European Smart Grids Task Force

Expert Group 3

Final Report:

Demand Side Flexibility

Perceived barriers and proposed recommendations

April 2019

Acknowledgments

This report was prepared by the Working Group on the 'Deployment of demand side flexibility' in the context of the Expert Group 3 (EG3) of the European Smart Grids Task Force and is a product of intensive work and discussions during 2017-2018 amongst EG3 stakeholders. Special thanks are due to all the experts (see Appendix B) who contributed in the course of this work and especially to the Editorial Team.

DISCLAIMER

This document is the result of the consensus reached among experts of the Expert Group 3 (EG3) on the 'Deployment of Demand Side Flexibility' within the European Smart Grids Task Force.

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Executive Summary

This document provides the analysis of the Expert Group 3 (EG3) under the Smart Grids Task Force, on the deployment of demand side flexibility and the specific case of explicit demand response in Europe. Demand side flexibility in this context refers to enabling final customers to become active in the market, and to provide services to system operators ensuring efficient system operation on a regional level. Hence, the work focused on both aspects.

With the Clean Energy Package (CEP) as a starting point, and complementing the work already done under the Smart Grid Task Force, the EG3 identified main barriers and proposed related recommendations in order to enhance the development of Demand Side Response and address any potential regulatory gaps. These barriers and recommendations are built upon the analysis of use cases collected within the expert group, which describes projects currently running or in launching phase (pilot projects, research projects, market designs, both on national and cross-border scale).

Each recommendation responds to an identified barrier and proposes an action to be performed either at European level, or at national level. When possible, the action holder and action type is defined.

The action type may include further study of a particular topic or sharing best practices at EU level. It may also suggest additional legislation or update of existing legislation either at national or EU level. Since the CEP is expected to be adopted soon, any legislation proposed in this report mainly refers either to an update (amendment) of existing secondary legislation (networks codes or guidelines) or to new secondary legislation that can be adopted under the Electricity Directive and the Electricity Regulation[1].

The main recommendations of the report are summarised in the table below (ID is referencing to the corresponding chapter in this report):

ID	Recommendation	Level	Action holder	Action type/ result
3-2A	Periodically analyse use cases that draw out consumer behaviour requirements, in consultation with the relevant stakeholder groups (see also section 10.3.1).	EU	EC	Study
3-2B	Stakeholders should coordinate to create greater awareness of and trust in the opportunities of Demand Side Flexibility and the services that customers can participate in.	MS	MS Stakeholders	Ensure clear, trusted, accessible information
3-2C	As offers evolve, Member States could consider how to include new offers (new products or new providers) in price comparison tools if this is	MS	MS	Monitoring and amend rules if required

[1] According to Article 55 of the revised Electricity Regulation the Commission may adopt, amongst others, an implementing act on 'rules on demand response, including aggregation, energy storage, and demand curtailment rules', under the procedure of network codes.

ID	Recommendation	Level	Action holder	Action type/ result
	not available			
3-2D	Member States should monitor developments in consumer offerings, consider the need for changes to consumer protection rules and empower relevant bodies to take action, if required	MS	MS	Monitoring and amendments to legislation/rules, if required
3-4	NRAs could ensure TSO and DSO revenue regulation and network tariffs structures take into account costs and benefits of flexibility for the system and are non-discriminatory.	MS	NRA	Amendments to licenses/rules, if required
4-1A	There is need for standardisation or at least interoperability of hardware (EMS, smart meters, charging stations etc.)	EU	EC Stakeholders	Best practices sharing and possibly standards. CBA
4-1B	There is a need for harmonisation of market rules and energy products (details in chapter 5)	EU/MS	EC, Stakeholders, MS	Market rules CBA
4-2A	A comprehensive aggregator framework should be implemented, following the CEP and EBGL, and further developing topics like allocation of energy volumes should be addressed	EU/MS	EC, Stakeholders	New secondary legislation under CEP
4-2B	Develop a classification of *Transfer of Energy* models and a compilation of best practices for the ToE, including different compensation/remuneration and perimeter correction mechanisms.	EU	CEER	Stakeholder coordination
4-3	Study the integration of Implicit and Explicit DR	EU	EC, Stakeholders	Study
4-4	Define a data access & data sharing framework, including the list of topics in 4.3.4	EU/MS	EC/MS	New secondary legislation under CEP Framework defined at EU level Details at MS level
5-1	Products should be designed in a dialogue with stakeholders to assess possibilities and needs, at least at national level. Special attention should be given to avoiding too numerous and diverse products, while considering local specificities	EU	EC, Stakeholders	New secondary legislation under CEP Studies for CM products where not already covered by existing legislation (e.g. EBGL)
5-2A	Locational information in flexibility products should be mandatory for congestion management products, with	EU	EC	New secondary legislation under CEP where not already covered by existing legislation (e.g. EBGL)

ID	Recommendation	Level	Action holder	Action type/ result
	minimum granularity to the extent necessary			
5-2B	Define the data requirements that flexibility service providers must deliver to the relevant SO or responsible market operator Study how more locational information could be provided in aggregated flexibility products	MS	Stakeholders	Studies and coordination
5-3A	The pre-qualification process should be user friendly, striving to minimise the different steps and standardise them when possible. Proportionality of the process regarding the product type and requirements should be ensured Transparency of limits applied to bids and their justification should be ensured	EU	EC, stakeholders	Explore new secondary legislation under CEP, after analysis of implementation of SOGL for balancing
5-3B	Study possible alignment of prequalification process per product, and feasibility of the prequalification process at aggregated level	MS	Stakeholders	Market rules Study
5-4	Analyse the need for availability contracts, and their impact on the market liquidity	MS	Stakeholders	Market rules
5-5	The assets delivering flexibility products should be connected to a smart (sub)meter/gateway to collect data. Telemetry requirements should be established according to capacity thresholds. Other equivalent solutions (where possible) should be implemented for smaller units or aggregators.	MS	Stakeholders	Market rules
6-1	An EU framework shall be developed to ensure an equal and transparent level playing field for all service providers	EU	EC, stakeholders	Implement and analyse existing legislation in balancing/ID/DA and if needed update or create new secondary legislation under CEP Market rules
6-2	An integrated system approach should be a shared vision. Market processes should have sufficient coordination functions between them for economic efficiency and SoS.	EU	EC, stakeholders	Implement and analyse existing legislation in balancing/ID/DA and if needed update or create new secondary legislation under CEP Market rules
6-3	The appropriate model for the coordination of market processes should be chosen and made transparent.	MS	MS, stakeholders	Market rules

ID	Recommendation	Level	Action holder	Action type/ result
	TSOs and DSOs, in coordination with all market actors, should strive for efficient coordination, especially in designing, buying and settling flexibility products.			
7-1	The Harmonised Electricity Market Role Model should evolve to include common terminology for DSR, develop roles & responsibilities model for all relevant roles with respect to contracting and activating DSF, esp. the Aggregator role. This includes a process model and an information exchange model.	EU	Stakeholders	Stakeholder coordination
7-2	Share and develop best practices for value stacking	EU	EC	Study
7-3	Share and develop best practices for sub-metering	EU	EC	Study
7-4A	Develop a categorisation of best practices for baseline design, and methodology development for selecting and validating baseline methodologies for specific products.	EU	Stakeholders	Stakeholder coordination
7-4B	Develop market monitoring, at national level or potentially at EU level, to provide a view how much flexibility is active in the market, and to monitor and prevent strategic behaviour and gaming by market players.	EU + MS	NRAs	Stakeholder coordination
8-1	Increase LV observability with smart meter data	EU	EC	Clarify existing legislation (GDPR and e-Privacy regulation)
8-2	Include the digitalisation perspective on achieving DSF	MS, EU	MS, Stakeholders	Study
8-3	Create a smart meter roadmap > 2020	MS, EU	MS EC	Study
8-4	Improve forecasting at distribution level	EU	Stakeholders	Assessment and possible new secondary legislation under CEP or update of existing network codes
8-5	Address large scale simultaneous behaviour of DR technologies	EU	Stakeholders	Assessment and possible update of existing network codes
8-6	Develop other options for mitigating grid constraints	MS	MS	Study and/or national codes
9-1	Further studies should be done to consider and clarify what (and how) information should be made transparent in the energy sector. It may be useful to map categories of energy	EU	EC	Clarify interactions of energy data with existing legislation (GDPR)

ID	Recommendation	Level	Action holder	Action type/ result
	related data against how it interacts with data privacy regulations			
9-2	Following 9.1., more detailed MS specific study to identify data needs and accessibility are needed (see also 4.2)	MS	MS Stakeholders	Study
9-3	EU safety, security and liability policies and regulations should be reviewed and updated as necessary to address new risks arising from the use of digital technologies in the energy sector.	EU	EC	Update of existing legislation and network codes
9-4	Regulators across sectors should collaborate more and consider relevant updates to license conditions in order to address the new complexities that flexible electricity services will bring	MS	NRAs	Enhanced cross sectoral working and on-going license reviews
10-1	To improve knowledge sharing through periodic analysis of research projects and proactive feedback	EU	EC	Study

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1. Introduction

1.1 Objectives

This document is the result of a 2 year's work stream of Expert Group 3 (EG3) under the Smart Grids Task Force on the deployment of demand side flexibility and the specific case of explicit demand response in Europe. Demand side flexibility in this context refers to enabling final customers to become active in the market but also to system operators to make best use of flexibility in order to ensure efficient system operation on a regional level. Hence, the work focused on both aspects:

- Access to and use of flexibility for all market parties, and
- Framework arrangements between final customers, aggregators, and suppliers (or their BRPs) and possibly other actors.

At the end of 2016 the European Commission adopted its legislative proposal (Clean energy for all Europeans package or CEP)[2] on a new electricity market design specifically addressing the issue of demand side flexibility, which is expected to be formally adopted by the co-legislators in the first half of 2019. The objective of the working group was to identify the remaining regulatory and non-regulatory gaps that have to be addressed at EU level and propose further and more specific EU action (e.g. through network codes, Commission recommendations, stakeholder coordination, additional studies, etc.) and the areas that such EU actions will have to cover.

The group build on previous work of the Smart Grids Task Force, as well as on existing studies, projects and market models for demand response in EU and worldwide (including USEF, the Penta-lateral Forum, TSO-DSO cooperation and others). Moreover, the existing and envisaged EU legislation - including network codes – served as a basis for this work.

1.2 Scope and limitations

This document aims to identify barriers for demand side flexibility to access relevant markets and products through explicit mechanisms (explicit demand side flexibility). Demand side flexibility (DSF) is defined as *the ability of a customer (Prosumer) to deviate from its normal electricity consumption (production) profile, in response to price signals or market incentives.* Demand side flexibility consists of:

- Load
- Demand side generation
- Demand side storage

The relevant markets and products within scope are shown in the figure below:

[2] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans.

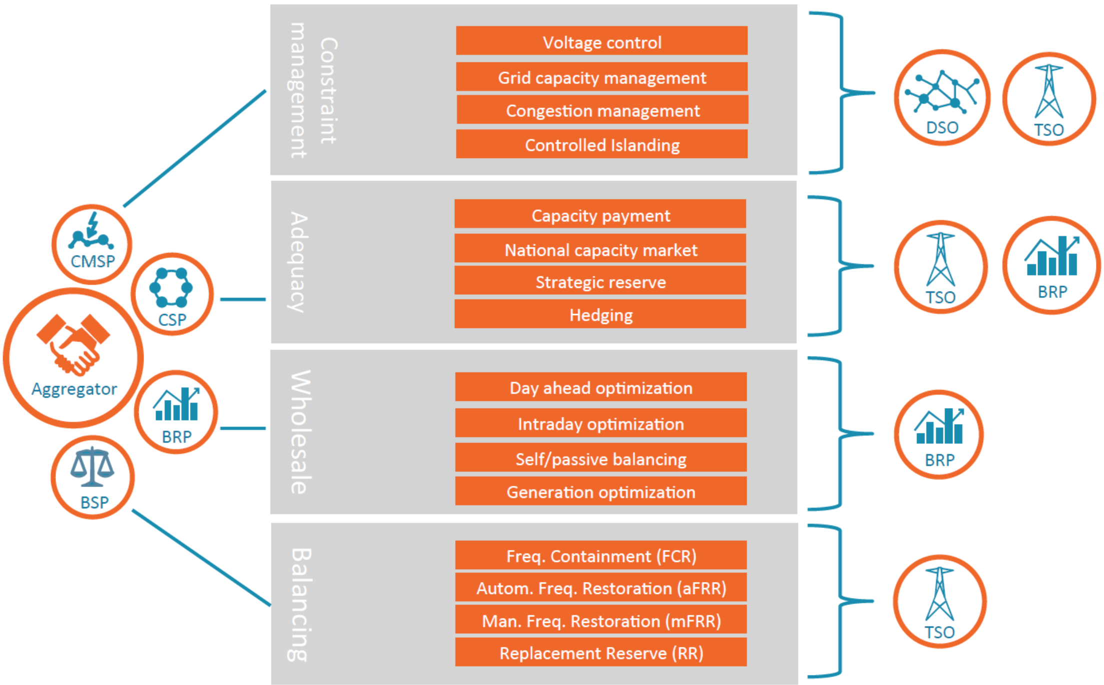

Figure 1: Organised markets and products accessible for DSF[3]

This document focuses on DSF accessing markets and products in normal state of the transmission and distribution grids. This includes mechanisms where flexibility is deployed to optimise network planning, by for instance deferring grid reinforcements, but excludes mechanisms used in alert state and emergency state.

The report does not address barriers or suggesting recommendations that are already covered by any existing European legislation or by the revisions of the Electricity Directive and the Electricity Regulation. It is furthermore assumed that all European legislation (including secondary legislation such as network codes) is - where applicable - transposed correctly into national law and correctly applied. Hence, the report does not contain any recommendations on issues such as a framework for aggregators and demand side flexibility that are already fully addressed in the revised Electricity Directive (Articles 13 and 17). However, the report does address areas where the expert group considered existing EU legislation as being insufficient or where it considered that additional rules at EU or at national level are required.

The report also focuses on explicit demand response and only addresses implicit demand response in conjunction with explicit demand response, in particular for situations when a final customer has contracts for implicit and explicit demand response and hence their activation may lead to conflicts. What concerns implicit demand response no additional recommendations could be issued that would go beyond the requirements of the revised electricity directive on dynamic price contracts (Article 11 of the revised Electricity Directive) and smart metering systems (Articles 19 – 21 of the revised Electricity Directive).

1.3 Methodology

The analysis was based on use cases on flexibility that were provided by EG3 members. To ensure coherence between the use cases the following approach was followed:

[3] Listed markets and products are defined in the document “Flexibility value chain, update 2018”, USEF, 18 Oct. 2018.

- Definition of a common set of specific questions to be answered by all use cases. Those questions were clustered around two main topics: access / use of flexibility and framework / contractual arrangements;
- Members of the expert group were asked to provide use cases that actually have been executed in Europe or were active in 2018 and that allow to specifically respond to those questions.

By the end of March 2018, 41 use cases were provided by the Stakeholders participating to the Expert Group on Demand Side Flexibility. Those use cases include national pilot projects or demonstrators, European R&D projects, current market designs or theoretical frameworks (details on all use cases can be found in the Annexed document). The use cases have been further analysed and, on that basis, the main barriers for demand side flexibility have been identified. Subsequently, recommendations have been developed on how those barriers could potentially be addressed on either EU or Member State level. Those barriers and recommendations have been clustered around the following main topics as reflected in the structure of this report:

- Customer perspective
- Market access
- Product design
- Market processes and coordination
- Measurement, validation and settlement
- Technical solutions and platforms to fulfil system and grid needs
- Privacy and security
- Market and technology readiness, economics

2. Definitions

Below the most relevant definitions are stated, a full set of definitions can be found in Appendix A.

Implicit demand-side flexibility is the consumer's reaction to price signals. Where consumers have the possibility to choose hourly or shorter-term market pricing, reflecting variability on the market and the network, they can adapt their behaviour (through automation or personal choices) to save on energy expenses. This type of Demand-Side Flexibility is often referred to as "price-based" demand-side flexibility.

Explicit demand-side flexibility is committed, dispatch able flexibility that can be traded (similar to generation flexibility) on the different energy markets (wholesale, balancing, system support and reserves markets). This is usually facilitated and managed by an Aggregator that can be an independent service provider or a Supplier. This form of Demand-Side Flexibility is often referred to as "incentive driven" demand-side flexibility.

An **aggregator framework** is a set of regulations describing how explicit demand-side flexibility can participate in existing markets and products; it contains the following elements:

- Information exchange & confidentiality
- Balance responsibility & Transfer of Energy
- Relationship between implicit and explicit DR
- Baseline design
- Portfolio conditions
- Measurement and validation (incl. value stacking)
- Rebound effects
- Customer relation / protection
- Market power / gaming monitoring / mitigation

3. Customer perspective

3.1 Description

A number of the topics discussed in the report touch on issues that relate to customers. In most cases, it impacts both residential and industrial customers. In this section we highlight issues which are particularly relevant to customers and signpost where the topics are explored in greater detail in the document.

3.2 Barriers

3.2.1 Standardisation & interoperability

The success of Demand Side Response (DSR) is strongly dependent on user acceptance and engagement (EU: "the customer in the heart of the Energy Transition"). This requires technical solutions at customer premises (smart appliances, home energy management solutions, etc.) which are simple in use and which have a proper return on investment (or other non-monetary returns) for the customer. Standardisation (to a degree) and interoperability are also important for energy managers of companies and engineered systems that can incorporate several business cases at once, including peak shaping, facilitating large buildings and industries to provide their flexibility to the grid. As a consequence, a degree of standardisation and interoperability are essential[4], however these conditions are not always met today. Market fragmentation makes it challenging to create novel standardised protocol, data and model services, which, when scaling up, should bring costs down and increase current low customer acceptance. This topic is discussed in more detail in chapter 4.

3.2.2 Customers awareness and protection

There is a general lack of customer awareness about what opportunities there are to engage in DSR, and the business case to take part. This can be attributed to a lack of clear information regarding what is possible, technologically speaking, what is on offer, how well that serves their energy needs and what kind of advantages implicit and explicit DSR can have in their energy bill or as an additional source of energy.

When consumers shop around for energy services, a key driver is often to save money. And before installing equipment able to provide flexibility to the grid, they will look at whether they will get return on their investments. But to do that, consumers should have good ways to compare products, consider what are the cost and benefits, and also the opportunities and risks of those products. This requires clear explanation of the product and its risks by the service provider.

The diversity and complexity of offers might make it more difficult for consumers to navigate the market than before, and to assess the benefits, opportunities and risks of the new offers available to them. Moreover, new offers might touch upon a number of issues, from existing horizontal and sectoral rights to contractual aspects limited to that offer, including key consumer issues such as data privacy and security. This also has implications on the protections needed for customers.

[4] *See also DG-Connect study: "Interoperability for Demand Side Flexibility"*

3.2.3 Financial incentives

Some of the case studies reviewed concluded that there is often not a clear business case for the consumer to take part in flexibility services, due to the system value of the flexibility being still too low or a lack of clear information about what opportunities are available or unclear quantification of the costs and benefits, including future revenue streams, for both the demand and supply side. For example, the benefits from load management may not be big enough to put up with the efforts and risks, as the costs to set up, install and get approval to take part are also often significant, both in time and money. Or the price signals may not be clear or immediate enough to incentivise a change in behaviour.

There are different groups of customers and offers (particular products in offer) should be suitable for the widest groups of customers. Therefore, national and local circumstances are here very important.

3.2.4 Data security and privacy

This topic is treated in more detail in chapter 9.

3.3 Recommendations

3.3.1 Standardisation & interoperability

The recommendations are detailed in chapter 4.

3.3.2 Customer awareness and protection

<u>EU level</u>

Periodically analyse use cases that draw out customer behaviour requirements, in consultation with the relevant stakeholder groups (see also section 10.3.1).

<u>National level</u>

It is recommended that, at least at national level, stakeholders coordinate to create greater awareness about the opportunities presented by Demand Side Response and the services that customers can participate in. These awareness programmes should make information available in a clear and accessible manner and may be tailor-made information to different household consumer segments (e.g. vulnerable, energy poor, elderly). They can be run by multiple groups, for example system operators could coordinate simpler, clearer information about opportunities and customer groups could run information sessions with their members on how they can get benefits from smart technologies, dynamic pricing and engage with aggregators. Topics could include:

- Different services available, the markets they can participate in, and market signals of need.
- The risks and benefits of taking part, including relating to their ability to override a curtailment of their consumption and the penalties they may face, depending on specific situations.
- Cyber security and confidentiality directives protecting them.

Since there is not only one type of consumer, any effort in increasing customer engagement has to take into account the particularities of residential, commercial and industrial customers.

Since it can be difficult to compare different offers (either new products or new providers), Member States could consider how such new offers, including those by aggregators, could be included in price comparisons tools.

In this regard, the customer should be able to access his own data whenever possible and make it available to third parties in order to receive offers from them. This includes consumption data and the times and for which quantities of his flexibility service was activated in as close to real time as possible and through different platforms like an sms, email or an app. Recommendations relating to clarity of access to data across the system are set out in more detail in later sections of this document.

Member States, or NRAs as relevant, should monitor the development of demand response offers. As these evolve, they should consider whether and where consumer protection rules need to be adapted to appropriately protect consumers in the evolving system and provide NRAs or the appropriate organisation with any new powers required to take action.

3.3.3 Customer choice

EU level

A number of aspects in the Clean Energy Package will address issues related to customers' choice and protection when using Aggregators, including contractual issues. Future market development with respect to demand response services and consumer benefits will greatly depend on the effective implementation of such measures. Therefore, it is important to ensure the implementation of the new framework and to identify possible missing links.

3.3.4 Financial incentives

EU Level

The Clean Energy Package is likely to bring in a number of elements to help consumer be fairly remunerated for the energy. This will have to be evaluated once the new legislation is implemented by Member States.

National level

As set out in the customer awareness recommendation above, customer awareness programmes should ensure that information is available so that choices are clear and that remuneration claims can be verified. Where third parties such as Aggregators are engaging with consumers, Codes of Practice should be considered that set out that quotes must be realistic and verifiable, amongst other aspects.

It is also important to ensure that markets are not unnecessarily complicated to understand and access. Flexibility providers should be able to stack value i.e. be able to access multiple markets without unnecessary restrictions. Stakeholder views on this should be sought and, if appropriate, changes made by the relevant body to streamline markets. This should include:

- wide input from all stakeholder groups when designing markets and processes;
- as far as possible, the barriers to entering multiple markets must be lowered, to help stack value across markets. This includes mirroring requirements to participate in one market as closely as possible (as far as practical), in other markets; and ensuring contractual clauses to not unnecessarily prevent participation in multiple markets.

NRAs should ensure that TSO and DSO revenue regulation (price control) and network charges allow flexibility use (including demand response) when it is efficient to do so. TSO and DSO price control should take into account costs and benefits for the system and should treat the use of various flexible technologies in a non-discriminatory manner.

3.3.5 Data security and privacy

This topic is treated in more detail in chapter 9.

4. Market Access

4.1 Description

This chapter addresses the general barriers to access the market and the challenges customers face when dealing with Demand Side Flexibility (DSF), with a focus on how to facilitate their access to the market.

4.2 Barriers

4.2.1 Lack of standardisation

Having different standards and prequalification methods and requirements across Europe is a barrier that many market participants cannot overcome.

For technology providers, especially those providing Energy Management Systems (EMS) or smart meters, that provide flexibility services to the system, having different technology requirements in each country, especially if not designed in terms of flexibility services provided but in terms of technology used to do so, means having to develop a new device and system for each market. In many cases this might not be worth it, which puts customers from different countries at a disadvantage, not giving them access to the same services and opportunities.

Besides, different criteria can apply in the prequalification requirements and design of flexibility products. Different product design in each country supposes an extra effort and a layer of complexity added to providers that need to adapt their products.

Most EMS or related platforms have a proprietary technology and are closed to third party improvements and applications. This not only raises the price of the technologies making them inaccessible to many customers, but it also supposes a barrier for companies that could develop a platform based on someone else´s technology. Furthermore, current technologies prevent the usage of the Distributed Energy Resources (DERs) in future scenarios as a result of the single-purpose offering of DERs and EMS and their interfaces

4.2.2 Lack of a framework for DSR providers

There are several issues regarding the lack of a clear framework for DSR providers, like for example for aggregators. Some of these issues are:

Allocation of energy volumes and balance responsibility: Clear allocation of energy volumes is not always present. The same system doesn't have to be applied in every country, but it has to be consistent with the CEP and the EBGL (allocation of volumes, and financial flows).

Baselining methodology: A lack of an appropriate methodology for baselining is commonly identified as a barrier for access to the market, especially when this methodology is not completely transparent or when it is not standardised and accurate.

Remuneration: DR services are not always remunerated in the same way as generation, which is a barrier of entry for new technologies especially. Remuneration should be compliant with EBGL and no distinctions be made.

4.2.3 Integration of Implicit and Explicit Demand Response

A clear framework has to be put in place for Implicit and Explicit Demand Response to work together in an optimal way. Conflicts on remuneration and accounting of energy flows may arise when for instance a customer has two different contracts, one with its supplier with implicit DR and one with an independent aggregator providing explicit DR, and where both are active at the same time. It may then not always be clear which part of the DR realised is the effect of which actor (supplier or independent aggregator). Baselining methodologies as a barrier and recommendation are dealt with in further detail in chapter 7.

4.2.4 Data access and data sharing

Correct functioning of Demand Side Flexibility is heavily dependent on the exchange of data between involved stakeholders (customers, market parties, grid operators etc.) Timely access to correct data is crucial for the business model of relevant market parties. For fair market competition also a level playing field in data access and data sharing needs to be ensured, while at the same time customer privacy through GDPR compliancy needs to be respected. Today however, although on a generic level agreed, these issues have not been tackled in a way that is required for successful implementation of DSF.

4.3 Recommendations

4.3.1 Standardisation of EMS, smart-meter platforms and technologies

EU level

EC guideline and stakeholder coordination
In general, it is recommended to strive for standards, or best practice, and interoperability on EU level, as this creates a larger addressable market, leading to lower costs for the consumer and consequently higher level of acceptance, while taking into account the costs of standardisation. Implementation of these standards and creation of interoperability should be left to Member States, this to accommodate an effective roadmap from each Member State, where the existing situations may differ significantly.

Orchestrate, on EU level, actions to accelerate results of the involved EU actors (appliance vendors, market parties, grid operators, regulators), including better coordination of industrial, national and EU initiatives, to stimulate interoperability between devices in accordance with agreed processes, with support for the roles and responsibilities of the involved actors. This has also been concluded in the DG-Connect study (ref: SMART 2016-0082, ISBN 978-92-79-91236-8 on interoperability.

It is recommended to define smart appliance capabilities which could be built in to all appliances (or appliance with large grid impact) and the communication interoperability that should be set. Special attention should be paid to make the interface agnostic regarding the different flexibility products, since the way flexibility will be used will likely change during the lifetime of the device, due to the energy transition and technology evolution. Delivery of necessary data for validation of the realised flexibility service towards markets and grid operators should be part of these capabilities. To accelerate adoption, new devices that have significant impact on the grid (such as heat pumps, CHPs, EV-chargers, PV-panels and stationary batteries) should be provided with a interoperable control interface which allow customers to exploit the flexibility in those devices in energy markets or to assist in congestion management. (see also section 8.2.4).

It is recommended to explore which requirements are needed to accept the measurements of an appliance itself (e.g. EV charger) for validation of flexibility service delivery. It is thereby important that regulation remains generic in the sense that it creates a market and stimulates developments and not that it slows down innovation by prescribing specific solutions.

It is recommended that, in order to ease consumer adoption, a standardisation of hardware should take into account the different customer classes. "Plug and Play" like for many other technologies should be encouraged on European and Member States level.

It is recommended that a standardised common interface technology is defined, with a focus on interoperability (see also section 8.3.2).

It is recommended that a CBA is performed in cooperation with stakeholders to assess standardisation of different aspects.

Regarding harmonisation of energy products and product definitions, detailed recommendations can be found in section 5.3.1.

Regarding standardisation of smart meters, detailed recommendations can be found in section 8.2.5.

National level

It is recommended to enforce on Member State level the use of technology neutral standards and interoperability (protocols, messages) for interaction of customer assets (appliances, home energy management systems, etc.) with the market and system operators through regulation and / or new codes.

4.3.2 Framework for DSR providers

EU level

A clear framework for DSR providers should be put in place, fully implementing the provisions in the CEP and EBGL, and based on the barriers identified above. While some of these aspects are covered in the CEP, the European Commission (EC) should provide guidance for its implementation.

EC Guideline or Network Code

Allocation of energy volumes and balance responsible party: The aggregator is responsible to deliver the volumes committed. Regarding the allocation of energy volumes, two different options are possible:

1) Aggregator Implementation Models without perimeter correction (*broker*[5] and *uncorrected* model), which has been suggested may be recommended for products where no, or low, energy volumes are shifted (e.g. reserves products where the focus is on capacity).
2) Aggregator Implementation Models with perimeter correction (*contractual*, *corrected* and *central settlement* model), which has been suggested may be better suited once larger volumes of energy are shifted.

[5] Definitions of the different Aggregator Implementation Models can be found in "*Workstream on Aggregator Implementation Models*", USEF, Sep 2017

EC Guideline

Clear rules for financial flows:
Financial flows should be clarified at a National Level following the compensation principles stated in the CEP. Any guideline for implementation on financial flow has to be compliant with the rules already covering this aspect in the EBGL.
The supplier should be remunerated for the energy volume deducted from their portfolio. Of course, where demand response leads to an increase of demand, the compensation should go the other way, i.e. to the aggregator/consumer. The payment should not exceed the energy costs (i.e. not include extra charges or margins). Different approaches are possible to make the consumer, aggregator or TSO responsible for the payment.

Stakeholder coordination:
It is recommended towards regulators to develop a classification of Transfer of Energy (ToE) models, building on existing work, for example the USEF work, and a compilation of best practices for the ToE for independent aggregation, based on existing mechanisms (e.g. NEBEF, Belgian Law), including different compensation/remuneration and perimeter correction mechanisms.

4.3.3 Integration of implicit and explicit DR

EU level

Study

It is recommended that a study is performed on how implicit and explicit DR should interact and work together on a strict level playing field to reinforce participation of all flexibility capacities in the markets. For example, if implicit and explicit DR operate in the same site, this needs to be reflected in the baselining methodology applied, to correctly measure the explicit part. This integration must be clear in order to allow competition between different flexibility options based on their economic merits.
Description of which combinations are not viable, and how this can be avoided (in terms of roles and responsibilities), should be considered. Further recommendations regarding baselining methodologies are included in section 7.3.4.

4.3.4 Data access and data sharing

The consumer should have complete access to their electricity related data, to allow them to make a reasoned choice when changing suppliers or providers and to be able to make an optimal use of off-the-shelf technology solutions. The consumer should also be in control over the use of his personal data by third parties (GDPR) and recognising that the consumer via DSF is becoming an actor in the energy system, this also emphasises the importance of level playing field with respect to access and sharing of data.

EU level

Secondary legislation

When addressing data access, it is important to recognise that this topic is broader than only data standards and data exchange protocols. It is therefore recommended to define an EU framework from a broader scope that only identifies all relevant topics/ building blocks of data access and data sharing. Decisions and choices on implementations of these building blocks (such as decisions on data formats[6]) are done on national level (see recommendation in 9.3.1).

[6] In line with recent decisions of the European Parliament and Council on this topic in the CEP.

This approach enables sharing of best practices in a comparable way on EU level, and may in the future potentially be valuable, when a need for some harmonisation would become relevant.

This framework should contain at least the following topics

1. Data format (structured/ unstructured)
2. Operational agreements: reporting procedures, data quality, and processing of data
3. Legal aspects: Terms of Use, liabilities and responsibilities, compliancy
4. Financial aspects: socialised costs (e.g. open data) or non-socialised costs
5. Data exchange protocols (including performance)
6. Governance: roles and responsibilities in the exchange of data.
7. Meta data: findability and accessibility of directories
8. Identification and Authentication services
9. Consent management & mechanisms: standard contracts, explicit authorisation, delegation of data ownership etc.

National level

It is recommended that at national level decisions and choices are made with respect to the implementation of the building blocks of the EU framework.

It is recommended that national rules guarantee the access to data of the final customer by eligible parties based on the consent of the final customer or other basis foreseen by GDPR.
It is recommended that Member States provide the necessary certification and supervision of parties managing data within their borders.

On a national level, the data necessary to foster new flexibility markets and support existing ones should be identified and any gaps made available to the market (e.g. Metering and consumption data, data required for consumer switching, for the optimal use of DSF and other services. Specific data required by aggregators: historical interval data (with enough depth to identify patterns), real-time data, settlement data, standing data (size of consumer, tariff class, network area they are connected to, in general data required for the prequalification process).

5. Flexibility product design

5.1 Description

Flexibility products[7] should be designed based on clear needs, which should be defined by the requesting party, checked with market parties whether it can indeed be delivered and taking into account existing products (e.g. balancing). Such flexibility products will cover several timeframes and address several purposes such as trade for portfolio optimisation (DA/ID) but also balancing, congestion management or voltage control.

Products will have technical and economical attributes and units delivering such products will be prequalified against their performance[8] (is the unit, or an aggregation of units, technically able to deliver) and their impact on the grid[9] (can the grid distribute/transport).

Consideration of existing products is required to assess the need to define new ones (e.g. for congestion management or other non-frequency ancillary services), and need for standardisation at regional, national or EU level should be questioned. A key focus should be on including DSR in these products, like any other technology, as long as it meets the requirements.

The barriers and recommendations in this section are mainly focused on products for grid and system services (e.g. congestion management, balancing).

5.2 Barriers

5.2.1 Need for product definition

For other than balancing markets, where there is already EU legislation requirements, a clear definition of products is needed, even for local needs, where it is important to avoid too many different and non-comparable products. This raises the question which level of standardisation/harmonisation is needed, for which products, and how it can be guaranteed that all relevant market stakeholders can participate. Product definition should be made by taking into account the situation of relevant market stakeholders, and by guaranteeing the participation of all resources contributing to system needs.

5.2.2 Locational information

Today locational information is not given in any type of bids, except if introduced along EBGL in balancing. However, this locational information in flexibility bids is becoming key to assess and address the impact on physical infrastructure, especially for services like congestion management.

One barrier we observe is the lack of an automated, reliable way for aggregators to determine the location of assets in the power grid. When aggregators want to provide congestion management services, they need to know the location of the congestion.

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[7] Modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system, be it for wholesale trade, frequency ancillary services, non-frequency ancillary services or congestion management.

[8] Product prequalification: checking whether the unit can (technically) deliver the product it wants to sell/deliver.

[9] Grid prequalification: checking whether the grid can manage the delivery of the product that the unit wants to sell/deliver (both congestion management and balancing products), according to the agreement and applicable framework between the different system operators on prequalification.

5.2.3 Prequalification

Prequalification for actors and products is defined in Electricity Transmission System Operation Guideline (SOGL) and Electricity Balancing Guideline (EBGL). However, this constitutes an additional process for market parties to follow and could lead to limitation of bids: the process should be clarified, and limitations applied to bids should be justified.

5.2.4 Temporality of products: Long term versus short term

There is a trade-off between the use of long term (capacity/availability) versus short term (energy) products, or a combination of both. The following issues that have not been addressed up to now should be considered:

- How DSF can contribute to (long-term) availability products and to longer-term products.
- How to enhance liquidity (until close-to-real-time), while at the same time providing the possibility for capacity/availability products to fulfil long-term needs.
- How to ensure TSO-DSO coordination for product use and avoid locking flexibility into one market or one product (unless there is a clearly defined need for e.g. availability contracts).

5.2.5 Multiple BRPs on one connection point

When different BRPs are involved on one connection point: it is not unambiguous which energy needs to be assigned to which BRP, especially when DSR is playing a role in that connection point. Responsibilities should be clear.

5.3 Recommendations

5.3.1 Need for product definition

EU level – formal action from the EC and Stakeholders coordination / National level – Stakeholders coordination

Balancing products are defined in EBGL, giving a European frame to such products. For other types of grid services, such as congestion management, a European frame is needed for product definition, to avoid discrimination among market parties or technologies, especially for those products[10] where compatibility with existing (cross-border) wholesale and balancing products must be ensured: categories of products should be defined with a template listing possible attributes and technical characteristics, allowing national implementation using such a template[11]. Products should be designed in a dialogue with stakeholders to assess possibilities and needs, at least at national level. Special attention should be given to avoiding too numerous and diverse products, while considering local specificities.

Some characteristics like products minimum size or temporal granularity should be defined in such a way that participation of all resources contributing to system needs is possible.

System operators and stakeholders should coordinate in defining needs and related potential products.

[10] EB GL should be taken into account here.
[11] Cf. TSO-DSO report on Active System management (2019), where TSOs and DSOs propose a template of possible technical characteristics for such products.

Products should be technology neutral: all possible providers with the needed technical conditions should have the same opportunities. Generation and consumption, as well as all other possible technologies, should compete equally. To guarantee this, definitions on certain technologies should be clarified (for example storage, that can be considered consumption and generation, and as such is sometimes excluded from both).

5.3.2 Locational information

EU level – formal action for EC and Stakeholder (SH) coordination
Providing locational information should be a requirement for flexibility products offered for congestion management but limited to the extent necessary.

We recommend that EU stakeholders (ENTSO-E and DSO associations) come forward with a proposal on how the market is notified in which geographical area or part of the grid, congestion is expected and bids are requested, taking into account privacy aspects (GDPR) and cyber security aspects (e.g. by avoiding communication of details of grid topology). The solution should also support bids from aggregated flexibility. The user of a flexibility register (as recommended in the ASM report) for this purpose should be considered.

National level

- Requirements on data that flexibility providers must provide to the relevant TSO and DSO or responsible market operator should be established. Impact on market power, liquidity should be considered as well as grid and system requirements. Liability and quality of the data should be ensured between the buyer and the seller of the flexibility product.
- System operators and stakeholders (including aggregators) should study how more locational information could be provided in aggregated flexibility products (need, feasibility, impact). While locational information is needed for certain purposes like congestion management or network security analysis, the possibility of trading in portfolio-based mechanisms for the wholesale and balancing markets should also be preserved.

5.3.3 Prequalification

EU Level – formal action for EC and SH coordination
Prequalification process is defined for balancing in SOGL and EBGL.
The prequalification process should be user friendly, striving to minimise the different steps and standardise them when possible[12].
Proportionality of the process regarding the product type and the requirements should be ensured.

Potential limits/restrictions set to bids from prequalified units due to grid constraints should be made transparent and should be justified (in both processes of product & grid prequalification).

National level
Prequalification processes will be implemented at national level, with clear technical expectations, clear control procedures and clear roles and responsibilities.

[12] For example, see also TSO-DSO report on Active System Management (2019) where steps of the process are proposed.

In addition to balancing, where obligations already apply, prequalification rules should be reviewed at national level to ensure they do not create entry barrier to the market.
Besides, the following issues should be considered:

- Alignment of the prequalification process per product.
- Feasibility of the prequalification process at an aggregated pool level rather than for each end-point individually (the location used would then be the highest level of the aggregated pool, e.g. substation). Product prequalification would then assess whether the pool of assets can deliver the product, while grid prequalification whether the grid can transport the delivered energy.

5.3.4 Temporality of products: Long term versus short term

National level

As part of the product definitions, the need for availability contracts within the different products should be analysed, together with mechanisms to limit the potential negative impact on liquidity in other markets / products.

5.3.5 Multiple BRPs on one connection point

National level

Monitoring and communication requirements:

- The assets delivering flexibility products should be connected to a smart (sub)meter / smart gateway to collect data at the right time interval (depending on the product definition). Behind the connection point, assets may need different monitoring/metering and this need should be assessed and discussed with concerned stakeholders.
- Where not already defined, telemetry requirements should be established according to capacity thresholds (MW), since, especially for lower power grid users, additional equipment could not be cost-efficient. Other equivalent solutions should be implemented (where possible) for smaller units or aggregators so that real-time information about these units, in a sufficiently aggregated way that is equivalent to telemetry, is available to TSOs and DSOs.

In any case, for settlement purposes, the reference meter should remain the one installed at the main connection point.

6. Market processes and coordination

6.1 Description

Several market processes tackle different purposes (wholesale trading, balancing, congestion management) and different timeframes. For these market processes, roles and responsibilities (especially new ones) should be made clear, especially regarding market facilitation and coordination between them). Information exchange is needed to support efficient market functioning, also ensuring secure system and grid operation. Rules for bids gathering, selection and activation are needed. Transparency towards all market participants from the side of market operators must be ensured.

6.2 Barriers

6.2.1 Market accessibility

With the increasing share of distributed resources and small players, access to the market becomes a key concern. In reality, market access could indeed be limited (through prequalification or bid limitation) depending on the location, the voltage level of the connection, the service offered or the type of asset (generation, storage, demand side response). The TSO and DSO have jointly provided a long-term vision (excluding emergency situations) in which congestions should be solved through a market-based allocation of flexibility services in combination with an adequate grid reinforcement where justified and economically and technically feasible rather than compulsory limitation procedures.

6.2.2 Market fragmentation and market efficiency

As shown in Figure 1, flexibility can be used in many different markets and products. If every buyer of DSF organises its own market, this could lead to market fragmentation and lack of (price) transparency. Like wholesale trading, where spot markets provide liquidity and price transparency (compared to bilateral deals only), also other products (i.e. ancillary services) can be traded on (a limited number of) market places. It can also help small players to smoothly enter the market and value their services at most.
Coordination between different market processes would aim to avoid discrepancies and liability issues such as double activation of the same bid, or counter effect that could endanger the system as well as link together different market places to avoid market fragmentation.

6.3 Recommendations

6.3.1 Market accessibility

<u>EU level – EC and SH coordination</u>
The EU framework shall be developed to ensure an equal and transparent level playing field for all service providers providing explicit or implicit demand response and flexibility resources participating in the markets. At least the following issues and principles should be addressed:

- Any type of actor, regardless its location, the voltage level of its connection points or its technology should be able to access the different markets, wherever feasible, if they fulfil the product requirements.

- A market-based[13] approach considering all types of flexibilities is preferred: all participants are put into competition and with a fair remuneration considering all types of flexibilities is preferred.
- All similar resources should compete equally.
- In a market-based approach, roles and responsibilities of different parties (especially new ones) need to be clarified and well defined, subject to national specificities. Existing role models should be analysed and if necessary updated accordingly.

6.3.2 Market fragmentation and market efficiency

<u>EU level – EC formal action and SH coordination</u>

- An integrated system approach[14] should be a shared vision, to assess and reduce the risk of market fragmentation.
    - An integrated electricity system approach is the basis, in which all actors' roles and responsibilities, from local to cross-border, are recognised
    - Roles and responsibilities should be defined and shared, including clarity on market facilitators.
    - A consistent model should be established to allow stacking value of flexibility across markets.
- Market processes should have sufficient coordination functions between them for economic efficiency and security of supply sake, especially when the same assets can provide different services to different market processes, and when timeframes overlap. In that sense, fully separated market processes should be avoided.
- TSOs and DSOs should pay special attention into implementing coordination between the different market processes they are active in, such as balancing and congestion management. Several options of coordination between market places exist (from separate to integrated market processes), they should be framed at European level and assessed at national level. A proposed description of the models is made in the Common TSO-DSO report on Active System Management (2019).
- Rules of bid selection (technical and economic approach) should be clear and transparent.

<u>National level</u>

- Coordination of market processes, especially when same assets could compete for different services and timeframes overlap, is to be addressed, especially when it impacts the efficiency of the electricity system (e.g. the coordination of balancing and congestion management). It would cover aspects such as avoiding double remuneration, use of the same asset for different market mechanisms, real-time delivery, cross-border participation rules etc.
- TSOs and DSOs, in coordination with all market actors, should strive for efficient coordination, especially in designing, buying and settling flexibility products.
- Flexibility requests from System Operators to the market should be standardised.

[13] "Market-based" could encompass mandatory or free bidding, cost-based or other mechanisms, e.g. remuneration via tariff design or different connection agreements, may be needed in some cases (to tackle non-liquidity or market power).
[14] See TSO-DSO data management report (2016).

7. Measurement, validation and settlement of flexibility products

7.1 Description

When DSF is brought to the market through an explicit mechanism, there is a need to quantify the amount of flexibility (typically expressed as energy) that has been delivered. Since flexibility (by definition) cannot be measured, a **baseline** is needed to quantify the delivered flexibility.
The concepts of measurements (as input for flexibility quantification), validation (of measurements and quantification – including baseline design and verification), and settlement (of delivered flexibility), need to be addressed on three levels:

1. Roles and responsibilities
2. Processes
3. Information exchange

Typically, the product (e.g. an ancillary service) that requires / uses the flexibility, defines the requirements for measurement, validation and settlement (MV&S). There are several reasons to involve other stakeholders (next to the product owner i.e. TSO/DSO) when designing these requirements:

- Alignment of MV&S requirements (as part of TSO / DSO product design) may reduce costs at the FSP and customer side, and thus overall system costs.
- Flexibility quantification is also input for the Transfer of Energy (ToE), where applicable. For the sale of flexibility in wholesale markets through independent aggregation, a baseline methodology for this ToE should be defined (as for balancing products).
- When DSF participates in a TSO or DSO product and if the Transfer of Energy is organised (esp. in case of independent aggregation), the TSO/DSO product requirements will have direct impact on wholesale settlement (and consequently on “third party” Suppliers/ BRPs).
- When value stacking (i.e. resources active in different products, at the same time) is allowed/possible, the flexibility quantification needs to be coordinated, to avoid double counting
- All TSO and DSO products are likely to have impact on the system balance; therefore, the balance responsibility needs to be clearly assigned.

7.2 Barriers

The main barriers with respect to measurement, validation & settlement are described below.

7.2.1 Value stacking

The business case for demand side participation can be improved if value stacking is allowed. Value stacking requires clear descriptions how the activated flexibility is allocated to the different services.

7.2.2 Place of measurement

The metering point (at the connection point) is not necessarily the optimal place to register explicit DSF activations. However, the use of sub-meters is not always supported by the regulatory framework, especially if the sub-meter is embedded in the appliance or device. If the placement of a second meter is required, this could lead to disproportionately high costs.

7.2.3 Transfer of Energy

The concept of independent aggregation typically introduces the need for a Transfer of Energy (ToE). This ToE requires clear descriptions for MV&S, as it impacts wholesale settlement.

7.2.4 Baseline methodology

Finding a baseline methodology that is accurate, simple, transparent, unbiased, without introducing gaming-options, is far from trivial. It is, however, essential for a proper functioning of explicit demand side flexibility, since:

- Non-accurate or biased baselines may render a flexibility asset non-eligible to participate in TSO/DSO products, lowering the possibility for demand side participation.
- Complex baseline methodologies will impact the reproducibility, transparency and implementation costs.
- Specific baseline methodologies could introduce gaming options, esp. in day-ahead and intra-day markets and products.

7.3 Recommendations

National level

In general, measurement, validation and settlement procedures need to be designed and implemented on national level. However, there is a strong need to harmonise these procedures at EU level to the extent possible, for the following reasons:

- Cross border exchange of energy, and of ancillary services.
  If MV&S requirements are not aligned, the level playing field could be violated.
- Removal of market entry barriers.
  Barriers may be created for market parties that wish to extend their activities to other Member States, when MV&S requirements are not aligned, due to costly IT modifications/implementations.

EU level

Next to existing regulation such as the Electricity Balancing Guideline[15] and the Capacity Allocation and Congestion Management Guideline[16], further harmonisation may be needed. To explore and achieve these harmonisation requirements, we provide several recommendations in this section.

Stakeholder coordination:

The Harmonised Electricity Market Role Model[17] should evolve to include common terminology for DSF, develop roles & responsibilities model for all relevant roles with respect to contracting and activating DSF, esp. the Aggregator role. This includes a process model and information exchange model. It is recommended to European associations of TSOs and DSOs, in close coordination with market parties to develop this role model.

7.3.1 Value stacking

Study:

It is recommended to share and develop best practices for value stacking. Since value stacking is often achieved through portfolio management (pooling of flexible resources), this also needs to be taken into consideration

- Value stacking: the possibilities and limitations to offer different services using the same flexible resource, at the same time.

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[15] cf. http://data.europa.eu/eli/reg/2017/2195/oj

[16] cf. http://data.europa.eu/eli/reg/2015/1222/oj

[17] cf. https://www.ebix.org/artikel/role_model

- Portfolio management: Ability to pool flexible resources in all products and markets, allowing aggregators for each DSF activation request to select and modify the resources until (and including) the activation window.

This action could be led by the European Commission.

7.3.2 Place of measurement

EU level
Study:
It is recommended to share and develop best practices for sub-metering, focusing on:

- Allowing aggregators to limit their (balance) responsibility to the flexible device that is actively controlled by using a sub-meter
- Specifying the requirements on hardware and meter reading process and validation that allow embedded metering equipment to be used for delivery validation, and as input for the ToE calculation.
- Specifying the requirements on hardware and meter reading process and validation that allow separate metering equipment, installed by the aggregator, to be used for delivery validation, and as input for the ToE calculation.

This action could be led by the European Commission

7.3.3 Transfer of Energy

EU level
Stakeholder coordination:
Recommendations regarding Transfer of Energy are included in section 4.3.2

7.3.4 Baseline methodology

EU level
Stakeholder coordination:
It is recommended to develop a categorisation of best practices for baseline design, and methodology development for selecting and validating baseline methodologies for specific products (possibly for specific flexibility resources). The scope would encompass wholesale markets, frequency and non-frequency ancillary services, congestion management, adequacy mechanisms. This action could be led by TSOs and DSOs, with their associations, in close cooperation with market parties.

EU and National level
Stakeholder coordination:
It is recommended towards National regulators to:
Develop or extend market monitoring, at national level or potentially at EU level. On the one hand to provide an up-to-date view of how much flexibility is unlocked and available for the market (in MW), and how much has been activated (in MWh) in all relevant markets and products. On the other hand, to monitor and prevent strategic behaviour and gaming by market players.

8. Technical solutions and Platforms to fulfil system and grid needs for flexibility

8.1 Description

This chapter addresses technical issues, which need to be tackled to fulfil customer, system and grid needs. From the use case analysis, it becomes clear that in Europe demand side participation is already maturing in balancing markets in different EU countries, and many pilots and projects have and are being initiated to develop other services and in other markets. As a result, this chapter identifies the next level of implementation challenges which are encountered and which need legislative support to overcome. It also addresses the need for consistent legislation from the perspective of the energy business in its transition towards a sustainable, reliable and affordable energy system, as well as from the perspective of the digital transformation, in which IOT, data and cloud-based ecosystems will play a pivotal role. Finally, this chapter provides non-prescriptive recommendations on the approach to solve the identified barriers.

8.2 Barriers

8.2.1 Low observability in LV grids

DSOs will be challenged with the changing electricity system, since the load on the grid and the distributed RES generation are expected to increase significantly (energy that flowed in one direction now flows in two directions: to and from the recipient). This increase is expected to happen at a pace which traditional grid expansion may not be able to keep up with (due to financial, staff and technology resource constraints), which leads DSOs in search of other options to solve this issue.
Also, the dynamics of the load will change: market parties may stimulate through dynamic pricing the use of energy at windy or sunny periods, creating higher peaks in grid usage, whereas at the same time DSOs try to mitigate congestion, caused by these higher peaks, through demand side flexibility in order to flatten grid usage.

HV grids have a good level of automation and can provide real time data on grid load, whereas MV grids have a lower degree of monitoring and control capabilities. Full automation of the LV grid (“the last mile”) is costly and complex due to its size. DSOs therefore usually lack good observability in the LV grids, while, with increasing DER penetration rates, good observability will become a necessity for DSF validation; not only for DSOs but also for TSOs as they intend DER to use for e.g. balancing purposes.” It should be born in mind that increasing observability will lead to increasing CAPEX (sensors and measurement units) and OPEX (communication).

The rapidly changing load profiles, which will become more “spikey”, are likely to drive the traditional “scenario based” overall grid investment strategy to a more geographically differentiated and data-driven investment planning strategy (“at the right time, at the right place”). Therefore, the fact that the LV grid cannot provide sufficient data today, will have also a negative impact on the future LV grid investment strategy.

In conclusion, lack of sufficient data, due to low LV grid observability, will not only hinder LV grid monitoring and quality of service to customers, but also the objective of realising an affordable energy system.

8.2.2 Lack of clarity on the use of smart meter data without customer consent

Today smart meters are in use or being rolled out in large parts of Europe. It is generally recognised that smart meters are essential for many types of demand side flexibility, especially when different actors (supplier, independent aggregator) will engage with the customer simultaneously.
With the implementation of new privacy legislation (GDPR and future e-Privacy regulation), it is not always clear to the relevant stakeholders, which smart meter data, for which purposes and under which restrictions, could be used without customer consent. As the privacy legislation applies horizontally to a number of different sectors, it is sometimes unclear for which particular use cases or under which circumstances smart meter data could be used in grid operators' legal tasks on grid operations and planning (even after having performed a DPIA)[18].
Due to this lack of clarity, there are different interpretations emerging in the different Member States, which, as a consequence, may hinder the development of DSF in the European energy market.

8.2.3 Lacking the digitalisation perspective: emerging platforms fragmentation

In current European debates on flexibility, a lot of emphasis is put on flexibility products, aggregator business models in relation to existing suppliers and in which (existing or new to establish) markets these products should be traded. Less focus is given on digitalisation perspectives and how these markets should operate in delivering DSF to grid operators (TSOs and DSOs) and how TSOs and DSOs should implement coordination so that no mutual harmful interference emerges when they interact with these markets.

In analysing the use cases on pilots in Europe, it becomes very evident that many actors are developing and piloting platforms (with many different variations).

Competition in the commercial domain can lead to efficient market structures but also carry's the risk of markets being fragmented. When, in the regulated domain, TSOs and DSOs, with different visions stemming from their existing roles and responsibilities, independently develop platforms to interact with trading platforms in the commercial domain, a very complex and costly platform landscape may arise. Independently designed algorithms running on these platforms may, if not synchronised "by design", impact TSO-DSO coordination and data exchange. If this is not well addressed this may emerge as a risk to system stability.

Also, clarity is needed about which functions should be implemented in the commercial domain and which functions in the regulated domain; Clarity on this is needed to ensure a level playing field in the market while at the same time maintaining full responsibility and control over security of supply and system stability at the regulated domain.

8.2.4 Lack of requirements for smart customer assets

The energy system of the future will contain a significant number of assets of which ownership resides at the customer. If these assets are not correctly integrated in the energy system, this will endanger future system stability and reliability; seamless integration of smart assets with the grid, required for power quality management and system stability, is regarded as a system operator responsibility. As a consequence, correct integration in the system does not only require a standardised "physical" connection to the grid, but also require monitoring and control functionalities on those customer assets which are relevant from an energy system

[18] Linked to General Data Protection Regulation (GDPR).

perspective and which can be accessed via a standardised ICT interface for smart interworking with the market and system operators.

Today these requirements are not yet typically part of national standard connection agreements. As the current EU vision on the definition of the grid edge is only based on the physical connection (before and after the smart meter) and because the market in some cases is fragmented, due to competition, the logical interface (not standardised) is usually only offered to commercial market parties, leading to the risk of future customer lock-in (less churn rate) and possible system stability and reliability risks for system operators; this is a focal point. It should be noted that this topic is high on the US grid operators' agenda[19], where in Europe this topic is already partly identified in SOGL, DCC and RfG networks codes (requires more work, e.g. on standards).

8.2.5 Need for EU smart meter roadmap after 2020

Based on respective Member States CBA's, roll out of smart meters is taking place and, although the EU 2020 target will not be completely reached, this will be finalised by 2020 in most of the European countries. The requirements for smart metering coming from the clean energy package (CEP) will be transposed to Member States by 31/12/2020.

The functionalities of these smart meters are based on EU recommended functionalities in 2012. It is clear that the market will develop further after 2020, and that the energy system, due to decentralisation, will undergo a major transformation. We are more informed today about how it may develop than back in 2012. It is now clearer that new requirements (e.g. providing real time data) will be imposed on the grid edge. This will require a modular and flexible architecture in which these future requirements (not yet known today) can be easily implemented when they become relevant.

No Europe-wide accepted vision exists today on how metering and access to data and functionality of relevant customer assets (as described in point 8.2.4) should be developed after 2020 and in a consistent way following industry developments in IOT and communication technologies.

In addition, it is not clear how in general the potential of digitalisation (IoT solutions and communications technologies) will be taken into account. There are various (competing) solutions, such as IoT and other standardised (communication) technologies referring to the IEC 62357 standard, and they evolve rapidly, and effective deployment may be hindered by regulation lagging behind.

So, the question is how, from a customer perspective, the grid edge and metering should develop against affordable costs. If not yet well addressed, this may lead to the situation that (new) large scale rollouts to replace the existing smart meter stock will need to take place after 2020 in the whole of Europe (not only in Sweden, Finland and Italy), likely at the cost of the end customer; a situation which, without a clear architectural roadmap, might not be future proof and would actually be unfeasible and unacceptable from a customer's point of view. While the metrological part will not change, an architectural review of what today is defined as a smart meter system (including integration with smart buildings and distributed resources) is urgently required, while taking into account investments already made to realise current national smart meter rollout plans.

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[19] *Source Electrical Power Research Institute (EPRI)*

8.2.6 Lack of common EU strategy on reliable IoT communications for the energy system

As customer assets become part of the energy system of the future and will need to be connected in a reliable and cyber secure way to platforms of markets and system operators, it becomes clear that also the data communication perspective needs to be better addressed. From the use case analysis, it becomes clear that a robust, secure and embedded communication channel will be required in order to support reliable DSF market interaction and grid operations, which is today not the case. This communication channel should also ensure confidentiality.

Also, future smart meter developments will require new communication solutions, taking into account future opportunities from IoT developments and new communication technologies (e.g. 5G, LTE-M), while also the topic of reducing dependencies (cyber security) between critical infrastructures (Telecoms and Energy) need to be examined. There is no commonly agreed vision yet on how the need for more real-time and reliable communications can be met versus the view point that decentralised intelligence should be able to maintain full system stability and market functioning in case communications is lost. As reliable communications will be vital for the grid and market to function, the question is also to what extend system operators need to have control over costs, reliability and life cycle management of communication technologies used by telco's in their service offering towards transmission and distribution system operators.

Today also no clear and integral European vision exists on how to realise a reliable infrastructure, required to access to data and functionality of smart customer assets which are relevant from an energy system perspective.

8.2.7 Inadequate load and generation forecasting at distribution level

Good quality forecasting of grid load and generation in the future will become an essential capability as the dynamic nature of the flows in the grid will increase due to changing weather patterns and new user behaviour, triggered by dynamic prices (set by suppliers), new types of usage (e.g. EV, heating) and TSO & DSO actions on re-dispatch and balancing across TSO & DSO grid boundaries. Good forecasting, in ISP[20] time frame granularity by grid operators, is essential to determine whether flexibility needs to be procured in the day ahead or intraday market. In general, this implies a new challenge for DSOs, as in the past, due to the traditional "copperplate" investment strategy, there was less need for detailed forecasting in the day ahead or intraday time frame.
The importance of improved load forecasting is also reflected in increasing requirements on forecasting, as laid down in EU network codes (e.g. the Generation & Load Data Provisioning Methodology: GLDPM).

Typically, system operators would like to identify their need for flexibility and, when economical and technical feasible, solve it in a timely manner via market-based procurement of flexibility, via long term contracts, in the day ahead or intraday time frame. Improved accuracy of load and generation forecasts could also increase DER hosting and dynamic load capacity of the grid.

The market today is allowed to operate between boundaries set by TSOs and DSOs and communicated market restrictions are based on operators' day ahead and intraday load and generation forecasts, derived from market parties' schedules, in relation to maximum grid capacity. As providing good quality input from market parties for DSO load and generation

[20] Imbalance Settlement Period.

forecasts today is insufficiently enforced, this implies that more strict market restrictions may applied then what actually would be required (grid operators stay on the safe side in their grid safety analysis). Also, the potential of dynamic curtailment capabilities (curtailment in shorter timeframes) is today not yet taken into account to a level that it can increase the grid hosting capacity.

8.2.8 Existing network codes might not sufficiently ensure system stability with large scale behaviour of DR technologies/ products

Historically, the stability of the grid was based on the physical behaviour of the assets (power lines, transformers, generators, motors resistors etc.) as well on their inherent self-stabilising behaviour and stochastic distribution of individual events. This was and still is key to ensure that no sudden and large-scale disturbances would take place. Those large-scale and coordinated disturbances pose the highest risk to the security of supply, since the power system capability to absorb or compensate them is very limited. New DR technologies and products underlying IT communication systems are a big potential solution to future problems, but at the same time they introduce one of the biggest risks into our power system, as coordinated large scale (mis) behaviour of small units, will be likely to trigger large scale failures.

Today's existing network codes may not, or not conveniently, address all activities related to DR. Therefore, today's network codes should be assessed to ensure that possible large-scale behaviour of DR technologies are conveniently addressed.

8.3 Recommendations

8.3.1 Increasing LV observability using of smart meter data
(following barrier 8.2.1 and 8.2.2)

EU level (European Commission: clarification on existing privacy regulation, GDPR)
DSOs and TSOs need to have a proper legal basis in place to make use of smart meter data to manage the distribution and transmission grid. Current national implementation of the privacy protection regulation (GDPR) and also future stricter e-Privacy regulation on data collection should not prohibit this.
Although the recently agreed CEP clearly states that smart meter data also enables DSOs to have better visibility of their networks and consequently reduce their operation and maintenance costs [21], currently there are different understandings in EU Member States of how the GDPR should translate to the use of smart meter data for grid operations and planning.

It is recommended that the European Commission (e.g. in cooperation with the European Data Protection Board and relevant market stakeholders) provides, as soon as possible, a common EU interpretation (clarification) on this: for what purposes (use cases), related to legal tasks (under existing regulation) of grid operators and market parties, is the use of smart meter data (individual and/or aggregated) by market participants and grid operators allowed without customer consent.

With respect to the upcoming e-Privacy regulation, it is recommended that the European Commission considers in its clarification for example:

- Collecting and processing data necessary for compliance with a legal obligation is excluded from future e-Privacy regulation (in line with article 6 of the GDPR).

[21] See Recital 52 in the adopted text of the revised Electricity Directive under the CEP.

- The infrastructure used for collecting data from smart meters and other energy assets is excluded from upcoming e-Privacy regulation as this infrastructure is a closed network, connecting a dedicated set of non-publicly available devices.

The text of the upcoming European e-Privacy regulation should reflect the above considerations.

8.3.2 Include the digitalisation perspective on the achieving DSF to become operational and develop a set of recommended reference architectures

(following barrier 8.2.3, 8.2.4 and 8.2.6)

EU level (EU stakeholders/ associations, European Commission: study)

Including the digitalisation perspective on achieving DSF flexibility to become operational, opens a new area of relevant topics which should be subject to further study. At this point in time no additional EU regulation is required, however it is recommended that the European Commission[22] initiates further studies and monitors activities of member states as described below.

It is advised to take the following aspects into account in these EU studies:

- Include the digitalisation perspective on how to achieve DSF in practice. Use of the IoT architectural perspective, as industry is evolving towards building IoT based ecosystems, may be one approach:
    - The customer assets ("things"[23]) to and interoperate with the grid and markets
    - The communications aspect
    - The platform aspects

  Other standard reference architectures may be considered because already deployed, such as the IEC reference architecture (IEC 62357).
- Investigate how the existing grid edge "physical" definition could be supplemented with a well-defined "logical" definition (ICT interface) between customer assets and platforms of market parties and the grid operators: what new ICT interface requirements and operating rules need to be regulatory imposed on interaction stemming from:
    - Customer assets interaction with the grid.
    - The smart grid interaction with the market.
- Investigate how the performance of the overall system (customer assets in interaction with the grid) could be improved (e.g. dynamically optimising PQ set points on customer assets within agreed boundaries). It is recommended to learn from US based use cases on integrating smart assets.[24]

National level (Member States: study)

It is recommended that, at national level, Member States do further studies when necessary and consider how to incentivise the actions (e.g. through license and price control incentive) on the digitalisation perspective of achieving demand side flexibility. It is advised to take the following aspects into account:

- How to stimulate TSO-DSO cooperation and the potential for joint, coordinated or third-party platforms for market interactions on congestion management and balancing, as

[22] Both from a DG Energy and DG Connect perspective
[23] Such as sensors, smart (sub) meters & smart inverters
[24] Source: Electrical Power Research Institute (EPRI)

these platforms also contribute to real time TSO-DSO coordination and data exchange; this avoiding mutual harmful interference between TSO and DSO actions at a system level. CEN-CENELEC could be requested to engage in the process of providing standards for such data exchange.

- How a complex and costly platform landscape of DSOs and TSOs, developed in line with “existing roles and responsibilities” and established at national level, interacting with flexibility providers, directly or via trading platforms supporting different markets, could be avoided. At least a common interface (in case of different platforms) should be developed by the platforms or by intermediary parties to support easy access and level playing field for market parties (including end customers).

- The development of a first set of reference architectures to avoid barriers and provide solutions to several issues mentioned in section 8.2. Such architectures should encompass the TSO-DSO interface and should ensure that risk of stability can be handled by design and should show local and central solutions and their coordination.

- The option whether DSOs and TSOs, or other relevant market parties as appropriate, could facilitate the market via standard platform-based services[25] providing real time data from smart meters and connected customer assets to market parties and grid operators, after explicit customer consent, in line with the GDPR; data related to grid and system management could also be part of these platforms. This could help to ensure a market level playing field and to enable market parties to create a positive business case on energy services, as the financial burden of developing and installing gateways (hardware) and (cloud) platform investments could be taken by grid operators, possibly in cooperation with telecom companies.

- The need for (cross-sector) data access regulation, how to achieve reduced customer lock-in and foster competition through implementation choices in an EU defined data access framework (see par.4.3.4), and the need for a robust data infrastructure that is required for operating a regulated, reliable and stable energy system by TSOs and DSOs.

- How a robust, secure embedded communication channel (as part of this robust data infrastructure) between customer assets and platforms could be established that is required for interaction with market parties and grid operators. It need to be analysed how to reduce dependencies and how to mitigate cyber security risks between different critical infrastructures (telecoms and energy), and how to deal with public private cooperation in which grid operators, increasingly depending on commercial service providers, maintain control over their distribution system (addressing costs, reliability and life cycle management of communication technologies). Better understanding of the issues and choices of member states is needed as a first step.

8.3.3 Create a smart meter roadmap
(following barrier 8.2.5 and recommendation 8.3.2)

National level (Member States: study)

It is recommended that EU member states create a smart meter (architectural) roadmap for metering developments after 2020. Smart meters should be able to fulfil future market requirements, (e.g. high-resolution time intervals) while at the same time leveraging realised

[25] E.g. Decentralised Energy Resource Management (DERMS) services.

smart meter investments as long as possible. Although it is today already clear that DSF, communications and security functionalities will certainly develop further, in general, requirements for the next 10 years cannot be foreseen today. Therefore, migration to a modular and flexible architecture for metering and other parts of the AMI value chain, which can be easily integrated in an existing infrastructure, is of crucial importance.

This roadmap should follow from the to be derived reference architecture on the digitalisation of the grid edge (IoT) as addressed in recommendation 8.3.2. It should identify how and with possible external “add- on” technology to the existing generations of smart meters, demand side flexibility and other future requirements could be met. Future metering and related data requirements thereby should at least respect existing network codes.

Where large-scale rollouts are being planned, both for new and to be replaced existing smart meters, responsible parties (NRAs) must ensure future-proof solutions identified, following accurate and adequate CBAs in accordance with EU directive 2009/72/CE as confirmed by the recently adopted CEP.

EU level (European Commission: study)

It is recommended that the European Commission works on basic requirements and principles and continues to promote across member states the importance and benefits of a clear smart meter roadmap within the context of the evolving grid edge interaction and the development of standard based ecosystems. It is recommended that the European Commission analyses member states’ roadmaps (including its opt-outs) as input for possible future EU data access regulation.
“Grid -smart assets” interaction (data exchange on the grid-edge) could be considered as a potential topic for future network code, if the need is assessed.

8.3.4 Improve load and generation forecasting at distribution level (following barrier 8.2.7)

EU level (EU stakeholders/ associations: new or enhanced existing network code)

It is recommended to investigate how the accuracy of forecasting load and generation (wind, PV) at distribution level could be further improved in the day-ahead and intraday timeframes by all market actors and how this legally could be enforced, as this is beneficial for all parties. As part of this, closer coordination between transmission and distribution system operators should also be incentivised, for example to reduce uncertainty and remove the need for a larger ‘buffer’ in the forecast. Improved registration of existing and future customer assets, providing flexibility, should be included in this study, which should start with analysing the SOGL and proposing amendments where this is considered necessary. As forecasting is also relevant for TSOs (balancing), it is also relevant to study the relation and possible synergies between forecasting tools applied by TSOs and DSOs (e.g. on underlying weather predictions).

The result should be that System Operators would achieve better insight through better data input from BRPs in what load levels to expect in defined timeframes on their respective networks (DSO forecasts load and generation on distribution networks and making them available to TSO, following the GLDPM.) In this way, the reliability of the need for market-based flexibility improves, and flexibility could be procured in a timely manner: for grid constraints purposes, or for other market purposes (such as balancing).

Grid operators would be enabled to set the threshold levels in a more precise and dynamic way, allowing market parties to operate their assets (PV wind/ load) more up to these levels (e.g.

including dynamic line rating). This would reduce the need for communicating market restrictions, due to grid constraints.

8.3.5 Existing network codes covering system stability shall be assessed to ensure adequate large-scale behaviour of DR technologies/ products
(following barrier 8.2.8)

EU level (EU stakeholders/ associations: new or enhanced existing network code)

It is assumed that all DR products will be validated against the technical requirements of the network code (DCC). It is recommended to enhance existing network codes to cover for those new types of large-scale simultaneous asset behaviours.

Finally, it is recommended to address in EU network codes the question of system resilience, which will be increasingly dependent on real time communication provided by commercial telecom service providers.

8.3.6 Develop also other options for mitigating grid constraints
(following all barriers)

National level (Member States: study, national codes)

DSF is intended to be used for trade, balancing, congestion management and adequacy mechanisms. Although markets for DSF solutions may be an option, they are not an aim in themselves, but may be a useful tool to manage an efficient energy system, at least cost to consumers.

Alongside this, it is also recommended that member states also develop other options (technical solutions on regulated assets, grid tariff solutions, advanced connections agreements, and rule - based solutions such as curtailment) to mitigate emerging grid constraints. For example, sending signals through network tariffs or access rules may help reduce the amount of actions system operators need to take to manage the system.
This will be relevant in case a market-based solution is not realistic (in case of technical or economical reason) or will come too late (in case market is not yet ready).

9. Privacy and Security

9.1 Description

The use of flexibility required increased sharing of data, both existing data and new types of data. This brings with it a need to ensure there is appropriate privacy and security controls. Elements of this topic have been touched on in previous sections of this document. Duplication has been avoided as far as possible, so the points highlighted in this section focus on the topic from a slightly different angle.

9.2 Barriers

It is clear that in any area, data privacy must be appropriately protected. Private data needs to be protected at source, in transit and at rest, with appropriate arrangements to securely destroy the data in a timely fashion. As part of this, who can have access and their routes of access needs to be defined and specified, as well as what level of granularity they can get.

As a principle, having appropriate data privacy rules in place has broad agreement. However, as noted in chapter 8, there are not always clear views on who should have access to what information – some argue for making information more accessible, while others argue only one party, for example, the TSO should have access, and not disclose details to potential competitors. Consumers also need to have access to their smart meter or other household level data, and give others access to it. In some cases, access to customer data has been identified as a barrier. This data will need to be made available in adequate formats for further use by multiple stakeholders. As above, this needs to appropriately protect data privacy. And consumers need to trust that this will happen. There are a number of questions that do not have clear and consistent answers, such as:

- Who gets access to the data?
- What data is made public?
- Who obtains the permission from the customer to share the data?
- Who has responsibility for that data?

In addition, greater usage of aggregators is expected to facilitate customers' participation in flexibility markets. However, this requires customers to trust that the aggregators' equipment and communications will be secure against cyber security risks, and that the aggregators will appropriately protect any personal data. Where customers do not have this trust, they will not engage in the market.

9.3 Recommendations

9.3.1 Data Privacy

<u>EU level</u>

Systems and markets need information to work efficiently. Further studies should be done to consider and clarify what (and how) information should be made transparent and available in the energy sector. On EU level, it may be useful to map which categories of energy related data fall under the scope of data protection regulations and what this entails, to ensure consistent interpretation across member states.

<u>National level</u>

It is recommended that at a National level, more granular work is done to identify data needs and who can access the data and how (see also 4.3.4). Different market arrangements, for example who collects metering data, mean that the detailed discussions of data access make uniform applicability across the EU of more granular details difficult.

9.3.2 Data security

At a technical level, this subject is being considered in other forums, both at an EU and a National level. It is widely accepted that information must be secured appropriately, e.g. by encryption, and must fulfil all national and EU regulations. For example, the communications between the flexibility provider and TSO/DSO, and any algorithms used in market places, must be reliable and secured.

EU level

Policy makers and regulators must work together across policy areas. EU safety, security and liability policies and regulations should be updated to address new risks arising from the use of digital technologies in the energy sector.

National level

Regulators across sectors should collaborate more in order to address the new complexities that flexible electricity services will bring.

Customers must also have confidence that there is data security to foster trust for anyone who participates in the system. So any party interacting with customers must seek ways of demonstrating that a customer can trust them. This could be through contracts or, for example, or through following an applicable code of conduct, which includes demonstrating that they are following all appropriate privacy and security regulations. When considering market arrangements, for example pre-qualification rules, data security should be considered. However, given the range of markets arrangements across Europe, it is not recommended that a standard application to energy market is pursued, above the existing data security work.

10. General

10.1 Description

There is a lot of interest in flexibility and flexibility markets across Europe. This section looks at how the many trials and small-scale projects can be given more visibility, to make the learning more useful.

10.2 Barriers

If there is not clear visibility of the range of trials available, there will be a high risk that trials are either unnecessarily duplicated or the lessons learnt cannot be applied to make trials and learning from effective and efficient. While there is information logged about trials that have EU funding, it is not always easy to identify similarities without significant effort.

10.3 Recommendations

10.3.1 Improve EU collective learning (following EG3 analysis)

<u>EU level</u>

Analysing 41 use cases of flexibility studies, pilot and platform developments (331 pages) showed that there is a lot happening in Europe. The analysis showed that many of these studies, developments, and pilots face mainly the same issues as addressed in the described barriers.

The European Commission could consider knowledge sharing and periodic analysis of such use cases, including but not limited to research projects.

We recommend the Commission should consider periodically analysing use cases themselves, in a way similar as that done by the EG 3 group. But taking it one step further, with help from and through interaction with the use case contributors, then doing the analysis and disseminating the results, via a report, back to all contributors. We are convinced that through this, EU collective learning could be improved significantly, with acceleration towards the future energy system as a result.

Appendix A: Glossary

Term	Definition	Source
Active System Management (ASM)	Supervise and control power flows and voltage by TSO and DSO, this includes a variety of network planning and access options, adequately designed connection requirements for DG, ancillary services from DER to solve grid constraints.	Based on: Active Distribution System Management (Eurelectric, Feb. 2013)
Aggregator	A service provider that contracts, monitors, aggregates, dispatches and remunerates flexible assets at the customer side.	USEF
Ancillary Service	A service necessary for the operation of a transmission or distribution system. Ancillary services include both balancing services and grid management services	Directive 2009/72/EC
Balancing	All actions and processes on all timelines through which TSOs ensure, in a continuous way maintaining the system frequency within a predefined stability band and comply with the amount of reserves needed per Frequency Containment Process, Frequency Restoration Process and Reserve Replacement Process.	EG3 report on flexibility
Balance Responsible Party (BRP)	A market-related entity or its chosen representative responsible for its imbalances.	EG3 report on flexibility
Balancing Service Provider (BSP)	A market participant providing Balancing Services to a Transmission System Operator.	EG3 report on flexibility
Commercial domain	Part of the electricity system that is deregulated (as a result of market liberalisation), i.e. activities that are performed by commercial parties in a competitive environment (albeit many activities are still subject to specific regulation, e.g. energy supply).	USEF
Congestion management	Regulated mechanism imposing trade and/or dispatch restrictions, possibly non-voluntarily	USEF
Congestion / Grid capacity management service provider (CMSP)	A market participant providing Congestion management or Grid capacity management Services to a Transmission System Operator or Distribution System Operator.	USEF
Demand-side Flexibility (DSF)	Flexibility at the customer side, this includes both flexible load, generation and storage. DSF is “behind-the meter” or “behind- the connection”, meaning that the measurements on connection level typically also include other (flexible or non-flexible) load or generation.	USEF
Distribution System Operator (DSO)	A natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	Directive 2009/72/EC

Explicit Demand-side Flexibility	Committed, dispatchable flexibility that can be traded (similar to generation flexibility) on the different energy markets (wholesale, balancing, system support and reserves markets). This is usually facilitated and managed by an Aggregator that can be an independent service provider or a Supplier. This form of Demand-Side Flexibility is often referred to as “incentive driven” Demand-Side Flexibility.	Explicit and Implicit Demand-Side Flexibility, SEDC (smartEn), Sep. 2016
Flexibility	Ability to purposely deviate from a planned / normal generation or consumption pattern.	USEF
Flexibility platform	IT system that either facilitates or coordinates the trade, dispatch and/or settlement of demand-side flexibility.	USEF
Flexibility Requesting Party (FRP)	Market actor buying flexibility from FSP, i.e. either energy or (ancillary) service, either directly or through exchange / market platform.	USEF
Flexibility Service Provider (FSP)	Market participant offering services using flexible resources. This is either a BSP, BRP, CMSP or any combination of these three roles.	USEF
Frequency Containment Reserves (FCR)	Active power reserves available to contain system frequency after the occurrence of an imbalance	Guideline on electricity transmission system operation
(Electricity) Futures	In finance, a futures contract (more colloquially, futures) is a standardised forward contract, a legal agreement to buy or sell something at a predetermined price at a specified time in the future, between parties not known to each other. The asset transacted is usually a commodity or financial instrument.	Wikipedia
Grid capacity management	Using flexibility as an alternative to grid reinforcement without trade or dispatch restrictions, offered by the end-user and/or aggregator on a voluntary basis	USEF
Grid management	Operating and maintaining the grid, this includes both congestion management and grid capacity management.	USEF
Imbalance Settlement Period (ISP)	the time unit for which balance responsible parties' imbalance is calculated. Normally 15, 30 or 60 minutes’ time intervals.	Electricity balancing guideline
Implicit Demand-side Flexibility	The consumer’s reaction to price signals. Where consumers have the possibility to choose hourly or shorter-term market pricing, reflecting variability on the market and the network, they can adapt their behaviour (through automation or personal choices) to save on energy expenses. This type of Demand-Side Flexibility is often referred to as “price-based” Demand-Side Flexibility.	Explicit and Implicit Demand-Side Flexibility, SEDC (smartEn), Sep. 2016
Independent Aggregation	Situation where a customer has an agreement with an aggregator to dispatch and market (parts of) its flexibility, whereas this aggregator operates without the consent from or a contract with the electricity supplier of the customer.	USEF

Intraday (ID) period	Timeframe of the electricity market after intraday gate opening time and before intraday gate closure time, where for each market time unit, products are traded prior to the delivery of the traded products	Based on CACM Article 2 (37)
Nominated Electricity Market Operator (NEMO)	Entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling	Guideline on capacity allocation and congestion management (CACM)
Ramping rate	Rate of change of active power by a power generating module, demand facility or HVDC system	Guideline on electricity transmission system operation
Regulated domain	Part of the electricity system that is regulated, i.e. activities that are performed by a body with a natural monopoly, typically a TSO or DSO.	USEF
Renewable Energy Sources (RES)	Natural energy resource which replenishes to overcome resource depletion caused by usage and consumption, either through biological reproduction or other naturally recurring processes in a finite amount of time in a human time scale, such as sunlight, wind, rain, tides, waves, and geothermal heat.	Wikipedia
Transfer of Energy (ToE)	Wholesale electricity transaction (financial adjustment mechanism) between the Supplier and the Aggregator, triggered by a Demand Response activation by the Aggregator on the retail side, restoring the energy balance of both the Aggregator and the Supplier (and their BRPs).	USEF
Transmission System Operator (TSO)	A natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	Directive 2009/72/EC

Appendix B: Editorial Team and list of participants of the working group 'Deployment of Demand Side Flexibility'

Editorial Team	
CEDEC	Peter Hermans
CEER	Louise van Rensburg
ENTSO-E	Mathilde Lallemand Gerda De Jong
smartEn	Andres Pinto-Bello
Key contributor assisting the Editorial Team	
USEF	Hans de Heer

List of participants		
EC:		
DG ENER (Chair)	Manuel Sánchez Jiménez Konstantinos Stamatis Kai Tulius	
DG JRC	Nikoleta Andreadou Ioulia Papaioannou	
DG CNECT	Patricia Arsene	
DG JUST	Georgios Kiriazis Lara Blake	
Experts:		
Association	**Expert**	**Alternate**
ANEC	Francesca Carrettoni (ANEC)	
APPLiA	Mustafa Uğuz (ARÇELİK A.Ş.)	Lenka Jancova (APPLiA)
BEUC	Merce Almuni Heidi Ranscombe	Andrea Di Masi Monika Stajnarova
CEDEC	Peter Hermans (Stedin)	-
CEER	Karin Alvehag (Swedish NRA)	Stefan Voegel (Austrian NRA) Louise van Rensburg (OFGEM)
ebIX	Kees Sparreboom (TenneT)	Vlatka Cordes (Westnetz)
ECOS	Rita Tedesco (ECOS)	Tomi Engel (Object Farm)
EDSO	Torsten Knop (Innogy)	-

EHI	Martin Bergemann (Siemens AG)	Paolo Basso (EHI) Geert de Cock (EHI)
ENTSO-E	Hans Vanderbroucke (Elia) Mathilde Lallemand (ENTSO-E) Gerda de Jong (ENTSO-E)	Marco Foresti (ENTSO-E) Benjamin De Boissezon (Rte)
ESMIG	Willem Strabbing (ESMIG)	Patrick Gaiger-Smith (Green Energy Options)
Eurelectric	Alain Taccoen (EDF) Markus Merkel (EWE)	Pierre Braun (Eurelectric)
GEODE	Jan Pedersen (Agder Energi)	-
Orgalime/T&D	Renzo Coccioni (Schneider Electric)	Sigrid Linher (ORGALIME) Laure Duliere (T&D Europe)
smartEn	Frauke Thies (smartEn)	Andrés Pinto-Bello Gómez (smartEn)
Observers:		
EUROGAS	Eva Hennig	
EFET	Daria Nochevnik	
FEBELIEC	Peter Claes	
USEF	Hans de Heer	

ANNEX: Description of Use Cases

The description of use cases that served as a basis for the identification of barriers, can been found in separate document annexed to this report.