs). These targets are for electricity smart meters.

There are no targets imposed by the Energy law for the deployment of gas smart meters.

No technical constraints shaping the deployment policy have been identified.

The following tables highlight the latest statistics, showing respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Poland as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	1,360,000	109,661	33,844	60,422
Number of connection points equipped with smart meters	1,360,000	109,661	24,540	58,317
Total number of meters	16,219,000	1,500,000	7,283,892	65,993
Total number of connection points	16,219,000	1,500,000	2,891,833	73,757
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	80,131	3,322	89	161
Number of smart meters that does communicate default metering data	1,360,000	109,661	27,632	60,209

Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	0	0	6,122	53

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	0	0	No targets imposed by Energy Law	No targets imposed by Energy Law
Number of visits to consumer premises	60,000	4,000	4,933	10,100
Number of installed smart meters	60,000	2,800	7,021	14,422
Number of deactivated smart meters	0	0	42	51
Number of refusals	0	0	5	1

21.3. Functional specificiations

From the ten key functionalities recommended by the European Commission (Recommendation 2012/148/EU), all but two are activated by default, with the remaining two foreseen and set to be available.

All functionalities used will be set free of charge for the customer, in an attempt to make the smart meter as attractive as possible and reduce the number of refusals in the process.

Customers in Poland (through the appropriate metering device) can access consumption data in accordance with the table below: so, quarter hourly data via the H2 interface, or hourly data via the DSO or supplier website. It is important to note that only a certain number of days of historic data is accessible to customers.

Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	N/A	N/A

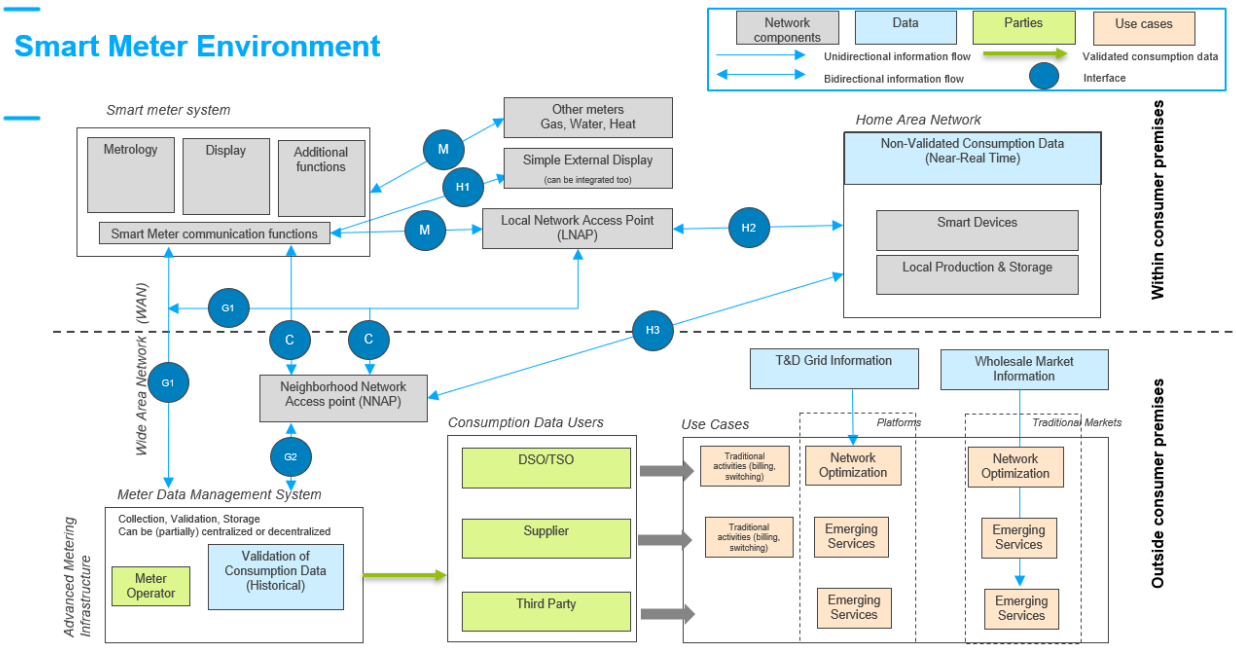
H2 Interface (Smart Devices)	Days of quarter hourly data	Every second
Compulsory DSO website	Days of hourly data	Daily
Compulsory Supplier website	Days of hourly data	Daily
Compulsory Third Party website	N/A	N/A

21.4. Technical specifications

With respect to the figure below, that gives a schematic representation of the functional architecture and communications in a smart metering environment, so far PLC (Power Line Carrier) was chosen for the C interface. The PLC technology is used as a main communication channel between meters and NMAP (data concentrator). For DSOs, this channel is a natural way of transmission, it is reliable and independent, as well as secure. A wireless mBus or a modem connected to the USB port of a smart meter can be used as an alternative way of communication.

As for the G1 and G2 interfaces, GSM technology was chosen, the reason behind this choice is economic as well as functional.

In Poland, the H2 interface has been implemented as USB or wireless mBus interface.



21.5. Data management

21.5.1. Data access and privacy framework

In Poland, energy suppliers and other third-party actors need an explicit consent from the customer in order to access his metering data.

21.5.2. Provisions to provide and revoke access to data

It will be possible for customers to provide access to metering data and authorize a third party to these data, a process that is foreseen in the draft law. Similarly, it will be possible for customers to refuse access to metering data. This process is also foreseen in the draft energy law.

21.6. Consumer impact

21.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No

Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

21.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	A general public resistance to the impact smart meters will have on privacy (but lack of objective grounds).	As a result of the lack of objective grounds, no counter measures have yet been adopted to address this resistance.
Cybersecurity	Some general concerns have been raised with regards to cybersecurity.	No counter measures have been adopted currently.
Electromagnetic radiation	Some concerns have been raised by this point following some tests carried out in the laboratory.	In order to address this concern, it is mandatory to comply with existing standards.
Accuracy of meters	N/A	N/A
Price of meters	N/A General concerns have been raised with regards to the costs borne by customers.	N/A

Installation barriers	N/A	N/A

21.6.3. Research on consumer benefits

Research has been carried out involving Polish consumers. This is done under the umbrella objective to investigate how to ensure that consumer benefits coming from smart metering are realised in practice, for both residential customers and small businesses (SMEs).

In one pilot project, over 26 thousand meters, 87 Data Concentrators and modems were installed at the Retkinia housing estate in Lodz (a high-density urban area and multi-family housing with multiple divisions of medium voltage, low voltage networks and short power lines). Furthermore, almost 24 thousand meters and 639 concentrators and modems were installed in Augustów and its vicinity in the large dispersed area where the overhead network is characterized by long supply lines.

The AMI meters installed at the customer premises are able to communicate with data concentrators through a low voltage power network based on PLC technology (Power Line Communication). Replacing legacy meters for AMI devices improves, as expected, the performance of the DSO and the quality of customer service, allowing users to view detailed data on energy consumption. The AMI meters installed are able to record not only the measured values on the display but also the power consumption and current consumption of electricity at regular intervals, such as hourly intervals or voltage drop information. This will allow the customer to analyse his energy consumption and then choose the best way to settle (change his tariff to suit his own needs) or change his behaviour in terms of electricity consumption (change habits and hours of maximum energy consumption).

A similar project is that carried out by Energa-OPERATOR that involved 800,000 households[56]. The meter exchange occurred in 2013-2014 and the customers are already using the opportunities brought to them by the new smart meters, such as:

- Change of electricity tariff no longer requires a visit by a company representative
- New tools for customers, like portal and mobile applications for checking daily energy consumption
- Checking the energy consumption of every appliance in the house
- And many more benefits.

TAURON Dystrybucja has completed a large four-year smart meter rollout (2014-2018) where over 360,000 meter points were installed to provide customers with reliable and secure communication for better energy management while improving the overall Distribution System Operator (DSO) service offering. The AMIplus Smart City Wroclaw project, is a multi-vendor project initiated by DSO, TAURON Distribution, and it is the one of the largest AMI and smart metering deployment implemented in Poland to date. With multiple meter suppliers on board, this project is also one of largest interoperable smart grid projects in the world. Besides typical benefits as remote reading, switch on/off, change of tariff, TAURON provided a dedicated app for customers to use on their mobile devices and computers which is crucial for building energy consumption awareness in a digitally advancing society.

[56] http://www.escansa.es/usmartconsumer/documentos/USmartConsumer_European_Landscape_Report_2016_web.pdf

21.6.4. Communication campaign

A dedicated communication campaign is foreseen while proceeding with the new draft law (from the side of Ministry of Energy).

Moreover, during the deployment of smart meters by DSOs (as part of pilot projects), the following communication activities and measures were introduced:

- DSOs ran an information campaign to prepare clients for the coming changes, to inform them about meters exchange, as well as to educate, answer their questions and resolve their doubts about the changes.
- DSOs also undertook the following activities:
  - Preparing a communication strategy.
  - Meetings with local governments, media representatives and the populace and to inform them about program.
  - Training installers how to inform clients about metering installation and AMIplus project.
  - Preparing the list of questions and answers for helpline workers.
  - Preparing information about smart metering as well as about installation procedure.
  - Preparing and printing the information and instruction leaflets for customers. Preparing posters with day and time of installation.
  - Preparing media and outdoors campaign.
  - Launched dedicated web platform www.amiplus.pl for customers, with necessary information about AMI project.
  - Product placement for smart meters was used in TV series.

21.6.5. Advanced consumer services

There are plans and initiatives that leverage smart metering to support advanced services such as the integration of distributed energy resources (distributed generation, storage, e-mobility, demand response, etc.).

21.7. Conclusions

In Poland, the Ministry of Energy is the entity that is entitled to define deployment targets and conditions for smart electricity and gas meters.

The primary law that enables smart metering for electricity and gas is the Energy Law. Poland's Energy Law as amended in 2013 made the installation of smart meters eligible but not mandatory. Following the revision of the CBA in 2014, which provided a positive net present value, the Ministry of Energy has prepared a draft legislation (which is currently, in 2018, under public consultation) which foresees a deployment rate of 80% to be reached by 2028. For 2020, 1.5 million installations have been targeted (including SMEs). These targets are for electricity smart meters. There are no targets imposed by the Energy law for the deployment of gas smart meters.

The DSOs are responsible for the deployment of smart meters and they will incur the costs related to it through distribution tariff. Furthermore, the DSOs shall facilitate installation of in-home displays and are responsible for the collection and storage of metering data.

Digitalisation of the distribution network and the retail market, as well as supporting energy efficiency are primary drivers for the deployment of smart meters.

From the ten key functionalities recommended by the European Commission (Recommendation 2012/148/EU), all but two (functionalities (a) and (b)) are activated by default, with the remaining two foreseen and set to be available. All functionalities used will be set free of charge for the customer, in an attempt to make the smart meter as attractive as possible and reduce the number of refusals in the process.

Customers in Poland (through the appropriate metering device) can access quarter hourly consumption via the H2 interface, or hourly data via the DSO or supplier website. It is important to note that only a certain number of days of historic data is accessible to customers. In Poland, energy suppliers and other third-party actors need an explicit consent from the customer in order to access his metering data.

So far PLC (Power Line Carrier) was chosen for the C interface and for the G1 and G2 interfaces, GSM technology was chosen, the reason behind this choice is economic as well as functional. The H2 interface has been implemented as USB or wireless mBus interface.

The main foreseen services in Poland enabled by smart metering are bill forecasting, provision of historical consumption, pre-payment functionality and allowing end-consumers to participate in flexibility markets.

21.8. References

Id	Reference description
1	Amended Energy Law (2013)

22. PORTUGAL

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Portugal.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

22.1. Legal and Regulatory Framework

22.1.1. Market model

Entidade Reguladora dos Serviços Energéticos (ERSE) is the independent Portuguese Energy Services Regulatory Authority since 1997.

REN (Rede Elétrica Nacional) and REN Gasodutos are the electricity and gas Transmission System Operators (TSOs), respectively.

Energias de Portugal (EDP Distribuição) is the main electricity distributor (DSO), and it is a former state-owned company privatised in 2013. It holds the concession to operate the national distribution network in high and medium voltage, and most municipal concessions to operate in the low voltage distribution network. Besides EDP, there are only few other smaller electricity distributors[1].

The distribution of natural gas is provided by six distributors (four of them belong to GALP), which work under concession contracts, and five autonomous natural gas distribution units (four of them belonging to GALP), which have a license[1].

With regard to smart metering, the Portuguese Government is legally entitled to define deployment targets and conditions for both electricity and gas smart meters.

Ownership and installation of meters belong to DSOs, while ownership and installation of home displays belong to the Consumer. The Supplier has the duty to compensate the buyer in case of technical and administrative losses.

Metering data collection, validation, storage and transmission to third parties are bestowed to DSOs, which are also responsible for metering data protection, in compliance with the General Data Protection Regulation (GDPR).

22.1.2. Legal grounds

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), which has a technical and functional scope and provides billing, data provision and costs.

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

22.1.3. Primary drivers

Not available.

22.1.4. Smart metering programme financing

Not available.

22.1.5. Recent publications by the NRA

The most relevant official document that is available is the 3rd National Energy Efficiency Action Plan (NEEAP 2017)[5], which was prepared in compliance with the Energy Efficiency Directive (EED, 2012/27/EU), but no information about deployment of smart meters is included in it.

22.2. Cost benefit analysis

22.2.1. Relevant study

Two Cost-Benefit Analyses (CBA) have been conducted in Portugal since 2012.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation	Publicly available
2012	Consulting Company	NRA	Positive Net Present Value	Comply with Dir. 2009/72/EC	Yes
2015	NRA	NRA	Positive Net Present Value	Periodic regulatory assessment to keep costs under control	No

22.2.2. Market roles and key parameters

In the economic assessment, the following market roles have been taken into account to support direct costs and benefits: DSO, Supplier, Consumer, State/Society, TSO and Producer.

Key parameters for the assessment	
Evaluation period of the CBA [years]	50 years

Billing and metering frequency in the reference case for electricity [times/year]	Billing: 12 (monthly) Metering: 4 (quarterly)
Does this also apply for gas?	Billing: yes, 12 (monthly) Metering: no, 6 (every two months)
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	Technical: 6% Non-technical: 3%
What is the electricity losses unit cost? [€/MWh]	The same as electricity price for end consumers, which is dynamic for the period (between 200 and 400 €/MWh)
What is the economic lifetime of electricity smart meters? [Years]	15 years
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	1.5 €/MWh
What is the discount rate taken into account? [%]	6%
What is the inflation rate taken into account? [%]	1.6%
What is the cost reduction rate due to technological maturity? [%/year]	2% for the first 10 years
What is the installation success rate (installation/visits)? [%]	99.95%
What is the refusal rate (refusals/visits)? [%]	0.05%
What is the deactivation rate (deactivations/installations)? [%]	Not considered
What is the carbon price taken into account? [€/t + reference year]	The carbon price is implicitly taken into account in the electricity spot market price

22.2.3. Main cost and benefit items

As detailed in the following list, all cost items suggested by the European Commission (Recommendation 2012/148/EU) have been taken into account in the CBA, with the only exception of OPEX costs associated to change management:

☒ CAPEX - Investment in smart meter

☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom

☒ CAPEX - Investment in In-home display

☒ CAPEX - Sunk cost of conventional meters

☒ OPEX - IT maintenance

☒ OPEX - Network management and front end

☒ OPEX - Telecom

☐ OPEX - Change management

☒ OPEX - Unplanned renewal and failures of smart meter

☒ OPEX - Revenue reduction

☒ OPEX - Meter reading

☒ OPEX - Call center and customer service

☒ OPEX - Consumer engagement programme

The following main benefit items, among those suggested by the European Commission (Recommendation 2012/148/EU), have been monetised:

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☐ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☒ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☒ Distribution capacity deferral

☒ Transmission capacity deferral

☒ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☒ Outage management (based on societal value of lost load)

☒ Outage management (based on reduced customer indemnification)

☒ CO2

☐ Air pollution (particulate matters, NOx, SO_2,...)

☐ Other

22.2.4. CBA results

The following table summarises the key outcomes of the CBA for an electricity rollout:

Key outcomes of the assessment (actualised values, referring to the whole evaluation period)	
Number of meters installed [n° of meters]	1 million/year*
Smart meter stock (at the end of the evaluation period) [n° of meters]	6 million
Total costs (CAPEX + OPEX) [€]	1,000-2,000 M€ (depending on the scenario)
Total benefits [€]	2,000-2,800 M€ (depending on the scenario)

*Values considered for the first 6 years of a 15-years life period of smart meters and taking into account a 1% possibility of failure

22.2.5. Deployment strategy and latest statistics

In Portugal, EDP Distribuição has led the transition to a smarter distribution grid by means of the InovGrid project that involved the development and implementation of smart grid concepts and technology. An important element of InovGrid has been the rollout of smart grid infrastructure in the Portuguese municipality of Évora in 2011[2]. The infrastructure spans the entire municipality, reaching around 32,000 electricity customers and its main components are[2]:

- EDP boxes, installed at all low-voltage customers, offering advanced smart meter functionalities, such as real-time readings on demand, load diagrams, voltage monitoring and remote services (connect/disconnect, contracted power and tariff set-up, tampering alarms, etc…)
- Distribution Transformer Controllers (DTC) installed in every secondary substation, acting as data concentrators and local metering, monitoring and automation devices (power quality monitoring, medium voltage switching, local sensors, etc.)
- A communication network based on power-line communication (PLC) and general packet radio service (GPRS) technologies, linking EDP boxes and DTCs to head end systems
- Charge stations for Electric Vehicles (EVs)
- Efficient public lighting systems based on LED luminaries with advanced control.

The deployment in Évora has demonstrated many of the benefits of smart grids, strengthening EDP's business case for this kind of projects. Aa a consequence, EDP Distribuição is currently deploying second-generation smart meters to 100,000 customers throughout the country, with the objective of developing the supply chain and improving the integration with existing business processes, in preparation for a future roll-out (currently, in 2018, pending government/regulator decision)[2].

SmartGalp (2010-12) was a technical study in the smart metering sector with the objective of demonstrating and quantifying the potential that the real-time consumption monitoring and new interactions with residential consumers could have on energy efficiency, consumption reduction, GHG emissions, and in cost reductions for the end-consumer[2].

While smart electricity meters have been progressively implemented in the last years, there are no smart gas meters currently installed in Portugal.

The current (as of 1/1/2018) state of play of smart electricity meter deployment for both households and Small-Medium Enterprises (SMEs) is resumed in the following table:

State of play of smart metering deployment in Portugal as of 1/1/2018	Electricity total (households and SMEs)
Number of smart meters	1,5 million
Number of connection points equipped with smart meters	1,5 million
Total number of meters	6 million
Total number of connection points	6 million
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A
Number of smart meters that does communicate default metering data	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A

Electricity smart metering has a 25% degree of penetration in the country, with 1,5 million of smart electricity meters installed out of a total of 6 million meters.

In particular, the following results in terms of smart electricity meters annual deployment were achieved in 2017:

Deployment outcomes in 2017	Electricity total (households and SMEs) *
Yearly installation target	600,000
Number of visits to consumer premises	N/A
Number of installed smart meters	600,000
Number of deactivated smart meters	N/A
Number of refusals	N/A

*Refers to the total number of smart meters for the normal low voltage network (i.e., up to 4.4 kVA).

As the table shows, the 2017 yearly installation target related to electricity smart metering has been fulfilled in Portugal.

Despite that smart metering deployment is moving forward in the country, the Portuguese Government has still not approved an official deployment strategy, and has not yet defined targets, at least at the moment of collection of data for this report.

22.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (2012/148/EU) are available and activated by default on smart meters. They are all free of charge for the customer, with the only exception of Functionalities B and G (see table below).

FUNCTIONALITIES	Foreseen and available (but not necessarily activated)	Activated by default	Free of charge for the customer
FUNCTIONALITY A: Provide readings directly to the customer and any third party designated by the consumer	☒	☒	☒
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings	☒	☒	☐
FUNCTIONALITY C: Allow remote reading of meters by the operator	☒	☒	☒
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☒	☒
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☒	☒
FUNCTIONALITY F: Support advanced tariff system	☒	☒	☒
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☒	☒	☐
FUNCTIONALITY H: Provide secure data communications	☒	☒	☒
FUNCTIONALITY I: Fraud prevention and detection	☒	☒	☒
FUNCTIONALITY J: Provide import/export and reactive metering	☒	☒	☒

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated has been provided:

	History (Historical data)	Granularity (Historical data)	Frequency (Readings)
DSO	years	quarter of an hour	monthly

Supplier	N/A	N/A	N/A
Central Data Hub	years	hourly	monthly
Smart Meter	months	hourly	every minute

Customers can access their consumption data by direct local access to smart meters or on the compulsory DSO web portal. Third parties' access to consumption data and/or to consumption data for emerging services has not been specified (Functionality A).

The Portuguese operator has implemented push (automatic) and pull (on demand) remote reading on smart meters (Functionality C).

Among the advanced tariff system possibilities, time-of-use tariffs and linkage with wholesale market data are currently foreseen as possible solutions (Functionality F).

Smart meters are able to measure reactive power and to measure grid injection separately from withdrawals (Functionality J).

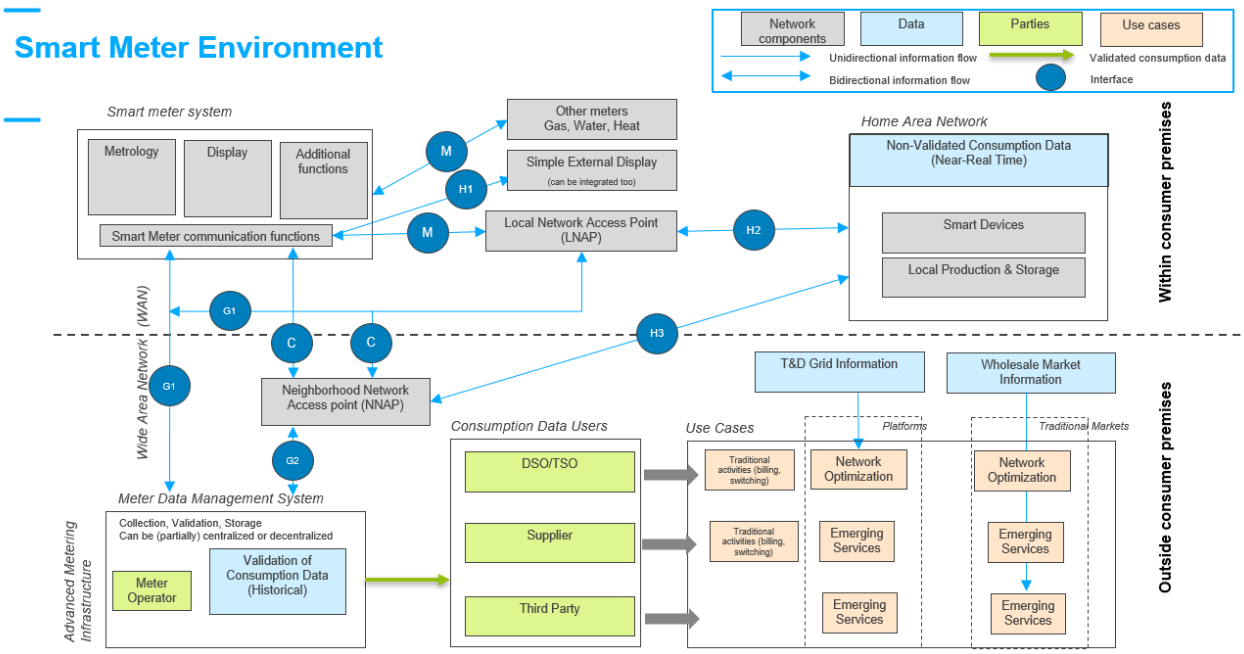
In Portugal, smart metering could be used in community-based distribution systems, but no such solution has been implemented so far.

22.4. Technical specifications

In Portugal, H1 interface is implemented on smart meters by default, while H2 interface is activated upon customer explicit request, relying on Wi-Fi technology.

C, G1 and G2 interfaces are also implemented by default, and they rely on Power Line Carrier (PLC) communication technology, which has been chosen according to its high performance, relatively low cost and experience gained in its deployment. PLC prime is the standard adopted to support the chosen PLC technology.

These interfaces can be seen in the figure below that gives a schematic representation of the functional architecture and communications in a smart metering environment.



22.5. Data management

22.5.1. Data access and privacy framework

Third parties and Suppliers need an explicit consent from the Customer to access his/her metering data.

22.5.2. Provisions to provide and revoke access to data

The customer can give access to his/her metering data to Third parties and Suppliers via a written approval, and revoke this access via a written form, both of which must be communicated to and validated by the DSO or a central party.

22.6. Consumer impact

22.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Portuguese market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes

Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes

As also seen in the table, in Portugal, smart meters can provide almost all (five out of six) the services identified as "advanced". Pre-payment service is the only advanced service that is not provided.

22.6.2. Consumer concerns

In Portugal, consumer organisations and civil society have expressed concerns about privacy, cybersecurity, electromagnetic radiation and accuracy of smart meters. These concerns have been mitigated by proving smart meters compliance to existing security standards. No concerns on smart meters pricing, back billing and installation barriers have been raised.

22.6.3. Research on consumer benefits

The Portuguese DSO has conducted research on consumers' ability to realize the smart metering benefits, but no details about it have been provided.

22.6.4. Communication campaign

The Portuguese DSO launched a communication campaign aiming at promoting consumers engagement during the rollout of smart meters.

22.6.5. Advanced consumer services

At present, pilot projects on smart metering integration with distributed energy resources (distributed generation, storage, e-mobility, demand response, etc…) are being conducted in Portugal.

22.7. Conclusions

Portugal has undertaken a number of studies in smart metering deployment and has conducted a comprehensive field trial of the technology. The main DSO, EDP Distribuição, has led the deployment by means of the InovGrid project, in which a rollout of smart grid infrastructure was implemented in the Portuguese municipality of Évora in 2011[2]. The positive results of such a pilot project have been utilised to support the installation of a second-generation smart meters to 100,000 customers throughout the country, in preparation of a future rollout, which is currently, in 2018, pending government/regulator decision. Indeed, the Portuguese Government has still not approved an official future deployment strategy and has not yet defined targets.

Currently (as of 1/1/2018), smart metering has a 25% degree of penetration in the country, with 1,5 million of smart electricity meters installed out of a total of 6 million meters.

Two Cost-Benefit Analyses (CBAs) on smart metering deployment have been conducted in Portugal in 2012 and 2015 respectively. They both provided positive results and contributed to smart meters implementation.

Different scenarios have been simulated in the latest CBA, providing two ranges of (present) values for total costs (CAPEX + OPEX) and total benefits as final result. Depending on the scenario, total costs and benefits can vary between 1,000-2,000 M€ and 2,000-2,800 M€ respectively. The expected annual smart meter installation is of 1 million meters per year, with 6 million of smart meters installed at the end of the evaluation period (100% conventional meters substituted with smart meters).

Almost all cost and benefit items suggested by the European Commission (Recommendations 2012/148/EU) have been taken into account in the CBA. The only costs that have not been considered are change management costs (OPEX), while benefits related to bill reduction due to dynamic pricing, provision of explicit flexibility services, easier access to PV production and air pollution have not been monetized.

Privacy and data protection matters related to smart meters are at a very early stage in Portugal. There is no clearly defined data management strategy and main risks have not been identified yet. A Data Protection Impact assessment has not been performed and a Data Protection Officer is still to be appointed.

In Portugal, all 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are available and activated by default on smart meters. They are all free of charge for the customer, with the only exception of two functionalities (real-time use of readings and remote on/off control of the supply).

Besides these functionalities, smart meters enable different "standard" and "advanced" services in the Portuguese market, such as:

- **Data leveraging** (standard): allow consumers to compare the energy consumption with similar peers
- **Unusual usage alert** (standard): alert the consumer when an unusual high consumption occurs during a long-time period.
- **Historical consumption** (standard): provide access to historical data consumption in order to compare weekly or monthly consumption over time
- **Dynamic tariffs** (advanced): consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly (implicit demand response)
- **Flexibility provision** (advanced): ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator (explicit demand response)

- **Energy sharing** (advanced): metering data synchronization and detailed aggregation of self-consumption in local energy communities, allowing consumers living in apartment to have access to rooftop PV
- **Prosumers integration** (advanced): either as a prerequisite to install decentralized generation or as a way to introduce new tariffs
- **Electric vehicles charging at home** (advanced): ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It could also be used to charge more rapidly at home with a higher but non-firm connection capacity

In Portugal, consumer organisations and civil society have expressed concerns about privacy, cybersecurity, electromagnetic radiation and accuracy of smart meters. Therefore, a tailor-made communication campaign should be organized in order to mitigate those concerns by providing smart meters compliance to existing security standards.

22.8. References

Id	Reference description
1	https://ec.europa.eu/energy/sites/ener/files/documents/2014_countryreports_portugal.pdf
2	Energy Policies of IEA Countries – Portugal 2016 Overview https://www.iea.org/publications/freepublications/publication/Energy_Policies_of_IEA_Countries_Portugal_2016_Review.pdf
3	Portugal National Energy Efficiency Action Plan (NEEAP 2017) - https://ec.europa.eu/energy/sites/ener/files/documents/pt_neeap_2017_en.pdf

23. ROMANIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Romania.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

23.1. Legal and Regulatory Framework

23.1.1. Market model

In Romania, the Energy Regulatory Authority is the entity that is entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to DSOs as they are the parties in charge of meter ownership and meter installation. Furthermore, the DSOs are responsible for the collection and storage of metering data, as well as the transmission of metering data to third parties.

Regarding data privacy, the DSOs and energy suppliers have been appointed as the Data Protection Officer (DPO), in compliance with the General Data Protection Regulation (GDPR).

23.1.2. Legal grounds

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. There are currently no laws that enable smart metering for natural gas.

23.1.3. Primary drivers

Digitalizing retail markets is the main driver for smart metering deployment in Romania, not only to optimise network operations, but also to foster innovation and create the enabling framework to deliver new services and dynamic tariffs for households and SMEs. Fuel poverty is another factor that is driving the smart meter rollout in Romania, in order to reduce the number of those at risk of fuel poverty which stood at 40% in 2014[57].

Another driver is also the need to invest in the modernisation of the distribution grid and to optimise DSO internal processes in order to provide a high-quality distribution service to customers[58].

23.1.4. Smart metering programme financing

The costs of smart meter rollout in Romania are borne by the DSOs. The distribution tariff will absorb most of these costs which means that the final customer will bear the majority of these costs. In the period of 2017-2018 around 10% of the DSOs investment cost were allocated to smart metering.

23.1.5. Recent publications by the NRA

The most recent publications issued by the national regulatory authorities is an analysis carried out on the results registered on December 31, 2017 for the usage of smart metering systems realised according to ANRE Order no. 145/2014 regarding the implementation of smart metering systems.

23.2. Cost benefit analysis

23.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
September 3 2012	A.T Kearney - The European Bank for Reconstruction and Development (EBRD)		Positive Net Present Value	Legal obligation

The main motivation behind the CBA carried out was to be in compliance with Dir. 2009/72). The cost-effectiveness and ability to realise benefits will also be important given that the exercise was commissioned by the EBRD.

23.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the assessment: DSO and consumer.

[57] https://www.degruyter.com/downloadpdf/j/picbe.2017.11.issue-1/picbe-2017-0015/picbe-2017-0015.pdf

[58] https://www.ebrd.com/news/2015/ebrd-supports-cez-distribuie-projects-in-romania.html

Key parameters for the assessment	
evaluation period of the CBA [Years]	20
billing and metering frequency in the reference case for electricity [times/year]	4
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	Technical losses: 12% Non-technical losses: 7%
What is the electricity losses unit cost? [€/MWh]	45
What is the economic lifetime of electricity smart meters? [Years]	10
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	Variable
What is the cost reduction rate due to technological maturity? [%/year]	N/A

23.2.3. Main cost and benefit items

As detailed in the following list that includes cost elements suggested by the Commission in its Recommendation 2012/148/EU, only the CAPEX associated with the smart meter itself and the investment requirements in IT was considered. On the other hand, on the OPEX side, most cost items have been taken into account, following the guidance issued by the European Commission, with the only exception of change management and revenue reduction.

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☐ CAPEX - Investment in Telecom
☐ CAPEX - Investment in In-home display
☐ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☐ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☐ OPEX - Consumer engagement programme

The main benefit items considered in the analysis are discussed below.

For the consumers, benefits will come from bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills) and due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames).

For the utility, smart meters will enable optimization of regulated duties, namely:

- Meter reading & operation savings
- Operation & maintenance of assets
- Distribution capacity deferral
- Technical losses reduction
- Non-technical (administrative, including fraud) losses

23.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for electricity smart metering:

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	9,516,762
Non-actualised CAPEX for the whole evaluation period	€901,075,805
Non-actualised OPEX for the whole evaluation period	€779,592,191
Non-actualised benefits for the whole evaluation period	€2, 810,624,626

The resulting ratios have been computed in per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- OPEX per meter: 94.68 €
- CAPEX per meter: 81.91 €
- Benefit per meter: 295.33 €

23.2.5. Deployment strategy and latest statistics

The implementation of smart metering systems is set in accordance with Art. 66 of the Law no. 123/2012 for electricity and natural gas. They key points are highlighted below:

(1) ANRE assesses the implementation of smart metering systems in terms of long-term costs and benefits for the electricity market, profitability and feasible implementation deadlines based on all the data obtained from the implementation of the projects and the installed systems which provides the functionalities specific to smart metering systems.

(2) DSOs are required to submit to ANRE (Romanian Energy Regulatory) drafts for the implementation of smart metering systems based on their own CBAs, in order to comply with the provisions of paragraph (3). CBAs will include a detailed description of how to fulfil the mandatory functionality for these systems, as specified by the technical regulations in force, as well as the benefits to end-users after installation of the systems.

(3) On the basis of the projects referred to in paragraph (2), ANRE approves a calendar for the implementation of smart metering systems so that:

a) final customers with an annual consumption higher than a threshold, expressed in kWh, set by ANRE on the basis of the information and data collected in accordance with paragraph (1) and (2) and customers holding production sources with installed power of less than 10 kW shall have intelligent metering systems in place by 1 January 2024;

b) final customers who do not comply with the provisions of item (a) have intelligent metering systems in place by 31 December 2028, by deploying large-scale, intelligent metering systems exclusively in terms of investment efficiency.

(4) The implementation of the systems provided in paragraph (2) shall be approved within the annual investment plans of the distribution system operators. ANRE may approve the advancement of the application of the provisions of para. (3) under the conditions of cost-benefit analysis demonstrating the existence of benefits also at the level of consumers, and choosing this solution is more advantageous than the installation of classical meters.

The following tables highlight the latest statistics, showing respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Romania as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	415,993	26,713	N/A	N/A
Number of connection points equipped with smart meters	415,493	26,713	N/A	N/A
Total number of meters	8,490,669	747,119	N/A	N/A
Total number of connection points	8,490,669	747,119	N/A	N/A
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	N/A	N/A	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A	N/A	N/A	N/A

Number of smart meters that does communicate default metering data	N/A	N/A	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A	N/A	N/A

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME
Yearly installation target	Up to 10% of total annual amount of planned investment	Up to 10% of total annual amount of planned investment	N/A	N/A
Number of visits to consumer premises	N/A	N/A	N/A	N/A
Number of installed smart meters	149,946	9,672	N/A	N/A
Number of deactivated smart meters	N/A	N/A	N/A	N/A
Number of refusals	N/A	N/A	N/A	N/A

23.3. Functional specificiations

From the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU), all but three are to be activated by default, with the remaining foreseen and set to be available.

The default setting will not provide readings directly to customers (and/or third parties designated by customers) and will also not support advanced tariff systems. Lastly, the default setting will not provide import/export and reactive metering (therefore will not be able to make a distinction between network injection (prosumers) and withdrawals).

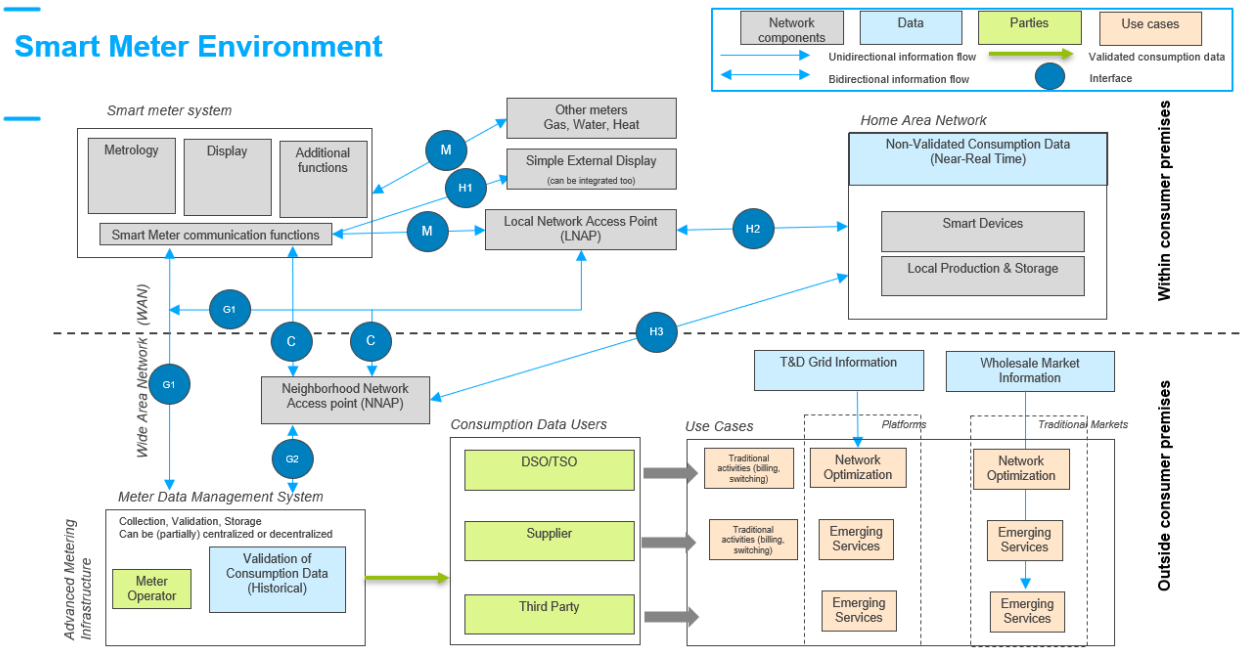
From the 10 key functionalities, only half of them are set to be free of charge for customers. Those that will not be free of charge are mainly linked to meter reading (i.e. frequency of meter readings, capability to read meter readings remotely, etc.).

Customer and third-party access to consumption data will only be available via the DSO web portal.

Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	N/A	N/A
H2 Interface (Smart Devices)	N/A	N/A
Compulsory DSO website	Yes	Daily
Compulsory Supplier website	N/A	N/A
Compulsory Third Party website	N/A	N/A

23.4. Technical specifications

With respect to the figure below, that shows a schematic representation of the functional architecture and communications in a smart metering environment, PLC (Power Line Carrier) was chosen for the C interface. On the other hand, GSM/ GPRS was chosen for the G1 and G2 interfaces. The reason behind this choice is economic as well as functional.



23.5. Data management

23.5.1. Data access and privacy framework

In Romania, energy suppliers and other third-party actors need an explicit consent from the customer in order to access his metering data.

23.5.2. Provisions to provide and revoke access to data

The customer can provide access to his metering data by delegating that task to a third-party actor or energy supplier as part of an energy supply contract where the DSO will simply execute the request for metering data (no verification by an independent third party required).

Furthermore, the customer can provide access to his data through a specific app or website with secured access.

Similarly, if the customer wishes to revoke access to his metering data, he/she can do so using the same methods described above, either as part of an energy supply contract or via a secured app or website with a secured access.

23.6. Consumer impact

23.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes

Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

23.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	N/A	N/A
Cybersecurity	N/A	N/A
Electromagnetic radiation	Some concerns have been raised by this point but are not based on proven facts or testimonies.	In order to address this concern, the countermeasure proposed is to ensure compliance to existing standards.
Accuracy of meters	Concerns have been raised on the accuracy of meters on the basis of the feedback received from pilot projects.	A dedicated communication campaign has been launched to address those concerns.
Price of meters	N/A	N/A

Installation barriers	N/A	N/A

23.6.3. Research on consumer benefits

No research has yet been conducted on issues related with consumers and their ability to realise the smart metering benefits.

23.6.4. Communication campaign

Communication campaigns have been launched before and during the installation of smart meters, usually by publishing information on the websites of those DSOs involved in the implementation of the smart meter rollout.

The aim of these campaigns is to maximise transparency in the process (smart meter rollout) and limit the number of concerned consumers may have.

23.6.5. Advanced consumer services

There are legal provisions and regulations that stimulate small local production and in general, production from renewable sources and high efficiency cogeneration which, along with the implementation of smart metering, creates the premises for services that integrate distributed energy resources (i.e. distributed generation, storage, e-mobility, demand response, etc.).

23.7. Conclusions

In Romania, the Energy Regulatory Authority is the entity that is entitled to define deployment targets and conditions for smart electricity and gas meters. 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. There are currently no laws that enable smart metering for natural gas

DSOs are in charge of meter ownership and meter installation and are responsible for the collection and storage of metering data, as well as the transmission of metering data to third parties.

The costs of smart meter rollout in Romania are borne by the DSOs. The distribution tariff will absorb most of these costs which means that the final customer will bear the majority of these costs. In the period of 2017-2018 around 10% of the DSOs investment cost were allocated to smart metering

Digitalizing retail markets and modernising the distribution grid are the main driver for smart metering deployment in Romania, not only to optimise network operations, but also to foster innovation and create the enabling framework to deliver new services and dynamic tariffs for households and SMEs. Fuel poverty is another factor that is driving the smart meter rollout in Romania.

The CBA performed in 2012 provided a positive net present value for the large-scale rollout of electricity smart meters. At the 1/1/2018, almost 5% of all electricity metering points were equipped with a smart meter.

From the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU), all but three are to be activated by default, with the remaining foreseen and set to be available. The default setting will not provide readings directly to customers (and/or third parties designated by customers) and will also not support advanced tariff systems. Lastly, the default setting will not provide import/export and reactive metering. From the 10 key functionalities, only half of them are set to be free of charge for customers. Those that will not be free of charge are mainly linked to meter reading (i.e. frequency of meter readings, capability to read meter readings remotely, etc.).

Customer and third-party access to consumption data will only be available via the DSO web portal. In Romania, energy suppliers and other third-party actors need an explicit consent from the customer in order to access his metering data. The customer can provide access to his metering data by delegating that task to a third-party actor or energy supplier as part of an energy supply contract where the DSO will simply execute the request for metering data, or he can provide access to his data through a specific app or website with secured access. Similarly, if the customer wishes to revoke access to his metering data, he/she can do so using the same methods described above, either as part of an energy supply contract or via a secured app or website with a secured access.

With respect to the functional architecture and communications in the smart metering environment, PLC (Power Line Carrier) was chosen for the C interface. On the other hand, GSM/ GPRS was chosen for the G1 and G2 interfaces.

The main foreseen services in Romania enabled by smart metering are bill forecasting, provision of real-time and historical consumption data, the provision of dynamic tariffs, and integration of prosumer in the electricity market.

23.8. References

Id	Reference description
1	Raport_PP_SMI_11_Aprilie_2018 *(usage of smart metering systems realised according to ANRE Order no. 145/2014 regarding the implementation of smart metering systems)*
2	https://www.ebrd.com/news/2015/ebrd-supports-cez-distribuie-projects-in-romania.html

24. SLOVAKIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Slovakia.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

24.1. Legal and Regulatory Framework

24.1.1. Market model

Energy regulation in Slovakia is undertaken by the Regulatory Office for Network Industries ("Úrad pre reguláciu sieťových odvetví" - URSO), established in 2001.

SEPS (Slovenska Elektrizacna Prenosova Sustava) and Eustream are the Slovak electricity and gas Transmission System Operators (TSOs) respectively.

In Slovakia, there are three biggest regional distribution companies (DSOs): ZSE (West), SSE (Central), and VSE (East of Slovakia). They are 51% controlled by the State, and the remaining minority shares and the executive rights are in the hands of private investors.

At national level, Slovenské elektrárne (SE) is the biggest electricity provider in Slovakia with 69% of the country's generation market. SE is the main Supplier of electricity for ZSE, SSE and VSE and also supplies electricity to large businesses. SE is also the main provider of ancillary services in Slovakia.

SPP Distribution is the only operator of the gas distribution system (DSO), and it was legally unbundled from SPP in 2006. It is 51% controlled by the State, and the remaining 49% in hand of a private investor.

With regard to smart metering, the Ministry of Economy of the Slovak Republic is legally entitled to define deployment targets and conditions for smart electricity meters, while there is not a defined entity to perform this function for gas smart meters.

Ownership and installation of both meters and home displays belong to DSOs. Metering data collection is bestowed only to DSOs, while metering data storage is charged to both DSOs and the Central Data Hub, who are also responsible for metering data protection together with the Suppliers, in compliance with the General Data Protection Regulation (GDPR). Also metering data transmission to third parties is in charge of both DSOs and the Central Data Hub, but the DSOs are not allowed to provide the data to Third parties. Concerning possible technical and administrative losses, there is no specific buyer compensation, but rather possibilities for subsidies within energy efficiency programs.

24.1.2. Legal grounds

The Slovak primary law that enables smart metering is Act on Energy No. 251/2012, which has already been revised. In particular, Section 42 and 77 address "Intelligent metering systems" for electricity and gas respectively[1].

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[2]. In particular, the Decree sets:

- Criteria and conditions for the introduction of smart metering systems for individual categories of end-users of electricity
- Required technical parameters of smart metering systems
- Data transmission requirements and collaboration of individual systems
- The way of access to measured data from individual electricity market participants
- Deadlines for introducing smart metering systems for each category of end-users of electricity
- The efficiency of electricity market participants in the installation and operation of smart metering systems

At present, there is no equivalent Decree for the gas sector, but a cost benefit assessment (CBA) is being undertaken.

24.1.3. Primary drivers

Enabling dynamic tariffs for households and SMEs, as well as digitalizing the distribution grid, optimizing the network operations and integrating the decentralized energy resources with flexible access (load shedding, infeed curtailment) are the main drivers for smart metering deployment in Slovakia.

24.1.4. Smart metering programme financing

Not available.

24.1.5. Recent publications by the NRA

The most recent publication of the Slovak NRA on smart metering is "Designing solutions for the introduction of intelligent metering systems in the Slovak electricity sector"[3], written in Slovak language.

The most relevant official document that is available is the 4th National Energy Efficiency Action Plan (NEEAP 2017)[4], which was prepared in compliance with the Energy Efficiency Directive (EED, 2012/27/EU), but no information about deployment of smart meters is included in it.

24.2. Cost benefit analysis

24.2.1. Relevant study

In Slovakia, two Cost-Benefit Analyses have been carried out between 2012 and 2013.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation	Publicly available
2012	Government	N/A	N/A	Set the scene	No
2013	Government	N/A	N/A	Comply with Dir. 2009/72	No, but some information can be found in Slovak language here[3]

In particular, the 2012 CBA was conducted in the gas sector by Ministry of Economy in cooperation with NRA.

24.2.2. Market roles and key parameters

The DSO, Supplier and Consumer have been identified as the market roles supporting direct costs and benefits in the economic assessment.

Key parameters for the assessment	
Evaluation period of the CBA [Years]	8 years (2013-2020)
Billing and metering frequency in the reference case for electricity [times/year]	12
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	5.5%
What is the electricity losses unit cost? [€/MWh]	54 or 33.85 €/MWh (depending on DSO)
What is the economic lifetime of electricity smart meters? [Years]	5-8 or 12-15 years (depending on DSO)
What is the economic lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	N/A
What is the discount rate taken into account? [%]	N/A
What is the inflation rate taken into account? [%]	N/A
What is the cost reduction rate due to technological maturity? [%/year]	N/A
What is the installation success rate (installation/visits)? [%]	N/A

What is the refusal rate (refusals/visits)? [%]	N/A
What is the deactivation rate (deactivations/installations)? [%]	N/A
What is the carbon price taken into account? [€/t + reference year]	N/A

24.2.3. Main cost and benefit items

The main cost and benefits items considered in the CBA have not been specified. The value of total costs for the whole evaluation period is equal to 67.9 million euros.

24.2.4. CBA results

While the major outcome of the first CBA (2012) was that total costs associated to the introduction of smart metering exceeded the benefits, different results were found in the second CBA (2013), namely:

- the actualised number of meters installed during the whole evaluation period (2013-2020) is 205,613 meters
- the smart meter stock at the end of the evaluation period (2020) amounts to 100,000 meters

24.2.5. Deployment strategy and latest statistics

The results in terms of smart electricity and gas meter deployment for households and Small-Medium Enterprises (SMEs) in Slovakia are resumed in the following tables.

State of play of smart metering deployment in Slovakia as of 1/1/2018 (1st and 2nd DSO data)	Electricity households	Electricity SMEs	Gas households	Gas SMEs
Number of smart meters	46,126	34,619	0	2,808
Number of connection points equipped with smart meters	45,842	33,047	0	2,768
Total number of meters	1,664,790	206,922	0	77,703
Total number of connection points	1,664,790	206,922	0	77,663
Number of smart meters that does not communicate (de-activated upon specific consumer request)	23	2	0	0
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	65	7	0	N/A
Number of smart meters that does communicate default metering data	46,126	34,619	0	N/A

Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	9,809	18,123	0	N/A

These values have been provided by two DSOs out of three. The 3rd Slovak DSO has provided only global data of smart electricity meters for households and SMEs to be added to previous values:

State of play of smart metering deployment in Slovakia as of 1/1/2018 (3rd DSO data)	Electricity total (households and SMEs)
Number of smart meters	46,580
Number of connection points equipped with smart meters	46,580
Total number of meters	642,031
Total number of connection points	640,000
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	N/A
Number of smart meters that does communicate default metering data	46,580
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A

Up to 1/1/2018, combining the deployment results given by the three DSOs, for electricity households and SMEs customers, there are globally 127,325 smart meters out of 2,513,743 meters installed and 125,469 connection points equipped with smart meters out of a total of 2,511,712 connection points in Slovakia. Electricity smart metering has hence only a 5% degree of penetration in the country.

Referring to gas metering for SME customers, on 1/1/2018 only 2,808 smart meters have been installed out of 77,703 meters installed. Currently, the gas smart metering has hence only 4% degree of penetration in the country. The connection points equipped with smart meters are 2,768 out of a total of 77,663 connection points.

In particular, the following results in terms of smart meters annual deployment were achieved in 2017:

Deployment outcomes in 2017	Electricity households	Electricity SMEs	Gas households	Gas SMEs*

Yearly installation target	44,300	2,700	0	No numerical goal**
Number of visits to consumer premises	49,194	3,404	0	At least once a year***
Number of installed smart meters	46,498	3,960	0	95
Number of deactivated smart meters	11	7	0	56
Number of refusals	9	4	0	0

*In 2017, the DSO installed meters only for SMEs with annual consumption of 60,000–400,000 m^3 (tariff class 9 and 10). By smart gas meters it is understood the electronic meter that re-calculates the volume of gas from operational consumption to so called basic consumption according to the Decree 269/2012, section 1, article 6, with transmission of metered data, which are provided to gas suppliers and end consumers according to the legislation. In Slovakia, the meters installed for SMEs are meters that have only the basic functionalities of Intelligent Metering Systems (IMS), i.e. distance data transmission without the option of consumption management.

**The target is to connect each SME gas customer, who meets the business and technical conditions for the connection to distribution network.

***As it is part of maintenance and telemetric activities.

As the table shows, the 2017 yearly installation targets related to electricity smart metering have been exceeded in Slovakia, with a total of 50,458 installed smart meters for households and SMEs customers.

Slovakia is planning to deploy 220,000 smart meters and has a defined target for 2020.

Depending on the Slovak DSO, smart metering deployment is mandatory for the 80% of all connected points with an annual consumption of at least/above 4 MWh.

Any eventual exception to mandatory installations is based on CBA and annual consumption indications.

The major technological constraints shaping the deployment policy are related to problems in IP Multimedia Subsystem (IMS) communication due to geographical constraints, on which there are ongoing Pilot Projects before the start of the rollout.

24.3. Functional specificiations

All 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are available and activated by default on smart meters in Slovakia. They are almost all free of charge for the Customer, with only few exceptions, listed below.

Direct readings to the Customer and to any Third party designated by the Customer himself/herself is a paid service that can be activated on request (Functionality A).

Allowing remote reading of meters by the operator is not free of charge for the Customers of all Slovak DSOs (Functionality C), while proving two-way communication between the smart metering system and external networks is free of charge only for one DSO's customers and not for the other two Slovak DSOs' customers (Functionality D).

FUNCTIONALITIES	Foreseen and available (but not necessarily activated)	Activated by default	Free of charge for the customer
FUNCTIONALITY A: Provide readings directly to the customer and any third party designated by the consumer	☒	☒	☐
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings	☒	☒	☒
FUNCTIONALITY C: Allow remote reading of meters by the operator	☒	☒	☐
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☒	☒	☐
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☒	☒
FUNCTIONALITY F: Support advanced tariff system	☒	☒	☒
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☒	☒	☒
FUNCTIONALITY H: Provide secure data communications	☒	☒	☒
FUNCTIONALITY I: Fraud prevention and detection	☒	☒	☒
FUNCTIONALITY J: Provide import/export and reactive metering	☒	☒	☒

Regarding the consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated has been provided:

	History (Historical data)	Granularity (Historical data)	Frequency (Readings)
DSO	5 years	15-min. profile for balancing; 1 per month for billing registers*	Daily

Supplier	N/A	N/A	Monthly/daily (depending on the DSO)
Central Data Hub	N/A	N/A	Monthly
Smart Meter	Min. 35 days*	3 mins	Every day after midnight/every 15 mins (depending on the DSO)

*Data must be kept for a minimum of 35 days according to Act 3/2012. The history of consumption is accessible to customers through the web portal, on which there are data from the implementation of the Intelligent Metering System (IMS) meter. Consumption data are uploaded on the portal no later than 5 days after the closing of the billing period.

Customers can view a 15-minute consumption profile through the web portal. Furthermore, it is possible to provide Customers and Third parties (if allowed) with the readout data directly from the meter by means of a separating member every 3 minutes or to control the output by means of output impulses online. Concerning emerging services, Third parties can read the consumption data directly from the meter electronically or on DSO web portal only if the Customer makes his/her data available to them (Functionality A).

The frequency with which readings are updated is daily for consumption profiles and monthly for registers (Functionality B).

In Slovakia, one DSO has implemented push (automatic) remote reading on smart meters, while another DSO has implemented pull (on demand) remote reading (Functionality C).

Among advanced tariff system possibilities, it is foreseen to use only time-of-use tariffs in Slovakia. Although prepayment schemes are not foreseen, it is possible to realize them in MDM (Mobile Device Management) thanks to the switching functionality (Functionality F).

Smart meters are able to measure the net injected energy into the grid and to measure both the net injected energy and grid injection separately from withdrawals (Functionality J).

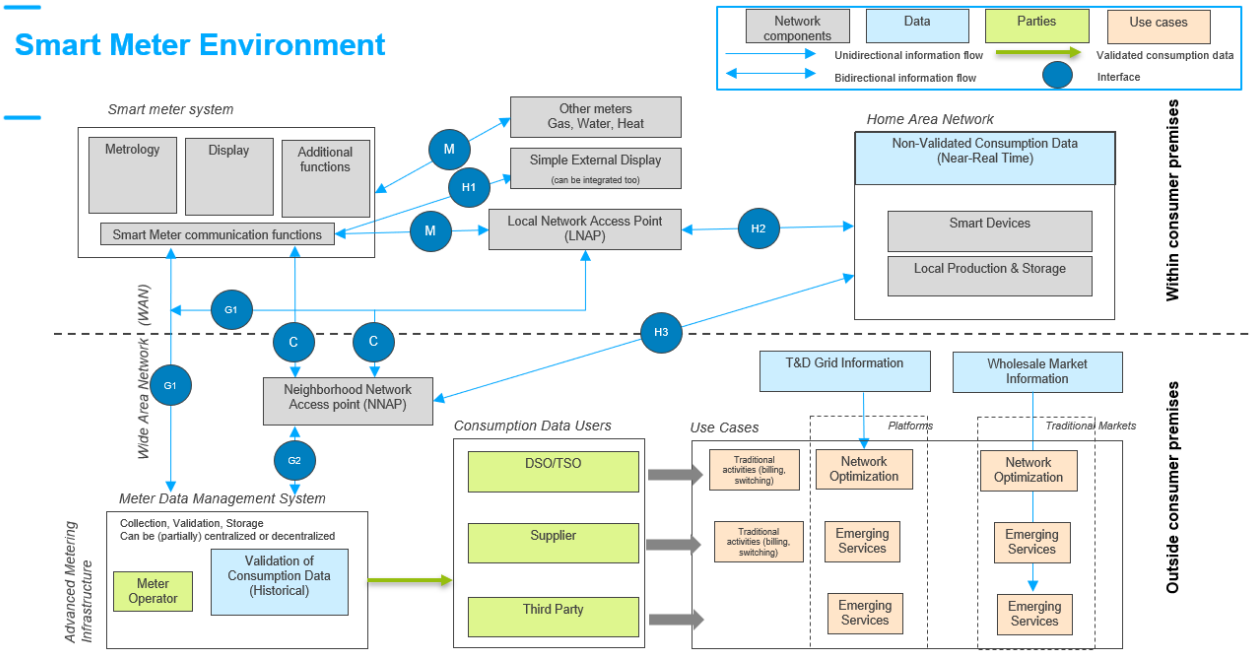
In Slovakia, smart metering is not intended to be used in community-based distribution systems, as no demand for such functionality is expected.

Finally, besides compulsory websites, no other initiatives aiming at providing customers the access to their data have been undertaken so far in Slovakia.

24.4. Technical specifications

While H1 and H3 interfaces are not implemented on smart meters, H2 interface can be activated upon customer explicit request. G1 interface is implemented by default, while C and G2 interfaces are implemented by only one Slovak DSO and not by the other two DSOs. These interfaces can be seen in the figure below that gives a schematic representation of the functional architecture and communication paths in a smart metering environment.

The chosen technologies for H2 and C interfaces are RS485 DLMS and RS485 IEC62056-21 respectively. Both G1 and G2 interfaces rely on Global System Mobile (GSM) communication technology. These technologies have been chosen because of their relatively low price, their reliability and availability.



24.5. Data management

24.5.1. Data access and privacy framework

Suppliers and Third Parties need explicit consent to access Customers' metering data, but there are legal obligations when data have to be provided regardless the Customers' consent, i.e. DSO has to provide metering data to the Supplier due to invoicing.

24.5.2. Provisions to provide and revoke access to data

Currently, the Customer cannot give or revoke himself/herself the access to his/her metering data, but it is the DSO that fulfils its legal duties and provides data to all parties that are identified by the law.

24.6. Consumer impact

24.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Slovak market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No

Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	No
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	No
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	No
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

As seen in the table, at present, smart meters provide only one service to the customer, that is access to historical data, and are still not able to provide any service identified as "advanced".

24.6.2. Consumer concerns

Not available.

24.6.3. Research on consumer benefits

Not available.

24.6.4. Communication campaign

Not available.

24.6.5. Advanced consumer services

Not available.

24.7. Conclusions

The Slovak primary law that enables electricity and gas smart metering is Act on Energy No. 251/2012. While the Decree No. 358/2013 of the Ministry of Economy of the Slovak Republic is the delegated law laying down the procedure and conditions for the introduction and operation of smart metering systems in the electricity sector, there is no equivalent decree for the gas sector.

Up to 1/1/2018, electricity smart metering has reached a low degree of penetration in the country with only 5% of traditional meters replaced with smart meters. Concerning gas smart metering systems, only 4% of gas meters have been replaced with smart meters.

Slovakia is working on the deployment of smart metering systems principally in order to enable dynamic tariffs for households and SMEs, digitalise the distribution grid, optimise the network operations and integrate the decentralized energy resources with flexible access (load shedding, infeed curtailment).

Two Cost-Benefit Analyses (CBAs) on smart metering deployment have been conducted in Slovakia between 2012 and 2013. The first CBA (2012) gave negative results, revealing that the total costs associated to the introduction of smart metering exceeded the benefits.

The Slovak NRA has not specified neither cost nor benefit items, according with the guidelines provided by the European Commission in Recommendation 2012/148/EU. The total amount of costs that should be incurred for the whole evaluation period (8 years, 2013-2020) is €67.9 million, but no information is given regarding the associated total benefits.

Privacy and data protection matters related to smart meters are at a very early stage of development in Slovakia. There is no clearly defined data management strategy and main related risks have not been identified yet. Moreover, a Data Protection Impact Assessment has not been carried out yet.

In Slovakia, all 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are available and activated by default on smart meters. They are all free of charge for the customer, with the sole exception of three functionalities (A, C and D). Besides the functionalities, the only service smart meters can enable is providing access to historical data consumption in order to compare weekly or monthly consumption over time. Other advanced services cannot yet be provided or supported by smart meters in Slovakia. A communication campaign aimed at facilitating consumers' engagement and promoting behavioural change, has not been organized yet.

24.8. References

Id	Reference description
1	Act No. 251/2012 on Energy and on the amendment of certain laws - http://www.urso.gov.sk/sites/default/files/z_251-2012_en.pdf
2	Decree No. 358/2013 - Decree of the Ministry of Economy of the Slovak Republic laying down the procedure and conditions for the introduction and operation of smart metering systems in the electricity sector- http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/laws/1627.pdf
3	Designing solutions for the introduction of intelligent metering systems in the Slovak electricity sector - http://www.rokovania.sk/File.aspx/ViewDocumentHtml/Mater-Dokum-156547?prefixFile=m_
4	4th NEEAP 2017 - https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans

25. SLOVENIA

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Slovenia.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

25.1. Legal and Regulatory Framework

25.1.1. Market model

The Energy Agency (*Agencija Republike Slovenije za energijo*) is the national regulatory authority of the Republic of Slovenia. It directs and supervises electricity and gas energy operators and carries out tasks regulating energy operators' activities in the field of heating and other energy gases.

The Slovenian electricity transmission system operator (TSO) is the company ELES d. o. o., which owns and operates the Slovenian transmission network.

According with the Energy Act (EZ-1, Official Gazette of the Republic of Slovenia, no. 17/2014), in Slovenia, only a legal person owning or leasing a distribution system and holding a concession granted by the Government, for the provision of the service of general economic interest, can perform electricity distribution system operator (DSO) activity[1].

In 2007, the Government of the Republic of Slovenia issued, by Decision No. 36001-4/ 2007/5, a concession of electricity DSO service of general economic interest to the company SODO d. o. o. for a period of 50 years. After signing the concession contract, SODO d. o. o. signed lease contracts on the electricity distribution network and provision of services for the DSO (SODO) for the entire duration of the concession, with five Slovenian individual electricity distribution companies (EDCs): Elektro Celje, d. d., Elektro Gorenjska, d. d., Elektro Ljubljana, d. d., Elektro Maribor, d. d., Elektro Primorska, d. d. Therefore, SODO d. o. o together with EDCs provides electricity supply to more than 940,700 users of distribution network in the Republic of Slovenia.

The gas TSO Plinovodi d. o. o. owns and is responsible for the Slovenian natural gas transmission network. Fifteen entities carry out the service of gas DSO serving less than 100,000 customers in total, so that they are not subjected to legal separation of activities (unbundling).

Concerning smart metering, according to the Energy Act[1], the Government of the Republic of Slovenia is legally entitled to "issue a decree prescribing measures and procedures for the introduction and interoperability of intelligent metering systems in the territory of the Republic of Slovenia". The Government should lay down these deployment targets and conditions "taking into account the results of the economic assessment (in compliance with Dir. 2009/72/EC), best practices, as well as the importance of developing the internal electricity market"[1].

The Energy Act defines the electricity and gas DSOs roles in the smart metering deployment in Articles 49 and 174 addressing *"Intelligent metering systems"* for the electricity and gas sector respectively, stating: "the electricity/gas DSO shall provide household customers and other system users with intelligent metering systems that encourage the active participation of consumers in the electricity/gas market".[1]

Furthermore, smart electricity meters should "enable the charge of costs by actual consumption, the use of new methods of charging that are adapted to supply and demand in the market, and the implementation of services by providers in the market".[1]

Ownership and installation of meters, buyer compensation for technical and administrative losses, as well as metering data collection, storage and transmission to Third parties are bestowed to DSOs. DSOs are responsible for the installation of in-home displays, while Customers have their ownership. The Slovenian DSOs are also appointed as Data Protection Officers in compliance with the General Data Protection Regulation (GDPR).

25.1.2. Legal grounds

In 2012, the distribution network operator for electricity in Slovenia (SODO) presented the "Development programme for Smart Grids in Slovenia", which defines the strategic guidelines for introducing smart grids to obtain a functioning system in Slovenia by 2020[3].

The new Energy Act (EZ-1, Official Gazette of the Republic of Slovenia, No 17/2014)[1] is the official Slovenian Energy Law that transposes a number of EU directives concerning electricity and gas markets (2009/72/EC and 2009/73/EC), energy efficiency (2012/27/EC) and renewable energy sources (2009/28/EC). It has already been revised and it lays down the principles of energy policy, energy market operation rules, as well as principles and measures in order to ensure security of supply and increase in energy efficiency, energy saving and energy generated from renewable energy sources.

The Energy Act is currently the primary law that enables electricity and gas smart metering in Slovenia, as it includes Articles 49 and 174 addressing "Intelligent metering systems" for the electricity and gas sector respectively[1].

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)")[2] was adopted in Slovenia. This regulation sets out measures and procedures for ensuring the introduction and connectivity of the Advanced Measurement System (AMS) of electricity in the Republic of Slovenia. It mainly regulates the technical requirements for smart metering systems and the method and conditions for its introduction into the Slovenian electricity network. Under this Regulation, an AMS includes: system counters for system users, a communications infrastructure that enables the transmission of data from system meters to the metering centres and metering centres and a unified information system (a system for unified access to data from metering centres in the RS).

Currently there is no equivalent decree setting measures and procedures for the implementation of smart metering for gas in Slovenia.

In 2015, the Government of the Republic of Slovenia adopted the "Slovenian Strategy for Smart Specialization (S4)"[4], a development investment platform in areas where Slovenia has a critical mass of knowledge, capacities and competencies.

Metering plays an important role in a smart energy grid environment. Accordingly, the *Smart Cities and Communities* area is among the identified priority areas in Slovenia with the aim to develop globally-competitive systemic solutions in the field of smart grids and IT platforms, supported by at least two pilot projects, in particular in the area of energy, urban mobility and safety[4].

25.1.3. Primary drivers

There are many drivers for smart metering deployment in Slovenia, with the most relevant being the following:

- Enabling dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors
- Integrating decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Energy usage control
- Efficient supplier switching
- More efficient network planning
- New energy services (flexibility market)

25.1.4. Smart metering programme financing

Not available

25.1.5. Recent publications by the NRA

In 2016, pursuant to Article 6 of the Decree[2], the electricity DSO SODO published the "Plan for the introduction of an advanced measuring system in the electricity distribution system of Slovenia"[5]. The plan foresees that the share of electricity distribution network users connected to AMSs will be 91% by 2023 and will reach 100% by 2025.

25.2. Cost benefit analysis

25.2.1. Relevant study

In accordance with EZ-1 and EU Directives 2009/72/EC and 2009/73/EC, an economic "Cost-benefit analysis of advanced metering in Slovenia"[6] was prepared in 2014.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation	Publicly available
2014	DNV KEMA Energy & Sustainability, KORONA	NRA (*Agencija Republike Slovenije za energijo*)	Positive Net Present Value	Define ideal target and planning	Yes[6]

25.2.2. Market roles and key parameters

In the economic assessment, the following market roles have been taken into account to support direct costs and benefits: DSO, Supplier, NRA, Consumer, State/Society, TSO and Producer and Telecom service provider.

Key parameters for the assessment	
Evaluation period of the CBA [years]	2015-2048 (33 years, equivalent to approx. two investment cycles)
Billing and metering frequency in the reference case for electricity [times/year]	12 (monthly)
Does this also apply for gas?	yes, 12 (monthly)
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	5%
What is the electricity losses unit cost? [€/MWh]	57,2 €/MWh
What is the economic lifetime of electricity smart meters? [Years]	15 years
What is the economic lifetime of gas smart meters? [Years]	15 years
What is the value of the lost load? [€/MWh]	4,280 €/MWh
What is the discount rate taken into account? [%]	Social discount rate: 5% (base case scenario), 5.5% and 3.5% for sensitivity analysis
What is the inflation rate taken into account? [%]	For the period 2013-2015, applied inflation rate is provided in the network charges act.: 1.8% (2013); 1.9% (2014 and 2015) For the period after 2015: 1.7%
What is the cost reduction rate due to technological maturity? [%/year]	0.5% until 2020; 0% after 2020
What is the installation success rate (installation/visits)? [%]	N/A
What is the refusal rate (refusals/visits)? [%]	N/A
What is the deactivation rate (deactivations/installations)? [%]	N/A
What is the carbon price taken into account? [€/t + reference year]	linear growth from 3.6 €/t, 16.5 €/t in 2020, 36 €/t in 2030

25.2.3. Main cost and benefit items

As detailed in the following list, all cost items suggested by the European Commission (Recommendation 2012/148/EU) have been taken into account in the Slovenian CBA. In addition, two more costs have been considered in the economic assessment, that is costs of a global programme implementation and of a marketing campaign.

☒ CAPEX - Investment in smart meter

☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom

☒ CAPEX - Investment in In-home display

☒ CAPEX - Sunk cost of conventional meters

☒ OPEX - IT maintenance

☒ OPEX - Network management and front end

☒ OPEX - Telecom

☒ OPEX - Change management

☒ OPEX - Unplanned renewal and failures of smart meter

☒ OPEX - Revenue reduction

☒ OPEX - Meter reading

☒ OPEX - Call center and customer service

☒ OPEX - Consumer engagement programme

☒ Other cost items: OPEX - Global programme implementation; OPEX - Marketing campaign

The following main benefit items have been monetized among those suggested by the European Commission (Recommendation 2012/148/EU):

☒ Bill reduction due to energy efficiency (reduction in energy volume inducing money savings of gas and electricity bills)

☒ Bill reduction due to dynamic pricing (price defined the day before or near real time, applying on fixed time frames)

☐ Provision of explicit flexibility services (rather based on a request than a price signal)

☐ Increased competition in retail market

☐ Easier access to photovoltaic production

☒ Meter reading & operation savings

☒ Operation & maintenance of assets

☒ Distribution capacity deferral

☒ Transmission capacity deferral

☒ Generation capacity deferral

☒ Technical losses reduction

☒ Non-technical (administrative, including fraud) losses

☒ Outage management (based on societal value of lost load)

☒ Outage management (based on reduced customer indemnification)

☒ CO2

☐ Air pollution (particulate matters, NOx, SO2,...)

☐ Other

25.2.4. CBA results

In the CBA, the DNV KEMA Energy & Sustainability (KORONA) has carried out three different mandatory roll-out macro-scenarios. The first one is the case of a full roll-out of smart electricity meters, the second one is a combined electricity and gas smart meters scenario and the last one is a gas-only scenario.

The analysis showed that a mandatory roll-out of smart electricity metering in Slovenia can generate significant net benefits for consumers and society as a whole. Costs discounted to their present value will be particularly high at the beginning of a smart metering roll-out, whereas significant discounted benefits will arise over a much longer period. It will therefore take at least one investment cycle for smart meters until discounted costs are outweighed by discounted benefits.

A joint mandatory roll-out for electricity and gas would provide net benefits only for some roll-out scenarios (5 out of 10 outlined scenarios). However, a break-even between discounted costs and benefits will only be achieved in the most beneficial scenario after 25 years, which might be too long-term when uncertainty on future developments is considered. Therefore, a joint mandatory roll-out could cause cross-subsidization, that is the practice of charging higher prices to electricity consumers in order to subsidize lower prices for gas consumers.

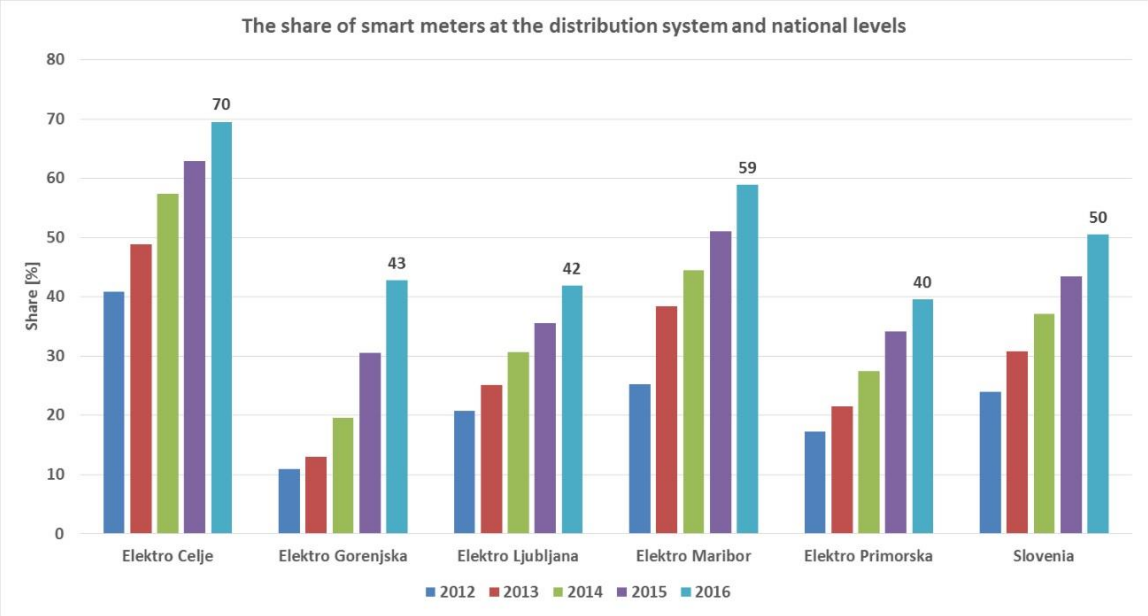
A much larger number of electricity meters than gas is installed in Slovenia (number of consumers supplied with electricity much higher than with gas). Therefore, a positive result for a joint roll-out of smart metering is mainly driven by large net benefits on the electricity side, which outweigh the net costs on the gas side. For this reason, a gas-only scenario was performed within the CBA as well. Applying the same joint electricity-gas scenario parameters to the gas-only scenario, they resulted in discounted costs more than two times higher than discounted benefits. Even when considering more optimistic values within a sensitivity analysis, the negative results tended to be very robust, so that the CBA did not recommend proceeding to a roll-out of smart gas metering in Slovenia.

Key outcomes of the assessment for the rollout of electricity smart meters (actualised values, referring to the whole evaluation period)	
Number of meters installed [n° of meters]	1,491,141
Smart meter stock (at the end of the evaluation period) [n° of meters]	892,786
CAPEX [€]	152 M€
OPEX [€]	65 M€

Total benefits [€]	38 M€

25.2.5. Deployment strategy and latest statistics

The share of smart electricity meters from 2012 to 2016 is shown in the picture below by individual electricity distribution areas and for the entire Slovenia.



Source: Slovenian Energy Agency (https://www.agen-rs.si/web/en/advanced-metering-infrastructure)

The current state of smart metering deployment (as of 1/1/2018) for both electricity and gas in Slovenia is resumed in the following table.

It is noted that no smart gas meters are currently deployed and/or foreseen in Slovenia because of the negative results provided by the CBA (see paragraph 2.2.4), with the sole exception of 165 installed gas smart meters for SMEs.

State of play of smart metering deployment in Slovenia as of 1/1/2018	Electricity households	Electricity SMEs	Gas households	Gas SMEs
Number of smart meters	489,899	54,433	0	165
Number of connection points equipped with smart meters	489,899	54,433	0	165
Total number of meters	841,540	93,793	119,678	13,952
Total number of connection points	841,540	93,793	119,678	13,952
Number of smart meters that does not communicate (de-activated upon specific consumer request)	0	0	N/A	N/A
Number of smart meters that does not communicate (due to technical reasons)	40,885	4,543	N/A	N/A

Number of smart meters that does communicate default metering data	449,014	49,890	N/A	N/A
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	N/A	N/A	N/A	N/A

Therefore, for electricity households and SMEs customers there are globally 544,332 smart meters out of 935,333 metering points installed in Slovenia. Electricity smart metering has hence reached a 58% degree of penetration in the country. Considering both electricity and gas, the total number of installed smart meters is 544,497 out of 1,068,963 electricity and gas metering points. Therefore, as of 1/1/2018, 51% of conventional meters (electricity and gas) has been replaced by smart meters in Slovenia.

In particular, the following results in terms of smart meters annual deployment were achieved in 2017, where there was no deployment of smart gas meters according to negative results of the CBA (see Paragraph 2.2.4).

Deployment outcomes in 2017	**Electricity households**	**Electricity SMEs**
Yearly installation target	54,000	6,000
Number of visits to consumer premises	N/A	N/A
Number of installed smart meters	58,525	6,503
Number of deactivated smart meters	N/A	N/A
Number of refusals*	N/A	N/A

As the table shows, while the 2017 yearly installation target has not been fulfilled for electricity households, it has been exceeded for electricity SMEs customers.

At the end of 2017, 58% of the consumers connected to the electricity distribution grid were equipped with smart meters, only slightly less, namely 52%, were actually connected to the remote data acquisition. Almost one-half of all installed smart meters complies with the technical criteria disposed by the official document "Technical reference for the implementation plan for the Slovenian Advanced Metering Infrastructure"[8]. In accordance with government regulation, all built-in smart meters must comply with all the requirements by 2025.

According to the Energy Act[1], since the CBA delivered positive results on a smart electricity metering roll-out in Slovenia, "at least 80% of those consumers who have been assessed positively, have to be equipped with intelligent metering systems for electricity by 2020".

In addition to this 2020 target, the "Plan for the introduction of an advanced metering system in the electricity distribution system of Slovenia"[5] sets a target of 91% electricity distribution network users equipped with smart meters by 2023 and expects this number to reach 100% by 2025 (see paragraph 2.1.5). However, this Plan was published in April 2016 and it has not yet been updated.

Such deployment is mandatory only for households and SMEs consumers, as all medium and large business (11,500 industrial customers; P > 41kW) have already been equipped with smart metering systems.

25.3. Functional specificiations

The 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are activated by default or available and foreseen according to the table below. In both cases, they are always free of charge for the Customer.

FUNCTIONALITIES	Foreseen and available (but not necessarily activated)	Activated by default	Free of charge for the customer
FUNCTIONALITY A: Provide readings directly to the customer and any third party designated by the consumer	☒	☐	☒
FUNCTIONALITY B: Update the readings referred to in point (A) frequently enough to allow the information to be used to achieve energy savings	☒	☐	☒
FUNCTIONALITY C: Allow remote reading of meters by the operator	☐	☒	☒
FUNCTIONALITY D: Provide two-way communication between the smart metering system and external networks for maintenance and control of the metering system	☐	☒	☒
FUNCTIONALITY E: Allow readings to be taken frequently enough for the information to be used for network planning	☒	☐	☒
FUNCTIONALITY F: Support advanced tariff system	☒	☐	☒
FUNCTIONALITY G: Allow remote on/off control of the supply and/or flow or power limitation	☐	☒	☒
FUNCTIONALITY H: Provide secure data communications	☒	☐	☒
FUNCTIONALITY I: Fraud prevention and detection	☐	☒	☒
FUNCTIONALITY J: Provide import/export and reactive metering	☒	☐	☒

At present, functionalities C, D, G and I are already a default setting on smart meters, while functionalities A, B, E, F, H and J are available and foreseen, but not necessarily activated.

Concerning consumption data storage at different levels (DSO, Supplier, Central Data Hub, Smart Meter), the periods of time and the granularity in which historical consumption data are stored and the frequency with which readings are updated has been provided:

	History (Historical data)	**Granularity (Historical data)**	**Frequency (Readings)**
DSO	At the level of metering centres (distribution utilities) only: - Aggregated data: min. 3 years - Detailed data: min. 2 years (day, week, month, year)	15 minutes (planned)	Daily
Supplier	N/A	N/A	Monthly
Central Data Hub*	Same as at DSO level	15 minutes (planned)	Daily
Smart Meter	40 days	15 minutes	15 minutes

*Remark: Central Data Hub not yet established as defined in the AMS deployment Plan[5]

More specifically, legislation binds DSOs to collect daily load profiles for industrial customers and to do meter reading just once a year for households and SMEs customers.

Customers and Third parties (only upon Costumer consent) can have access to consumption data by direct local access to smart meters or on the compulsory DSO web portal (Functionality A). Customer and authorised Third parties' access via Central Data Hub web portal is not available yet but is planned in the AMS deployment Plan[5].

Third parties' access to consumption data for emerging services has the following features:

	History	**Granularity**
Meter data management system	- Aggregated data: min. 3 years - Detailed data: min. 2 years (day, week, month, year)	Hourly, 15 minutes (planned)
Direct access to the smart meter	40 days	15 minutes

The Slovenian operator has implemented pull (on demand) remote reading on smart meters (Functionality C).

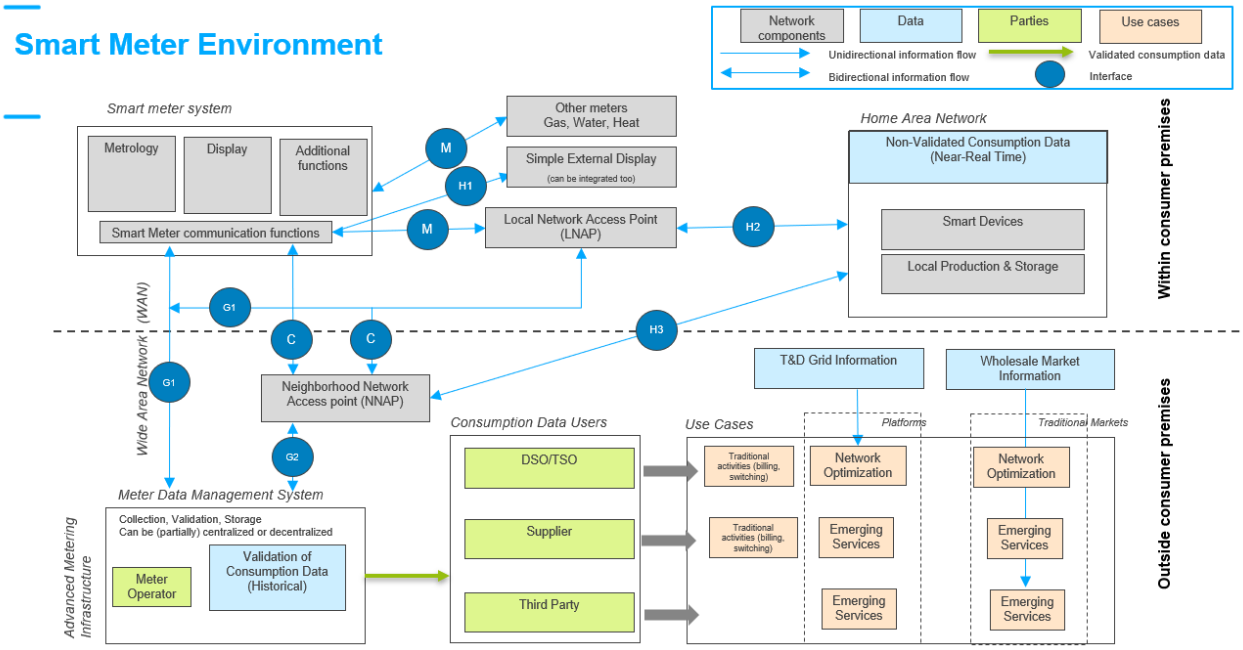
Time-of-use tariffs are the only tariffs that are currently foreseen as possible solution among advanced tariff system possibilities (Functionality F).

Smart meters are able to measure reactive power and to measure grid injection separately from withdrawals (Functionality J).

In Slovenia, energy communities and self-consumers are foreseen to use existing smart meters.

Due to delays in the implementation of the Central Data Hub, there are currently some informal initiatives to provide the access to data via real-time data retrieved from H2 interface (customer port)- see schematic below that shows the functional architecture and communication interfaces in a smart metering environment. Moreover, a solution based on cloud services is foreseen.

25.4. Technical specifications



As the following table shows, in Slovenia, C, G1 and G2 interfaces are implemented by default on smart meters, while H1 and H2 interfaces can be activated upon customer explicit request.

The reason for the technology choices is the outcome of the analysis performed in order to provide the technical and economic background for smart metering implementation according to the AMS deployment Plan[5].

	Interface implementation	Technology
H1	activated upon customer explicit request	Wired/Wireless M-Bus
H2	activated upon customer explicit request	WPAN, Wi-Fi
H3	No	Not implemented
C	implemented by default	PLC
G1	implemented by default	GSM
G2	implemented by default	Ethernet (Fiber Optic), GSM, WiMAX

25.5. Data management

25.5.1. Data access and privacy framework

Third parties and Suppliers need an explicit consent from the Customer to access his/her metering data.

No Data Protection Impact Assessment has been performed in Slovenia so far.

25.5.2. Provisions to provide and revoke access to data

Customers can give access to their metering data by providing a written approval communicated to and validated by the DSO or a central party.

The Customer can revoke such access automatically after a predefined delay or by submitting a written form. In the latter case, the written form must be communicated to and validated by the DSO or a central party, or, alternatively, delegated to a third party or a supplier as part of a service contract.

25.6. Consumer impact

25.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the Slovenian market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers. In particular, active and low-income customers are the customer segments detected to be more sensitive to the new enabled services.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	No
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	No
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No

Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	No
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

As seen in the tablet, in Slovenia, smart meters can provide three of the six services identified as "advanced": dynamic tariffs, flexibility provision and prosumers integration in the market.

25.6.2. Consumer concerns

In Slovenia, consumers expressed the following concerns on smart metering:

	Concern expressed	Based on proved facts or testimonies	Countermeasures adopted
Privacy	Yes	General public resistance to smart metering but lack of objective grounds	No
Cybersecurity	Information not available	N/A	N/A
Electromagnetic radiation	Information not available	N/A	N/A
Accuracy of meters	Yes	Tested in laboratory	Other

Price of meters	No	N/A	N/A
Installation barriers	No	N/A	N/A

Further concerns were expressed on replacement of meters, concerning accuracy problems due to harmonics in older generation meters, mostly in combination with switching devices (e.g. PVs).

25.6.3. Research on consumer benefits

A specific research on consumers' ability to realize the smart metering benefits has been partially conducted through the CBA analysis.

25.6.4. Communication campaign

No communication campaign aiming at promoting consumers engagement has been launched in Slovenia during the rollout of smart meters.

25.6.5. Advanced consumer services

Currently, there are regulatory actions and public consultations addressing initiatives that leverage smart metering to integrate distributed energy resources in Slovenia.

25.7. Conclusions

In Slovenia, DSOs are responsible for all the roles related to the smart metering system except for the in-home display ownership, which is of consumers.

The new Energy Act 2014[1] is the primary law that enables the deployment of electricity and gas smart meters in Slovenia and it transposes the European Directives 2009/72/EC and 2009/73/EC. In 2016, the "Plan for the introduction of an advanced measuring system in the electricity distribution system of Slovenia"[5] set a target of 91% electricity distribution network users equipped with smart meters by 2023 and expects this number to reach 100% by 2025, but it has not been updated yet with the last installations.

Up to 1/1/2018, electricity smart metering has reached 57% degree of penetration in the country. Concerning gas smart metering systems and according with the CBA negative result, no full roll-out was already achieved.

Slovenia is working on the deployment of smart metering systems principally in order to enable dynamic tariffs for households and SMEs, digitalise the distribution grid and the retail market, integrate the decentralized energy resources with flexible access (load shedding, infeed curtailment) and control the energy usage for the consumers for ensuring a more efficient network with new energy services.

In the Slovenian economic assessment, only the macro-scenario of a full electricity smart meters roll-out has showed a positive result for the NPV. In the case of joint mandatory roll-out for electricity and gas the NPV resulted positive in the half of the 10 outlined scenarios, while the gas-only scenario showed a negative result.

The Slovenian DSOs are appointed as Data Protection Officers in compliance with the General Data Protection Regulation (GDPR) but concerning privacy and data protection matters related to smart meters, the Slovenia is at a very early stage. In fact, there is no clearly defined data management strategy and its main risks have not been identified yet. Finally, a Data Protection Impact assessment has not been carried out yet.

In Slovenia, all the minimum functionalities required are already in place for electricity smart meters or at least foreseen. In particular, functionalities C, D, G and I are already activated by default setting on smart meters, while functionalities A, B, E, F, H and J are foreseen.

Besides the minimum functionalities, the Slovenian market provides further type of services, such as:

- **Real-time consumption:** make accessible to consumers energy consumption data in real-time (in € or equivalent)
- **Unusual usage alert:** alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services
- **Historical consumption:** Provide access to historical data consumption in order to compare weekly or monthly consumption over time.
- **Dynamic tariffs (implicit demand response) (advanced)**: Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing,...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly
- **Flexibility provision (explicit demand response) (advanced)**: Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.
- **Smart meter to integrate Prosumers in the market (advanced)**: Either as a prerequisite to install decentralized 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 the balancing markets).

In Slovenia, consumers expressed concerns on privacy and accuracy problems of meters due to harmonics in older generation meters, mostly in combination with switching devices (e.g. PVs), but no particular counter measures have been adopted yet.

No dedicated communication campaign aiming at promoting consumers engagement has been launched in Slovenia during the rollout of smart meters.

25.8. References

Id	Reference description
1	Energy Act (EZ-1, Official Gazette of the Republic of Slovenia, no. 17/2014) - http://www.energetika-portal.si/fileadmin/dokumenti/zakonodaja/energetika/ez-1/ez-1_energy_act_proposal.pdf
2	"Decree on Measures and Procedures for the Establishment and Connectivity of Advanced Measuring Systems for Electricity" - http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED6907
3	"Development programme for Smart Grids in Slovenia" (SODO, 2012) - https://www.sodo.si/_files/434/pametna_omrezja_2012_pop7.pdf

4	"Slovenian Strategy for Smart Specialization (S4)" (2015) - http://www.svrk.gov.si/fileadmin/svrk.gov.si/pageuploads/Dokumenti_za_objavo_na_vstopni_strani/S4_document_2015_ENG.pdf
5	"Plan for the introduction of an advanced measuring system in the electricity distribution system of Slovenia" (SODO, 2016) - https://www.sodo.si/_files/3320/Nacrt_uvedbe_NMS_SODO_07072016.pdf
6	"Cost-benefit analysis of advanced metering in Slovenia" (2014) - https://www.agen-rs.si/documents/54870/69293/Cost-benefit-analysis-of-advanced-metering-in-Slovenia/a7833d3c-6176-44be-8e89-8414a5036e7c
7	Slovenian National Energy Efficiency Action Plan 2020 (NEEAP 2017) - https://ec.europa.eu/energy/sites/ener/files/si_neeap_2017_en.pdf
8	"Technical reference for the implementation plan for the Slovenian Advanced Metering Infrastructure" (EIMV, FERI 2016) - https://www.sodo.si/_files/3311/Studija_2315_NMI_SODO_skupna_v32.pdf

26. SPAIN

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Spain.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

26.1. Legal and Regulatory Framework

26.1.1. Market model

In Spain, the Ministry of Energy, supported by the National Authority for Markets and Competition (CNMC), is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to energy network operators as they are the parties in charge of meter ownership and installation, data collection and storage, and data transmission to third parties. Furthermore, provisions will also apply to consumers as they also have the option to own the meter. Ownership of the in-home display is not regulated.

In Spain, electricity DSOs are responsible for the information from the meters connected to their grid, and for sending and receiving information from smart meters to energy suppliers and other parties, according to the provisions established related to consumer billing. However, there is also an obligation to send the information to the System Operator, following the channels and deadlines established in the corresponding Operation Procedures approved by the Government. Regarding the storage of data, a centralised Supply Point Information System, known in Spanish as SIPS (*Sistema de Información de Puntos de Suministro*), gathers consumers' aggregated load data, which is accessible for all energy suppliers. However, the granularity of this data is limited, so no hourly load curves are stored in here and the data cannot be accessed unless the consumer gives his/her consent to share it with other energy suppliers.

26.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Royal Decree 1110/2007[59], of August 24th. This Decree approved the Regulations on Measurement Points of the Electricity System and it has been revised to include updated timeline and conditions. The order *ITC/3860/2007*[60] (1st additional provision) reviews the electricity tariffs and further sets the implementation of smart metering deployment for electricity. While order *IET/290/2012*[61] also reviews the latter to include various modifications to the replacement plan of smart electricity meters, energy supply and distribution, and electricity tariffs.

Consequently to the negative outcome of the CBA for gas smart meters deployment, there is no specific law in place framing the deployment of smart metering for gas. Nonetheless, Orden ETU/1283/2017 on natural gas activities, requested the Comisión Nacional de los Mercados y la Competencia to prepare a new CBA on gas smart meter rollout by 2019.

26.1.3. Primary drivers

The main drivers for smart metering deployment in Spain have been defined as:

- Digitalizing retail markets with the aim to foster innovation and create the enabling framework to deliver new services
- Digitalizing the distribution grid and optimizing network operations, enabling dynamic tariffs for households and small and medium-sized enterprises, and
- Integrating decentralized energy resources with flexible access (load shedding, infeed curtailment)

26.1.4. Smart metering programme financing

Smart metering costs are borne by the DSOs that have an obligation to install the smart meters by 2018. Part of the money required for the smart metering deployment is recovered through the meter rental fee and another part through the electricity tariff (for example, through the recognition of investments made by the DSOs in telecommunication assets).

26.1.5. Recent publications by the NRA

The two most recent publications issued by the CNMC relate to the second milestone of the rollout plan of smart meters[62] and to the overall compliance of the Spanish regulation with European recommendations[63], respectively. During 2019, the report related to the final milestone of the Plan will be published.

[59] Royal Decree 1110/2007 is available here: https://www.boe.es/buscar/doc.php?id=BOE-A-2007-16478

[60] Order ITC 3860/2007 is available here: https://www.boe.es/buscar/doc.php?id=BOE-A-2007-22458

[61] Order IET 290/2012 is available here: https://www.boe.es/buscar/doc.php?id=BOE-A-2012-2538

[62] Energía - Informe sobre el cumplimiento del segundo hito del plan de sustitución de contadores, CNMC 2017, https://www.cnmc.es/expedientes/infde06317

[63] Informe sobre el estado actual de adecuacion a la normative comunitaria del plan de sustitucion de contadores, CNMC, 2014 https://www.cnmc.es/expedientes/infde020014

26.2. Cost benefit analysis

26.2.1. Relevant study

In Spain, the rollout of electricity meters already began in 2008, when the requirement of the European Commission for a CBA had not been published. Therefore, there is no CBA for electricity smart meters with an exhaustive quantitative analysis of the costs and benefits. Instead, an overall analysis[64] was performed before the implementation plan in which the plan and conditions of the rollout and the rental price of meters were evaluated.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2007		NRA	N/A	Definition of ideal target and planning

In the case of smart gas meters, a CBA[65] was conducted in 2011 by the CNMC. The results are shown in the table below.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2011		NRA	Negative Net Present Value	Comply with European Directive 2009/73/EC

26.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were considered in the assessment: DSO and Consumer. From the consumer's perspective it was of interest to analyse the influence of the meter rental price.

As mentioned in section 2.2.1, no CBA for electricity smart meters was conducted but an overall analysis before the implementation plan was performed instead. In this analysis the conditions of the roll-out and the rental price of meters were evaluated.

The main elements of the analysis performed for electricity meters are specified below as well as the main elements of the CBA[66] performed in 2011 for gas smart meters.

Key parameters for the assessment	Electricity	Gas

[64] Informe sobre el mandato establecido en el real decreto 1634/2006 relativo al plan de sustitucion de equipos de medida, CNE, 2007: https://www.cnmc.es/sites/default/files/1564391_4.pdf

[65] Analisis coste beneficio de la implantacion de contadores de gas inteligentes en Espana, CNE, 2011: https://www.cnmc.es/sites/default/files/1555496_7.pdf

[66] Analisis coste beneficio de la implantacion de contadores de gas inteligentes en Espana, CNE, 2011: https://www.cnmc.es/sites/default/files/1555496_7.pdf

evaluation period of the CBA [Years]	10	20
billing and metering frequency in the reference case for electricity [times/year]	12	12
Does this also apply for gas?	No	N/A
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	-	N/A
What is the electricity losses unit cost? [€/MWh]	-	N/A
What is the economic lifetime of electricity smart meters? [Years]	15	N/A
What is the economic lifetime of gas smart meters? [Years]	N/A	8
What is the value of the lost load? [€/MWh]	-	N/A
What is the cost reduction rate due to technological maturity? [%/year]	-	5%

26.2.3. Main cost and benefit items

As mentioned in 2.2.1 above, the analysis performed for electricity meters was not an exhaustive quantitative analysis so there was no quantification of the cost items.

In the CBA conducted for gas smart meters, the cost items below were considered:

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT
☒ CAPEX - Investment in Telecom
☒ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☐ OPEX - Unplanned renewal and failures of smart meter
☐ OPEX - Revenue reduction
☒ OPEX - Meter reading
☐ OPEX - Call center and customer service
☐ OPEX - Consumer engagement programme

In the analysis for electricity meters, the benefits focus on:

- Bill reduction due to energy efficiency (based on volume rather than unit price)
- Increased competition in retail markets
- Meter readings & operations savings
- Operation & maintenance of assets

- Deferral of distribution capacity
- Reduction of technical losses
- Reduction of non-technical losses (administrative, including fraud)
- Outage management both based on societal value of lost load and on reduced customer indemnification

In the CBA performed for gas smart meters, the benefits focus on:

- Deferral of distribution capacity
- Meter readings & operations savings
- Non-technical (administrative, including fraud) losses
- Bill reduction due to energy efficiency (based on volume rather than unit price)
- Reduction of CO_2 emissions

26.2.4. CBA results

As mentioned above, in the case of electricity smart meters there were no quantitative results to the analysis performed.

In the case of gas meters, the CBA yielded the results summarized in the following table (actualised figures for 2013):

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	10.04 million
Actualised CAPEX for the whole evaluation period	€944 million
Actualised OPEX for the whole evaluation period	€265 million
Actualised benefits for the whole evaluation period	€1.05 billion

The resulting ratios have been computed in per unit, taking the number of installed meters as the reference denominator:

- OPEX per meter: 26 €
- CAPEX per meter: 94 €
- Benefit per meter: 105 €

26.2.5. Deployment strategy and latest statistics

The Ministry of Energy is overseeing the rollout that is being regulated by the CNMC. It is the responsibility of DSOs to install smart meters in all domestic and small and medium-sized enterprises with electricity meters up to 15 kW of contracted power by the end of 2018.

The CNMC has proposed to also include the replacement of electricity meters in connection points of up to 50 kW of contracted power. This proposal has not been approved yet (at least at the moment of data collection for this report).

By the end of 2018, up to a maximum of 2% of the meters will not be replaced as long as the reason is not attributable to the DSO. In any case, the DSO needs to justify to the CNMC the reason why these meters have not been replaced. This information can be used to identify measures that can solve the issues related to deployment.

No technical constraints have been observed that are fundamentally shaping the deployment policy.

The following tables highlight the latest statistics, respectively an "instant picture" of smart deployment at 1/1/2018 and the outcomes of the installation programme during the year 2017.

State of play of smart metering deployment in Spain as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	26 000 000	67 500	Not applicable	Not applicable
Number of connection points equipped with smart meters	Not available	Not available	Not applicable	Not applicable
Total number of meters	28 000 000	Not available	Not applicable	Not applicable
Total number of connection points	26 000 000	675 000	Not applicable	Not applicable
Number of smart meters that does not communicate (de-activated upon specific consumer request)	N/A	Not available	Not applicable	Not applicable
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	See below	Not available	Not applicable	Not applicable
Number of smart meters that does communicate default metering data	Not available	Not available	Not applicable	Not applicable
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	Not available	Not available	Not applicable	Not applicable

After the installation of the smart meter there is a time period until the meters are integrated in the DSO's Automated Metering Management (AMM) system. Although CNMC has proposed that this period should not be longer than 3 months, this is not legally established.

In the case of electricity smart meters for small and medium-sized enterprises (SMEs), the data provided by the DSOs shows that around 10% of meters between 15 and 50 kW had been replaced by the end of 2017. This replacement has been done even though there is no obligation to do so for meters above 15 kW.

The 2017 deployment outcomes for most of the items specified below have not been made available by the CNMC.

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME

Yearly installation target	Not available	Not available	Not applicable	Not applicable
Number of visits to consumer premises	Not available	Not available	Not applicable	Not applicable
Number of installed smart meters	5 000 000	Not available	Not applicable	Not applicable
Number of deactivated smart meters	Not available	Not available	Not applicable	Not applicable
Number of refusals	Not available	Not available	Not applicable	Not applicable

26.3. Functional specifications

All 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) are foreseen and all except for the following functionalities are being activated by default and free of charge for the consumer, with the clear intent to maximise smart metering deployment benefits.

b) Update the readings referred to in point

a) frequently enough to allow the information to be used to achieve energy savings

In the following table, information is given about the period the data can be stored, the granularity and the frequency that the consumption data is updated.

Level of the…	History	Granularity	Frequency of consumption data update
DSO	Not established but at least 2 years for billing purposes	hourly (electricity)	weekly
Supplier	Not established but at least 2 years for billing purposes	hourly (electricity)	weekly (information provided by the DSO)
Central data hub	3 years (aggregated data)[67]	aggregated	monthly (billing period)
Smart meter	At least 3 months (load curve data)	hourly (electricity)	hourly

With regards to the implementation of standardised interfaces in the smart metering environment shown in the figure below, the H1 interface is implemented and the measurements are shown on the smart meter. The interfaces H2 and H3 will not be implemented, whereas C, G1 and G2 will be implemented by default.

[67] Real Decreto 1435/2002, de 27 de diciembre, por el que se regulan las condiciones básicas de los contratos de adquisición de energía y de acceso a las redes en baja tensión, Ministerio de Economía, 2002 https://www.boe.es/buscar/act.php?id=BOE-A-2002-25422

Customer access to consumption data will be made available through the following channels:

- Locally through the display on the smart meter via H1 interface
- DSO web portal in a regulated format
- Supplier web portal – some suppliers are offering this functionality, however it is not mandatory

Although not yet regulated, there is also an alternative to connect the smart meter to a "smart energy box" at the consumer premises. Via the Smart Energy Box, a consumer has access to his/her energy data.

Third party access to consumption data will be made available through the following channels, as long as the consumer gives permission:

- DSO web portal
- Supplier web portal

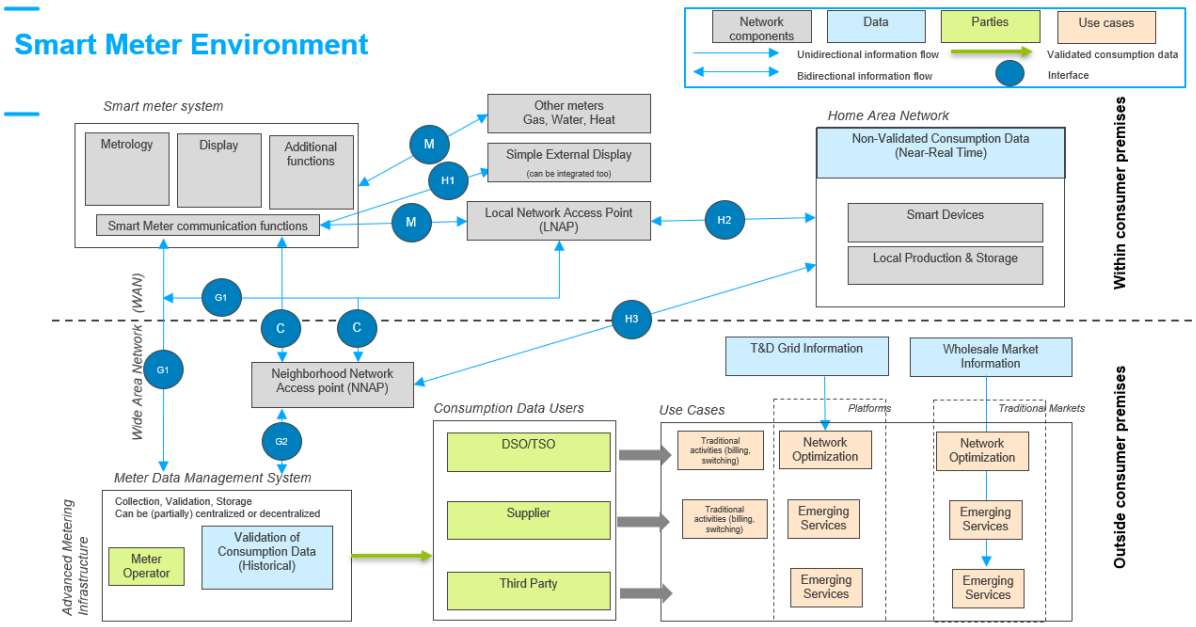
Remote readings by the operator are possible, both push (automatic) and pull (on demand by the operator). Additionally, advanced tariff system possibilities like pre-payment schemes, time-of-use tariffs and linkage to wholesale market prices are foreseen.

The smart meter will also be able to measure the net injected energy into the grid, including reactive power, and it will be able to measure grid injection and withdrawals separately.

Furthermore, community-based distribution metering systems in which metering data is aggregated between multiple users that are physically close to each other, using the same distribution infrastructure, is also under analysis.

26.4. Technical specifications

The technology for H1, C, G1 and G2 interfaces has not been fixed yet (at least at the moment of data collection for this report). The technology that can be used is open (GSM, GPRS, PLC, RTC, etc.) and may vary between areas. Based on the feasibility and optimal costs, the chosen technology solution may use existing infrastructure or be adjusted to the area's specific situation (e.g.: communication problems in remote areas)



Additionally, there are two existing communication protocols with different characteristics: PRIME and METERS&MORE, both based on power line communication (PLC).[68]

26.5. Data management

26.5.1. Data access and privacy framework

A centralised Supply Point Information System (SIPS) and a Privacy Framework has been established to safeguard consumer privacy whilst enabling access to aggregated energy consumption data from domestic and microbusiness premises.

The Spanish Regulations *Real Decreto 216/2014 and Resolución 6203/2015* defined a framework for DSOs for the provision of hourly load profiles to end-users with less than 15 kW of contracted power. DSOs are required to publish the hourly load profiles from October 1st, 2015. Suppliers can bill their customers according to these hourly load profiles that are sent by the DSOs through secure FTP. This process should be followed when the smart device is integrated in the energy system. DSOs must also provide consumers the option to access a website that allows them to consult and download their hourly load profiles once it has been billed[69].

According to the regulation, neither the energy suppliers nor the CNMC will have access to any information that directly reveals the identity of the consumer behind the smart meter. They do get access to aggregated energy consumption data through the SIPS data hub.

This central data hub, SIPS, contains aggregated load data that can be accessed by all energy suppliers and consumers. Consumers have the right to access their data freely and may prohibit the dissemination of their data to suppliers or third parties by a written statement. In this case, consumer's written statement should be explicitly stated in the data hub, and his/her energy supplier becomes responsible for keeping a copy of such request.

Where third parties wish to access hourly energy consumption data, they must have the consumer's consent and comply with relevant provisions in relation to the provision of information. The energy supplier with a contract in place will have automatic access to this data and will be fully responsible for guaranteeing the confidentiality of his/her customers' hourly load curves.

Although currently not publicly available, a Data Protection Impact Assessment was conducted by the Spanish Data Protection Agency at the request of the Ministry of Energy, in line with European recommendations.

The main risk identified from this analysis was the availability of consumers' hourly load curves to third parties. Consequently, the regulation was modified to avoid the availability of such data in the Spanish data hub, the SIPS system.

[68] Informe solicidado por la DGPEM sobre la situacion actual relativa a la interoperabilidad de los sistemas y equipos de medida que permiten la telegestion, CNE, 2012: https://www.cnmc.es/sites/default/files/1547617_2.pdf

[69] Overview of smart metering in Germany, Spain and the United Kingdom, EDI-net, 2017 https://www.klimabuendnis.org/fileadmin/Inhalte/7_Downloads/EDI-Net_Overview_of_Smart_Metering_20170430.pdf

26.5.2. Provisions to provide and revoke access to data

Consumers have the right to revoke access to third parties to their aggregated data in the SIPS system. For that, the consumer can either use a specific app or website with secured access or fill in a written form requesting his energy supplier to stop sharing the specific data that the consumer wants to keep private. This written consent needs to be explicitly stated in the data hub.

In relation to customers' hourly load curves, the consumers must provide a written consent to the DSO allowing third parties to access their hourly data. Such consent must be renewed every two years by the consumer. This written consent refers to the access to the hourly load curve by energy suppliers that are different from the one with whom an energy supply contract is in place.[70]

26.6. Consumer impact

26.6.1. Available services

The following table proposes an extended list of services enabled by smart metering and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes – offered by some DSOs/energy suppliers and third parties. Not regulated
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	No
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	Yes – offered by some DSOs. Not regulated
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes

[70] According to Royal Decree 1074/2015: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2015-13140

Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing...) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes. Through PVPC[71]
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	No
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes – it is foreseen to be enabled in the short or medium-term
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes – bigger development is needed

26.6.2. Consumer concerns

The table below summarises the main concerns expressed by the Spanish consumers in relation to the smart metering rollout, and the counter measures adopted to address them.

[71] More information available here: https://www.ree.es/en/activities/operation-of-the-electricity-systemvoluntary-price-small-consumer-pvpc

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework
Cybersecurity	general public resistance to smart metering but lack of objective grounds	yes - proven compliance to existing standards
Electromagnetic radiation	general public resistance to smart metering but lack of objective grounds	yes - proven compliance to existing standards
Accuracy of meters	general public resistance to smart metering but lack of objective grounds	yes - proven compliance to existing standards
Price of meters	no concern expressed	no
Installation barriers	general public resistance to smart metering but lack of objective grounds	yes - exceptions and preventive measures have been introduced in the legal framework

Additional preventive actions have been taken, like the organisation of working groups by the CNMC, to face consumer concerns that may arise and to make regulatory proposals.

26.6.3. Research on consumer benefits

The CNMC has collaborated in European Projects that were focused on consumer awareness of the benefits coming from smart meters deployment.

26.6.4. Communication campaign

At least three months before the rollout of smart meters, information about the date and conditions of the smart meter installation process had to be provided by energy suppliers.

Additionally, the CNMC has developed a tool that simulates the electricity bill for consumers with smart meters installed, to assist them in understanding the new methodology.[72]

26.6.5. Advanced consumer services

Currently smart meters are already being used by prosumers, and it is expected that they will also play a key role in the development of charging stations for electric vehicles in the short term.

[72] https://facturaluz2.cnmc.es/facturaluz2.html

26.7. Conclusions

In Spain, the Ministry of Energy, supported by the National Commission on Markets and Competition (CNMC), is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

Those provisions will mostly apply to energy network operators as they are the parties in charge of meter ownership and installation, data collection and storage, and data transmission to third parties. Furthermore, provisions will also apply to consumers as they also have the option to own the meter.

Regarding the storage of data, a centralised Supply Point Information System, known in Spanish as SIPS (*Sistema de Información de Puntos de Suministro*), gathers consumers' aggregated load data, which is accessible for all energy suppliers. However, the granularity of this data is limited, so no hourly load curves are stored in here and the data cannot be accessed unless the consumer gives his consent to share it with other energy suppliers.

The primary law that enables smart metering for electricity is the Royal Decree 1110/2007. This Decree approved the Regulations on Measurement Points of the Electricity System and it has been revised to include updated timeline and conditions. The Order *ITC/3860/2007* 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 to the replacement plan of smart electricity meters, energy supply and distribution, and electricity tariffs.

In the case of smart metering deployment for gas, no primary law is in place that enables the replacement of the current gas meters.

Primary drivers for smart metering deployment are the opportunities for the digitization of the energy grid and market, as well as for the renewable energy integration.

In Spain, the rollout of electricity meters already began in 2008, when the requirement of the European Commission for a CBA had not been published yet. Therefore, there is no CBA with an exhaustive quantitative analysis of the costs and benefits. Instead, an overall analysis was performed before the implementation plan in which the plan and conditions of the rollout and the rental price of meters were evaluated. In the case of smart gas meters, a CBA was conducted in 2011 by the CNMC.

The Ministry of Energy is overseeing the smart meter rollout. It is the responsibility of DSOs to install smart meters in all domestic and small and medium-sized enterprises with electricity meters up to 15 kW of contracted power by the end of 2018.

The CNMC has proposed to also include the replacement of electricity meters in connection points of up to 50 kW of contracted power. This proposal has not been approved yet.

All 10 key functionalities recommended by the European Commission are foreseen and almost all are being activated by default and free of charge for the consumer, with the clear intent to maximise smart metering deployment benefits.

Concerning the implementation of standardised interfaces for communication and connectivity in the smart metering environment, the H1 interface is implemented and the measurements are shown on the smart meter. The interfaces H2 and H3 will not be implemented, whereas C, G1 and G2 will be implemented by default. Although not yet regulated, there is also an alternative to connect the smart meter to a "smart energy box" at the consumer premises. Via the Smart Energy Box, a consumer has access to its energy data.

Third party access to consumption data will be made available through the DSO or supplier web portals, as long as the consumer gives permission.

The technology for H1, C, G1 and G2 interfaces has not been fixed. The technology that can be used is open (GSM, GPRS, PLC, RTC, etc.) and may vary between areas. Based on the feasibility and optimal costs, the chosen technology solution may use existing infrastructure or be adjusted to the area's specific situation (e.g.: communication problems in remote areas).

Although currently not publicly available, a Data Protection Impact Assessment was conducted by the Spanish Data Protection Agency at the request of the Ministry of Energy, in line with European recommendations.

The main risk identified from this analysis was the availability of hourly load curves to third parties of consumers. Consequently, the regulation was modified to avoid the availability of such data in the Spanish data hub, the SIPS system.

The central data hub, SIPS, contains aggregated load data that can be accessed by all energy suppliers and consumers. Consumers have the right to access their data freely and may prohibit the dissemination of their data to suppliers or third parties by a written statement. In this case, the consumer's written statement should be explicitly stated in the data hub, and his/her energy supplier becomes responsible for keeping a copy of such request. Consumers have the right to revoke access to third parties to their aggregated data in the SIPS system.

26.8. References

Id	Reference description
1	Royal Decree 1110/2007
2	Order ITC 3860/2007
3	Order IET 290/2012
4	Energía - Informe sobre el cumplimiento del segundo hito del plan de sustitución de contadores, CNMC 2017
5	Informe sobre el estado actual de adecuacion a la normative comunitaria del plan de sustitucion de contadores, CNMC, 2014
6	Informe sobre el mandato establecido en el real decreto 1634/2006 relativo al plan de sustitucion de equipos de medida, CNE, 2007
7	Analisis coste beneficio de la implantacion de contadores de gas inteligentes en Espana, CNE, 2011
8	Real Decreto 1435/2002, de 27 de diciembre, por el que se regulan las condiciones básicas de los contratos de adquisición de energía y de acceso a las redes en baja tensión, Ministerio de Economía
9	Informe solicidado por la DGPEM sobre la situacion actual relativa a la interoperabilidad de los sistemas y equipos de medida que permiten la telegestion, CNE, 2012
10	Overview of smart metering in Germany, Spain and the United Kingdom, EDI-net, 2017

27. SWEDEN

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in Sweden.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

27.1. Legal and Regulatory Framework

27.1.1. Market model

In Sweden, all electricity meters installed are smart meters from the perspective that they are remotely read. The National Regulatory Authority (NRA) has decided on the general functional requirements for these meters, whereas the DSOs are legally entitled to define deployment targets and conditions for smart electricity meters.

There is no such framework for smart metering for gas due to a small market. The gas market in Sweden has approx. 37000 customers of which 2600 are business customers. Although, now at least one gas distributor (12000 customers) has chosen to install smart meters for gas by 2019.

Requirements regarding smart electricity meters will mostly apply to the DSOs as they are the parties in charge of meter ownership, installation, data collection and data storage. The DSOs have also the responsibility of the metering data protection officer (Art. 37 GDPR).

Regarding in-home display ownership and installation, the final customer can either buy this through 3rd part retailer, or from the electricity suppliers.

27.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Electricity Act 2012 which has been revised. Delegated laws that further frame the implementation of smart metering for electricity is the Metering Regulation which, based on the information collected for this report, was to be revised the 1st of September 2018. The new provisions must be then applied on the 1st of January 2025 at the latest. The purpose of the revisions is to define amongst others the minimum functional requirements for the smart metering rollout.

27.1.3. Primary drivers

Drivers for the smart metering deployment in Sweden include the objectives to:

- Enable dynamic tariffs for households and SMEs
- Digitalize distribution grid and optimize network operations
- Digitalize retail market to foster innovation and new services by private actors, integrate decentralized energy resources with flexible access (load shedding, infeed curtailment)
- Facilitate demand response

27.1.4. Smart metering programme financing

Smart metering costs are borne by the DSOs; there is a cap defined for that (per meter category) by the Swedish NRA. The costs are financed through the overall four-year revenue cap, via the tariffs paid by the customers.

27.1.5. Recent publications by the NRA

At the moment of writing this report, the most recent publication issued by the national regulatory authority is the decision on new functionalities regarding the next generation of smart meters[73]. The previous publication, issued in 1999[74], related to the regulation on the measurement, calculation and repotting of transmitted electricity.

27.2. Cost benefit analysis

27.2.1. Relevant study

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
2015	National regulator authority		N/A. All electricity meters were changed to smart meters in 2007.	

The cost and benefit analysis for a smart metering rollout in the case of electricity was published in 2015 and is publicly available[75].

27.2.2. Market roles and key parameters

Market roles taken into account in the assessment were DSOs', suppliers, NRA, consumer, state/society and energy service providers. The main benefits considered in the analysis were:

[73] https://www.regeringen.se/pressmeddelanden/2018/06/nasta-generation-smarta-elmatare-kan-introduceras-i-sverige/

[74] https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-1999716-om-matning-berakning-och_sfs-1999-716

[75] https://www.ei.se/sv/Publikationer/Rapporter-och-PM/rapporter-2015/funktionskrav-pa-framtidens-elmatare-ei-r2015-09/

- Bill reduction due to energy efficiency (reduction in energy volume inducing money savings electricity bills)
- Easier to install photovoltaic production
- Meter reading and operation savings
- Operation and maintenance of assets
- Technical losses reduction
- Outage management (based on societal value of lost load)
- More information on the quality of voltage
- Increased competition in the energy service market
- Decreased investment in the grid
- Increased satisfaction of customers
- Increase the willingness of customers to change energy providers
- Reduced the interruption time

Key parameters for the assessment	
evaluation period of the CBA [Years]	-
billing and metering frequency in the reference case for electricity [times/year]	-
Does this also apply for gas?	No
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	-
What is the electricity losses unit cost? [€/MWh]	37
What is the economical lifetime of electricity smart meters? [Years]	10 (+2)
What is the economical lifetime of gas smart meters? [Years]	N/A
What is the value of the lost load? [€/MWh]	6600 interruptions without notifications
What is the cost reduction rate due to technological maturity? [%/year]	N/A. The cost and benefit are analysed for each functional requirement.

27.2.3. Main cost and benefit items

As detailed in the following list, all cost items have been considered, following the guidance issued by the European Commission (Recommendation 2012/148/EU).

☒ CAPEX - Investment in smart meter
☒ CAPEX - Investment in IT

☒ CAPEX - Investment in Telecom
☒ CAPEX - Investment in In-home display
☒ CAPEX - Sunk cost of conventional meters
☒ OPEX - IT maintenance
☒ OPEX - Network management and front end
☒ OPEX - Telecom
☒ OPEX - Change management
☒ OPEX - Unplanned renewal and failures of smart meter
☒ OPEX - Revenue reduction
☒ OPEX - Meter reading
☒ OPEX - Call centre and customer service
☒ OPEX - Consumer engagement programme

27.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for the electricity smart metering rollout:

Key outcomes of the assessment	Number
actualised number of meters installed for the whole evaluation period [Number of meters]	5,3 million
actualised CAPEX for the whole evaluation period	-
actualised OPEX for the whole evaluation period	-
actualised benefits for the whole evaluation period	The cost and benefit are analysed for each function requirement.

27.2.5. Deployment strategy and latest statistics

The first generation of smart meters for electricity was rolled out in 2007 and today 5,3 million smart meters are installed in Sweden for households, SMEs and large enterprises. New functional requirements were published by the NRA in 2015 and the Swedish government decided that these should be implemented latest by the 1st of January in 2025 and DSOs are responsible to define their own deployment strategy for this. This is the state of play of deployment of the next generation of smart meters in Sweden.

There is no information made available regarding the customer segmentation in small, medium or large enterprises and therefore there are no statistics about this.

27.3. Functional specifications

Of the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) all will be implemented but function for "fraud prevention and detection", in the next generation of smart meters to be deployed in Sweden by 2025. These functions will be available free of charge for all low voltage customers but will be in fact paid through the overall customer tariff. The respective functions will be activated by default, apart from certain aspects of functionality (a) "Provide readings directly to the customer and any third party designated by the consumer" and (b) "Update the readings referred to in point (a) frequently enough to allow the information to be used to achieve energy savings".

Consumption data history is stored by the DSO for at least 3 years according to regulations[76] and in the smart meter for four months. Granularity depends on the customer; high voltage customers which energy usage is settled hourly is measured and stored by hour. Low voltage customers are settled monthly and can choose to have their energy usage measured and stored hourly or monthly (default).

The DSOs update consumption data to TSO and the electricity suppliers before 9 am the day after. The customers are updated before the end of the delivering month and the billing date. Frequency of consumption data update from the next generation of smart meters will be near-real time.

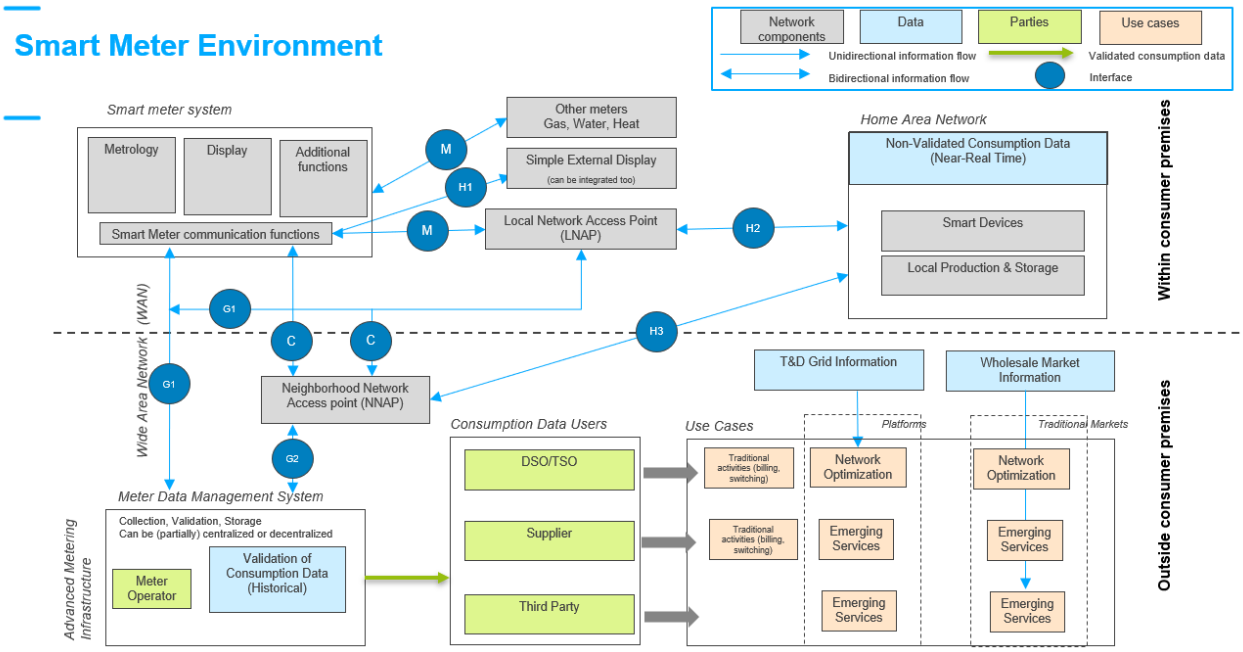
Key functional features	Functionality A: Customer access to consumption data	Functionality B: Frequency of consumption data update every…
H1 Interface (IHD)	Will be activated upon customer explicit request and according to the energy business recommendation.	Near- real time
H2 Interface (Smart Devices)	This functionality will be updated by the next generation of smart meters	N/A
Compulsory DSO website	N/A – Website is not compulsory, but some companies provide data to customers through their websites.	N/A
Compulsory Supplier website	N/A – Website is not compulsory, but some companies provide data to customers through their websites.	N/A
Compulsory Third Party website	N/A – Website is not compulsory, but some companies provide data to customers through their websites.	N/A

[76] EIFS 2016:2 12 Kap 1§, https://www.ei.se/Documents/Publikationer/foreskrifter/El/EIFS_2016_2.pdf

Third party can be given access to consumption data only if requested by the customer through a power of authority and communicated to the DSO. The third party will then get a copy of the energy data market message sent from the DSO to the retailer (EDIEL) for that specific customer and connection point.

27.4. Technical specifications

In respect to the following figure, which gives a schematic representation of the functional architecture and communication in a smart metering environment indicating also the relevant interfaces, no standard has been adopted in Sweden so far, and different kinds of technology are used.



27.5. Data management

27.5.1. Data access and privacy framework

A Data Protection Impact Assessment recommended by the European Commission (Recommendation 2014/724/EU) was performed in Sweden in November 2017[77] as a part of the publication of the functional requirements for the next generation of smart meters in Sweden. The main risk identified was related to security and privacy. To address this and mitigate the potential impact, an obligation was imposed on DSOs and energy service companies to devise measures and develop working routines in order to ensure data security and protect customers' privacy.

[77] https://www.ei.se/Documents/Publikationer/rapporter_och_pm/Rapporter%202017/Ei_R2017_08.pdf

27.5.2. Provisions to provide and revoke access to data

Third parties and suppliers need an explicit consent from the customer to access his/her metering data. For suppliers, access to data is given for a specific customer and a specified connection point through an energy data market message when the supply contract is signed. Access to data for suppliers is revoked automatically when the contract changes, when the customer moves from that connection point or changes supplier. For third parties, access to data is given for a specific customer and connection point through written approval i.e. a power of attorney. This access for third parties is revoked automatically when an end date is set of the power of attorney or the customer moves from the specific connection point. Access for customer data for third parties can also be revoked if asked by the customer.

27.6. Consumer impact

27.6.1. Available services

The following table proposes an extended list of services enabled by smart metering, and further details their availability in the market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	-
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	-
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long time period. This may also include safety aspects if critical loads are providing health services	-
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes
Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes

Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	No
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self consumption.	No. But there is a pilot project ongoing.
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	No

27.6.2. Consumer concerns

Concern expressed by consumers	Motivation	Counter measure adopted?
Privacy	Concerns has been expressed	DSO responsibility
Cybersecurity	Concerns has been expressed	DSO responsibility
Electromagnetic radiation	Concerns has been expressed	DSO responsibility
Accuracy of meters	No concerns	N/A
Price of meters	No concerns	N/A
Installation barriers	No concerns	N/A

Regarding accuracy of meters, Swedac is an authority in Sweden with responsibility to make sure that rules and requirement applied to regulated meter technology is followed. This is done through supervision and market check.

27.6.3. Research on consumer benefits

Research on consumer benefits has been done mostly by the energy industry's R&D companies and at the universities.

27.6.4. Communication campaign

The DSOs communicate with their customers when the rollout and installation of the next generation of smart meter is done. Different channels are used and one of them is a written letter. Information regarding the functionalities and requirements from the NRA is publicly available, and the Swedish government has published a press release regarding the next generation of smart meters in Sweden in 2018.

27.6.5. Advanced consumer services

In pre-discussions regarding functional requirements, load shedding within the hour was discussed as an issue indicating the need to real time data. As far as is known by now, no retailer has this on offer yet for householders.

27.7. Conclusions

The first generation of smart meters for electricity was rolled out in 2007 and today 5,3 million smart meters are installed in Sweden for households, SMEs and large enterprises. New functional requirements were published by the NRA in 2015 and the Swedish government decided that these should be implemented latest by the 1st of January in 2025 and DSOs are responsible to define their own deployment strategy for this.

The primary law that enables smart metering for electricity is the Electricity Act 2012 which has been revised. Delegated laws that further frame the implementation of smart metering for electricity is the Metering Regulation revised the 1st of September 2018. The new provisions must be then applied on the 1st of January 2025 at the latest. The purpose of the revisions is to define amongst others the minimum functional requirements for the second generation smart metering rollout.

Smart metering costs are borne by the DSOs; there is a cap defined for that (per meter category) by the Swedish NRA. The costs are financed through the overall four-year revenue cap, via the tariffs paid by the customers.

The main drivers for the smart metering deployment in Sweden are the digitalisation of the distribution grid and the retail market, facilitating demand response, enabling the provision of dynamic tariffs for households and SMEs.

The cost and benefit analysis for the rollout of second generation smart meters was published in 2015 and is publicly available.

Of the 10 key functionalities recommended by the European Commission (Recommendation 2012/148/EU) all will be implemented but function for "fraud prevention and detection", in the next generation of smart meters to be deployed in Sweden by 2025. These functions will be available free of charge for all low voltage customers but will be in fact paid through the overall customer tariff.

Consumption data history is stored by the DSO for at least 3 years and in the smart meter for four months. Granularity depends on the customer; high voltage customers which energy usage is settled hourly is measured and stored by hour. Low voltage customers are settled monthly and can choose to have their energy usage measured and stored hourly or monthly (default).

Third parties and suppliers need an explicit consent from the customer to access his/her metering data. For suppliers, access to data is given for a specific customer and a specified connection point through an energy data market message when the supply contract is signed. Access to data for suppliers is revoked automatically when the contract changes, when the customer moves from that connection point or changes supplier. For third parties, access to data is given for a specific customer and connection point through written approval i.e. a power of attorney. This access for third parties is revoked automatically when an end date is set of the power of attorney or the customer moves from the specific connection point. Access for customer data for third parties can also be revoked if asked by the customer.

The main services enabled by smart metering in Sweden are the provision of real-time and historical consumption data, the provision of dynamic tariffs, allowing end-consumers to participate in flexibility markets, and the integration of prosumer in the electricity market.

27.8. References

Id	Reference description
1	Press release by the Swedish government about the next generation of smart meters in Sweden: https://www.regeringen.se/pressmeddelanden/2018/06/nasta-generation-smarta-elmatare-kan-introduceras-i-sverige/
2	Regulation regarding measure, calculate and report transmitted electricity: https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-1999716-om-matning-berakning-och_sfs-1999-716
3	Functional requirements of the next generation electricity meter. https://www.ei.se/sv/Publikationer/Rapporter-och-PM/rapporter-2015/funktionskrav-pa-framtidens-elmatare-ei-r2015-09/
4	The Swedish NRA's regulations and common advice regarding measurement, calculation and reporting of transmitted electricity. https://www.ei.se/Documents/Publikationer/foreskrifter/El/EIFS_2016_2.pdf
5	Functional requirements on electricity meters published by the Swedish NRA in August 2017. https://www.ei.se/sv/Publikationer/Rapporter-och-PM/rapporter-2017/funktionskrav-pa-elmatare-ei-2017-08/

28. UNITED KINGDOM

This document – called country fiche - provides a description of the actual state of play as well as the enabling framework for smart metering deployment put in place in the United Kingdom.

It has a special focus on electricity, and it is organized to provide an update of the 2014 Smart Metering Benchmarking Report issued by the European Commission and at the same time explore additional topics of interest, most notably, access to data, data management and consumer outcomes. These points reflect the most recent relevant European policy initiatives, like the recast Electricity Directive under the Clean Energy Package and the General Data Protection Regulation.

Finally, a limited set of recommendations that, from our expert judgment, have the potential to facilitate the cost-effective deployment of smart metering and ultimately foster innovation and consumer participation in European gas and electricity markets, have been provided.
This document was shared with the national authorities to ensure their views were correctly captured.

This document was the main material that was used to consolidate those national experiences into a European benchmark report. Insights from the benchmarking exercise were shared and discussed during a dedicated stakeholders' workshop that took place in February 2019.

28.1. Legal and Regulatory Framework

In the United Kingdom of Great Britain and Northern Ireland, commonly known as the UK, the Government is legally entitled to define deployment targets and conditions for smart electricity and gas meters.

28.1.1. Market model

In the UK-Great Britain, smart metering provisions will mostly apply to energy suppliers as they are the parties responsible for installation of meters and data collection. This includes the provision of in-home displays (IHDs) whose roll out has been integrated with smart meters for domestic consumers as the key enabler of energy saving benefits. All GB smart meters must meet the minimum functional requirements defined in the Smart Metering Equipment Technical Specifications (SMETS) in force when they are installed.

In the UK-Northern Ireland, there are no smart meters and the associated decision maker (department for the economy of the devolved government in NI) has not taken legislative actions or regulatory initiatives to frame the deployment which is still under consideration.

In the UK-Great Britain, the central data & communication company (DCC) has been granted a licence to put in place a communications platform to send and receive information from smart meters to energy suppliers, energy network operators and third parties such as energy service companies. Regarding the storage of data, it will be kept on a consumer's smart meter i.e. there is no central database. The first generation of smart meters (SMETS1 meters) are currently operated outside the DCC, which means in some cases when a consumer switches energy supplier they lose smart functionality as the new energy supplier is not able to operate the meter in smart mode. To address this, these meters will be enrolled into the DCC. This issue does not arise in respect of second generation smart meters as they operate via the DCC by default. Another worth-noting arrangement found in the UK-GB is the setup of an independent coordinating body for the consumer engagement programme – that is the Smart Energy GB – funded by larger suppliers, with smaller suppliers contributing to the body's fixed costs (see 28.6.4).

Regarding data privacy, no Data Protection Officer (DPO) has been explicitly and formally appointed by the authorities. A Data Access and Privacy Framework was established; it determines the levels of access to energy consumption data from smart meters for energy suppliers, network operators and third parties. It also establishes the purposes for which data can be collected and the choices available to consumers. In compliance with the General Data Protection Regulation (GDPR), it is the responsibility of each organisation handling smart metering data to assess whether they need to appoint a DPO.

28.1.2. Legal grounds

The primary law that enables smart metering for electricity is the Energy Act 2008, as amended by the Energy Act 2011 and the Smart Meters Act 2018. The regulatory framework has been revised to include various modifications to energy supply, network operator, communication service provider licence conditions and relevant industry code, as specified in section 88(2) of the Energy Act 2008. This applies to both electricity and gas.

28.1.3. Primary drivers

Digitalizing retail markets and enabling a smarter energy system are the main drivers for smart metering deployment in the UK, with the aim to foster innovation and create the enabling framework to deliver new services. The final goal is to put households and business in control of their energy use. This also includes specific provisions to enhance the prepayment user experience and contribute to address fuel poverty.

28.1.4. Smart metering programme financing

The investment costs to suppliers from smart meters are recovered from energy bills in the same way as traditional metering. Smart meters could bring significant efficiency savings to industry as documented in the cost-benefit analysis, for example through reduced call centre activity necessary to deal with bill queries, lower costs of serving pre-payment customers, better debt management and no longer requiring meter readings. These savings will reduce the cost to serve for energy suppliers and are expected to be passed on to their customers.

28.1.5. Recent publications by the NRA

The most recent publications issued by the national regulatory authorities relate to didactic material for households or periodic smart meter statistics.

28.2. Cost benefit analysis

28.2.1. Relevant study

The cost benefit analysis conducted in the UK-GB considered a joint rollout for electricity and gas. Updated information on this assessment, at the moment of data collection for the present report, can be seen below.

Publication date	Author	Contracting authority	Results for 80% in 2020	Motivation
10-nov-2016	UK-GB Government		Positive Net Present Value	Review costs and benefits using feedback from early deployment years and latest projection data from industry
2016	UK-NI Government (Department for the economy)		Negative net present value	Review and update of 2011 CBA

In the UK-GB, the focus of the latest assessment of the smart metering programme, according to the national authorities, is on gathering robust evidence to inform any further actions required to maximise benefits for consumers.

For example, UK Government bodies have carried out primary consumer research, which will provide further evidence on early consumer experiences and impacts.

This will include an assessment of the contribution of consumer engagement activities which have been implemented in light of the Early Learning Project research.

In the UK-NI, the update led to a negative CBA and therefore no further action has been taken for organizing the deployment of smart meters. In this 2016 CBA the majority of costs and benefits were unknown and data from other studies and jurisdictions was used and extrapolated to fit local circumstances (for instance prepayment). Moreover, this data was subject to significant uncertainties and caveats given that the considered smart metering rollouts were still in their infancy.

Sensitivity analysis was undertaken in an attempt to mitigate the lack of robust data. The official position is that, given the negative CBA outcome, no decision was taken to rollout smart meters. However, this does not rule out smart meters being introduced at some time in the future. Although it would be prudent, given the potential significant cost burden on electricity consumers and high levels of energy poverty, to wait until definite lessons and concrete data/evidence emerge from other countries that have rolled out smart meters.

The rest of the country fiche will therefore only apply to UK-GB, unless specified otherwise.

28.2.2. Market roles and key parameters

In coherence with the national market model described above, the following market roles were taken into account in the assessment: Supplier, Consumer and State/society.

Key parameters for the assessment	
evaluation period of the CBA [Years]	18

billing and metering frequency in the reference case for electricity [times/year]	2
Does this also apply for gas?	Yes
What % do electricity losses (technical & non-technical) represent? [% of total supply at low voltage]	N/A (fixed value)
What is the electricity losses unit cost? [€/MWh]	variable
What is the economic lifetime of electricity smart meters? [Years]	15
What is the economic lifetime of gas smart meters? [Years]	15
What is the value of the lost load? [€/MWh]	variable
What is the cost reduction rate due to technological maturity? [%/year]	1,00%

Variable parameters, like energy unit costs, carbon prices and value of lost load is determined in compliance with UK Government publications on valuations of energy use and greenhouse gas emissions for appraisal[78].

28.2.3. Main cost and benefit items

As detailed in the following list, most cost items have been taken into account, following the guidance issued by the European Commission (Recommendation 2012/148/EU), with the only exception of consumer service and call centre costs.

- ☒ CAPEX - Investment in smart meter
- ☒ CAPEX - Investment in IT
- ☒ CAPEX - Investment in Telecom
- ☒ CAPEX - Investment in In-home display
- ☒ CAPEX - Sunk cost of conventional meters
- ☒ OPEX - IT maintenance
- ☒ OPEX - Network management and front end
- ☒ OPEX - Telecom
- ☒ OPEX - Change management
- ☒ OPEX - Unplanned renewal and failures of smart meter
- ☒ OPEX - Revenue reduction
- ☒ OPEX - Meter reading
- ☒ OPEX - Call centre and customer service
- ☒ OPEX - Consumer engagement programme

Benefits considered focus on bill reduction due to energy efficiency (based on volume rather than unit price), increased competition in retail markets, savings in meter readings and operations and finally CO_2.

[78] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

28.2.4. CBA results

The following table summarizes the key outcomes of the cost benefit assessment for the UK-GB case:

Key outcomes of the assessment	Number
Actualised number of meters installed for the whole evaluation period [Number of meters]	53 million
Actualised CAPEX for the whole evaluation period	£4.8 billion
Actualised OPEX for the whole evaluation period	£6.2 billion
Actualised benefits for the whole evaluation period	£16.7 billion

The resulting ratio have been computed in per unit, taking the number of installed meters as the reference denominator and including additional provisions for new and replacement of defective smart meters:

- Opex per meter: 101 €
- Capex per meter: 131 €
- Benefit per meter: 352 €

28.2.5. Deployment strategy and latest statistics

The Department for Business, Energy and Industrial Strategy is overseeing the rollout which is being delivered by energy suppliers and regulated by the NRA (Office of Gas and Electricity Markets (OFGEM)) but no explicit target has been defined. It is the responsibility of energy suppliers to offer smart meters in all domestic and small businesses premises (subject to all reasonable steps) by the end of 2020.

However, the rollout is voluntary for consumers who can refuse a smart meter.

No technical constraints have been observed that are fundamentally shaping the deployment policy. The DCC's communications service providers are contracted to provide at least 99.25% Wide Area Network coverage by the end of 2020; that is already at 95% (early 2019). Deployment is also being shaped by Home Area Network (HAN) coverage. The core solution ensures at least 70% of premises have Home Area Network coverage. This will increase to at least 95% of premises from 2019. Industry is working to develop alternative HAN solutions for the remaining c. 5% of premises.

The following tables highlight the related statistics for the rollout: and represent respectively an "instant picture" of smart deployment the1/1/2018 and the rollout results specifically during the year 2017.

The statistics of the UK-GB rollout programme are regularly updated and are published online under this website:

https://www.gov.uk/government/collections/smart-meters-statistics .

State of play of smart metering deployment in UK-GB as of 1/1/2018	Electricity households	Electricity SME	Gas households	Gas SME
Number of smart meters	5 132 436	802 766	3 843 258	257 814
Number of connection points equipped with smart meters	5 132 436	802 766	3 843 258	257 814
Total number of meters	27 308 313	2 499 218	22 594 329	823 099
Total number of connection points	27 308 313	2 499 218	22 594 329	823 099
Number of smart meters that does not communicate (de-activated upon specific consumer request)	Not available	Not available	Not available	Not available
Number of smart meters that does not communicate (due to technical, regulatory or legal choices)	Not available	Not available	Not available	Not available
Number of smart meters that does communicate default metering data	Not available	Not available	Not available	Not available
Number of smart meters that does communicate extended metering data (=that goes beyond default settings and based on explicit consent from consumers)	Not available	Not available	Not available	Not available

Deployment outcomes in 2017	Electricity households	Electricity SME	Gas households	Gas SME

Yearly installation target	Not available	Not available	Not available	Not available
Number of visits to consumer premises	Not available	Not available	Not available	Not available
Number of installed smart meters	2 674 780	84 302	2 071 214	63 769
Number of deactivated smart meters	Not available	Not available	Not available	Not available
Number of refusals	Not available	Not available	Not available	Not available

28.3. Functional specifications

All 10 key functionalities recommended by the European Commission are implemented and are activated by default and free of charge for the consumer, with the clear intent to maximise smart metering deployment benefits.

The default setting does not preclude consumers from exercising their privacy rights. Access to energy consumption data (for domestic and microbusiness consumers) is governed by the smart metering Data Access and Privacy Framework[79].

In order to ensure that consumers have access to their detailed energy consumption information, UK-GB require all suppliers to provide, on request, up to 24 months of daily data, as detailed in the table below.

Key functional features	**Functionality A: Customer access to consumption data**	**Functionality B: Frequency of consumption data update every…**
H1 Interface (IHD)	2 years of daily data, 13 Months of half hourly data	10 seconds (electricity) / 30 minutes (gas)
H2 Interface (Smart Devices)	2 years of daily data, 13 Months of half hourly data	10 seconds (electricity) / 30 minutes (gas)

[79] Broad details of the Framework are available here: https://www.gov.uk/government/consultations/smart-meter-data-access-and-privacy. Conclusions of a review of the Framework were published in 2018. See: https://www.gov.uk/government/publications/smart-metering-implementation-programme-review-of-the-data-access-and-privacy-framework

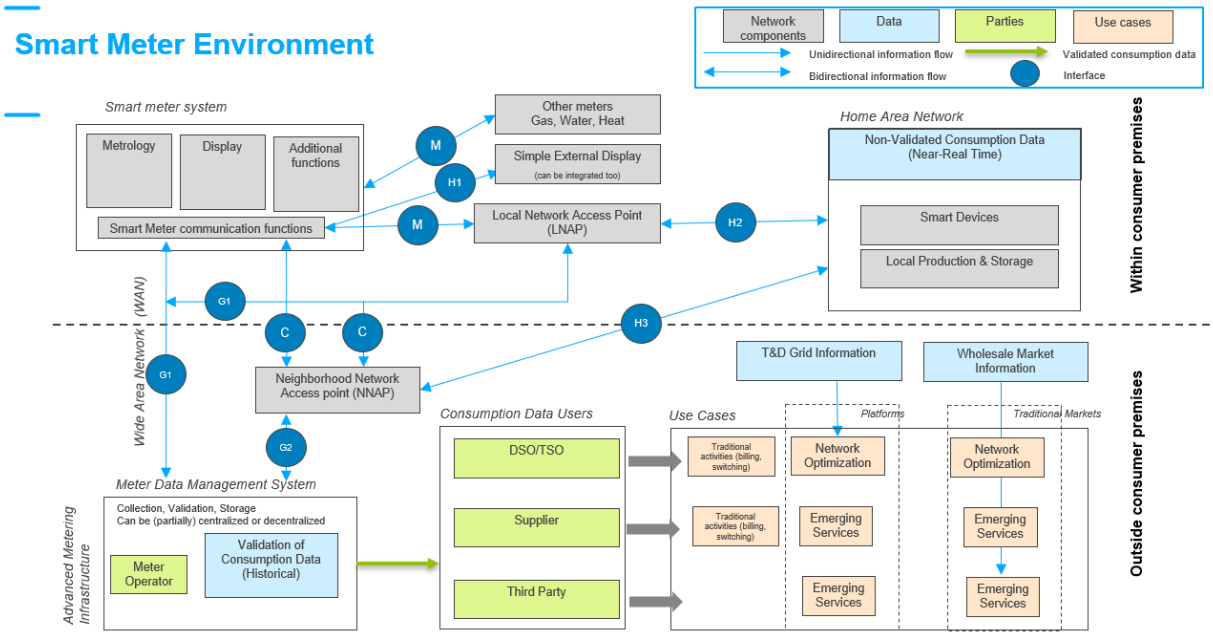
Compulsory DSO website	N/A – gas and electricity networks will have access to monthly data but there is no requirement for a compulsory website (networks can access more granular data subject to approval of a privacy plan by Ofgem)	N/A
Compulsory Supplier website	2 years of daily data (suppliers must provide access does not need to be a website, see comments). Suppliers can access more (or less) granular data but the compulsory requirement extends only to daily data.	Daily
Compulsory Third-Party website	N/A – gas and electricity networks will have access to monthly data but there is no requirement for a compulsory website (networks can access more granular data subject to approval of a privacy plan by Ofgem)	N/A

In relation to domestic consumers, energy suppliers must make available, on request, data relating to energy consumption in each day, week, month and year (up to 24 months). This information must be provided free of charge and in a readily accessible format. This data must be made available to the consumer either via the internet or through the use of a suitable consumer device. Suppliers may also send the information to consumers in paper format, if that is what the consumer needs. In addition to receiving consumption data through their In-Home Display or requesting this information directly from their supplier, consumers can also authorise other DCC Users (e.g. switching websites) to access their consumption data directly from their meters via the DCC. This will enable consumers to share their actual energy consumption data with third parties, if they choose to do so. These organisations could offer data management and analytical services, which could help consumers interpret their smart meter data and more readily identify competitive tariffs or energy efficiency measures.

Consumers can also choose to connect Consumer Access Devices (e.g. internet gateways, home hubs etc), to their Home Area Network which can access information from smart meters. An energy supplier is required to connect the CAD to the Home Area Network upon request from the consumer.

28.4. Technical specifications

In respect to the following figure, which is a schematic representation of the functional architecture in a smart metering environment, ZigBee Smart Energy is the chosen technology for H1 and H2 interfaces leveraging on its low power characteristics, while G1 relies on 2G/ 3G and Long-Range Radio (LRR). 2G/ 3G was chosen because of the prevalence of the existing infrastructure, the extended network capacity and its more robust economic case. LRR was chosen due to geographic & population concentration issues within the relevant territory.



Related standards, whose proper use is a key element to assess information security, are outlined in the Great Britain Companion Specification (GBCS)[80].

G interface standards depend on the communication service provider and are not stipulated by the authorities in charge of the smart metering programme.

28.5. Data management

28.5.1. Data access and privacy framework

A GB smart metering Data Access and Privacy Framework[81] has been established to safeguard consumer privacy whilst enabling proportionate access to energy consumption data from domestic and microbusiness premises, which is likely to be 'personal data', for the purposes of data protection legislation. The central principle of the Framework is that consumers have control over who can access their energy consumption data, how often and for what purposes, except where this is required for regulated purposes.

In summary, third parties accessing energy consumption data through the DCC require explicit consumer consent (full details are set out in the Smart Energy Code, Section I).

Energy networks can only access domestic consumption data relating to periods of less than one month if they have obtained the customer's consent or have implemented procedures, which have been approved by Ofgem, to treat the data such that, as far as reasonably practicable, it can no longer be associated with an individual consumer at a particular premise. No restrictions are in place in relation to gas and electricity network operators accessing microbusiness energy consumption data.

[80] GBCS and other specifications can be found here: https://smartenergycodecompany.co.uk/the-smart-energy-code-2/

[81] See earlier footnote with links to the Data Access and Privacy Framework.

Energy suppliers can access less granular (e.g. monthly) energy consumption data without consumer consent. In relation to more detailed energy consumption data specific rules have been established covering domestic and microbusiness premises.

In relation to domestic premises:

- Energy suppliers can access energy consumption data that is more detailed than monthly, but no more detailed than daily, without consent but this is subject to requirements in relation to the provision of information and must be conducted in accordance with the requirements of the GDPR. Domestic energy consumers have the right to 'opt-out' of this data being collected (note energy suppliers can still access this data in order to fulfil narrowly defined regulated activities, such as the investigation of theft).

- Where energy suppliers wish to access energy consumption data that is more detailed than daily, they must have the consumer's explicit consent and comply with relevant provisions in relation to the provision of information. The only exception to this is where energy suppliers are undertaking approved trials, where the consumer has the right to opt out.

In relation to microbusiness premises, energy suppliers can access energy consumption data from microbusiness customers that is more granular than monthly provided. Moreover, they give the consumer the opportunity to opt-out and comply with relevant provisions in relation to the provision of notice (note energy suppliers can still access this data in order to fulfil narrowly defined regulated activities, such as the investigation of theft).

Full details of these requirements, as they apply to energy suppliers, can be found in Standard Supply Licence Condition 47 (Electricity) and Standard Supply Licence Condition 41 (Gas)[82].

These provisions are designed to complement the obligations placed on energy suppliers and other parties under the GDPR. A Data Protection Impact Assessment[83] was conducted in line with European recommendations and made public in December 2012 in a general effort to communicate to the public on data privacy and information security matters. In 2018 a comprehensive review of the Data Access and Privacy Framework was undertaken, and the related findings and conclusions were published in the same year.[84]

28.5.2. Provisions to provide and revoke access to data

In GB a central data and communications provider has been established to provide the national smart metering infrastructure (DCC). Energy suppliers and electricity network operators are required to become users of the DCC, enabling them to request data directly from smart meters (subject to the conditions of the Smart Energy Code and Licence Conditions). Third parties – such as price comparison websites – can also choose to become users of the DCC.

When third parties are accessing energy consumption data through the DCC they are required to put procedures in place to obtain and verify consumer consent. These procedures are subject to an assurance regime, undertaken by an independent competent organisation. This regime incorporates detailed assessments of procedures, self-assessments and random sample assessments.

[82] Available here: https://www.ofgem.gov.uk/licences-industry-codes-and-standards/licences/licence-conditions

[83] The Privacy Impact Assessment is available here: https://www.gov.uk/government/consultations/smart-meter-data-access-and-privacy

[84] See footnote 2.

When energy suppliers and networks are accessing energy consumption data, they are able to do so directly through the DCC, subject to the provisions of the Data Access and Privacy Framework.

Energy suppliers and third parties are required to provide consumers with information on the following:

- granularity (e.g. daily, half-hourly) of data that they intend to collect;
- purposes for which this data will be (or may be) used;
- consumer's right (if any) to object or withdraw consent. Third parties are also required to provide specific information to consumers on the process by which they may object or withdraw consent.

28.6. Consumer impact

28.6.1. Available services

The following table presents an extended list of services enabled by smart metering and further details their availability in the UK-GB market. Those services have been collected based on an international survey and have the common feature of providing benefits directly to consumers.

Description of service	Available in the market?
Relatively to other consumer: leverage smart meters data to allow consumers to compare the energy consumption with similar peers	Yes
Bill forecasting: use historic smart meter data consumption and on-going consumption level to forecast the amount of the bill at the end of the month	Yes
Real-time consumption: make accessible to consumers energy consumption data in real-time (in € or equivalent)	Yes
Real-time carbon impact: make accessible to consumers energy consumption data in real-time (in tCO2 eq.)	No >>the carbon impact is not available directly via the smart meter but can be calculated by the energy supplier and provided via the In-Home Display (although this is not mandatory).
Unusual usage alert: alert the consumer when an unusual high consumption occurs during a long-time period. This may also include safety aspects if critical loads are providing health services	Yes
Fuel poverty detection: Data analytics used to detect fuel poverty (deprivation) for households who haven't yet searched for help or don't have access to social protection	No
Historical consumption: Provide access to historical data consumption in order to compare weekly or monthly consumption over time.	Yes

Dynamic tariffs (implicit demand response) (advanced): Consumers with a smart meter and a variable tariff (time of use, spot based, peak pricing) can benefit due to the fact that smart meters will help them provide better information on the actual cost of energy and enable them to react accordingly	Yes>>>this is supported by smart meters and is available
Flexibility provision (explicit demand response) (advanced): Ability to provide and valorise flexibility to the power markets, either through to existing supplier or by signing a new service agreement with a new, independent, aggregator.	Yes
Pre-payment (advanced): A pay-as-you-go tariff used in combination with an interface device displaying their credit balance still available, their outstanding debts and status of emergency credit. This can help vulnerable consumer understand and control their electricity consumption	Yes
Energy sharing (advanced): With local energy communities, smart metering will allow for metering data synchronization and will allow detailed aggregation of self-consumption, allowing consumers living in apartment to have access to rooftop PV. This VP targets regulation on local energy communities, virtual net metering and collective self-consumption.	Yes >>this is supported by smart meters
Smart meter to integrate **Prosumers** in the market (advanced): Either as a prerequisite to install decentralized 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 the balancing markets).	Yes
Smart meter to ease charging of **Electric vehicles** at home (advanced): Installing a smart meter could, depending on the local regulation, ease the charging process by taking market and grid constraints into account, possibly charging at lowest costs. It also could be used to charge more rapidly at home with a higher but non-firm connection capacity (combined with DSO real time control on this flexible capacity)	Yes >>this is supported by smart meters

28.6.2. Consumer concerns

Regarding data privacy and information security, the UK government recognises the need to provide reassurance to the public and clearly explain the range of steps that it has taken with security experts, including the National Cyber Security Centre, to provide robust security for the smart metering system. The Government worked in partnership with GCHQ on its blog on smart metering infrastructure. The responsible national authorities state that they will continue to support Smart Energy GB, amongst others, to provide clear messages to the public on smart meter security.

Additional preventive actions have been taken like the Smart Meter Installation Code of Practice or the foundation of a lead entity for consumer engagement in the national programme.

The UK Government recognises the need for consumers to receive independent, impartial information about the benefits of smart meters and how to use them, and reassurance where misconceptions may arise. It was for these reasons that the Government mandated the establishment of an independent not for profit organisation, the Smart Energy GB, to lead the national consumer engagement campaign for smart meters. Smart Energy GB works with trusted third parties including Citizens Advice, National Energy Action, the National Housing Federation and Age UK, among many others, to ensure that consumers are able to access advice about the rollout.

28.6.3. Research on consumer benefits

Extensive research and evaluation have been carried out with GB consumers since the outset of the Smart Metering Implementation Programme to both inform the policy design and evaluate its effectiveness on an on-going basis. The primary purpose of this programme of research has been to help ensure consumer benefits are realised among both domestic and non-domestic consumers.

The largest piece of domestic research and evaluation to date, conducted in the early stages of the smart meter rollout was the Early Learning Project (ELP)[85], whose purpose was to help the Programme understand how best to deliver consumer benefits through effective engagement.

The ELP identified that informing consumers of the ways they can reduce their energy usage is essential to ensuring they can translate the information they receive on their energy consumption (via the in-home display) into actionable information that they can utilise to help them save energy. The ELP further identified that this provision of information is most effective when delivered at the point of installation and when the information was tailored to the consumer's household and energy habits. The Smart Meter Installation Code of Practice requires suppliers to offer consumers tailored energy efficiency advice at the point of installation.

It was also identified that some consumers would particularly benefit from tailored follow-up support to ensure they are able to realise the benefits of smart meters. The Government therefore carried out further work to assess the provision of post-installation support for vulnerable and pre-payment consumers and works with industry to ensure good practice is shared.

28.6.4. Communication campaign

UK-GB Government changed energy supplier Licence Conditions requiring them to set up and fund a central delivery body (the Smart Energy GB) for consumer engagement and to be accountable for ensuring it delivers the following objectives:

- To build consumer confidence in the installation of smart meters;
- To build consumer awareness and understanding of how to use smart meters and the information obtained from them;
- To increase consumer willingness to use smart meters to change their behaviours so as to enable them to reduce their energy consumption;
- To assist vulnerable, low income and pre-payment consumers to realise the benefits of smart metering systems while continuing to maintain an adequate level of warmth and meet their other energy needs.
- In addition, where it is cost effective, to extend the consumer engagement activities undertaken by Smart Energy GB to also include the engagement of microbusinesses

[85] Reports from which can be found here : https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials

Smart Energy GB[86] is responsible for the national campaign for smart metering. This campaign uses a wide variety of approaches, from above the line media e.g. TV, radio and digital through to PR and partnerships. In addition to Smart Energy GB's campaign, energy suppliers can undertake their own activities to encourage take up of smart meters among their own customers.

28.6.5. Advanced consumer services

In July 2017 the Government and energy regulator Ofgem jointly published the paper "Upgrading our energy system: Smart Systems & Flexibility Plan"[87], which presents the national vision for enabling a smart, more flexible energy system. The plan set out 29 actions, a number of which build upon the functionality provided by smart metering, under three broad themes:

- Removing barriers to smart technologies, including storage and Demand Side Response
- Enabling smart homes and businesses
- Ensuring that markets work for flexibility and smart solutions

In October 2018 an update was published on progress against the actions in the Plan. It also identified nine additional actions beyond those set out in the Plan that Government, Ofgem or industry have committed to[88].

28.7. Conclusions

As a consequence of its positive cost benefit analysis for GB, the UK has defined an ambitious deployment strategy, aiming for every home and smaller business in Great Britain to be offered a smart energy meter by the end of 2020.
The rollout has been underway for a number of years, and the UK is facing significant returns of experience. These have triggered initiatives that were taken at national level to maximise consumer benefits and ease supplier switching.

- On maximising consumer benefits due to energy demand reduction:

The main quantitative sources of evidence on the impacts of feedback are the series of large-scale international review studies, and two major GB studies: the 2011 Energy Demand Research Project (EDRP) and the 2015 Early Learning Project (ELP) an extensive programme of research into how best to deliver consumer benefits through effective engagement.

The ELP research included a statistical study which quantified the impact of early smart-type meters on household energy consumption in the year following installation as: energy savings for electricity 1.6 – 2.8%; and gas 0.9 – 2.1% (95% confidence intervals). The synthesis report concluded that there was scope to improve on this through effective consumer engagement, and it was realistic to expect durable savings of 3% based on the evidence to date and potential improvements identified, and that greater savings may be achievable over time.

[86] More information on SEGB can be found here: https://www.smartenergygb.org/en

[87] More information: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/633442/upgrading-our-energy-system-july-2017.pdf

[88] See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/756051/ssfp-progress-update.pdf

The EDRP was co-funded by the Government to provide information on GB consumers' responses to a range of forms of feedback, including smart meter-based interventions. EDRP trials generally found that the combination of a smart meter with an IHD was associated with significant electricity savings; the trials more closely comparable to the GB roll-out showed statistically robust electricity savings of 2% to 4%. For gas, it was the provision of a smart meter rather than the IHD which was most significant in delivering savings (with savings being around 3%).

The following assumptions were taken in the latest CBA, for the conservative, higher and lower benefits scenarios respectively:

Gross annual demand reduction	Electricity (prepayment and credit)	Gas (credit)	Gas (prepayment)
Conservative	2,8%	2%	0,5%
Higher benefits	4%	3%	1%
Lower benefits	1,5%	1%	0,3%

- On maximizing interoperability for first generation (SMETS 1) smart meters:

The rollout of smart meters in Great Britain is being delivered in two stages – the Foundation Stage, which began in 2011, transitioning into the Main Installation Stage, which commenced in November 2016. This was the point when the national data and communications provider, the Data Communications Company (DCC), became operational and the specification for second generation meters (SMETS2) that work with the DCC was designated into regulations.

A standard for the minimum common functionality of smart meters deployed during the Foundation Stage, known as SMETS1, was defined in 2012. This addressed the variability in the smart-type meters which some energy suppliers were already installing and helped ensure consumers received a consistent, minimum service offer. In allowing for SMETS1 meters to count towards energy suppliers' 2020 roll-out targets, government sought to foster early consumer benefits of smart metering and provide industry with valuable experience to support the subsequent deployment of smart meters at scale [8]. A number of energy suppliers have been installing SMETS1 smart meters for their customers, using their own data and communications systems to provide smart services.

Like SMETS2 meters, SMETS1 meters provide the benefits of accurate billing and near real-time energy consumption information. However, these SMETS1 meters currently operate via data and communications systems put in place by individual energy suppliers, as opposed to a single national data and communications infrastructure which is accessible to all suppliers. Consequently, consumers may lose smart services on switching to another energy supplier, depending on which energy supplier they are switching to and from.

A programme to enrol SMETS1 meters into the DCC (which will make these meters interoperable) is underway.

28.8. References

Id	Reference description
1	House of Commons Science and Technology Committee Evidence Check: Smart metering of electricity and gas Government Response to the Committee's Sixth Report of Session 2016–17, HC 846, Published on 7/12/2016 by authority of the House of Commons
2	A Smart Route to Change, Smart Energy GB, 25 July 2016: https://www.smartenergygb.org/en/resources/presscentre/press-releases-folder/a-smart-route-to-change
3	Government Response to the Consultation on the Consumer Engagement Strategy, December 2012: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43042/7224-gov-resp-sm-consumerengagement.pdf
4	Smart Metering Energy Efficiency Advice Materials Project
5	Smart Metering Installation Code of Practice, June 2016: http://www.smicop.co.uk/SMICoP%20Document/Smart_Metering_Installation_Code_of_Practice%20Version%203.1%20June%202016.pdf
6	Realising the Potential of Demand-Side Response to 2025 – A focus on Small Energy Users, 15 September 2016:https://www.contractsfinder.service.gov.uk/Notice/9259cf19-d9d8-49fb-8bde-3fe0f2f1b00d
7	The smart security Behind the GB Smart System, Dr Ian Levy, GCHQ: https://www.ncsc.gov.uk/articles/smartsecurity-behind-gb-smart-metering-system
8	https://www.gov.uk/government/publications/smart-meter-roll-out-gb-cost-benefit-analysis
9	Smart Meter Early Learning Project and Small-Scale Behaviour Trials: 2 March 2015: https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials
10	Government Response to the Consultation on the Consumer Engagement Strategy, December 2012: www.gov.uk/government/uploads/system/uploads/attachment_data/file/43042/7224-gov-resp-sm-consumerengagement.Pdf
11	Gaz and Leccy Cinema Takeover: Smart Energy GB YouTube Channel: https://youtu.be/PTO5HdGtku0
12	Smart Energy for All, Smart Energy GB: https://www.smartenergygb.org/en/resources/press-centre/pressreleases-folder/smart-energy-for-all-updated

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