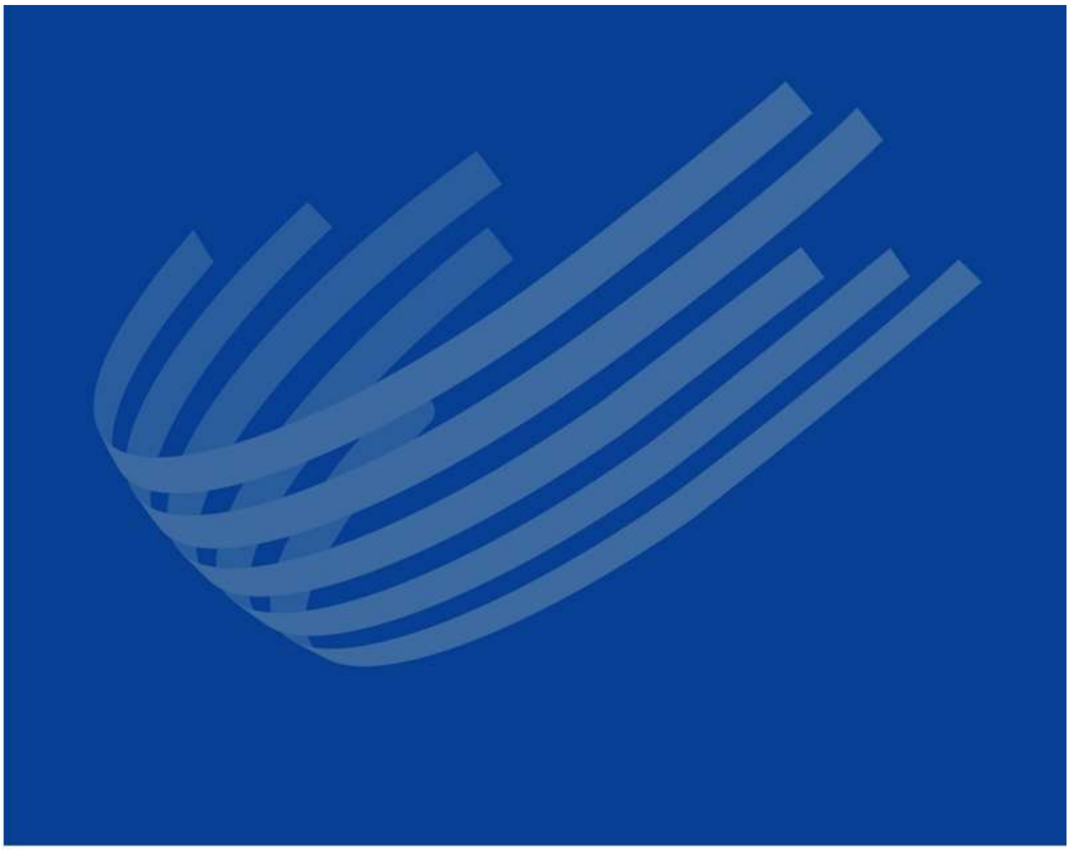
evolvDSO

Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks



evolvDSO

COOPERATION

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D6.2 – Roadmap detailing electricity system of the future (short-term/mid-term and long-term), with new/evolving DSO roles, adjustments to regulatory framework and new market architectures

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Executive Summary

The evolution towards an active distribution management approach requires an evolution in the roles adopted by the Distribution System Operator (DSO). Previous analyses within the evolvDSO project presented a role model, consisting of a set of eight distinct roles that should support the implementation of an active distribution system management. Figure 1 gives an overview of the eight different roles according to their level of innovation.

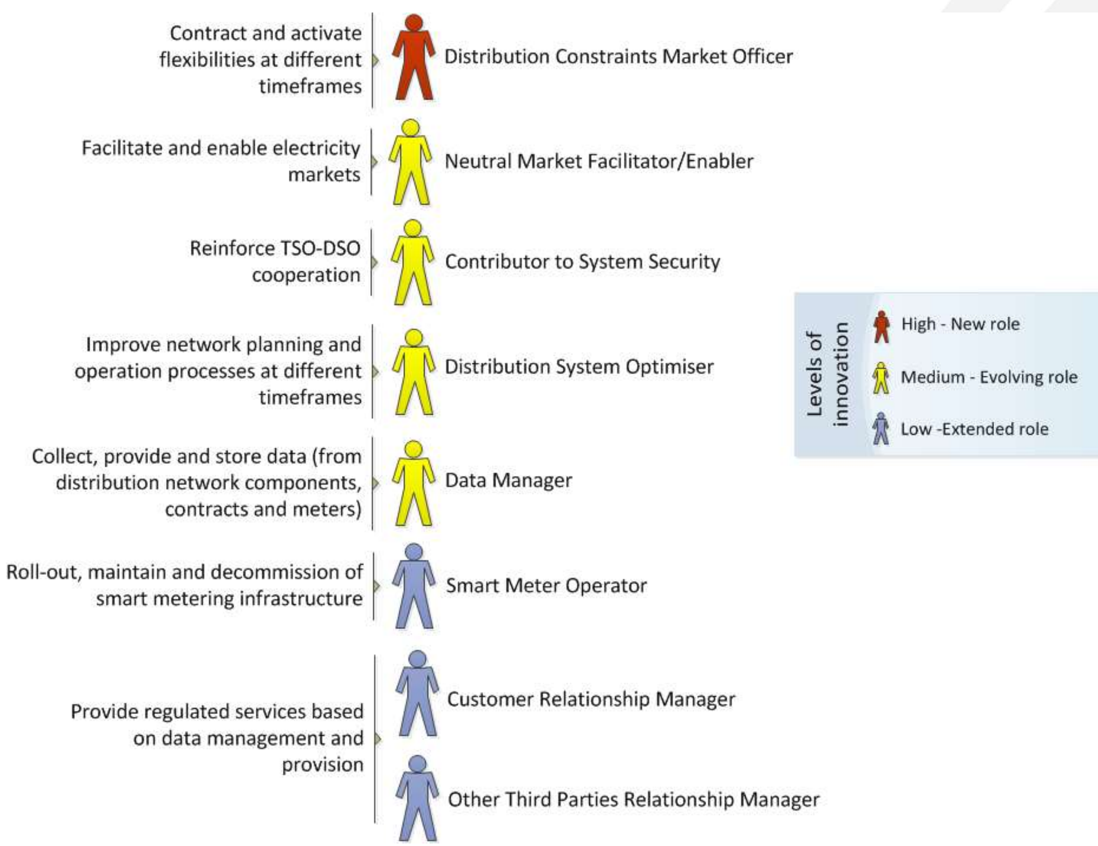

Figure 1: evolvDSO role model

The role model itself has been proven to be robust and widely applicable. Three projects within the same FP7 call (DREAM, IDE4L, and INCREASE) were analysed and the assessment highlighted that the different evolvDSO roles are compatible with the concepts and solutions developed within these projects. Dependent on the projects, some roles were considered more relevant or were present in a more detailed way. In general, no substantial conflicts were observed between the role model developed and the projects analysed.

The adoption of the roles by the DSO is dependent on the regulatory framework, the state of the technology and the level of interest of the concerned DSOs. In particular, following aspects will influence the adoption of the role model: the evolution of ancillary services, the status of demand response, developments in system operation, developments in data management and the status of smart metering infrastructure. These aspects differ across countries and explain why the expectation for the timing of the adoption of the role model is country dependent.

This report analyses for six different countries (Belgium, France, Germany, Ireland, Italy and Portugal) the main national enablers and barriers for the adoption of the individual roles by the DSO. An example of a possible enabler is the recognition of the role by the regulator. An example of a possible barrier is the adoption of the role by another third party.

In general, roles that require few modifications to the regulatory framework are expected to be adopted in the short-term (i.e. 2020). Roles that require substantial changes to the existing regulatory framework are expected to be adopted in the longer term (i.e. by 2030 or even beyond). For some countries, some roles are already today adopted by the DSO. Not all roles are or will necessarily be adopted by DSOs in all European countries. The role of the Distribution Constraints Market Officer (DCMO) is the only entirely new role of the role model and is expected to be possibly adopted in the longer term for each country. The roles of Neutral Market Facilitator (NMF) and Contributor to System Security (CSS) are expected to be adopted in the short term or in the longer term, dependent on the country. The other five roles of the role model are currently to a certain extent already adopted by the DSO or are expected to be adopted in the short term. Figure 2 illustrates the expected adoption of the role model for different countries within Europe. The presence of different arrows highlights the existence of national divergent opinions related to the adoption of the role model.

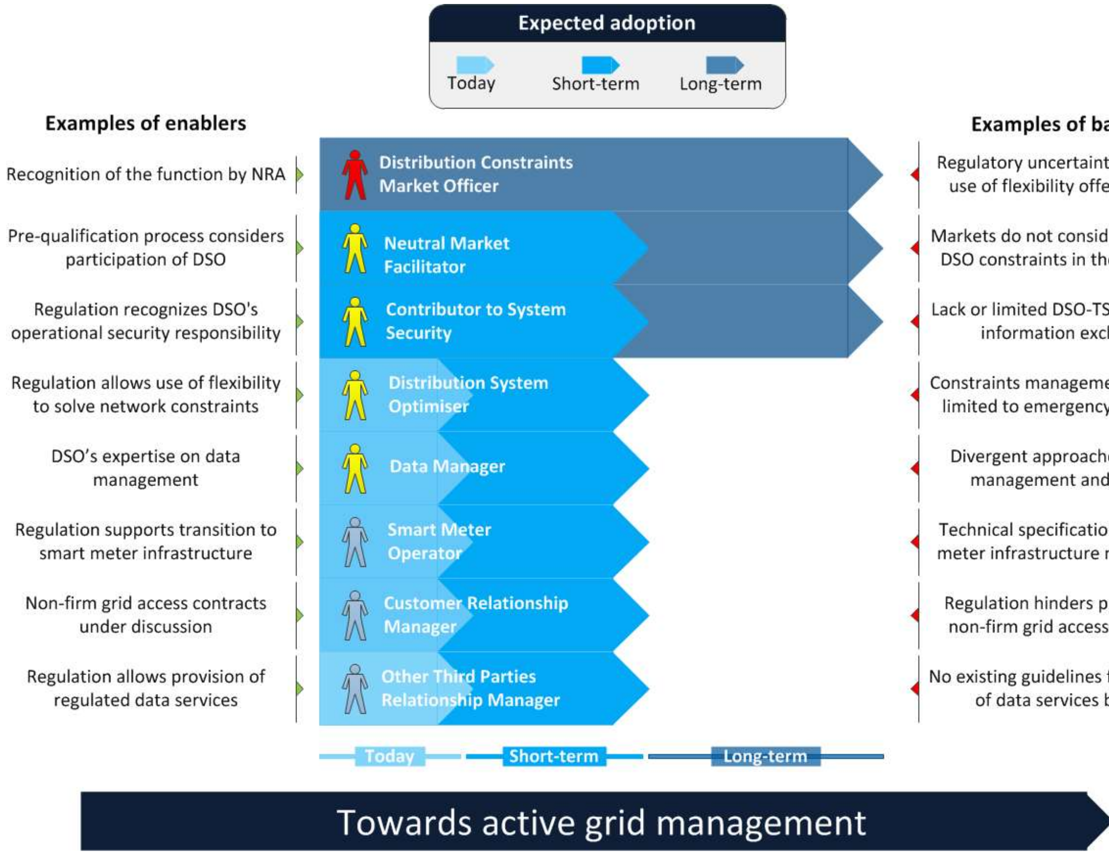

Figure 2: Outlook for the expected adoption of the role model across the surveyed countries

Based on the assessment of the individual countries, a European roadmap is presented for the adoption of the evolvDSO role model, highlighting for each role a selection of key aspects to be taken into account when the role will be adopted by the DSO or by another third party. A successful implementation will strongly depend on the concrete implementation details facilitated by regulation and market design. It should be assured that no conflict between roles arises and that benefits related to cost efficiency, system security, operational efficiency and innovation are fully exploited. The key elements considered, focus on the interaction between roles, the level of transparency and neutrality, the interaction between stakeholders and the dynamics of the regulatory framework.

The document concludes with a set of key recommendations with respect to the future regulatory framework and market design. Within each country, the regulatory framework will evolve at its own pace. However, following key aspects are important, independent of the national situation:

1. The DSO will play a key role in the transition of the power system;
2. Flexibility has a value for different stakeholders in the power system;
3. Coordination between system operators at transmission and distribution grid level is crucial;
4. Flexibility should be allocated where the value is the highest;

5. The cost of flexibility should be recognized and a trade-off should be made with the benefits of flexibility;
6. Data should be available for relevant stakeholders in a neutral, transparent, secure and cost-efficient way;
7. Changes to the regulatory framework and market design should take into account ongoing European evolutions with respect to harmonisation and integration but there is no one-size-fits all solution, as national contexts can differ considerably.
8. Innovation will be a facilitator for a continuous evolution of the evolvDSO role model

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Notations, abbreviations and acronyms

ARTU	Advanced Remote Terminal Units
AS	Ancillary Services
BRP	Balance Responsible Party
CRM	Customer Relationship Manager
CRP	Conditional Re-Profiling
CSS	Contributor to System Security
DCMO	Distribution Constraints Market Officer
DM	Data Manager
DG	Distributed Generation
DR	Demand Response
DRES	Distributed Renewable Energy Sources
DSM	Demand Side Management
DSO	Distribution System Optimiser
DSO	Distribution System Operator
DSU	Demand Side Unit
EEG	Erneuerbare-Energien-Gesetz
ENTSO-e	European Network of Transmission System Operators
EnWG	Energiewirtschaftsgesetz
EU	European Union
HV	High Voltage
LV	Low Voltage
kW	Kilo Watt
MV	Medium Voltage
MS	Member State
NMF	Neutral Market Facilitator
NRA	National Regulatory Agency
OLTC	On-Load-Tap-Changer
OTPRM	Other Third Parties Relationship Manager
PQ	Power Quality
R3DP	Tertiary reserve dynamic profile
RES	Renewable Energy Sources
RTU	Remote Terminal Unit
TLS	Traffic Light System
TSO	Transmission System Operator
WP	Work Package
SGAM	Smart Grid Architecture Model
SII	Integrated information system
SMGW	Smart meter gateway
SMO	Smart Meter Operator
WAN	Wide Area Network

Table 1: Acronyms list

Acknowledgements

This report is not only the result of a state of the art analysis of literature and other publically available information. It represents the outcome of joint research efforts by the entire consortium, including specific information provided through several surveys, meetings and workshops, as well as through interesting group and bilateral discussions within the evolvDSO consortium.

The authors wish to gratefully acknowledge the valuable input of all involved experts from the different partners within the evolvDSO consortium, being e-Distribuzione, cyber GRID, EDP Distribuçao, EDSO for Smart Grids, Energy Pool, Enedis, ESB Networks, Innogy, RWTH Aachen University, FGH, Energinet.dk and VITO / EnergyVille. A special mention to ENTSO-e experts which contribution helped to compliment the messages enclosed in this document.

1. Introduction

1.1 The evolvDSO project: target and objectives

During the last decade, the power sector is experiencing substantial changes. The European targets with respect to renewable energy generation have led to an increased interest in distributed generation, opening opportunities for flexible capacity to enter the market. As the focus on flexible demand is gaining momentum, the evolution of power systems and their mode of operation are imperative. These tendencies impose the continuous development of different roles and responsibilities of the energy market stakeholders.

It is within this context that the evolvDSO project sheds a light on the need for distribution system operators (DSO) to adapt their roles and functionalities to future perspectives. Figure 3 shows the conceptual approach adopted by the evolvDSO project. As depicted from Figure 3, the development of scenarios served to define future roles. For these roles and related services, several tools and methods were developed. They cover a large selection of DSO activities:

- Planning guidelines and methodologies for grid development;
- Operational Scheduling;
- Grid Optimisation;
- Operation and Maintenance.

The selected tools and methodologies have been tested in real-life field tests. Results from these tests provided input for recommendations to adapt the regulatory framework and market design. Recommendations take into account current market trends (e.g. integration of decentralised generation capacity, increase of demand response, electrification and storage, activity integration of DSOs and TSOs). The recommendations are complemented by a roadmap for the evolution towards a more sustainable and efficient power system, optimally fulfilling the needs of all players in the electricity market.

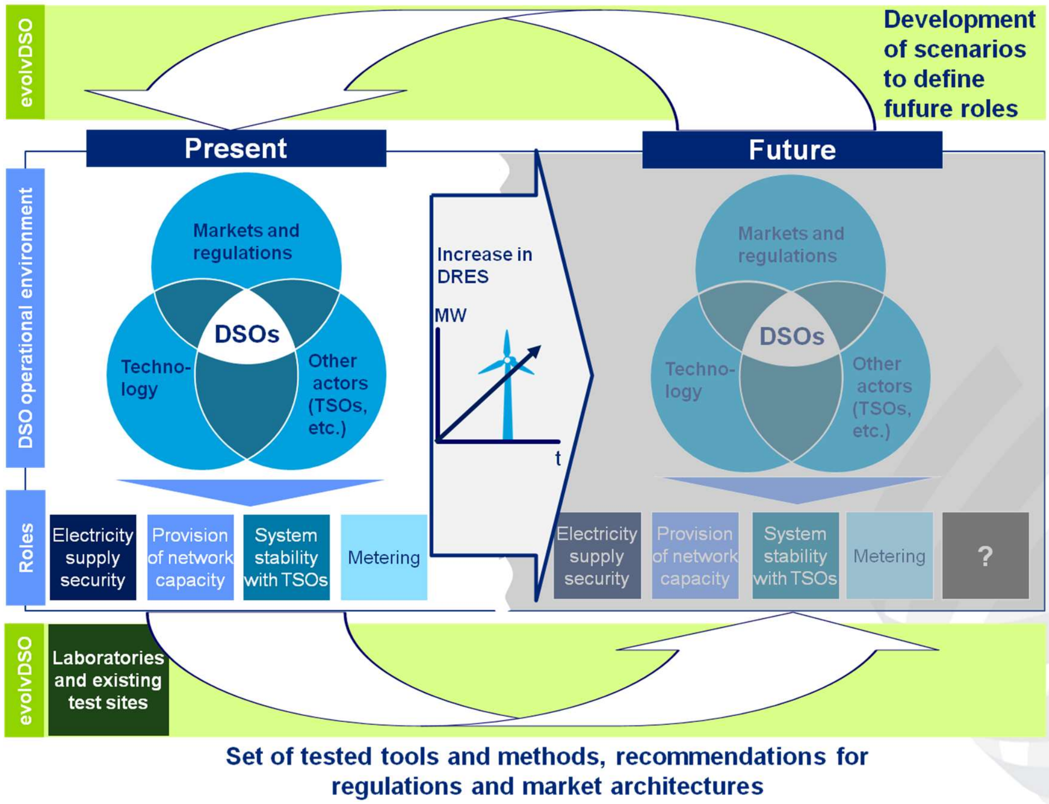

Figure 3: The evolvDSO approach

The stated, ambitious targets of the evolvDSO project have been carried out in four phases, enveloping eight work packages (WP). The project plan and implementation strategy are summarized in Figure 4. The figure also shows the relation between work packages and project plan phases.

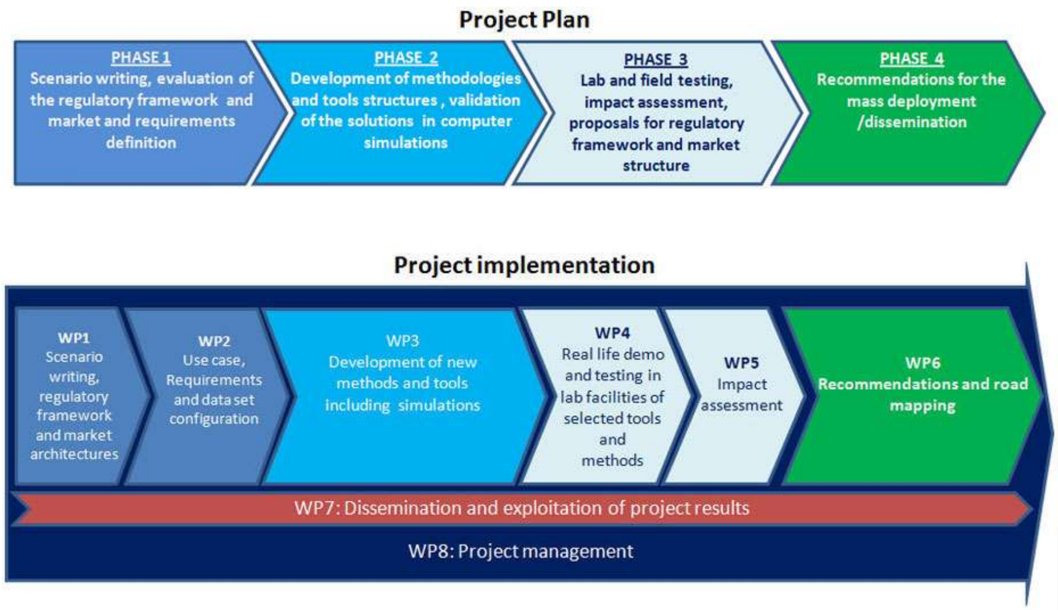

Figure 4: The evolvDSO project plan and implementation

1.2 Scope and objectives of this deliverable

As part of the activities within phase 4 (Figure 4), this deliverable concludes the work developed within the entire project. In particular, this work uses the conclusions obtained in WP1 (scenario writing, regulatory framework and market architectures), as well as elements from WP3 (tool development), and WP5 (impact assessment) to create a set of recommendations to facilitate the adoption of evolvDSO roles and implementation of evolvDSO tools and methodologies. These recommendations are expected to be relevant at both European and country-specific level.

This deliverable has the following objectives:

- Provide recommendations to facilitate the adoption of evolvDSO roles. These recommendations may be used by NRAs to create the appropriate regulatory framework, fostering innovation and cooperation among stakeholders at all levels.
- Elaborate a roadmap to cover current needs and future expectations of the power system at European level.

1.3 Methodology

To develop the recommendations enclosed in this document, the authors iterated with evolvDSO consortium members as well as with external parties (e.g. ENTSO-e, flexibility service providers, regulators,…). The starting point for the discussion with all parties was based on the knowledge already acquired from previous works, namely [1]–[5]. Additionally, this knowledge was complemented with information coming from publicly available sources (e.g. literature, European projects). The feedback received allowed to gradually prioritize the key elements to be analysed and to fine-tune the results. When elaborating the analysis and preparing recommendations, particular attention was paid to aspects relevant for the evolution of DSOs such as (total) system efficiency, transparency, cooperation, (reduced) complexity, impact on the end user, innovation, etc.

The core of the analysis presented in this report is primarily based on the information provided by the five DSO members of the consortium. The analysis encompasses several regulatory frameworks spread across Europe. The information provided by other parties (not DSOs) was used to complement the core analysis and to highlight peculiarities of the analysed frameworks.

1.4 Report structure

The document comprises the following chapters:

- **Chapter 1** introduces the overall framework of the evolvDSO project as well as an overview on the scope, objectives, approach and structure of this report;
- **Chapter 2** presents the evolvDSO role model and highlights how the evolvDSO roles map with the frameworks proposed by the TWIN projects;
- **Chapter 3** describes national enablers and barriers for the adoption of the evolvDSO role model and presents national timelines for the adoption of the roles;
- **Chapter 4** provides an overview of the time-wise adoption of the evolvDSO role model at European level, highlights key elements to take into account at the moment of adoption and concludes with a list of key recommendations;
- References and annexes are presented in **Chapter 5** and **Chapter 6**, respectively.

2. Framing the evolvDSO role model

2.1. Summary of the evolvDSO role model

The evolvDSO role model consists of eight (8) roles. Each role tackles specific topics/issues at distribution system level identified within the work done for the evolvDSO project. These roles focus on activities of paramount importance for the implementation of an active distribution system management approach [4]. Figure 5 illustrates this role model highlighting the level of innovation each role brings to the distribution business[1].

Figure 5: The evolvDSO role model

Each role is unique and therefore presents distinctive characteristics. Table 2 summarizes the main characteristics for each role.

[1] More information concerning the level of innovation can be found in [4].

Role	Main characteristics
DCMO	• Adds the capability to contract flexibility resources (i.e. local system services), based on the needs of the Distribution System Optimiser (DSO) • Procures local flexibility in the short- and long-term • Provides the opportunity to acquire an additional lever to treat different system needs • Does not replace the need to perform grid expansions
NMF	• Supports market participation of resources connected to the distribution grid • Takes care of the pre-qualification process and the transparent instrument (e.g. traffic light) to assess the grid status in concert with potential market actions • Innovates on the mechanisms for information exchange with market players
CSS	• Responsible for the exchanges of network planning and operational data (structural data) with the TSO and coordinate related actions • Provides possible cost-efficient local solution options to system-wide problems • Acts upon grid users to support the TSO in balancing the system in critical situations • Enhance bilateral communication between TSO and DSO to use local solutions, assess local impacts and define cascading processes in an optimal manner
DSO	• Improves development, operation, and maintenance of the distribution network • Enhances grid access for users (cost-effective and non-discriminatory) • Provides optimal grid expansion, operational planning and real-time grid operation by optimizing the use of available levers taking into account centralized and distributed functions
DM	• Handles metered, contractual and network data • Collects, validates, analyses, and archives (historical records) data • Data collected and managed is used to support market players in their actions • Improve the traceability of market actions by adding the possibility to cross-check them with data on physical activations • Enhance quality of the settlement process for optimal remuneration of flexibility use and to avoid disputes or free-rider behaviour
SMO	• Manages the smart metering infrastructure (from installation to maintenance to decommissioning)

CRM	• Provides Data-based services (basic and advanced) • Coordinates contractual arrangements, sets requirements, manages legal arrangements with retailers/suppliers and BRPs, and provides detailed data to eligible parties
OTPRM	• Similar to CRM • Provides Data-based services (basic and advanced) • Manages the communication with regulators, conceding and local authorities, service providers and other third parties

Table 2: Main characteristics of evolvDSO roles

A role is adopted in order to provide services. However, a role may need to interact with other roles to achieve this goal. Table 3 shows some of the services[2] identified within evolvDSO and the roles involved in their provision.

Services	DCMO	NMF	CSS	DSO	DM	SMO	CRM	OTPRM
Optimising network development			●	●	●	●		
Elaboration of master plan	●			●	●	●	●	
Contracting non-firm grid access				●	●	●	●	
Optimising work programmes	●			●	●	●	●	
Optimising network operations	●	●	●	●	●	●	●	
Managing impact of flexibilities		●	●	●	●	●		
Operate distribution constraints market (long-term)	●			●	●			
Deliver other regulated services					●	●	●	●
Decide asset renewal priorities				●	●		●	●
Manage TSO requests	●	●	●	●	●	●		

Table 3: evolvDSO services and role's interaction

[2] More information on the services towards an active distribution management can be found in [5].

2.2. Mapping of role model with TWIN projects

This section shows results from the interaction of Twin projects, i.e. projects selected for funding in the context of topic 2013.7.1.1: Development of methods and tools for network integration of distributed renewable resources of the SMARTCITIES-2013 call. The collaboration framework established between evolvDSO, DREAM, IDE4L and INCREASE allows for, among other things, the discussion of the evolvDSO role model. In the following, results from the role model framework analysis are discussed for each project.

The objective of this exercise is twofold:

- Encourage interaction with the EU energy community;
- Validate and frame the role model against the proposed solutions of the other Twin projects.

This exercise, mapping of the evolvDSO role model to the solutions proposed by TWIN projects, started with a one-day workshop with the project coordinators of the respective TWIN projects but was conducted entirely by evolvDSO partners. Research tasks within the TWIN projects (INCREASE, IDE4L and DREAM) did not focus on the development of such a theoretical framework.

Before presenting the results it is important to understand the objectives of each TWIN project. To this end a short description of each project is provided below. All information concerning the projects can be found in [6]–[13].

2.2.1. INCREASE

2.2.1.1. Objective

The objective of this project was to investigate solutions for managing problems (e.g. voltage related, oscillations, …) arising from Distributed Generation based on Renewable Energy Sources (DRES) by means of a multi-layer hierarchical control strategy for DSO networks (inverter-connected units, OLTC transformers, etc.). Particular focus was given to solutions that tackle local voltage issues.

The hierarchical control strategy allows for the provision of system[3]- and ancillary services (voltage control, voltage unbalance mitigation, line congestion and reserves). Within the Increase project, the DSO is assumed to control both inverters and On-Load Tap Changers (OLTC).

The Two-layer multi-agent control strategy propose a local management of voltage via droop control and a supervisory control for set-points (droop constants and OLTC tap positions) and energy exchange across different markets (e.g. for ancillary services and for wholesale energy trade).

The project had four pilots (field trial) driven by *Distribution System Operators (DSOs).* In Belgium, the field trials focused on how the OLTC could be controlled in an optimal way from techno-economic perspective. In Slovenia, the focus was on the investigation of the effects of the *DSO* applying direct control to the inverters of solar panels and OLTC tap position settings in order to handle situations where over- and under-voltages appear within different transformer feeders. In the Netherlands, the trial evaluated the fair power curtailment of Distributed Generation (DG). In Austria, the voltage unbalance mitigation strategy was tested to see if the present voltage unbalance could be improved.

2.2.1.2. Mapping of evolvDSO role model

Figure 6 shows the role model framed by the multi-layer hierarchical control strategy. The illustration shows three main layers: service, middleware (communication and process) and physical. The service layer interfaces with power markets for wholesale electricity trading and ancillary services. The Traffic Light System (TLS) is implemented in the middleware layer with input from the service and

[3] In this document, system services refer to services that could be acquired by network operators (TSO and/or DSOs). These services may be used by the network operator for congestion management, voltage control, etc. [2]–[4]

physical layers. In the physical layer decisions taken at higher layers are implemented (e.g. by controlling inverters and OLTCs).

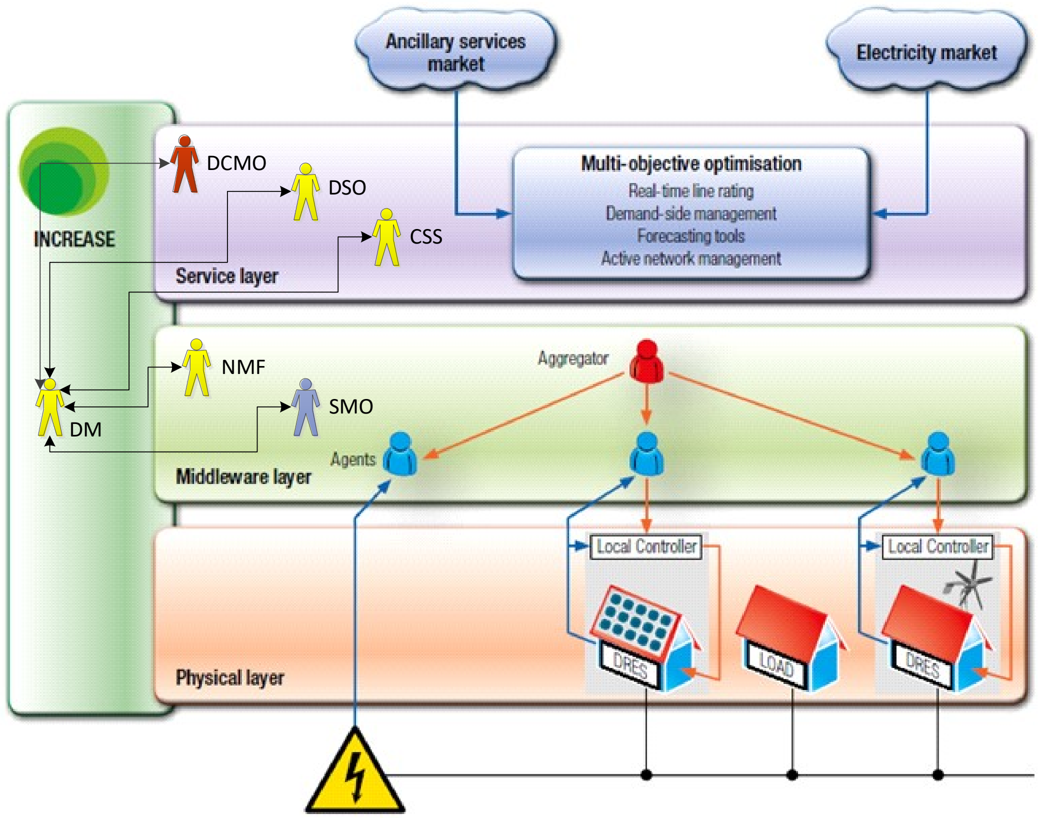

Figure 6: INCREASE framework and the evolvDSO role model[4]

Table 4 lists the activities performed by each role within this framework.

Role	Justification
Data Manager (DM)	• Within INCREASE, it was assumed that the data manager role was adopted by an independent party. However, the main assumption is that data[5] are made available to the *DSO*. • Within the project, data communication was considered critical for certain parts of the solution.
Distribution System Optimiser (DSO)	• This role is assumed to be adopted by the *DSO* and received most of the attention in the project as can be observed in the field trials. The *DSO* operates the distribution system (e.g. operates the OLTC[6]) and sets the parameters for the droop control.

[4] Source: own creation based on INCREASE framework.
[5] Grid related data such as volumes, location and timing for activation.
[6] However, it was observed that this solution is quite expensive. So their use is reserved for situations when the voltage cannot be solved with available options.

	• Furthermore, all INCREASE solutions support further evolution of active distribution grid management.
Distribution Constraints Market Officer (DCMO)	• In INCREASE, no real focus was given to the *DSO* as buyer of flexibility-based services. • However, the role[7] was perceived as a natural evolution in case flexibilities are offered to the market.
Contributor to System Security (CSS)	• The role[8], within the project, was not explored (left open) in detail. • The concept of offering services to the *TSO*, regardless if the role is taken by an aggregator or *DSO*, was not analysed in depth. However, the project sees the possibility for these services to be "required or offered in the future." The need for such services will be driven by system needs, share of DG, etc. • In INCREASE, most investigated services (e.g. voltage control) are for *DSO* use.
Neutral Market Facilitator (NMF)	• In this context, the *DSO* adopts the NMF role[9] by using the TLS to check load flows when schedules are made. That is, the TLS is used to evaluate grid dynamics, affected by DR unit schedule. The approach allows *DSOs* to intervene in case grid constraints are not respected. • However, the TLS is implemented without a pre-qualification[10]. Here, the validation of schedules is not done in real-time. This differs from the TLS and pre-qualification concept used in evolvDSO.
Smart Meter Operator (SMO)	• In INCREASE, the role is supposed to be active in the background. In the project, one of the key assumptions was the availability of smart meters, but no specific reference was made to who should take up this role[11].
Customer Relationship Manager (CRM) & Other Third Party Relationship Manager (OTPRM)	• References were made for these roles but without specific assumptions.

Table 4: Roles' participation in the INCREASE framework

[7] Acquisition of system services for congestion and voltage management.
[8] Supporting the provision of ancillary services to the *TSO*.
[9] Validating schedules (rejects/accepts) of units providing flexibility (e.g. demand response units) by means of a traffic light system (TLS).
[10] Within evolvDSO the pre-qualification process "characterizes the flexibility that a market agent (i.e. flexibility operators or aggregators) intends to offer in terms of location, amount, duration, response time, grid impact, etc. With this information, *DSOs* could manage the grid in an optimal and active way, reducing potential operational security problems." [4]
[11] Collecting data from smart metering equipment.

2.2.2.DREAM

2.2.2.1. Objective

The objective of this project was to support further Distributed Energy Resources (DER) integration via a market-based approach for control and coordination of flexibility[12]. This is achieved by an advanced heterarchical management approach.

The approach consists of an adaptable hierarchy depending on topology and current operational constraints. This approach gives full local autonomy to (advanced) remote terminal units (ARTU) which in turn reduces global information exchange. The idea is to use flexibility (both from DER and the network) to solve in real time technical constraints with a distributed optimisation process.

The approach presented within this project explores the optimal (grid) configuration to support the implementation of the Neutral Market Facilitator (NMF) role.

The project introduced a new kind of flexibility mechanism. This market allows for the trading of flexibility in real-time. The mechanism allows the *TSO* to procure flexibility. When flexibility is not needed by the *TSO*, it is possible for the *DSO* to procure (remaining) flexibility services to solve technical issues in real time. That is, flexibilities validated by the NMF role and not contracted via the mechanism may be acquired by the *DSO*. This allows the *DSO* to behave as a market participant and thus adopting the DCMO role.

2.2.2.2. Mapping of evolvDSO role model

Figure 7 illustrates the role model framed by the advanced heterarchical approach within DREAM project. DREAM uses the Smart Grid Architecture Model (SGAM) to frame their solutions (“pitches” as called within the project). The portfolio of “pitches” shapes the approach followed in the DREAM framework. The approach presented in DREAM provides solutions to stakeholders of interest for the role model, i.e. *TSOs*, *DSOs*, aggregators and end-consumers.

[12] Within DREAM, the concept of flexibility sources include grid assets (e.g. transformers), loads and generation assets.

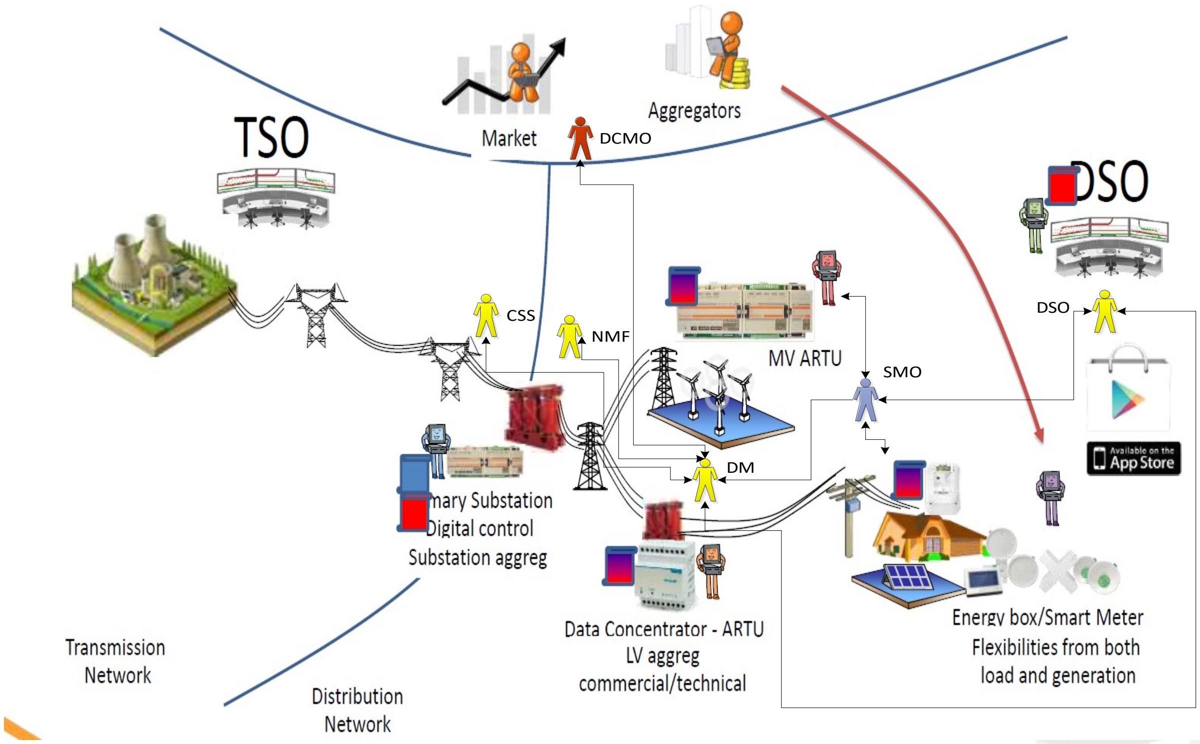

Figure 7: DREAM framework and the evolvDSO role model[13]

Table 5 lists the activities performed by each role within this framework.

Role	Justification

Data Manager (DM)	• In DREAM, this role[14] is at the core of every solution. However, its impact is directly related to the possibility to store data (persistence of data) in order to allow other roles to perform advanced calculations (e.g. forecasts, anticipating potential situations).
	• Here the approach is to allow for local availability of (grid) data.
	  ○ For pre-qualification, the information collected and used is stored locally.
	  ○ For flexibility offers, the *DSO* aggregates offers at the primary substation and transmits them to the *TSO*. The *TSO* informs back activation schedules.
	• This entails the development of a distributed database (via RTU[15]). However, implementation may have various technical and regulatory challenges, e.g. allowing the *DSO* to aggregate flexibility offers at primary substation (aggregators → *DSO*); implementing a data exchange framework for the *TSO* to inform about flexibility schedules (*TSO* → *DSO*).

[13] Source: own creation based on DREAM framework
[14] Serving all roles concerning data needs (collection, transfer, archive, …).
[15] Remote Terminal Unit

Distribution System Optimiser (DSO)	• The role[16] is situated in the timeframe day-ahead to real-time. • Here the *DSO* runs a contingency analysis and checks what is potentially needed in real-time. ○ Via real-time measurements (TLS), the *DSO* tries to dampen oscillations. Here, if the proposed solutions result in oscillations, then solutions are adapted. The intervention of the *DSO* may consist on acting on the OLTC or reconfiguration of the grid. If this is not sufficient, the *DSO* interacts with neighbouring grids. • As a function of this role, it is considered that losses and constraints are collected and verified, every time flexibility is contracted.
Distribution Constraints Market Officer (DCMO)	• The role[17] is quite relevant in DREAM. • Within the project, the *DSO* is considered as a buyer of flexibility to solve constraints in real time. However, *TSO* has priority for contracting flexibility. That is, *DSOs* only contracts offers not used by the *TSO*. • The mechanism that allows procurement of flexibilities by the *DSO* is an innovation proposed by the project.
Contributor to System Security (CSS)	• This role[18] is considered within DREAM's framework. • Here, the *DSO* is responsible for the aggregation of flexible offers at the level of the primary substation. • Besides this aggregation, the *DSO* validates flexibility designated for Frequency Containment Reserves (FCR).
Neutral Market Facilitator (NMF)	• In DREAM, this role[19] is central if the NMF role is interpreted in a way that optimal configuration can be done based on computer engineering and distributed optimization. ○ The *DSO* is able to check offers made to the market and validate them • The approach followed implements a pre-qualification procedure in concert with distributed intelligence (intelligence at the RTU) and adaptability for optimal solutions (i.e. avoid oscillations via OLTC, grid reconfiguration,…). • A centralized approach was considered as limited due to computational limitations and therefore, distributed optimization approach was chosen. In addition, distributed optimization may reduce costs (in respect to a threshold).
Smart Meter Operator (SMO)	• This role is quite relevant for the flow of information. • The role collects data from smart metering equipment and transmits the data to the *DSO*. This considers the data concentrator and the smart meter as part of the

[16] Operating the distribution system and setting the parameters for the droop control.
[17] Acquisition of system services for congestion and voltage management.
[18] Supporting the provision of ancillary services to the *TSO*.
[19] Supporting the market platform and validating schedules (rejects/accepts) of units providing flexibility (e.g. demand response units) by means of traffic light system (TLS).

	DREAM framework. • Key assumption was made on that the smart metering infrastructure is available.
Customer Relationship Manager (CRM) & Other Third Party Relationship Manager (OTPRM)	• References were made for these roles but without specific assumptions.

Table 5: Roles' participation in the DREAM framework

2.2.3.IDE4L

2.2.3.1. Objective

The objective of this project is to allow for higher integration of Renewable Energy Sources (RES) while fulfilling distribution reliability requirements. The novel approach for distribution automation presented in this project observes the network in its entirety. At the level of the substations, data are aggregated and used for decision making.

The project develops strategies for the operation of the distribution system and for the aggregation of distributed energy resources. Actors such as *DSOs* and aggregators are in scope.

On the regulated side, the *DSO* is assumed to take an active role concerning market actions (e.g. validating bids), services (e.g. purchasing system flexibility services for congestion management) and grid access (e.g. checking that grid constraints are not violated by the activation of DER).

On the commercial side, aggregators take all actions (e.g. forecasting, estimation of flexibility needs) to make services available to grid operators and market agents.

Within the project, the *DSO* takes care of all technical solutions while, aggregators are responsible for all commercial activations. It is the view of the project that *DSOs* should not sell services (based on flexibility) to the market. The market platform itself is assumed to be operated by a NMF, different from a *DSO*.

Within the solutions implemented by the *DSO,* direct and indirect control were considered. Direct control is considered only to be used in emergency cases. For indirect control the market is used.

2.2.3.2. Mapping of evolvDSO role model

Figure 8 and Figure 9 show how the role model is framed within the IDE4L framework. Figure 8 provides a high-level view of the interactions between systems. Figure 9 illustrates, in a condensed manner, the timeframe envisioned for the actions within the IDE4L framework. In both figures evolvDSO roles have been mapped. Overall, the evolvDSO role model and the framework proposed by

IDE4L are compatible. Both, IDE4L and the role model consider as stakeholders of interest the *TSO*, *DSO* and aggregators.

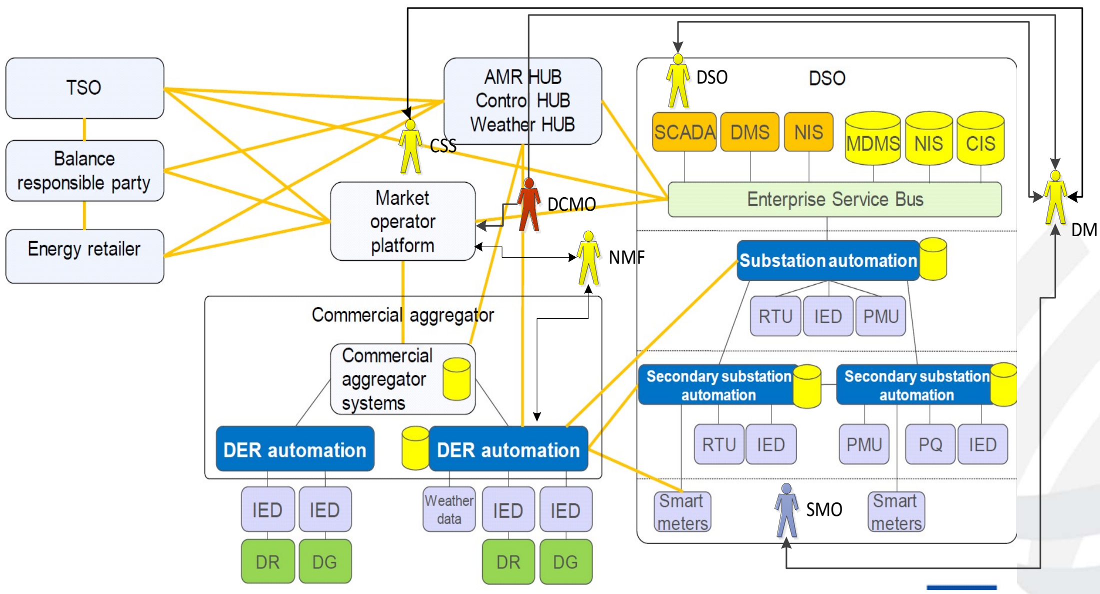

Figure 8: IDE4L framework and the evolvDSO role model[20]

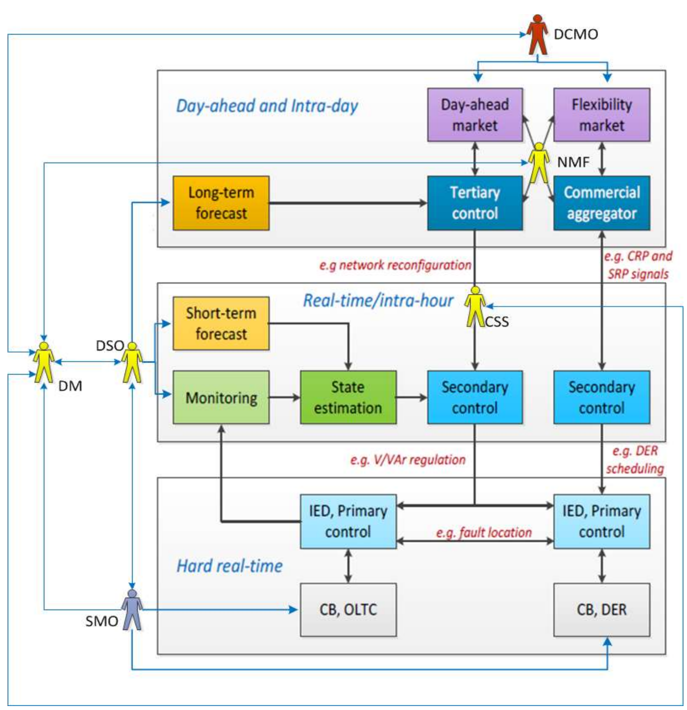

Figure 9: IDE4L framework (timeframe) and the evolvDSO role model[21]

[20] Source: own creation based on IDE4L framework

Table 6 lists the activities performed by each role within this framework.

Role	Justification
Data Manager (DM)	• In IDE4L, this role[22] is quite relevant. • It is recognized that *DSOs* collect lots of data for all timeframes, i.e. data that comes from the smart meter, secondary substations, etc. This requires a kind of hierarchical infrastructure. • The project considered that all information exchanges between *DSOs* and aggregators should mainly go via the market with some flows directly to relevant stakeholders. • This framework implements a data- and control-hub, where the DM could be seen as a middleman between *DSO* and aggregator to safely share and transfer data. • The IDE4L framework considers possibly for the DM role to be adopted by a third party.
Distribution System Optimiser (DSO)	• Here, the flexibility that is contracted by the system operator is used mainly in the operational planning phase but taken into account in the long term planning. However, the *DSO* may also use short-term solutions such as grid reconfiguration and/or dynamic tariffs[23] to manage congestions.
Distribution Constraints Market Officer (DCMO)	• The role is considered within IDE4L. • The *DSO* is contracting and managing flexibilities. Flexibility procurement is considered as one of the options to manage congestions. Alternative options are reconfiguration of network topology or assets (e.g. OLTC). ○ Within the framework of Tertiary controller[24] (*DSO*) conditional re-profiling[25] (CRP) services are purchased from commercial aggregators (CA) to solve congestions. • It is the perspective of the project that *DSOs* should not sell services to the market.

[21] Source: own creation based on IDE4L framework
[22] Serving all roles concerning data needs (collection, transfer, archive, …).
[23] Dynamic tariffs may be used to manage grid congestions if they include a grid utilization component. In this way the status of the grid could be reflected (in full or in part) by the tariff.
[24] "From the DSO's architecture viewpoint, CRP products activation is triggered within the framework of their Tertiary Controller (TC). The TC takes responsibility to purchase CRP services from Commercial Aggregators (CAs) if needed to solve congestions. In particular, the DSO's Control Center (CC) is assumed to be able to manage MV networks by means of market-related measures to propose changes of scheduled generation/consumption values of DER units, through flexibility offers/bids to provide a feasible combination of schedules." [13]
[25] The conditional re-profiling refers to a product where the capacity for a specified generation/demand modification is previously procured for a specific period of time but the activation is optionally triggered by a control signal from the flexibility buyer at short notice. This product is based on the conditional re-profiling (CRP) product described for active demand in the ADDRESS project. In this type of flexibility product, sellers and buyers trade controllable power, i.e. deviation from the forecasted level of demand –called baseline-, and not a specific level of demand." [13]

Contributor to System Security (CSS)	• The support function assumed for this role concentrates on sharing data that are relevant to the AS and which are provided by commercial players. • Here, *DSOs* are not considered as a seller of services to the *TSO*. This is an activity reserved for commercial aggregators only. This limits the flexibility that could "flow" back (via the *DSO*) to the *TSO* to support the system. • Within the project the *DSO* is assumed to exchange dynamic information concerning the status of the grid. Focusing on extracting metrics for system security.
Neutral Market Facilitator (NMF)	• Within the project the role is assumed to be active only at the market platform as independent and neutral. • It is also assumed that *DSOs* pre-qualify flexibilities and validate (by means of a TLS system) what the aggregator wants to do/activate. However, the adoption of the role is not limited to the *DSO*.
Smart Meter Operator (SMO)	• The role[26] is considered without specific assumptions. • Within the project it was assumed that the *DSO* adopts this role.
Customer Relationship Manager (CRM) & Other Third Party Relationship Manager (OTPRM)	• Here, the CRM role (assumed to be adopted by the *DSO*) smooths the interaction with aggregators to guarantee that no market asymmetry is induced. • References were made for this role but without specific assumptions.

Table 6: Roles' participation in the IDE4L framework

[26] Collecting data from smart metering equipment.

2.3. Conclusions

As can be seen from the analysis of the Twin projects, the evolvDSO role model is applicable to all three projects. Note that all projects used as reference the Smart Grid Architecture Model (SGAM). In all the Twin projects, the DSO is the central stakeholder for the implementation of the proposed solutions, which requires changes in the roles currently adopted by the DSO.

The role of the DCMO, which is the new role developed within evolvDSO, is present in all three TWIN projects. However, dependent on the project, the role of the DSO as contractor for flexibility is a key concept or it is perceived as a natural evolution in the future.

With respect to the NMF role, all projects appoint the DSO as the party validating flexibility schedules. In addition, across the Twin projects, the TLS concept for flexibility management at distribution system level is highlighted, reinforcing the need for a clear NMF role.

The role of CSS is present in each of the TWIN projects. However, the concrete implementation of the role is different. Within INCREASE, the role is not detailed but it is assumed to be in place. IDE4L limits the CSS role to the exchange of data that are relevant for AS markets. In DREAM, the DSO is actively aggregating flexibility on behalf of the TSO.

The role of DSO is an essential role in all of the projects. The use of flexibility by the DSO for operational purposes gains a lot of attention. Dependent on the project, flexibility is used by the DSO in long term planning, day-ahead operational planning or in real-time.

The DM role is considered as critical in the different TWIN projects. All projects consider data collection and sharing as the core for the success of their solution. Even when the role is adopted by a third party (e.g. INCREASE) data access by the DSO should be safeguarded.

The role of SMO is considered in all projects as relevant due to the need for smart meters to implement most of the proposed solutions.

The CRM and OTPRM role are not explored in detail in the TWIN projects, however, these roles are assumed to be present.

3. National enablers and barriers for the adoption of the evolvDSO role model

Electricity distribution has been traditionally considered as a natural monopoly. National Regulatory Authorities create and enforce the framework in which the distribution business develops. Table 7 presents the NRAs of the Member States (MS) included in this study. In section 6.2 (annex), a short introduction to each of these regulatory agencies is presented.

	Country	Federal	Regional
NRAs	Belgium	CREG	VREG (Flanders) CWAPE (Wallonia) Brugel (Brussels)
	France	CRE	
	Germany	BNetzA	
	Ireland	CER	
	Italy	AEEGSI	
	Portugal	ERSE	

Table 7: National Regulatory Agencies

As highlighted by Table 7, the current study focuses on six (6) MS: Belgium, France, Germany, Ireland, Italy and Portugal. For each regulatory framework, it was observed that a set of approaches are being either discussed or carried out towards the implementation of a more reliable, secure and sustainable power system [4]. In concrete, the implementation of mechanisms and technologies for the adoption of a pro-active approach by the DSO towards the market, grid users and, overall, the power system is under discussion. These approaches are the driving factors for the adoption of the evolvDSO role model (section 2.1).

The existence of enablers and/or barriers dictates the pace at which the role model will be adopted. Support or resistance to the adoption of a certain role may come from the regulatory and technological domain. From previous work within the development of the evolvDSO project it was observed that both domains are interlinked. Each one pulls the other. That is, regulatory decisions may be influenced by technological propositions (i.e. innovations, proof of concept, etc.) and vice versa.

In line with the above statements, for a certain role to be adopted, several requirements have to be fulfilled. Table 8 shows an overview of requirements for each role to be adopted. The fulfilment of these requirements means that potential regulatory gaps have been overcome and that there is clear direction on the use of the technologies needed. At the core of the analysis is the assumption that the DSO is the party adopting the role model.

Role	Main requirements for role adoption by DSOs
DCMO	• Regulatory consent for DSOs to procure flexibility-based system services in a market set-up • Access to market mechanism for the procurement of services • Coordination of local and national markets
NMF	• A higher level of observability and controllability provided by smart grid technologies • Implementation of pre-qualification or Traffic Light System (TLS) mechanisms • Ability of being aware of all possible activations impacting the local grid • Regulatory consent to use market and system information together (incl. distribution grid constraints)
CSS	• A higher level of observability and controllability provided by smart grid technologies • Definition of cascading approaches towards system issues allowing for better coordinated actions that ensure technical and economic optimums • Implementation of a platform/mechanism for coordination of DSO-TSO actions
DSO	• A higher level of observability and controllability provided by smart grid technologies • Regulatory consent for the use of new levers (e.g. flexibility-based services) to delay grid expansion or to manage grid constraints
DM	• Regulatory consent for DSOs to access, archive and process data • Clear rules for data security and privacy as well as actors eligibility to access data (for transparency)
SMO	• Implementation of smart metering infrastructure (according to regulation)
CRM OTPRM	• Regulatory consent for DSOs to provide services based on data that are collected through the smart metering infrastructure

Table 8: Main requirements for role adoption

In the following chapters, for each country, the current national context will be analysed (e.g. regulatory highlights, evolution of ancillary services, status of demand response, developments in system operation and data management and the status of smart meter implementation). Based on the country context, enablers and barriers for the adoption of the evolvDSO role model, specific to each country, are listed:

- Enablers refer to the conditions that have a positive impact on the adoption of the role by the DSO.
- Barriers refer to the conditions that might hinder the adoption of the role by the DSO.

To complement the analysis, for each country, the expected timing for the role model adoption will be illustrated. This time-wise expectation for the adoption of the role model highlights when the relevant role could be considered to be adopted. This is illustrated by country specific pictures where horizontal arrows will point to the expected time horizon for each individual role.

In general, the adoption of the role model may vary widely among MS dependent on the country specific enablers and barriers. For some MS, the adoption of the role may be perceived as feasible in the short-term while in other MS the same role may only be adopted in the long-term. The SMO role illustrates this very clearly. This role is already a reality in France, Italy and to certain extent in Portugal whereas, in Belgium and Ireland the role may well be adopted in the short-term. Concerning Germany, there is no clear expectation for its adoption since no regulatory decision on a massive roll-out of smart meters has been taken.

It was considered that for roles to be adopted in the short-term (by 2020) there must be at least clear indications on ongoing discussions, regulatory material in preparation, ITC infrastructure in place (or planned to be in place), and a clear view on market design appropriate for the implementation. Roles expected to be adopted in the long-term (~2030 and beyond) show no clear indications on the topics above mentioned.

The adoption of the role model is a continuous process. This means that there is no specific point in time in which a given role could be said to be adopted.

3.1. Belgium

The national context of Belgium is provided in section 6.3.1 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.1.1. Enablers

The enablers identified from the current context description of Belgium are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- The Flemish regulator **explicitly recognizes the role of the DCMO**, envisioning the DSO as Flexibility Requestor Party (FRP). The FRP is considered as a way to allow DSO acquire AS for system services (e.g. congestion management, power losses, voltage management, ...).The Flemish regulatory agency advises that the flexibility requests from the DSO should be market-based to foster transparency and non-discrimination.
- Regulatory discussions are taken place for the creation of "ancillary service rules" in order to provide a **regulatory framework for ancillary services for DSOs**.
- **DSOs are allowed to use flexibility**. The Brussels regulator explicitly considers demand-side management as option to avoid grid capacity expansions and replacements (Ord. July 19°, 2001 – Brussels capital region). The Flemish regulator current regulation does not impede the use of flexibility options such as demand-side management by the DSO.
- The Belgian TSO is supporting the **development of the market of flexibility-based services** by creating additional products for flexibility coming **from the distribution grid**.
- **The remuneration scheme of the DSO supports the role of the DCMO**. The consideration of TOTEX provides DSOs a certain level of freedom to choose between investments (CAPEX) and operational actions (OPEX). This is critical for innovation development since it does not constraint the DSO on the solutions he might implement. So selection of solutions is done based on potential savings/benefits.[27]

NMF:

- The regulator **explicitly recognizes the role** of the DSO as neutral market facilitator.

[27] As described in [30].

- DSOs are **involved in a prequalification process** and are able to set any kind of temporary limits to the provision of flexibility in certain situations by means of a Network Flexibility Study (NFS). This ex-ante study is only for certain flexibility products and for flexibility activated by the TSO.
- Discussions are ongoing related to operational zones. Green and red zones for grid operation have already been defined. Discussions are ongoing concerning the description of the situations in between these zones. This is a step towards the implementation of «**traffic light approach».**

CSS:

- Regulation and other stakeholders **recognize the responsibility of the DSO** to safeguard operational security.
- Regulation and other stakeholders **recognize the need to enhance TSO-DSO collaboration**.
- The **evolution of ancillary service products** illustrates the need for involvement of distribution grid-connected resources to total system security. Since a couple of years, the Belgian TSO is expanding its portfolio of ancillary service products to the distribution grid connected flexibilities (e.g. R3DP [19], R1[17]). In addition, the bid-ladder project could potentially open the possibility for Belgian DSOs to transfer flexibility to the TSO bidding platform.

DSO:

- NRAs are discussing and studying options for **advanced monitoring and control technologies**. In Wallonia and Brussels (capital region), NRAs in collaboration with DSOs are studying the technologies required to make the distribution grid smarter. In Flanders, a policy platform is launched to discuss the actions for the transition towards smarter grids.
- DSOs are **allowed to use flexibility for grid planning**. In Brussels, Ordinance of July 19th (2001) allows for DSM to be used to avoid grid investments (both capacity expansions and replacements). In Wallonia, DSOs offer non-firm grid access contracts to grid users to manage grid reinforcements while avoiding congestions.

DM:

- The Flemish regulator **explicitly recognizes the DM role** and considers that handling sensitive and commercially interesting data is best performed by a regulated, neutral and independent stakeholder.
- Belgian DSOs put forward the initiative of a **shared data platform**: Atrias. This initiative aims to discuss data needs and related infrastructure for the secure delivery of data.

SMO:

- The Flemish regulator officially decided on the **segmented roll-out of smart meters**. In addition, as from 2019, consumers will have the possibility to request a smart meter (before roll-out) at own expense.
- Discussions are ongoing between regulators related to smart meters. The Flemish regulator organizes a **platform for stakeholders** related to smart meters. In Wallonia and Brussels, regulators and DSOs are discussing technical adjustments for the introduction of smart meters.
- Flemish DSOs have implemented several **successful pilot projects** related to smart meters.

CRM & **OTPRM**:

- There are ongoing discussions on non-grid access contracts. **Variable grid access contracts** are present in pilots. In Wallonia, DSOs may offer interruptible service contracts to avoid congestions.
- The Atrias platform is an example of **discussions between stakeholders** with respect to topics of high interest, i.e. a platform for data sharing. In Flanders, the smart meter pilots increased interaction between DSOs and consumers.
- **New market players** are looking actively for services. Aggregators in the Belgian power market are involved in discussions e.g. around data and flexibility management.
- There is an increased need for **interaction between system operators**. The Belgian TSO is extending his AS products to resources connected at the distribution grid, which requires an increased interaction between TSO and DSO.

3.1.2.Barriers

The barriers identified from the current context description of Belgium are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- Today, regulatory uncertainty exists with respect to the **cost recovery** from procurement and use of flexibility.
- Currently, the **cost of flexibility** versus other alternatives (e.g. grid reinforcements) provides few incentives for Belgian DSOs to procure flexibility.
- Today, there is **no market environment** where DSOs could procure flexibility.

NMF:

- The scope of the prequalification process for Flemish DSOs is limited since it only allows ex-ante involvement. The **real-time status of the distribution grid is currently not implemented.**
- There exists **regulatory uncertainty on DSO actions outside emergency situations**.
- Today, only **limited** and non-structural **information exchange** is organized **between TSOs and DSOs** related to the procurement, activation and settlement of AS from distribution grid.

CSS:

- There is **no structural information exchange** (e.g. through a dedicated platform) **in real-time** available, which is needed in case real-time support from the DSO to the TSO is requested.
- There is a **limited consideration on the participation of DSOs towards ancillary services.** The TSO organizes AS markets as a single buyer market without providing a role to the DSO. AS-products, based upon resources from the distribution grid, do not need any involvement of the DSO in the process of procurement and activation. The «Bidladder» project lead by the Belgian TSO aims to provide all market players (grid users, aggregators and small production units) with a bidding platform for balancing services (as part of balancing market). However, it is not clear what could be the role of the DSO in this platform.

DSO:

- DSO options towards flexible resources are limited to emergency situations. Alternatives to grid reinforcements are still limited.
- Cost of flexibility is perceived higher than other alternatives since it is unclear if full costs can be recovered. Therefore, Belgian DSOs have few economic interests to procure and use flexibility instead of other alternatives.

DM:

- Difficulty in reaching **agreement for a shared platform** (Atrias). This initiative is stagnated at the moment showing the complexity to reach an agreement.
- The Flemish regulator envisions a new role of **Flexibility Data Manager** (FDM) at distribution system level. The FDM role is considered to be **adopted by the TSO**.

SMO:

- There is no homogeneous approach towards the roll out of advanced metering infrastructure. In Flanders, smart meter roll-out is expected by 2019. There is no clear timeframe for Wallonia and Brussels.
- A recent study shows a negative CBA for smart meters in Belgium [31].

CRM & **OTPRM**:

- There is currently no clear vision on what services the DSO should develop to respond to the needs of other stakeholders.
- No decision is reached with respect to the features of the non-firm grid access contract.

3.1.3. Time-wise expectation for the adoption

Figure 10 shows the expected time horizon for the adoption of the role model in Belgium. Most of the functionalities are expected to become a reality in the short-term. As expected, roles that require considerable regulatory changes are foreseen in the long-term.

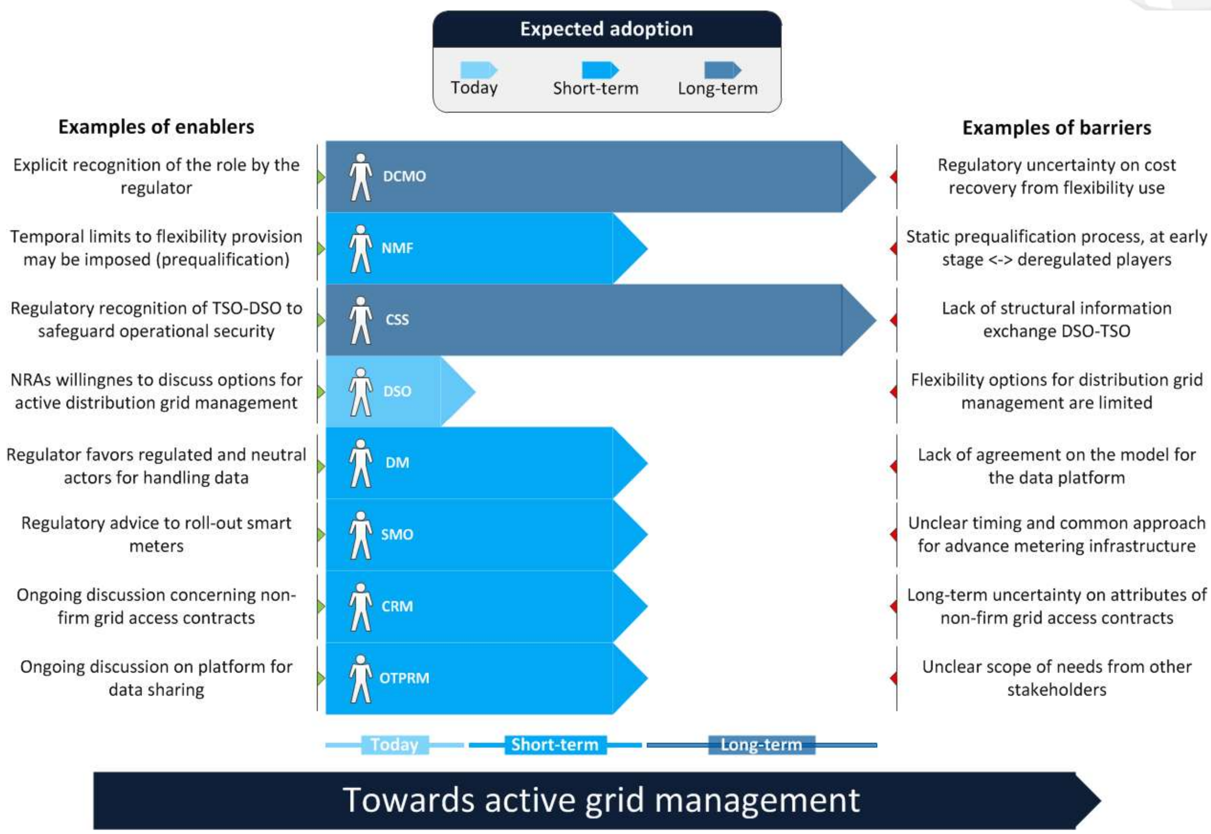

Figure 10: Role model expected adoption - Belgium

3.2. France

The national context of France is provided in section 6.3.2 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.2.1. Enablers

The enablers identified from the current context description of France are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- Current French regulatory framework could allow the use of flexibility by the DSO while ensuring associated **costs are covered by the network tariff.**
- The article 199 of law for the energy transition and its associated decree **allows the use of local flexibility services** proposed by grid users, local authorities,…

NMF:

- The decree 'effacement' (demand curtailment) reinforces **DSOs' role as data supplier for the verification of demand response activations**.
- **The adoption of other roles such as the DM role** (which is already the case for France) may reduce data management complexity**.**
- The balancing, ancillary, capacity markets and the rules for third party access to energy markets consider DSO participation in the **registration process for flexibility**.

CSS:

- **Current discussions between network operators** are ongoing to improve network management and security of supply.
- DSOs can **provide valuable information to the TSO** through aggregation of network data at primary substation level.

DSO:

- **New tools** are being developed in order to use the ever-growing body of data for network optimization.
- The current regulatory framework allows the DSO to **coordinate with production units.** This coordination allows for the optimization of maintenance works.
- Current regulatory developments may allow the **use of flexibility by DSOs**. New solutions emerge to allow better network optimization. Smart grid technologies will allow the DSO to get more data and thus better understand the state of the network.

DM:

- The current regulatory framework allows the DSO to perform services associated with this role.
- DSOs **collaborate with regulatory institutions** in order to define the level of expectation and methods for data anonymization. This collaboration also aims to clearly identify the boundaries between regulated and non-regulated activities associated with data management.

SMO:

- The current regulatory framework allows the DSO to perform services associated with this role.

CRM & **OTPRM**:

- There are ongoing contractual and regulatory evolutions related to **non-firm access contracts.** The regulator, DSO and generators associations are in favour of setting up these types of contracts rapidly (expected to be implemented by 2018 for MV-connected generators).
- There is **regulatory support to develop data services**. The TE Act (2015) establishes a framework for the DSO to deliver detailed consumption and generation data to actors such as local authorities and even at the level of the building, a destination of the landlords or lessors in case of energy efficiency works on the building. DSOs will deliver **more evolved services**. The article 23 of the Digital Act (published on October 2016) creates open data from the DSO (and TSO) and reinforce the position of the DSO by allowing the publication of more evolved services. Both laws deal with anonymization, definition of standards, etc.

3.2.2. Barriers

The barriers identified from the current context description of France are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- Current **flexibility aggregation rules are not adapted** to a local use of flexibility by the DSO. The flexibility perimeters and flexibility offers may be aggregated at national level. E.g. a flexibility offer on the balancing mechanism is made using a value of power or energy considering all the flexibilities within the perimeter. An additional level of aggregation could be envisaged in order to allow these flexibilities to offer services to the DCMO.
- The existing **market platforms are not adapted** and do not allow the DSO to access flexibilities. In addition, focus is only on national markets and not on local markets.
- There is no explicit **coordination mechanism** put in place yet in order **to avoid activation conflicts** between DSO and TSO.
- There is a **lack of explicit basis for the use of demand increase activations** to manage system balancing or constraint management.

NMF:

- DSOs **are limited in their actions towards grid management** (outside emergency situations). DSOs are **not allowed to deactivate or modify flexibility programs** for distribution constraint management.
- Current flexibility registration rules are not adapted and do **not consider local aggregation** levels.
- **Distribution constraints are not considered** in current market rules.
- **Aggregators favour the national level** as the regulatory framework considers only an aggregation at national level. The contribution of each individual flexibility to the flexibility market offer is unknown. This is not in favour of local prequalification.

CSS:

- There is **not yet a final agreement on data to be exchanged** between system operators.

DSO:

- DSO **cannot use data from smart meter for network optimization/operation** purpose due to privacy issues.

- DSOs' remuneration provides **no clear incentive** to implement alternatives to network reinforcements. This is mainly due to the uncertainty to recover the costs of implementing the alternatives.
- The **existing feed-in tariff** does not favour the emergence of new flexibilities as it does not allow producers to reduce their generation to help solving grid constraints.

DM:

- There is not yet a final agreement concerning **standards** for data communication

SMO:

- There is an unclear framework for **EV charging infrastructure data.**

CRM & **OTPRM:**

- The process for amending rules associated with data and services provision could be time-consuming.
- **Third parties** in France **are very diverse**. The expectations of these parties are also different. This implies that it is difficult to build a homogeneous and common vision of the expectations in terms of publication of data. In addition, it is difficult to harmonise the level of requirements on data provision for the different regions, taking into account differences between rural and urban regions.

3.2.3. Time-wise expectation for the adoption

Figure 11 pictures the expected time horizon for the adoption of the role model in France. This illustration shows that regulation provides support to the roles concern with data management and metering. To tackle new paradigms in network planning, regulation provides a clear framework for the implementation of non-firm grid access contracts.

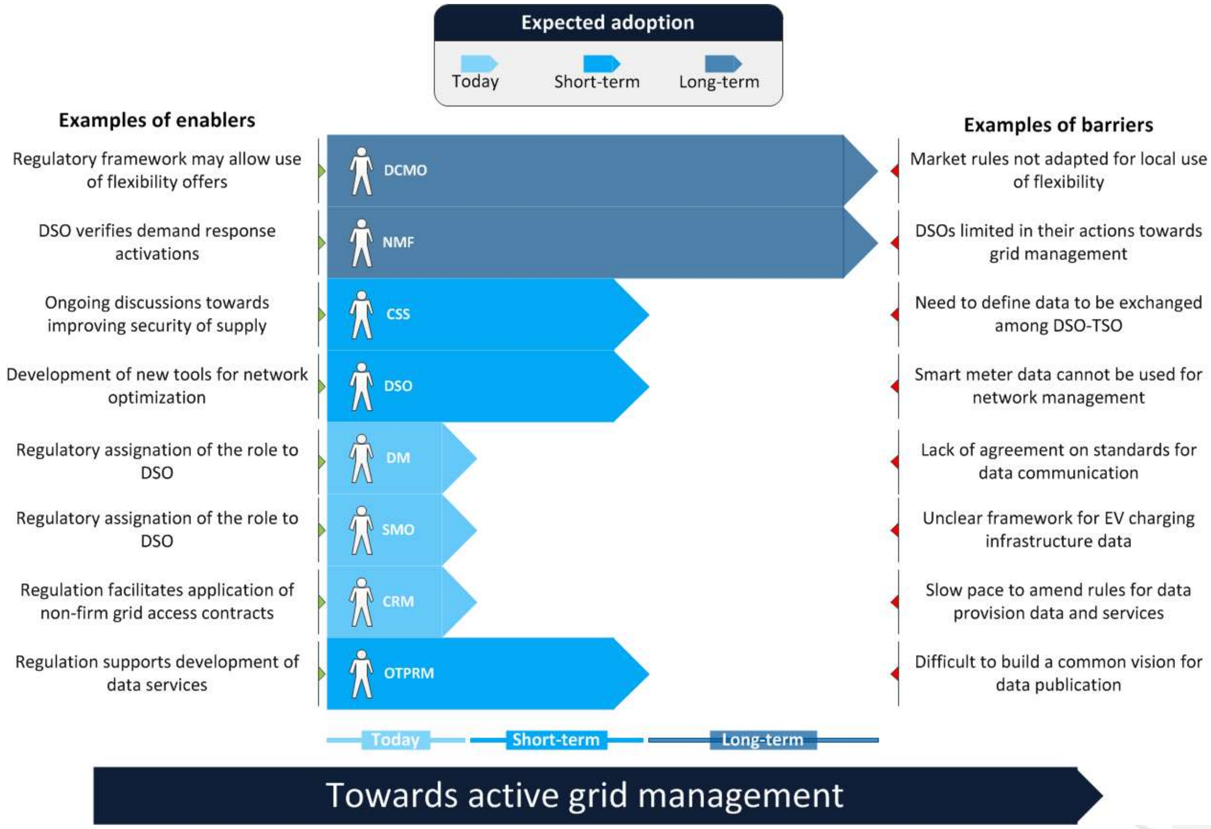

Figure 11: Role model expected adoption - France

3.3. Germany

The national context of Germany is provided in section 6.3.3 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.3.1.Enablers

The enablers identified from the current context description of Germany are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- The policy with respect to **feed-in management** favours this role. The EEG[28] (§ 14) would allow DSOs to manage flexible resources (e.g. DRES) output with reimbursement for proprietors/owners. This measure can be used in case of grid congestion. However, it has been allowed only as a temporal measure (i.e. as an exemption) until grid reinforcement is implemented. The EnWG[29] (§ 11 Abs. 2) allows DSOs to curtail feed-in (peak shaving) from flexible resources. Currently, this is only allowed for a maximum of 3% of energy produced throughout the year. This possibility is linked to §14 EEG. Peak shaving was introduced to reduce network reinforcement costs. The EnWG (§ 14a) might allow to steer loads at low voltage level.[30]
- The German metering law (Messstellenbetriebsgesetz) defines the **smart meter roll-out** in general. It also serves as an enabler for more complex methods of flexibility utilization in distribution grids from a technical perspective.

NMF:

- DSOs are involved in a **pre-qualification process** run by TSOs for devices / loads that are bidding in the reserve markets. The DSO involvement in prequalification gives long term

[28] EEG stands for Erneuerbare-Energien-Gesetz - https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=73930
[29] EnWG stands for Energiewirtschaftsgesetz - http://www.gesetze-im-internet.de/enwg_2005/
[30] The decree that further describes rights and duties has not been published yet.

clearances (the DSO agrees what is generally possible with regards to the connection of the device etc.).

CSS:

- Network operators collaborate intensively and have already **well-established processes concerning system security** (e. g. black start, load shedding). Curtailment of DRES connected to the distribution grid on behalf of TSO is allowed (§13.2 EnWG).
- Aggregated **real-time and prognosis data** for distribution grids exist for operational purposes. These data are made available for the TSO.

DSO:

- The DSO is allowed to use peak shaving as a new planning paradigm.
- The metering law (Messstellenbetriebsgesetz) introduces **new settlement rules for most smart meters**[31]. These data are available for DSOs. DSOs can use the data for planning and to improve existing processes.
- New meters (for consumption above 20.000 kWh/year and for flexible resources above 7kW) will also deliver "technical data" (cos φ, U, etc.) on the DSOs' request which will lead to enhanced observability.

DM:

- **Aggregated real-time and prognosis data for distribution grids exist** for operational purposes. These data are also available for the TSO.
- The function of "**Smart Meter Gateway Administrator" (SMGW-Admin) will be assigned to the DSO**. This in addition to the assignation of the DSO as "Metering Point Operator" (MPO) of last resort (grundzuständige Messstellenbetreiber). SMGW-Admin will be a very digital and certified role and exhibits a lot of scale economies – some DSOs might be able to leverage on that.

SMO:

- DSOs will adopt the "Smart Meter Gateway Administrator" (**SMGW-Admin) role.**
- There is an **organized roll-out of smart meters as of 2017**. DSOs are supposed to roll-out smart meters (intelligente Messsysteme) from 2017 onwards for customers above 6.000 kWh per year. All other customers will receive electronic meters; DSOs might voluntarily decide to introduce smart meters for all customers. New smart meters at installations

[31] 96 values per quarter of an hour per day. This data is delivered on d+1.

above 20.000 kWh per year and at flexible resources above 7kW will deliver "technical data" (cos φ, U etc.) which can be accessed by DSOs (upon request).

CRM & **OTPRM**:

- Smart meters are technically feasible to allow for **load based tariffs**.
- The metering law explicitly states, that SMGW / **intelligent metering system** should also be useful and useable in markets beyond energy (i.e. water, district heating, banking etc.), i.e. any party that has an interest in a highly secure data connection might be a prospective customer from the MPO's point of view.
- Peak shaving (§ 14a EnWG) and smart metering might **increase the flexibility potential** and the **contact points** between the DSO and other markets.
- As MPO is regulated via price caps (and not "inside" the DSOs' revenue cap) chances for **additional revenue via the provision of regulated data services** exist.

3.3.2. Barriers

The barriers identified from the current context description of Germany are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- The **regulatory framework is not clear** on the possibility to access flexibilities in situations not categorized as emergency (i.e. outside red zone/phase). So far no real political discussion on the "yellow phase" has begun. Measures considered within EEG and EnWG can only be implemented in "red phase". The decree that further describes § 14a EnWG is still yet to be provided by the government[32]
- Smart meters in Germany are able to transmit "steering signals" via secured communication infrastructures but the **box that is needed to turn a digital signal into action in a steerable device** (e.g. steering box at a heat pump) is still missing / not defined yet. The steering box needs to be able to "write" information into smart meter gateway which is currently forbidden under the BSI's technical directive (BSI TR 3109-01)[33].
- Political discussions on "**clauses for experimentation**", i.e. stipulations in the energy law that would allow the regulator to overrule certain regulation in case of research projects, show that

[32] However, the necessity has been identified and a general discussion about the needs to leverage load flexibility has already started.
[33] https://www.bsi.bund.de/DE/Publikationen/TechnischeRichtlinien/tr03109/index_htm.html

as long as DSO are not formally enabled by law to procure flexibility they would have to buy through a nationwide platform.

NMF:

- There is no consideration of DSO needs in short-term tenders. The DSO is **only involved in long-term processes.** Distribution short-term constraints are not being taken into account in tenders for system services (the DSO is currently unable to be involved in such tenders).
- There is a **limited consideration of DSO constraints.** The regulator discusses a decentralized model with regards to balancing markets that should serve as a starting point for a full-fledged aggregation model in Germany. Until now, DSOs and their needs/restrictions are not mentioned in the current draft for short-term regime.

CSS:

- The **TSO** is aiming for **direct control of generators connected to the distribution grid**. DSO responsibilities concerning this matter are still unclear.
- The TSO is aiming for **detailed data** to establish a separated state estimation and prognosis for the distribution grid behavior where aggregated data already exists. A continuous development of the TSO/DSO interface has already started with processes like the Energieinformationsnetz (energy information grid).

DSO:

- The regulator seems to favor a **CAPEX oriented regulation**. This regulation motivates integration of flexibility only indirectly via efficiency incentives.
- The network tariff model offers only **limited options** to motivate grid friendly behavior of flexibilities. It has especially no influence on generators since they do not pay grid fees in Germany.

DM:

- In 2020, the **TSO will become the settlement authority** for intelligent metering systems. This puts the role of the DM (in Germany) under pressure. In the target model, the DSO will continue to support the TSO in their settlement duties (i.e. all supplier changes need to be communicated towards TSOs, complex metering points incl. virtual metering points cannot be settled directly).
- The **DSO role in the aggregation model** is currently discussed (interim model) but not entirely secured. The energy transition will continue on a more digitalised basis but the DSO will not become a full-fledged DM[34].

[34] Here the reference is made to the description of the Data Manager role as envisioned in the evolvDSO project.

- The **TSO is aiming for detailed data** to establish a **separated state estimation** and prognosis for the distribution grid behavior where aggregated data already exists. A continuous development of the TSO/DSO interface has been started already with processes like the Energieinformationsnetz (energy information grid).
- The **new metering law introduces a “star-like” data delivery** (from 2020 onwards). The intelligent metering systems will distribute all values to eligible parties / market roles directly in a decentral manner. The new metering law puts more emphasis on the metering point operator as a new role in data management, i.e. replacement values / substitute values are either to be “produced” by the intelligent metering system automatically or by all eligible market roles decentralized.

SMO:

- **Technical specifications** for smart meters are **not entirely finished. Parallel price regulations** create regulatory uncertainty. **Price caps** for new meters are not part of DSOs overall revenue cap. Tough price regulation (i.e. price caps) would frame the development path for smart meters. Economies of scale need to be harvested in order to meet the price caps.
- Some **DSOs** (especially **smaller** ones) will be **forced to buy SMGW-Admin** in a system as a service agreement (which the BSI regulation allows for).
- WAN communication might be **technically challenging** in the country side.

CRM & OTPRM:

- There is **no regulatory clarity for data beyond the metering law**. The new metering law clearly states which party or roles is allowed to receive, store and use which data (in electricity and gas) – these may not be sold / forwarded to third parties. Additional and explicit consent by customers is needed if data that goes beyond metering law is to be collected (by any role/party). The metering law considers ¼h-values as produced by German smart meters as to measure “WORK” (kWh) only. Therefore, short-term introduction of more complicated /load-oriented pricing schemes is questionable.
- A national register of power plants (independent of technologies) is to be created (Marktstammdatenregister) which will include a lot of **information for free**, i.e. it is almost impossible to capitalize on such information.

3.3.3. Time-wise expectation for the adoption

Figure 12 illustrates the expected time horizon for the adoption of the role model in Germany. The role of the DSO as a buyer of flexible resources for grid management is expected in the long-term, similar to other Member States. In Germany, it is critical that regulation provides a framework that fits this purpose.

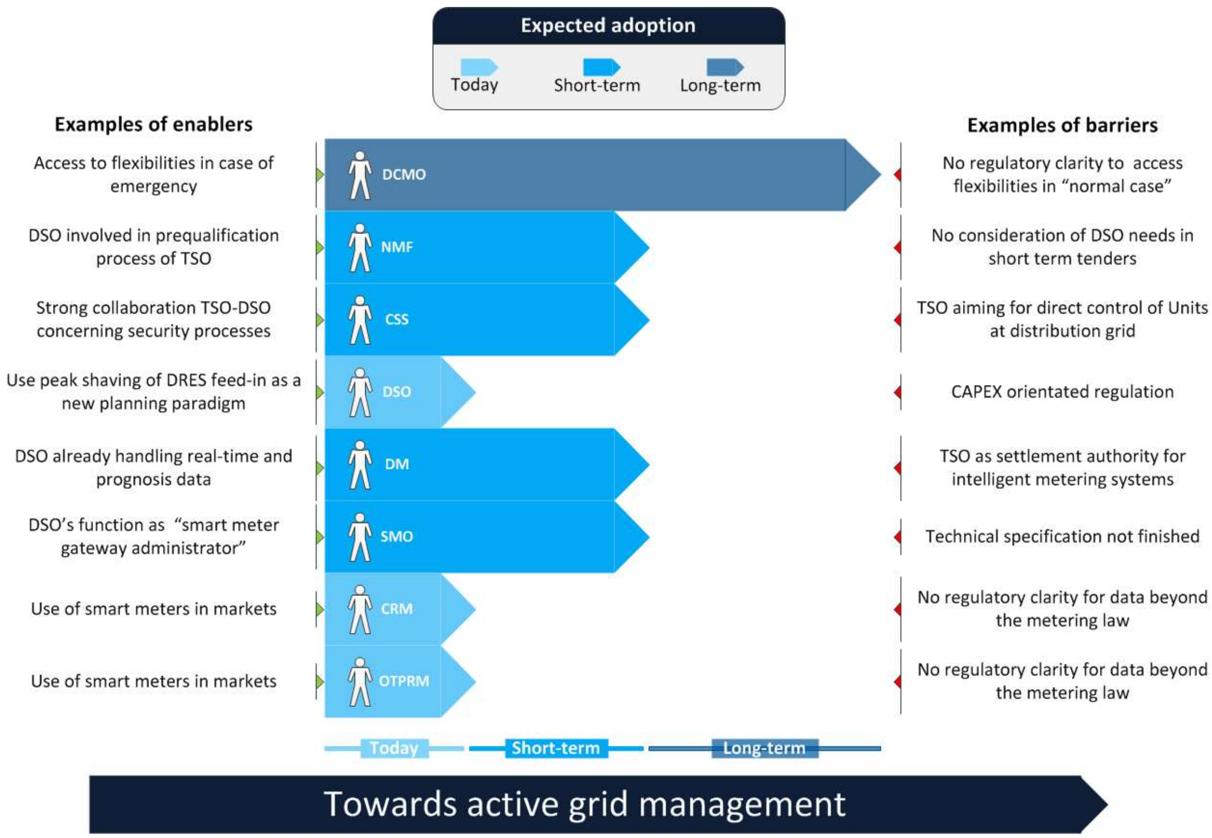

Figure 12: Role model expected adoption - Germany

3.4. Ireland

The national context of Ireland is provided in section 6.3.4 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.4.1. Enablers

The enablers identified from the current context description of Ireland are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- As part of the DS3 programme, the TSO are developing **products** that include generation/storage/consumption **connected at distribution level**.
- The DSO is a participant in the advisory council for service development.

NMF:

- There is an **explicit recognition of the role** by the regulator.

CSS:

- There is the **recognition of DSO's responsibility** to safeguard **operational security**.
- There are **ongoing discussions between TSO and DSOs** to improve the management of restoration guidelines and security of supply.
- The **information of the DSO is regarded as valuable by TSO**. This information may be aggregated at primary substation.

DSO:

- There are ongoing discussions and R&D trials for **better grid optimization** that should allow an appropriate evaluation of new technologies and development of new software tools.

DM:

- There is an **explicit recognition of the role** by the regulator.

SMO:

- There is an official regulatory decision to roll-out smart meters by the DSO. Smart Meters are due to be deployed in Ireland from 2018. DSOs were tasked with specifications and roll-out plan for smart meters.

CRM & **OTPRM**:

- There are ongoing discussions to increase interaction between stakeholders.

3.4.2. Barriers

The barriers identified from the current context description of Ireland are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- The **regulatory framework is unclear** concerning the use of flexibility-based solutions for distribution grid management
- Today, there exists **no market environment** where DSOs could procure flexibility.

NMF:

- There is a **limited consideration of DSO involvement**. Current flexibility registration rules are only considered at TSO level. Therefore local prequalification cannot be implemented. DSOs are not allowed to control flexibility programs (such as DSM schemes) for distribution constraint management.
- **Distribution constraints are not considered** in current market rules.
- There is **limited information exchange** between DSOs and other stakeholders. DSOs are not aware of the schedules from flexibility programs.

CSS:

- There is **no structural information exchange** (e.g. through a dedicated platform) in real-time available, which is needed in case real-time support from the DSO to the TSO is requested
- The AS-products, based upon resources from the distribution grid, do **not** need any **involvement of the DSO in the process of activation**.

DSO:

- The existing DSO tariffs do not incentivize the emergence of new flexibilities. The reinforcement of the network is incentivized rather than the use of alternatives (e.g. flexible resources).
- There is a limited visibility of the LV grid.

DM:

- There exist divergent approaches to data management and access.

SMO:

- Some decisions/specifications remain to be finalised. In addition, not all people are in agreement with the smart meter roll-out – some negative press has been published.

CRM & **OTPRM**:

- There is a lack of framework to provide non-firm grid access contracts.
- There is no clear roadmap of what services are to be developed by the DSO for other stakeholders.

3.4.3. Time-wise expectation for the adoption

Figure 13 shows the expected time horizon for the adoption of the role model in Ireland. Most roles are expected to be fully functional in the short- to long-term. It is worth to mention that roles in which a high level of innovation is required are expected for the long-term, namely DCMO, NMF and CSS.

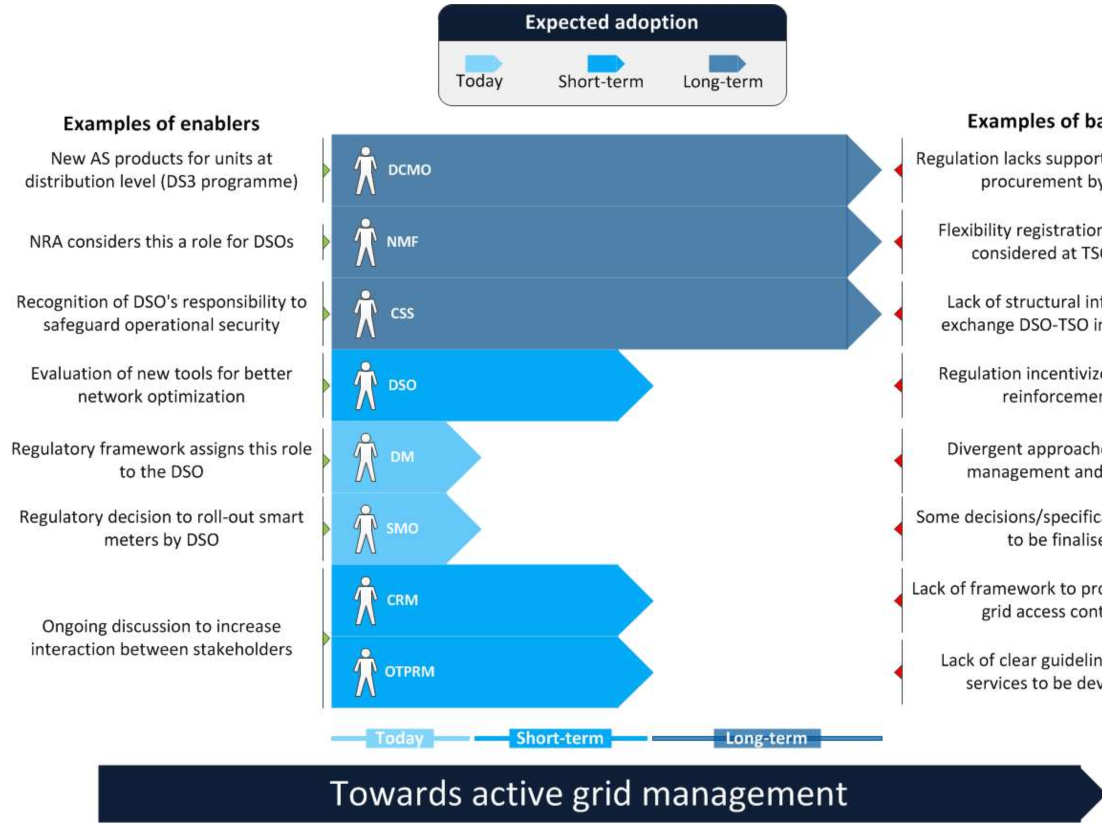

Figure 13: Role model expected adoption - Ireland

3.5. Italy

The national context of Italy is provided in section 0 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.5.1. Enablers

The enablers identified from the current context description of Italy are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- There are **ongoing discussions** with respect to the **new model for the evolution of ancillary services.** The centralized extended dispatching model variant b (section 6.3.5) would open the way to enabling DSOs to require local services not in conflict with the system services and at regulated price. This variant could be applied as evolution of this model.

NMF:

- There are **ongoing regulatory discussions on the roles of DSOs in dispatching rules.** Even though not explicitly recognized, the NRA is open to the possibility that distributors, ex ante, communicate to dispatching users and to the TSO the presence of constraints on their networks for the definition of virtual units of production and consumption.
- **Slow market reform process is recognized by the regulator**. The NRA recognized that the reform of the market needs a longer timeframe (rather than the 2 years transition period) to be completed. Hence, the Authority will evaluate, through additional consultations, the specifications of the "plant controller" for producers connected to MV and LV networks. The controller should be able to receive signals from actors like the aggregator and translate them into actions on the production unit. These signals may be used by the TSO (in an aggregated way) for the participation to MSD and by the DSO in order to provide useful information for the operation of the network (thus improving and integrating the observability). The controller should also send information on the actual operation of the plant production.

CSS:

- There are **tests undergoing concerning data exchanges (structural data) between network operators** in order to enhance cooperation and grid observability (to be completed by 2016). The aim of these tests is to define the data exchange and the indication of accuracy of the estimates and verify the usefulness of this data exchange.

DSO:

- The Regulator identified some **Smart Distribution System functionalities**. The increased Observability of the network implies a higher potential for monitoring the MV network. The MV regulation would allow a higher hosting capacity (network investment deferment due to a better network capacity use) and the availability of information to improve network operation.

DM:

- The **DSO collects all the contractual, network and metering data** in order to comply with its regulated duty of metering operator. The DSO then provides this data to the data platform called SII (see section 6.3.5).

SMO:

- The DSO is fully responsible for the smart metering infrastructure. Currently, the 2nd generation of smart metering infrastructure is being deployed.

CRM & **OTPRM**

- There is an external data hub already in place. Metering data are already available through the data platform SII. There is however an increased need for interaction between stakeholders.

3.5.2. Barriers

The barriers identified from the current context description of Italy are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- The regulatory framework **does not support the procurement of flexibility**. Until the dispatching market reform is completed, present regulation does not allow the DSO to perform this role. To date, the DSO can only communicate to the TSO constraints on the distribution network.
- At least in this transition phase (2017-2018) the DSO will not be able to acquire flexibility in the market according to the proposed **reform of the dispatching market**.
- The regulatory framework is unclear on how **costs** from the implementation of alternatives to current operational practices **could be recovered**.

NMF:

- **DSOs are not informed about the flexibility that is activated** on the network
- There is a **limited consideration of distribution grid constraints.** The proposed regulation for the dispatching market is based on the assumption that any modulation of units of consumption and production on the distribution network does not lead, in general, to problems for the distribution network (no constraints). Only ex-ante DSOs may communicate to dispatching users and the TSO the presence of critical points on their networks to be taken into account in the definition of the virtual units of production and consumption.

CSS:

- DSOs play no role in the TSO AS market. The TSO organizes AS markets as a single buyer market without providing a role to the DSO. The AS-products, based upon resources from the distribution grid, do not need any involvement of the DSO in the process of procurement and activation to date.

DSO:

- There are **limited alternative options for optimal planning and operation**. The DSO is not allowed to use flexibility for grid planning or operational purposes.
- The regulatory framework is unclear on how costs from the implementation of alternatives to current operational practices could be recovered. Italian DSOs have few economic interests to procure flexibility instead of other alternatives.

DM:

- No particular barrier.

SMO:

- No particular barrier.

CRM & **OTPRM**

- There exists no definition of non-firm grid access contracts in current regulation.
- The level of complexity and innovation required for the provision of regulated data services is unclear

3.5.3. Time-wise expectation for the adoption

Figure 14 illustrates the expected time horizon for the adoption of the role model in Italy. The current framework implemented in Italy introduces a data hub (SII) that works in tandem with the DM role adopted by the DSO.

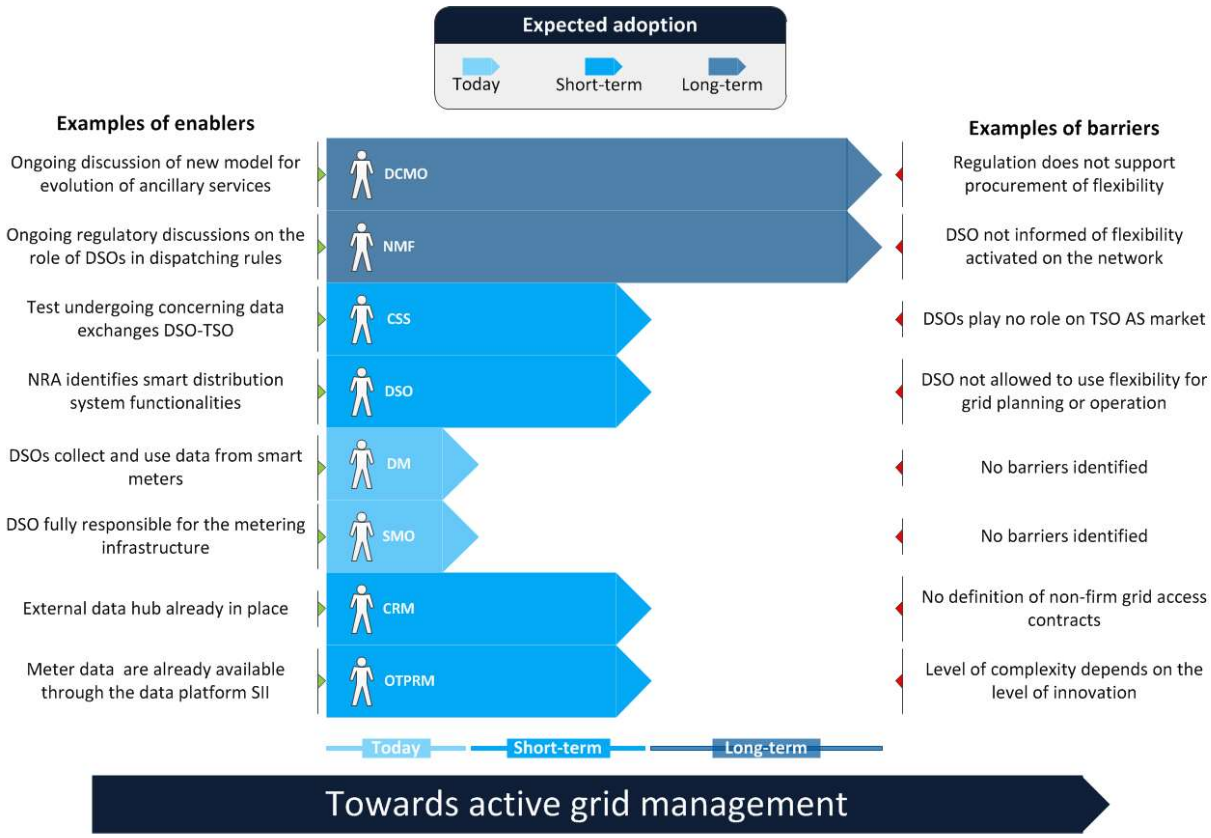

Figure 14: Role model expected adoption - Italy

3.6. Portugal

The national context of Portugal is provided in section 6.3.6 (annex). The main elements related to the status of the market for ancillary services, the status of demand response, developments in system operation, developments in data management and the status of the smart metering infrastructure are presented. Based on this assessment, the main enablers and barriers for each role are listed in the following two sections.

3.6.1. Enablers

The enablers identified from the current context description of Portugal are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO:

- **The availability of data** to calculate flexibility needs is an important enabler. There exist telemetered data for all VHV, HV, MV and Special Low Voltage costumers (Low Voltage costumers with subscribed capacity > 41.4 kW). These data would be complemented by the deployment of smart meters associated with residential customers and the existence of telemeters associated with all the secondary substations. These data create an opportunity to evaluate more efficiently local network constraints and to assess which end-users present a load diagram better suited to help solving those constraints through DSR. Near real-time data will be useful to help understand how much consumption is coming from different customers in different periods. Although the elasticity of consumption of different customers may vary, the contribution customers make to create constraints is a function of their consumption. This is why the telemetered data are important.

NMF

- The **availability of relevant data** (see DCMO role) is important. In Portugal, the DSO is aware of activations of resources associated with its network. **Investment plan of the DSO in HV and MV networks** includes an average 11 M€/year investment for the period 2017-2018, and 10.5 M€/year for 2019-2021 dedicated to the enhancement of access to new markets. These investments address three aspects identified as priorities for the development of smart grids:
    - Advanced components: integration of technologically advanced components that enhance the network performance and efficiency;

  - Network monitoring: equipment that increase the capacity to monitor the network and provide more online data of the operational conditions;
  - Active network management: enhance the capabilities associated with network management based on the data acquired.
- The **development of tools** regarding predictably, observability and controllability of distribution network resources is important.

CSS

- There is already **existent cooperation between the TSO and the DSO**. Hypothetical interruptibility commands originated by the Global System Operator and directed to consumers or producers associated with the DSO network are transmitted by the TSO to the DSO, who executes them.

DSO

- The regulator is willing to discuss and study **options for advanced monitoring and control technologies.** The DSO is implementing software enabling to forecast DER (short term). These forecasts are already done when deciding when to disconnect lines associated with maintenance/developing of HV networks. The regulatory framework might be opened for discussion should the DSO demonstrates, to the NRA, a situation where use of flexibility might be the best solution.
- The **development of an asset management program** (including the development of IT systems enhancing asset management)[35], whose implementation should occur within the next two years is crucial.
- The development of the **concept of integrated network planning and maintenance strategies** which implies:
  - Coherent network planning of the Transmission and Distribution networks – both the TSO and the DSO plan their network considering the planning and the requirements of the other entity;
  - The integrated network planning aims at a better evaluation of the trade-offs between maintenance and investment plans ;
  - It also aims to improve the assessment of the adequacy of investment plans according to risk criteria.
- There are **increased monitoring and control functionalities** used by the DSO. The DSO finished the installation of telemetering in its 66,000 secondary substations. It is expected to

[35] After the conclusion of that program, the DSO will comply with ISO 55,000 requirements.

have 10,000 DTC (Distribution Transformer Controllers) and 550,000 smart meters, representing 9% of end-users, by the end of 2016.

DM

- The **NRA recognizes DSO independency and efficiency**. The DSO has experience with data management and data from SM is necessary for DSO's processes (e.g. quality of service, planning). The recognition of synergies between meter operation, collection and management of data is an important facilitator. This avoids duplication of ICT infrastructure and no additional neutral entity has to be regulated.
- The DSO is developing information systems associated with AMI data management storage and analysis.

SMO

- There was a **successful implementation of a smart grid pilot**. The InovGrid project in Évora, involving 31,000 customers, is used as a test bed for several R&D projects. The development of several other smart grids initiatives by the DSO, encompassing the installation of more than 100,000 smart meters, are also ongoing.
- **Large-scale development in 2016** focused on urban areas and the phase-out of conventional meters.

CRM & OTPRM

- **New market players entering the market**, creating an environment able to foster innovation.

3.6.2.Barriers

The barriers identified from the current context description of Portugal are listed below. These barriers are classified per role. The current list of examples is not exhaustive.

DCMO

- The **regulation does not allow the DSO to contract commercial flexible resources**. Although the DSO may ask the TSO to curtail load, the final decision will not belong to the DSO, under the current regulatory framework.
- There is a **lack of recognition for new OPEX.**
- There is a **lack of access to the flexibility market** by the DSO. Today, there is no market environment where the DSO could procure flexibility.

NMF

- The **scope of the pre-qualification process** limits DSO´s support towards ancillary services. The DSO cannot pre-qualify flexibility for AS provision (and the TSO will only start to pre-qualify flexibility for interruptibility in 2017). There is also no discussion with respect to a traffic light system involving the DSO. Although the DSO is aware of activations of resources associated with its network (in fact, it has to activate them on demand by the TSO), the DSO cannot refuse these activations.
- The system is currently overseen from a national perspective, not considering local levels. Therefore, local prequalification of flexibility operators would require the development of complementary criteria associated with the observance of locally observed unavailability risks.
- There is a **lack of clear definition of distribution constraints** allowing to implement the "traffic light" concept. Regarding pre-qualification criteria, technical constraints leading to the activation of ancillary systems and the definition of transparent rules considering the activation of those services with individual generators or end-users.

CSS

- There is a **limited participation of DSOs concerning AS procurement and activation.** The TSO does not consider active DSO participation for AS activation.

DSO

- There is a need of to invest in data analytics and extend grid control functionalities. There is a need to improve data storage, treatment functionalities and know-how. Lack of technical capability hinders the effective use of data collected from the smart grid infrastructure.
- The regulatory framework is not incorporating the use flexibility (as additional lever) for grid planning and operation.

DM

- **The role might be adopted by a third party.** The DSO has a concession to operate the National Distribution Network (HV and MV networks). LV networks are the property of the municipalities. Currently, the DSO has the 278 LV operation licenses, granted by that many municipalities. They are valid for 20 years and most of them will expire by 2021. The concession of those licenses will be done through a tender. The full implications of this concession procedure and outcome are still not clear, including the potential implications for the role of data manager.

SMO

- There is a **complex political environment.** There is no roll-out authorization decision by the Portuguese Government. There is also no installation defined by any authority, at the moment [36]. The full rollout shall be a decision by the Portuguese Government, which will always take the position of the NRA (as well as its Cost-Benefit Analysis and studies) into account.

CRM & OTPRM

- The regulatory framework is **not providing the possibility to the DSO for offering and enforcing flexibility contracts.**
- There is **no clear definition on advanced services** and how to improve them.

3.6.3. Time-wise expectation for the adoption

Figure 15 shows the expected time horizon for the adoption of the role model in Portugal. In Portugal, roles closely related to the historical activities of the DSO are already a reality. The smart meter operator (SMO) is a good as example to illustrate this. In Portugal, even though no statutory decision concerning the roll-out of smart meters has been taken, the DSO is already changing legacy meters that reach their end-of-life (EoL) by smart meters.

[36] However, installations of smart meters are taking place.

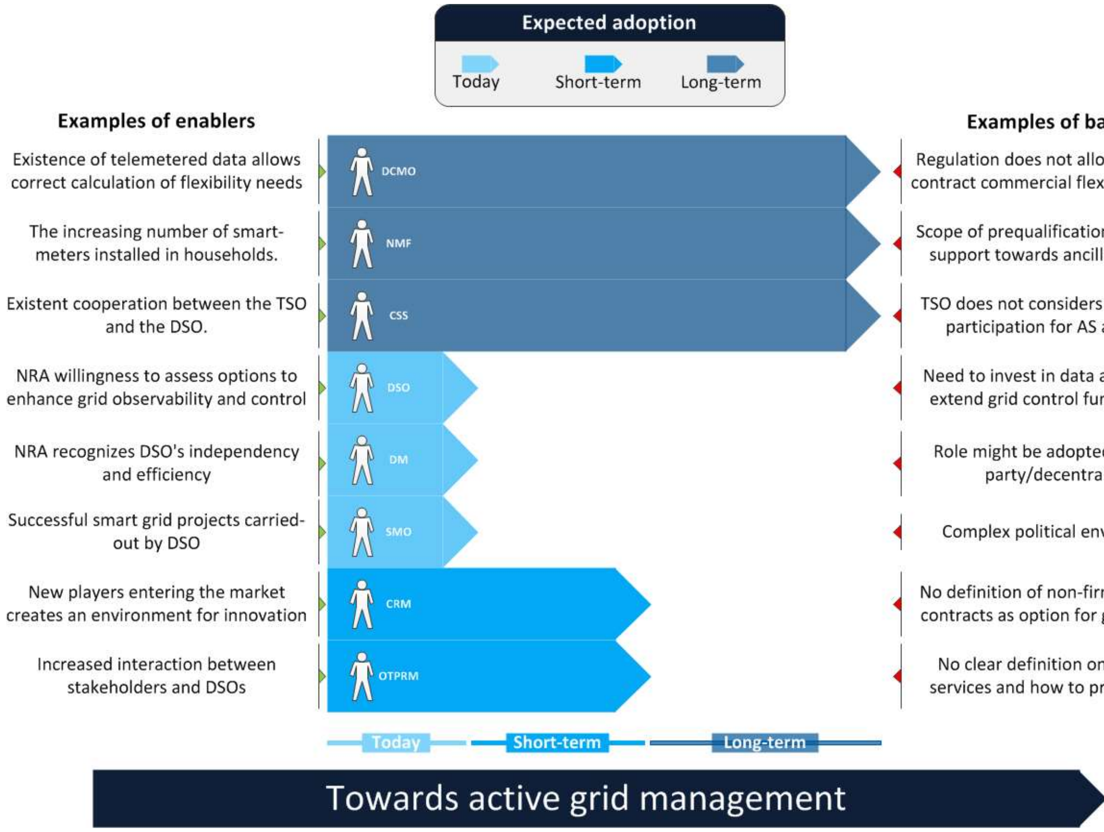

Figure 15: Role model expected adoption - Portugal

4. Roadmap and key recommendations for the adoption of the evolvDSO role model

Today, important evolutions at European level are ongoing supporting the need for evolving roles for the DSO. In addition, changes in the European regulatory framework will impact the feasibility of the adoption of the evolvDSO role model.

Changes in the regulatory framework to continuously guarantee a secure and cost-efficient grid operation are at the heart of European regulation [39]. At European level, Network Codes are under development. These codes determine to a large extent the future regulatory framework with respect to topics such as network security, reliability and connection, data exchange and settlement, emergency procedures, balancing and ancillary services. As a result, these codes will also determine the relationships between different stakeholders and the roles these stakeholders will take up in order to guarantee a transparent and secure grid operation. Examples of relevant Network Codes related to the future role of the DSO are the Demand Connection Code [36] and the guideline on System Operation[38].

Changes in regulatory framework will impact the evolution and adoption of the roles taken up by stakeholders in the power system. The need for a change in roles, mainly related to the role of the DSO, is addressed by several stakeholders in various position papers [30], [40], [42], [46], [47], [49], [50], [51], [53], [54], [55]. The evolvDSO role model tries to provide an answer for this need. A more detailed assessment of the link between the evolvDSO roles, the needs of different stakeholders and the services that could be delivered by DSOs is presented in the different deliverables of the evolvDSO project. The main question is now at which pace different countries will adapt the existing regulatory framework and market design to make the adoption of the different roles possible.

The following chapter discusses the applicability of the role model for smaller DSOs. The most important examples of enablers and barriers will be discussed and the expectation will be presented of the timing of the adoption of the evolvDSO role model within Europe. In addition, key aspects that should be taken into account at the moment of implementation of the different evolvDSO roles will be discussed. The chapter concludes with a list of eight key recommendations with respect to future changes in regulation and market design.

4.1. Applicability of the role model for smaller DSOs

Around 2,500 companies qualify as DSOs throughout Europe, according to a Eurelectric paper of 2014[37], on a market gathering around 250 million of connected customers. On average, a DSO company would therefore be responsible for roughly 100,000 connection points. In practice, the DSO landscape is however very diverse and often does not correspond to this figure. Overall, it is estimated that only 200 DSOs are in charge of 100,000 customers or more, up to 35 million for France's Enedis. The aggregated weight of these 200 companies – 10% of the total amount of DSOs – can reasonably be estimated at around 70%-80% of all customers in Europe. With a sum of more than 80 million customers, the 5 DSO companies taking part in the EvolvDSO project represent almost a third of connection points in the EU.

The amount, size, area, scope and governance of DSOs vary nationally and locally because of a mix of historical, economic, geographical, regulatory and political reasons. This leads to a fragmented landscape, with countries where one DSO operates nation-wide (Ireland, Slovenia, Cyprus) and others counting up to 900 (Germany). Last but not least, it should be noted that DSOs do not necessarily act as an interface between households and the transmission grid. It sometimes happens that a small local DSO operates low voltage distribution grids and connects to a larger DSO at Medium Voltage level.

That variety of situations explains why no "one size fits all" policy has so far been envisaged at the European level. This rationale also applies to the existence of the 100,000 customers *de minimis* threshold[38]: EU Member State may decide not to enforce unbundling rules on DSO companies below this amount of customers.

Taking this into account, it is clear that the future roles of DSOs in the future electricity system could not be completely homogeneous throughout Europe. This may be due to a wide array of factors:

- **Size**: The first issue may be the one of the size of DSO companies. In an evolving electricity system, DSOs must acquire a broader range of capabilities such as market facilitation, communication, and digital technologies. It is not clear whether a "critical mass" to take up these challenges exists and at which level it is located.
- **Scope**: An important difference between the smallest DSOs and larger ones lies in the scope of their activities. Small DSOs operate grids in small areas with a limited amount of customers,

[37] « Power Distribution in Europe : Facts & Figures », Eurelectric, 2014. http://www.eurelectric.org/media/113155/dso_report-web_final-2013-030-0764-01-e.pdf
[38] Article 26 (4) Directive 2009/72/EC

potentially having a closer relationship with them. Additionally, some small DSOs do not connect to the TSO at high voltage but to a DSO at medium voltage. This introduces an additional layer in the electricity system.

- **Governance**: Multiple governance structures exist among DSOs. They vary with regards to shareholders, management, decision-making processes, relations with authorities and regulators, business models and corporate strategies. Although some differences of course exist even between large companies, the gap is wider with smaller DSOs, as most of the latter retain strong ties with local utilities as a result of the current unbundling rules. In contrast, larger DSO companies are enforced to be further unbundled and break potential ties with commercial organizations.
- **Constraints**: As small DSOs often remain integrated in vertical utilities, the issues they face on their network are not the same as the ones of larger DSOs. Local utilities often operate across the whole value chain from generation down to retail. This leads to higher visibility and control opportunities for local DSOs over their area of action.

With regards to the future roles of DSOs identified by the project, those diverging characteristics could require some adaptations related to several standing issues. Local DSOs have continuously demonstrated their ability to adapt their core business of grid operators to various kinds of transformations. There is therefore no doubt that they will successfully take up evolving roles such as Distribution System Optimiser, Smart Meter Operator or Customer Relationship Manager. However, the complexity of the DSO business will increase dramatically and necessitate brand new capabilities in new fields. Small distribution companies could therefore lack resources to undertake such a transformation as for the roles of Distribution Constraints Market Officer, Neutral Market Facilitator, or Other Third Parties Relationship Manager.

Regarding roles that entail an increased cooperation among actors in the energy system, such as Distribution System Optimiser or Data Manager, situations were a smaller DSO is connected to a larger DSO at medium voltage would represent an additional complexity, i.e. an additional layer of interaction and cooperation. Taking up the role of Distribution Constraints Market Officer would not seem realistic in this case. Regarding the role of Contributor to System Security, enhanced cooperation would be an absolute necessity, but the participation of local DSOs would be very beneficial to the whole energy system.

Moreover, an issue could be raised regarding role entailing neutrality, such as Neutral Market Facilitator. Exemption from unbundling rules that are still in force may create political difficulties for undertaking such activities.

4.2. Examples of enablers and barriers at European level

4.2.1. Examples of possible enablers

Table 9 gives an overview of examples of enablers for the adoption of the evolvDSO role model. Enablers refer to favourable conditions that have a positive impact for the adoption of the role by the DSO. For each role, examples of enablers are listed. To note that the enablers listed are examples from different countries and are not necessarily relevant for each individual country.

Role	Examples of possible enablers

DCMO	• Recognition of the functions involving this role by NRA
	  • Possibility to use flexibility offers
	  • Awareness of potential uses of flexibility by DSO
	• Regulatory approach to costs recovery

NMF	• Explicit recognition of the functions involving this role by NRA • Definition of pre-qualification process that considers participation of DSO • NRA actively involved in discussions aimed at facilitating market access for distributed flexibilities
CSS	• Regulatory framework recognizes DSO's responsibility to safeguard operational security • NRA recognizes the need for stronger DSO-TSO collaboration • network operators actively discussing approaches and functionalities to enhance cooperation • Existence of structural data exchange DSO<->TSO (network data)
DSO	• DSO is enhancing observability of the system by testing and integrating advanced monitoring and control technologies • Regulatory framework allows the use of flexibility-based services to solve network constraints
DM	• Explicit recognition of the functions involving this role by NRA • DSO is enhancing observability of the system by testing and integrating advanced monitoring • Existence of initiatives towards data sharing platform • DSO's expertise on data management
SMO	• Regulatory framework supports transition towards smart metering infrastructure • DSO's expertise on management of metering infrastructure
CRM & OTPRM	• Regulatory framework allows the provision of regulated data services • Non-firm grid access contracts being implemented or discussed at distribution system level • Increase demand of data services from new actors entering the market place

Table 9: Examples of possible enablers

4.2.2. Examples of possible barriers

Table 10 gives an overview of examples of barriers for the adoption of the evolvDSO role model. Barriers refer to unfavourable conditions that might hinder the adoption of the role by the DSO. For each role, examples of enablers are listed. To note that the enablers listed are examples from different countries and are not necessarily relevant for each individual country.

Role	Examples of possible barriers

DCMO	• Uncertainty on the recognition of costs derived from the use of flexibility-based services for grid constraints management
	  ◦ Lack of regulatory approach to recognize flexibility as a cost
	  ◦ DSO's remuneration favors grid expansion over alternatives (e.g. use of flexibility) for tackling operational issues
	• Regulatory uncertainty regarding procurement and use of flexibility offers by the DSO

NMF	• Markets do not consider/integrate DSO constraints in their clearing • Framework for pre-qualification of flexibilities used by both system operators and commercial parties does not exist • Lack of platform between DSOs and flexibility providers (e.g. aggregators) to support transparent DSO actions (e.g. blocking) ◦ Local aspects and potential impact of flexibility procurement and activation by third parties at DSO level is not fully recognized
CSS	• Lack or limited structural information exchange between DSO & TSO • Limited consideration of DSO as contributor to system security • Current DSO-TSO coordination mechanism not adapted to avoid conflicts when flexibility is activated (AS)
DSO	• Regulatory uncertainty regarding the use of flexibility by DSO and its costs recovery for system operation • DSO actions towards constraints management are limited to emergency situations
DM	• Role already taken by another party • Divergent approaches to data management and access

SMO	• Lack of regulatory decision to deploy smart meter infrastructure
	  ◦ Lack of business case
	  ◦ Technical specifications not entirely finished
	• Reluctance to change (consumers)

CRM & OTPRM	• No existing guidelines for provision of data services by DSO • Difficulty to harmonize offering and capitalize on data service provision • Regulatory framework does not allow the provision of "non-firm access contracts" at DSO level • Pace of regulatory change to amend rules associated with the provision of new data and services • Lack of expertise on new business cases

Table 10: Examples of possible barriers

4.3. Time-wise adoption of evolvDSO role model – European perspective

The timing for the adoption of the future role model for the DSO is driven by several factors e.g. the regulatory context, the state of technology, market design, consumer expectations,…. As mentioned in previous chapters, the adoption of the role model is a continuous process. Features of a given role could be available today, in the short-term or in the long-term. The possible implementation of features that characterize a role is bounded by the regulatory context and the needs of the power system.

Figure 16 provides an outlook of the expected time horizons for the adoption of the role model across the Member States participating in the study. In addition, the figure provides a selection of examples of possible enablers and barriers for the adoption of the role model. The arrows represent an estimate of the timing of the adoption of the different roles across Europe, summarizing the views of different countries. In general, it can be concluded that a higher level of innovation of a certain role requires on average a longer adoption time. The existence of more than one arrow in a given role highlights the situation in which the expected adoption among the Member States surveyed differ. The Neutral Market Facilitator, for instance, illustrates this situation. The NMF, in this case, is expected to be adopted between 2020 (short-term) and 2030 (long-term). Similar to the NMF, the Smart Meter Operator shows that expectations for its adoption vary from today till the short-term. This is explained by the fact that in some Member States smart meters have already been rolled-out by the DSOs.

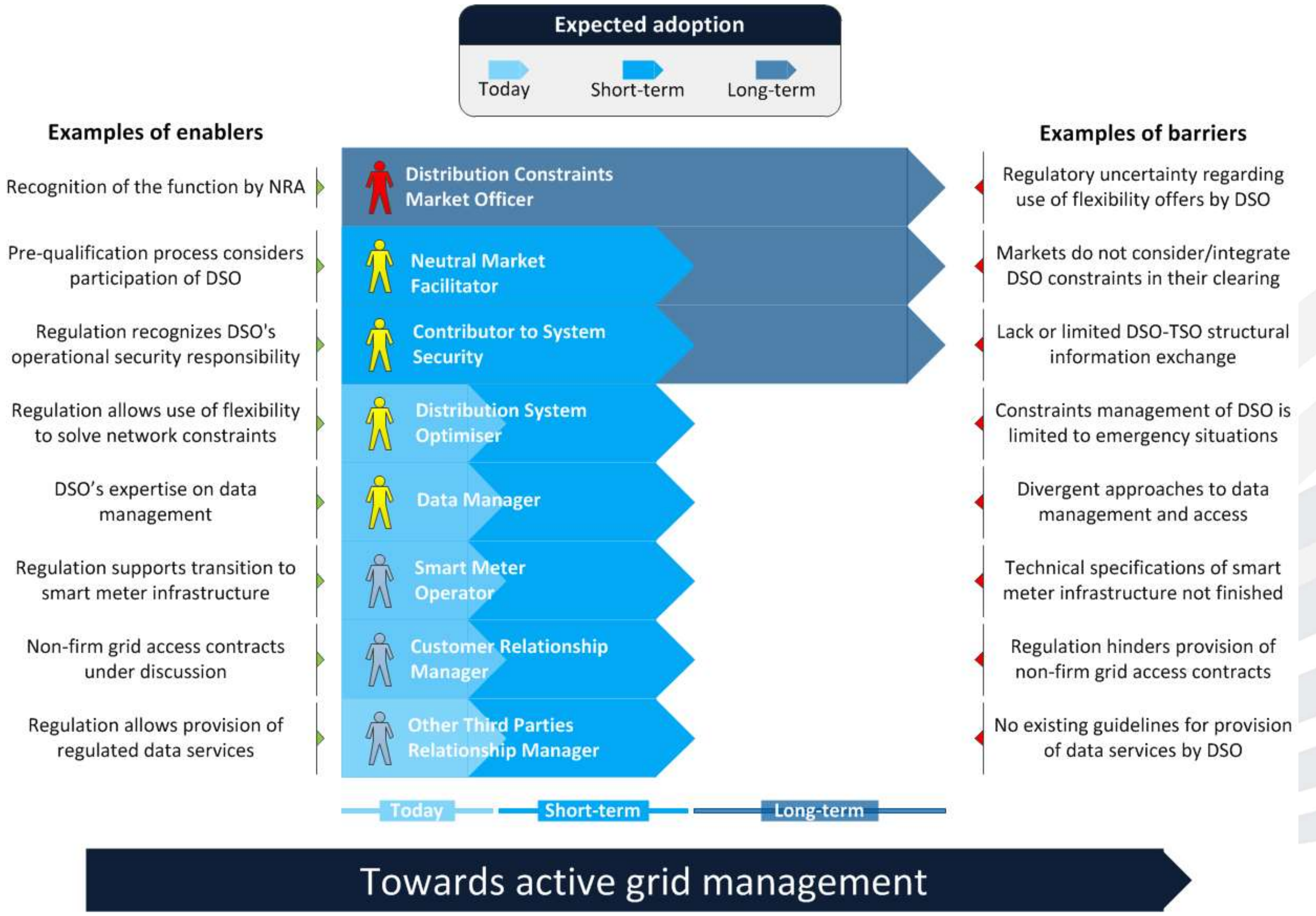

Figure 16: Outlook for the expected adoption of the role model across the surveyed countries

4.4. Key elements in the vision for the adoption of the roles

At the moment of implementation of the different roles from the evolvDSO role model, specific attention has to be given to the following key aspects that are important for a successful adoption of the roles. A successful implementation will guarantee that benefits related to cost efficiency, system security, operational efficiency and innovation are fully exploited. Key elements are related to the interaction between roles, the level of transparency and neutrality, interaction between stakeholders and the regulatory framework.

The key elements listed below are shared between the members of the evolvDSO consortium and consulted external stakeholders (ENTSO-E and flexibility service providers). It must be noted that, although consensus exists among the general principles of the role model, several debates are ongoing between stakeholders with respect to the appropriate market design and concrete implementation of the roles.

4.4.1.DCMO role

- DSO as additional buyer for flexibility in the market creates possibilities for flexibility providers (higher demand, organized market,…):

    - Flexibility should be used in the system (for global or local purposes) where the need is the highest and consequently, the social value the highest. This should lead to an increase of social welfare.
    - Clear and transparent rules are needed to avoid any perception/misunderstanding of market power by the DSO in case both role of DCMO and NMF are adopted
    - Small DSOs are exempted from unbundling rules. More market-oriented roles adopted by the DSO require an alignment with unbundling rules.

4.4.2.NMF role

- The role of NMF will result in improved grid observability, increased system security and optimal use of the existing grid infrastructure:

    - Flexibility should be accessible by external market players through neutral, non-discriminatory and transparent markets. Isolated and non-harmonized markets should be avoided. DSOs constraints have to be taken into account, with clear and transparent rules, taking into account a system wide perspective to maximize global social welfare.

- The role of facilitator of the flexibility market requires high levels of transparency and neutrality for different processes, e.g. prequalification, blocking of activations, settlement of activated flexibility,… This requires a clear regulatory framework supported by transparent technical procedures.
- Data exchange between TSOs and DSOs will gain further importance.

4.4.3.CSS role

- The role of CSS will allow the DSO to actively collaborate with the TSO in the implementation of security measures and the use of local system opportunities for system-wide challenges:

  - Data exchange between TSOs and DSOs will gain further importance (e.g. implementation of cascading processes, avoidance of conflicting activations of flexibility by DSO and TSO,…).
  - Importance of cooperation with respect to observability areas, as seen in system operation guideline, in both directions.
  - Need to define priority rules between TSO and DSO for the use of flexibility taking into account system security, optimal grid operation and facilitation of market access.
  - Link between local and global challenges should be carefully addressed.
  - The support of the TSO in the flexibility procurement by the DSO should be based on a clear regulatory framework.

4.4.4.DSO role

- The role of DSO will allow the DSO to use flexibility in network planning and real-time operations in order to optimize the use of the existing grid capacity, host a higher share of RES and potentially reduce the increase of costs for RES integration (e.g. deferral of grid investments,…):

  - Efficient use of flexibility by the DSO for planning purposes requires advanced monitoring and control technologies.

- The use of flexibility in operation provides a broader range of solutions and will allow to continue the management of the grid in a cost efficient manner. This requires a good view on the cost of flexibility on the one hand and the cost of grid investments on the other hand.
- Coordination between TSOs and DSOs should be further detailed by implementation and future revision of the guideline on System Operation. In addition, coordination between DSOs that are connected directly to the TSO and DSOs that are only connected to another DSO will become important.

4.4.5.DM role

- The role of DM will allow an increased access to data for different stakeholders, allowing the development of new business models and new processes for grid investment and maintenance.

  - Distribution data management should be handled by a neutral party (DSO or another trusted third party). Dependent on the actor being the DM, perception of neutrality might be low and clear and transparent rules should support neutrality.
  - Data management platforms should aim for a common standard for information provision towards stakeholders.
  - Data should be displayed in non-discriminatory manner, answering the needs of different stakeholders in a cost-efficient way (content, format,…).
  - Costs for timely data provision and in the format requested might be expensive and should be properly remunerated by the appropriate stakeholder.

4.4.6.SMO role

- The role of SMO will allow the availability of detailed data for a wide range of applications, e.g. grid tariffs based on individual consumption patterns or new revenue streams for flexibility providers.

  - Smart meters and related functionalities are a new asset for the SMO and attention should be paid to new processes that will need to be formulated.
  - Thorough assessment of technologies, functionalities and costs should ensure the usability of the advanced metering infrastructure for a sufficient long time period.

4.4.7.CRM and OTPRM role

- The role of CRM and OTPRM will support the DSO in the evolution towards an active system manager, providing services for all stakeholders e.g. non-firm grid access contracts with power limitation, …

  - External stakeholders will need to interact with the DSO to clearly express and discuss future needs and expectations towards the DSO.
  - Attention has to be given to the fact that technological support for the provision of certain services (e.g. data platform) might not be ready on time to allow the DSO to provide the services requested.
  - The role of CRM and OTPRM and the related data services to be provided, will benefit from a strong collaboration between TSO and DSO.
  - The provision of data in the timeframe and format requested by stakeholders, answering different needs, should be done in a cost-efficient way in order to optimize global welfare.

4.5. Recommendations and conclusions

In this section, a selection of key recommendations is presented, highlighting the main conclusions of this deliverable.

Key message 1: The DSO is a key player in a power system in transition. DSOs play a key role in the transition to smart power systems through active distribution system management.

At distribution system level, new challenges occur due to the increase of DER and the increased need for flexibility by several stakeholders. The role model provides a theoretical framework to deal with these challenges by means of defining responsibilities and potential services to be delivered. In particular, the DSO could fulfill a central role by taking up new roles that support an active management of the distribution grid.

Key message 2: There is a need for flexibility services. Flexibility has potential value for many power system stakeholders. DSO could make use of flexibility to safeguard normal operation and prevent/mitigate emergency situations. They may need these services in different timeframes as alternatives for grid investment and/or conventional operational actions while at the same time facilitating market participation of other stakeholders in a neutral way.

DSOs will use flexibility as an additional source to continue ensuring a secure and cost-efficient operation of the grid. In addition, DSOs will support the use of flexibility by other stakeholders by facilitating the market participation of flexibility, taking into account local grid constraints.

Key message 3: The transmission and distribution grid are part of one integrated power system. This requires sufficient coordination between TSOs and DSOs. TSOs and DSOs need to have jointly defined mechanisms for optimal coordination and use of system flexibility services for the sake of the entire power system and its stakeholders.

The collaboration between system operators is crucial in order to fully benefit from the advantages flexibility brings to different stakeholders. An important aspect that supports collaboration between system operators will be the exchange of relevant information in a structured and safe manner. The exchange of information will increase the observability areas of both system operators and will avoid conflicting activations from system operators.

Key message 4: The regulatory framework and future markets should recognize the need for flexibility services by different stakeholders. Flexibility should be allocated where its social value is the highest. The possibility of activating innovative flexibility services on distribution grid level for the sake of the entire power system, different market players and end users should not be discouraged by the regulatory framework.

Different stakeholders will have a need for flexibility and depending on alternative solutions, each stakeholder will assess a certain value to flexibility. In order to optimize the benefits for the entire system, flexibility should be assigned to the stakeholder where the need is the highest, and consequently, the social value is the highest. A fair allocation of flexibility will require necessary insights in the cost of flexibility on the one hand and the cost of alternative solutions on the other hand.

Key message 5: The regulatory framework and future markets should recognize the cost of flexibility. The recognition of costs should be established by a set of clear rules that are associated with innovative smart grid solutions and grid investments over different timeframes.

Regulatory uncertainty with respect to cost recovery for the procurement and use of flexibility by system operators could be considered as an important barrier for the use of flexibility. In addition, the recognition of the cost of flexibility should happen in a 'smart' way, taking into account the trade-off between flexibility and alternative investments. Cost recognition should also try to foster smart and innovative solutions by system operators. Together with the recognition of costs, a clear assessment of the benefits should be made to guarantee solutions that increase social welfare.

Key message 6: Data management will gain importance in the power system of the future. The regulatory framework should continue to safeguard the availability of neutral, secure, cost-efficient and transparent data and information management on distribution grid level for all concerned stakeholders and their needs.

The availability of relevant data is important for all involved stakeholders to exploit the benefits of the use of flexibility. The provision of these data should guarantee all necessary privacy and security requirements. In addition, it should be mentioned that the cost of data provision for the DSO could be substantial. Consequently, costs should be covered by the relevant stakeholders.

Key message 7: The national regulatory framework and national future markets will need to consider market harmonization and alignment with other national markets and regulatory frameworks. Regional and national differences should be taken into account (no one-size-fits all) but attention should be paid to the ongoing initiatives in European market harmonization in order to avoid isolated and non-harmonized markets.

Within Europe, several initiatives are ongoing to harmonize and integrated different energy markets. European regulation (i.e. network codes) provides guidelines that show how the future energy market should look like. The existence of harmonized markets will allow a more efficient use of flexibility within Europe. Nevertheless, it will remain important to consider the specific national context as this might justify specific local regulation for a local problem. Specific local challenges might also depend on current regulation, market design and state of the grid.

Key message 8: Innovation will be at the heart of the paradigm shift for grid management. Innovation will be a facilitator for a continuous evolution of the evolvDSO role model.

In the future, innovation will have an impact on the management of the grid. System operators will face new challenges and will explore new opportunities. The changing environment will require network operators to embrace the potential of technological trends. Technologies like Internet of Things, new ways of data protection (e.g. block chain),…will be part of the future discussions. Regulation, technological breakthroughs and innovative business models are intertwined. The core idea promoted by the evolvDSO role model is evolution. Roles will evolve and adapt driven by technological changes, new regulation and the need to develop additional services. Allowing innovation to be at the center of the discussion will promote a continuous evolution of the role model.

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6. Annex

6.1. Steps involved in the provision of a service: an example

The following example has been extracted from [4]. The generic example presented below refers to the service “contracting non-firm grid access.” This example is considered generic because it does not refer to a particular regulatory framework. Depending on the regulatory framework in place the interactions may be different.

The service “contracting non-firm grid access” starts when grid users submit a grid connection request. Upon receiving the request the CRM verifies it and transmits it to the DSO. The DSO performs the grid connection study. The study includes load flow calculations taking into account long-term forecasts of generation and load. After that, the DSO elaborates a connection offer stipulating the potential power limitation of the connection. The study and the connection proposal are stored by the DM. The DSO sends the proposal to the CRM so that it is presented to the grid user. If signed, the DM stores the contract and the CRM request the SMO to manage the metering infrastructure for the grid user. The SMO is responsible for the well-functioning of the grid user’s metering infrastructure.

The above description is illustrated in Figure 17.

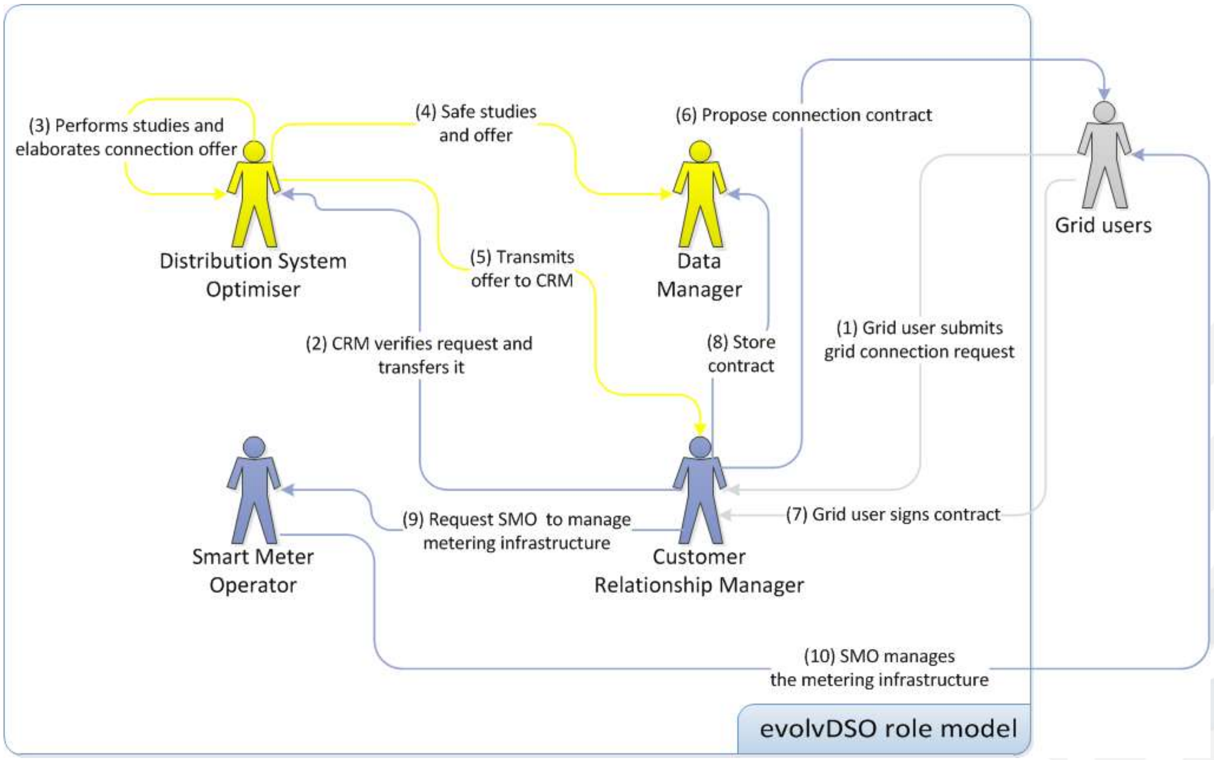


Figure 17 Interactions for the provision of the service "contracting non-firm grid access"

6.2. National Regulatory Agencies

6.2.1. Belgium

Federal

- CREG: Commission pour la Régulation de l'Electricité et du Gaz (http://www.creg.be)

Regional

- VREG: Vlaamse Regulator van de Elektriciteits- en Gasmarkt (http://www.vreg.be/)
- CWAPE: Commision Wallone pour l'Energie (http://www.cwape.be/)
- Brugel: Le regulateur Bruxellois pour l'Energie (http://www.brugel.be/)

In Belgium, the responsibility for energy policy and regulation is complex due to the fact that competences are shared between the federal and the regional governments (Flanders, Wallonia and Brussels Capital Region). The federal government is responsible for the transmission system level (>70 kV) and focuses on e.g. large production, nuclear power production and consumer rights. At the regional level the authority extends to the fields of electricity distribution (=< 70 kV), decentralised production and renewable energy.

Consequently, Belgium has different regulators assigned to the different political regions (i.e. CREG at federal level and VREG, CWAPE and Brugel at regional level). The CREG provides e.g. advice to public authorities concerning electricity and natural gas markets and monitors and controls the application of law and regulation with respect to competition, transparency, end-user rights,.... VREG, CWAPE and Brugel are for example responsible for the regulating of the distribution grids, advising the regional governments on different energy themes and monitoring the Flemish electricity and gas market.

6.2.2. France

Federal

- CRE: Commission de Régulation de l'Energie (http://www.cre.fr/en)

In France, the CRE has the mission of monitoring and surveillance of the electricity and natural gas markets, embodied by the possible exercise, where appropriate, of its powers to investigative and sanction (to verify the correct application of principles of separation, so as to prevent cross-subsidisation, discrimination or restriction of competition) (Articles 30, 34 and 40 of Law No. 2000-108 of 10th February 2000).

As one of its main tasks, CRE ensures the independence of network operators by:

- Issuing reports. Annually the CRE reports on the compliance with these codes of conduct established by any transmission system operator, and any distribution system operator, as well as evaluating the independence of network operators.
- Issuing approvals, after consultation with the Competition Authority, on the accounting rules for the separation of activities between production, transmission and distribution of electricity, and other activities of operators involved with electricity (and natural gas).
- Monitors and surveys the correct application of principles of separation, so as to prevent cross-subsidisation, discrimination or restriction of competition.
- Sizing abuse of positions of authority and practices impeding the free exercise of competition.
- Provide recommendations in order to implement Smart Grids in France addressed to the DSO, TSO and propose evolutions of regulation and normalization
- ...

CRE also monitors the CO2 market in cooperation with the Autorité des Marchés Financiers (law No. 2010-1249), for actors in the French electricity and gas markets, transactions of quotas emissions in Europe, and the transactions of Kyoto emissions units.

6.2.3.Germany

Federal

- BNetzA: Bundesnetzagentur (http://www.bundesnetzagentur.de)

Energy regulation means the supervision of operators of energy supply networks ("network operators") by the Bundesnetzagentur and the federal state regulatory agencies. The energy supply network is needed both by energy retailers ("network users") to supply customers and by power plant operators to feed in electricity. Since there is always only one network operator in each network area, operators might be able to use their monopoly position to favor or discriminate against certain network users. It is therefore the regulatory bodies' task to ensure that all network users can access and use the energy supply network on a non-discriminatory basis.

The aim of energy regulation is to create conditions for increased competition in the markets for energy generation, trade and supply. The Bundesnetzagentur makes (amongst other things) a key contribution by:

- Approving network charges for gas and electricity transport and distribution,
- Preventing or removing obstacles in access to energy supply networks for suppliers and consumers,
- Standardising processes for switching supplier as well as meters and metering point operators, and
- Improving the conditions for connecting new power plants to the grid. (Source: www.bundesnetzagentur.de)

6.2.4.Ireland

Federal

- CER: Commission for Energy Regulation (http://www.cer.ie)

Ireland's independent energy regulator is the Commission for Energy Regulation (CER). It has a range of responsibilities from an economic perspective to customer protection and safety. As well as energy, the CER is also the economic regulator for the Irish public water and wastewater sector. The primary responsibility of the CER, in relation to energy, is to regulate the Irish electricity and natural gas sectors. These responsibilities incorporate electricity generation, electricity and gas networks, and electricity and gas supplies activities.

6.2.5.Italy

Federal

- AEEGSI: Autorita per l'energia elettrica il gas ed il sistema idrico (http://www.autorita.energia.it)

In Italy, The Italian Regulatory Authority for Electricity Gas and Water makes its own decisions under the terms of its founding law, procedures and regulations. It enjoys a high degree of autonomy from the government in its judgements and evaluations. Its regulatory powers include the setting of tariffs and the definition of service quality standards and the technical and economic conditions governing access and interconnections to the networks for those services where technical, legal or other constraints would interfere with normal competitive market conditions and the ability of the market to protect the interests of users and consumers.

AEEG-SI is the independent regulatory body of the energy markets and the integrated water services. It was established by law 14th November 1995, n.481 with the purpose to protect the interests of users and consumers, promote competition and ensure efficient, cost-effective and profitable nationwide services with satisfactory quality levels in the electricity and gas sectors. With law 22nd December 2011, n. 214, new regulatory competences in the integrated water services sector were attributed to the Authority, while Legislative decree 4th July 2014, n. 102, assigned new tasks in the district heating and cooling sector.

6.2.6.Portugal

Federal

- ERSE: Entidade Reguladora dos Serviços Energéticos (http://www.erse.pt)

In Portugal, the main Regulatory Authority is ERSE , which is responsible for the economic, quality of supply and commercial relations regulation of the Sector. ERSE is an independent body from the government, although acts in the scope of the general energy policy established by the Government. ERSE's mission is to protect customers' interests but, at the same time, to ensure the economic and stability of regulated agents, such as Network Operators.

DGEG is a governmental agency that contributes to the conception, promotion and assessment of energy policies. It also participates in the development of the legal and statutory framework associated with systems, processes and equipment associated with production, transmission, distribution and usage of energy, with the objective of assuring the security of supply, energy source diversification, energy efficiency and environmental preservation. DGEG is responsible for technical regulations, licensing and technical supervision of the Sector.

6.3. National country context

6.3.1. Belgium

Evolution of ancillary services

Concerning the evolution of ancillary services, the CREG commissioned multiple studies to the Belgian TSO, Elia, on the evolution of the ancillary services needs and the diversification of reserve sources with an outlook towards 2017-2018 [14], [15]. Both studies concluded that, in order to enable an economically efficient procurement of FCR (Frequency Containment Reserves) and FRRa (automated Frequency Restoration Reserves), the participation of load must become a reality. Within this context Elia is already considering how to open up the different products to allow more flexibility [16].

Since 2013, the Belgian TSO procures primary reserve from large industrial customers connected to the transmission grid. These industrial processes detect frequency variations in the grid automatically and react to them by activating their primary reserve [17]. Typically, Elia may contract a volume of this product up to 50% of the total volume of R1. The transmission system operator Elia intends to expand its existing ancillary service, primary reserve or R1, by also allowing distribution grid connected users to provide load reductions [18].

Furthermore, in order to facilitate the market participation of flexibility, in 2014 Elia elaborated a new reserve product, R3 DP (tertiary reserve dynamic profile) [19]. This product is open to both injections as reductions of consumption, for sources connected to both the Elia grid as the distribution grid. For 2015 Elia contracted up to 2010 MW for R3 DP [20]. In 2013, Elia received the task of organising a strategic reserve mechanism to cover the structural shortages in generation in the winter period [21]. This system forms part of the government plan to accompany the shutdowns of power stations and safeguard the security of the Belgian control area's electricity supply in the short, medium and long term.[39]

Elia's ambition is to also create the possibility for offering free bids on the balancing market from flexibility coming from grid users, aggregators and smaller production units. To realize this Elia created the pilot project BidLadder aiming to provide all market parties with a bidding platform by 30

[39] This plan, known as the Wathelet Plan, had a number of priorities: improving the performance of existing power stations so that they do not need to be shut down; launching a call for tender for 800 MW to be generated by new gas-fired units; extending the operation of Tihange 1 nuclear power unit by 10 years; setting up strategic reserve; increasing interconnection capacity; improving demand-side management.

June 2017, in a first stage for the delivery of flexibility to the balancing market from delivery points in the Elia grid, and later potentially – after deliberation with the DSOs - from delivery points connected to the distribution grid [16].

Status of demand response

As of for the status of demand response, at federal level, the electricity law of April 29th of 1999 is applicable [22]. This federal electricity law, dealing with the organisation of the Belgian electricity market, does not make a reference to demand response directly. However, the issue of demand response and flexibility is mentioned in the context of more general topics, such as security of supply or ancillary services. In addition, the technical regulations for the management of and access to the transmission grid expresses the potential of demand response as a mean to safeguard security of supply. There is no explicit reference to demand-side management in the Energy Decree nor Energy Resolution, but there is no impediment either. The technical regulations of the Flemish region describe that restrictions of consumption are allowed within the framework of congestion management.

In 2016, CREG issued a flexibility study which identifies the areas of improvement to facilitate the participation of load in the different electricity markets in Belgium [23], [24]. Within the report, a proposal is launched to answer to the issue of the 'transfer of energy' (TOE)[40]. The basic principle of the suggested market model is the free choice of the consumer to valorise its flexibility to every FSP (Flexibility Service Provider), regardless of its electricity supplier. This means that all existing markets should be opened up to ensure a healthy competition between the different types of providers of flexibility. This implies the need to create a legal framework to define the roles and functionalities of the actors involved. Also the VREG gave a specific advice related to flexibility. The advice on flexibility suggested an adaptation of the market model to facilitate the participation of demand response [25]. The approach for the new market model was based on the same principles as the CREG in order to provide an answer to the transfer of energy.

Developments in system operation

Concerning system operation, In Flanders, discussions are ongoing how the grid operator can guarantee operational safety via monitoring. Therefore, the operator has the right, but not the obligation, to set any kind of temporary limits to the provision of flexibility in certain conditions.

[40] In the study of the CREG, the transfer of energy is defined as the activation of flexibility in which two different BRP's are involved (one for the supplier and one for the FSP (Flexibility service provider)) and/or in which the FSP and supplier are different stakeholders. Upon activation of flexibility in this case, the energy profile will differentiate in real time from the predictions. Hence, the supplier of the energy which was purchased, cannot recover, nor charge the energy, because it were not consumed. Additionally, the BRP is unbalanced by the action of a third party.

Currently, this limitation is performed in the form of a Network Flexibility Study (NFS) ex ante and only for certain flexibility products. Creating a level playing field requires that all forms of flexibility are considered in the assessment of the network operator. In the long term, the NFS should be replaced by a "traffic light approach”[41].

The Flemish regulator also proposes that the DSO can take up the role of FRP (Flexibility Requestor Party) and request flexibility, but only under certain conditions. DSO should not take up the role of FSP nor aggregator of commercial flexibility. Moreover, the request for flexibility should never jeopardize or abuse its role as neutral data manager and market facilitator. All purchases must be done in a transparent, non-discriminatory way, following market-based procedures. The Ordinance of July 19th, 2001, concerning the organization of the electricity market in the Brussels Capital Region stipulates that, amongst others, demand-side management can be used to avoid grid investments, both grid capacity expansions and replacements. In Wallonia the legal bases applicable at this time (e.g. technical regulations for transmission and distribution), allow for the network operator to offer a contract for interruptible services to its grid users, when the state of the grid imposes it. The use of this flexibility is provided in order to avoid congestions.

Developments in data management

Atrias is the platform that gathers the Belgian DSO’s [26]. The platform fulfils a dual role, on the one hand it is responsible for the implementation of mechanisms to exchange information between market players and on the other hand it organizes sectoral dialogue in which suppliers, network operators and regional regulators sit together. Current developments concerning this platform suggest that the platform will become independent. This is expected to increase third party participation.

The project “Atrias” aims to offer the industry the opportunity to develop a comprehensive, shared vision on a market model where more flexibility is integrated. This market model will consist of the following elements:

- A shared agreement on and common understanding of the different market roles for flexibility
- Harmonisation of the business relationships between market roles
- A shared vision on the necessary activities to initiate, execute and finish flexibility transactions

An agreement on the content of the information and the date on which this information is necessary to initiate, execute and finish the flexibility transactions.

[41] Development of coloured "congestion zones" where a flexibility activation is temporarily not feasible indicated by a certain colour. Ideally, a traffic light decision (go / no-go) for each activation of flexibility near real time.

The Flemish regulator proposed the role of Neutral data manager for the DSO. This implies access to the data and the same quality of service for all parties involved. Special attention should be given to the non-discriminatory and non-restrictive treatment of new, non-traditional parties. The network user must be able to inspect the data at any time. The main activities include the management of the access register for flexibility and the activation register for flexibility.

Situation of smart metering infrastructure

In the period 2009-2010 the Flemish DSOs had a first research project (the "POC" Proof of Concept) equipped with smart meters. There were then 4,750 smart electricity and gas meters placed at 2,800 clients. After the positive evaluation of the POC, it was decided during the course of 2010 to proceed with a much broader research project (the pilot). The ambition was to install 50.000 smart meters spread over the entire operating range [27]. At the closure of the pilot project (end of 2013), the largest Flemish DSO made a final count of 34.581 smart meters. The other Flemish DSO installed 6,910 meters on 43,150 addresses.

In 2010 the Flemish regulator kicked off a policy platform with regard to smart grids and smart meters. This policy platform brings together stakeholders in smart grids and smart meters within the Flemish government and beyond. The policy platform aims to get an overview and to take the actions that are part of the transition to a smart grid. It also includes the preparation of an advice to the Flemish Minister for Energy, with regard to the legislative framework required for this transition.

The advice of the Flemish regulator with regard to the smart meter roll out is composed to assist the Flemish government in defining the functionalities and deployment modalities of smart meters [28]. The current proposal of the VREG with regard to the roll-out, instructs an obligated, segmented roll out starting from 2019 [29]. The main focus is on new buildings, major renovation projects, prosumers and meter replacements. Furthermore, there is the possibility to request a smart meter by the end consumers at his own expense.

The regulators of Wallonia and Brussels Capital Region are currently studying the technologies required for the conversion of the networks into smart grids and the functionalities needed for the introduction of intelligent metering system [22]. Furthermore, DSO's also analyse the required technical adjustments for the introduction of smart meters.

6.3.2. France

Status of demand response

According to the energy code42, DSOs should:

- Contribute to monitor demand response perimeters. In this regard, the TSO, aggregators and electricity suppliers provide to the DSO all information needed. These information are managed in a confidential manner;
- Deploy energy efficiency measures and promote connection of renewable electricity sources to the distribution network and Demand Response;

In addition the code clearly states that a DSO cannot operate as demand response operator. They should ensure demand response operators can activate demand response resources on the distribution network without prior agreement of any electricity supplier.

Developments in system operation

In the current regulatory framework,

- The decree 'effacement' establishes the role for DSO in order to contribute to verify curtailments.
- The Article 199 of the TE Act (2015) incentivize, until the 17/08/2019, after a proposition of a public organizations to the DSO, the experimentations of local flexibility services to manage the network at local level

Until 17/08/2019, Article 199 of the TE Act[43] incentives public authorities to propose to DSO the provision of local flexibility services to manage the network at local level. This service should allow the local optimization of power flows between end users and producers connected to the distribution network. If such flexibility service reduces investment or operation costs, the DSO must pay for the service at a level equal to the associated cost savings. The remuneration for this service is included in the cost covered by the use of public electricity distribution network tariff.

[42] The Energy Code and its application decrees describe the roles and responsibilities of a DSO in France regarding the network they manage.

[43] https://www.legifrance.gouv.fr/affichTexteArticle.do?cidTexte=JORFTEXT000031044385&idArticle=JORFARTI000031045812&categorieLien=cid

Regarding innovation, the French Energy Regulator (CRE) has decided to support the innovation projects of system operators and the CRE has defined a regulatory framework to support investment and the development of research and development projects (R&D). The 4th tariffs for the use of electricity transmission and distribution networks (TURPE 4 applied until July 2017) introduced a measure to give the TSO and the largest DSO the resources to implement the R&D and innovation projects necessary to build smart grids. This decision guarantees that there is no tariff obstacle to realize R&D projects or invest in innovation. A follow-up measure will also be implemented. This measure is designed to provide power system stakeholders with greater visibility over the system operator projects in the field of innovation. In addition, Decision of the Minister of Environment, Energy and the Sea, in charge of International Relations on the climate together with the Minister of Economy, Industry and Digital, announced the 15th of March 2016, the launch of three projects for the large scale deployment of smart electricity networks, as part of the "sustainable City" solution of the New industrial France.

In its 12/06/2014 deliberation[44], the French regulator listed several recommendations on smart grids to be implemented by the DSO. Among these recommendations are:

- The DSO could proactively participate in the feasibility studies for the deployment of new charging points for electric vehicles in order to deploy it in an optimal way;
- The DSO could use distributed generators to manage voltage control by reactive power absorption. In this regard, new connection agreement solutions could be envisaged to allow the use of such resources to manage reactive power;
- In order to optimize the economic conditions for the integration of distributed generation and reduce the connection costs and lead times for generators, the DSO should study the feasibility of evolutions involving in order to provide alternative connection solutions from the reference connection one, when it is beneficial in terms of global welfare. Unlike the reference connection solution, these alternative solutions could imply limiting the real power injected by the distributed generators;
- The DSO should study the mechanisms for the effective use, in an objective, transparent and non-discriminatory way, the flexibility capabilities connected into the network when it is economically advantageous and consistent with the tariff to use them;
- The DSO and the TSO should study the mechanisms allowing the participation of the distributed generators to maintain the reactive power level at the connection point between the transmission and distribution networks (at the primary substation level).

[44] http://www.cre.fr/documents/deliberations/orientation/smart-grids-recommandations-sur-leur-developpement

Developments in data management

In the decree 'effacement'[45] (demand response or active demand), the DSO must provide the data from the metering devices to measure curtailments realized on connected sites. If these data are not available with the characteristics needed, methods based on statistical data, could be used if they allow to obtain reliable results.

In the current regulatory framework, the TE Act (2015) was also the first big step for data manager role for DSO. It established a framework of the DSO to deliver detailed consumption and generation data to actors such as local authorities and even at the level of the building, a destination of the landlords or lessors in case of energy efficiency works on the building. In addition, the article 23 of the Digital Act (published on October 2016) goes even further: it creates open data from the DSO (and TSO) in order to develop new energetic offers, uses or services.

In the current regulatory framework, DSOs are responsible for sharing distribution connected entities metered data to relevant public stakeholders, especially to ensure they can deliver their climate-air-energy plans[46]. The CRE, in its 12/06/2014 deliberation[47], recommended DSOs to foresee the deployment of interfaces so that distribution network data can be easily shared with distribution network organizing authorities and, if applicable, any stakeholders wishing to use this data.

[45] https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000029190216&categorieLien=id
[46] http://www.developpement-durable.gouv.fr/Plan-climat-energie-territorial.html
[47] http://www.cre.fr/documents/deliberations/orientation/smart-grids-recommandations-sur-leur-developpement

Situation of smart metering infrastructure

According to the energy code, the DSO is in charge of the operation of the metering infrastructure of end users connected to the distribution network, especially:

- Ensure meter delivery, installation, metrological control, maintenance and replacement of metering devices,
- Ensure management of metering data and other missions related with this metering data;

6.3.3. Germany

Evolution of ancillary services

In Germany the evolution of ancillary services is currently under discussion as the energy transition leads to more and more decentralized generation and a reduced operation of existing conventional power plants. Historically, centralised conventional power plants were used to ensure sufficient ancillary service in the system. Therefore, new concepts for ancillary service provision have to be considered and impacts of decentralised provision of ancillary services must be identified and managed. For example by public studies and platforms as provided by the Deutsche Energieagentur (dena) an ongoing discussion process is organized. The different dimensions of ancillary services frequency control, voltage control, system operation and system restoration have to be considered. In this process the necessary interaction between TSO and DSO are identified and processes guaranteeing a secure operation of transmission and distribution grid are developed.

Status of demand response

Historically, load management was mainly used to ensure sufficient residual load to account for non-dispatchable generation. This was realised by using e.g. electrical heating systems, i.e. night storage heating using temperature dependent load profiles that makes it easy to involve the suppliers into the scheme. For the TSO level the "Verordnung über Vereinbarungen zu abschaltbaren Lasten" (AbLaV) defines an aggregated capacity of maximal 3,000 MW of interruptible load which have to be tendered for flexibilities of industrial customers. Following the current legal framework in Germany, controllable loads connected to the distribution grid can be contracted. This rule is yet to be specified further by a federal decree and is thus not utilized by market players extensively.

With the expected growth of market-based DSR the probability of peak loads in the distribution system rises, which might lead to uneconomic reinforcements of the distribution system if the current approach / legal logic is followed. Several ideas exist how to mitigate this problem. Generally, the DSO should supervise market based actions of DRES, storages and loads within the grid which might lead to high but very brief peak loads and thus induce uneconomic grid reinforcements. Therefore, a traffic light system is discussed right now which makes it possible to communicate between market players and DSO to prevent critical situations with the aim to influence market based actions as little as possible. In the yellow phase of this traffic light approach, DSOs use flexibilities contracted via a market based approach beforehand (e.g. in framework contracts) to counteract peak loads in their system. Especially for a large scale electric vehicle development it would be obligatory to implement a load management system to organise a sufficient charging without overloading the existing grid infrastructure. In emergency situations (red phase) the DSO has the right and duty to ensure safe and secure grid operation by interacting directly with grid users, i.e. by circumventing suppliers.

Developments in system operation

Regulation has evolved allowing DSOs to manage their grid more actively. Actions that DSOs can take relate to reduce network reinforcement costs as well as to manage grid congestions. Additionally, DSO and TSO show a strong collaboration. This can be observed in security relevant processes and actions towards DRES (by DSOs on behalf of TSO).

Developments in data management

Regulatory developments have caused many changes in the data management arena, e.g. the introduction of the new metering law (Messstellenbetriebsgesetz). This law installs new settlement rules. Another example is the definition and assignation of a new function concerning the smart meter gateway. The availability of relevant information driven by regulatory developments and the roll-out of smart meters is expected to enhance planning and operational processes at distribution system level.

Situation of smart metering infrastructure

As from 2017, DSOs will start the roll-out of smart meters for consumers that reach a certain threshold of energy consumed per year. Additional to the new metering functionalities of these meters, some of them might be able to provide technical data to the DSO. For consumers that do not reach the established threshold electronic meters will be provided.

6.3.4. Ireland

Evolution of ancillary services

EirGrid and SONI (the transmission system operators) within the island of Ireland currently have a DS3 Programme underway to develop solutions to the challenges the electricity system is facing with the hope of achieving their renewable energy targets by 2020 in a secure manner.

The DS3 Programme is made up of 11 workstreams, which fall under the three pillars of System Performance, System Policies and System Tools. One of the key areas in the DS3 Programme is System Services. The TSOs are working to obtain services from generators and market participants. The programme brings together many different strands, including development of financial incentives for better plant performance, and the development of new operational policies and system tools to use the portfolio to the best of its capabilities. Standards for wind farms and conventional plants are also being reviewed to give enhanced operational flexibility for the future.

Status of demand response

Currently medium to large electricity users can participate in Demand Side Unit (DSU) or Aggregated Generating Unit (AGU) schemes offered by the TSO in Ireland. The DSU, usually a third-party company specialising in demand side management, may contract with a number of demand sites and aggregate them together to operate as a single DSU. Instructions to reduce demand are issued to the DSU by the TSO at an aggregate level and the DSU then co-ordinates the reduction from all its demand sites. Demand sites typically use on-site generation, plant shutdown or storage technology to deliver the demand reduction. An Aggregated Generating Unit is similar to a DSU, a key difference being it is composed of on-site generation only.

In 2015 EirGrid became one of the first TSOs in Europe to trial demand response, offering consumers a price if they reduced demand at specific times. The pilot project is benefiting 1,500 householders, who will have their electricity bill cut by €100 for participating in the scheme [32]. The competition is open to identify companies that will work with EirGrid to provide a demand response service. The end goal for EirGrid is to manage demand on the national grid and to give homeowners more control over their electricity bills.

Developments in system operation

Ireland has ambitious renewable energy targets, the bulk of which will be supplied by wind generation. The All Island Facilitation of Renewables Studies [33] was undertaken to fully understand the technical and operational implications associated with high shares of wind power in the All Island power balance. One of the main suggestions from the study was that the system could be operated with 75% non- synchronous generation. Currently EirGrid have imposed an operational limit of 55% non-synchronous generation on the system.

In Ireland consultation is currently on-going between the TSO, DSO and regulators as to how best to increase the operational limit to above 55%. Some fundamental additional requirements have been identified:

- Extended static and dynamic sources for reactive power;
- Uncompromised grid code compliance of the complete wind portfolio and all other generators throughout the whole lifetime;
- Replacement of rate of change of frequency (ROCOF) relays in distribution networks by alternative protection schemes or increased ROCOF relays threshold;
- Monitoring of short circuit levels and adjustment of network capacity, in particular in 110 kV networks.

Ensuring grid code compliance for all generation on the system (including wind) and increasing ROCOF relay thresholds are currently the biggest challenges from a regulatory perspective.

Developments in data management

In Ireland there is currently regulatory frameworks in place that describe the service levels the DSO operate to in performing the Meter Registration System Operator, Data Collector and Meter Operator functions.

The role of the Data Manager is envisaged to change in the future. From a regulatory perspective the following expectations will need to be clearly defined:

- Define the level of expectation and the methods for data anonymization;
- Define clearly the boundary between regulated and non-regulated activities for the data;
- Set standards for data communication.

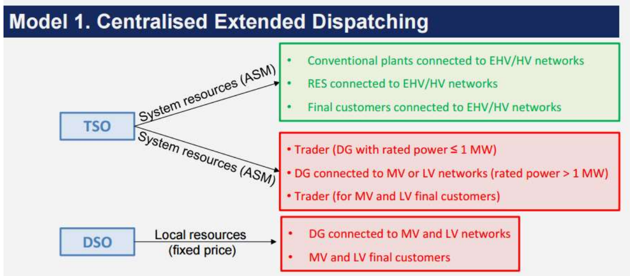
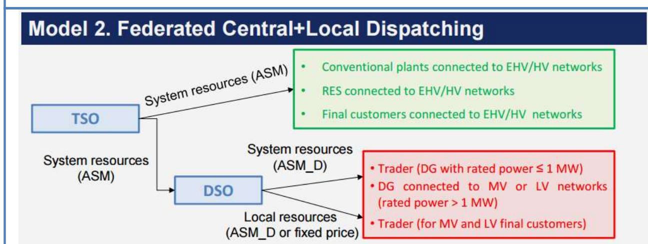
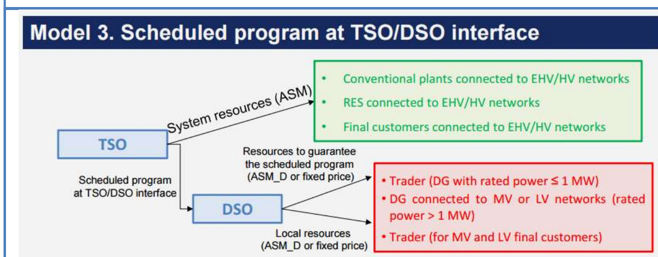
Situation of smart metering infrastructure

In 2007 the CER along with the Department of Communication, Energy and Natural Resources (DCENR) established the National Smart Metering Programme (NSMP). In 2012 they made the decision to rollout electricity and gas smart meters for all residential and small and medium sized businesses [34] as part of Phase 1. Phase 2 commenced in 2013 which incorporated the high level design and the procurement phase. Phases 3 and 4 detailed design, procurement, building and testing phases are scheduled to be completed by 2018. The rollout of smart meters is currently scheduled to commence in 2018, though this depends on many factors.

6.3.5. Italy

Evolution of ancillary services

In 2013, through 354/2013/R/eel AEEG opened a consultation process where three different models were under evaluation:

<table>
<tr><th>Models</th><th>Brief Description of DSO participation</th></tr>
<tr><td>
</td><td>• Model 1-a: DSO verifies that the power flow in the planning phase and in real time due to the participation of the DG to the Ancillary Service Market (ASM) are compliant with the capacity of the distribution network.
• Model 1-b: DSO requires to DG units (like PV plants) some local services (e.g., voltage regulation), not in conflict with the system services.</td></tr>
<tr><td>
</td><td>• DSO: enters into purchase and sale contracts for the tradable resources by DG (like PV plants) (ASM_D, Ancillary Service Market for Distribution network) and provides system resources to the TSO; procures the resources necessary to operate the distribution networks, while respecting all constraints (ASM_D or regulated price)</td></tr>
<tr><td>
</td><td>• DSO: is obliged to maintain a scheduled cumulative program within each single HV/MV interface (nodal model) or within one zone that includes more HV/MV interfaces (zonal model). System resources for the TSO are not provided;</td></tr>
</table>

In June 2016, the AAEGSI published the document DCO 298/16 "FIRST PHASE OF THE MARKET REFORM FOR THE DISPATCHMENT: Enabling access of demand, non-programmable renewables and distributed generation to the Dispatching Market", where, at a glance, the model 1 "extended centralized dispatching" is preferred. This consultation does not elaborate on the role of distribution companies even though are affected by these changes since units of consumption and smaller size production units are connected to distribution networks. In practice, the assumption is that "movement of units of consumption and production on the distribution network does not lead to problems for the distribution network operation".

Open points:

The technical requirements of the device "plant controller" acting as an interface between Terna and the aggregator, between the aggregator and the producers and/or consumption units (customers, producers or prosumer), as well as between the aforementioned subjects and distribution companies are still to be defined by the National technical Committee (CEI).

Status of demand response

No relevant update until the above revision of the dispatching market is completed. Currently, the status quo is that demand response is not allowed to participate in Italian wholesale markets as well as the MSD.

Developments in system operation

According to the consultation 255/2015/R/eel, the Authority proposed incentive regulation mechanisms for distribution companies in order to accelerate the transition of the networks to Smart Distribution System.

The table below summarized the set of interventions proposed:

Innovative Function	Main role	Applicable without a direct communication channel with network end users	Type of application and M2M services
Observability of the power flow and Distributed Energy resources	Distributors	Yes	Monitoring
Voltage regulation at MV level	Distributor and enabled active users	Yes	Control
Active power regulation of end users	Distributor and users enabled	No	Control
Remote tripping	Distributor and active users enabled	No	Protection
Advanced MV network operation	Distributor	Yes (but communication with network devices needed)	Control and protection
Use of storage systems for network needs	Distributor	Yes	Control

Table 11: Summary of the innovative functionality of a "Smart Distribution System" identified by AEEG-SI

Regarding the functionality n.1 (improved observability), which impacts both the CSS and DSO role, the Authority introduced additional output based rewards (at a glance, € per "observed" MW of non-programmable renewable distributed generation at a primary substation).

a) “OSS-1 (= observability functionality n.1)”: DSOs deliver to Terna data and measures from primary substations and from renewable based generators (continuously and instantaneously)
b) “OSS-2” (= observability functionality n. 2): DSOs send to Terna accurate estimation of generation per type of sources and load consumption on the distribution network (continuously and instantaneously).

With reference to the use of storage systems managed by the DSO for network needs, the Regulator will allow the DSO to install storage systems only under specific conditions and after the positive outcome of a Cost Benefit Analysis. Specific regulation is still to be defined.

Developments in data management

The Integrated Informative System already makes historical data available to traders, NRAs, customers or their delegated parties via a centralised management platform. Starting from the second generation of smart metering infrastructure, the following data will be available to external stakeholders through the SII (integrated information system).

- 15 minutes intervals load curves of the day n-1 (daily)
- Maximum power of the day n-1 (daily)
- Average Voltage quality parameters (weekly)
- Other data (not relevant for this analysis)

Situation of smart metering infrastructure

With Resolution 87/2016 / R / eel the Authority for Electricity gas and water system has defined the functional specifications of low voltage smart meters and expected performance of the second generation of smart metering systems (2G), in view of the replacement of first-generation meters that have completed their expected lifetime (15 years, according to EU rules).

At a glance, 2G smart meters are provided with two communication channels:

- The first towards the "electric system" – namely “Chain n.1” - using the Band A Power Line Carrier (PLC), the RF 169 communication technology or other telecommunications technologies. The chain-1 allows the remote management of meters and provides validated data to be delivered to the retailer or other party designated by the customer

- The second one towards end user devices – namely "chain 2" which must at least be able to exploit the C Band Power line carrier (PLC) (this is relevant for enabling end users demand response). Real time availability of metering data (15 minutes interval) would allow the participation of low voltage end users to the dispatching market "MSD";
  Chain 2 will be available towards the end user with a standardized communication protocol to transmit near real time data, to any intelligent device to installed at user premises. Data characteristics and their frequency, data models and protocols are expected to be defined by the Technical National Committee (CEI) by the end of 2016.

In particular, maintaining the technological neutrality towards the choice of individual distribution operators, the mode of operation and expected meter performances have been defined, taking into account the experience from 1st generation of devices, the technology updates and the expected market evolution . The main functionalities of 2nd generation meters are:

- Remotely management of all the contractual parameters (maximum power, freezing of registers for switching, etc.) and the meter firmware;
- 15 minute consumption and generation profiles recording, and provision of the relevant validated data in a time adequate to allow pre-paid contracts, etc.;
- Total energy (active, reactive) in the current day and over defined time intervals;
- Provision of the information about the current tariff time band;
- Voltage monitoring according to EN 50160 ;
- Automatic notification of events to the central systems;
- Authentication of the user device on the chain 2 for guaranteeing security and privacy of data.

Note: The Electricity Authority will apply for the first time in Italy the TOTEX approach to recognize the overall expenditure (CAPEX + OPEX) in second generation meters.

6.3.6. Portugal

Evolution of ancillary services

In Portugal there are some power plants which operate under contracts that guarantee them an adequate remuneration (CMEC).[48] These contracts were created in 2007, succeeding to PPA agreements. The goal of CMEC contracts was to include that generation in the market participation, but at the same time to ensure the return of the power plants that were established in the PPA. In this way, power plants would participate in the MIBEL[49] market and supply electricity according to the market dynamics, but the difference between PPA and market prices could be recovered through the CMEC. Even though CMEC guarantee the remuneration of the power plant, they oblige it to participate in the market. These contracts will gradually phase out until 2027.

The Portuguese and Spanish energy markets are integrated into an Iberian Market, which sets energy prices for both countries. The Spanish market for ancillary services is larger and more mature than the Portuguese market and sets a referential for these services in a competitive regime.

Offers associated with ancillary services for the Portuguese system are benchmarked with the equivalent Spanish market. The Portuguese price cannot exceed by 20% the estimated marginal cost of a CCGT power plant operating in Spain.

Wind farms connected with the TSO network, or with an installed capacity > 6 MVA, must withstand incidents, without disconnecting from the network, within the conditions:

- Frequency deviations between 47.5 and 51.5 Hz;
- Negative current component <5% of the nominal current.

Furthermore, they must withstand voltage sags associated with single-phase, bi-phase or three-phase short-circuits, as described in Figure 18.[50]

[48] *Custos de Manutenção de Equilibrio Contratual*, or Costs for the Maintenance of Contracted Equilibrium.
[49] MIBEL – Iberian Market of Electricity
[50] Portaria n.º 596/2010.

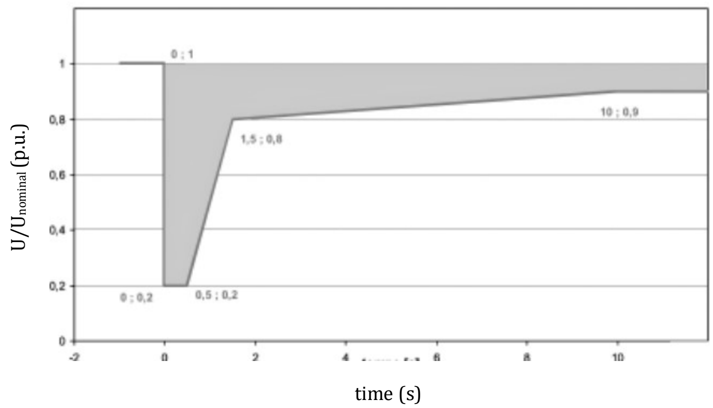


Figure 18 Wind farm capacity to withstand voltage sags

The TSO is responsible for the ancillary service management. The TSO operates the ancillary service market, guaranteeing the equilibrium between offer and demand of electrical energy.

Wind farms can have an installed capacity of up to 20% of the capacity at the point of common coupling. The maximum capacity that the wind farm can supply to the network is not altered, despite the overcapacity of the wind farm. Therefore, the DSO can ask the wind farm to reduce the power delivered to the network, due to constraints associated with the network, up to the declared capacity of the point of common coupling.

Status of demand response

There is the possibility to adhere to an interruptibility contract, regulated through Portaria n.º 592/2010. This contract is optional for VHV, HV and MV end-users. Should they accept the regime, they are entitled to a discount both in the subscribed demand tariff and on the energy tariff. The Portuguese Government introduced modifications to this legal framework through Portaria n.º 268-A/2016 (from October 13th). It requires that, during 2017, the conditions for the provision of this AS should be adjusted to market conditions.

In 2015, there were 52 end-user installations with interruptibility contract, with a total of 1,410 MW of interruptible demand. This demand can be curtailed on demand by the System Operator (the Portuguese TSO). In 2015 there was no curtailed demand. The total discount associated with these contracts was 110 M€ in that year [35].

Developments in system operation

REN – Rede Electrica Nacional, S.A., the Portuguese TSO, is the entity responsible for the global management of the electrical energy system in Portugal. This global management includes the coordination between different infrastructures, the security and continuity of the electrical energy provision and the ancillary service management, through a market operated by REN.

Included in the system operation responsibilities is the possibility to curtail energy produced by special regime producers (which include wind and solar energy producers), should exceptional operational conditions of the electric system emerge that jeopardize the security and continuity of the system. Should the TSO identify the need to curtail generators associated with the DSO network, it will communicate that need to the DSO in order to allow it to be implemented.

Developments in data management

Smart meters' installation opens new technical possibilities, allowing the access to a more detailed information of consumption that can be used by customers and third party entities regarding new market efficiency services. Currently, there are increasing requests from suppliers regarding the creation of solutions allowing the provision of detailed data from consumption (e.g. individual load diagrams)

In this context, EDP Distribuição is creating conditions to provide data requested by different stakeholders (customers, suppliers and energy services companies), positioning itself as an independent manager of information and market facilitator. In this sense, EDP Distribuição is developing Energy Data Management systems that will foster this new approach that will benefit final consumers. An important aspect that must be always guaranteed is related to users' data privacy, which means that DSO should act in accordance to customers' permissions regarding the provision of their data to market players. In this moment, users can access their information through EDP Distribuição website or in a real time base if they have an *In-Home-Device* connected to its smart meter,

Situation of smart metering infrastructure

EDP Distribuição started to pave the way for the Smart Grids transformation in 2007 with the InovGrid project, with the first pilot in the municipality of Évora. Here, a holistic and innovative approach was applied where 31,000 smart meters in all of Évora's domestic client facilities were installed, as well as other solutions such as electric vehicle charging station or public lighting control. EDP Distribuição also implemented new smart grid pilots in other municipalities, with a new generation of smart meters (with communication systems primarily based in PLC Prime,). These projects were located in Alcochete, Faro (islands) Batalha, Marinha Grande, São João da Madeira, Lamego and Guimarães municipalities, where 100,000 smart meters were installed.

Furthermore, EDP Distribuição is also deploying smart meters in large scale, mainly focused in urban areas, and all new end-user connections. Considering all the installations so far, EDP Distribuição has already installed more than 500,000 smart meters, representing almost 9% of the 6 million Portuguese domestic end-users. EDP Distribuição has also installed telemeters in all 67,000 secondary substations (MV/LV substations) as well as in every public lighting circuit (around 55,000).