European Commission

ASSET STUDY on
Format and procedures for electricity (and gas) data access and exchange in Member States

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About the ASSET project

The ASSET Project (Advanced System Studies for Energy Transition) aims at providing studies in support to EU policy making, research and innovation in the field of energy. Studies are in general focussed on the large-scale integration of renewable energy sources in the EU electricity system and consider, in particular, aspects related to consumer choices, demand-response, energy efficiency, smart meters and grids, storage, RES technologies, etc. Furthermore, connections between the electricity grid and other networks (gas, heating and cooling) as well as synergies between these networks are assessed.

The ASSET studies not only summarize the state-of-the-art in these domains, but also comprise detailed qualitative and quantitative analyses on the basis of recognized techniques in view of offering insights from a technology, policy (regulation, market design) and business point of view.

Disclaimer

Authors

This study has been developed as part of the ASSET project by Tractebel Impact.

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Executive summary

Context

Interoperability of energy services within and across EU Member States is essential to support the establishment of a truly internal energy market with well-functioning retail markets. This can be facilitated via the convergence and, as far as possible, alignment of national practices when it comes to the **efficient exchange** of data, and **easy access to accurate and timely information**. Interoperable procedures for data access and exchange not only can reduce costs through improved customer processes, but they are also expected to render retail energy markets more competitive:

- it should become easier for energy suppliers to become active in other Member States, through compatibility of national data access and exchange practices as well as data management models (lower market barriers),
- customers are given tools and options to get empowered and actively participate in the energy market (flexibility and energy services).

The aim of this fact-finding exercise has therefore been to map the EU 28 Member States' practices regarding the **format and procedures in place concerning data access and exchange**, for electricity and gas, in accordance with Annex I.1(h) of the Electricity 2009/72/EC and Gas 2009/73/EC Directives, while also bearing in mind the principles of the Energy Union Strategy (COM[2015] 339 final) and the Clean Energy for All Europeans Package (COM[2016] 864 final/2, in particular Articles 19, 20, 23 and 24). The findings from this study are meant to also serve in the current reflection on the potential for convergence of the respective national practices on the way to facilitating the interoperability of energy services within the EU[1].

Methodology

Given the wide range of aspects considered, the study focuses on **retail electricity consumption data access and exchange**. The focus on residential clients is justified because in most Member States (MS), already today, larger consumers have the possibility to actively participate in the market. The study concentrates on electricity since for most MS, data management systems for electricity and gas are at least similar (see Table 16). Also, flexibility and emerging energy services are expected to be more relevant for electricity. For consumption data access and exchange, the study focuses on 3 aspects:

- How is consumption data managed in terms of reading, validation, storage and exchange between stakeholders for traditional activities of billing and supplier switching? Are there common standards at national level and to what extent are they compatible between MS?
- How can customers access their consumption data?
- How can third parties access the customer's consumption data?

The study aims at reflecting the current (**end of 2017**) status in all 28 MS. Future planned changes of the data management model are identified separately. Information was gathered through a combination of interviews and an in-house undertaken review of national legislation. Interviews were based on questionnaires and held with a variety of stakeholders: Distribution System Operators (DSOs), Transmission System Operators (TSOs), National Regulatory Authorities (NRAs), energy suppliers, energy associations and a central platform developer. The present report includes information from 24 MS,

[1] See for instance the related work on interoperability (Expert Group 1)under the Smart Grids Task Force.

since 4 MS (Bulgaria, Malta, Romania and Slovakia) were not responsive. For 21 out of the 24 MS, the questionnaire was received and validated, i.e. confirmed by the interviewee, together with a country sheet providing a general description of the situation in that country. For 3 countries, information was gathered, but time has not permitted to complete the last step of the final approval of the country information by the interviewee.

Findings

Data management models

In line with the requirements set in Annex I.1(h) and Annex I.2 of the 2009 Electricity and Gas Directives, CEER (2015) "*understands that there should be a national common standard for data content, data format and data exchange in the retail market*"[2]. Also, it recommends MS to "*explore the costs and benefits of harmonising these standards at a broader geographical area, namely at regional and/or European level*".

The extent to which a data management model relies on single formats and procedures depends on the level of granularity considered. Different layers can be distinguished:

1. **Role models:** Role models describe the stakeholders involved in the data management model and the way they interact with each other. Typical stakeholders involved are DSOs and suppliers, independent service providers and data exchange platform administrators. Data management models can involve the same stakeholders, but the way they interact can be different.
2. **Communication standards:** From a technological point of view, the main difference in the aforementioned interaction relates to the communication standard, or the language, used between stakeholders. There are a few international standards (EDIFACT, CIM), but communication standards can also be national-specific. However, even within a same communication standard (EDIFACT, CIM or a national one), it is not guaranteed that formats and semantic choices are unique at regional or national level.
3. **Policy choices:** Differences in data management models can be driven by national- or region-specific energy or economic policy choices. Data management may differ for instance according to the existence of taxes and surcharges that need to be considered in the communication protocols between stakeholders. Similarly, data management models differ in case of non-standard procedures foreseen in some regions or countries, often reflecting regional or national policy preferences (e.g. disconnection of a consumer for insolvency is possible in one region/country, but not in another region/country).

It was beyond the scope of the current study to assess all layers of differences that potentially exist within and between MS. Role models are studied by identifying the stakeholder(s) responsible for data management (consumption data reading, validation and storage) and by considering the way they interact in standard billing and supplier switching processes (the number of interactions between stakeholders for a standard billing and switching process was considered). Regarding communication standards, the general communication standard (EDIFACT, CIM or a national-specific) were looked at, without considering more detailed differences that may exist. Different policy choices were not assessed at all.

Our findings indicate that, at national level, all MS have high-level standardized national procedures implemented[3]. However, it is likely that not

[2] CEER (2015), p. 25

[3] In principle and based on the information received, Latvia has a decentralized data management system without standardization of procedures across the country. On the other hand, Latvia has one dominant DSO. De facto, one could argue

all of them are fully standardized. Regional differences were not studied but there is anecdotal evidence that they exist and they matter. For instance, ensuring national standards can be more challenging if energy policy is a regional competence.[4] Hence, we cannot exclude that market participants face barriers even within a MS.

At EU level, we conclude that suppliers are likely to face strong market barriers from a data management perspective. The most implemented international standard is EDIFACT (BE, DE, FI, LU, SE), yet EDIFACT is a standard only at syntactic level but not at semantic level, i.e. it does not involve a common vocabulary. The CIM International Standard might become an alternative to EDIFACT, as CIM is a standard both on semantic and syntactic layers (FI is considering the possibility to switch to it). On the other hand, we find that a large number of countries have their own formats. Interoperability between MS of data management models can thus be questioned. Also, role models differ. In particular, we considered the number of interactions between stakeholders for a standard billing and switching process. Although this might be an over-simplified indicator, we can nevertheless observe a large variety of processes across MS. Again, regional differences regarding policy and communication format choices are expected to be stronger between than within MS. Even if 2 MS use EDIFACT as a basis for their communication, it does not necessarily mean that the communication is compatible.

Access to data and emerging energy and flexibility services

Easy access to accurate and timely data through smart meter deployment is a pre-condition for the emergence of flexibility and novel energy services. Today, **the level of smart meter coverage varies widely**, from MS having reached (almost) full coverage (e.g. SE, FI, IT, EE, MT, ES) to MS currently examining smart meter roll-out or running pilot projects (e.g. BE, HU, LT).

Smart meters being rolled out do not necessarily comply with the 10 common minimum functionalities recommended by the EC (2012/148/EU) and in particular with those that can deliver benefits to consumers, namely [a] (provide readings directly to the customer and any third party designated by him), [b] (update the readings frequently enough) and [f] (support advanced tariff systems). For instance, functionality [b] ([f]) is not implemented in ES (DK). AT reports that all functionalities are possible, but can be activated only in specific contexts and only with the consent of the customer.

Consumption data access opportunities by customers and third parties between countries are heterogeneous. This is partially linked to the smart meter coverage. With the roll-out of smart meters the options for data access broaden. Due to the absence of a validation process, historical and (near) real-time data available directly from the smart meter is usually non-validated, except for AT and to a lesser extent for DE and LT. Progressively, MS facilitate customer access to historical consumption data on a web portal. The portal is provided either by the DSO, the supplier or, where available, the central data hub operator. At least one of these options is available in almost all countries where smart meters are being rolled-out. However, only a few countries make (near) real-time data available on compulsory web portals. The DSO web portal or direct contact with the DSO are the most common interfaces available for third parties

that procedures are standardized. For the UK, the Data Communications Company (DCC) has been mandated to contribute to the introduction of a central switching programme (ongoing). Consumption data can already be accessed through a central DCC interface.

[4] In Belgium, for instance, the so-called "Turteltaks" to finance renewable energy was raised in Flanders but not in Wallonia. This tax needs to be treated in the information exchange between suppliers and DSOs.

to access validated data. Non-validated data is usually available via the smart meter gateway and, in a few countries, via a compulsory web portal.

Giving and revoking consent is the key requirement on which customer control is built on, especially in the light of the General Data Protection Regulation (GDPR, 2016), enforceable from May 2018. However, the information we gathered indicates that **a fully transparent consent mechanism is usually not implemented yet**:

1. For all the countries but PL the customer is the actor giving the right to third parties to access his validated consumption data;
2. A clear protocol that enables the customer to actively control third parties' access is defined in DK, EE, ES and PT;
3. FI, FR and UK are planning to enable the customer to exercise this control beyond the traditional consent or authorization. Other countries (Italy) have started a consultation process;
4. All other countries rely on the customer's consent, generally written but sometimes also oral;
5. For countries like EL, LV, PL and SI, this control is identified by the current energy contract: third parties (except the current supplier) are not meant to have access to validated data. The same can be said for other countries where current regulation has not disciplined access to validated data for third parties (beyond the chosen supplier): in principle third parties can't access to customer's validated data unless the customer delegates access to the web portal, when available. The most concerning observation was that in countries without well-defined data access procedures, clients grant access to third parties by providing credentials (like the password) to a web portal. This is problematic since clients lose control on the data once they have given their credentials.

Recommendations

Based on the present fact-finding exercise, there are differences among MS when it comes to access and exchange of data, and we cannot exclude barriers even within MS. In the light of our observations, a number of recommendations can therefore be formulated:

1. To reduce potential market barriers within a MS, we propose that

- national authorities further reinforce the collaboration of stakeholders in national forums and working groups[5]. In particular, it should be ensured that all concerned parties, including traditional stakeholders and new energy service companies (ESCOs), are well represented;
- the national regulator should enforce compliance with a single national format. This is especially the case in decentralized data management systems[6] and in countries where energy policy is a regional competence. In particular, the national regulator should verify whether national formats are general enough to accommodate differences in regional policy choices.

[5] We find that almost all MS enable at least some form of collaboration between stakeholders (DSOs, suppliers, TSOs, regulators, etc.) in developing further formats and procedures.

[6] Thema (2017, p.10), "*decentralized solutions […] can reduce, but not fully eliminate, market barriers if the processes, data types and communication interfaces are legally binding and if the regulator has enough authority to enforce compliance*."

2. To reduce market barriers between MS, we propose that

- the national regulator increases transparency at MS level, by making publicly available on a website the role models, the data formats and all standard as well as non-standard procedures for processes such as supplier switching and billing. Only 12 out of the 24 responding countries provided at least some publically available descriptions of billing and supplier switching processes (see Table 18). Furthermore, the EC could consider setting up a European website where national procedures are collected and centrally published in at least one common EU language;
- standardization organizations update existing international standards, like CIM, as a pivot language ensuring the compatibility of national communication choices. Clearly defined national formats and procedures are a pre-condition for an efficient mapping.

3. With regard to the consumption data access by customers and third parties, we believe that the **existence of a transparent consent management for giving, and especially revoking access should be the first priority to be addressed by MS deploying smart metering systems**. We found out that today, clearly defined consent mechanisms do not usually exist. Since this is new and we do not have legacy systems in place yet, we invite the EC to promote harmonized consent mechanisms across MS.

4. More generally, we urge the EC to reflect on a **Cost-Benefit Analysis** for aligning national practices for data access and exchange as part of an impact assessment to **support secondary legislation promoting interoperability of energy services**. Facilitating interoperability within and especially between MS will be a further step towards the establishment of a truly internal energy market with well-functioning retail markets. Market barriers are lowered and new services and more choice can be delivered to customers. On the other hand, interoperability of systems comes at a cost. The CBA should thus identify the different pathways towards convergence and address the right balance between stronger interoperability[7] and extent of benefits provided to customers and the energy system as a whole.

At the same time, we believe that the analysis should revisit the implication of a certain role model, and in particular the stakeholders and the flows involved, for consumption data access and sharing. With the objective of promoting retail competition, one accordingly can question roles to be executed in the same way depending on the stakeholder defined for these roles. **Different role models are thus expected to imply different levels of operating, capital and maintenance costs**.

Finally, based on the interviews held, we expect that **a high degree of harmonisation, as opposed to alignment or some level of convergence of national practices, will be rather challenging to achieve and might face strong opposition from stakeholders in MS**: Data management choices tend to be driven by historical reasons and especially by the number of DSOs[8]; also countries having

[7] The Smart Grids Architecture Model (SGAM) framework (CEN-CENELEC-ETSI Smart Grid Coordination Group,2012) defines 5 layers of interoperability, going from more technical to more business related aspects.

[8] Several countries have officially (DK, EE, NL, PL, PT – because of a central data hub) or de facto (CY, EL, FR, HR, IE, LT, LV, PL) a centralized system because there is one single or a dominant DSO managing the system. On the other hand, countries like AT and DE (more than resp. 130 and 890

recently invested in their system will not be inclined to change again. Therefore, **a robust analysis of the costs and benefits involved in aligned practices** of data access and exchange within the EU **should be carefully and timely undertaken as to build confidence in any proposed changes**.

DSOs) have a decentralized, DSO-based management system and there are currently no discussions of changing this.

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Glossary

1G, 2G, 3G, 4G	First, Second, Third, Fourth Generation
ACM	Authority for Consumers & Markets
Agence ORE	Energy Network Operator's Agency
AMI	Advanced Metering Infrastructure
AN	Access Network
AS	Applicability Statement
ASN	Abstract Syntax Notation
BNetzA	Bundesnetzagentur
CBA	Cost Benefit Analysis
CC&B	Customer Care and Billing
CCP	Contract Control Protocol
CEFACT	Centre for Trade Facilitation and Electronic Business
CEN	European Committee for Standardization
CEER	Council of European Energy Regulators
CENELEC	European Committee for Electrotechnical Standardization
CERA	Cyprus Energy Regulatory Authority
CIM	Common Information Model
CMS	Central Market System
CNMC	Comisión Nacional de los Mercados y la Competencia
CRM	Customer Relationship Management
COSEM	Companion Specification for Energy Metering
CP	Charging Point
CRM	Customer Relationship Management
CSV	Comma-separated values
CUPS	Código Unificado del Punto de Suministro
CWaPE	Commission wallonne pour l'Energie
DCC	Data Communications Company
DEP	Data Exchange Platform
DG	Distributed Generation
DLMS	Device Language Message Specification
DMS	Data Management System
DNO	Distribution Network Operator
DPA	Data Protection Act
DSM	Demand Side Management
DSO	Distribution System Operator
EAN	European Article Numbering
EbIX	European forum for energy Business Information eXchange[9]
ebXML	Electronic business XML
EC	European Commission

[9] EbIX is a non-profit European organisation with the avowed objectives to advance, develop and standardise the use of electronic information exchange in the European energy industry.

EDIEL	Electronic Data Interchange for the Electricity Industry
EDIFACT	Electronic Data Interchange For Administration
EDM	Energy Data Management
EG1	Expert Group 1 of the Smart Grid Task Force:
EMG	Energy Management Gateway
ESCo	Energy Service Company
ETSI	European Telecommunications Standards Institute
EU	European Union
EV	Electrical Vehicle
FING	Foundation Internet Nouvelle Génération
FTP	File Transfer Protocol
GBCS	Great Britain Companion Specification
GDPR	General Data Protection Regulation
GPRS	General Packet Radio Service
HROTE	Hrvatski Operator Tržišta Energije d.o.o. (Croatian Energy Market Operator)
HTTP	HyperText Transfer Protocol
HTTPS	HTTP Secure
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IPET Section	Energy Market Data Exchange Section
ISO/OSI	International Organization for Standardization / Open Systems Interconnection
JSON	JavaScript Object Notation
LAN/LN	Local Area Network
LNAP	Local Network Access Point
LV	Low Voltage
M2M	Machine to Machine
MDM	Meter Data Management
MDMS	Meter Data Management System
MID	Measuring Instruments Directive
MRSO	Meter Registration System Operator
MS	Member States
MSCONS	Metered Services Consumption report message
MV	Medium Voltage
NA	Not Available
NAN/NN	Neighbourhood (Area) Network
NEDU	Nederlandse EnergieData Uitwisseling
NIST	National Institute of Standards and Technology
NNAP	Neighbourhood Network Access Point
NRA	National Regulatory Authority
NSA	National Security Agency
NV	Non-validated datas
PDF	Portable Document Format
PDR	Punto di Riconsegna

PLC	Power Line Communications
PoD	Point of Delivery
PRIME	PoweRline Intelligent Metering Evolution
PV	Photovoltaic
PVPC	Precio Voluntario del Pequeño Consumidor
QoS	Quality of Service
RDF	Resource Definition Framework
RF	Radio Frequency
RFC	Request for Comments
SCL	Substation Configuration description Language
SCM	Secured Communication Module
SCTD	Sistema de Comunicación Transporte-Distribución
SEC	Smart Energy Code
SII	Sistema Informativo Integrato (Integrated Information System)
SIM	Subscriber Identity Module
SIPS	Sistema de Información de Puntos de Suministro (Supply point Information System)
SM	Smart Meter
SME	Small Medium Enterprise
SMET	Smart Metering Equipment Technical Specifications
SMTP	Simple Mail Transfer Protocol
SOAP	Simple Object Access Protocol
TC	Technical Committee
TCFM	Télécommande Centralisée à Fréquence Musicale
TSO	Transmission System Operator
USP	Universal Service Provider
V	Validated Data
VAN	Value Added Network
VREG	Vlaamse Regulator voor de Elektriciteits en Gasmarkt
VRM	Vendor Relationship Management
WAN	Wide Area Network
XML	eXtensible Markup Language
ZSE	ZigBee Smart Energy

Country codes:

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

Study Objective

Under the current provisions in the Electricity and Gas Directives[10], Member States shall define at national level a single format and procedure for consumers and, under their explicit consent, supply undertakings should have access to their meter data at no additional cost. More recently, the European Commission has initiated important measures to strengthen the consumer empowerment, as described in the Energy Union Strategy[11], the new Market Design Initiative under the "Clean Energy for All Europeans" Package and more specifically, with regards to the proposal for a revised electricity Directive (articles 23 and 24)[12]:

Article 23 (1&2):

> *1. "When setting up the rules regarding the management and exchange of data, Member States or, where a Member State has so provided, the designated competent authorities shall **specify the eligible parties which may have access to data** of the final customer **with their explicit consent** in accordance with Regulation (EU) 2016/679 of the European Parliament and of the Council. For the purpose of this Directive, data shall include **metering and consumption data as well as data required for consumer switching**. Eligible parties shall include at least customers, suppliers, transmission and distribution system operators, aggregators, energy service companies, and other parties which provide energy or other services to customers."*
>
> *2. "Member States shall organise the management of data in order to ensure efficient data access and exchange. Independently of the data management model applied in each Member State, the party or parties responsible for data management shall provide to any eligible party with the explicit consent of the final customer, access to the data of the final customer. Eligible parties should have at their disposal in a non-discriminatory manner and simultaneously the requested data. **Access to data shall be easy, while relevant procedures shall be made publicly available**."*

Article 24 (1&2):

> *1. "Member States shall **define a common data format and a transparent procedure** for eligible parties to have access to the data listed under Article 23 (1), in order to promote competition in the retail market and avoid excessive administrative costs for the eligible parties."*
>
> *2. "**The Commission**, by means of implementing acts adopted in accordance with the advisory procedure referred to in Article 68, **shall determine a common European data format and non-discriminatory and transparent procedures for accessing the data**, listed under Article 23 (1), that will replace national data format and procedure adopted by Member States in accordance with paragraph 1. Member States shall ensure that market participants apply a common European data format."*

Furthermore, Article 19 strongly invites Member States to **promote new services** (energy management services, innovative pricing formulas) and the **introduction of smart metering systems**. These systems should comply with minimum functional and technical requirements. Also, they should be interoperable and able to connect with consumer energy management platforms (Articles 19&20). This is seen as essential for the development of the internal market in electricity.

[10] Annex 1.1(h) of Directive 2009/72/EC and Directive 2009/73/EC

[11] COM(2015) 339 final.

[12] COM(2016) 864 final/2, 23.2.2017.

In practice, Member States are progressing at different speeds with the implementation of the obligation under Annex I.1 of the current Directives for electricity and gas, and diverging practices are emerging usually reflecting domestic needs and requirements. **The aim of this study is to map the EU 28 Member States' practices regarding the format and procedures in place regarding data access and exchange, for electricity and gas, in accordance with Annex I.1(h) of the Electricity 2009/72/EC and Gas 2009/73/EC Directive.**

To this respect, and with emphasis on electricity, the study should map national practices and present detailed information for all EU-28 Member States concerning:

- Data formats and procedures (including consumer consent process) for access and exchange used in Member States, and
- Progress towards establishing a single national framework.

The results should:

- Reveal the state-of-the-art and progress level in the EU-28 with respect to data access for traditional activities/processes such as billing and switching of suppliers, and also for processes in support of flexibility and emerging services.
- Reveal the state-of-the-art and progress level in the EU-28 with respect to Smart meter integration, energy management integration and data formats used.
- Help identify the extent of commonalities and differences in the formats and procedures set in place at national level.

Methodology

Activities considered

In order to map MS' practices in place regarding the format and procedures for accessing and exchanging data in the case of electricity (and gas), **three activities** have been investigated:

1. supplier switching processes
2. customer billing processes
3. Support for flexibility and emerging energy services

While **activities 1 and 2** are **traditional activities** usually involving customers, DSOs and suppliers, **activity 3** relates to enabling the customer actively participate in novel energy services, including demand response and self-generation.

For the traditional activities, the current data management architecture sets the framework for roles and processes and hence needs to be considered in its current form and expected evolution. With the consumer getting empowered through improved data access enabled by smart meter technologies, a series of **new activities** (3) is expected to emerge. The access to metering data by the customer and third parties is hence crucial, also in light of the compliance with the GDPR.

Given the wide range of aspects considered, the study focuses on **retail electricity consumption data access and exchange**. The focus on residential clients is justified because in most MS, larger consumers have the possibility already today to actively participate in the market. The study concentrates on electricity since for most MS, data management systems for electricity and gas are at least similar. Also, flexibility and emerging energy services are expected to be more relevant for electricity.

Type of information collected

For the traditional activities 1 and 2, the following aspects have been studied:

- What is the **data management architecture** of today and how is it expected to evolve?
- **What are the roles and what is the process** developed to give access to the data (e.g. role model) to eligible parties;
- **Which data format** (EDIFACT, CIM, XML, CSV, etc.) and technology are used (XML, CSV, HTTP, FTP, Platforms, and - to the extent that information is available on - security, data privacy, performance, validation, authentication, non-repudiation, etc.) to provide final customers with their energy consumption data and suppliers and other eligible stakeholders with metering and market data (with consumers' consent when personal data is concerned and in line with the General Data Protection Regulation 2016/679).
- What are the **steps in the business processes** for switching and billing?

Flexibility and emerging energy services encompass various activities. They all have in common that consumers and other market participants need to have access to accurate and timely information. The presence of smart meter systems is therefore a necessary condition. Two aspects have been investigated: The functionalities of the smart meter and the access rules for the data collected.

Functionalities:

- What kind of historical data is stored in the smart meter or the DSO/supplier and for which time horizon?
- What kind of real time data is collected by the smart meter?
- What functionalities are legally required for the smart meter?

Access to data:

- Data access by final customers: does the consumer easily have access to data from the smart meter? Which type of data is available (granularity, historical data, access to real-time data)? Which technology and standards are used for exchanging data?

- Data access for third parties: How can third parties access historical and real-time consumption data? What are the access rules?

Information collection process

For the collection of the country information, we relied on desk research, questionnaires and expert interviews. We proceeded in 2 steps:

Questionnaire generation:

- A first version of a questionnaire was prepared based on desktop research and tested on a subset of the 28 Member States (BE, DE, DK, ES, EE, FI, FR, IT, NL, UK). For this subgroup of countries, information was mostly available from previous studies, which was then complemented with country expert interviews. The findings were presented to the members of the Expert Group on standards and interoperability (EG1) of the Smart Grids Task Force.[13]
- Based on the feedback received, a refined questionnaire was developed and validated by the EG1. The final questionnaire was then used for all responding Member States.

The interview process:

1. The questionnaire was sent to the national expert who filled in the questionnaire before the interview;
2. A one hour interview was performed with the national expert to complete the questionnaire, to clarify any open question but also to identify specific national issues that are not easily identifiable in a general questionnaire;
3. A final version of the questionnaire and a country sheet were send back to the national expert for validation

Identification of national contacts:

With the help of the EC, the EG1, CEER and Eurelectric, a list of national experts was identified and contacted. The names and affiliation of the identified experts for electricity and gas can be obtained on request. In Table 1, the participating authorities, associations and companies are listed.

[13] Smart Grids Task Force: https://ec.europa.eu/energy/en/topics/markets-and-consumers/smart-grids-and-meters/smart-grids-task-force.

	overal status	contact Electricity	contact Gas
BE		Atrias	idem, no separate questionnaire
DK		Danish Energy Association Dansk Energi	Danish TSO Energinet & Danish Energy Association Dansk Energi: validated paragraph, questionnaire received but not-validated
EE		TSO Elering	idem: validated questionnaire and paragraph
FI		Finnish Energy -Trade Association & Energy Authority	Energy Authority: validated questionnaire and paragraph
FR		Enedis	GRDF, questionnaire received
DE		BDEW	idem
UK		Energy UK, energy association	idem
IT		Enel	idem: validated questionnaire and paragraph
ES		Enel	No contact available, questionnaire not received, but paragraph edited during Scope I, comments, received in September, have been integrated
NL		Aliander, DSO	idem, no separate questionnaire
AT		Energie AG, supplier	idem
BG		/	/
HR		HERA, regulator & HEP, TSO	HERA, regulator: validated questionnaire
CY		CERA, Cyprus Energy Regulatory Authority	No liberalized market
CZ		CEZ, DSO	no contact
EL		HEDNO, DSO	idem: validated questionnaire and paragraph
HU		MEKH, regulator	idem: validated questionnaire and paragraph
IE		CRU, regulator	idem, no questionnaire received
LV		Public Utilities Commission	idem: validated questionnaire and paragraph
LT		ESO, supplier	idem: validated questionnaire and paragraph
LU		ILR, regulator	idem, questionnaire received
MT		/	/
PL		Energa, supplier	PSG, DSO; no questionnaire received; no interview done
PT		EDP	REN, DSO: questionnaire received but both questionnaire and paragraph non-validated
RO		/	/
SK		/	/
SI		Borzen, Market operator	TSO Gas: questionnaire received
SE		Ellevio, DSO	No Contact available

Table 1 National contacts

The colour code indicates if we were able to fully implement the data collection methodology for electricity. Green means that a questionnaire was received and validated, i.e. confirmed by the interviewee, together with the country sheet. The four red boxes indicate the countries where it was not possible to receive a response. The three orange boxes indicate that the process could only partially be implemented (either only a questionnaire has been received but no interview, or no final validation has been received). Although gas-specific aspects are not considered in this report, we nevertheless provide the contacts we could identify and indicate whether a gas-specific questionnaire was received.

Report structure

The remainder of the report is structured as follows: before starting the analysis of the activities considered, we provide a literature review. Also, we present in more detail the European regulatory context and the underlying economic goals (Section 0). We continue with presenting our findings in Section 0. As of Section 0, a country sheet for each Member State presents more detailed, country-specific, results.

Literature review

Economic background

Easy access to accurate and timely energy consumption data is key for the further development of efficient retail markets. Smart meters in particular have more than just the potential to reduce the costs of the customer processes, through more accurate and automatic data available for billing and supplier switching. They also facilitate market openness and assist the active participation of consumers (consumer empowerment). Smart meters enable innovative pricing formulas, consumers to share their data for participation in flexibility markets via aggregators, the development and uptake of new products regarding energy efficiency offered by ESCOs, etc. In this way, smart meters also support the achievement of the 20/20/20 targets. Market openness is further supported by data management systems being interoperable within and between MS: market barriers are lowered, since energy suppliers do not need to adapt their internal data management system to become active in other regions or MS.

It is for this reason that the European Union Electricity and Gas Directives[14] of the Third Legislative Package in 2009 stated that "*customers should have at their disposal their consumption data, and shall be able to, by explicit agreement and free of charge, give any registered supply undertaking access to its metering data. The party responsible for data management shall be obliged to give those data to the undertaking. Member States shall define a format for the data and a procedure for suppliers and consumers to have access to the data. No additional costs shall be charged to the consumer for that service*." Also, it is strongly recommended that MS introduce intelligent metering systems and that they ensure interoperability of these systems within their territories. Furthermore, the importance of the use of standards and best practices for the development of the internal market is stressed.[15] Where roll-out of smart meters is assessed positively, at least 80 % of electricity meters shall be replaced by intelligent metering systems by 2020. On November 30th 2016, the Commission published a proposal[16] stating that all consumers should be entitled, if they wish so, to have a smart meter installed where there is no systematic roll-out of or smart metering is negatively assessed as a result of cost-benefit assessment (Article 21). Smart meters should allow consumers to reap the benefits of the progressive digitalization of the energy market via several different functions. Consumers should also be able to access dynamic electricity price contracts.

Smart meter roll-out and standardization

17 EU Member States are proceeding with a wide-scale smart metering roll-out (at least 80% penetration rate by 2020) for electricity and 2 Member States with a selective (up to 23% penetration rate) roll-out. For gas, 7 Member States intend to roll-out a total of 45 million gas smart meters by 2020.[17]

The wider use of smart metering technologies is expected to dramatically increase the amount and granularity, but also the commercial value, of data generated and

[14] Annex I.1(h) of Directive 2009/72/EC and Directive 2009/73/EC

[15] Annex I.2 of Directive 2009/72/EC and Directive 2009/73/EC

[16] COM(2016) 864 final

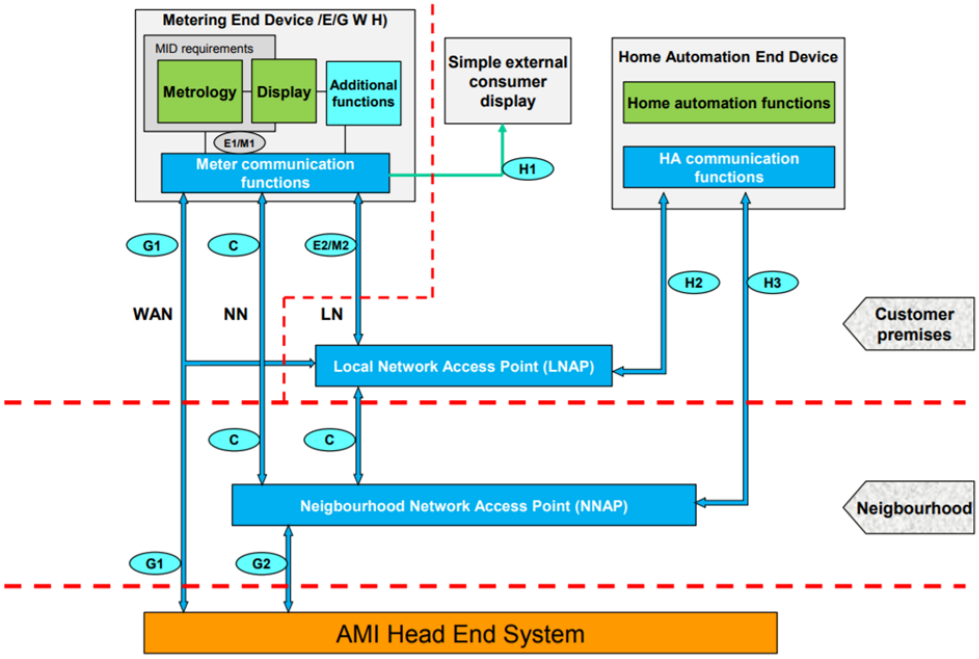
[17] Commission Report COM(2014) 356, as updated in the Smart Grids Task Force EG1 Report: "Status report based on a survey regarding Interoperability, Standards and Functionalities applied in the large scale roll-out of smart metering in EU Member States", October 2015.

exchanged within the (power) system, making the obligation for a single data format and procedure even more topical.

The European Commission has therefore issued mandates, namely on smart meters M/441 and smart grids M/490, which have led to the development and update of related technical standards.[18] After the successful completion of these mandates, the CEN-CLC-ETSI Smart Energy Grid Coordination Group continued the work with the purpose to follow-up on identified standardization gaps and undertake potential revisions in response to market and technology developments. To this respect the Group issued a new release of the original first set of standards and proposed an updated framework of standards which can support Smart Grids deployment in Europe.. More than just a flat list, this report aims to provide to Smart Grid users with a selection guide which, depending on the targeted system and the targeted layer (component, communication or information layers), will set out the most appropriate standards to consider.

Similarly, the Smart Meters Coordination Group, following up on earlier work under the M/441 mandate, still gives input to the development and maintenance of new and existing standards for advanced metering infrastructures, in order to help deliver the seamless interaction between the different interfaces and functional entities in the respective communications network (see figure below), and support the European smart metering roll-out. The following chart gives a high level view of the architecture considered for smart metering communications:

[18] Setting common standards that are applied across the whole of the European single market ensure the protection of consumers, facilitate cross-border trade, ensure the interoperability of products, encourage innovation and technological development, include environmental protection and enable businesses to grow. Products and services that meet these European Standards (ENs) can be offered and sold in all of the participating countries. In Europe, these standards are developed and agreed by the three officially recognized European Standardization Organizations: the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI). The close collaboration between CEN and CENELEC was consolidated at the start of 2010 by the creation of a common CEN-CENELEC Management Centre (CCMC) in Brussels. The ESOs can also cooperate with respectively the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) to reach agreements on common standards that can be applied throughout the whole world, thereby facilitating international trade. Source: www.cen.eu.



SOURCE: CEN/CLC/ETSI/TR (2011)

Figure 1 Smart metering reference architecture

The EC, in cooperation with the industry and ETSI, launched in 2015 a standard for a reference language for energy-related data to be used by in-home appliances: SAREF (Smart Appliances REFerence ontology)[19], which has also been recently showcased as supporting practical applications of an open architecture for demand side flexibility.[20]

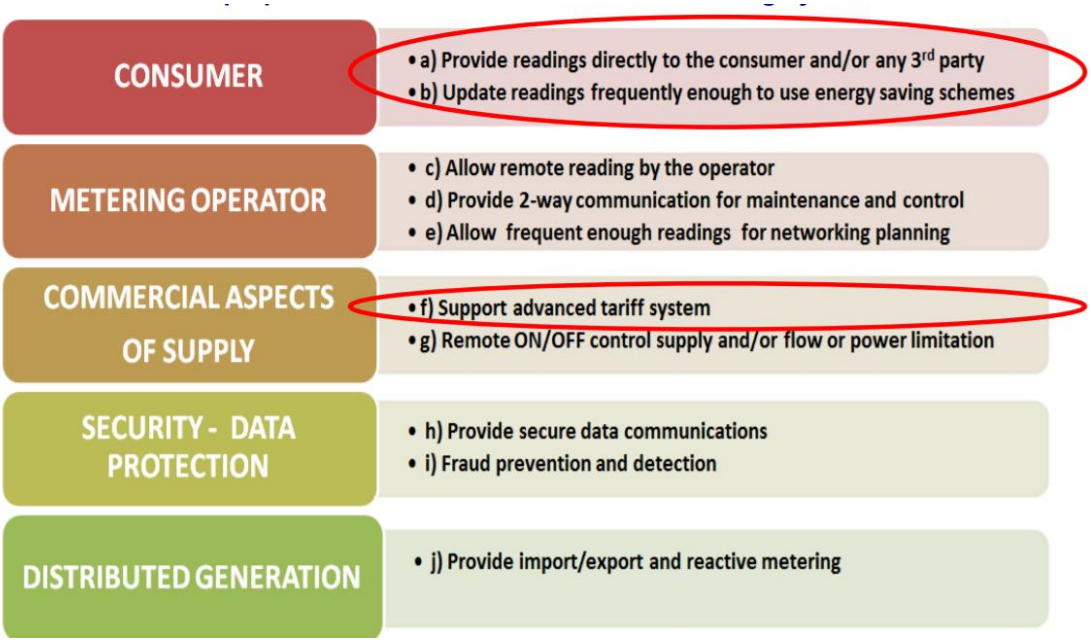
Next to the mandates to standardize smart meters, the EC[21] issued a Recommendation of 10 common minimum functionalities for smart metering systems in 2012:

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) prevent and detect fraud;
j) Provide import/export and reactive metering.

[19] http://www.etsi.org/deliver/etsi_ts/103200_103299/103264/01.01.01_60/ts_103264v010101p.pdf

[20] https://ec.europa.eu/digital-single-market/en/news/digitalising-energy-sector-common-language-consumer-centric-world

[21] Recommendation 2012/148/EU, drawn in 2012 in consultation with NRAs from MS that had by that time already experience in or had progressed with the roll-out.

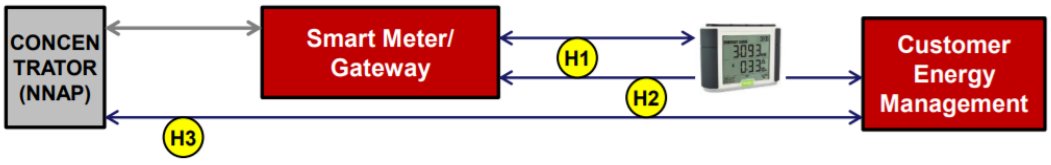


SOURCE: EUROPEAN COMMISSION

Figure 2 Minimum functionalities for smart metering systems

Especially for functionalities (a), (b) and (f), local interfaces within the metering infrastructure are needed (see Figure 1 and Figure 3):

- H1 is the interface between the smart meter and a simple external display device (where applicable) via one-way communication;
- H2 is the interface used for smart grid communications (including Demand Side Flexibility) which exchanges information between the advanced metering infrastructure (AMI) and DSF applications. H2 connects the smart metering gateway (LNAP) and the energy management gateway. H2 enables two-way communication for home automation end devices (which may include advanced consumer displays). H3 refers to a similar link between the NNAP and the energy management gateway. The MS survey carried out by EG1 in 2015[22] established that the H3 interface was not planned to be used.



SOURCE: EURELECTRIC

Figure 3 Local interfaces for information exchange and interworking

[22] SGTF EG1 report on Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering.

Data protection

Self-data

Self-data refers to "*the collection, use and sharing of personal data by and for individuals, under their complete control and designed to fulfil their own needs and aspirations.*" (Fondation Internet Nouvelle Génération, FING). Usually, Self-data is about the restitution of data from companies to the consumers (the latter receive access to their data) or the co-generation of data (consumers accept which aspects of their behaviour are quantified and shared). Self-data allows sharing the benefits of data and contributes therefore to consumer empowerment. In business, self-data is known as Vendor Relationship Management (VRM), in opposition to the Customer Relationship Management (CRM): "*Just as CRM gives companies means to relate to many different customers, VRM gives customers means to relate to many different companies. With VRM, economic signaling between demand and supply will be far more direct and efficient. It will also support genuine two-way relationships and minimize the need for surveillance and "big data" based guesswork by companies*" (Capgemini[23]).

General Data Protection Regulation

In Europe, the concept of Self data is closely linked to the General Data Protection Regulation (GDPR). The GDPR intends to strengthen and harmonize data protection for all individuals within the European Union. It was adopted on April 27th 2016 and is enforceable from May 25th 2018, when it replaces the data protection Directive 95/46/EC. Some of the key aspects include[24]:

- The right to access: the right for data subjects to obtain from the data controller confirmation as to whether or not personal data concerning them is being processed, where and for what purpose. Further, the controller shall provide a copy of the personal data, free of charge, in an electronic format.
- The right to be forgotten: data subject to have the data controller erase his/her personal data, cease further dissemination of the data, and potentially have third parties halt processing the data.
- Data portability: the right for a data subject to receive the personal data concerning them, which they have previously provided in a 'commonly used and machine-readable format' and the right to transmit that data to another controller.

A Data Protection Authority has to be established in every Member State in order to ensure that the rules are respected and fines are applied in case companies do not comply. Unlike a Directive, the GDPR does not require any enabling legislation to be passed by national governments and is thus directly binding and applicable.

Self-data initiatives

A number of initiatives are taken in several Member States to prepare for the GDPR. In UK, Midata is a voluntary program launched by the government in 2011 in cooperation with the industry and consumer organizations to provide consumers access to their data in an electronic and portable format. Several energy companies are part of the initiative (British Gas, EDF Energy or E.ON amongst others). In France, MesInfos has been exploring the potential of Self data since 2012. In a pilot project in 2016-2017, several companies (amongst others: EDF, Enedis, Engie, GRDF) gathering personal data agreed on giving back the data and making it available on a personal cloud (Cozy Cloud).

[23] https://www.capgemini.com/blog/cto-blog/2015/08/what-is-vendor-relationship-management

[24] http://www.eugdpr.org

Related background documentation

CEER: Benchmarking Report on Meter Data Management - Case Studies (2012)

This report describes the 2012 status of the meter data management model for electricity and gas in AT, BE, DK, DE, IT, NO, ES, NL and the UK. It also includes a description of the expected future data management model in case changes were already foreseen at the time.

The report shows that there is a variety of meter data management choices: centralized access and decentralized storage approach seem to be favored. Two of the cases have a strictly centralized approach with centralized access and storage (DK, NO) and one case has a strict decentralized approach (DE). In five of the nine case studies, a new regulation is in place for a new meter data management (MDM)-model: AT, DK, IT, NO and the UK. Out of the participating countries, only one has rolled out smart meters: Italy. Also, the rationale for centralized MDM is strengthened in the smart metering world because of the increased amount of information exchanged. In most countries, the customer clearly has the choice over who can access the smart meter consumption data.

CEER: Advice on Customer Data Management for Better Retail Market Functioning – Electricity and Gas (2015)

Due to the fact that market designs and conditions differ across Europe, CEER believes that different countries might require different meter data management models. Instead of suggesting a specific MDM model, CEER proposed five guiding principles for customer data management models. The five guiding principles are: privacy and security, transparency, accuracy, accessibility and non-discrimination. Each principle has been accompanied with seven concrete recommendations to facilitate the development of customer data management in European retail energy markets in accordance with these principles.

Smart Grid Task Force EG1: Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering (2015)

This work focused on monitoring and analyzing which functionalities, standards and interfaces are used in smart metering systems being rolled-out in Europe. The report concentrated on the following aspects: the deployment of three smart metering functionalities that can deliver benefits to customers ((a), (b) and (f) mentioned above), the implementation of local interfaces within the metering infrastructure to support the delivery of these functionalities (H1, H2, H3), the available communication standards chosen for the selected local interfaces, and possible additional companion standards developed reflecting the level of interoperability (to be) reached on these interfaces.

17 EU MS were covered by the study. All 17 MS responded implementing functionality (a), with three (DK, IT, SE) of them indicating to do so in the next planned roll-out.[25] 3 (LV, EE, ES) do not implement functionality (b) as it was specified by the Commission in its Recommendation (with at least 15 minute update frequency). 2 of them (LV, EE) will do so on customer request. 5 MS (AT, SE, DK, IE, FI) will not implement functionality (f). Only one MS (ES) will (partly) not use the H interfaces. Others will implement these interfaces initially, later or on consumer request, and the majority intends to roll-out interface H1. 7 MS (DK, EE, ES, LV, IT, MT, RO) indicated that they currently use a web-portal as an alternative or complement to the H1, H2, H3 interfaces although these interfaces might be implemented later or on consumer request. A majority of MS did not make additional definitions for improving interoperability on the H interfaces. The

[25] Danish smart meters installed after 2011 must have an interface for e.g. an external display.

investigation also showed that in references made to standards for the H interfaces, the CENELEC TC205 standards are never mentioned. Since they deal with data definitions, there is a risk that the data and its format provided by the AMI is not aligned with the data and formats required by in-home energy management systems.

Smart Grid Task Force EG1: My Energy Data (2016)

This report presented an analysis of ongoing initiatives on data access and management in the field of energy distribution in 10 MS, as well as the North American Green Button initiatives. The European countries covered are: BE, DK, EE, FI, FR, DE, GB, IT, ES and NL. Data management models and initiatives were assessed on how they give domestic customers the possibility of downloading their energy consumption information and how access to that information is granted to third parties , such that analytical and other services can be provided to customers. A general overview of use cases and implementation issues were presented. Data formats and information models already in use in FR, DE, ES, EE, IT, NL, GB, BE and DK were listed. Reasons why these formats were chosen were explored. Finally, the report highlighted lessons, approaches and recommendations for an industrial initiative.

The table below provides an overview of the main data formats/standards in use in the different MS to provide energy consumption data to customers.

Member State	Meter Reading Data available	Information Model	File format
France	Indexes (day), Load curve	Specific	CSV (RFC 4180)
Spain	Load profile	Specific	CSV (RFC 4180), Excel, PDF
Germany	Load curve	Specific	JSON (RFC 7159, ECMA 404 & 262)
Estonia	Load curve	Specific	XML (W3C)
Italy	Indexes (day, month), Load curve	Specific	
The Netherlands	Load curve	Specific	P4 : XML (W3C)
	Load curve (direct access to the meter)	DLMS/COSEM IEC 62056-61	P1 : IEC 62056-21
Great Britain	Meter registers; 13 months of half hourly interval readings for imported energy	DLMS/ COSEM and ZigBee Smart Energy on the metering equipment	Zig Bee Smart Energy over the smart meter home area network; XML from DCC (remotely)
Belgium	load curve	specific	EDIEL - XML in preparation
Denmark	Load curve	specific	ebIX

SOURCE: MY ENERGY DATA

Figure 4 Main standards in use in Member States considered to provide data to consumers

The "My Energy Data" team does not plead for a single data format across Europe. Instead, it states that an industrial initiative could work towards an approach which allows compatibility or alignment with existing systems already decided. Moreover, this could allow benefits from such a convergence of national practices to be realized more widely than the organizations/MS represented in the industrial initiative.

CEER: Review of Current and Future Data Management Models (2016)

This report updated the status of data management models in retail energy markets of 8 countries out of the nine analyzed in 2012. The countries analyzed are: NO, IT, ES, GB, BE, DE, DK, and NL.
The data management models were analyzed in light of the guiding principles and recommendations in *CEER (2015).* Future developments were also covered.
Participating countries now and in the future will have a variety of different data management models, which vary not only in terms of technical functionalities, but also in terms of legal frameworks, responsibilities and regulations. As a general trend, it was observed that all but 2 countries will have a full roll-out of smart metering. All but 1 country are making changes in their data management models, moving to centralized or partially centralized models. When assessing the fulfilment of the guiding principles and recommendations of CEER (2015), the review found that recommendations on privacy and security, customer rights and information, customer confidence, cases of data inaccuracies and non-discrimination overall have relatively high degrees of fulfilment. The degree to which customers have technical access to data in the data management models is observed to be quite low. In terms of harmonization of data management standards in a regional or European perspective, there is generally a low degree of consideration.

Country	Current model	Future model
Norway (NO)	Decentralised	Centralised data hub
Italy (IT)	Decentralised	Centralised data hub
Germany (DE)	Decentralised	Decentralised
Denmark (DK)	Centralised data hub	Centralised data hub
Netherlands (NL)	Centralised communications hub with partially centralised storage	Centralised communications hub with partially centralised storage
Spain (ES)	Decentralised	Centralised communications hub with decentralised storage
Great Britain (GB)	Decentralised	Centralised communications hub with decentralised storage
Belgium (BE)	Partially centralised	Centralised data hub

SOURCE: CEER

Figure 5 Data management models in 8 Member States

Eurelectric: The power sector goes digital – Next generation data management for energy consumers (2016)

The report studied current and possible evolutions brought by the complete digitalization of the European power systems. Roles will transform: customers will gain control over their energy consumption, suppliers will be able to enlarge their portfolio of services, new actors (energy service companies and aggregators) will appear in the market, DSOs will embody the role of neutral market facilitators and become more active system managers. This transformation will be enabled if smart meter data, smart market data and smart grid are implemented in a coordinated way. Case studies,

initiatives set up by suppliers, countries, stakeholders' associations, DSOs and TSOs across Europe were also presented.

ENTSO-E: Data exchange in power systems: European State of Play and Perspectives (2017)

The report gives a European perspective to the development of Data Exchange Platforms (DEP) in the electricity markets. A high level background is firstly framed in order to understand current and future data exchange requirements in the electricity markets (regulatory framework and guiding principles, types of data classification, stakeholder involved and their related data requirements). Synthetic comparisons on the status are shown for some MS (BE, DK, EE, IR, IT, NL, NO, DE). Selected data exchange models are presented with further detail (NL, DE and EE). The opportunity and rationale of DEPs for handling future electricity market scenarios is then evaluated as well as future possible developments.

What is missing

Studies dealing with the formats and procedures concerning data access and exchange rarely cover all the MS; hence a complete view about the status in Europe is missing. This applies not only to the general data management system, but also to general business processes like supplier switching and billing and emerging services.

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- European Smart Grid Task Force EG1 (2016 bis): My Energy Data.
- European Smart Grid task Force EG3 (2013): Options on handling Smart Grids Data.

Study findings

This chapter summarizes the findings of the questionnaire and interview process that was undertaken during the current investigation.

1. First, we discuss the **traditional activities of supplier switching and billing**. The business processes are built on the national data management models. We explain therefore the roles of the different actors, what kind of consumption data is accessed, stored and exchanged and who is involved. We then discuss potential challenges for the interoperability of the data management models that include differences in the communication semantics, different business processes and we touch on the issue of the definition of processes for exceptions (but we have not collected data on the last issue);
2. Second, we discuss the status of **emerging services and products** and focus on the status of the smart metering roll out and of the respective functionalities;
3. Finally we discuss the possibility for customers and third parties to access consumption data and hence the implications from the implementation of the **GDPR requirements**.

Traditional business processes: Supplier Switching and Billing

Business processes can represent an entry barrier for energy suppliers if they are too complex, opaque or just not compatible with each other. Aligned message formats can reduce IT costs and facilitate entry into different jurisdictions. On the other hand, the business processes that exist today are, in many cases, largely a legacy of the time since the deregulation. Countries have invested at national level into specifying processes, developing standardized procedures and formats. Also, national or even regional requirements that often are linked to public service obligations (e.g. see the case of disconnections for arrears) created the need for the treatment of exceptions that are difficult to harmonize.

Supplier switching and billing are the most traditional services for which all MS were required to establish uniform national procedures. This study is limited to basic processes. We already find differences in the procedures and the message formats. An exhaustive comparison that includes the treatment of exceptional cases would reveal an even more diverse picture.

This section is organized in the following steps. We first describe the status of the data management model in the MS, the roles that different actors have in that model and the kind of consumption data stored. We then move to the challenge of interoperability and discuss the communication formats as well as the number of interactions between the actors to provide the basic services. A complete description of the procedures by country is reported in section 0. In addition, the contributors provided links to public documents describing those processes followed by a short description of non-standard processes and exceptions. These links are included in the country sheets, in chapter 0.

We conclude with an overview of how stakeholders can participate in the definition of the processes at a national level.

Customer data management models

Customer data management comprises the processes by which data is sourced, validated, stored, protected and the basis on which it can be accessed. In about half of the countries that responded to the questionnaire, data is managed in a centralised or partially centralised way. In the other half of the countries, there is a decentralized data management system. All countries with a decentralized system have standardized procedures put in place, except LV and UK. With the advent of smart meters, some of these countries are evolving to a more centralized system (except AT, DE[26] and ES). This does not necessarily mean centralization of competences and data storage, but rather harmonizing access to consumption data relevant for market processes, through the creation of a centralized data hub. This is e.g. the case in the UK where a central unit (DCC) will be created, who will transmit smart meter data to the relevant parties but that will not store any data.

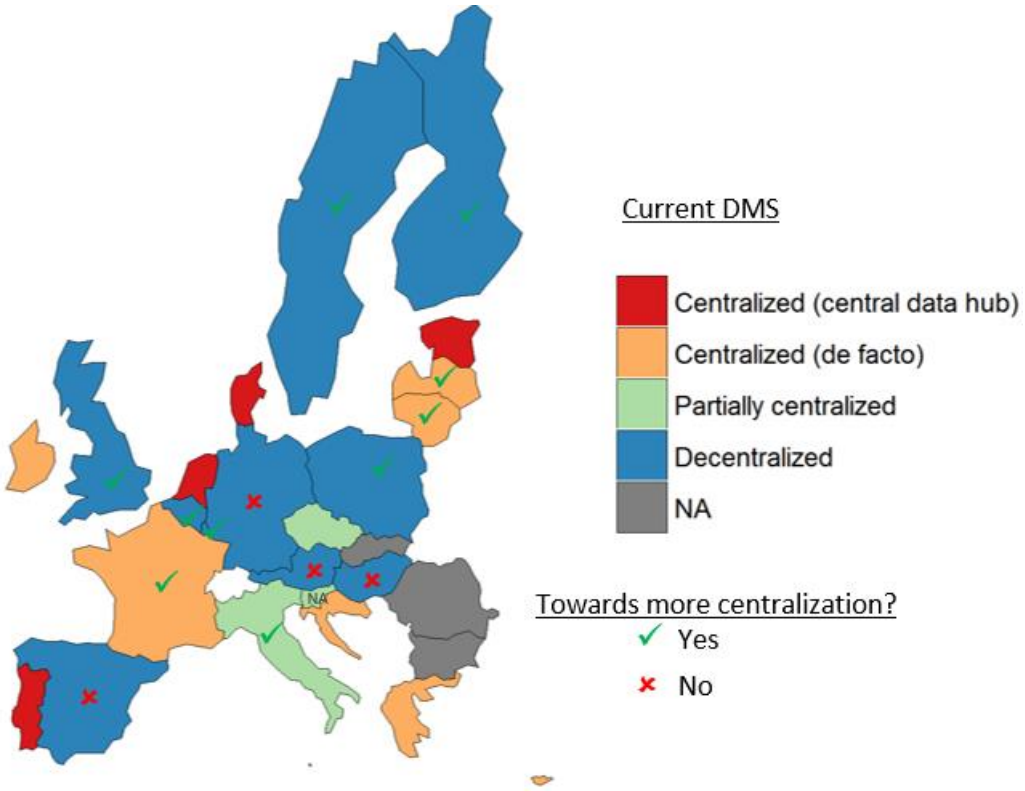


Figure 6: Data Management System: Models across MS

Within the centralized systems category, two groups must be distinguished: there are centralized systems based on a central data hub (DK, EE, NL, PT) and de facto centralized systems, where there is a main DSO covering most of the market: CY, EL, FR, HR, IE, LT, LV. PL has a central data hub managed by the largest DSO of the country. Another group (CZ, IT, SI) is defined as partially centralized however this is not a homogenous group since it includes distinct architectures of Data Management Models. The choice between centralised and decentralised systems seem to be driven by the legacy system rather than economic considerations. Only four countries based

[26] The roll out of smart meters for retail clients in Germany has not yet started.

their choice on a cost benefit analysis (CZ, IE, NL and SI) and opted for a central or partially central system. FI performed a CBA for the future system and is expected to move to more centralisation.

	Centralized, decentralized or partially centralized DMS?	Has this choice been the result of a CBA?	Standardized procedures in case of decentralized system?	Is there an evolution towards more centralization or decentralization decided?
AT	Decentralized	No	Yes	No, central routing with decentralized database as of 2012
BE	Decentralized	No	Yes	End 2019: (partially) centralized market system managed by a joint venture of all DSOs (no CBA). All data relevant for market processes stored at central level.
BG				
CY	Centralized (de facto)	No		Full operation of the MDMS by the DSO as of April 2019.
CZ	Partially centralized	Yes, 2012	Yes	n.a.
DE	Decentralized	No	Yes	No
DK	Centralized (central data hub)	No		No
EE	Centralized (central data hub)	No		Ongoing process started, by law, in 2013, toward more centralisation
EL	Centralized (de facto), but one centralized system for small customers and two centralizes systems for bigger customers	No		New system in 2020, could be a unique system or two separate systems (CRM and MDM) but not decided yet
ES	Decentralized although some features of a centralized system can be observed	No	Yes	No
FI	Decentralized	No, but for the future data hub, CBA has been made on 2014	Yes	More centralization (all retail market processes): central data hub as of 2020
FR	Decentralized data management system but centralized de facto	No	Yes	The Energy Network Operator's Agency "Agence ORE" will publish open data as a central open data hub for DSOs.
HR	Centralized (de facto)	No		No
HU	Decentralized	No	Yes	No
IE	Centralized (de facto)	Yes, 2005		No
IT	Partially centralized (the management of meter data is still centralized but master data are already managed in a centralized way)	No	Yes	Yes. Toward further centralization as of 2018 the SII (central data hub) will receive validated meter data from DSOs, then suppliers will receive validated readings from the SII. The SII currently receives master data
LT	Centralized (de facto) (the main DSO covers almost all households)	No	n.a.	discussions on data hub creation

LU	Decentralized	No	Yes	Data gathering centrally (as of 2016), then sent to DSO's.
LV	Centralized (de facto) (the main DSO covers almost all households)	No	No	Discussions ongoing for more centralization.
MT				
NL	Centralized (central data hub)	Yes		Further centralization for customer consent on 3rd party access.
PL	Decentralized	No	Yes	More centralization by creation of data communication company owned by DSO's.
PT	Centralized (the largest DSO manages the central data hub)	Yes		No
RO				
SE	Decentralized	No	Yes	Ongoing centralization, to be implemented by 2021
SI	Partially centralized, officially one DSO (SODO) but 5 local distribution regions having bilateral contracts with SODO	Yes, in 2014	n.a.	n.a.
SK				
UK	Decentralized	No	No	More centralization through central unit (DCC) for smart meter data reading as of 2018, storage remains decentralized.

Table 2 Data management model

Roles

In all countries the same party is responsible for both consumption data reading and validation. On top of this, for almost all countries the data is currently stored by the same responsible party. AT, DK, LU and NL form the exception to this rule.

In most countries the DSOs are responsible for the complete data management (reading, validation, storage). However the number of countries where data is stored in a central data hub is expected to grow, as shown in

	DSO	Supplier	Central Database	Smart Meter	planned change
AT	✓	✓	☐	✓	
BE	✓	✓	☐	✓	Data relevant for market processes stored at central level
BG	☐	☐	☐	☐	
CY	✓	✓	☐	No smart meters installed yet	
CZ	☐	☐	☐	☐	
DE	✓	✓	☐	✓	Smart meter foresee since not yet available
DK	✓	✓	✓	✓	
EE	✓	☐	✓	✓	
EL	✓	☐	☐	No smart meters installed yet	
ES	✓	☐	☐	✓	

FI	✓	✓	☐	✓	Data will be stored in the central datahub as of 2020
FR	✓	✓	☐	✓	
HR	✓	☐	✓	✓	
HU	☐	☐	☐	☐	
IE	☐	☐	☐	☐	
IT	✓	✓	✓	✓	
LT	✓	☐	☐	✓	
LU	☐	✓	☐	✓	
LV	✓	☐	☐	✓	
MT	☐	☐	☐	☐	
NL	☐	☐	✓	✓	
PL	✓	✓	☐	☐	
PT	✓	☐	✓	✓	
RO	☐	☐	☐	☐	
SE	✓	✓	☐	✓	Data will be stored in Elmarknadshub 2021
SI	✓	☐	✓	✓	
SK	☐	☐	☐	☐	
UK	☐	✓	☐	✓	

Table 4. Germany has opened the service of metering to competition, i.e. DSOs are default providers of the data management service, but alternative meter providers are possible.

	Who is responsible for consumption data reading?	Who is responsible for consumption data validation?	Who is responsible for consumption data storage?
AT	DSO	DSO	Suppliers & DSO
BE	DSO	DSO	DSO
BG			
CY	DSO	DSO	DSO
CZ	DSO	DSO	DSO
DE	Meter operator (usually DSO)	DSO	DSO
DK	DSO	DSO	TSO (central data hub)
EE	DSO	DSO	DSO + TSO
EL	DSO	DSO	DSO
ES	DSO	DSO	DSO
FI	DSO	DSO	DSO
FR	DSO	DSO	DSO
HR	DSO	DSO	DSO
HU	DSO	DSO	DSO
IE	DSO	DSO	DSO
IT	DSO	DSO	DSO

LT	customers	DSO	DSO
LU	DSO	DSO	Supplier (for integrated supply customers)
LV	DSO	DSO	DSO
MT			
NL	Supplier	Supplier	DSO
PL	DSO	DSO	DSO
PT	DSO	DSO	DSO
RO			
SE	DSO	DSO	DSO
SI	DSO	DSO	DSO
SK			
UK	Supplier	Supplier	Supplier

Table 3: Roles in consumption data management

Consumption data storage

The DSO stores consumption data in all MS, except in the UK (supplier) and LU (supplier, for "integrated supply customers"[27]). In half of the countries suppliers also store consumption data (mandatory). Central databases exist in countries that either have (partially) centralised data management systems or have a dominant DSO. However also countries like Italy with a large number of DSOs rely on a central database. BE, DK, FI and SE are expected to move to a central database.

	DSO	Supplier	Central Database	Smart Meter	planned change
AT	✓	✓		✓	
BE	✓	✓		✓	*Data relevant for market processes stored at central level*
BG					
CY	✓	✓		*No smart meters installed yet*	
CZ					
DE	✓	✓		✓	*Smart meter foresee since not yet available*
DK	✓	✓	✓	✓	
EE	✓		✓	✓	
EL	✓			*No smart meters installed yet*	
ES	✓			✓	
FI	✓	✓		✓	*Data will be stored in the central datahub as of 2020*
FR	✓	✓		✓	
HR	✓		✓	✓	
HU					
IE					
IT	✓	✓	✓	✓	

[27] Customers that only receive one bill from their supplier for grid and supply.

LT	✓	□	□	✓	
LU	□	✓	□	✓	
LV	✓	□	□	✓	
MT	□	□	□	□	
NL	□	□	✓	✓	
PL	✓	✓	□	□	
PT	✓	□	✓	✓	
RO	□	□	□	□	
SE	✓	✓	□	✓	*Data will be stored in Elmarknadshub 2021*
SI	✓	□	✓	✓	
SK	□	□	□	□	
UK	□	✓	□	✓	

Table 4 Consumption data storage

Interoperability

Interoperability can be impeded on different levels: communication language and semantics, the processes themselves and the handling of specific processes. We first define the three areas of obstacles and then discuss the findings in the following sections.

From a technological point of view, main differences relate to the "language" used. Main languages are EDIFACT (BE, DE, etc.), CIM (Finland, for example, is considering the possibility to switch to it), or national-specific (PL discusses Blockchain for instance, NL XML based). All the other elements (security & communication protocol, etc.) seem not to be a blocking issue for interoperability.

The exact sequence for a standard switching or billing process can be different. Following these sequences, communication needs to be adapted going from one country to another. The number of interactions, the sequence and/or the type of data exchanged can be different. This can thus represent a market barrier for a supplier willing to operate in different jurisdictions.

- While we focus on standard processes, countries are likely to have **specific situations to treat, typically related to different public service obligations** (e.g. in some countries, customers can be switched off, in some other countries not, etc.). This seems to be a detail, but if a supplier wants to become active in a country, he has to foresee all these particular cases from a messaging point of view. Our report does not cover these cases, but several interviewees pointed out that a full alignment seems very challenging, since exceptions can be the result of local social policy regulations.
- Even within a country, **some message choices can be different in the details**, depending on the DSO (for instance, anecdotal evidence indicates that this seems to be the case in BE for non-standard processes). Barriers can thus not be excluded within countries. Our report, however, does not cover this level of detail.

Communication formats

Interoperability may be hampered by the "language" used for communication between the DSOs and suppliers for traditional activities. Most of the countries still use a national-specific communication format, which is often txt-, csv- or xml-based. PL and LU have decided to change to EDIFACT in the near future. EDIFACT is currently the

standard in BE, DE, LU, SE and FI, but the latter is evaluating the opportunity to change to CIM. It is important to stress that the use of a communication format still leaves flexibility in the implementation. Communication between countries that use the same format is not automatically compatible.

	Billing		Switching	
	Current	Near future	Current	Near future
AT	National-specific: xml	-	National-specific: xml	-
BE	EDIFACT	-	EDIFACT	-
BG				
CY	n.a.	n.a.	n.a.	n.a.
CZ	n.a.	n.a.	n.a.	n.a.
DE	EDIFACT		EDIFACT	
DK	National specific: xml	-	National specific: xml	-
EE	National-specific: xml	-	National-specific: xml	-
EL	National-specific	-	National-specific	-
ES	National-specific: xml		National-specific: xml	
FI	EDIFACT	Evaluating CIM as an option, to be specified when data hub definitions are ready (3 years from now)	EDIFACT	Evaluating CIM as an option, to be specified when data hub definitions are ready (3 years from now)
FR	National-specific	-	National-specific	-
HR	National-specific	-	National-specific: .txt files	-
HU	National-specific	-	National-specific	-
IE	National-specific		National-specific	
IT	National specific: xml/csv	-	National specific: xml/csv	-
LT	National-specific	-	National-specific	-
LU	National-specific: paper bills	EDIFACT	EDIFACT	-
LV	National-specific	-	National-specific	-
MT				
NL	National-specific	-	National-specific	-
PL	National-specific	EDIFACT	National-specific	EDIFACT
PT	n.a.	n.a.	n.a.	n.a.
RO				
SE	EDIFACT	Move to Elmarknadshubb 2021	EDIFACT	Move to Elmarknadshubb 2021
SI	National-specific: .csv files	ebIX technology	National-specific: .csv files	ebIX technology
SK				
UK	National-specific	-	National-specific	-

Table 5: Communication formats

Number of interactions between the stakeholders

The precise process of switching and billing between the stakeholders is described in Appendix 10.4 for responding countries. Here we use the number of interactions as a proxy to identify if the processes differ between countries.

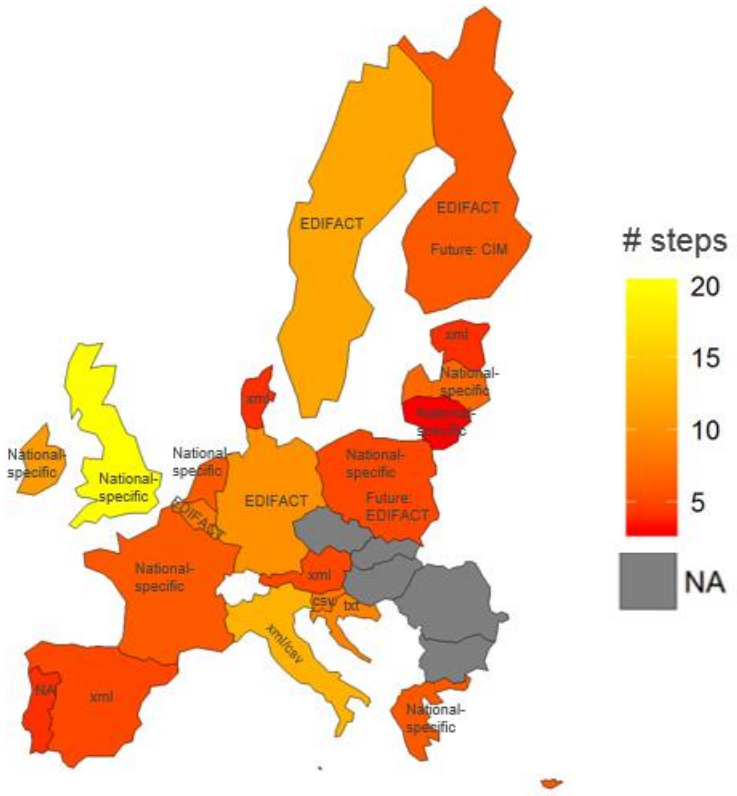


Figure 7: Communication standards and number of steps in a switching process

The billing process often requires only a few interactions between market parties. Typically the consumption data is read by the DSO and communicated to the supplier, after which the (unique) bill is sent by the supplier to the customer.

The number of interactions between market parties when switching supplier can vary more from country to country (from 4 to over 20 interactions). Also, the time required for switching supplier can range from 2 days (e.g. Austria) to 21 days (e.g. Italy). For some countries, it would be technically possible to switch supplier instantaneously, but administrative measures prevent this.

	Billing steps	Switching steps	Switching time [days]
AT	2	5	
BE	2	8	
BG			
CY	n.a.	6	
CZ	n.a.	n.a.	n.a.
DE	6	10	Max 3 weeks
DK	1	4	
EE	2	4	
EL	3	6	
ES	n.a.	5	
FI	2	6	
FR	1	6	
HR	5	9	20
HU	2	n.a.	n.a.
IE	n.a	11	5
IT	2	13	
LT	1	3	21
LU	5	10	
LV	3	7	15
MT			
NL	n.a	6	
PL	3	5	21
PT	3	4	
RO			
SE	3	12	
SI	3	8	21
SK			
UK	1	>20	

Table 6: Billing and Switching processes: number of steps of a standard process

Exceptions handling and the limits of harmonization

The contributors to this investigation stress the effort that countries have been putting into describing business processes, taking into account regional aspects related to public service obligations, energy policy or even taxes and levies (e.g. local taxes

applying only in one part of a country, specific switching situations)[28]. Countries like AT have spent several years in specifying processes, in BE the effort is ongoing.
Common processes that would be general enough to cover all regional-specific cases are probably challenging to achieve. Also, many respondents expressed reluctance to changing their processes in light of allowing for regional/EU-wide interoperability ("why should we change what works?").
A minimum requirement for interoperability would be a **transparent platform (web-based) where national standard and non-standard processes are listed and described.**

National coordination of processes

Data exchange formats and processes are evolving over time. In most countries the concerned market participants have the opportunity to contribute in developing these processes. Some countries established a common platform on which market parties can be consulted (e.g. in Austria). In other countries regular workshops are held (e.g. France, Germany) organized by the regulator in which the stakeholders participate directly or through their representing organizations. In Portugal there appears to be no means for market participants to contribute to the development of data exchange formats and processes.

	Are there opportunities for the market participants to contribute to the development of the data exchange formats and processes?
AT	Consultation of market parties via ebUtilities platform.
BE	A specific governance is foreseen in collaboration with the market
BG	
CY	Info not available (n.a.)
CZ	n.a.
DE	Formats and procedures are developed and kept up to date partly in cooperation with industry association, and DSOs. Consultations are performed.
DK	The TSO, the DSO´s and suppliers cooperate on the development
EE	A data exchange platform "Estfeed" that is developed together with the market participants for their use
EL	Suggestions, remarks and complaints are accepted and overviewed by the DSO
ES	Collaborative process managed by the CNMC (regulator) with voluntary participation of DSO and suppliers
FI	Formats and procedures are developed and updated partly by the industry association and TSO, in close co-operation with DSOs and suppliers.
FR	Regular workshops on formats & procedures are organized by the regulator. DSOs and suppliers are represented directly or indirectly.
HR	Opportunities for regulator and suppliers.
HU	Market participants may cooperate with each other in line with the corresponding regulations. They are also able to submit any proposal for legislative change to the liable ministry. Decision is up to the legislator.
IE	Yes, through Market Process Change Requests at Governance Forums.

[28] Example: a switching linked to other changes (switching supplier and moving to another house at the same time) can be a dedicated process in one country, or it can be two separate processes in another country.

IT	Market participants should respect standardized rules and format set at national level by the Regulator. through transparent processes open to stakeholder participation.
LT	Market participants are allowed to make requests and changes.
LU	Through public consultation for the "model" document decided by ILR and through Forum https://luxmaco.vbulletin.net/luxmacoforum.
LV	Market participants can send their proposals to the DSO.
MT	
NL	Functional changes are discussed between the TSO, DSOs and the Dutch Energy Association (NEDU, incl. suppliers). Changes are then proposed to the regulator ACM.
PL	Through DSO and supplier associations lobbying
PT	No
RO	
SE	Workshops with SVK "ETG" meetings held regularly for market participants. Elmarknadsutveckling as well.
SI	Through regular consultations held by the NRA (Agen-rs) or through IPET, an organisation concentrating on changes in the electricity market.
SK	
UK	n.a.

Table 7: National coordination of processes

Emerging Services

The second focus of this fact finding study is the state of emerging services that are enabled by smart metering technologies. Emerging services empower customers to actively participate in the energy market (flexibility and energy services).

Better data and better access to this data are seen to be a necessary condition for such services to emerge. The wider use of smart metering technologies[29] is expected to dramatically increase the amounts and granularity, but also the commercial value, of data generated and exchanged within the (power) system. Smart meters should allow consumers to reap the benefits of the progressive digitalization of the energy market.

In this section, we first report on the current state of smart meter roll-out in the MS, largely in line with the European Smart Grid task Force EG1 (2015). Then we compare what kind of data (history and granularity) is available in the smart meter and on the side of the DSO/supplier. Then we review the national requirements on the capabilities of the smart meter and their compliance with Recommendation 2012/148/EU and in particular with functionalities (a), (b) and (f). We then finally discuss the possibilities for the consumer to either access his data or to mandate access to a third party (the energy service provider).

Smart meter deployment

By the end of 2017, the level of smart (electricity) meter coverage varies widely, from MS having reached (almost) full coverage (e.g. Finland, Sweden, Estonia) to MS currently examining smart meter roll-out or running pilot projects (e.g. Belgium, Croatia, Lithuania, Luxembourg). Italy also finished full implementation of first generation smart meters and are now proceeding with the 2nd generation roll-out.

[29] Commission Report COM(2014) 356, as updated in the Smart Grids Task Force EG1 Report: "Status report based on a survey regarding Interoperability, Standards and Functionalities applied in the large scale roll-out of smart metering in EU Member States", October 2015.

Targets usually aim for a (close to) full penetration of smart meters. The targeted timing is also different between each country, the range is in between 1-2 years up to 15 years. In some of the cases the targets have proven to be rather ambitious (UK) and there is a chance that they cannot be reached on time.

As per ownership, the DSOs are the owners of the smart meter equipment, except for UK, France and Germany (where the owner of the "digital" meter is the "meter operator", which is usually the DSO). Details on the status of the smart meter roll out are summarized in the following table:

	Targeted smart meter roll-out and status end of 2017 (according to information collected by the questionnaire)	Who is the owner of the smart meter?
AT	80% (95%) by 2020 (2022) *today, only pilots except Oberösterreich (17%)*	DSO
BE	regional initiatives, roll-out in Flanders as of 2019	DSO
BG		
CY	80% planned by 2020, subject to further decision by the NRA	DSO
CZ	n.a.	DSO
DE	*(digital meters by 2032)* today no deployment of smart meters	meter operator (usually DSO)
DK	100% by 2020	DSO
EE	100% achieved	DSO
EL	The pilot roll-out has not been realized yet.	DSO
ES	100% by end 2018 >81% today	DSO
FI	99% achieved	DSO
FR	90% by 2022	local authorities/"syndicats d'énergie"
HR	95% by 2030 today pilot projects	DSO
HU	No target yet, CBA analysis is in progress	DSO
IE	~10% by 2020, 100% by 2024	DSO
IT	First generation was completed in 2011 Second generation 80% by 2022 for the main DSO only. No mandatory target at national level for second generation	DSO
LT	100% of main DSO customers by 2024 today pilot projects	DSO
LU	95% by 2020 today 10%	DSO
LV	99% by 2022 today 30%	DSO
MT		
NL	> 80% by 2020	DSO
PL	today 8%	DSO
PT	target: 50% today coverage: 18%	DSO
RO		

SE	Completed: all Swedish customers have smart meters since 2009	n.a.
SI	100% by 2025 today 52%	DSO
SK		
UK	100% by 2020 Today: ~17% of domestic meters operated by large suppliers are smart meters	supplier

Table 8: Smart meter roll-out

History and granularity of the consumption data stored

Emerging energy services require historical time series to understand consumption levels and patterns. We report the history and granularity of data stored at different places. Once again the range of duration and granularity vary widely. DSOs in BE or PL store consumption data for 10 years, while DSOs in LV store data for 3 years only. Granularity of data stored by DSOs and suppliers ranges from 15 minutes (BE, LT, PT) to 30 min (FR) to daily (AT), monthly or yearly. For data stored directly in the smart meters, a lower variety is observed.

Hist.|gran..	DSO	Supplier	Central Database	Smart Meter	planned change
AT	7y|daily	7y|daily		60d|≤15min	
BE	10y|yearly or ≤15min	contract period|≤15min		n.a.	
BG					
CY	<1y|n.a.	<1y|n.a.		the smart meter roll-out has not be launched yet	
CZ	5y|≤15min		n.a.|hourly	<1y |≤15min	
DE	depends on DSO.	n.a.|n.a.		2 years | 15 min data	
DK	n.a.|n.a ;	n.a.	3y|hourly	few months (3. months +10 weeks) |hourly (although some DSOs have chosen to let their meters register and store 15 min)	
EE	5y|hourly		5y|hourly	n.a. |hourly	
EL	>10|monthly-4monthly-6monthly-yearly depending on customer			No smart meters installed yet	
ES	5y|hourly			3m|hourly	
FI	6y|hourly	6y|hourly		one billing period, usually 3 months |hourly	data stored central DB
FR	10y|30min, daily, 6 months, yearly	10y|30min, monthly		4-5m|10-60min	

HR	8|monthly, half-yearly		2|monthly	30d|≤15min	
HU	8y|yearly	8y|yearly		8y||≤15min	
IE	7y| monthly	n.a.|n.a.		n.a.|n.a.	
IT	5y|monthly clustered per time bands (1G meters), 15min (2G meters) keeping time bands classification	n/a|monthly (<55kW) divided per time-bands	n.a.	36d|15min (1G meters) or 38d|15min and a total 6m (2G meters)	Starting from February 2018, 15 min readings metering data and monthly readings will be sent to SII (that becomes the sole interface with the DSOs for the suppliers) for all customers.
LT	10|monthly			n.a.	
LU		50months|15min, yearly		<1year|15min	
LV	3y|hourly +10y billing data			65d, 13m|hourly, monthly	
MT					
NL			5y|yearly, 2m (SM)	30d max|15min	
PL	10y|hourly	n.a.			
PT	5y|15min		3y|15min	5y|daily	
RO					
SE	10y|monthly	10y|monthly		no requirement| n.a.	
SI	3-5y|monthly(SM), yearly		3y|15min	n.a.	
SK					
UK		No obligatory history. If supplier is changed, the information is not transferred.		13m|30min	Even in the future, DCC will not store data.

Table 9: History and granularity of data stored

Smart meter functionalities

Apart from the data stored in the smart meter, metering devices differ in their capabilities (reflecting the respective national requirements). The European Commission recommends 10 common minimum functionalities to be satisfied by smart metering systems (Recommendation 2012/148/EU):

Common minimum functionalities for smart metering systems
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.

Not all of the 10 common minimum functionalities are satisfied in countries where smart meters are present. In three countries with smart meters present (Estonia, Lithuania and Poland) it is not possible to remotely control the supply and or flow through the smart meter (g). Other functionalities not satisfied are (b), (d), (e), and (f). For many countries this information is still lacking.

	Does the smart meter satisfy the 10 common minimum functionalities for smart metering systems required by the EC?	If not, which functionalities are not foreseen?
AT	×	e, f (partially)
BE	n.a.	n.a.
BG		
CY	Even though there are no smart meters as yet installed, for the Pilot project scheme of 3000 smart meters the DSO has taken into account the EU reccomendations well as the latest available technology.	-
CZ		
DE	×	d, g, j
DK	n.a.	n.a.
EE	×	g
EL	No smart meters installed yet	
ES	×	b

FI	×	i, j
FR	✓	-
HR	✓	-
HU	□	
IE	□	
IT	✓	-
LT	×	d, g
LU	✓	-
LV	✓	-
MT	□	
NL	×	g
PL	✓	-
PT	✓	-
RO	□	
SE	n.a.	n.a.
SI	×	j
SK	□	
UK	✓	-

Table 10: Smart meter requirements fulfilment

Smart meters features

For the countries where smart meters are installed, a pre-payment service is often not available. Most of the smart meters installed measure both the peak and average consumption but the granularity can vary greatly from below 1 minute (in Estonia and Netherlands) to every 60 minutes. All countries except Slovenia indicated that it is possible to configure the system and to carry out software upgrades at distance.

	Pre-payment service available?	Smart meter reading		Possible to configure the metering system at a distance and to carry out software upgrades, to ensure that the metering system is state-of-the-art?	Single communication standard used?	
		Type of measure	Granularity		For communication of real-time data (P1)	For communication of historical data (P4)
AT	☐	Both Peak and Average Consumption	every 15 minutes	☐	n.a.	Yes, XML Format Consumption Record
BE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
BG	☐	☐	☐	☐	☐	☐
CY	☐			☐		
CZ	☐					
DE	n.a.	n.a.	every 15 minutes	☐	No	No
DK	n.a.	n.a.	every 15 minutes	n.a.	n.a.	n.a.
EE	☐	Both Peak and Average Consumption	<1 minute	☐	n.a.	Yes
EL						
ES	answer will be provided in the next report		every 1 minute	☐	n.a.	n.a.
FI	☐	Average Consumption	Today all meters register every 60 minutes, some (50%) can be reprgrammed remotely to have a metering resolution of 15 minutes	Some (roughly 50%) can be programmed remotely, but some require visiting locally. The programmability depends on the type of meter and the reading solutions chosen.	No	No
FR	☐	Both Peak and Average Consumption	every 10 minutes	☐	Yes, national-specific	Yes, DLMS_COSEM
HR	☐	Both Peak and Average Consumption	every 15 minutes	☐	Yes	No P4
HU	☐			☐		
IE	☐			☐		
IT	☐	Load	every 15 minutes	☐	Yes, PLC C-band protocol from chain 2	No P4

LT	☐	Both Peak and Average Consumption	every 60 minutes	☐	Yes, PLC	Yes, PLC
LU	☐	Both Peak and Average Consumption	every 15 minutes	☐	Yes	Yes
LV	☐	Energy profile	every 5 minutes	☐	No	Yes
MT	☐			☐		
NL	☐	Both Peak and Average Consumption	<1 minute	☐	Yes	Yes
PL	☐	Both Peak and Average Consumption	every 60 minutes	☐	Yes	Yes
PT	☐	Energy, Voltage, Current	every 1 minute	☐	Yes	Yes
RO	☐			☐		
SE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SI	☐	Average Consumption	every 15 minutes	☐	No	No
SK	☐			☐		
UK	☐	Actual Consumption		☐	Yes	Yes

Table 11: Smart meter features

Status of GDPR for electricity and gas

The EU General Data Protection Regulation (GDPR)[30] intends to strengthen and harmonize data protection for all individuals within the European Union. It was adopted in 2016 and is enforceable from May 2018, when it replaces the data protection Directive 95/46/EC. One of the key aspects is the right to access: the right for data subjects to obtain from the data controller confirmation as to whether or not personal data concerning them is being processed, where and for what purpose. Further, the controller shall provide a copy of the personal data, free of charge, in an electronic format.

This section tries to answer the question to what extent MS have already prepared for fulfilling the requirements of the GDPR for electricity and (gas)consumption data. To this end, we assess how customers can have easy access to their historical and real-time consumption data, how they can share access with third parties and how the consent process is organized.

Customer access to consumption data

Historical consumption data

Traditionally, customers can consult their metered (monthly or yearly) consumption data on their bill in all MS. In addition, most countries allow for an access to historical consumption via a one-off request to the DSO or supplier.

With the roll-out of smart meters the options for data access, and for emerging services and flexibility, broaden. The smart meter itself provides access to real time and some historical data. Access is given either by the smart meter interface itself, the home H1 interface or the smart meter gateway (port P1).[31] Historical data stored in the smart meter is typically not validated, since it did not pass through the validation process. Data is thus not usable for billing purposes. AT, DE and LT are an exception. For AT and DE, it is reported that the official calibration of the smart meter is enough to validate the data provided by the latter. Progressively, MS facilitate to follow consumption data on a web portal. The portal is provided either by the DSO, the supplier or, where available, the central data hub operator. At least one of these options is available in almost all countries where smart meters are being rolled-out.

[30] https://www.eugdpr.org/

[31] Note that behind the meter devices also allow the creation and access to smart data, even if the regulated meter remains a traditional one.

V = validated data NV=non-validated data										
		On the bill	**Compulsory DSO web portal**	**Compulsory Supplier Web Portal**	**Central Data Hub web portal**	**(Smart) Meter Display**	**In-home display (H1 interface)**	**Smart Meter Gateway (P1 port)**	**Contact with the Supplier (one-off consumer request)**	**Contact with the DSO (one-off consumer request)**
AT		V	V			V	V		V	V
BE		V				n.a.	n.a.	n.a.	V	V
BG										
CY		V							V	V
CZ		V	V			NV	NV		V	V
DE		V	n.a.		n.a.	V	NV	NV	V	V
DK		V		V	V	NV	NV		V	
EE		V			V					
EL		V		V (not compulsory)					V	V
ES		V	V			NV				
FI		V	V	V (not compulsory)	*(in near future)*	NV	NV	NV	V	V
FR		V	V	V			NV	NV	V	V
HR		V	V & NV			NV		NV (only large customers)	V & NV	V
HU		V	V (not compulsory)						V	V
IE		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	V	V
IT		V	V (not compulsory)			NV			V	V
LT			V (not compulsory)			V				V
LU		V		V (not compulsory)					V (integrated customers)	
LV			(not compulsory)							V
MT										

NL		V				NV		NV	V	V
PL		V	V (not compulsory)	V (not compulsory)				V	V	V
PT		V	V & NV	V	V & NV	NV	NV		V	V & NV
RO										
SE		V	V	V					V	V & NV
SI		V							V	
SK										
UK		V		V (not compulsory)			NV		V	

Table 12: Customer's access to historic consumption data

(Near) real time consumption data

Due to the absence of a validation process, (near) real-time data available directly from the smart meter is usually non-validated, except for AT and to lesser extent DE and LT. Only a few countries make them accessible on compulsory web portals.

V = validated data NV=non-validated data							
	Compulsory DSO web portal	**Compulsory Supplier Web Portal**	**Central Data Hub web portal**	**(Smart) Meter Display**	**In-home display (H1 interface)**	**Smart Meter Gateway (P1 port)**	**Post-meter devices**
AT				V	V	V	
BE				n.a.	n.a.	n.a.	NV
BG							
CY							
CZ				NV	NV		
DE	n.a.		n.a.	V	NV	NV	
DK				NV	NV		
EE							
EL				NV			
ES				NV			
FI				NV	NV	NV	NV

FR	V	V		NV	NV	NV	
HR						NV	NV
HU				NV			
IE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	NV
IT				NV	NV available in pilot projects	NV	NV
LT				V			
LU				NV	NV	NV	
LV							
MT							
NL				NV	NV	NV	NV
PL	V			NV		NV	
PT	V & NV	V		NV	NV		
RO							
SE				NV	NV		
SI				NV			
SK							
UK				NV	NV (depending on supplier)		NV

Table 13: Customer's access to real time consumption data

Third party access to consumption data

Third party access to customer's consumption data is managed with different approaches across the MS. The interfaces available to allow for this access vary widely:

1. The DSO web portal or direct contact with the DSO are the most common interfaces available for third parties: in AT, BE, Cyprus, ES, FI, FR, HR, LU, LV, PL, PT, SE, SI, at least one of the two options is possible. Some of these countries have already committed or are discussing to move to a central data hub, opening another access possibility;
2. In countries like FI, PT and UK validated data can be provided to Third Parties through the Supplier's web portal;
3. Where a central data hub is already operational, like in EE, DK, PT and SI, third party access to validated consumption data is possible through the hub;

4. In the next future some countries have already planned to structure third party access through a future central data access hub. These are: BE, Finland, FR (currently under testing), SE and UK.

V = validated data NV=non-validated data								
MS	**Compulsory DSO web portal**	**Supplier Web Portal**	**Central Data Hub web portal**	**(Smart) Meter Gateway**	**Contact with the Supplier (one-off request)**	**Contact with the DSO (one-off request)**	**Direct contact with the client**	**Planned evolution**
AT	V			V		V	V	
BE	V (not compulsory but offered by some DSOs on a voluntary basis)			NV		V	V & NV	Possible access to the Central Data Hub Web portal
BG								
CY					V	V	V	
CZ	V				V	V		
DE	n.a.		n.a.	V and NV	n.a.	n.a.	n.a.	Rules for data access for third parties are under discussion but not finalized
DK			V					
EE			V					
EL						V	n.a.	
ES	V						V & NV	

FI	V	V (not compulsory Supplier web portal but provided by some suppliers on a voluntary basis		NV	V	V	V & NV	Possible access to the Central Data Hub Web portal
FR	V, accessible for large third parties			NV		V	V & NV	There is currently a protocol tested with an identification EnedisConnect with services like MyEnergieCoaching similar to Green Button Connect).
HR	V & NV. accessible for large customers. Also the smart meter profile readings is accessible			NV		V & NV	V & NV	
HU							V	
IE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	V	
IT				NV	V		V & NV	As of today, only the supplier can access data of its customers on the central data hub, the SII. Third parties access through the DSO is not foreseen in the regulation
LT							V	
LU				NV	V only for integrated supply customers	V only for non-integrated supply customers	V	
LV	V & NV (not compulsory DSO web portal but offered by some DSOs on a voluntary basis)							

MT								
NL				NV*			V & NV	
PL	V (not compulsory but offered by some DSOs on a voluntary basis)					V	V	
PT	V & NV	V	V & NV		V	V & NV		
RO								
SE						V	V	Central Elmarknadshubb 2021 will provide access to third parties and suppliers starting from 2021
SI	V & NV (compulsory DSO web portal), but only supplier have access to the DSO's web portal		V & NV			V		
SK								
UK		V (web portal not compulsory but provided only by Suppliers within the MyData initiative)					V & NV	Possible access data through the DCC (Data and Communications Company), in the future also real-time data is expected to be accessible through the DCC, with customer's consent

Table 14: Third party access to customer's consumption data

Consent procedure for third party access

Validated data:

The necessary customer consent, for giving and revoking access, is the key requirement on which the customer control is built on:

1. For all the countries but PL the customer is the actor giving the right to third parties to access his validated consumption data;
2. A clear protocol that enables the customer to actively control third parties' access is defined in DK, EE, ES and PT;
3. FI, FR and UK are planning to enable the customer to exercise this control beyond the traditional consent or authorization. Other countries (Italy) have started a consultation process;
4. All other countries (except PL) rely on the customer's consent, generally written but sometimes also oral;
5. For countries like EL, LV, PL and SI, this control is identified by the current energy contract: third parties (except the current supplier) are not meant to have access to validated data. The same can be said for other countries where current regulation has not disciplined access to validated data for third parties (beyond the chosen supplier): in principle third parties can't access to customer's validated data unless the customer delegates access to the web portal, when available. The most concerning observation was that in countries without yet well-defined data access procedures, clients may grant access to third parties by providing credentials (like the password) to a web portal. This is problematic since clients lose control on the data once they have given their credentials.

Non-validated data:

For non-validated data, it is typically up to the customer's responsibility to share data. With few exceptions, data directly accessible via the smart meter gateway is non-validated. The responsibility on this type of access goes usually beyond the perimeter of the actor accountable to manage customer's consent related to validated consumption data. Data from post-meter devices (not covered in the tables) always provide non-validated data: this data is direct ownership of the customer who can share them according to the private law on personal data in every country, so stakeholders from most MS reported that there are no plans to regulate this type of data.

MS	The customer is the actor giving the right to third parties to access his validated consumption data	The DSO is the actor giving the right to third parties to access customer's validated consumption data	How is the right to access this validated data provided?	The customer clearly sees who has access to his data	Where/how the customer can see who has access to his data:	Customer's consent is managed by	Planned evolution	Non-validated data access management if it is accessible to third parties
AT	☐		**Customer gives consent or provide his password to the DSO's database. However, the sharing of the password is recognized as a problem. Access management should be DSO central.**	**No**		**in discussion**		**Only validated data evenutally accessible**
BE	☐		**Written customer's consent**	**Yes, on request**	**On request asking the DSO**	**The customer takes his own responsibility**		**There is a P1 plug in for accessing data. DSOs/Atrias is not responsible for P1 data access. P1 data can not be used for contesting billing, etc. (just energy services) + not clear how the control can control third party's access on his non-validated data**
BG								

CY	☐		**Written customer's consent**	**Not regulated**		**DSO**		**Only validated data evenutally accessible**
CZ								
DE	☐		**Rules for data access for third parties are under dscussion but not finalized**					**The smart-meter-gateway administrator is responsible to manage customer's consent on non-validated data evenutally accessible from the gateway**
DK	☐		**Specific website: common portal eloverblik.dk**	**Yes**	**Specific website: common portal eloverblik.dk**			
EE	☐		**Specific website: e-Elering web portal**	**Yes**	**Specific website: e-Elering web portal**	**TSO (via the e-Elering customer portal)**		**Only validated data evenutally accessible**
EL	☐	☐	**Mutual agreement with the customer**		**The access is possible only during the contract duration, so only his supplier is allowed to have access to the data**	**DSO**		**Non-validated data are provided by the meters which belong to the customer and these devices are not whithin the scopes of DSO's responsibility.**

ES	☐		**Specific website: DSO's web page**	**Yes**	**Specific website: DSO's web page**	**customer and DSO**		**Non-validated data only accessible contacting the DSO.**
FI	☐		**Written or oral customer's consent**	**Yes**	**The authorisation form is subject to general legal requirements of authorisation**	**Data provider**	**The customer will be able to set and visualize the authorization for third party's access on the customer portal of the central data hub. Plus the central data hub's manager will be accountable for managing customer's consent**	**Also for non-validated data customer's consent is needed**
FR	☐		**Scanned customer's consent or direct access to the database depending on the size of the third party**	**Not clear**		**n.a.**	**Visualization of third party access will be available for the costumer through DSO websites as of mid-2018.**	
HR	☐		**Written consent, username and password provided by the customer**	**No**	**The customer has given consent through written permission**	**DSO**		**Non-validated data access is managed with the traditional written customer's consent**

HU								
IE								
IT	☐		**Customer 's consent is always required however actual regulation does not discipline access to customer validated data by third parties. Delegated access to a web portal, when available, might occur**	**Not regulated**	**In principle third parties cannot access customer validated data; the customer can delegate the third party.**	**Data controller/processor (the supplier or the service provider)**		**Non-validated data access is managed traditionally through customer's consent. Only third parties authorized directly by the costumer can see his data. Actual regulation does not specify a definitive procedure or tool.**
LT	☐		**The client can send the data to a selected third party**	**Yes**	**The customer sends the data by himself**	**DSO**		**only validated data evenutally accessible**
LU	☐		**Form or web portal of supplier or DSO, depending if "integrated supply customers"or "non-integrated supply customers"**	**Not clear**	**only one-off requests**	**DSO or supplier, depending if customer us suplied through integrated supply contract or not.**		**one single P1 plug-in for providing third parties access to it. To activate the P1 port, there is a security key that has to be provided by the DSO.**

LV	☐			**Not regulated**	**n/a**	**For households there is a single contract between supplier and customer, which includes suppliers obligation to cooperate with DSO in order to provide full service.**		
MT								
NL	☐		**With unambiguous permission of the customer. The consent process is currently not formalized**	**No**	**n/a**	**The service provider**		**Right to access to non validated data oocurs via P1 (customer sees who is physically connected to his smart meter, or via website like HelloData. If data is accessed via P4/P3, consent is not clear and there is no clear/easy information available on who is taking data from SM.**
PL		☐	**Through his energy supply contract**	**No**	**It depends on the supplier's rights**	**DSO**		**Only validated data evenutally accessible**

PT	☐		**Specific website: (DSO's central data hub web portal)**	**Yes**	**Specific website: (DSO's central data hub web portal)**	**DSO**		**Non-validated data accessible interfacing with the DSO'central data hub and the DSOs**
RO								
SE	☐		**Once provided the power of attorney, the third party can receive Ediel messages**	**Not clear**	**On request asking the DSO**	**DSO**		
SI	☐		**Through his energy supply contract**	**No**		**DSO**		**Aggregators usually install their own smart meters to follow up on consumption in real time.**
SK								
UK	☐		**Specific website: supplier's web portal in case the customer's supplier is one of the 7 ones which have joined the MyData Initiative. Customer's permission required.**	**No**	**The customer has provided consent or directly data to the third party**	**Rules as per DPA/GDPR**	**Compulsory supplier's web portal accessible also to third parties (under customer's consent)**	**Also to access non-validated data the customer has provided consent or directly data to the third party.**

Table 15: Customer's control on third party access

Country Sheets

Austria (AT)

Austria completely liberalized its electricity (gas) market in 2001 (2002). The consumption data management system has always been decentralized, with DSOs occupying a key role regarding data reading, validation and storage. End of 2017, there were 130 electricity and 19 gas DSOs. 16 (the biggest companies) out of them are responsible for both electricity and gas networks.

Although the data management for electricity and gas is highly decentralized, communication between market participants is harmonized since 2012, according to the ebXML (electronic business XML) standard. ebXML is a continuation of various communication protocols like AS1/AS2/AS3, FTP, HTTP, HTTPS, SOAP or SMTP. More information and standardized communication documents for the market participants for electricity and gas can be found on the energy industry common platform http://www.ebutilities.at/.

Smart meter deployment targets are ambitious. A coverage of 80% (95%) is envisaged by 2020 (2022).[32] However, end of 2017, only the region of *Oberösterreich* is well advanced, with a coverage of 17%. In other regions, only pilot projects exist. Since 2012, all smart meters have by law the same functional requirements. In particular, they satisfy the 10 minimum functionalities recommended by the EC (2012/148/EU) but some of them (e.g. reading 15 minute interval) can only be activated by customer consent. There are currently no smart gas meters.

Consumption data is stored at DSO and supplier level, for a period of 7 years. When a smart meter is installed, stored data has a daily granularity unless the customer opts for a 15min granularity. Validated data can be accessed by the customer via the DSO (web portal, one-off request) or the supplier (one-off request). Validated historical and real-time data can also be retrieved directly from the smart meter (a history of 60 days at 15min granularity is available). Third parties can access the customer's consumption data via direct contact with the customer or via the DSO web portal. In the latter case, customers give their password to the third party, which is recognized as an issue. Finally, third parties can also connect to the smart meter via the P1 port and communication is possible over a few protocols posted to the customer.

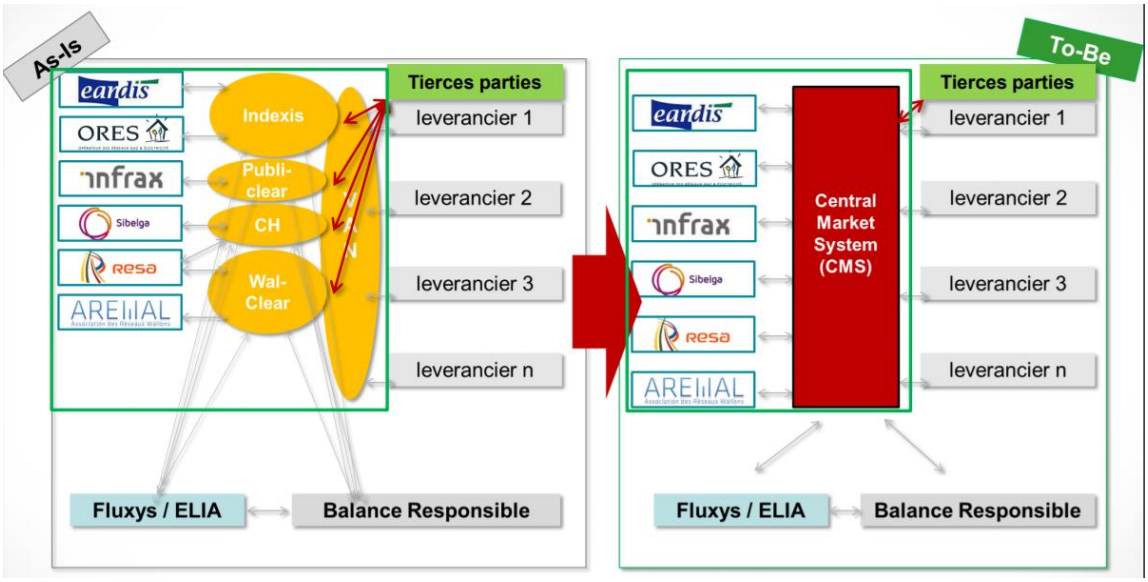
Traditional business processes like supplier switching, billing, processes in the smart meter context and consumption data for smart meter are harmonized across the country and based on the XML standard. Usually, the customer receives a unique annual bill from the supplier (it's also possible form the DSO and the supplier) but he can also opt for a separate and/or a monthly billing. The main reason for incorrect billing is caused by the client's reading, but this is expected to fall away with the introduction of the smart meter. A supplier switch could be implemented in a few seconds from a technical point of view. On average (compliance with civil law deadlines) it takes a few days (2 days for the *Netz Oberösterreich* DSO) taking manual interventions and checks into account. All standardized market communication processes are described on http://www.ebutilities.at/utilities/prozesse/.

Emerging services based on smart and self-data currently experience little interest in Austria.

[32] *Intelligente Messgeräte-Einführungsverordnung (IME-VO) Novelle 2017*.

Belgium (BE)

The liberalization of the Belgian electricity and gas markets was completed in 2007. The market is divided in three Regions (Wallonia, Flanders and Brussels) which are each supervised by a local regulator: VREG for Flanders, CWaPE for Wallonia and BRUGEL for Brussels. The common system for electricity and gas consumption data exchange, formats and procedures is converging from a DSO centered towards a more centralized system: probably as of 2019, a central market system (CMS) managed by Atrias will ensure the exchange of data between the DSOs and third parties. Atrias is a joint venture of all Belgian DSOs. In principle, data remains stored at DSO level, but all data relevant for market processes will also be stored at central level. The market model in place as of 2019 is described in the Market Implementation Guide 6 (MIG 6), replacing the current MIG 4.1 model.



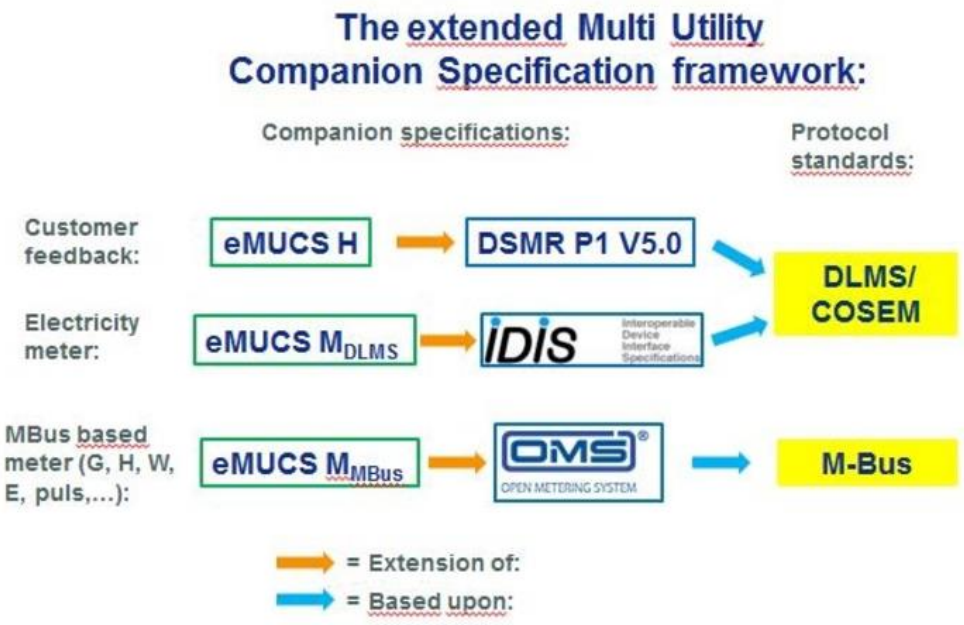
SOURCE: ATRIAS

DSOs are responsible for the installation, reading and maintenance of the meters. For traditional business processes (supplier switching and billing), communication between DSOs and suppliers is based on EDIFACT standards. However, market processes can have regional nuances (e.g. a regional tax) and it is also reported that semantic choices are sometimes differing between DSOs. Hence, even within Belgium, a supplier can face different communication rules procedures depending on the Region in which he is active.

Today, customers have rather limited possibilities to access their consumption data: they can request information directly to their supplier or DSO, but an access via a DSO or supplier web portal does not exist. Access to (non-validated) consumption data via smart meters still remains limited, given that smart meters are not yet widespread. Third parties can access the customer's consumption data via the DSO: either by requesting the information directly to the DSO or via a web portal that some DSOs offer (but which is not compulsory). Prior to getting the data, the third party needs a written consent given by the consumer. The DSOs, who also have the goal to make measurement data available to the final customer and/or a party mandated by this customer, have decided to develop a new central system for the exchange of this

information with third parties. This new system will be available on the same moment as the CMS, described in the MIG Third Parties Data Access (TPDA).

Every Region defines its own smart meter roll-out strategy. In Flanders, most of the meters are still traditional Ferraris meters. Smart meters were installed in 2016 in a few municipalities, for testing purposes. Following a positive cost-benefit analysis by the Flemish regulator VREG in 2017, the objective is to replace all traditional meters (< 56 kVA) as of 2019, both for electricity and gas. New houses and those with solar panels will be the first. In Brussels, a pilot project of 5000 smart meters is currently taking place. In Wallonia, there is no official strategy yet, while the main Walloon DSO ORES is starting the deployment of the Linky smart meter.33 4 DSOs (Eandis, Infrax, Sibelga and Resa) are currently working on standardizing protocols to ensure compatibility between different smart meter types: eMUCS (extended Multi Utility Companion Specifications).



SOURCE: EANDIS

eMUCS considers several building blocks: the interface towards the Home Automation Network (H), between the Head End Systems and the E-meter (M DLMS) and between the meters (M MBus).

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[33] https://www.ores.be/particuliers-et-professionnels/smart-metering

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Czech Republic (CZ)

In the electricity sector, DSOs play the main role in the data management, being responsible for consumption data reading, validation and storage. The data collection and management is organized in a partially centralized way.

Customers can have access to their historical consumption data either via their bills, or via a web portal provided by the DSO. It is also possible to contact directly the DSO or the supplier. Wherever there is a smart meter installed in place, real time consumption data reading is possible.

Third parties can have access to customer consumption data, provided the customer gives the right. They can use the DSO`s website or ask for the data via a one-off request either from the DSO or from the supplier.

The smart meter-roll out in the households sector reached a 1% coverage by today, thanks to several pilot projects. Today, there is also a test project in place to try-out third generation smart meter devices. There is no national target set yet for smart meter deployment.

Cyprus (CY)

Cyprus has a centralized data management system entirely managed by the only DSO serving the country.

The Meter Reading Department, which is under the DSO, is responsible for the Meter Registration and Meter Reading and Management. Each Supplier has access to its customers through the Meter Reading Department.

Several procedures are ongoing for the use of an MDMS software (Meter Data Management System). On the 6th of October 2017, the Cyprus Energy Regulatory Authority (CERA) has issued a Regulatory Decision (05/2017) for the implementation of a mandatory timetable for the full operation of the MDMS by the DSO, which is April 2019.

In the meantime, the DSO is trying an interim application through a controlled access to the CC&B (Customer Care and Billing) and through the controlled management of certain information by each user. With the control access to the CC&B, the DSO will have access to the meter data as well as the data of the network users. From the other hand, the EAC (Electricity Authority of Cyprus) -Supplier will have access only to its customers' data. During November 2017, the DSO will have a clear view whether this application is feasible and if the answer is positive, the application will be available for use in December 2017.

This application constitutes the current database for retail customers.

The DSO is then accountable for consumption data reading, validation and storage. The process to store the validated data from readings takes more than 2 days. Both the DSO and the suppliers store historic data, the minimum requirements in term of history is below one year while no requirements are demanded in terms of granularity.

The supplier switching procedure has been approved by CERA in 2017 and there are currently no suppliers other than the incumbent company.

As the first mass rollout of smart meters has not started yet, meter data are provided through conventional meters. This has its impact on the billing procedures and on the data access for customers and third parties.

Customers have access to their own historic validated consumption data through their bill. Further, the DSO and the supplier must be able to provide the data if one-off customer request is received. Real-time consumption data is not accessible as currently the reading is performed by conventional meters. Third party access can get customers' validated data through one-off request with the DSO and the supplier or with a simple direct contact with the client. The right to the third party to get access to validated data is given by the customer, although the customer consent is managed by the DSO. Overall, validated data can be provided by the DSO upon written approval of the customer, otherwise the customer can provide himself his own data to third parties.

The bill is unique and is sent by the supplier. The customer pays for his effective consumption every 2 months and the energy bill is based on the conventional meters' readings performed every 2 months.

There are not relevant commercial initiatives that offer the possibility to get non-validated data from post-meter devices.

As mentioned, the smart meter roll-out has not be launched yet, but a Cost Benefit Analysis (CBA) has been performed. In particular through Articles 92(2) and 93(3) of the Law Regulating the Electricity Market, CERA has ensured the implementation of smart meters, where it is feasible, which may be subject to an economic assessment of all the long-term cost and benefit elements of the market and the individual customers. The NRA set up a 10-year plan for the implementation of smart metering. If smart meter development is positively assessed, at least 80% of customers should be equipped with smart metering systems by 2020. Under the provisions of 2009/72/EC Directive and the relevant Cyprus Law, CERA gave instructions to the DSO to carry out a CBA to ensure the implementation of intelligent metering systems, specifically for the implementation of an AMI system (Advanced Metering Infrastructure). At his initial stage it was decided that a theoretical cost-benefit study will be carried out, which will be updated with real figures after the implementation and evaluation of a pilot assessment. On March 2014, the DSO submitted to CERA the above CBA study. A pilot study with 3000 meters was launched to update it with real data.

The DSO has submitted to CERA a revised timetable for a full rollout plan which will take 112 months to purchase and install 400.000 smart meters. The plan is divided into four phases (purchase of 100.000 meters each phase – purchase of 57143 meters each year) and after the end of each phase the data collected will be evaluated including, if deemed necessary, specifications updates. The plan is to start the implementation of the mass rollout end of 2017 / beginning of 2018. On this basis, CERA is about to issue a decision for a mass rollout of smart meters, however awaiting the positive feedback and positive decision for the mass rollout by the EAC Board of Directors.

CERA is also taking part in the project "Smart net metering for promotion and cost-efficient grid-integration of PV technology in Cyprus" with the Acronym SmartPV, which is co-financed by the European Commission under the LIFE+ Programme. Under this research program a pilot demonstration project has been carried out, whereby 300 smart meters (202 are single meters and 98 double meters) have been installed to the 300 participants. The results of this project are now under investigation.

Even though there are no smart meters massively installed yet, for the Pilot project scheme of 3000 smart meters, the DSO has taken into account the EU recommendation as well as the latest available technology.

Gas Market

There is currently no gas market in Cyprus, so all the procedures and format are internal and managed by the only gas service provider.

Germany (DE)

The German retail markets for gas and electricity offer customers (on average) the choice of currently (in 2015) 130 suppliers for power and 105 suppliers for gas (BNetzA/Bundeskartellamt Monitoringbericht 2017).

Germany relies on a decentralized data management approach. DSOs are the central actors for data collection and storage. Nationally standardized market processes are given by the German regulatory authority (Bundesnetzagentur, BNetzA). No central platform exists in Germany; data handling is organized in a decentralized way with a common nationally standardized standard. Privacy concerns dominate the German discussion and have been mentioned as reason for "local" data storage.

A cost benefit analysis about smart meters in 2013 (Ernst and Young) showed no economic case for a full role out. Nevertheless, in 2016 the government implemented the Directive 2009/72 EG for a general roll out starting 2017 until 2032 (Gesetz zur Digitalisierung der Energiewende, Messstellenbetriebsgesetz).

Meter reading and operation is a competitive sector in Germany, even if usually the DSO performs the meter reading. The meter operator owns the meters and is obliged to progressively replace the installed devices by smart meters. Germany distinguishes between modern meters and intelligent meter systems but only the later allows for remote communication.

The replacement of traditional Ferraris meters with modern meters should be finished by 2032. Smart gateways for remote meter readings are not compulsory for average size households. Larger consumers or owners of larger decentralized production facilities will have to install intelligent meter systems once at least three certified intelligent meter systems are available. The technical specifications of the future smart meters are defined. Hence, Germany is advanced with the regulatory work and the specification of technical details. However, today there is no certified intelligent meter system on the German energy market.

The supplier receives from the DSO the data he needs for the customer billing. The DSO usually collects the data (is the meter responsible party) and owns the database for storing consumption data.

Customers can choose between all-inclusive contracts (supplier pays grid fees to DSO and charges the customer accordingly – this is the dominant choice) or separated contracts (customer pays grid fees directly to DSO; supplier charges commodity costs).

There are nationally standardized market processes between DSOs, suppliers and meter operators, given by the German regulatory authority (BNetzA).

The degree of information and frequency depends on the metering system:

- from DSO to supplier: Electricity consumption in kWh for the relevant period (monthly data)
- from DSO to supplier (in case of all-inclusive contract) or to customer: grid fees and grid usage related taxes/levies
- from supplier to customer: Electricity consumption in kWh for the relevant period, commodity prices, taxes, grid fees and grid usage related taxes/levies (in case of all inclusive contract)"
- supplier - customer: at least annually, depends on the contract (e.g. shorter periods)

EDIFACT syntax using the specific formats: MSCONS, INVOIC, REMADV, PRICAT is used for the communication on billing information between DSO and supplier.

The customer switching process for electricity is described in BNetzA-Festlegung "Geschäftsprozesse zur Kundenbelieferung mit Elektrizität", BK6-16-200 (Prozesse "Lieferbeginn", "Lieferende", "Kündigung")" and for Gas in „Lieferantenwechsel Gas" (Prozesse „Lieferbeginn", „Lieferende", Kündigung",BK7-16-142. The legal maximum time for a switch is three weeks (Gesetz über die Elektrizitäts- und Gasversorgung). The new supplier receives historical consumption data.

The data exchange for supplier switching is based on the EDIFACT syntax using the standard message format UTILMD. Messages are exchanged by e-mail and AS2 (see EDI@Energy "Regelungen zum Übertragungsweg" and EDI@Energy "Allgemeine Festlegungen") The data formats are nationally standardized and given by the German regulatory authority (Bundesnetzagentur, BNetzA).

Customers have access to their own meter and depending on the ability of their metering device can have access to different granularity.

Since the smart meters ("*Moderne Messeinrichtungen*") currently rolled out do not have (by default) a gateway for remote access (remote meter reading) data sharing does not apply. Intelligent meter systems (Smart meters combined with gateway) are currently tested but are not yet available.

The law (StromNZV § 26a) requires access to the reserve markets for demand response from final customers (for new contracts from 30/06/2016 and from 01/01/2018 for all contracts). However, the details on how that should be done, are not worked out yet and are under discussion.

Many supply companies offer home hubs and smartphone apps for home monitoring and control. However, since smart meters (including a gateway) are not yet available on the market those initiatives are either independent of the meter or, in some trial cases, based on a camera put on the meter.

The data exchange in the gas market mirrors the electricity regulation. Data are stored de-centrally, DSOs are responsible for metering and passing on information to the suppliers. The data format and message formats are the same.

References

- Processes "customer switching"
  - BNetzA-Festlegung "Geschäftsprozesse zur Kundenbelieferung mit Elektrizität", BK6-16-200

- BNetzA-Festlegung "Lieferantenwechselprozesse Gas, BK7-16-142

- contracts "Lieferantenrahmenvertrag"
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  - Link: BK7-09-001_BK6-09-034
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- Gesetz zur Digitalisierung der Energiewende, August 2016
  - BK6-17-046_Konsultation%20von%20Eckpunkten.pdf => final version of September 2017, to be implemented by 2018.

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  - Data formats, see www.edi-energy.de and Bundesnetzagentur (BNetzA)

- Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen (Messstellenbetriebsgesetz - MsbG)

http://irex.energy/projects/MIG6-Supplier-Implementation-Roadmap

Denmark (DK)

Denmark has developed a centralized data management system. The central data hub has been set up in 2013 to handle the interaction between the players in the electricity market. The central data hub is owned and operated by Energinet.dk, the Danish TSO.

Energinet.dk has established codes that set the rules for the use of and the access to the Datahub. Actors (DSOs, suppliers or third parties) who want access to the Datahub must sign agreements in which they warrant to comply with applicable legislation, including the Danish Act on Processing of Personal Data. No further evolution is foreseen up to now, however the TSO, the DSOs and the suppliers cooperate on the development of the data exchange formats and processes.

The DSO is (and that is not planned to change) responsible for data reading and validation which occurs in 5 days after reading. The validated data is then stored in the data hub – and also in the system of the DSO.

The central data hub must store at least 3 years of consumption data; however, consumption data is also stored in the Supplier's database, in the DSO database (with hourly granularity) and in the smart meters (the meters typically have memory for a few months data).

Although smart meters are technically able to read data with a 15 minutes resolution, only hourly data is currently read and sent to the data hub. The Datahub handles 15 minutes readings, where it is required for billing. For all other purposes, only hourly values are provided. Then an hourly granularity is the most general minimum requirement for consumption data stored in the central data hub and in the smart meters.

Customers can get access to their historic validated consumption data on a common portal, eloverblik.dk, on the compulsory web portal provided by the supplier, on the central Datahub web portal as well as on the bill. On the smart meter display non-validated real time data is accessible.

A third party can instead get access to customers' validated data on the central data hub. This access is granted via a portal where the costumer can give his consent to a selected third party and see who has still access to his data.

The steps for implementing a standard switching process are 4 while for billing the step is only one as the supplier just needs to take the necessary data from the hub. The consumer receives just one bill from the supplier. The billing frequency on effective consumption depends on how the supplier chooses to handle this process. Often, but not always, the customer pays for his effective consumed energy every three months based on a standard profile; however, it is expected that he will be billed based on his realized profile in the very short term.

For both switching and billing data exchange the communication standard used is based on XML language.

The data hub and the smart meters were introduced independently from each other. The data hub was set up before the deployment of the smart meters (2013) while smart meters will reach a 100% coverage by 2020. By then wherever an old meter is still installed DSOs are obliged to send annual data to the hub once a year. Smart meters will remain ownership of the DSO who is always responsible of data reading.

Gas:

For gas, data operations are organized differently than the Danish electricity market. Whilst a supplier centric model and datahub was implemented in the Danish electricity retail market of 1 April 2016, the Danish Gas retail market is still based on a system where the customer has two legal relations/contracts with both the supplier and the DSO.

Currently there are four DSOs, about twenty gas suppliers and one TSO (Energinet https://en.energinet.dk/) in the Danish gasmarket. The DSOs are responsible for reading, validating and storing consumption data. The gas suppliers are dependent on the DSOs who provide consumption data for e.g. customer billing and switching. Data communication between the DSO's, the suppliers and the TSO is standardized by codes on business processes on EDI communication. The codes regulate data switching in the billing, switching and moving processes. :https://energinet.dk/Gas/Detailgasmarked/EDI-kommunikation.

There are timeframes for switching and other processes. The new supplier informs the customers' DSO about the switching at least ten working days before the customer is able to switch supplier. The DSO informs the customers' old supplier about the switching. The DSO will ask the customer for metering data to be further communicated to the old supplier who will then send the final settlement to the customer.

Further, the suppliers keep consumption data from their customers in their own databases. Hence the customer can get access to his own data through his bill or after a direct one-off request to his DSO or Supplier. Each household has a measuring unit but it does not provide real-time info on prices.

Supplier switching is regulated by the Natural Gas Supply Act and underlying Orders. As for billing, the customer receives two separate bills, one from the DSO and one

from the supplier. Only if the supplier is vertically integrated with the DSO, the customer receives one bill. From January 2019 there will no longer be vertically integrated DOSs in Denmark. If asked by a supplier the DSO is obliged to facilitate that the supplier can provide a customer with one bill - that is if the supplier is not vertically integrated with the DSO in question. The private household pays every three months his effective consumption considering a standard profile. Customer billing is regulated by the Natural Gas Supply Act and underlying Orders.

A third party might get customer's validated consumption data using the same channels (one-off direct request to the customer's DSO or Supplier) or asking the customer to provide the data. This can happen only under customer's consent. The customer is indeed the one who can give the right to third parties to access his validated and non-validated consumption data however he is not currently able to clearly see whoever has access to it and no procedure currently defines how to give and revoke access rights. The supplier is currently the market actor accountable of managing the customer consent.

There are ongoing discussions about a future supplier centric model including one consolidated gas DSO hence becoming a de facto data hub. An act is currently being passed paving the way for Energinet to own the gas distribution systems if they are put out for sale by the current owners - the municipalities. Thus consumption data will be processed and managed from one central DSO. In any case there is an open and constructive dialogue with TSO Energinet who is responsible for technical market codes in cooperation with the DSO's and the Gas Suppliers like the one for managing the data exchange.

References

Link to public documents describing the Switching and Data exchange for billing processes:

https://en.energinet.dk/Electricity/Rules-and-Regulations/Market-Regulations

gas price comparison tool

http://www.gasprisguiden.dk/ -

https://ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/2016_01_18_gasanalyse.pdf - analysis on the Danish gas sector

http://energitilsynet.dk/gas/ - link to the Danish gas regulator

Link to public documents describing billing and switching processes in the gas sector: https://energinet.dk/Gas/Detailgasmarked/EDI-kommunikation

Estonia (EE)

Estonia has a centralized data management system. Consumption and production data are measured by smart meters installed by the DSOs, stored in a central datahub owned and maintained by the TSO and notably made available to consumers and third parties (such as energy service providers) via a data access platform, Estfeed. The Estonian electricity and gas transmission system operator Elering is the neutral party that manages the Estfeed platform.

The platform and the centralized data exchange system is the outcome of an ongoing centralization process started, by law, in 2013. It was understood that the 27 DSOs, many of whom are very small, were unable to invest properly into building datahubs. Also, that it is much better to have a single datahub for clarity and efficiency reasons. Its central database must store at least 5 years of consumption and production data

with an hourly granularity. The same minimum requirements (both in terms of history and granularity) are mandatory for the data base of the DSOs, who are both owners of the smart meters and responsible for Consumption and production data reading and validation. As the last generation of smart meters installed covers 100% of the metering points, the system is fed by 700 000 measurements every hour. The measured data is validated in less than 24 hours. Data is stored also in the smart meters, but the minimum requirements are only related to the hourly frequency.

The smart meters installed in the country are compliant with the minimum functionalities defined by the Recommendation 2012/148/EU except for the recommendation ***g*** which is only partially fulfilled as the on/off switching is not possible. Currently the devices can perform both peak and average measures with a frequency that goes under the minute. Their metering interval of the reading can be changed, and software upgrades are possible at a distance.

The platform consents access to all the market actors (DSOs, suppliers, customers and third party) once provided the required authorization by the consumer. If allowed, a selective access is provided via national ID card and/or mobile ID whose authentication is backed by the national authority. The data exchange is then secured via an end-to-end encryption as well as state-of-the-art security servers which are also in use in the banking and public sectors in Estonia.

Customers have access to their own historic validated consumption and production data, which they can see through the e-Elering web portal, on their bill or through any third party energy service to which they have granted permission to access their data via Estfeed. Currently there are no relevant commercial initiatives aiming to provide non-validated consumption and production data to the customer. Through the e-Elering platform, the customer can give the right to third parties to access his validated consumption and production data, view who has used his data and revoke rights, and it is also possible to give a written mandate to suppliers to access data their consumption data. Customer's consent is managed by the national TSO. The supplier must have a written or digital mandate by the customer, or alternatively a mandate provided on e-Elering, in order to see the customer's data.

Data exchanges for traditional activities (billing and switching) are managed through the central platform. The communication standard used for the exchanges is specifically designed for Estonia (national specific) and is based on XML communication language.

A normal switch is effective in 21 days since the customer's request and requires 4 steps. The 21 day delay is due to regulation, technically this could be achieved within 1 day. Soon the supplier switching will be effective within 7 days following a desire by market participants to change the regulation and reduce the switch time from 21 days to 7 days. In 2016 26 000 (3.7% of the customers) have been performed.

The customer pays for his actually consumed energy every month, the bill for energy consumption is based on the realized hourly profile. Both joint bill and separate bills are possible: some customers obtain a single bill (paying energy and grid charges), other suppliers send only an energy bill and then the grid operator sends a separate bill. Whether to send a single bill is a choice of the supplier – a single bill is more convenient for the customer, however by including grid charges on a single bill, the supplier assumes the credit risk for the grid charge. Generally large customers are billed with two bills. Most households receive a single bill. The billing sequence is composed of 2 steps only: the meter data request to the datahub and bill sent to the customer, both actions are performed by the supplier.

Gas Market

A centralized system has been chosen, by regulation, also to manage data in the gas market. Data is currently stored in both DSOs' and central platform data base although the central platform stores hourly values, while the DSOs measure daily values (the DSOs spread the single daily measurement across the 24 hours in order to fit the data into the central database). The smart meter deployment is currently covering 2000 out of 54 000 metering points. Development, access and security of the platform are managed following the same principles valid for the electricity market. DSOs are responsible for data reading and validation (that occurs within the first 24 hours), the TSO is accountable for data storage and data accessibility.

The customer receives historic validated data for the accounting period (past month) on the bill, but he can obtain both historic and almost real time validated data through e-Elering (TSO web portal) and the data sharing platform Estfeed, or via any third party's energy service which they have chosen, that receives the data from the central data exchange platform Estfeed (which makes available validated data from the central data hub). Non-validated historic and real-time consumption and production data are also accessible through the smart meter display. Third party access to validated consumption and production data is regulated as in the electricity market.

The procedures used for billing and switching are based on the same steps and communication standards of the electricity market with few differences. The average time needed for switching is 15 days. The bill is sent separately for energy consumption (from the supplier) and grid charges (from the grid operator). The two bills double the steps needed for the billing procedures as the platform needs to provide the data to both supplier and grid operator. The bill is based on the realized profile only for 1600 metering points whose reading is collected electronically. The other 52 000 points are billed according to the standard load profile. The smart meters account however for 70% of total gas sales volume however – smart meters are primarily installed at large consumers' premises.

Greece (EL)

HEDNO is the unique DSO in Greece and is responsible both for storage and management of measurement data. For small customers the measurement data are stored together with customer data in an in-house CRM (Customer Relationship Management) system while for bigger customers the data are stored and managed in a separate MDM (Meter Data Management) system. All systems are centralized, which means that the two platforms for data storage of small and big customers are common and unique for the whole country. A new system is expected as of 2020: the system will substitute the current one but whether there will be a unique system or two separate systems (like the CRM and MDM) has not been decided yet. The new system will be centralized as well. The reason for future substitution is the modernization and the unbundling of market. The legacy system is being inherited by the former bundled market and does not cover the special needs of the deregulated market.

Data is stored in the DSO's database: more than 10 years (since 1990) of historic data must be available with a monthly granularity (more precisely it depends on the size and type of customer: so monthly, 4 monthly, 6 monthly and yearly granularity can be found). There are no other relevant points of storage (like the central data hub or the smart meter) where the data is stored under certain requirements. Selected access to the system is guaranteed by pre-defined procedures and quality control for authenticating data and users. The evolution of the data exchange format and processes is open to suggestions, remarks and complaints that are accepted and overviewed by the DSO accountable for the data management system.

The DSO is responsible for consumption data reading, validation and storage. The time required for validation is less than 24 hours. The country is being divided in 20 meter reading sections, one for each working day of the month. Since the reading frequency for small customers is quarterly (every 4month), 100,000 measurements are acquired, stored, validated and sent to the suppliers each day.

Customers have access to their own historic validated consumption data through their bill and through the supplier web portal (which, however, is not mandatory), further the DSO and the supplier must be able to provide the data under if one-off customer request is received. Non-validated real-time consumption data is also available via the meter display. As no smart meters have been installed in the country yet, the data is provided by the conventional meter.

As for non-validated data some suppliers provide customers with smart home solutions, which cannot be used for billing. The DSO does not have access to the relevant information about the type and number of these devices though.

Supplier access to customer's validated consumption data is managed by the DSO. The DSO is indeed responsible to give the right to access customer's validated consumption data, provided that the supplier has the agreement of the customer. This is verified by the system. The access is granted only during the contract duration. Beside the supplier with an active energy supply contract no further third parties can have access to customer's validated data (suppliers other than those who have a signed contract with the client can have access to the client's data only after his agreement).

Post-meter devices can provide non-validated consumption data to customers, the use of this type of data is out of the perimeter of the current data management system and of the DSO.

A CBA for smart meters has been performed with positive results, but the pilot roll-out of 200,000 smart meters has not been realized yet.

Although no smart meters are installed the typical switch requires just 2 days to be implemented. The contact point for both new and old supplier is the DSO and the communication standard used is a national specific standard that uses in-house application used to exchange the necessary information. The validation procedure is performed real-time by the system, that's why the procedure is so quick.

The lack of smart meters seems to affect the procedures currently valid for billing. The bill is unique, the customer usually pays for his effectively consumed energy every 4 months, the bill is based on the realized profile. The conventional meters have two registers (two zones), one for the day, one for the night. Incorrect billing is common in the cases that the meter is read by stakeholders other than the DSO, like the supplier or the customer.

Gas Market

The gas market in Greece is quite small, the unbundling of the market was very lately completed but the regulatory framework is not completed yet. At the moment there are three DSOs serving the biggest cities of Greece, the small customers (households) are around 500,000 while the bigger customers are some thousands. The small customers at the moment do not have the right to switch to a new supplier, but this is going to change starting from the first of January 2018. The bigger customers have already the right to choose their supplier, but the procedures are not standardized yet. A CBA for smart meters has been performed but the results were negative.

As the unbundling process is still open, metering regulation is to be published. Currently the DSO is responsible to measure, validate and storage the consumption data, everything is done within 24-48 hours after the reading.

The customer can currently get his validated consumption data through the bill and in case of a direct one-off request to the DSO. However, the situation is evolving DSOs' portals will become available starting from the first of January 2018 when households will become eligible customers able to switch.

The bill is unique and is sent by the supplier. The small customer usually pays for his effectively consumed energy every 2 months, but this is an aspect that changes on the type of customer. Standard profiles will be implemented from January 2018. Until then, the consumption is allocated on the realized profile, proportional depending on the number of days. As the Supply Code is currently under public consultation, no communication standards and procedures for billing have been defined yet.

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Spain (ES)

The data exchange management between retailers and DSOs in Spain is decentralized although some features of a centralized system can be observed. The information interchange is based on the SIPS (Sistema de Información de Puntos de Suministro, Supply Point Information System). Every DSO manages his own SIPS with the information related to his supply points. Customers can oppose to the publication of the information of his supply point in the SIPS, by declaring himself as "Robinsons". The format and information included in the SIPS files is defined by the regulator CNMC (Comisión Nacional de los Mercados y la Competencia). In those files there is technical information and consumption information identified by a code (the CUPS) corresponding to the supply point. No personal data is included in the files. Technical data includes the location (city), type of tariff, maximum contracted power, etc. and also the retailer serving this supply point. Consumption information includes the validated monthly consumption (used for billing), for the last three years. Those SIPS files are sent (mandatory) monthly to the CNMC, who publishes them to make them accessible to all the retailers.

Retailers can access those SIPS files from the CNMC web portal (centralized way, where all files from all DOS can be found) or from the web portal of every DSO (decentralized way, where only the information for this DSO is found). The main difference is that the files in the CNMC web portal are updated monthly and only mandatory data is included, meanwhile the SIPS files in the DSO web portal can be updated more often (e.g. twice a month) and can contain some additional information (optional). Access to the web portals is secured by the use of user names and passwords. This DSO portal is also used to interchange requests and answers between DSOs and retailers. Information interchanged through requests are fully updated.

Information in the SIPS as well as procedures, data exchanges and messages are standardized at national level by the regulator CNMC. Procedures are agreed through

a collaborative process managed by the CNMC, with the voluntary participation of DSOs and suppliers, ratified by the Ministry, and published by the CNMC.

Every DSO is responsible for getting the metering data from its supply points; it stores, protects, processes, validates and distributes them.

This model was put in place in 2003, during the liberalization process of the domestic electricity market and has been maintained since then. No changes toward a totally centralized system are expected.

In Endesa, communication with smart meters is secured by encryption with AES 128 symmetrical keys.

The major distributor in the country (Endesa Distribucion) currently processes 10.2 million of hourly load curves every day.

Consumption data are indeed stored in the DSO database satisfying these two requirements: last 5 years of history and hourly granularity. Hourly consumption data must be stored also in the smart meter but just for three months. As a consequence, the customer has access to his own historic validated consumption data on the compulsory DSO web portal as well as through the bill. Customers access to the DSO web portal is secured by registration and using user name and password. For supply points with smart meters the maximum time lag between the reading and the availability of validated data in the customers' web portal depends on the DSO but is about 5 days. The frequency of the data collection depends on the type of costumers and DSO own practices.

Non-validated data, both historic and real-time, is instead accessible only through the smart meter display. It is worth to remind that detailed information (i.e. hourly consumption) is based on smart meters data, so the availability of this information is linked to the availability of smart meters.

Additional data provided to the client by post-meter devices are not regulated: this information is treated as a private agreement between the consumer and the service provider. Suppliers are indeed developing and offering new products and extra services as real time interconnection between meters and customers (or with home appliances) is not yet in place in Spain (not requested by current national regulation). However, it is worth reminding that just measures read, treated and validated by the DSO are used for billing purposes as well as for energy acquisition; regulation is not expected to change. There are also free apps that allow users to access his consumption data consumption from any mobile device, accessing the DSO data base. There is one DSO in Spain that offers to their customers the possibility to request an instantaneous reading of your meter and get the value in real time, but always through the central system of the DSO. Some pilot projects for data sharing platform have been set up but not on a large scale (as Data Protection Law issues will have to be addressed).

A third party might get validated data via de DSO compulsory web portal or through direct contact with the client. Further, the customer can authorize a third party to access his historic validated consumption data through the DSO web page where he can also see who has been appointed of this kind of access. Non validated data is only in the meter and no access to data in the meter is possible for the customer or a third party, unless through the display.

As said, the consumer can share his information to third parties, but a specific process for third party data access has not been defined yet.

In this system an average switch is implemented within the first 5 days after the customer's request. The information exchanged, and updated in the SIPS, after a switching operation considers: CUPS (Código Unificado del Punto de Suministro), type of request, supplier code, technical and administrative information.

There is only one bill sent by the supplier. Hourly load profiles are sent daily from DSO to suppliers, and customers are billed monthly according to their effective hourly consumption and the realized profile. This is certainly valid for the regulated market: in the non-regulated market retailers can offer other tariff schemes. In Spain, customers with contracted power below 10KW can chose a regulated or a non-regulated billing scheme. In the regulated billing scheme (called PVPC, Precio Voluntario del Pequeño Consumidor), this is stablished by the regulator and it is currently based in the actual hourly consumption; in the non-regulated billing scheme, retailers are free to offer any kind of billing schemes to the customers.

The necessary data exchange for both switching and billing is and will be performed using a national specific communication standard.

The legal target for smart meters (with remote reading capability) deployment is 100 percent by the end of 2018 in the domestic segment (contractual power equal or lower than 15 kW).At 31/12/2016 the coverage of installed smart meters was higher than 81% nationwide.

The current roll-out is related to the first generation of smart meters installed in Spain. DSOs are responsible for metering but the customer in Spain is entitled to own his meter, though this is not the usual case. In the future there could be a review of Smart Meters specifications (after the initial roll-out). This first generation of smart meters is compliant with nine out of the ten common minimum functionalities for smart metering systems required by the EC (Recommendation 2012/148/EU) as functionality ***b*** is not provided. These devices allow remote software upgrades as well as the possibility to change the metering interval. The finest granularity is 1 min for all type of measures that can be collected by the Endesa smart meter however, the only legal requirement is 1 hour granularity.

The data transfer protocols between Central System and smart meters installed in Spain are mainly two: Meters and More protocol SMITP (Smart Metering Information and Telecommunication Protocols), used for smart meters installed by Endesa Distribucion, and the DLMS (Device Language Message Specification) over PRIME PLC protocol for all the others main DSOs.

Gas Markets

The data exchange management in Spain is a decentralized system. The information interchange is based on the SIPS (Sistema de información de Puntos de Suministro - Supply point Information System). Every DSO manages his own SIPS with the information related to their supply points. All the suppliers can access to all the SIPS of all DSOs through a common platform called SCTD for getting information about all customers connected to the grid. The common SCTD platform has been developed by DSOs. Every DSO is responsible for metering and collecting the data; it stores, protects, processes, validates and distributes them to the designated suppliers. Procedures and messages are standardized at national level by the CNMC. Switching and billing processes are like the ones described for the electricity market as well as digital format and exchange channels.

As the data collection in the very small customers is every two months, and in bigger ones every month, smart meter roll-out is not expected in a short-medium term. Nowadays telemetry is mandatory for customers with a consumption of more than 5 GWh/year.

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Finland (FI)

The current data exchange model is a nationally standardized decentralized system. The data is bilaterally exchanged by the main responsible parties for these activities: DSOs and suppliers.

Starting from 2020 at the earliest the data management model will become fully centralized as every data exchange will be done through a Datahub, operated by Finnish TSO Fingrid. The meter reading activity will remain decentralized as DSOs will remain responsible for meter reading and validation. They will then send validated meter data to the Datahub. Currently the DSO is instead responsible for the two-way metering: both consumption and grid feed data reading, validation (that is performed within 1 day at the latest), storage and exchange. The future centralization is then related to all the other retail market processes: supplier switching, moving, meter data storage and exchange. This choice has been a result of a CBA performed in 2014.

The Finnish TSO has been chosen for its neutral role across other market actors.

Data exchange formats and processes for data exchange are developed and updated by the industry association (market processes incl. time limits) and by the TSO (technical instructions for messages), in close co-operation with DSOs and suppliers.

In the future the Datahub will store the meter data and allow the data exchange. The database will then respect the following requirements in terms of history and granularity of the consumption data stored: 6 years of historic data will be stored with a hourly granularity (15 minutes in the future). Meter data are now stored in the DSO and the supplier database with the same characteristics in terms of history and granularity demanded to the future Datahub. Further, smart meters must store hourly data for at least the balance period/one billing period; but usually 3 months minimum. Overall the current system enables the daily reading of the hourly consumption from the 99% of the meters installed while other meters are read at least 4 times per year.

As of today, the customers have access to their historic validated consumption data through their bill (only the billing period), the compulsory DSO's web page (some DSOs offer also mobile versions) or directly from the DSO or the supplier after a direct one-off request. Most of the suppliers in the Finnish market provide a web portal for customers to access historic validated data, although on a voluntary basis. Real-time and historic non-validated data are accessible through the smart meter display, an In-home display (H1 interface) connected to the smart meter (these are value-added services) and the smart meter gateway (P1 port, provided by the DSO on customer request). It is worth to specify then that not all customers receive meter readings straight from the meter, unless they have ordered a meter for that, but all customers receive the hourly meter data via webpage.

Post meter devices can provide validated or non-validated consumption data whether the device gets information by messages/web-portal or reads the data directly from the meter respectively.

In the future customers will get their data directly from the Datahub. Datahub will offer a user interface for the customers, a so-called customer portal, from where the customers can see information about themselves who will have registered in the Datahub. In the customer portal the customer will be able to see the metering data of their accounting points, contract information and other data. The customer will see all

of his information regardless of which DSO's area their accounting points are or who the supplier is.

In the country there are commercial initiatives allowing the client to have additional non-validated data about his consumption. These are: e.g. Free My Consumption by Vattenfall, Energy Watch by Vattenfall, Fortum home display (Fortum kotinäyttö) by Fortum. Further, it has to be noted that there are already initiatives providing flexibility services for small customers like Fortum Fiksu by Fortum and the pilot project by Helsingin Energia (demand response service for households).

Only under customer's consent a third party can have access to customer's validated data through the DSO compulsory web portal, the supplier web portal (if available) or directly from the supplier or the DSO after a direct one-off request. The consent form is subject to general legal requirements of authorisation and no special set of rules is formed for electric markets concerning authorisation. Once available this will be possible through the Data Hub web portal. As for non-validated consumption data, once the customer's consent is obtained, a third party can read a standard open interface at the meter for real time consumption (on consumer's behalf) if a customer has requested it. The same is valid for non-validated data provided by a post-meter device. Validated or non-validated data can also be provided directly by the customer.

The customer is the one who can give third parties the right to access his consumption data. This right is provided via written or oral consent. As only DSO, supplier and third party to whom customer has given consent can have access to customer's data, it can be said that the customer can clearly see who has access to his data. Currently the data provider (either the DSO or the supplier) is accountable for managing the customer consent, but in the future this role will fall in the perimeter of the Datahub. Indeed, in the future a customer will be able to check, in the customer portal provided by the Datahub, to which companies, for which data and for which time period they have given an authorisation. The customer can edit the authorisation information if he wants to.

The data exchanges for a switching operation are nationally standardized and currently managed by the DSO. The switching process normally follows 6 steps. Supplier switching takes maximum 14 days and is possible any day of the week. More precisely the necessary data exchange process takes maximum 5 days, but new supplier must inform new contract minimum 14 days before the delivery starts. A potential new supplier can't have access to historic data before the contract is concluded.

The future data hub will centrally manage master data for switching operation and will act as unique interface between the DSOs and the suppliers.

Consumption data for billing purposes are currently obtained by suppliers through bilateral exchanges with the DSO, responsible to provide effective consumption data to them. The way the bill is sent to the customer is not harmonized as there are two billing models. For switched customers the supplier bills energy, while the DSO bills distribution charges and electricity taxes (dual billing model). One unique bill is sent from the suppliers for those household and small customers who never switched (only households and small customers who are still buying electricity from their local supplier). Based on legislation the client pays for his effective consumption at least every 3 months; however, consumed energy is usually billed more often, every 1 or 2 months depending on the contract. The client pays according his realized meter consumption (hourly time-series). The bill is sent according to national standards: the information presented in the bill must comply with certain minimum requirements

Data exchanges for both switching and billing use EDIFACT as communication standard for meter data. In the future the communication standard chosen might change into CIM, however this still will be definitely defined once the Datahub specifications are ready. The central data hub will be the future interface for both DSOs and suppliers for the exchange data for switching and billing. The security of these exchanges is managed by data exchange operators.

The first roll-out of smart meters is completed and today the coverage is around 99%. The owner of the meters is and will remain the DSO. As for the generations of devices currently installed in the country, it has to be said that, although there are numerous different smart meters of different revisions from different companies, all are basically 1st generation. Many have more functionalities than the ones defined as minimum requirements. They are generally compliant with the 10 common minimum functionalities required by the EC Recommendation 2012/148/EU although functionality j is only partially fulfilled as reactive power metering is not possible. It is possible to configure the metering system at a distance and to carry out software upgrades. The meters are set to measure average consumption every 60 minutes. However, it is possible to change the metering resolution to 15 minutes with some restrictions. To do that all meters must be either reprogrammed or replaced entirely. Some (roughly 50%) can be programmed remotely, but some require visiting locally. The programmability depends on the type of meter and the reading solutions chosen. The rest of the meters have to be entirely replaced.

Gas market

There is derogation in effect for Finnish gas market. As such, the market does not exist yet and the creation of gas market is still in very early stages (so it is not possible to switch supplier). It is expected that the gas market will be opened to competition in 2020. As the DSO is also the supplier the data exchange is currently managed internally. The DSO is then responsible for data reading, validation and storage. Metered data have to be delivered to the balance settlement in three days. In case a customer might want to get access to his validated consumption data he needs to make one-off direct request to the DSO. Validated consumption data is not available on the bill which is unique and is paid based on the effective realized consumption profile every 3 months.

References

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France (FR)

DSOs play a central role in the French electricity and gas consumption data management. They are responsible for data reading, validation and storage. The major DSO for electricity distribution is Enedis, covering 95% of the clients and acting therefore as a main entity in the data exchange. Next to Enedis, there are 150 independent DSOs, 5 of them having between 100.000 and 1 million clients and the rest serving much smaller areas. Concerning gas, the major DSO is GRDF, covering 95% of the clients and acting therefore as a main entity in the data exchange as it is the case for electricity with Enedis. Next to GRDF, there are 23 independent DSOs with a natural gas distribution system.

Electricity consumption data is stored at DSO and supplier level. At DSO level, there is a legal obligation to store 10 years of data, with a yearly or half-yearly granularity in case of manual reading. If a smart meter is installed, the typical granularity is daily, unless the customer explicitly chooses 30min data.[34] The supplier has a legal obligation too to have 10 years of history available (granularity is monthly in case of smart meters, unless the customers requires 30min). Within the smart meter, 4-5 months of hourly data can be stored locally. Customers can access their data relatively easily, since DSOs and suppliers are obliged to give access to validated historic and daily refreshed data via web portals. They can also retrieve real time data from their smart meter (via P1 port or H1 interface), but this data is non-validated.

Concerning gas, the main difference is about the granularity: the customer has a daily information if a smart meter is installed. Hourly data are available with a specific subscription via the supplier.

DSOs are together responsible for Energy Individual Data Protection. Customers must be able to share - or authorize DSOs to - share their data to any authorized third party through express customer consent. However, the consent process for individual customer is not yet defined in a unique procedure. Three different approaches are currently accepted on a legal base. Large third parties can access the customer's data directly through the DSO web portal and also through web services, based on an agreement between the DSO and the third party. It is assumed that the third party has collected the customer's consent previously. The DSO can perform controls. Smaller third parties access the data via one-off requests to the DSO, based on a scanned consent provided by the customer. Ex-post, the customer cannot clearly see who is having access to his data, but this is expected to change by mid of 2018, when DSO web portals should foresee and implement such a functionality. As a third possibility being currently experimented, third parties can develop and use a connector to Enedis API portal, which enables them 1) to authenticate the client as a DSO customer and check its consent to share data with the 3rd party and then 2) to get access to customer data. This 3rd approach is expected to be generalized by mid of 2018. GRDF is currently working and experimenting very similar access for third parties.

The smart meter roll-out is handled by the DSO. Replacing old electricity meters with smart meters is mandatory as of today. The project will span 5 to 6 years, with a targeted coverage of 90% by the end of 2021 (regulation 2014/07/17). Smart meters fulfil all of the 10 functionalities recommended by the EC (Recommendation 2012/148/EU). Enedis has started the roll-out of smart meters (Linky) and has launched pilot projects to provide customers access to their data (via Linky) as well to

[34] In that case, a history of 10 years would also be possible, as long as not more than 20% of the customers choose that option.

transfer their data to third parties (Solenn and Enedis data connect). The Linky smart meter reads only electricity consumption, not gas. The download of daily data from the DSO web portal is possible at any time for customers in a simple standard file format. Enedis is working on an alternative file format based on the IEC international data model CIM, which could be a starting point to build a common interoperable standard. GRDF has started the roll-out of smart gas meters (Gazpar) in May 2017, and the roll-out should span nearly 6 years.

Communication standards for traditional business processes like billing and supplier switching are national-specific. Formats and procedures are validated in workshops organized by the regulator CRE. Processes are described on https://www.gte2007.com/referentiel.php.

Croatia (HR)

Croatia was the 28th (and up till now last) member state to join the European Union in 2013. The Croatian electricity and gas market were liberalized in 2008. As there is only one DSO for the Croatian electricity market, Croatia has de facto a centralized data management system. For gas, the data management system is decentralized due to the existence of 35 DSO's. As from 2018 the market operator (HROTE) will act as centralized system manager for supplier switching data, with the DSO still responsible for meter reading, data validation and storage.

Electricity

The DSO plays a central role in the Croatian market model and is responsible for meter reading, data validation and storage of this data. The most relevant master and consumption data, needed to execute activities like switching, billing or moves is stored in a central database, managed by the DSO. For (traditional) meters, the DSO obtains a meter reading every 6 months or monthly if the households choose to send it on a monthly basis voluntarily. Data is stored for 8 years according to the network rules, of which 2 years online and 6 years of archive.

Exchange of data for traditional activities (switching, billing) between suppliers and the DSO is mainly email-based. For billing, for instance, the meter reading is sent by email to the suppliers, who send a unique bill (incl. grid and energy charges) to the customers. Croatia is currently modernizing this system and recently bought SAP software.

Smart meters are deployed only in pilot projects, but it is targeted to have 95% of all meters remotely read by 2030. Currently, there is a CBA ongoing on smart meters. The first mass deployment (100.000 meters) is foreseen for 2018 and will likely be PLC read G3 smart meters.

Customers can access their consumption data through their bill or via a DSO web portal using their customer number and password. A third party can access customer data through a special DSO portal, if there's a written consent of the customer. For households, the data is sent by the DSO to the third party. Data access can be limited in time at the customer's request.

Gas

For gas too, the DSO's play a central role and they are responsible for meter reading, data validation and storage of the data. Meter reading takes place minimum twice a year but depending on the DSO this can be also monthly or quarter-yearly. Billing is based on a realized profile. Customers receive one unique bill from their supplier. Customers can access their validated consumption data through their bill or via a one-

off request to the DSO or their supplier. Third parties (usually only suppliers when in a switching process) have to contact the DSO to obtain customer data.

Switching supplier takes 12 days on average (with a legal limit of 15 days). All communication between stakeholders is well standardized through a platform of the market operator HROTE. For billing purposes communication between supplier and DSO is via email or a special application.

Hungary (HU)

In Hungary, the electricity data management system is decentralized, there is no central data hub in charge of the data management activity. The DSOs are responsible for the data collection and validation, and for forwarding it to the supplier. In the electricity sector there are six DSOs and three suppliers, so called universal service providers (USPs) for the households. Almost 100 percent of the households are served by these USPs. The data management procedure is not standardized, it changes for each DSO, although these processes are required to be in compliance with the regulation framework.

The traditional way for customers to access their consumption data is to consult the monthly bill. On the other hand, some of the DSOs and suppliers provide access to own consumption data via their websites. Third parties can have access to consumption data only by requesting it from the customer itself. Technically, third parties can get access to the customer's consumption data solely based on the customer's authorization.

Supplier switching is possible, but customers in reality tend to stay with the USPs who provide services at regulated electricity tariff. Accordingly, although the main steps of supplier switching are regulated, household customers are in fact not really interested in supplier change.

There is a single billing procedure in place, in most cases customers receive a bill on a monthly basis provided by the supplier which contains both the electricity and grid charges. Customers pay based on estimated consumption, reconciliation to actuals takes place on an annual basis.

Currently there are only a few smart meters installed in the country. There is a test smart meter program in place, coordinated by the DSOs. Based on the results, a cost-benefit analysis is expected to be carried out in the near future. Due to this early phase of the process there is no national target for smart metering coverage in place at the moment.

In the gas market four DSOs are responsible for household data collection and validation, and for forwarding it to the supplier. On the supplier side, there is only one main supplier for households as it is the only supplier with country-vide universal service provider license. Due to this factual situation, the data management system is partially centralized, i.e. at supplier level.

Based on their own initiative, the DSOs and the supplier (in cooperation with other, industrial suppliers) created a common platform for a centralized data exchange for a more effective data communication, reconciliation and consumption settlement. The existence of this platform shows a need towards a more centralized and regulated data management system. Today, there are ongoing discussions on this subject, the final concept is still to be clarified.

Similarly to the electricity system, customers receive a single bill from the supplier. They pay based on their average historical consumption, which amount is reconciled once in a year as a main rule.

Roll-out of smart metering is in a test phase, the number of currently installed smart meters is very small.

Ireland (IE)

The Irish electricity market has been going through a process of liberalisation since 1998. This liberalization has happened in phases with sectors of the market being progressively opened for competition. The domestic market has been open to competition since 2005.

Currently, smart meters have been only deployed in a test phase. A first generation, MV90 (Itron) has been remotely collecting interval data since 2002, but only for large customers. Also, a number of smart metering trials (3 phases) have taken place between 2009-2011 for ~10,000 customers. As a first step in the large scale deployment, it is planned to roll out 250,000 smart electricity meters between mid-2019 and end-2020. The remaining 2.2 million meters are targeted for installation over the next 4 years (2021-2024), with the DSO being the owner of the smart meter. The final procurement of the smart meters is expected in 2018. The meters will be foreseen to satisfy the 10 common minimum functionalities as required by the EC.

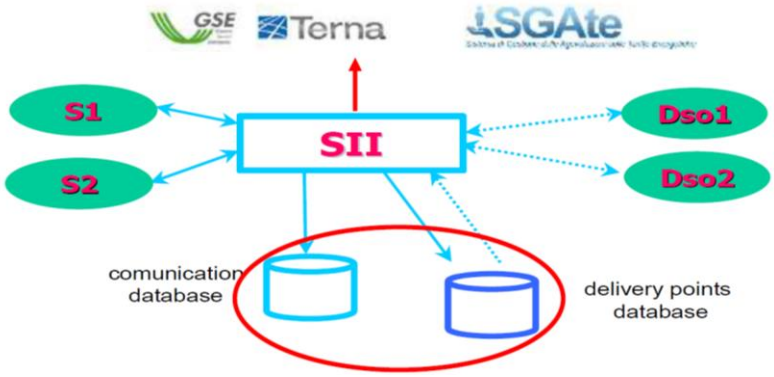
The DSO is responsible for the customer data management. This is a centralized system by default, as after the unbundling a single DSO (ESB Networks) was created. There is no evolution foreseen towards more decentralization. The Meter Registration System Operator (MRSO) has been set up as a "ringfenced" function within ESB Networks being responsible for the Change of Supplier process and the processing/aggregation and distribution of meter data. Hence, the DSO occupies a central role in the Irish electricity system, being responsible for data reading as well as validation and storage. It takes 24-48h to read, validate and store customer data, which is then stored for 7 years with a monthly granularity.

The customer can access his/her (validated) historic consumption data only through directly contacting either the supplier or the DSO. As no smart meters are installed yet, real-time consumption can only be read on the meter display itself. A third party can only access the customers' consumption data by sending a request to the MRSO who will not release any data without customer authorisation.

The MRSO is also responsible for the supplier switching process and sending data to the suppliers for bill settlement. Irish customers then receive a unique bill from their supplier. Switching supplier requires 11 interactions between the stakeholders and takes on average 5 days. The communication format used between the stakeholders relies on a national-specific format. In 2016, 327 000 customers switched their supplier.

Italy (IT)

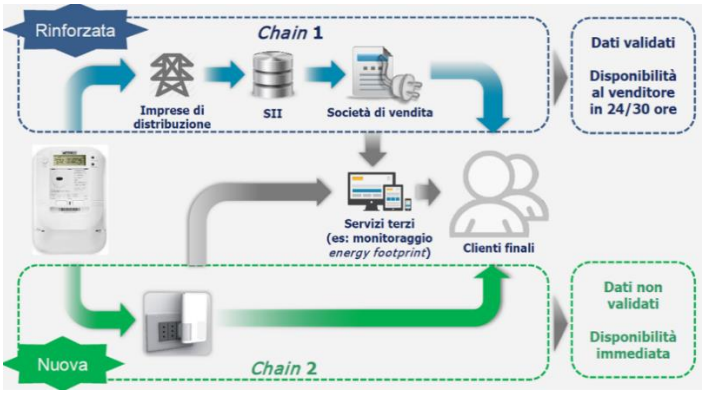
The data management model in Italy is in transformation. The current model is partially centralized and follows procedures standardized at national level. A third party (Acquirente Unico, a public entity) manages the central platform called SII (Integrated Information System), introduced to simplify communications among the different operators, stepping from a "n" to "n" communication system to a "1" to "n" communication system. SII is a central *hub* for the main technical information about the point of delivery (POD) and customers personal data.



SOURCE: CEER

Figure 8 The current SII data management model for switching processes

SII is currently responsible for the technical management of the switching. However, the data management system is on progress towards a further centralization. The next evolution, starting from February 2018, foresees the SII as the central platform also for metering data: DSO will send validated meter readings to suppliers only through the SII so suppliers will have to interact only with the central platform.). DSOs then are and will remain in the future responsible for metering, from the collection, to the validation and storage of the consumption data to the transmission of data to suppliers through to the SII.



SOURCE: AEEGSI

Figure 9: Future consumption data flow with SII as centralized platform for consumption data and smart meters 2G

Also, the SII stores data files received by the DSO, to make them available to suppliers but, as of today, SII doesn't control data quality.

With 1G (first generation) smart metering system, data are delivered per time band monthly to SII and retailers with an average rate end-to end rate of 95%. With 2G (second generation) smart metering system, data related to load curves will be delivered daily to SII and retailers with an average performance rate of 95% within 24 hours and 97% within 96 hours. Starting from February 2018, all of these data (1G and 2G) will be delivered to SII and SII will make them available to retailers.

As regards the security of the data flow, in the 1G smart metering systems in the meter to concentrator segment data are authenticated using an algorithm; from

concentrator to central system, a mutual authentication (through password) mechanism is adopted. From the central system to SII/Retailers data are sent through a standardized M2M flows. 2G smart metering system will adopt authentication and encryption techniques in the different segments of the communication chain. Advanced Encryption Standard with 128-bit keys is adopted to secure meter to concentrator and meter to in-home devices (chain 2) communication, according to NIST (National Institute of Standards and Technology) standards; concentrator to DSO database communication takes place in secured transport sessions adopting IP over telecommunication public networks (e.g. GPRS 3G/4G).

Once the transmission is completed, the metering data reach the central system and are kept in a secure environment to ensure operational continuity and security of information, in accordance with the ISO / IEC 27017 guidelines published in 2015 by the International Organization for Standardization, which - together with the ISO / IEC 27018 standard - is the technical standard issued by the ISO with specific reference to the security controls of information applicable to the provision and use of cloud computing services.

Market participants should respect standardized rules and format set at national level by the Regulator. No specific additional contribution can be brought by market operators

Given the current architecture of the data management system, consumption data are stored in the DSO database, in the SII (the SII stores data files sent by the DSO but, as of today, the SII doesn't control data quality), in the smart meters and eventually in post-meter devices. Suppliers are used to store data too. DSO's database is required to store 5 years of consumption data. As for the required granularity a distinction is necessary. For customers equipped with 1G smart meter, the data are stored with a granularity of monthly consumption data clustered per time band. For customers equipped with 2G smart meter the data are stored every day with a granularity of 15', keeping also the classification of time band. The granularity in the supplier's database depends on the type of customer: for small customers (with contractual power less or equal to 55 kW) monthly readings divided per time bands are required.

A distinction has to be made for the minimum requirements of the data stored by the smart meter. 1G Smart Meters (first generation installed) store the last 36 days of 15' minutes consumption and the total consumption per time bands of the previous month; while 2G Smart Meters (second generation) store the last 38 days of 15' minutes consumption and the total consumption per time bands of the previous 6 months. Regarding the granularity of the readings, from a technical point of view 1G smart meters record 15 minutes granularity readings, but for billing purposes 15 min readings are currently delivered to retailers only for MV and LV customers with contracted power higher than 55kW, while for LV clients with a contractual power lower than 55 kW three "time bands clustered" readings (according to time of use bands pre-defined by the NRA) are used. Starting from February 2018, 15 min readings metering data and monthly readings will be sent to SII (that becomes the sole interface with the DSOs) for all customers. Finally, post-meter devices can have data storage among their functionalities. Granularity and history depend on the device (so it is up to the commercial initiative).

The consumer can access historical validated data on the bill and through specific one-off request. Customers of the main DSO have also access to their own metering validated data via a secured web portal; however, this access is provided as a voluntary initiative and it is not mandatory. Currently the customer has not access to the central data hub web portal, but the Italian legislation and the Italian NRA foresees the possibility to allow customers to have access to their historic consumption

data on the SII. In order to achieve this, specific regulatory interventions have to be put in place.

Non-validated real-time consumption data are instead accessible to the customer through several channels: the smart meter display, the in-home display (H1 interface) connected to it in the case of pilot projects, the smart meter gateway (P1 port). Historic non-validated consumption data are instead accessible only on the smart meter display and eventually through a post-meter device (it depends on how this device is designed). The Smart Meter Gateway can collect and store Near Real Time non-validated data but cannot request the smart meter to provide the historical data registered on board.

To date, only the supplier can access the SII. There is no specific regulation on third party access to customers' data yet. Data Privacy rules are in place. Actual regulation hence does not discipline access to customer validated data by third parties. If the customer can access his validated data e.g. via a web portal and in this situation, he can delegate a third party. A third party can access customers consumption data only with explicit consent of the customer itself. This is how he has control on who has access to his data Who acts as the data controller or processor is also accountable for managing customer consent (so the supplier or the service provider).

There are several initiatives at the commercial level, to provide clients with services and smart devices able to improve their energy footprint. Without giving an exhaustive list, some initiatives are below mentioned:

- **Energy Control by Edison:** a sensor applied to the meter sends non-validated real-time information about in-house consumption. The service allows to control consumption in real-time, compare private consumption with the one of an average household with the same characteristics, set target and alert messages related to a particular threshold.
- **E-good life by ENEL Energia:** it's a kit that enables the monitoring of (non-validated) real time consumption data and a smart management of the connected home devices (smart plug; smart appliances; motion sensors; …). Everything can be controlled and managed also outside home thanks to a dedicated app. The kit offers a number of functionalities including a system of alerts (e.g. if the customer is exceeding his power threshold).

Eventually the third party could access validated and non-validated data directly from the customer and just non-validated data from the smart meter gateway or post-meter device under customer's consent.

The switching process in the electricity sector is currently managed by the SII according to national standardized procedures. DSOs and suppliers have a tailored access to it, restricted to their customers after having gone through an accreditation process. The new supplier has access to historical consumption data (last 12 months) and to consumption data (switching meter reading) related to the POD of his client, with a different granularity depending on the contractual power.

The switching process occurs in three weeks if the switching request is sent by the 10th day of the month M-1, it takes effect on the first day of the following month M. With the roll-out of the 2G smart meters, it is possible that some further adaptations to the switching process will be assessed (e.g. the reduction of the timing of the switching process). During the last year (2016) 10.1% out of all the PODs in the country (so both domestic and non-domestic clients) have switched supplier. The future switching process will remain centralized and managed by the SII.

The customer receives a single bill from his supplier, containing also the part related to transmission and distribution tariff. He pays for the energy really consumed or on an estimation based on his historical consumption profile. In the regulated market, the

billing frequency depends on the type of customer. The bill is paid monthly for low voltage non-household clients with contractual power above 16.5 kW, every two months for non-households with contractual power below 16.5 kW. Suppliers on the free market bill at different intervals. The DSO sends metering validated data every month. Statistics on incorrect billing are not available as the Regulator has introduced the monitoring starting from 2017.

The data exchange for both billing and switching occurs and will occur using a national specific communication standard based on XML (CSV can be used as XML is not yet mandatory).

Italy is one of the first Countries in Europe having completed the smart meters rolled out (first generation - 1G). The deployment was voluntary until 2006. The Italian Electricity Regulatory Authority (AEEGSI) has then provided a mandatory schedule for all DSOs for the period 2007-2011: the roll-out of the 1st generation of smart meters has been completed in 2011. As of today, the coverage is larger than 98 percent.

The very first operative roll-out of the smart meter 2G (second generation, also known as "Open Meter"), planned by e-Distribuzione (Enel Group), has been approved by the Italian NRA (AEEGSI) in April 2017; the Authority has not defined a mandatory schedule for all the Italian DSOs yet. According to the approved plan, e-Distribuzione will substitute more than 80% of its meters by 2022, more than 95% by 2030. As of October 2017, more than 1.5 million of 2G meters are already in place. The ownership of the smart meters is and will be kept by the DSOs.

The 2nd generation of smart meter satisfies all the 10 common minimum functionalities for smart metering systems required by the EC with the Recommendation 2012/148/EU. For non-validated data they measure instantaneous consumption, while for validated data they record load curves with 15 minutes granularity. It is not possible to change the metering interval because the metering interval of these smart meters is already set by the MID European Directive at 15 minutes. Further, smart meters 2G will enable pre-payment functionalities, but regulation related to pre-payment has not been issued yet. It is possible to configure the metering system at a distance and to carry out software upgrades remotely. A single communication standard is used to send data from the P1 port. Smart meters 2G support indeed a dedicated communication channel known as Chain 2 towards the home area network, based on a new PLC C-band open communication protocol. A P4 interface is not foreseen in the Italian regulation.

Gas sector

The current data exchange model is standardized at the national level and decentralized for both switching and consumption data, the DSO is in charge of metering, storage, validation (performed in 3 days after the reading), switching operations and communication of consumption data to the supplier. Despite this, also the gas sector is moving towards centralization.

A plan for the roll-out of gas smart meter is in place in Italy, but, to date, regulation does not oblige DSOs to take tele-metering.

Consumption data are stored in the DSO database for settlement purposes: at least 5 years of data must be stored with monthly granularity, if available, or calculated as load profiling. Suppliers are used to store data too. When centralization will be implemented the SII will store data sent by the DSO.

The client's contact point for changing supplier and billing communications is the supplier, the supplier's contact point is the DSO. The customer can access validated consumption data only on the bill. The Italian legislation and the Italian NRA foresees

in the future the possibility to allow customers access to their historic consumption data on the SII. In order to achieve this, specific regulatory interventions have to be put in place.

It is expected to align the gas sector to the electric one in terms of the role of the Sistema Informativo Integrato for both processes, switching and metering data communication flows. As of today, the evolution towards centralization is expected in 2018.

The communication architecture can be both be:

- Point-to-Point generally using the public telecommunication channel
- Point-Multipoint: the data is sent from the smart meter to the concentrator using a 169 MHz band frequency channel

A switching process usually requires 21 days to be implemented. During the last year 6.6% of the domestic and non-domestic PdR (Punti di Riconsegna, point of delivery) have switched their supplier. The switching process in on the way to be centralized as already done for the electricity sector.

The customer receives a single bill from his supplier, cointaning also the part related to transmission and distribution tariff. In case a smart meter has been already installed (and remote - reading is active), he pays every month for his effectively consumed energy based on his realized profile. Otherwise he pays at least every 4 months in case his consumption is below 500 Smc/y, every 2 months if consumption is greater than 500 Smc/y but below 5000 Smc/y, every month for consumption above 5000 Smc/y. Statistics on incorrect billing are not available as the Regulator has introduced monitoring from 2017.

The data exchange for both billing and switching occurs and will occur using a national specific communication standard based on XML (CSV can also be used as XML is not yet mandatory).

The roll-out of smart meter for gas supply has been launched by the AEEGSI and is ongoing. The roll-out is expected to cover 100% of big and medium customers and approximately 40-50% of the total PDRs (Punto di Riconsegna) dedicated to small customers by the end of 2018. This percentage is differentiated on the basis of the DSO's size and varies between 8%, 33% and 50%. Data storage is included among the functionalities offered by these devices. As of today, daily granularity for G4/G6 categories is included among the technical functionalities as set by the Regulator.

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Lithuania (LT)

In Lithuania, as a consequence of the differences between the electricity and the gas market structure, the data collection and management system is organized in a different way.

In the electricity market, the DSOs are responsible for data collection and management. The DSOs forward the consumption data to the corresponding supplier via a special webpage. There are three DSOs responsible for households. However in reality one large DSO serves almost 100 percent of the households, which is at the same time also the public electricity supplier. As a result, the data collection and management is de-facto centralised. The consumption data has mainly monthly granularity and stored by the DSO. Customers can have access to their historical data on the DSO web portal. Meanwhile third parties can have access to consumption data only when direct consensus from consumer is received. After that, the third party can use the DSO`s information sharing portal or web service to access the customers' consumption data.

The consumption data collection method follows a national standard on both markets. The customers are entitled to read their own consumption data themselves, and register it electronically on the website of the DSO in case of electricity or the webpage of the supplier for gas. It is also possible to register it manually in a special booklet at multiple customer points all over the country. All data is considered validated after registration. A meter control and consumption data check is executed on a yearly basis, but this concerns only a part of the households.

The system is evolving towards a centralised and standardised data management system. A national plan aims to create a central data hub dedicated to electricity and gas consumption data collection and data management. Today this project is in an initiation phase, it is expected to be completed by 2024.

The electricity customers have several payment methods: self-service website, electronic invoice, and settlement booklet. Most of the consumers don't receive a bill on their consumption, although such option exists. Usually, the payment is realized at

the time when the customer registers its monthly consumption. However, consumers can also sign an average monthly payments agreement with DSO. In such case, consumer receive an electronic invoice on monthly basis, based on average consumption. DSO checks the consumers' consumption data once a year and correct the average calculation. Under this option, the consumers do not need to read consumption data themselves.

In the gas market all consumers have to choose an independent gas supplier, while in the electricity market, the household customers have the right to choose an independent electricity supplier or to buy electricity from the public supplier on a regulated price tariff. Most customers stay with a regulated energy price. In such case, the customer has a possibility to choose between a single time, dual (day-night) time and quadruple[35] (four time zones) time regulated price tariff.

There is a standard way for supplier switching procedure on both gas and electricity markets. Until now, only a very limited number of customers have switched supplier.

The smart metering deployment is in a test phase on both markets. Smart meters used in the pilot project send data on an hourly granularity to the DSOs. They are not equipped with a communication protocol with home applications. The metered data can be consulted on the DSO website with a one day delay. The smart meter rollout project is in the initiation phase. It is planned to finish rollout (100% smart meters installed for main DSO consumers) by 2024.

On the gas market, suppliers are the responsible to collect the consumption data and to forward it to the DSOs who are responsible for storing it. The system is decentralised: today there are five DSOs and eleven suppliers, but two main suppliers covering 98% of the market. There is no required standard in the data communication. Customers have access to their historical data on the suppliers` website. Third party access to data via the webpage is possible. The customers give their permission when signing a contract with a new supplier.

Luxembourg (LU)

The Luxembourg power and gas markets have been liberalized as of 2007. Customers can be divided into two categories: integrated and non-integrated supply customers. Integrated supply customers receive a unique bill, while non-integrated supply customers get separate bills for energy costs and grid charges. Residential customers are in all cases integrated customers.

Smart meters (*Smarty*) for electricity and gas are being installed by the DSOs as of 2016. They respect all 10 common minimum functionalities for smart metering systems recommended by the EC (Recommendation 2012/148/EU). Today (June 2017), about 10 percent of the connection points are equipped with a smart meter. By the end of 2019, a coverage rate of 90 (gas) and 95 percent (electricity) is targeted. Smart meters are the property of the DSOs.

The data management system, both for electricity and gas, is organized mainly decentrally. The seven electricity and gas DSOs are responsible for consumption data reading and validation. For collecting and validating data from smart meters, all DSOs came together to set up a central system that they manage commonly through an economic interest group (Luxmetering GIE). The electricity smart meters bundle electricity and gas (and potentially water and heat) measurement data and sends it in anonymised form to the Luxmetering central system on a daily basis. Communication occurs via PLC to concentrators located in local transformer stations and via GPRS or

[35] If consumer has a smart meter

fibre from the concentrator to the central system. Luxmetering sends the data to DSO, who match the anonymised data with customer data and forward it to suppliers.

Suppliers (DSOs) are required by the ILR[36] Regulation E16/30 to store consumption data for integrated (non-integrated) supply customers for up to 50 months. They are allowed to keep data for up to 15 years. Data from the smart meter is collected once day (although this could be increased technically). The smart meter can store data for the last 3 months (15 minutes granularity), but there is no legal obligation.

For communication between DSOs and suppliers, end-to-end authentication is ensured by the AS2 protocol. Messages for implementing a supplier switch are based on EDIFACT for electricity and on CSV for gas. Billing is still based on a national-specific format (paper bills), but will be EDIFACT-based in the future (for electricity). As the new market communication model only went live on 1 October 2017, performance indicators illustrating the overall efficiency of the data management system are not yet available, but the system is constantly improved by the DSO in collaboration with all concerned stakeholders. Technical adaptations to the market communication process are implemented after consultation with stakeholders through an online forum, while the rules of the market communication model are fixed and adapted by the Regulator after extensive public consultation.

Integrated supply customers are entitled to access to the validated data stored via their supplier. In practice, this access could be improved, as it is currently generally only possible via the bill (for the billing period) and via a one-off request to their suppliers. Some suppliers offer web portals providing access, but they are not compulsory. Third parties can access the validated data once, by means of a one-off request to the supplier and only with the explicit consent given by the customer (a form or via the web portal of the supplier). Access to real-time data and associated services are under development. The customer can access either through a device connected to the P1 port of the smart meter (10 second non validated data) or post-meter devices connected with a traditional (digital or analogue) meter. Currently, the smart meter foresees one single P1 plug-in for providing third parties access to it. To activate the P1 port, there is a security key that has to be provided by the DSO.

Latvia (LV)

In Latvia the electricity market is fully liberalized as of 2015. The gas market is currently undergoing unbundling procedures, which started in 2017. The regulation aims to mimic the same system as used in electricity market.

There are decentralized data collection and management systems in place for both electricity and gas markets. DSOs are responsible for data collection and validation. However, both markets de-facto work as a centralized one, as both are dominated by one DSO. In the electricity market, one single DSO owns 99% of the market, while on the gas market there is one single DSO today. There is no regulated standardization for collection and management process. However, due to the high concentration, in practice there is one main type of procedure in place. There is an intention towards standardization of the small DSOs' procedure.

In both markets, the supplier receives the validated consumption data from the DSO. The customers give permission to the supplier to interact with the DSO in their name when signing the service contract with the supplier. A third party can have access to the consumption data provided the customer gives its approval. In case of electricity, customers give its approval on the DSO website. In case of gas, it happens in a paper

[36] Institut Luxembourgeois de Régulation

format. The DSO is obliged to share the data, however the granularity of the shared data and the form of sharing is not detailed in regulation.

Consumers with smart meters can follow their own consumption on the DSO`s website, with a one day lag. Those customers who do not have a smart meter yet can ask the supplier for historical consumption data, on an extra cost. The DSO has no specific regulatory obligation about the communication format or consumption data granularity towards the customers.

In both markets there is a single billing system in place. The bill includes the energy and grid charges. The most often used way is to pay a flat price for a monthly average consumption, however there is a possibility to choose spot price in in case for electricity. The invoice and the realized consumption is reconciled on a yearly basis. Those one, who have smart meter they pay after the realized consumption. Via the smart meters the DSO collects hourly data, which is stored for three years.

Supplier switching process in both electricity and gas market has to be realized by law in 15 days.

The smart meters are owned by the DSO, the customers don't have to pay additional fee for installation or maintenance (costs are integrated in the grid charges). The current smart metering coverage in the electricity market is 30 percent. The major DSO has its own ambition to reach full coverage by 2022. In the gas market the smart meter spill-of is in a very early stage.

Netherlands (NL)

The Dutch retail market was liberalized in 2004. Issues related to data treatment caused problems for the billing (delays, erroneous information) and for the supplier switching. This led to a major reform of the system in 2013[37].

After a positive cost benefit analysis in 2010, the Netherlands have opted for a smart meter rollout for electricity and gas for household consumers and SME's. By 2020, it is projected that more than 80 percent of the consumers will have a smart meter. The replacement of the traditional meter by a smart meter is organized by the DSOs.[38] . In principle, the roll-out is mandatory. However, one can opt-out, either by refusing the installation of the smart meter, or by choosing the "administrative off" setting of the installed smart meter.

Energy suppliers occupy a central role in the Dutch market model. They are responsible for collecting, validating and computing meter data of household consumers and SME's. The suppliers assign this task to certified metering companies. Suppliers are the main contact towards the customer. They send the energy bill to the customer and initiate the supplier switching processes, they interacting with the DSO via the centralized database.

The most relevant master and consumption data, needed to execute activities like switching, billing or moves is stored in a central database, managed by the DSOs.[39] For (traditional) meters the DSO obtains a meter reading at least once a year. In case of a smart meter, data is read via the P3 ones every two months and if the situation changes (e.g. switch to another supplier or move). Consumption data is typically stored for 5 years (at least yearly data, 2-monthly data in case of smart meters) in the central database. Data is also stored in the smart meter (15 minutes data for maximum 30 days, or 2-monthly data for a longer history).

[37] "*Stroomopwaarts*"

[38] The consumer does not have to pay for the replacement[12], while he continues to pay a rental fee at the same level as for the traditional meter

[39] The ICT infrastructure is set up by EDSN (Energie Data Services Nederland).

Neither the customer nor third parties (except the customer's current supplier of course) have direct access to the central database. Customers can access their historical and validated data only via a one-off request to their DSO or supplier. Via the P1, they can access real-time data and the data stored in the smart meter (both non-validated). Note that the P1 is not provided directly by the DSO with the smart meter, but it is installed by the supplier. There are currently discussions about compulsory DSO websites, giving customers access to consumption data stored in the central database. A third party can access the data stored in the smart meter only, via a request through the P4 (communication central database – third party) and the P3 (communication customer – central database). The third party has thus access to a limited history only.

In principle, a third party needs the customer's consent to access consumption data. For the data shared via the P1, this is straightforward, given that access occurs through a plug-in device. Currently, there is generally only one single connection possible at the same time and P1 data formats are not always standardized.

Dutch DSO's have a shared vision on energy data. While realtime energy data can show us detailed information on lifestyles, the consumer has his right to his own privacy. Therefore DSO's will take responsibility in ensuring a secure access exchange of data and enabling the consumer to manage who has access to his smart meter data.

An ecosystem which gives consumers control over their energy data will make this possible. Via a personal interface consumers can give third party service providers access to their smart meter data. The ecosystem only provides authorization and a data infrastructure direct from sensor to service provider. By offering this infrastructure DSO's create a level field for third party service providers. Creating access to smart meter data in a non-discriminatory way will stimulate new, innovative products and services that match consumer's needs.

In the Netherlands, there are many services and applications (52 in 2017) that work with meter data from the smart meter (either through P4 or P1). They range from free and paid web based consumption feedback services to in house devices which show real time consumption.

Poland (PL)

Collection and management of electricity consumption data is decentralised in Poland. The DSOs are the responsible parties for collecting and storing the data, and also for communicating it towards the suppliers.

There are five main DSOs in the country, which are at the same time also electricity providers for the majority of polish households at a regulated retail price. A smaller amount of household customers have switched to independent suppliers that provide electricity at an unregulated market price. All DSOs follow their own communication model towards both customers and suppliers, fulfilling obligations set by the regulation.

In the future, the system would evolve towards a centralized model. There is an initiative to create a data centre hub, which would be responsible for consumption data collection. Under this umbrella the communication would be unified, implementing the EDIFACT standard. The DSOs are keeping their key role in the creation of the new data management system, as the data hub project is supposed to be realised by a joint venture company of the DSOs.

Customers can consult their historical consumption data on the bill they receive. They also have the possibility to download it from the DSO`s website or from the website of

the independent supplier, in case the customer had switched supplier. Third parties can have access to data directly from the DSOs web portal or through a one-off request. The permission to access data is given by the customer itself, when he or she signs the contract with the new supplier.

Supplier switching duration time takes an average twenty-one days. The planned implementation of the new data hub includes the target to reduce this duration time to a maximum fourteen days.

Customers normally receive a single bill on a monthly basis. Whenever the customer has switched to an independent supplier and the DSO is not the energy supplier anymore, the customer receive a separate bill for energy and grid charges.

The smart meter coverage in the country is around eight percent. The roll-out is an initiative of the DSOs, who are indeed the owners of the equipment.

Portugal (PT)

Portugal has a centralized data management system. This system is a result of a Cost-Benefit Analysis performed and its formats and processes develop under regulatory processes. The system, called SGL, is managed by the main DSO in the country and is meant to store the energy consumption data from all the DSOs in the Continental Portugal. This system gathers data from smart meters as well as telemetered data every day. Manual readings are performed on conventional meters at least 4 times per year. For conventional meter without an updated reading in the SGL in the last 24 hours the consumption is estimated.

It is expected that the system will remain centralized. In 2015, an analysis was made regarding the substitution of the SGL by a more advanced data storage application called EDM (Energy Data Management). The main DSO is in the process of developing this new system which is expected to be deployed in 2019.

The daily average of the total process runtime (from reading to validated data) is 14 hours. The DSOs in the Continental Portugal (the main one as well as the other much smaller DSOs) are responsible for consumption data reading, validation and storage. Each DSO must also provide its readings to the central data hub which stores the data in an easily accessible format. The time required for validation is less than 24 hours

Consumption data is stored in the DSO database, in the central data hub and in the smart meters. Different requirements are demanded in terms of history and granularity: 5 years with a quarter-hour detail is the requirement of the data stored in the DSO's database, 3 years of history with the same granularity are required to the consumption data stored in the Central Data Hub, smart meters, if installed, must be able to store instead 5 years of consumption data with a daily granularity.

Customers have access to their own historic validated consumption data through their bill, the compulsory DSO web portal and the central data hub (who both have to provide also historic non-validated data) and the compulsory Supplier web portal. Further, the DSO and the supplier must be able to provide the same data if one-off customer request is received. Non-validated historic and real-time consumption data is also available via the meter display or the In-home display connected to it (H1 interface), the same smart meter does not allow to read the data through a smart meter gateway though. The compulsory DSO web portal gives also access to real-time non-validated data and validated data, while in the supplier web portal only real-time validated data is instead available, no access to real-time data is possible through the central Data Hub web portal.

Once excluded the bill, the smart meter display and the In-home display, a third party can have access to customer consumption data (either historic, real-time, validated and non-validated) through the same channels available to the customer. The third party can access the data only if provided of the customer's consent, managed by the DSO. The customer on his side can also see who has access to his consumption data through a dedicated website managed by the DSO who accesses the data directly in the SGL application. There is also a portal associated with the switching process. That portal communicates the switching with the SGL.

Despite the smart meters do not have a full coverage yet, the average switch requires just 4 days to be implemented. The contact point is the DSO, who is responsible for the necessary data exchange.

The uncomplete smart meter deployment seems to affect the procedures currently valid for billing. The bill is unique and monthly sent by the supplier. If no remote reading values are available, the DSO performs at least four manual meter reading per year. The customer either pays for his effectively consumed energy based in those readings, or in the period not covered by readings, based in an estimation of the electrical energy consumption performed by the DSO (to be corrected after the next meter reading data is available). Estimated consumption values are based on a standard profile. As for smart meters deployment, the current target is to install 3 million of smart meter by 2020, reaching so approximately 50 percent of the customers, proceeding with the smart meter installation until 100% of costumers are reached. The smart meter installed remains ownership of the DSO.

There are currently two different generations of smart meters in the country. The first one, belonging to phase 1 deployment, with 35 000 units installed covers 0.58% of the meter points in the country is characterized for using PLC or GPRS as communication channel for data transmission. The second generation instead has a national coverage of 18%, serves approximately 1.1 million of customers (as of 2017) and uses PLC PRIME or GPRS as communication channel. The current and future device are compliant with the 10 common minimum functionalities for smart metering systems set by the EC through the Recommendation 2012/148/EU. Technically their hardware is specified to allow measures of current, voltage and energy every minute but the software is currently configured to register readings with 15 minutes granularity.

Gas sector

The Portuguese data management system for the retail market of gas is decentralized. Currently no evolution toward centralization is foreseen. The data is managed by the DSO according procedures that are not standardized. The DSO is responsible for data reading, validation and storage. Once read, consumption data are validated within the first 24 hours and then stored in the DSO's database where 10 years of historic data must be at disposal with a monthly granularity.

The consumer can have access to his own validated consumption data through his bill, using the compulsory supplier web portal. Anyway, both the DSO and the supplier must to furnish validated consumption data after a direct explicit request of the client. There are currently no channels that allow the consumer to get his own real-time consumption data.

While the central data hub does not provide access to the customer, a third party can have access to it for getting consumer's validated data. The customer's consent is an essential requirement to get access to the data: the consumer can assign it to a third party through a communication with his supplier who is accountable for managing the consent on behalf of his client.

During a switching the common contact point for both new and old supplier is the DSO. Normally the average time to implement a switch is 1 day. Currently the communication standard used is tailored for the country needs but in the future EDIFACT/EDIGAS will be used.

The customer pays every 2 months for energy consumption based on an estimation based on his historic demand. The DSO is responsible of the necessary data exchange with the supplier for billing purposes and uses and will use a communication standard designed specifically for the country.

Sweden (SE)

The current data exchange model is a nationally standardized decentralized system. The data is bilaterally exchanged by the main responsible parties for these activities: DSOs and suppliers.

The data management model is planned to be fully centralized by 2021.

Currently the DSO is responsible for consumption data reading, validation, storage and exchange. The DSO must store 10 years of consumption data with a granularity that depends on the rated current of the fuse: it is hourly for a rated current greater than 63 A, monthly otherwise. Also the supplier and the responsible for balance is obliged to store data. The supplier's database must satisfy the same requirements in terms of consumption data stored. Further, consumption data is also stored in the smart meters and eventually in the database of a third party appointed by the costumer.

Accordingly, the customer has access to his validated consumption data through the compulsory web portal provided by both the DSO and the supplier as well as on his bill or after a direct request to either the DSO or the supplier. Real-time or almost real-time non-validated consumption data is instead accessible on the smart meter display or the related in-home display (H1 interface) or contacting the DSO. New meters will provide new opportunities regarding real-time consumption data.

Only a third party in possess of the power of attorney granted by the costumer can access customer's validated consumption data. A direct contact with the DSO or, more unusually, with the client (who can collect the data previously from the DSO) are the two channels through which the third party can get access of validated consumption data. The DSO is accountable for managing customer consent and delivers the data to the designated third party following the same method used to provide data to the electricity supplier (Ediel Message). In other cases also the Supplier is accountable to manage customer's consent. That only after a power of attorney, signed by the customer, has been received.

The customer has then the right to request that a third party company receive his/her validated consumption data from the DSO. This is done with a power of attorney from the customer to the third party company who then present it to the DSO. The DSO will then report the validated consumption data to the third party company, in the same way and at the same time as to the supplier, until the customer moves or the power of attorney is revoked. The power of attorney usually also include access to the customers historical metered data which is supplied by the DSO when the request for validated consumption data is initially received from the third party company.

The switching process for an already existing customer takes maximum 14 days, in this case the overall process, when correctly performed, requires 12 steps including confirmation messages and meter values exchanges.

The customer receives generally two bills: from the DSO and from the supplier unless he is served by a vertically integrated energy company (in that case only one bill is

sent to the customer with both supplier and DSO information). Accordingly, whether the supplier belongs to a vertically integrated company impacts also the billing process.. Otherwise the flow of data to bill the energy consumption follows 3 steps: it goes from the meter value supplier to the DSO, from the DSO to the Supplier and then finally to the customer. The customer pays for his effectively consumed energy every 2 months based on his realized profile. Incorrect billing was received in 2016 in 0.35% of all the bills sent in the country. Within this already very small percentage in four cases out of ten missing or faulty meter values were the reason behind these errors in 2016 (0.0014% of the total bills: extremely low volumes).

Data exchanges for both switching and billing are performed using EDIFACT as communication standard. Though today this is a decentralized process it is working quite well and is fully automatic.

As for the smart meters deployment all Swedish customers have smart meters since 2009.

Slovenia (SI)

The Slovenian retail market was liberalized in 2007. Unbundling lead to the establishment of the DSO (SODO), which signed bilateral contracts with 5 regional distribution companies that were historically present. Due to this structure, consumer data is handled in a partially centralized way (at the DSO and regional distribution companies).

After a positive Cost-Benefit Analysis in 2014, Slovenia has opted for a smart meter roll-out for electricity for households and SME's. Currently, 52% of small consumers (< 43 kW) and all large customers are already equipped with a smart meter with PLC communication (2 generations). By 2025, it is targeted that every customer connected to the distribution grid will have one with the DSO being the owner of the meter.

The DSO occupies a central role in the Slovenian market model and is responsible for meter reading, data storage and data validation. Smart meters are read once a month, non-smart meters once a year. Customers can access their historic consumption only via their bill or via a one-off request through their supplier, which might be charged depending on the granularity of the data. Some suppliers also have a web portal but this is not mandatory. The DSO does not allow customers accessing their smart meter data via H1/P1 to avoid fraud. Third parties (only suppliers) need written customer consent and have access to data via a DSO web portal. Aggregators usually install their own smart meters to follow up on consumption in real time.

In 2016, 7% of household customers switched between suppliers. This switching process has to take place legally within 21 days. The communication standard between stakeholders used for switching supplier and billing currently relies on exchanging CSV-files. In the near future, this might be more standardized to ebIX technology.

United Kingdom (UK)

The British electricity market was liberalized in 1998, following the opening of the gas market 2 years before. Suppliers occupy a central role in the UK energy market, being responsible for data reading, validation and storage. Hence, currently the consumer data is managed in a decentralized way. With the advent of smart meters, this will change to a more centralized system with data being transmitted to relevant parties by a centralized Data and Communications Company (DCC).

The UK has targeted for all consumers to be offered a smart meters by 2020, with suppliers being the owner of the meter. The first generation of smart meters (SMET1) started in 2012/13 . With the introduction of a second generation (SMET2), the DCC has been set up to provide the communications and data transfer for smart metering data. DCC will provide access to smart meter data for its users (suppliers, DNOs, energy service companies or other third parties), subject to consumer consent (with certain exceptions, largely where that data is to be used for regulated purposes). The DCC is subject to the requirements of the *The Data Protection Act* 1998 (DPA), and under its license, must be a party to the Smart Energy Code (SEC) which details specific data protection measures. DCC does not store, analyze or have access to consumer data.

Devices in a Smart Metering System will communicate with each other and the DCC in a message format specified in the Great Britain Companion Specification (GBCS) document. All outgoing messages from Users (Service Requests and Pre-Commands) will be transformed from XML to GBCS format. The Smart Metering technical and security architecture is based on a suite of agreed, open standards, reflecting the UK Government strategy to facilitate the development of third party innovative solutions for consumer devices. These include standards relating to DLMS COSEM, ZSE, ASN.1, NSA Suite B cryptography and X.509 related IETF RFCs. The GBCS does not duplicate what is laid out in such standards but rather provides references to them. Communication is done through Zigbee.

For the old meters, meter reading is performed by the suppliers (or their agents) and/or more regularly provided directly to companies by consumers. The new, emerging system introduces remote meter reading through the DCC. Suppliers or other service providers can become members of the DCC and have access to consumer data if they receive the necessary approval from the client. After meter reading, customers receive a unique bill from their supplier on the basis set out in their contract. Data validation and storage will still take place at the supplier level. Consumers can initiate switching either through a new supplier or an intermediary (broker, website). Today, switching supplier takes about 16 days from the day the new supplier submits a request, with a legal limit of 5 weeks. Ofgem is currently redesigning the switching process, with the intention to move to reliable end of next working day switching by 2020.

Customers having a traditional meter can access their data via their energy bill, their meter (live reads only) or by contacting their supplier. When a smart meter is installed both historic and real-time consumer data can also be retrieved via the H1 interface. Following the miData initiative, suppliers will be obliged to have a web portal where customers and/or a third party can access their data. In the future, third parties will also be able to access data through the DCC, subject to customer consent. After giving consent, it is not clear whether the customer can see who has access to his data.

Participation of residential consumers to flexibility markets is allowed. However, the business of DSM flexibility so far is only developed for large consumers and not yet for residential clients.

The gas market in the UK is organized in a similar way as the electricity market. The industry codes for SMETS 2 hence also apply for gas.

Final comments

Data management models

In line with the requirements set in Annex I.1(h) and Annex I.2 of the 2009 Electricity and Gas Directives, CEER (2015) "*understands that there should be a national common standard for data content, data format and data exchange in the retail market*"[40]. Also, it recommends MS to "*explore the costs and benefits of harmonising these standards at a broader geographical area, namely at regional and/or European level*".

Whether a data management model relies on single formats and procedures depends on the level of granularity considered. Different layers can be distinguished:

1. **Role models:** Role models describe the stakeholders involved in the data management model and the way they interact with each other. Typical stakeholders involved are DSOs and suppliers, independent service providers and data exchange platform administrators. Data management models can involve the same stakeholders, but the way they interact can be different.
2. **Communication standards:** From a technological point of view, the main difference relates to the communication standard, or the language, used between stakeholders. There are a few international standards (EDIFACT, CIM), but communication standards can also be national-specific. However, even within a same communication standard (EDIFACT, CIM or a national one), it is not guaranteed that formats and semantic choices are unique at regional or national level.
3. **Policy choices:** Differences in data management models can be driven by national- or region-specific energy or economic policy choices. Data management differs according to the existence of taxes and surcharges to be considered in the communication protocols between stakeholders. Similarly, data management models differ in case of non-standard procedures foreseen in some regions or countries, often reflecting regional or national policy preferences (e.g. disconnection of a consumer for insolvency is possible in one region/country, but not in another region/country).

It was beyond the scope of the current study to assess all layers of differences that potentially exist within and between MS. Role models are studied by identifying the stakeholder(s) responsible for data management (consumption data reading, validation and storage) and by considering the way they interact in standard billing and supplier switching processes (the number of interactions between stakeholders for a standard billing and switching process was considered). Regarding communication standards, the general communication standard (EDIFACT, CIM or a national-specific) were looked at, without considering more detailed differences that may exist. Different policy choices were not assessed at all.

At national level, we conclude that all MS have high-level standardized national procedures implemented.[41] However, it is likely that not all of them

[40] CEER (2015), p.25

[41] In principle and based on the information received, Latvia has a decentralized data management system without standardization of procedures across the country. On the other hand, Latvia has one dominant DSO. De facto, one could argue that procedures

are fully standardized. Regional differences were not studied but there is anecdotal evidence that they matter. For instance, ensuring national standards can be more challenging if energy policy is a regional competence.[42] Hence, we cannot exclude that market participants face barriers even within a MS.

At EU level, we conclude that suppliers are likely to face strong market barriers from a data management perspective. The main implemented international standard is EDIFACT (BE, DE, FI, LU, SE), yet EDIFACT is a standard only at syntactic level but not at semantic level, i.e. it does not involve a common vocabulary. The CIM International Standard might become an alternative to EDIFACT, as CIM is a standard both on semantic and syntactic layers (FI is considering the possibility to switch to it). On the other hand, we find that a large number of countries have their own formats. Interoperability between MS of data management models can thus be questioned. Also, role models differ. In particular, we considered the number of interactions between stakeholders for a standard billing and switching process. Although this might be an over-simplified indicator, we can nevertheless observe a large variety of processes across MS. Again, regional differences regarding policy and communication format choices are expected to be stronger between than within MS. Even if 2 MS use EDIFACT as a basis for their communication, it does not necessarily mean that the communication is compatible.

Access to data and emerging energy and flexibility services

Easy access to accurate and timely data through smart meter deployment is a pre-condition for the emergence of flexibility and novel energy services. Today, **the level of smart meter coverage varies widely**, from MS having reached (almost) full coverage (e.g. FI, ES) to MS currently examining smart meter roll-out or running pilot projects (BE, HU, LT).

Smart meters do not necessarily comply with the 10 common minimum functionalities recommended by the EC (2012/148/EU) and in particular with those that can deliver benefits to customers, namely [a] (provide readings directly to the customer and any third party designated by the consumer), [b] (update the readings frequently enough) and [f] (support advanced tariff systems). For instance, functionality [b] ([f]) is not implemented in ES (DK). AT reports that all functionalities are possible, but can be activated only in specific contexts and only with the consent of the customer.

Consumption data access opportunities by customers and third parties between countries are heterogeneous. This is partially linked to the smart meter coverage. With the roll-out of smart meters the options for data access broaden. Due to the absence of a validation process, historical and (near) real-time data available directly from the smart meter is usually non-validated, except for AT and to a lesser extent for DE and LT. Progressively, MS facilitate customer access to historical consumption data on a web portal. The portal is provided either by the DSO, the supplier or, where available, the central data hub operator. At least one of these options is available in almost all countries where smart meters are being rolled-out. However, only a few countries make (near) real-time data available on compulsory web portals. The DSO web portal or direct contact with the DSO are the most common interfaces available for third

are standardized. For the UK, the Data Communications Company (DCC) has been mandated to contribute to the introduction of a central switching programme (ongoing). Consumption data can already be accessed through a central DCC interface.

[42] In Belgium, for instance, the so-called "Turteltaks" to finance renewable energy was raised in Flanders but not in Wallonia. This tax needs to be treated in the information exchange between suppliers and DSOs.

parties to access validated data. Non-validated data is usually available via the smart meter gateway and, in a few countries, via a compulsory web portal.

Giving and revoking consent is the key requirement on which customer control is built on, especially in light of the General Data Protection Regulation (GDPR, 2016), enforceable from May 2018. However, the information we gathered indicates that **a fully transparent consent mechanism is usually not implemented yet**:

1. For all the countries but PL the customer is the actor giving the right to third parties to access his validated consumption data;
2. A clear protocol that enables the customer to actively control third parties' access is defined in DK, EE, ES and PT;
3. FI, FR and UK are planning to enable the customer to exercise this control beyond the traditional consent or authorization. Other countries (Italy) have started a consultation process;
4. All other countries rely on the customer's consent, generally written but sometimes also oral;
5. For countries like EL, LV, PL and SI, this control is identified by the current energy contract: third parties (except the current supplier) are not meant to have access to validated data. The same can be said for other countries where current regulation has not disciplined access to validated data for third parties (beyond the chosen supplier): in principle third parties can't access to customer's validated data unless the customer delegates access to the web portal, when available. The most concerning observation was that in countries without well-defined data access procedures, clients grant access to third parties by providing credentials (like the password) to a web portal. This is problematic since clients lose control on the data once they have given their credentials.

Appendix

Electricity vs. Gas

country	comparison	main difference(s)
BE	similar	data granularity
DK	different	Gas has decentralized system (Similar to electricity by end 2018)
EE	similar	
FI	different	No liberalised gas market yet
FR	similar	Daily instead of hourly consumption data in case of a smart gas meter. Enedis (GRDF) responsible for electricity (gas) data treatment.
DE	similar	The data exchange in the gas market mirrors the electricity regulation. Data are stored decentrally, DSOs are responsible for metering and passing on information to the suppliers. The data format and message formats are the same.
UK	similar	The industry codes for SMETS 2 hence also apply for gas.
IT	different	fully decentralized yet
ES	different	decentralized system
NL	identical	
AT	identical	
BG	n/a	no info received
HR	different	Gas data is handled in a decentralized way (35 DSO's), electricity centralized at only DSO. As of 2018 gas evolves to a centralized system too. Communication for gas (billing and switching) well standardized through platform at market operator (HROTE). In electricity communication currently email-based but is being modernized (through SAP)
CY	different	No gas market
CZ	n/a	
EL	different	the unbundling process is still open

HU	similar	For households, there is one supplier on the gas market, three suppliers on electricity market. Communication of gas data consumption is eased between the DSOs and supplier by central data sharing platform. There is a motivation towards centralisation on the gas market, which is not seen on the electricity market.
IE	n/a	Only electricity questionnaire received
LV	similar	
LT	different	Electric data is collected by DSO, gas data is collected by supplier
LU	similar	data granularity
MT	choose	
PL	n/a	
PT	different	decentralized system
RO	choose	
SK	choose	
SI	different	decentralized system
SE	choose	

Table 16 Gas vs. Electricity data management

Technical terms explained

Multiple standards are defined for the energy industry and depend on the involved actors. In the following figure, some of the different standards, technologies and related actors are represented: the right hand side illustrates the interaction with classical consumers that are largely driven by commercial needs and the left hand side of the chart illustrates the emerging smart consumer that can provide demand response, owns an electric vehicle and distributed generation.

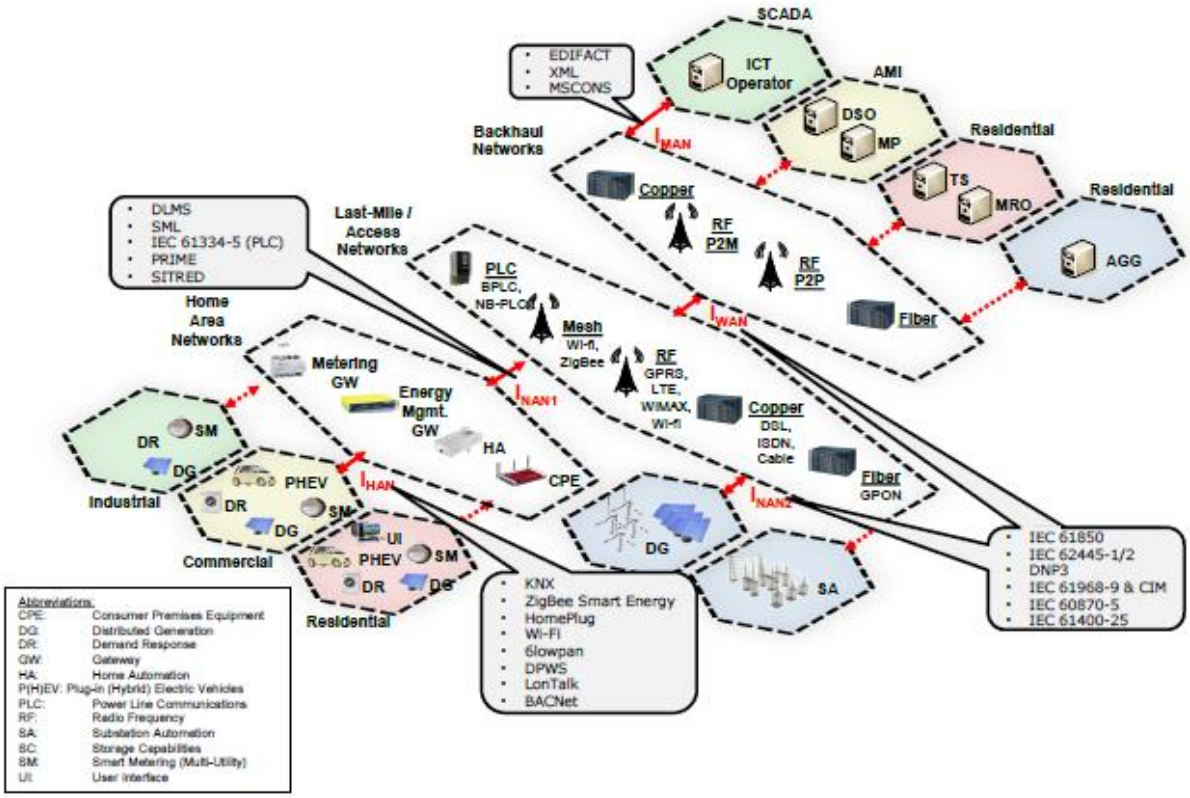


Figure 10 Smart Control of Energy Distribution Grids over Heterogeneous Communication Networks (2014)

This figure also reviews the possible technical terms that can be referred to in this study which does not always apply at the same level of communication. This part will help classifying each of them.

To help understanding the different layers these protocols apply and to which specific actors they relate, we suggest first to take a concrete example of power measurement with the French Linky system, then detail the terms that can be found in this study.

Example: The French Linky system

Linky is the name of the new Smart Meter of French TSO Enedis. Full details regarding this project can be found in France's country sheet.

In the figure billow, the Linky smart meter system is represented in a schematic view to identify the involved devices and the links between them.

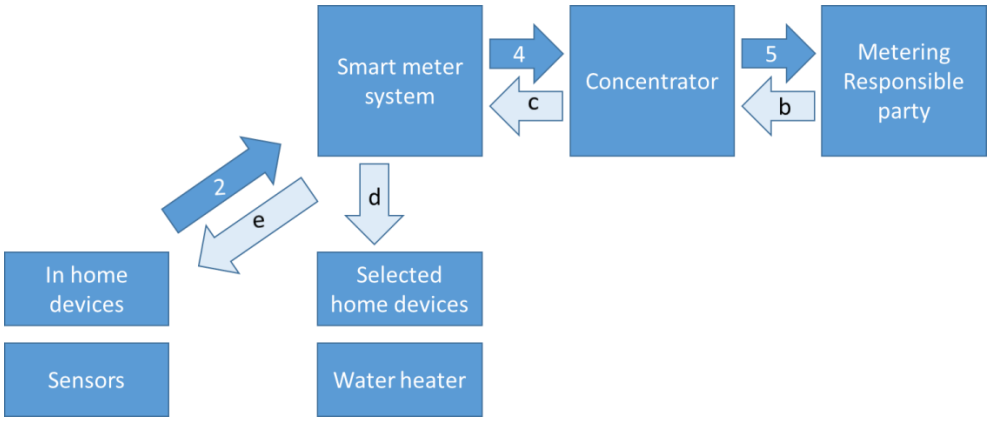


Figure 11 – Linky interactions with in-home and network devices

The smart meter system (Linky) can exchange information with in home devices, order specific ones and interact with the metering responsible party (Enedis). In home devices can be a device that manages photovoltaic panels, a charger for electric vehicles… etc. The concentrator reduces the amount of data collected from several smart meters to Enedis, or helps dispatching the orders given by it on specific smart meters. Note that, on this representation, additional parties can be added, like DSOs and suppliers, on the left hand-side. Those are taken into consideration in this study but not in this example.

Based on this representation and Enedis/CRE sources (see France's country sheet), protocols and standards used with Linky can be classified in the table below. Its first row matches the arrows id of the figure above and its first column identifies the layer the information applies to. Three main layers were identified from more physical to more abstract definition.

	2	4/c	5/b	
Physical link	EURIDIS Bus (CEI 61142-31:1993)	Power line	Wireless (Existing telecom infrastructure)	
Protocol	TIC (Enedis-NOI-CPT_54E)	PLC (ERDF-CPT-Linky-SPEC-PROFIL-CPL)		GPRS
Data format		COSEM		Unknown

Understanding to what layer a protocol applies to is mandatory to be able to define the technical specifications of an interchange.

Technical classification

The following part intent to classify the different protocols used in this document based on their level of appliance in a communication system.

Layers definition

Data syntax

The goal of the syntax is to ease the storage and the retrieval of information into containers. Most of the time, data are stored into files in the XML (eXtensible Markup Language) syntax. The meaning of security on data syntax would, for example, depend on whether the content of the container can be accessible or not by specific parties. The application of security would be, in this case, an encryption applied over the whole file which allows only authorized parties to have access to its content. The authenticity of the data is ensured with a certification appended to a container which is only verified when the data is unchanged.

Data semantics

Once the grammar or syntax is defined, rules regarding the data itself must be clarified too. A grammatically correct sentence does not always make sense. Such rules fall into the category of **Semantic Understanding**: rules governing the definition of things, concepts, and their relationship to each other. Together, they make up an informational model describing how the overall system works. A model is usually domain-specific.

Data protocol

The protocol describes the transmission method used between two – or more – parties. All protocols do not ensure the same constraints therefore they must be chosen depending on the use case. The mostly used protocol seen in this study is HTTP, which easily allows defining web-services. The meaning of security would be, for example, to ensure that data transmitted from A to B would not accessible from an (unauthorized) third party C. VPN can be used to ensure no one else than A and B communicate, SSL can be also used to trust the other party's authenticity (associated to HTTP it gives the so called HTTPS). HTTPS was the most used solution for web-services because of its ease of use.

Data security

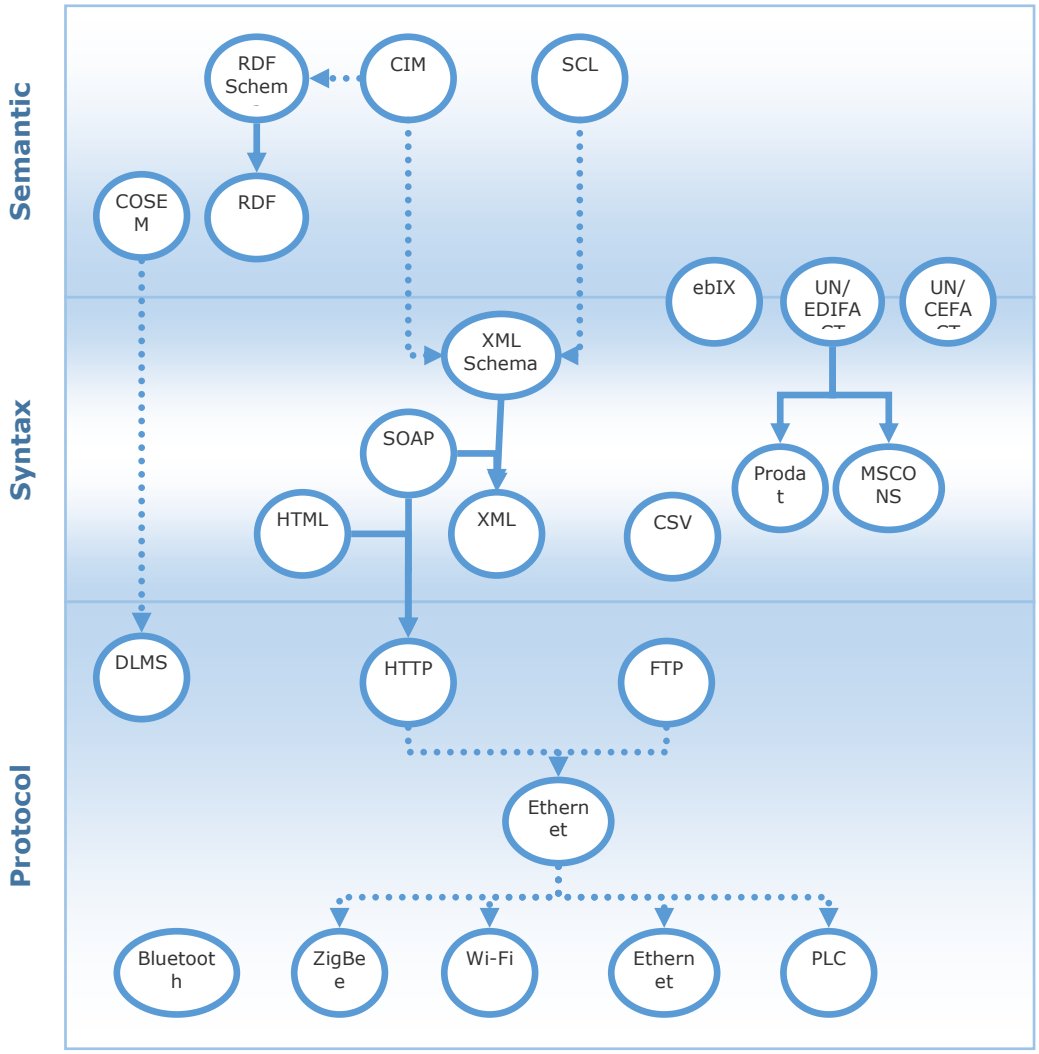
Data security is the set of methodologies and tools used to ensure the three main aspects of security: Confidentiality, Integrity and Availability. The first avoids unauthorized parties to access the information, the second ensures the information was provided by the declared author and no one else and the third claims that access cannot be prohibited or degraded by unauthorized parties. Security can be applied at all the different layers described above and has to be considered when defining each of them. It will therefore not be displayed as specific one.

Table-based classification

Based on the definition of the layers above, the proposed order is first, the definitions of the **protocols** used, then the definitions of the **syntaxes** that are transmitted through these protocols and finally the definitions of the **semantics** used above the syntax.

Representation

The following representation on what layer protocols apply. Dashed rows means the "preferred use of" while plain rows means "mandatory use of". Each protocol of a layer can use one of the above layer.



Definitions

Layers	Protocols	
Semantic	▪ CIM: standard that aims to allow application software to exchange information about an electrical network. It defines a common vocabulary, maintained as a UML model, and basic ontology for aspects of the electric power industry (IEC 61970-301). The IEC 61970-501 and 61970-452 standards define an XML format for network model exchanges using RDF. ▪ SCL: language and representation format specified by IEC 61850 for the configuration of electrical substation devices. Files exchanged respect pre-defined XML formats. SCL representation is sequential or hierarchical in nature and limited to exchange of data within substation equipment and tools. The IEC TC57 WG19 is involved in the harmonization CIM & SCL. ▪ RDF: model of data for objects or "resources" and the relationships among themselves, giving a simple semantic. This type of data model can be represented in XML syntax. ▪ RDF Schema: vocabulary that is used to describe characteristics and classes of RDF resources, with a semantic for the generalization and hierarchy of characteristics as well as of classes. ▪ COSEM: is an interface model of communicating energy metering equipment, providing a view of the functionality available through the communication interfaces. The modelling uses an object-oriented approach. It is a standard defined in IEC 62056.	▪ UN/EDIFACT: comprises a set of internationally agreed standards, directories and guidelines for the electronic interchange of structured data and, in particular, that related to trade in goods and services between independent, computerized information systems. Recommended within the framework of the United Nations, the rules are approved and published by UN/ECE in the United Nations Trade Data Interchange Directory (UNTDID). It provides a set of syntax rules to structure data, an interactive exchange protocol (I-EDI) and standard messages which allow multi-country and multi-industry exchange. EDIFACT does not require any specific transport technology but only gives the data format. Therefore EDIFACT is neither limited in regards to the physical transport medium nor in the employed transmission protocol. ▪ UN/CEFACT: Within the United Nations framework of the Economic and Social Council, the United Nations Economic Commission for Europe (UNECE) serves as the focal point for trade facilitation recommendations and electronic business standards, covering both commercial and government business processes that can foster growth in international trade and related services. In this context, the UN/CEFACT was established, as a subsidiary, intergovernmental body of the UNECE Committee on Trade, mandated to develop a program of work of global relevance to achieve improved worldwide coordination and cooperation in these areas.
Syntax	▪ Prodat: is a message format of EDIFACT sent to identify and describe products available for supply or for information purpose. This information includes only technical and functional product descriptions. ▪ MSCONS: is a message format of EDIFACT for consumption and metering data transmission. ▪ XML: language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The W3C organization defines the XML. ▪ XML Schema: language used to restrict the structure of the XML documents and to extend them with data types. ▪ CSV: CSV file stores tabular data (numbers and text) in plain text. RFC 4180 proposes a specification for the CSV format, and this is the	▪ ebIX: provides standardized and harmonized processes for the liberalized downstream electricity and gas markets with the focus on information exchange, following EU rules and allowing national customization. The modelling is based on open, international standards as from UN/CEFACT, OMG and IEC.

		definition commonly used. But in popular usage, "CSV" is not a single, well-defined format. ▪ HTML: language for creating web pages and web applications. It defines the structure of the document semantically which allows web browsers to render data in the most appropriate style. ▪ SOAP: protocol specification for exchanging structured information in the implementation of web services in computer networks. The specifications are exchanged through HTTP in XML-structured documents.	
Protocol	Data exchange protocol	▪ DLMS: is an application layer specification, independent of the lower layers and thus of the communication channel, designed to support messaging to and from (energy) distribution devices in a computer-integrated environment. It is an international standards established by IEC TC 57 and published as IEC 61334-4-41. ▪ HTTP: protocol to transfer hypertext – structured text that uses logical links (hyperlinks) between nodes containing text. Authentication is available as well as encryption (for the last it becomes HTTPS). ▪ FTP: protocol used to transfer any kind of data: text or binary. Authentication is available as well as encryption (for the last it becomes SFTP).	
	Physical protocol	▪ Wi-Fi: wireless technology for local area networking. Data exchanged over it can be encrypted ▪ Bluetooth: wireless technology for peer to peer data exchange. Encryption is always activated. ▪ ZigBee: is a radio technology for low-cost wireless links with reduced energy consumption. It defines local areas over ranges up to 100m and encryption can be added. ▪ Ethernet: ▪ as a physical technology, it describes how data is transferred through twisted wires. ▪ as a protocol, it describes how peers are identified inside a local area. ▪ PLC: is a communication method that uses electrical wiring to simultaneously carry both data and electric power.	
Physical link		▪ Power line: lines on which electric power is in transit. ▪ Twisted pair: a cable consisting of two wires twisted round each other. ▪ Bus: is a communication system that transfers data between electric components.	

Table 17: Layers and Protocols

Energy specific standards

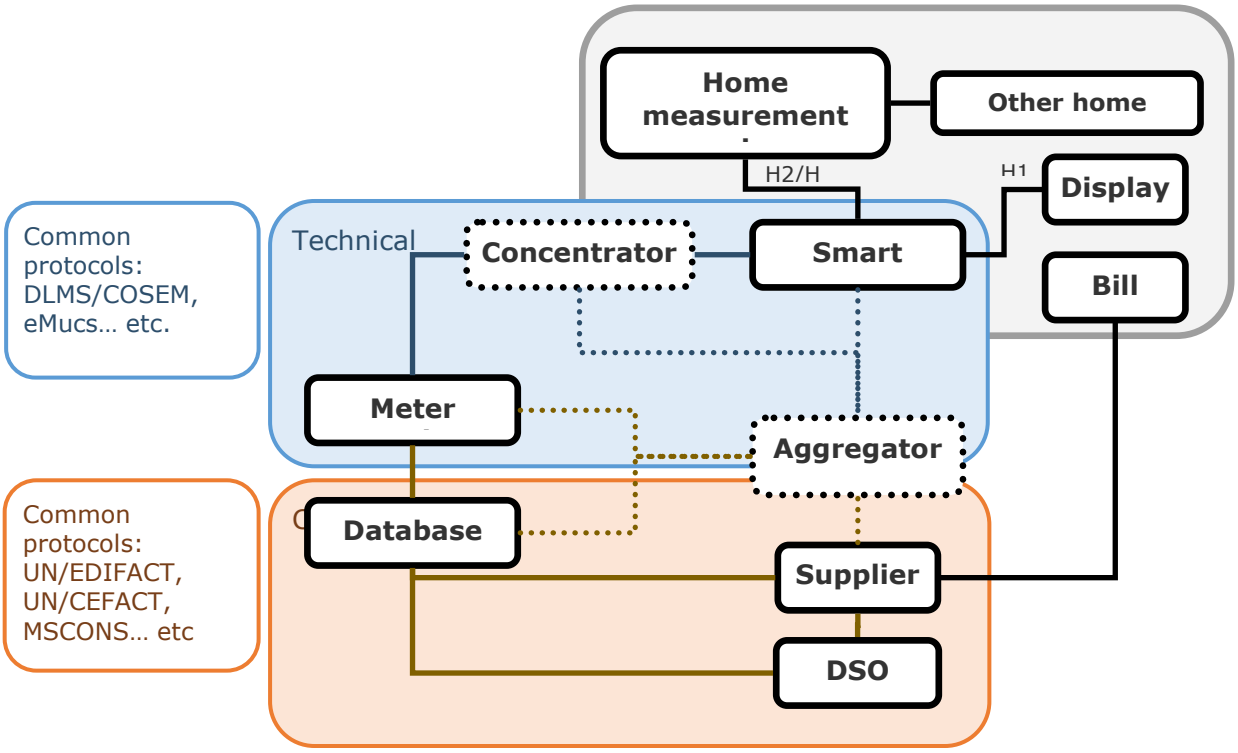
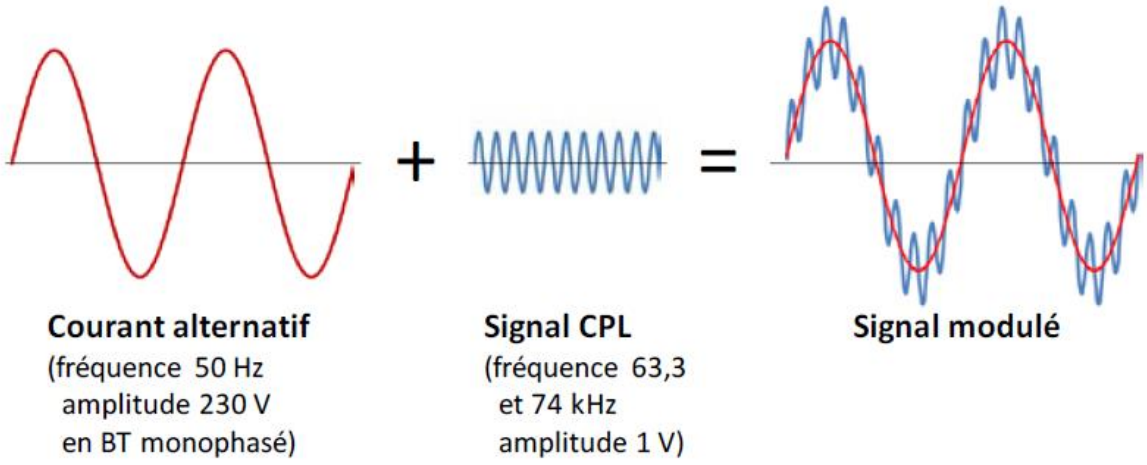


Figure 12 – Smart Metering: complete spectrum of potential parties involved and possible relationships

PLC

Power Line Carrier protocols are used in many Smart grid projects and for the Linky advanced metering system: a higher frequency, low-energy signal is superimposed on the 50 Hz alternating current on the power grid medium voltage, low voltage and downstream of the meter. This PLC signal makes it possible to transmit information, and in particular tariff signals, over the entire electrical network. It is received and decoded by any equipment having a PLC receiver of the same category located on the same electrical network. The TCFM operates on this principle at a lower frequency (175 Hz in most cases).

The PLC signals used in the Smart Grids projects and the Linky advanced counting system are in the CENELEC-A frequency range between 9 and 95 kHz. This is allocated to the communication of electricity system operators by standard NF EN 50065.



SOURCE: CRE

PLC communication principles

Switching and Billing Processes: roles and sequence description (electricity)

Together with the questionnaire our contributors have been asked to fill two further tables describing switching and billing processes. In a second step also the link to public documents describing those processes have been asked. Below a table summarizing for which countries we have received the tables filled and/or the link.

	Table Switching Process Provided	Table Billing Process Provided	Link to Public documents Provided
AT	Yes	Yes	Yes
BE	Yes	No	Yes
BG			
CY	No	No	No
CZ	No	No	No
DE	Yes	Yes	Yes
DK	Yes	No	Yes
EE	Yes	Yes	Yes for switching only
EL	Yes	Yes	No
ES	Yes although simplified	Yes although simplified	No
FI	Yes	Yes	Yes
FR	Yes	No	Yes

HR	Yes	Yes	No
HU	No	Yes	No
IE			
IT	Yes	Yes	Yes
LT	Yes	Yes	No
LU	Yes	Yes	Yes
LV	Yes	Yes	Yes for billing
MT			
NL	Yes, but in Dutch	No	Yes
PL	Yes	Yes	Yes for switching only
PT	Yes	No	No
RO			
SE	Yes	Yes	No
SI	Yes	Yes	No
SK			
UK	Yes	Yes	No

Table 18: Processes: information provided by contributors

Austria (AT)

Overview of processes (details for each process are available on request):

		Name of the excel-register		
Prozess	**Description**	**UseCase Description**	**Additional information**	**Process Description**
KUEND	Electronic notice of termination process	KUEND_UCD	KUEND_AI	KUEND_PD
WIES	Change Of Supplier	WIES_UCD	WIES_AI	WIES_PD
ANL	Installation search process	ANL_UCD	ANL_AI	ANL_PD
ANM	Enabling procedure	ANM_UCD	ANM_AI	ANM_PD
BELNB	Expression of interest process initiated at system operator	BELNB_UCD	BELNB_AI	BELNB_PD
ABM	Disabling procedure	ABM_UCD	ABM_AI	ABM_PD
VZ	Termination of energy supply contract for other reasons	VZ_UCD	VZ_AI	VZ_PD
STO	Abort process	STO_UCD	STO_AI	STO_PD
VOL	Transmission of power of attorney	VOL_UCD	VOL_AI	VOL_PD
VP	Power of attorney validation process	VP_UCD	VP_AI	VP_PD
IDZ	Installation ID selection	IDZ_UCD	IDZ_AI	IDZ_PD
ZUEM	Transmission of meter reading to supplier	ZUEM_UCD	ZUEM_AI	ZUEM_PD

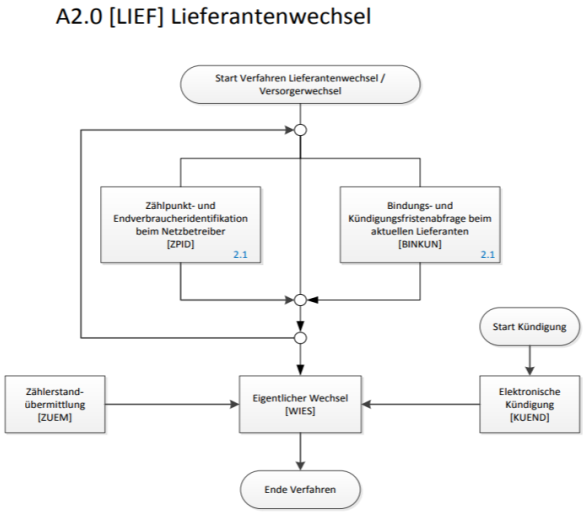
Table 19 Austria Overview of Processes

Switching process:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*request metering point and customer ID*	*new supplier*	*DSO*	*"ZPID"*
2	*check notice period*	*new supplier*	*old supplier*	*"BINKUN"*
3	*send meter reading*	*new supplier*	*DSO*	*"ZUEM"*
4	*implement contract*	*new*	*old*	*"KUEND"*

	termination	*supplier*	*supplier*	
5	*implement switching*	*new supplier*	*DSO - old supplier*	*"WIES"*

Table 20 Austria Switching Process



All processes related to traditional activities are described under http://ebutilities.at/.

Specifically for billing:

http://ebutilities.at/documents/20160502183211_ebUtilities-Invoice_03p00.pdf

Belgium (BE)

Switching:

Action	From	To
request	new supplier	metering point administrator
Rejection	metering point administrator	new supplier
Confirmation	metering point administrator	new supplier
End of supply notification	metering point administrator	old supplier
Unsolicitated cancel notification	metering point administrator	new supplier)
accesspoint master data	metering point administrator	new supplier
Historical Estimated Volumes	meter data responsible	new supplier
end index notification	meter data responsible	old supplier
Historical Consumption Data – Notification	meter data responsible	new supplier

Table 21 Belgium Switching Process

Link to public documents describing switching and billing processes:

Atrias. UMIG Marktprocessen :

http://www.atrias.be/FR/UMIG%2065/01%20Processus%20de%20March%C3%A9%20(Guide%20d'Implementation)/02%20Business%20Requirements/UMIG%20-%20BR%20-%20ME%20-%2003%20-%20Exchange%20Metering%20v6.5.pdf

http://www.atrias.be/UK/Publications_ProjectDocuments/L0%20Introduction%20to%20Market%20Processes%20FR.pdf

Cyprus (CY)

No table describing either switching and billing processes has been provided. No links to public documents describing these processes have been provided.

Czech Republic (CZ)

No table describing either switching and billing processes has been provided. No links to public documents describing these processes have been provided.

Germany (DE)

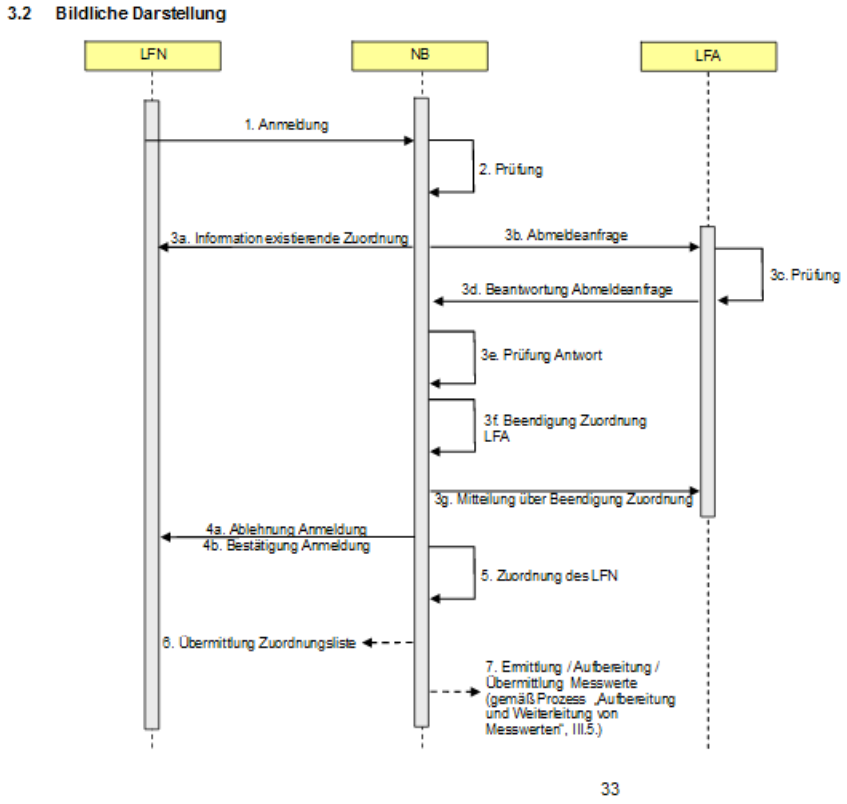
Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	termination request	new supplier	old supplier	UTILMD
2	confirmation/rejection	old supplier	new supplier	UTILMD
3	request	new supplier	DSO	Location, reason
4	Information on current mapping	DSO	new supplier	
5	termination request	DSO	old supplier	
6	response termination request	old supplier	DSO	
7	end of mapping to old supplier	DSO	old supplier	
8	confirmation of mapping	DSO	new supplier	
9	sending of mapping list	DSO	new supplier	
10	Historic consumption data	DSO	new supplier	

Table 22: Germany Switching Process – Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Request for meter reading*	*Supplier*	*DSO*	*regular or exordinary*
2	*Request for meter reading*	*DSO*	*meter operator*	
3	*send data*	*meter operator*	*DSO*	
4	*Checking*	*DSO*		*validation*
5	*if incorrect*	*DSO*	*meter operator*	*changed data*
6	*Final data send*	*DSO*	*Supplier*	

Table 23: Germany Billing Process - Electricity



BK6-16-200, ANLAGE 1

Figure 13: Germany: Switching procedure

Link to public documents describing switching and billing processes:

BNetzA-Festlegung "Geschäftsprozesse zur Kundenbelieferung mit Elektrizität", BK6-16-200
Electricity: https://www.bundesnetzagentur.de/DE/Service-Funktionen/Beschlusskammern/1BK-Geschaeftszeichen-Datenbank/BK6-GZ/2016/2016_0001bis0999/BK6-16-200/BK6_16_200_Anlage_1_GPKE_mit_Fehlerkorrektur.pdf?__blob=publicationFile&v=2
Gas: https://www.bundesnetzagentur.de/DE/Service-Funktionen/Beschlusskammern/1BK-Geschaeftszeichen-Datenbank/BK7-GZ/2006/2006_0001bis0999/2006_001bis099/BK7-06-067_BKV/Anlage_zum_Beschluss_BK_7-06-06_Id11200pdf.pdf?__blob=publicationFile&v=2

Denmark (DK)

Tables describing processes: switching process only

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Reporting of change of supplier to the DataHub*	new supplier	*datahub*	
2	*Approval of change of supplier in the DataHub*	*datahub*	new supplier	
3	*Sending of customer-related master data*	*datahub*	new supplier	
4	*Information to the grid operator and the old balance supplier*	*datahub*	*DSO and old supplier*	

Table 24: Denmark Switching Process - Electricity

Link to public documents describing switching and billing processes: https://en.energinet.dk/Electricity/Rules-and-Regulations/Market-Regulations

Estonia (EE)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*customer signs new contract with new supplier*	*Customer*	*New supplier*	*Sign contract online*
2	*new supplier notifies the old supplier*	*New supplier*	*Old supplier*	*Notify end of customer contract*
3	*old supplier ends the contract in the datahub*	*Old supplier*	*Datahub*	*Notify end of customer contract*
4	*old supplier notifies the datahub of the new contract*	*New supplier*	*Datahub*	*Notify datahub of new contract.*

Table 25: Estonia Switching Process – Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Request*	*Supplier*	*Datahub*	*Meter data*
2	*Send*	*Supplier*	*Customer*	*Bill*

Table 26: Estonia Billing Process - Electricity

Link to public documents describing switching and billing processes:
Link to public documents describing the Switching process: https://elering.ee/en/data-exchange#tab1
Link to public document describing the Billing process: not available

Greece (EL)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*contract*	*new supplier*	*customer*	
2	*request*	*new suppler*	*DSO*	
3	*approval*	*DSO*	*new supplier*	
4	*metering encapture*	*new suppler*	*DSO*	
5	*validation*	*DSO*	*new supplier*	
6	*confirmation*	*DSO*	*old and new supplier*	

Table 27: Greece Switching Process – Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*measurement capture and validation*	*DSO*		
2	*measurement sent*	*DSO*	*SUPPLIER*	
3	*measurement acceptance*	*supplier*	*DSO*	

Table 28: Greece Billing Process - Electricity

Link to public documents describing the Switching and Billing processes: there is no document or handbook available. The processes were designed in the past, they were approved by the regulator and then they were implemented via computer applications and so they are standardized leaving no area to the users to improvise or act outside the rules.

Spain (ES)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Switching request notification*	*New supplier*	*DSO*	
2	*Approved switching request notification*	*DSO*	*Old supplier*	*In case the request is correct and has been accepted by the DSO*
3	*Switch implemented*	*DSO*	*New Supplier*	*In case the request is correct, has been accepted by the DSO and the switch is feasible*
4	*Switch implemented*	*DSO*	*Old Supplier*	*In case the request is correct, has been accepted by the DSO and the switch is feasible*
2 bis	*Rejected switching request notification*	*DSO*	*New supplier*	*In case the request is not correct and has not been accepted by the DSO*
4 bis	*Rejected switching request notification*	*DSO*	*New supplier*	*In case the request is correct, has been accepted by the DSO but the switch is not feasible*

Table 29: Spain Switching Process – Electricity

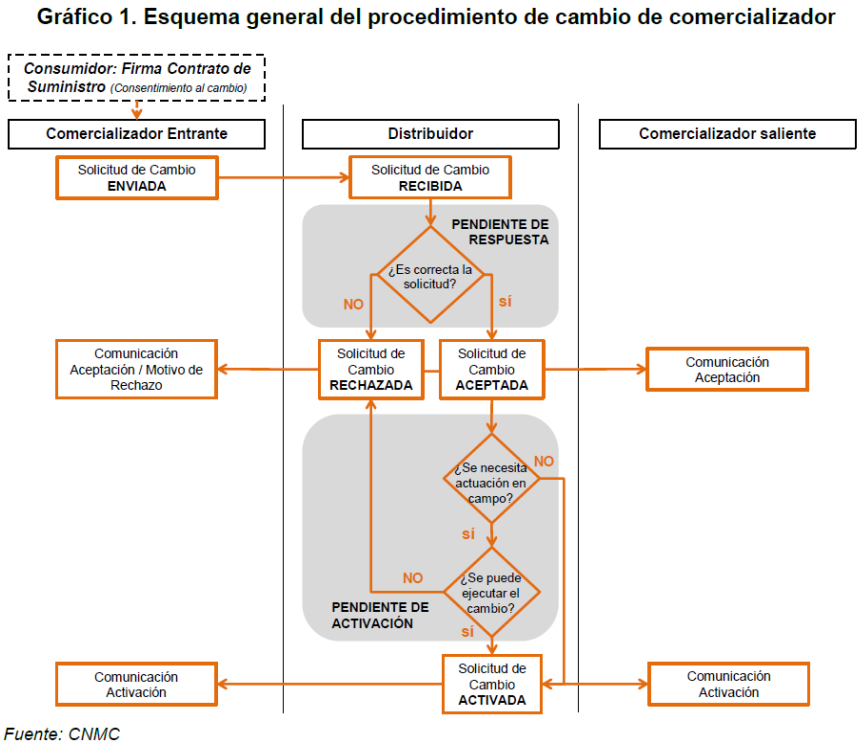


Figure 14: Switching process

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Validated data available in the SIPS and data acquisition*	*DSO*	*The supplier*	
2	*Final bill sent*	*The supplier*	*The customer*	

Table 30: Spain Billing Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Finland (FI)

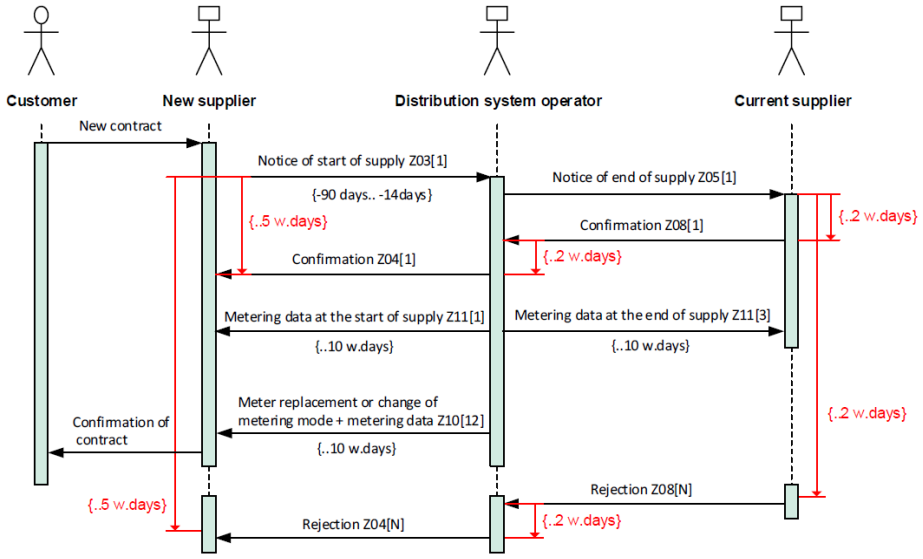
Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Start of supply notification*	*new supplier*	*DSO*	*new contract*
2	*Notification*	*DSO*	*old supplier*	*information on the new contract*
3	*End of supply notification*	*old supplier*	*DSO*	*confirmation/end of supply*
4	*Confirmation*	*DSO*	*new supplier*	*confirmation on the start of new supply*
5	*Notification*	*DSO*	*old supplier*	*meter data at the end of supply*
6	*Notification*	*DSO*	*new supplier*	*meter data at the start of supply*

Table 31: Finland Switching Process – Electricity

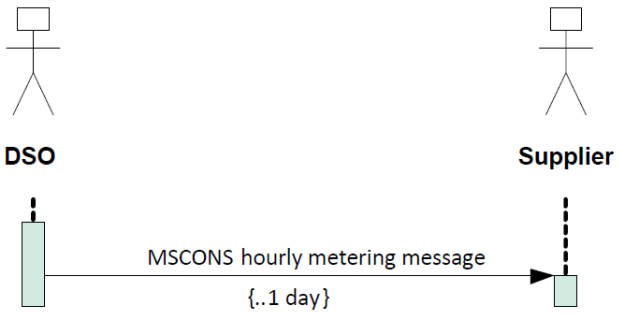
Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Send meter data*	*DSO*	*Supplier*	
2	*Billing the customer*	*Supplier*	*Customer*	

Table 32: Finland Billing Process – Electricity



SOURCE: Energiateollisuus

Figure 15: Finland Switching Process



SOURCE: Energiateollisuus

Figure 16 Finland Notice of hourly metered data to the Supplier

Links to public documents describing switching and billing processes:
https://energia.fi/files/1667/Message_exchange_and_procedural_instructions_in_the_electricity_retail_market_20161215.pdf
http://www.fingrid.fi/fi/asiakkaat/asiakasliitteet/Tiedonvaihto/2017%20liitteet/A%20new%20supplier%20in%20the%20Finnish%20electricity%20retail%20market.pdf

https://www.ediel.fi/en

France (FR)

Tables describing processes: switching process only

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Request*	*new supplier*	*DSO*	*Demande faite via portail SGE ou Webservices*
2	*Rejection*	*DSO*	*new supplier*	*Recevabilité ou non recevabilité en temps réel au moment de la demande du nouveau fournisseur*
3	*confirmation*	*DSO*	*new supplier*	*Recevabilité ou non recevabilité en temps réel au moment de la demande du nouveau fournisseur*
4	*notification beginning of contract*	*DSO*	*new supplier*	*flux C15*
5	*Access consumption data*	*DSO*	*new supplier*	
6	*notification end of supply notification*	*DSO*	*old supplier*	*flux C15*
7	*access denied date coonsumption*	*DSO*	*old supplier*	

Table 33 : France Switching Process – Electricity

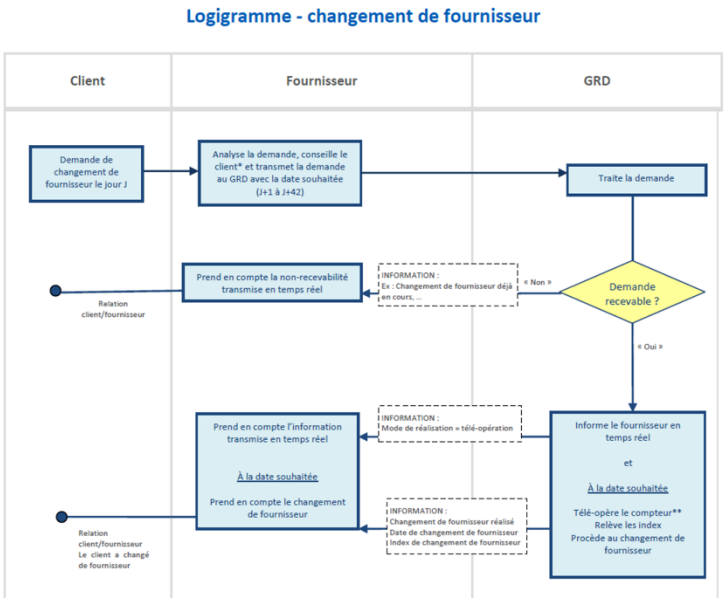


Figure 17: France Switching Process

Link to public documents describing switching and billing processes:
http://www.enedis.fr/sites/default/files/Enedis-FOR-CF_02E.pdf
https://www.gte2007.com/referentiel.php

Croatia (HR)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*request*	*new supplier*	*DSO*	
2	*rejection*	*DSO*	*new supplier*	
3	*correction of the request*	*new supplier*	*DSO*	
4	*confirmation of alignment*	*DSO*	*new supplier*	
5	*contract confirmation*	*new supplier*	*DSO*	
6	*confirmation of the request*	*DSO*	*new supplier*	
7	*End of supply notification*	*DSO*	*old supplier*	
8	*Access to historical consumption data, historical interval data and synthetic load profile category*	*DSO*	*new supplier*	
9	*Final consumption data*	*DSO*	*old supplier*	

Table 34: Croatia Switching Process – Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*meter reading*	*DSO*		
2	*consumption calculation*	*DSO*		
3	*billing*	*DSO*		
4	*sending data to supplier*	*DSO*	*supplier*	
5	*invoicing*	*supplier*	*customer*	

Table 35: Croatia Billing Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Hungary (HU)

Tables describing processes:

Billing: Sequence description	
Step number	**Action**
1	*DSO sends automatically the customer`s monthly consumption data to the supplier*
2	*The supplier sends the bill to the customer*

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Ireland (IE)

No table describing either switching and billing processes has been provided. No links to public documents describing these processes have been provided.

Italy (IT)

Tables describing processes:

Switching: Sequence description					
Step number	**Action**	**From**	**To**	**Main info/explanation**	**N° interactions**
1	*termination of the contract*	*new supplier*	*old supplier*	*To be sent by the 10th day of the month that precedes the date of the switching, that will be effective on the first day of the month M. It can be sent once the withdrawal period is expired*	1
2	*request for the termination*	*old supplier*	*SII (process manager)*	*By the next 3 working days following the receipt of the customer's recess. Step 1 and 2 will be unified in a next regulatory evolution: the new supplier will communicate the recess to the SII and the SII will notify the old supplier*	1
3	*switching request*	*new supplier*	*SII*	*To be sent by the 10th day of the month that precedes the date of the switching, that will become effective on the first day of the successive month*	1
4	*request acceptance*	*SII*	*DSO, old and new supplier*	*By the 8 working days after the acceptance, the new supplier can exercise his recess right once he gets some additional information on the credit (bad payment) history of the new customer.*	3
5	*settlement data*	*SII*	*old and new supplier*	*The SII sends the data needed for the settlement*	2
6	*switching data*	*DSO*	*old and new supplier*	*Technical and contractual data of the POD*	2
7	*switching reading and consumption data*	*DSO*	*SII, old and new supplier (only to SII in the future)*	*Measures (read by the DSO, by the client or estimated) to be ascribed to the switching date*	3

Table 36: Italy Switching Process - Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	DSO sends validated data meter each month.	*DSO*	*supplier/SII*	*DSO sends data to supplier and to the SII. Starting from February 2018, DSO will send data only to the SII and the SII will make them available to supplier. The data can be real or estimated but all data are validated.*
2	the Supplier issues and verifies that the bill is correct to send it to the customer	*supplier*	*customer*	*Supplier sends the bill to the customer. The bill must comply with the rules for integrated text for billing*

Table 37: Italy Billing Process - Electricity

Link to public documents describing switching and billing processes:

Link to public documents describing the Switching process:

- Delibera 487/2015/R/eel: https://www.autorita.energia.it/it/docs/15/487-15.htm
- DCO 544/2017/R/com: https://www.autorita.energia.it/it/docs/17/544-17.htm

Link to public document describing the Billing process:

- Delibera 463/2016/R/com: https://www.autorita.energia.it/it/docs/16/463-16.htm
- Delibera 501/2014/R/com: https://www.autorita.energia.it/it/docs/14/501-14.htm

Lithuania (LT)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*request*	*consumer*	*new supplier*	*consumer signs a contract with new supplier*
2	*notification registration*	*supplier*	*DSO*	*Supplier informs DSO about new contract with consumer. The notification is signed by supplier and consumer.*
3	*information*	*consumer*	*old supplier*	*Consumer informs old supplier following the requirements of the contract with old supplier. The step depends on the contract details.*

Table 38: Lithuania Switching Process - Electricity

Billing: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Declare consumption data and make payment*	*Consumer*	*DSO*	

Table 39: Lithuania Billing Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Luxembourg (LU)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*New supplier initiates switching procedure*			
2	*DSO confirms receipt of message*			
3	*DSO informs old supplier of request*			
4	*DSO confirms registration of new customer o new supplier*			
5	*DSO confirms end of registration to old supplier*			

6	DSO sends Meter reading to new supplier			
7	DSO sends Meter reading to old supplier			
8	DSO sends final bill for network charges to old supplier			
9	DSO send updated customer list to new supplier			
10	DSO send updated customer list to old supplier			

Table 40: Luxembourg Switching Process - Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	DSO reads meter / validates meter reading			
2	DSO sends meter data to supplier			
3	DSO sends bill to supplier			
4	supplier checks bill			
5	supplier pays bill			

Table 41: Luxembourg Billing Process - Electricity

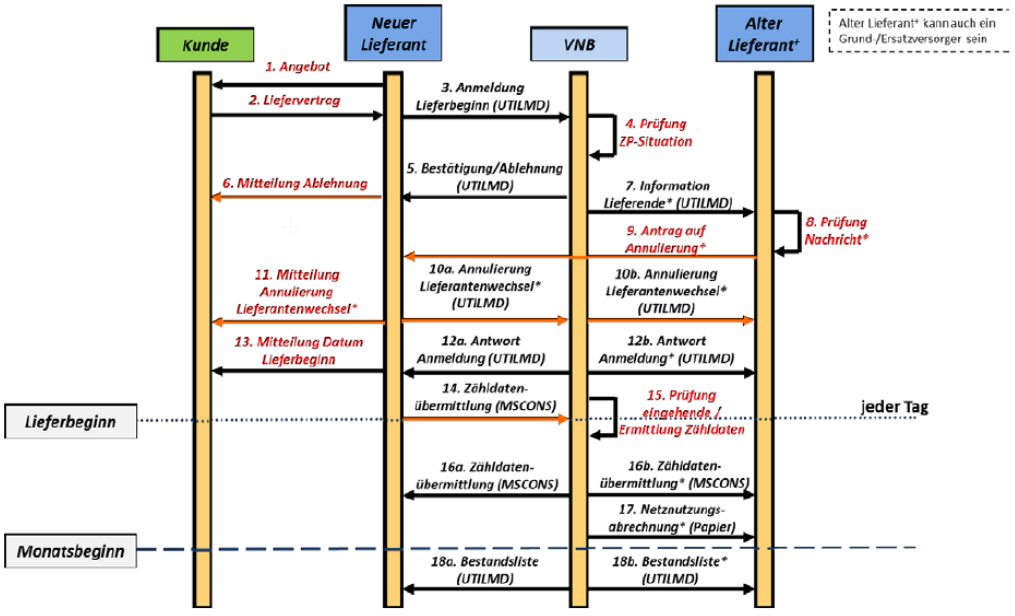


Abbildung 4[2]: Prozess Lieferbeginn (Einzug und Lieferantenwechsel)

Figure 18: Luxembourg Switching Process

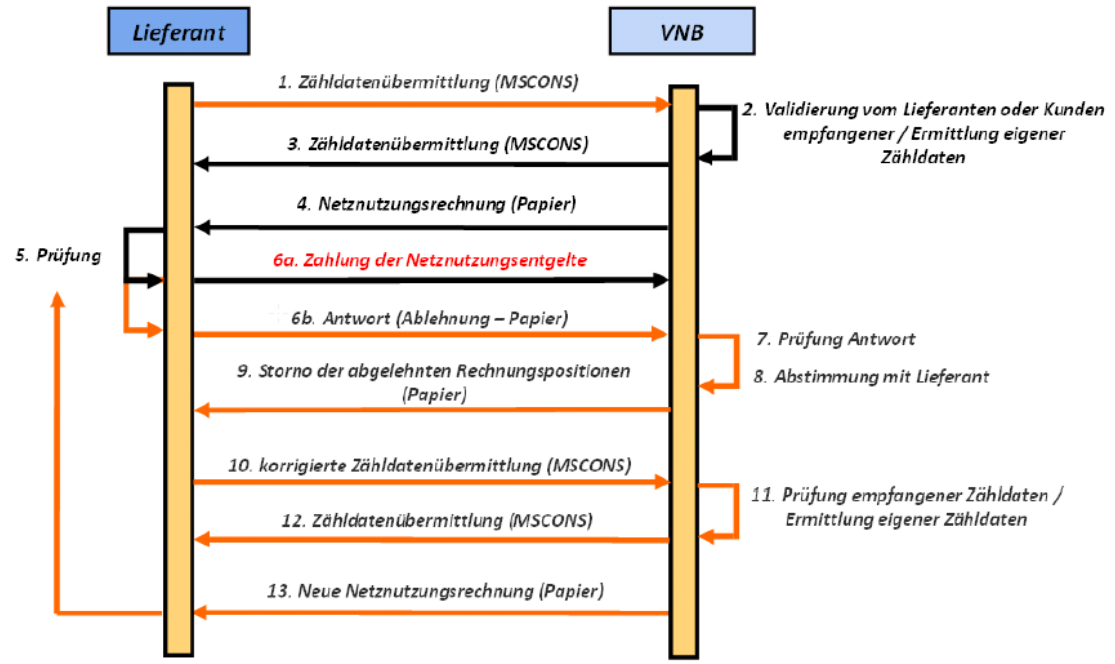


Abbildung 14: Prozess Netznutzungsabrechnung

Figure 19: : Luxembourg Billing Process

Link to public documents describing switching and billing processes:
Link to documentation on data formats:
Market communication Model – Electricity: https://luxmaco.vbulletin.net/filedata/fetch?id=874
Technical documentation (UTILMD) - https://luxmaco.vbulletin.net/forum/allgemein/current-luxmaco-documents/mdms-modell-der-marktkommunikation-strom/utilmd-aa
Technical documentation (MSCONS) https://luxmaco.vbulletin.net/forum/allgemein/current-luxmaco-documents/mdms-modell-der-marktkommunikation-strom/mscons-aa

Latvia (LV)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Customer picks new supplier*			
2	*New supplier till date 15 informs DSO about customers switching intentions*			
3	*DSO till date 25 informs the old supplier about planned switching*			
4	*DSO till date 25 informs the new supplier about planned switching*			
5	*Old supplier informs DSO on the end of contract time*			
6	*Within 5 days after switching DSO provides old supplier with final consumption data*			
7	*Within 5 days after switching DSO provides new supplier with start consumption data*			

Table 42: Latvia Switching Process - Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Customer hands in consumption information (in case of smart metering information is read remotely)*			
2	*Supplier access consumption information on DSO's database*			
3	*Supplier writes and sends bill*			

Table 43: Latvia Billing Process - Electricity

Link to public documents describing switching and billing processes:

Link for billing manual:https://www.sprk.gov.lv/lapas/legal-acts#legal-acts-in-electricity-sector

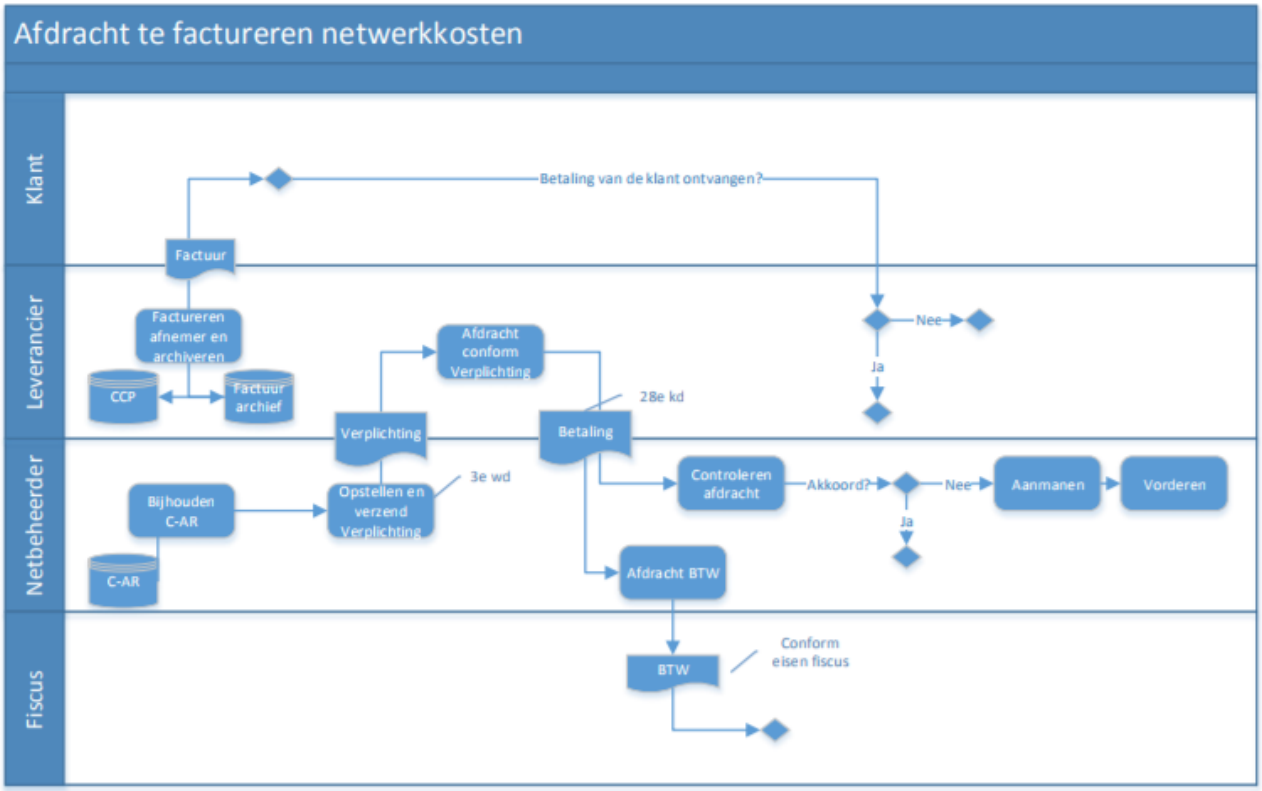
Netherlands (NL)

Tables describing processes: switching process

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	Consulting the EAN (European Article Numbering) codebook	*initiating supplier*	*DSO (through EDSN)*	
2	Consulting the Contract Control Protocol (CCP)	*initiating supplier*	*old supplier (through EDSN)*	
3	Consulting the access point metering data	*initiating supplier*	*DSO (through EDSN)*	*Historical consumption and meter readings*
4	Notification on supplier switch	*initiating supplier*	*DSO*	
5	Processing the supplier switch in the "connection register" and sending master data	*DSO*	*initiating supplier*	
6	Final meter reading	*initiating supplier*	*customer*	*Customer provides the meter reading or through P4 if smart meter*

Table 44: Netherland Switching Process – Electricity

3.3.1 Het Proces



Link to public documents describing switching and billing processes:

- DPM Mutatie- & meetprocessen KLEINVERBRUIK, V 4.0
- Detailprocesmodel Facturering en Afdracht v 9.0

http://www.nedu.nl/portfolio/klantprocessen/

Poland (PL)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Make Supply Contract (new Supplier with customer)*			
2	*request End of Supply with the old (current) supplier*			
3	*make new contract with DSO (customer - DSO) - if there is no current distribution contract*			
4	*Request Change of Supplier*			
5	*Supplier switch metering data*			

Table 45: Poland Switching Process – Electricity

Billing: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*data acquisition and validation*			
2	*calculation of the bill*			
3	*sending the bill to the customer*			

Table 46: Poland Billing Process – Electricity

Link to public documents describing switching processes:

ENERGA: http://www.energa-operator.pl/uslugi/zmiana_sprzedawcy/zasady_i_warunki.xml
ENEA: https://www.operator.enea.pl/zmianasprzedawcy/procedurazmianysprzedawcy
PGE: https://pgedystrybucja.pl/Dla-Klienta/Jak-zmienic-sprzedawce
Tauron: https://www.tauron-dystrybucja.pl/uslugi-dystrybucyjne/zmiana-sprzedawcy
Innogy: http://www.innogystoenoperator.pl/web/cms/pl/1734726/dla-domu/zmiana-sprzedawcy/informacje-o-procesie/

Portugal (PT)

Tables describing processes: switching process only

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Client asks for new contract*	*Client*	*New supplier*	
2	*New supplier asks for switching operation*	*New Supplier*	*DSO*	*The DSO evaluates the new contract and if it is necessary to make any intervention in the consumer's facility. If so, that need is communicated to the new supplier. Otherwise, the process continues to the next step*
3	*Activation communication and invoicing*	*DSO*	*Old and new Supplier*	
4	*Activation communication to client*	*New supplier*	*Client*	

Table 47: Portugal Switching Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Sweden (SE)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Request (Z03L)*	*Supplier*	*DSO*	
2	*Confirmation that the message is received*	*DSO*	*New Supplier*	*Confirmation that the DSO has received the request*
3	*Acceptance of the supplier switch (Z04L)*	*DSO*	*New Supplier*	*Confirmation that the request is accepted and information regarding the customer site*
4	*Confirmation that the message is received*	*New Supplier*	*DSO*	*Confirmation that the Supplier has received the acceptance message*
5	*End of delivery message (Z05)*	*DSO*	*Old Supplier*	*Message ending current supplier's delivery*
6	*Confirmation that the message is received*	*Old Supplier*	*DSO*	*Confirmation that the old Supplier has received the End of Delivery message*
7	*Start Meter value is sent*	*DSO*	*New Supplier*	*Start Meter Value so the supplier can start their delivery*
8	*Confirmation that the message is received*	*New Supplier*	*DSO*	*Confirmation that the Supplier has received the meter value*

9	*End Meter value is sent*	*DSO*	*Old Supplier*	*End Meter Value so the old supplier can finalize their billing*
10	*Confirmation that the message is received*	*Old Supplier*	*DSO*	*Confirmation that the Supplier has received the meter value*
11	*Consumption prognosis (S02) sent*	*DSO*	*New Supplier*	*A consumption prognosis sent regarding the site*
12	*Confirmation that the message is received*	*New Supplier*	*DSO*	*Confirmation that the Supplier has received the message (S02)*

Table 48: Sweden Switching Process - Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Collect meter values*	*Meter*	*Meter value supplier*	*Could be an external supplier or the DSO*
2	*Send meter values to DSO*	*Meter value supplier*	*DSO*	
3	*Validate meter values*			*DSO validate the meter value*
4.1	*Send meter values to Supplier*	*DSO*	*Supplier*	
4.2	*Create invoice*			*Both the Supplier and the DSO creates an invoice if you not a vertically integrated company.*
5	*Validate Invoice*			*Validate that the created invoices are correct*
6	*Send Invoice to customer*	*Supplier/DSO*	*Customer*	*Sent thru various channels. Digital as well as paper*

Table 49: Sweden Billing Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

Slovenia (SI)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*request*	*new supplier*	*DSO*	
2	*Rejection*	*DSO*	*new supplier*	
3	*Confirmation*	*DSO*	*new supplier*	
4	*End of supply notification*	*DSO*	*old supplier*	
5	*Acquiring meter data*	*DSO*		
6	*Final settlement grid fees*	*DSO*	*old supplier*	
7	*Confirmation of change*	*DSO*	*old supplier and new supplier*	
8	*Registry of consumers*	*DSO*	*new supplier*	DSO registers the new supplier in the register of consumers

Table 50: Slovenia Switching Process – Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*meter reading and fees calculation*	*DSO*	*supplier*	
2	*invoice preparation and sending*	*supplier*	*customer*	
3	*grid fees invoicing*	*DSO*	*supplier*	

Table 51: Slovenia Billing Process - Electricity

Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

United Kingdom (UK)

Tables describing processes:

Switching: Sequence description				
Step number	**Action**	**From**	**To**	**Main info/explanation**
1	*Customer initiates switch*	*Customer*	*new supplier*	
2	*Supply point registration request*	*New supplier*	*Meter Point Administrator*	
3	*Notify current supplier of loss*	*Meter Point Administrator*	*current supplier*	

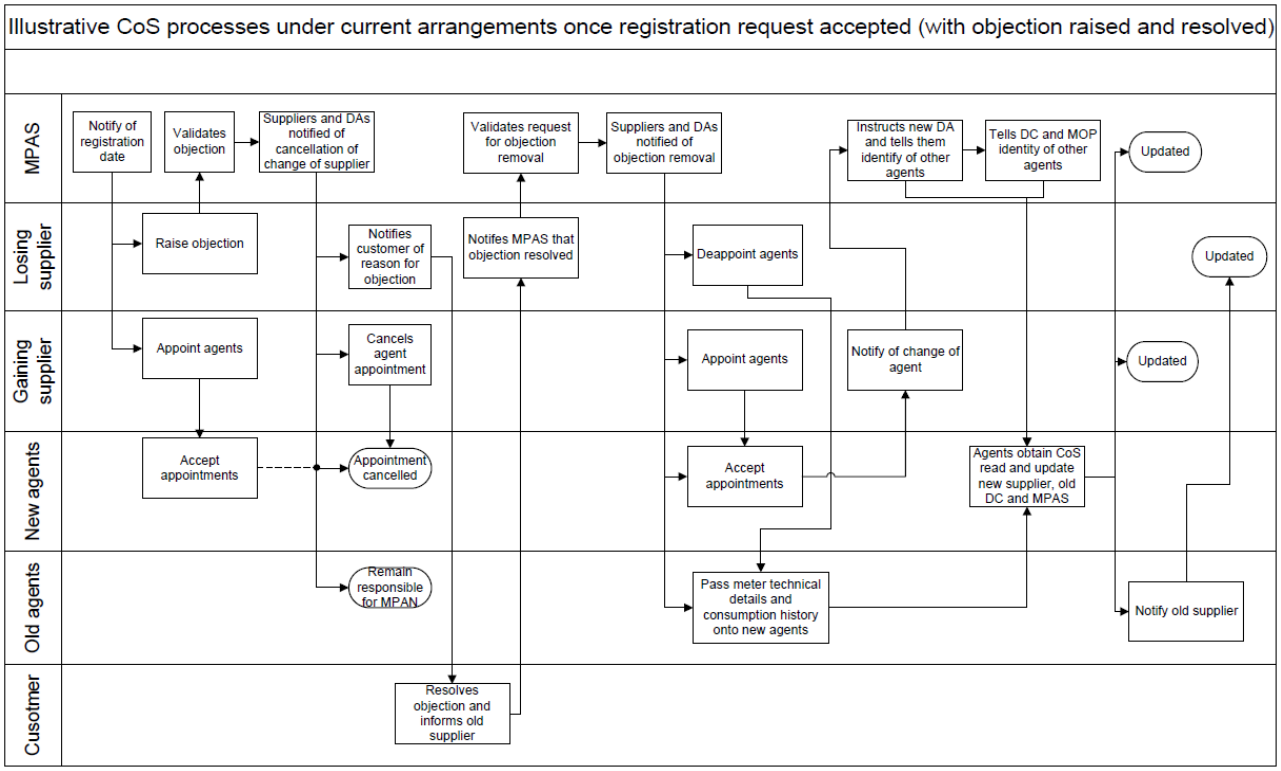
4	*Raise objection*	*current supplier*	*Meter Point Administrator*	*There are certain scenarios where the current supplier is able to object to a registration request from a new supplier*
5	*Resolve objection*	*Customer*	*current supplier*	*Where an objection is raised, the customer must be made aware and is provided the opportunity to resolve the objection*
6	*Remove objection*	*current supplier*	*Meter Point Administrator*	*Applicable where the customer has resolved the objection*
7	*appoint metering agents*	*New supplier*	*metering agents*	
8	*request metering details*	*New supplier's Metering Agent*	*Current Supplier's Metering Agent*	
9	End of supply notification	Meter Point Administrator	Current supplier	
10	*De-appoint metering agents*	*current supplier*	*Metering Agents*	
11	*Request/obtain opening meter reading*	*New Supplier*	*Customer*	
12	*Provide closing meter read*	*New Supplier*	*Current Supplier*	

Table 52: United Kingdom Switching Process - Electricity

Billing: Sequence description				
Step Number	**Action (what)**	**From**	**To**	**Main info/explanation**
1	*Supplier initiates meter reading request*	*Energy supplier*	*Meter Reading Agent*	
2	*Meter Reading Agent obtains reading and provides to energy supplier*	*Meter Reading Agent*	*Energy supplier*	*Where reading is not obtained, customers are encouraged to provide their own reading to the energy supplier*
3	*Energy supplier processes meter reading and generates bill*	*Energy supplier*	*Customer*	*Where no meter reading is obtained by the Meter Reading Agent, or provided by the customer, the bill will be based on an estimated meter reading.*

Table 53: United Kingdom Billing Process – Electricity

Switching:



Link to public documents describing switching and billing processes: No links to public documents describing these processes have been provided.

GETTING IN TOUCH WITH THE EU

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