Demonstration of **Inte**lligent grid technologies for renewables **Inte**gration and **Inte**ractive consumer participation enabling **Inte**roperable market solutions and **Inte**rconnected stakeholders

WP 7 – CBA, Regulatory Analysis and Business Models

Stakeholder Consultation

D7.6

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Executive Summary

The identification of disruptive business models is one of the core objectives of InteGrid. The successful development and implementation of these business models strongly depend on i) appropriate regulatory conditions, ii) their economic feasibility, and iii) the direct or indirect involvement of several stakeholders. This report addresses the last of these aspects by presenting the methodology, scope and outcomes of a consultation carried out among key institutional stakeholders about their views on the BMs proposed.

The stakeholder selection was based on the mapping exercise that had been previously performed and is presented in D7.5. Accordingly, the list of participants included 31 representatives from industrial consumers, energy regulators, policy-makers, DER owners, TSOs, DSOs, retailers, aggregators, ESCOs and data service providers. The consultation covered experts from four European countries, namely Portugal, Sweden, Slovenia and Spain.

	Business Model								
Stakeholder	**1**	**2**	**3**	**4.1**	**4.2**	**5.1**	**5.2**	**5.3**	**5.4**
Aggregator	B		C	B	B		**D**	**D**	**D**
Consumer/Prosumer	**D**		B		**D**	**D**	**D**		
Data Service Provider	B		**D**	B	B				
DER Owner	**D**		B					C	C
DSO	**D**	**D**	**D**	C	C		A	C	**D**
ESCO			**D**		B				
Industrial Consumer				**D**				C	C
National Data Protection Authority			**D**				C		
Policy Makers			A	A	C				
Regulator	**D**	C	**D**	C	C	C	C	**D**	**D**
Retailer			C		C	**D**	B		
TSO	A		A	C		**D**		**D**	A

Stakeholder mapping	
A Minimum Effort	B Keep Informed
C Keep Satisfied	**D** **Key Players**

The method of consultation consisted in personal interviews, either in person or via web conference. Each interview followed a semi-structured questionnaire adapted to each type of stakeholder so as to focus on the business models (BMs hereafter) more closely related to their expertise. The general structure of the interviews was as follows: first, the Integrid business models were presented; then, informants were asked about their perceived drivers and barriers for each business model, their financial, regulatory or social feasibility and the expected adoption by other stakeholders in the short, medium or long term. Lastly, the stakeholder feedback was analyzed using a qualitative methodology for each stakeholder group. This analysis aims to assess the drivers and barriers for each business model perceived by the different stakeholders.

Additional feedback was collected through the organization of some events throughout the consultation process. In particular, a European workshop was specifically organized for this purpose. The input gathered in these events was used to complement the barriers and drivers identified in the interviews.

The main lessons learnt for each BM are summarized below:

BM1: DSO procuring local flexibility for grid management

DSOs agree that procuring flexibility services will be part of their future. However, they believe that regulation does not provide the certainty DSOs need to change the way they operate their networks. Firstly, the necessary economic incentives to promote the use of flexibility are missing. Secondly, they currently bear the full risk in case flexibility providers fail to provide the service, leading to grid problems and/or

interruptions. Lastly, on the institutional realm, DSOs mentioned that they may face some internal resistance to adopt this business model.

Regulators generally agree that promoting the use of flexibility by DSOs is necessary if DER keep increasing as expected. They mentioned that the current CAPEX-oriented regulation is an important barrier for DSOs, but did not have a clear view of where future regulation should go. The lack of local flexibility mechanisms was also mentioned by interviews as an important barrier. Some participants mentioned public consultations and pilots as a way to overcome this, while one interviewee remarked the importance to coordinate local flexibility procurement with tariff schemes.

TSOs expressed their concerns about the inefficiencies of local mechanisms, especially market-based ones, due to their lack of liquidity. From the grid operation standpoint, TSOs mentioned that congestions in the grid should be the exception, and not the norm. Additionally, they mentioned that forecasting will become more difficult for the TSO, and that TSOs and DSO will have to share the security of supply responsibility.

Other stakeholders also commented on BM1. For instance, one DER owner deemed it difficult to provide the service to the DSO as they have no visibility over where and when flexibility will be needed, and the absence of clear pricing schemes. One policy maker mentioned that incentives are missing for both the DSO and the consumers. Retailers and ESCOs stated that additional hardware and communication would be necessary from their side. Likewise, they were concerned about the lack of harmonization across Europe, jeopardizing the scalability potential of their tools and operations, something essential in their business, according to respondents.

BM2: DSO improving fault location and asset maintenance

This is mostly an improvement of the internal DSO operations, with little interaction with external stakeholders. Therefore, most feedback was provided by DSOs alone.

In general, DSOs recognize that improving maintenance procedures and fault location can be beneficial. Nevertheless, there is not a clear consensus on how this should be technically done. On predictive maintenance specifically, some DSOs do not see the need for additional hardware in their networks as the necessary data would be already available; it is the appropriate algorithms able to cope with “big data” that would be necessary. Additionally, one participant said that, if extended to the LV grid, these solutions could be excessively expensive.

Concerning regulation, participants identified some important barriers. Firstly, they mention that even if they want to adopt predictive maintenance, regulation may still require them to perform time-based maintenance. Additionally, some regulatory frameworks fail to encourage DSOs to extend the life of assets. One participant concluded that due to the risk aversion of regulators, caused by information asymmetries, they are reluctant to allow for changes in asset maintenance practices.

Finally, they also highlighted the organizational aspects of implementing this business model. On the positive side, one participant mentioned that predictive maintenance can be beneficial in the coming years, when the older generation of engineers, used to operate based on experience, will be replaced by a younger generation, more used to data-driven processes.

BM3: Data services and platforms

This could be considered the most innovative BM identified and, therefore, received many comments from different stakeholders, including DSOs, industrial consumers, policy makers, retailers/ESCOs, aggregators, regulators, and a possible data service provider (DSP).

Whilst they all agree that data platforms will necessarily develop and some stakeholders believe this will be useful, some stakeholders are sceptical of the value data platforms will create. The most relevant barrier, on which there is a general consensus, is the difficulties in accessing the data as required to provide data-driven energy services. The first reason may be the refusal or lack of interest of many end consumers to share their data. This can lead to a vicious circle in which consumers are not offered value due to the limited access to data, and consumers do not accept to sharing the data due to the low perceived value. In this regard, the DSP believed that some early consumers who allow for their data to be used will benefit as this will progressively lead to a change in their behaviour. Another reason, which draws a very high level of consensus across stakeholders, is that data protection regulation seriously limits innovative data service opportunities.

Besides the data access problem, two other important aspects were raised by interviewees. Firstly, a potential DSP mentioned that data access and procedures are not expected to be harmonized in the EU. That means that DSP will have to create different solutions in different countries, which constitutes as major barriers, considering that data service provision will be a low-margin business and will need to be scalable.

Another risk for BM3 identified by one stakeholder is that IT companies are already gathering electricity-related data (or inferring this data) outside the metering infrastructure. That means that these companies will soon be able to offer very similar services in a much more dynamic business model.

BM4: Consumers reducing electricity bill and providing flexibility

The BM4 was mostly discussed with industrial consumers and the residential consumers' association, as they are the main actors in this business model. Nevertheless, DER owners, policy makers, retailers and ESCOs, aggregators, regulators and TSOs, also provided their viewpoints.

From the industrial consumer's standpoint, the interviews showed mixed opinions on the interest and possibilities for this BM. Some industries, usually the large and energy-intensive ones, are already very advanced in terms of internal energy management, whereas smaller and less energy-intensive industries are less concerned about optimizing energy usage (low benefits, or lack of resources to do so). These industries also see energy services with some scepticism. High fixed regulated costs are also mentioned as a reason for the lack of interest in this BM.

On the provision of services to grid operators, the industrial consumers also see different barriers. Some interviewees said they would participate in service markets, and some already do it (e.g. in tertiary reserve). However, others mentioned that they would not participate, as this would imply them changing their production schedules for a small benefit. Additionally, some industrials mentioned that they could not change their consumption to comply with balancing products requirements (traditionally tailored to centralized generators).

The residential consumer's association that participated in this stakeholder consultation mentioned three main barriers, especially about flexibility provision: i) low price elasticity of consumers, ii) difficulty in

understanding electricity markets, and iii) general mistrust in electricity companies. Therefore, consumers would be less willing to give away the control of their consumption for a reduced economic benefit.

Other stakeholders also expressed their opinions and concerns. DG owners, for instance, highlighted that energy and service markets (e.g. balancing) are not completely open yet for DR participation. It was also mentioned the need for enhanced infrastructure (communication) for these services to be provided. Aggregators mentioned that individual consumers are less aware or motivated regarding new possibilities, but that it could be more attractive for community users. However, the aggregator sees regulatory uncertainty over energy communities as a barrier.

Regulators also commented extensively on BM4, particularly on the need to re-design electricity tariffs to promote an efficient behaviour from end-users. Interviewees recognized that current tariff structures do not promote flexibility, but several mentioned different barriers, such as the lack of sufficient historical metering data to support tariff design changes due to the recent smart metering deployment, fear of causing unintended consequences or complaints from end-users, or even the reluctance from some incumbents or policy-makers to these changes. Additionally, regulators identified aspects already mentioned before, such as the low interest from the consumer's side to adopt advanced tariff schemes due to the small benefit perceived.

Finally, TSOs also expressed their expectations and concerns. They recognize that DR participation will be very beneficial to overall efficiency. However, they expressed the possible internal resistance in TSOs due to doubts about the ability of DR to participate in complex and sensitive services for the system, such as fast balancing services (e.g. aFRR, FCR). Technical requirements about observability, prequalification and product definition are identified as barriers too.

BM5: Flexibility provision through aggregation

The BM5 was mostly discussed with aggregators and retailers, the main actors for this business models, as well as regulators and TSOs.

Retailers showed different opinions regarding the concept of using their customer's flexibility to reduce imbalances. While some retailers confirmed that it could be something interesting in the future, others mentioned that other types of position adjustment (e.g. trading in the intraday market) will be always more efficient. Retailers also showed concern on how the independent aggregator and the supplier are going to interact with each other and other agents.

The independent aggregator interviewed acknowledges that service provision to DSOs and TSOs will be a viable business in the future, but not in the short term. He mentions the wide variation of national market rules and designs as an important barrier, as aggregators are limited in replicating their tools. With that regard, lack of standardization of market access interfaces is also a problem. Finally, he mentions the need for real-time data for certain services (e.g. balancing).

Regulators see different barriers for the cVPP and the tVPP concepts. Regarding the former, they mention that balancing products are still not completely adequate for DR participation. Also, that the framework for independent aggregators is underdeveloped, and that revenues from balancing markets may be limited. Regarding the tVPP, the barriers identified by regulators are similar to the ones for BM1. Firstly, the revenue regulation for DSOs is still CAPEX-based, and, secondly, local flexibility mechanisms are not in place yet, limiting the amount of flexibility that DSOs are willing/can procure.

The TSOs also mentioned the lack of role definitions for VPPs, BRPs and BSPs as a barrier. Also, they mention that VPPs may make the forecasting process more difficult, especially if these VPPs are large and resources are scattered across different regions.

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Abbreviations and Acronyms

aFRR	Automatic Frequency Restoration Reserve
AMI	Advanced Metering Infrastructure
AS	Ancillary Services
BM	Business Model
BRP	Balancing Responsibility Party
BSP	Balancing Service Provider
CAPEX	Capital Expenditures
CBA	Cost-Benefit Analysis
CDS	Closed Distribution System
CEC	Citizen Energy Communities
cVPP	Commercial Virtual Power Plant
DER	Distributed Energy Resource
DG	Distributed Generation
DoA	Description of Action
DSO	Distribution System Operator
EPEX	European Power Exchange
ESCO	Energy Services Company
GDPR	General Data Protection Regulation
Gm-hub	Grid-market hub
HEMS	Home Energy Management System
HLUC	High-Level Use Case
LV	Low Voltage
mFRR	Manual Frequency Restoration Reserves
MV	Medium Voltage
NRA	National Regulatory Agency
Q&A	Questions and Answers
TSO	Transmission System Operator
tVPP	Technical Virtual Power Plant
VPP	Virtual Power Plant
WP	Work Package

1. Introduction: goals and scope

1.1. The InteGrid project

The way electricity is produced and consumed is changing fast. Consumers are being empowered with more data, enabling better management of their own consumption, and more possibilities to participate in electricity markets. The concept of the producer is also changing. Now it includes not only the traditional large-scale power plants, but also the small generators connected to the distribution grid, storage, and Virtual Power Plants (VPP), through the aggregation of several users at the distribution level.

The creation of these new types of agents and the growing number of Distributed Energy Resources (DER) comes with the need for properly integrating them, both technically and from a regulatory perspective. They have the potential to contribute to the system with services that will enhance its performance and reliability, and potentially reduce operation costs.

A growing number of academic studies and research projects have been dedicated to the integration of a larger share of DER in power systems. Moreover, several pilot projects have been carried out by different DSOs in order to test the technical and economic viability of such integration. One challenge to be explored yet, however, is how the new agents and technologies can be integrated considering the roles of different stakeholders, and their expectation, while enabling new business models given the current and future regulatory environments.

InteGrid's vision is to bridge the gap between citizens and technology/solution providers such as utilities, aggregators, manufacturers and all other agents providing energy services, hence expanding from DSOs distribution and access services to active market facilitation and system optimization services, while ensuring sustainability, security and quality of supply. The main objectives of the project are:

1. To demonstrate how DSOs may enable the different stakeholders to participate in the energy market actively and to develop and implement new business models, making use of new data management and consumer involvement approaches.
2. To demonstrate scalable and replicable solutions in an integrated environment that enable DSOs to plan and operate the network with a high share of DER in a stable, secure and economic way, using flexibility inherently offered by specific technologies and by interaction with different stakeholders.

In order achieve the objectives mentioned above, the InteGrid project has carried out three different demonstrations in Europe (Portugal, Slovenia and Sweden) to enable the various stakeholders to develop new business models as well as to bring new technologies to the market.

Along with the physical demos, research will be conducted on the several topics surrounding the demonstrations and associated use cases. One of these topics is the analysis of the business models (BMs) that are enabled by the InteGrid solutions. These business models usually require the direct or indirect involvement of several stakeholders that should enable, support or implement them. Thus, this report presents the work carried out to identify these key stakeholders and to collect their perspectives and views on the potential business models that may arise from these innovative technologies and functionalities.

1.2. WP7 and the stakeholder consultation

The overall objectives of WP7 are to understand the potential business models enabled by the InteGrid solutions, carry a cost-benefit analysis of these solutions, and research the regulatory layer underlying their implementation in a set of focus countries.

Since the identification of disruptive business models is one of the core objectives of the InteGrid project, WP7 was structured having the BMs at the centre of the discussion as shown in Figure 1. The successful development and implementation of these business models strongly depend on i) appropriate regulatory conditions, ii) their economic feasibility, and iii) the direct or indirect involvement of several stakeholders. Therefore, the work in this WP includes, besides a characterization of the BMs (D7.5), a regulatory analysis and recommendations (D7.2), a cost-benefit analysis (CBA) (D7.4) and a consultation among key stakeholders about their views on the BMs proposed.

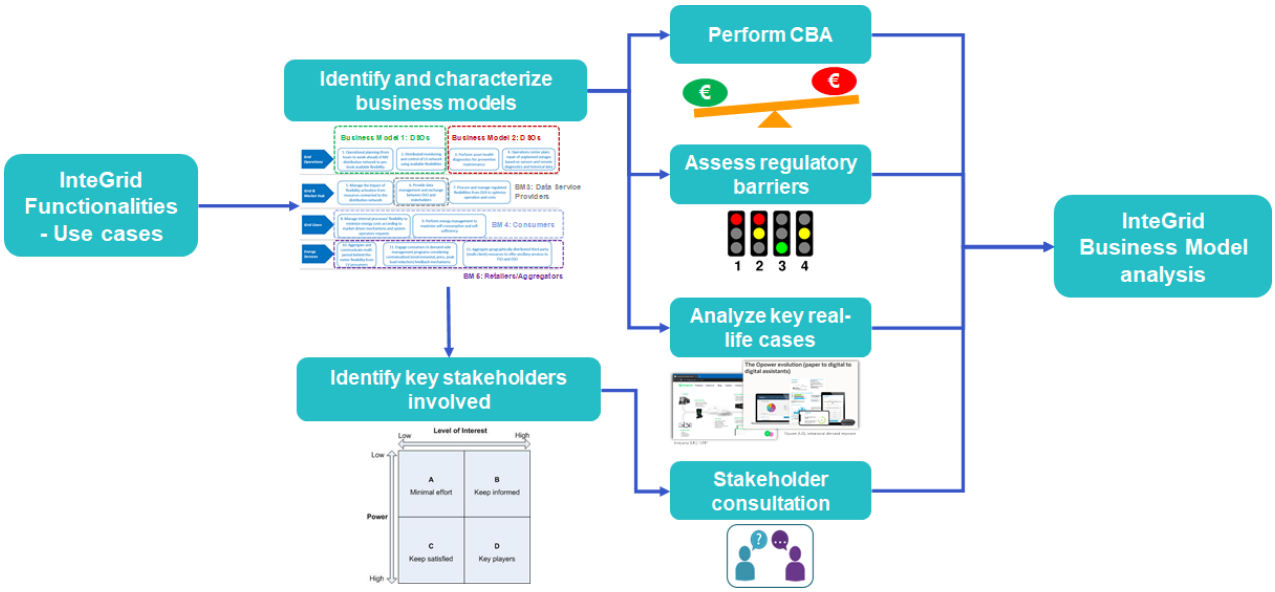


Figure 1: Flowchart of the business model analysis in Integrid

The latter is precisely the scope of this deliverable D7.6. The methodology followed to carry out this stakeholder consultation is based on the work presented in the deliverable D1.4 (WP1). The countries considered for this stakeholder consultation are the target countries considered in other WP7 activities, namely Portugal, Sweden, Slovenia and Spain[1].

[1] Since no demo was implemented in Spain within the scope of the project, the consultation in this country only covered institutional stakeholders. Austria was added to this list of target countries in the scope of the regulatory analysis. The CBA only covers those countries where a demo was implemented, i.e. Portugal, Slovenia, and Sweden.

1.3. The business models in InteGrid

In this WP, a business model is understood as a set of strategies chosen by a certain agent in order to generate economic benefits, i.e. additional revenues and/or cost reductions. These business strategies can combine multiple instruments, and several sources of economic benefits.

The instruments necessary to implement a business strategy vary and may include the provision of services, the selling of a product, adopting a new technology or the implementation of a new internal process. These business strategies are then combined into an actionable framework, meaning that the main agent has a common final goal for all business strategies.

Following the above-mentioned definition, a set of BMs have been identified based on a classification of the project's HLUCs. For each business model, a set of parameters has been identified, namely main actor, involved actors (partners, custumers, etc.), economic benefits for the main actor cost structure, etc. Figure 2 presents the five business models identified in InteGrid. Note that within these five BM categories, additional subcategorizations have been made as discussed below.

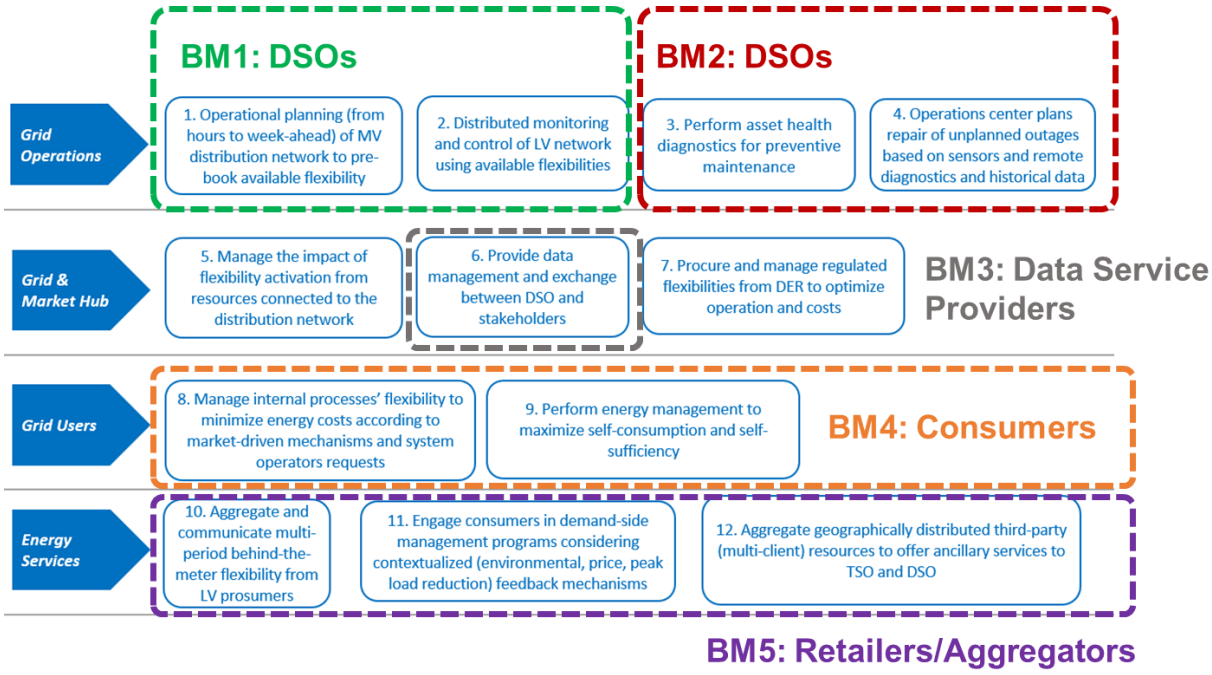


Figure 2: Business models mapping to HLUCs

Below, the main features of the five BMs are briefly described:

BM1 – DSO procures flexibility: The DSO is the main agent. In this business model, the DSO generates economic benefit by procuring flexibility from resources connected at the distribution level. By doing so, costs for the DSO are expected to be reduced and investments for network reinforcement deferred.

BM2 - DSO improves quality of service. The DSO is the main agent. The economic benefit is generated for the DSO in the form of cost reduction by reducing interruptions through improved fault location and improving asset management. The increase in quality of service may lead the DSO to higher incomes,

depending on how regulation incentivizes it, and the improved asset management may reduce overall maintenance cost.

BM3 – Data Services: In this BM, the Data Service Provider is the main actor. This BM encompasses businesses enabled by the implementation of the grid and market hub (gm-hub). Two sub-business models have been identified. On the one hand, data service providers will be able to exploit the data in gm-hub for the benefit of consumers, DSOs, TSOs, and aggregators. These agents may pay Data Service Providers for providing analyses that may decrease the energy bill (in the case of consumers), reduce costs (in case of system operators), or increase revenues (for aggregators). On the other hand, the operator/owner of the gm-hub operator may benefit from providing access to this platform; several different revenue models may be found for these services.

BM4 – Consumer reduces electricity bill: The consumer is the main agent of this BM. The economic benefit to be generated in this BM is the reduction of the electricity bill for the final consumers through load automation. Two sub-business models are identified, one for industrial consumers (BM4.1) and another for residential ones (BM4.2).

BM5 – Creating value through aggregation: In this business model, the Retailers/Aggregators are the main agents. They will be able to create value for end-users by reducing the electricity bill through aggregation and fostering the use of demand flexibility. This BM is divided into four sub-business models. The first one (BM5.1), centered in the retailer (or the BRP) that uses flexibility of commercial buildings to provide balancing services[2]. In the second business model (BM5.2), a platform will foster demand-side management by the residential consumers through tips and gamification (behavioural demand response). The third business model (BM5.3), in which the aggregator is the main actor, explores the idea of aggregation through the Commercial VPP concept (cVPP) profiting from providing ancillary services to the TSO. In the fourth business model (BM5.4), the aggregator explores the Technical VPP concept (tVPP), in which local services are provided to the DSO by the aggregated flexibility.

1.4. Document Structure

The remainder of this document is organized as follows. First, section 2 presents the overall stakeholder consultation methodology that has been followed. Secondly, section 3 summarizes the key results of the pre-intervention consultation carried out by the demo leaders following the guidelines provided by Task 1.4. Next, section 4 addresses the consultation performed whilst the demos were being set-up and running (during intervention), with a focus on institutional stakeholders. Finally, section 5 concludes.

[2] Alternatively, retailers may use the flexibility within their portfolio to minimize their own imbalance.

2. Stakeholder consultation methodology

The general methodological approach, or stakeholder consultation toolkit, to perform the stakeholder consultation was developed in Task 1.4 and presented in D1.4. This section summarizes the steps and methods identified therein and details how this toolkit has been applied within the project.

The design of the consultation comprises several steps including: deciding **who** should be consulted, **what** the contents of this consultation should be, **when** they should be consulted, and **how** they should be involved. The following subsections provides an overview of the answers to each one of the previous four questions.

2.1. Identification and mapping of the key stakeholders

The first step in the process of design and implementation of stakeholder consultation is deciding who should be consulted. Due to the number and the diversity of InteGrid BMs, the range of stakeholders potentially involved or affected in any way is wide. Therefore, this identification needs to be accompanied by an assessment of the relevance that each of them has for the BMs, so that key stakeholders may be prioritized.

In order to facilitate decision-making, a visual approach for this characterization was applied. More specifically, the "power/attention" matrix methodology, detailed in Deliverable 1.4 was used. Box 1 shown below presents a description of this tool.

Box 1: Stakeholder classification matrix (from Deliverable 1.4, page 26)

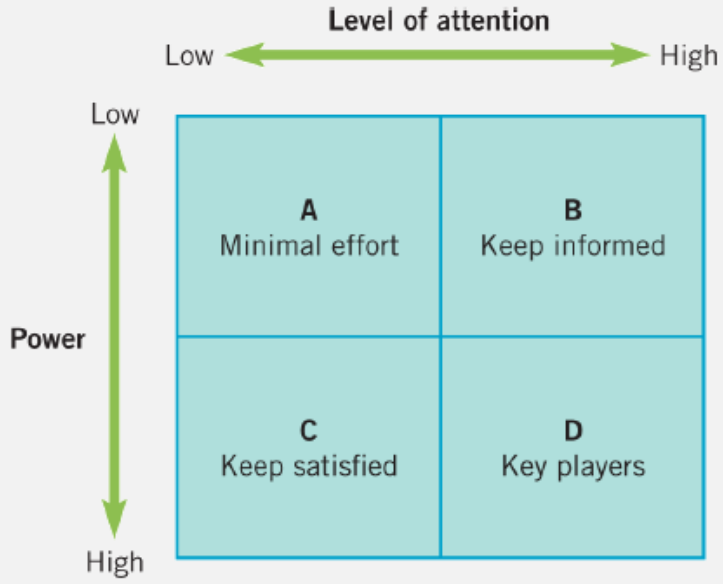


Figure 3: Stakeholder mapping: the power/attention matrix. Adapted from Newcombe (2003).

Figure 3 depicts the power-attention matrix, which visualises a categorisation of stakeholders according to their respective power and level of attention. Depending on the category, this model proposes different avenues to deal with these stakeholders. Stakeholders with little interest in energy activities and little power to influence strategies, policy or business models (Zone A) will require minimal effort on the consultation process.

Those stakeholders in Zone B with a high level of interest in the energy activities but little power to influence them will need to be kept fully informed of the potential actions, so good communication with this type of stakeholder is essential, although their participation in the consultation process prior to the implementation of the BM is not deemed key.

Stakeholders in the remaining two zones C and D represent different but equally important stakeholders. Clearly the acceptability of decisions by key players in Zone D is a major consideration when formulating a strategy, a policy or an action, but often it is the stakeholders in Zone C that are the most difficult to manage. Their level of interest in the actions will remain low as long as they feel satisfied with the policies adopted. However, if they become dissatisfied, they can easily increase their interest and, because of their powerful position, move to Zone D, thus becoming key players.

The stakeholders in Zones A and B need to be informed. Although lacking power (at least formally), they may have disproportionate influence on the more powerful stakeholders. Stakeholders as media, users through social networks, or representatives of the community can exert this kind of indirect influence.

The aforementioned power-attention matrix framework was applied to each BM individually, as presented in D7.5. The stakeholder categories that were considered and included in the matrix comprise the following:

- End-users: this group includes residential, commercial and industrial consumers (or their representatives such as consumer associations), as well as DER operators (mostly DG owners).
- Grid/system operators: this category comprises transmission and distribution companies, as well as independent system operators (ISOs) in case applicable. Additionally, operators of closed distribution systems (CDS) or citizen energy communities (CEC), when acting as grid operators, may be included in this group.
- Authorities: this category covers all the institutions in charge of designing and implementing different types of policy or regulation relevant to the BMs. Thus, it includes NRAs, competition authorities, policy-makers (at national, regional or local level), and data protection authorities.
- Retail and energy services: this term encompasses all those companies who provide any sort of energy-related services to end users or have any other type of commercial relationship with them, such as ESCOs, retailers, aggregators or data service providers.
- Other: this category intends to capture any other type of stakeholder that does not fit within the previous ones (e.g. equipment manufacturer, software developer, ICT companies, etc.).

Figure 4 presents an overview of the application of the stakeholder matrix to the BMs described above. This table clearly shows that the main stakeholders involved in the InteGrid BMs are the DSOs and end consumers, as well as regulators who still need to enable or facilitate the conditions required for most of

these BMs to materialize. Nonetheless, this does not mean that the central role of other stakeholders such as retailers/aggregators or TSOs may have on specific BMs.

	Business Model								
Stakeholder	**1**	**2**	**3**	**4.1**	**4.2**	**5.1**	**5.2**	**5.3**	**5.4**
Aggregator	B		C	B	B		**D**	**D**	**D**
Consumer/Prosumer	**D**		B		**D**	**D**	**D**		
Data Service Provider	B		**D**	B	B				
DER Owner	**D**		B					C	C
DSO	**D**	**D**	**D**	C	C		A	C	**D**
ESCO			**D**		B				
Industrial Consumer				**D**				C	C
National Data Protection Authority			**D**				C		
Policy Makers			A	A	C				
Regulator	**D**	C	**D**	C	C	C	C	**D**	**D**
Retailer			C		C	**D**	B		
TSO	A		A	C		**D**		**D**	A

Stakeholder mapping	
A Minimum Effort	B Keep Informed
C Keep Satisfied	**D** **Key Players**

Figure 4: Identification of key stakeholders through the power/attention matrix

Additionally, the previous stakeholders were categorized into residential/commercial consumers and institutional stakeholders (i.e. any other type of stakeholder, typically a company or other type of organization). The reason for this differentiation is that, as opposed to organization stakeholders who are normally driven by economic or regulatory conditions, the drivers of residential consumers, and to a certain extent commercial consumers, are usually affected significantly by behavioural aspects and information asymmetries. Hence, specific contents and methods of consultation are deemed necessary. This categorization was then used to target different stakeholder groups throughout the different consultation stages described in subsection 2.3.

Lastly, specific individuals within each stakeholder category were identified to be interviewed. In the case of residential/commercial consumers, individuals were selected among those involved in the actual demonstrations whereas (outside the scope of this report), in the case of institutional stakeholders, the relevant institutions and individuals within these institutions were identified by demo leaders for Portugal, Slovenia and Sweden respectively, and by Comillas for Spain.

2.2. Contents of the consultation

The second step of the preparation involves defining the contents of the consultation. This firstly requires reflecting upon the role of each stakeholders in the process of adopting and implementing the innovative technologies or solutions. Some of them would be customers of a given product or service (e.g. end users), others would be suppliers of these products or services (e.g. retailers or ESCOs), whereas others would simply act as enablers or moderators (e.g. policy-makers or regulators). Thus, their "stakes" and motivations may be different.

Within Task1.4, a high-level literature review was carried out to identify what contents are suited to different types of stakeholders. Nonetheless, given the differential features of the power sector[3], these general guidelines had to be adapted for the purposes of this consultation. Broadly speaking, the contents of the consultation could be summarized as follows:

[3] Electricity markets are usually considered highly complex due to the impact that technical characteristics of electricity (non-storability, network effects) have on the market functioning. The fact that electricity is considered as an essential service, and, largely due to the previous items, how highly regulated the power sector is.

- End-users: degree of knowledge about the energy services; drivers for the adoption of new services or products (economic, environmental, peer acceptance); willingness to adopt the innovation, main barriers for this adoption and possible enablers.
- Grid/system operators: advantages and disadvantages in terms of operation, value provided, costs and benefits (for the company or the system as a whole); regulatory barriers and missing elements in current regulation; data requirements and limitations.
- Authorities: added value to the system and end consumers; impact on industrial competitiveness and competition; regulatory and policy priorities; expected risks.
- Retail and energy services: potential of each BM for your company; main customers for your product/services; type of barriers to the materialization of the BMs (technological, regulatory, economic, end-user acceptance); market maturity and expected time to market.

More details about the contents of the consultation on residential/commercial consumers are provided in section 3 (pre-intervention consultation) and the corresponding demo reports (D3.6, D4.4 and D5.4) on the post-intervention consultation, whilst further information about the contents of the consultation to institutional stakeholders may be found in section 4.

2.3. Stages of the consultation strategy

The goals of a stakeholder consultation can vary depending on when the consultation is carried out. Broadly speaking, three main stages may be identified, i.e. before, during and after the implementation of the solutions. In this case, these three stages were covered in Integrid by adapting the stakeholder groups targeted, the consultation methods and the contents to each one of them. An overview of the goals and scope of the rounds of consultation carried out in InteGrid is depicted in Figure 5.

When focused on the end users directly involved in the demonstration, the consultation should usually take place both before and after the implementation. The pre-consultation aims to explore the views of end-users before the demonstration activities in order to identify potential drawbacks in the design or unexpected barriers that may jeopardize the success of the demo. Additionally, this stage may also allow the identification of any support or information stakeholders may need to understand and participate actively in the demonstration, overcoming potential reluctance from their side.

On the other hand, consulting the same end users after the implementation allows the evaluation of the results and lessons learnt required to ensure replicability. This stage focuses on identifying the drivers and barriers for users' engagement as well as additional means that may improve consumer engagement and participation, and direct involvement of other stakeholders.

Overall, this kind of consultation provides a channel to ensure that all agents with a stake in the project have a say at the initial stages and facilitates reaching agreements among stakeholders with different goals and preferences. Moreover, it may help create a sense of ownership that contributes to enhanced involvement during the demo, especially when an active demand participation and acceptance of citizens is necessary.

Nonetheless, the upscaling and replication of the project's BMs will require the involvement of additional stakeholders beyond the scope of the demonstrations. Therefore, the scope of the stakeholder consultation

has been broadened in order to capture the views of a wider range of stakeholders both in the demo countries, and in an additional country like Spain. Thus, key institutional stakeholder from the four countries have been addressed whilst the demonstrations were being set-up and running. Therefore, this during-interventional consultation aimed to assess the views of the categories of institutional stakeholders mentioned above about the barriers, risks and value of the BMs so that adjustments could be made accordingly in case needed.

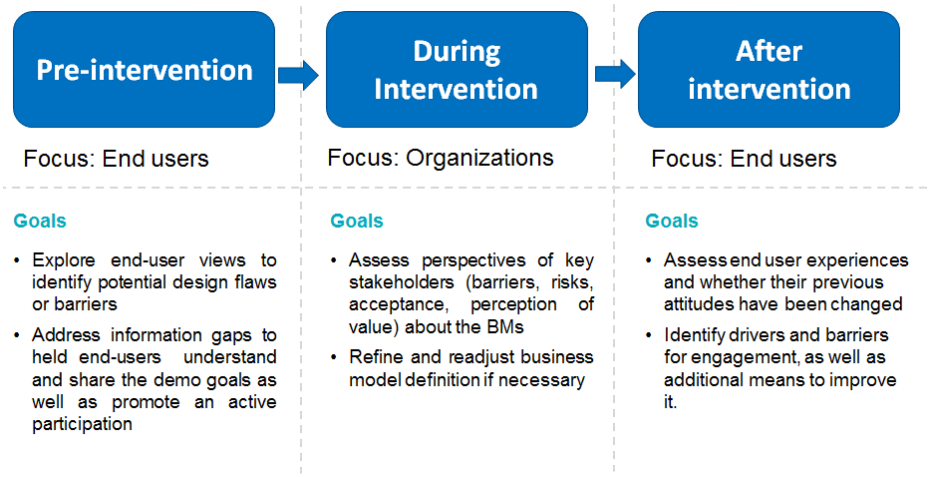


Figure 5: Stages of the stakeholder consultation and corresponding goals

The work of WP7 presented in this report focuses specifically on the intermediate step, i.e. the during intervention consultation, whereas the demo leaders (WP3-WP5) focus their consultation activities on the stakeholders directly involved in the demonstrations. For the sake of completeness, the report will include a summary of the main outcomes of the pre-consultation carried out by the demos to the extent that they are relevant to the BM definition. The reader is referred to the deliverables of the demonstration WPs for further information about the post-intervention consultation.

2.4. Methods of consultation

Stakeholder consultations may follow a wide variety of methods, as described in D1.4. On the one hand, on-line surveys or web-based engagement (forums, blogs, social media, etc.) allow reaching a high number of individuals at a low cost. However, the lack of close direct interaction usually yields low response rates and provide information that is more limited. On the other hand, personal interviews, focus groups or workshops may be used to gather deeper information and even obtain feedback that may be provided in other forms of consultation due to desirability bias. Furthermore, in the context of stakeholder workshops, several techniques can be used to stimulate discussion, e.g. photography, images, maps, etc.

In this case, the quality and depth of the feedback provided was prioritized over reaching a very high number of respondents. Therefore, methods relying on a close direct interaction were selected for the consultation. In the case of the end-users in the demo areas addressed in the pre-intervention and post interventions stages, workshops, personal interviews and focus groups were all used for different types of consumers. Alternatively, in the case of organizational stakeholders targeted in the during-intervention consultation, personal interviews were carried out. Further details are provided in the following sections.

3. Pre-intervention consultation

This section presents some of the key takeaways of the local stakeholder consultation workshops carried out at the beginning of the project by the three demonstrators, whose methodologies, participants and results are presented in D1.4[4]. The consultation activities performed in Sweden and Portugal focused on residential consumers, whereas in Slovenia, the activities addressed the employees working in two office buildings of Elektro Ljubljana.

3.1. Consultation among residential consumers in Sweden and Portugal

The stakeholder consultation carried out in Portugal and Sweden addressed residential consumers. Therefore, its results are mostly relevant to BM4.2 and BM5.2. Firstly, two workshops were organized in Stockholm and Lisbon with residential consumers in the demo areas. The main topics of the consultation were the views about community storage (only in Sweden) and the consumption feedback received by these users through LocalLife.

Firstly, a visual prototype of the energy feedback interface was tested in focus groups. The aim was to assess whether participants properly understood the feedback received about their household energy use and how it could drive behavioural changes, i.e. energy conservation and load-shifting. Moreover, different levels of aggregation in the information provided were tested in the Swedish workshop. The aggregation levels considered were apartment level, housing cooperation or building level, and neighbourhood level.

The results showed that participants generally preferred being presented with colours and bars rather than percentages. The specific energy tips to achieve the energy goals set were generally well received. Nonetheless, in Portugal, participants also expressed their interest in knowing the economic savings obtained by achieving the energy goals. The viewpoints concerning performance comparisons with other households or neighbourhoods were different among the participants, i.e. the competitive element appealed to some but not to others.

As mentioned above, the Swedish workshop additionally evaluated the effectiveness of different feedback aggregation levels. The results suggested that information at apartment level may be the most relevant to encourage people to take action. It also makes their contribution directly visible in the feedback they receive. Building or neighbourhood level feedback was encouraged by the participants as it adds more to the social sustainability by uniting people towards a common goal. However, based on the baseline survey results, further research is required to determine whether social identity can be used to strengthen engagement.

Regarding end-user attitudes towards energy storage business models, the workshops showed that while in Portugal the majority of participants favoured having their own individual battery in their apartments, in Sweden nearly all participants favoured a community battery. This provides insights into how behavioural

[4] This report is publicly available at: https://integrid-h2020.eu/uploads/public_deliverables/D1.4%20Consumers%20engagement%20strategies.pdf

aspects can affect the definition of successful business models. In this case, results are related to preferences for shared versus individual solutions in the two countries: Swedish participants favoured a shared option, whereas Portuguese participants perceived this rather as a risk. The main risk that was raised consisted in running out of energy due to the high demand of neighbours. This was also mentioned by some Swedish participants, but played an overall smaller role in the decision process. A reason for this might be that sharing concepts in housing, such as shared laundry rooms, are more common in Sweden and people are used to this type of solutions. A compromise of this conflict that was named in both workshops is a "limited sharing", e.g. with the possibility to reserve a certain amount of energy for each user.

On the other hand, some similarities were found in both countries concerning the management and ownership model for the battery systems. In both cases, end users were interested in managing their own storage system through an app rather than leaving the control to their supplier or ESCO. Nonetheless, in the case of Sweden, it was also found that end-users expected the system to be mostly automatic and require a limited active participation from their part. Concerning the ownership model, most participants showed their preference for a leasing/rental model over buying the battery system. The main reasons for this include the lower financial risk, the possibility to outsource some services (e.g. maintenance, and the possibility to replace the system more easily as technology evolves.

Besides the aforementioned workshops, a survey to assess energy attitudes, behaviours, and intentions, as well as social identity and cohesion in their neighbourhoods and buildings was carried out in Lisbon and Stockholm. The results were analyzed through regression analysis in order to build a model to predict the end-user intent to implement energy saving actions based on several influencing factors identified.

The Stockholm survey shows that the participants' energy saving behaviours are mainly influenced by their attitudes and the perceived control they have over energy saving activities. At this point in the project, the residents did not identify strongly with their neighbourhood or buildings, which therefore made the role of social identity inconclusive. Measures of social cohesion reveal room for improvement regarding neighbourhood social bonds and again indicate a need for increased social belonging.

On the other hand, the Lisbon survey did not find an influence of attitudes and perceived control on energy saving behaviour, which might be partly due to the fact that a shorter version of the questionnaire, designed to increase usability, was tested here. Differences between the samples regarding both energy behaviour and the evaluation of social interactions highlight the importance of tailored approaches to engage consumers in different communities with different needs.

3.2. Consultation among workers of office buildings in Slovenia

The Slovenian consultation workshops were conducted with the employees of Elektro Ljubljana working in their offices in Domzale and Ljubljana, i.e. commercial buildings. Hence, the outcomes are mostly relevant to BM5.1. These workshops aimed at evaluating how employees may support enhancing commercial building flexibility. This included raising awareness among employees, characterize existing habits and attitudes related to energy, and identify actions with a high acceptance that may drive beneficial changes.

In these workshops, office workers were asked about actions they could suggest to reduce peak consumption of the building, mostly focusing on reducing the air conditions consumption. However, this workshop also helped identify some concerns such as the fact that air conditioning was controlled centrally and therefore user have no control over it, and the fact that thermal comfort, something that is oftentimes subjective, should not be jeopardized. Additionally, they were asked about other actions related to switching off unnecessary loads that they could implement.

Office employees showed interest in participating in a peak load reduction program. Accordingly, a one-year program was introduced through which both office buildings would compete to reduce peak load the most based on some pre-defined targets. This program focused on smarter management of the air conditioning and on encouraging occupants to switch off unused computers and monitors. This is described in more detail in deliverable D4.1. A key objective of this program, beyond peak load reduction itself, is to motivate employees and create a sense of community.

4. During-intervention consultation

This section constitutes the core of this deliverable. It describes in detail the methodology followed to contact the potential participants and carry out the during-intervention consultation among institutional stakeholders. It also provides a summary of the stakeholders that finally took part in this consultation and presents the analysis and key lessons learnt that were drawn from the stakeholder consultation carried out in WP7.

4.1. Materials and methods used in the stakeholder interviews

As discussed in section 2.4, when selecting the method of consultation in this case, the quality and depth of the feedback provided by institutional stakeholders was deemed more relevant than reaching a very high number of respondents. Consequently, personal individual interviews were chosen for the during-intervention consultation as they allow for a close direct interaction.

A semi-structured questionnaire adapted to each stakeholder group according to the BMs more closely related to their expertise was used to guide the interview. This enabled to ensure a certain homogeneity among interviewees, whilst allowing enough flexibility to adapt to the responses and interests of each of them. An example of such script can be found in Annex I. A common general structure was followed in all cases. First, the Integrid business models were presented by Comillas, clarifying any possible doubts or comments the respondents may have. Then, informants were asked about their perceived drivers and barriers for each business model, their financial, regulatory or social feasibility and the expected adoption by other stakeholders in the short, medium or long term.

Informants were ensured that anonymity will be maintained[5] so that they would feel free to speak their mind. In this regard, it is important to highlight that participants were asked to provide their **personal viewpoints as professionals** in the field of power systems, and not the positions of the organizations they work for. Hence, the results presented in this report **may not be interpreted as the official view of any particular institution**. Participants were asked to provide their consent for recording the interviews exclusively for the purposes of enabling the transcription of the interview and their subsequent analysis. A template of the email sent to potential participants, which was conveniently adapted for each case, is provided in Annex II.

Interviewees were informed of their right to pause, resume or stop the interview at any moment. Most informants provided consent for transcribing the interview (approximately 90%), whereas a few preferred not to have it recorded. In these cases, , the interviewers took written notes of the discussions, asking for additional clarification or confirmation as necessary. Notwithstanding, none of the participants asked to halt the interview or asked for its contents not to be used for the consultation purposes.

[5] Participant names will not be made public without their previous explicit consent. The analysis will be presented in such a way that quotes and opinions cannot be attributed to a specific individual or institution.

Approximately 70% of the interviews were carried out face-to-face, whereas the remaining 30% were performed through web conferencing systems. Interviews were usually conducted by at least two members of the Comillas team who, in the case of some stakeholders from demo countries, were accompanied by local Integrid partners who significantly supported Comillas with any logistic and language issue. Interviews lasted between 30 and 90 minutes and were performed in English, with the exception of Spanish stakeholders who were interviewed in their mother tongue.

Transcripts of the recordings of the interviews were obtained automatically using a commercial software named Sonix[6]. The transcripts provided by the voice recognition software were later reviewed and corrected in order to address possible technical issues and mistakes caused by, among other factors, strong accents, inability of the software to correctly identify technical vocabulary and acronyms, or moments when several people were speaking at the same time.

Lastly, the stakeholder feedback was analyzed using a qualitative methodology for each stakeholder group. This analysis aims to assess the drivers and barriers for each business model perceived by the different stakeholders, trying to identify differences between the countries[7] if relevant. The initial findings were discussed with the whole team and the analysis was refined accordingly. Lastly, the analysis by stakeholder group was combined in order to synthesize the major barriers to the feasibility of each BM as identified by all stakeholders. Thus, the analysis combined a stakeholder, and country focus where applicable, with a business model focus to enrich the results.

4.2. Stakeholders interviewed

In order to select the participants, the different roles that should be included in the consultation, as per the stakeholder matrix shown in section 2.1, were listed. Demo leaders and other local project partners were asked to fill up a form with contact details of stakeholder representatives for each of the different groups identified (i.e., regulators, DSOs, etc.) in the demo countries. Stakeholder contacts in Spain were provided by Comillas. Then, stakeholders were contacted through email in different stages in order to arrange the corresponding meeting. In some cases, local project partners supported this process in ad-hoc trips or pre-organized events (e.g. Ljubljana in June 2019, or Lisbon in March 2019).

Table 1 shows the number of stakeholder representatives that were identified by project partners as potential participants as well as the final number of individuals who actually agreed to do so and eventually participated. Based on the stakeholder mapping previously described and the scope of the consultation, a tentative goal of between 8 and 10 institutional stakeholders per country on average was initially deemed appropriate. It can be seen that this goal has been achieved in Spain and Slovenia, and very close to do so in Portugal and Sweden. The reasons for this slightly lower figures in the latter two countries are i) the fact that a lower number of stakeholder representatives were contacted, and ii) lower response/acceptance rates. Overall, 31 personal interviews were carried out; this amounted to more than 20h of interviews to be analyzed.

[6] https://sonix.ai/

[7] The extent of the country differentiation was limited by confidentiality reasons in some cases, particularly for those stakeholder groups where it is straightforward to identify a specific institutions if its country is known, e.g. regulators or TSOs.

This participation rate was eventually considered adequate as the coverage of all key stakeholder groups in all countries, which was a priority, had been achieved. The only stakeholder group that was not covered in the consultation, are the data protection authorities; however, this stakeholder may have a relevant role in some business models, particularly those related to the use of metering data from residential users. Nonetheless, the participation of this stakeholder is mostly passive unless data protection regulation is violated and they are asked to address a complaint. These institutions have responsibilities over a broad range of sectors and generally do not have a strong relation to the electricity sector. Therefore, this was not considered a major limitation of the consultation.

Stakeholder		Spain		Portugal		Slovenia		Sweden		Total	
		Id.	Int.	Id.	Int.	Id.	Int.	Id.	Int.	Id.	Int.
End Users	Consumer/Prosumer (LV) representatives	3	1	1	1	6	4	2	1	12	**7**
	Industrial Consumer / Associations										
	DER Owner (MV and HV)	-	-	1	1	2	1	-	-	3	**2**
System Operators	DSO	2	2	1	1	5	1	2	2	10	**6**
	TSO	1	1	1	1	1	1	1	1	4	**4**
Authorities	Regulator	4	2	2	1	3	1	3	2	12	**6**
	Policy Makers										
Retail and Energy Services	Retailer	4	2	1	1	7	2	5	1	15	**6**
	Aggregator										
	ESCO										
	Data Service Provider										
Total		14	**8**	7	**6**	24	**10**	13	**7**	56	**31**

Table 1: Overview of stakeholder interviews carried out in each country (Id. → identified, Int. → interviewed)[8]

As mentioned in the previous section, the specific names and affiliation of the respondents are not provided for confidentiality reasons. For some stakeholder groups, it is straightforward to identify an institution if its country is known; hence, the analysis will be presented in such a way that quotes and viewpoints cannot be attributed to a specific individual or institution. Moreover, it is relevant to stress that participants contributed as individuals due to their expertise in the sector and that they did not represent or express the position of their company in any way.

[8] In some cases, several stakeholder categories were grouped in order to ensure respondent confidentiality, whereas in others the reason is because the same company may play several complementary roles (e.g. ESCOs and retailers may sometimes provide similar services to end consumers).

4.3. Analysis and lessons learnt from the interviews

This section presents the results of the qualitative analysis performed for each stakeholder group, identifying the drivers and barriers for each business model. For the sake of clarity, and since some stakeholders may fall under more than one of the twelve categories listed in Table 1, the analysis is presented according to up to 10 different stakeholder groups, These are: DSOs, industrial consumers and their associations, residential consumers associations, DER owners, policy-makers, data service providers, retailers/ESCOs, aggregators, regulators, and TSOs.

These interviews allowed identifying a set of drivers and barriers for the development of the BMs, which we believe provide relevant insights to the work in this WP. However, it is important to highlight that the analysis presented herein does not have statistical representativity since it is based on a limited number of interviews and not a survey over a representative sample.

4.3.1. DSOs

DSOs play a central role in the InteGrid solutions as grid optimizer and market facilitator. More specifically, the InteGrid solutions aim to allow DSOs to perform a more efficient grid operation through flexibility procurement, predictive maintenance and improved fault location. Following the list of BMs presented in section 1.3, the DSO is the main agent in the first two BMs, namely the DSO procuring and using flexibility for MV and LV grid operation (BM1), and the DSO improving quality of service through advanced fault location and predictive maintenance (BM2).

DSOs differ in their assessment of the second business model based on **cost reduction via asset management**, as a result of investments in data infrastructure (additional to the smart meter deployment) in order to carry out predictive maintenance and automatic fault location. Interviewees recognize that data-driven techniques allow for better problem identification which results in an increase in the margin; yet, others share their uncertainties that these data-driven technologies present superior advantages, as the following quote illustrates.

> *No distributor can say if this information is useful. We need pilot studies for this, to demonstrate that this information is actually helpful in identifying problems. The daily operation would actually suggest it is not. Yet, the analysis may show areas of improvement. Anyhow, we need evidence to know what the ROI[9] is.*

Some DSOs recognize that they had to overcome these internal uncertainties with solid data that proves the financial advantages of the model. Others deny that the deployment of a data infrastructure could add value, since the costs associated with this technological infrastructure overweight the potential gains, especially in low voltage. Thus, the financial feasibility of extending data-driven asset maintenance is questioned, with the current regulated costs. Moreover, some DSOs mentioned that a systematic approach based on hardware deployment and data analysis could be beneficial, but that certain optimization is

[9] Return on Investment

already achieved by the tacit knowledge gathered by maintenance crews. A specific DSO mentioned that this transition from tacit knowledge to data-oriented management could be appropriate in the coming years, when he thinks an important numbers of experienced engineers will retire and a younger generation, more used to a data-driven approach and less experienced, will be incorporated.

Others have opted for investments in data analysis only, rather than in data infrastructure (AMI, sensors and communication). They outsourced big data companies that provide specialized services to DSOs to improve asset management. Although their proprietary technologies are costly to acquire, the implementation of this data-driven maintenance prediction has proven more accurate than the traditional model, reaching reductions between 10 and 30% below traditional systems, according to an informant. Demonstrating the financial superiority of this data analysis model served to overcome the internal resistance, which is much mentioned as a barrier to this business model by all interviewees.

Additionally, regulation poses a limit to the development of this business model. DSOs are normatively required to revise selected assets annually, even when data-driven predictive maintenance would suggest that it is not necessary. Similarly, other informants recognize the potential value of this predictive asset maintenance, but current regulation renders it non feasible or crowds out the incentives to implement it: revenues are reduced according to the age of equipment, which provides little incentive to extend the life of the asset. This regulatory framework is currently under change, so that depreciation is prolonged. Until the new system is in place, DSOs have limited incentives to engage in predictive asset maintenance.

Informants recognize that information asymmetries between regulators and DSOs may create inefficiencies so that regulator cannot be sure whether data-driven predictive maintenance is accurate and prefer choosing the risk-free alternative. Informants insist on the risk aversion of regulators which explain why they are resistant to technology-driven innovations and for which there is no standard or demonstrated effectiveness.

There is also resistance to the **flexibility-based business model (BM1)**. DSOs in all countries recognize it is not being implemented and they are not offering non-firm contracts to their customers, or if they are, these non-firm contracts are offered in the context of pilot projects for innovation testing. This business model implies changing the functions traditionally associated to the DSO: the DSO will act as an active system operator and thus, informants reckon, should be rewarded for this function. As regulation does not allow for a compensation for DSOs, they see limited value in this business model for now. This is considered a major barrier: the missing regulatory incentives for DSOs' flexibility procurement. This is a condition expressed by all DSOs: the need for the institutionalization of pricing mechanisms, to reward actors in the market to ensure involvement. As one of the informants said, the regulatory model is based on energy and does not take into account the local capacity. In one country, for instance, they are facing a bottleneck in transmission and simultaneously excess of capacity. But actors have limited incentives to resell the spare capacity due to the low electricity prices.

Even in countries where regulation permits implementation of this business model, technical constraints prevent its full implementation. Current smart meter technology may not enough to ensure communication and interoperability between consumers and DSOs for flexibility management. DSOs remark that there is missing a communication and interoperability platform between providers and users. It is unclear who would pay for these networks/platforms. At the moment, DSOs do not have the responsibility or the incentives to invest in the creation of such platforms. However, informants from one country suggest that

the new generation of smart meters, expected to be deployed by 2025, may be a potential facilitator to manage flexibility in the residential market.

Also, there are concerns about grid management. Since DSOs are enforced to ensure grid capacity, and given the uncertainties around the potential of the flexibility model, DSOs are opting for grid reinforcement. Once these investments are in place, they may act as a further reason not to invest in alternative solutions. Because, as one of the interviewees said:

> *where we do have changes to the regulatory model, it impacts every investment you have done. So it's a red track. I mean, your whole balance sheet will be suddenly you can lose your money. It just disappears for four years now*.

Thus, any regulatory change, especially concerning the current regulated pricing model for DSOs, should take a forward outlook but also take into account the already deployed investments. One the other hand, however, interviewees also expressed concerns regarding the future once DSOs are allowed and incentivized to procure flexibility. One participant mentioned the difficulty in combining flexibility procurement and grid planning decisions. He argues that reinforcement decisions must be taken today, so that the grid is ready for a constraint five years from now. If reinforcements are not made in the expectation that flexibility will be procured, but for reasons outside the control of the DSO, flexibility is not available, security of supply can be compromised. The participant asks himself if in this situation, the DSO will have to bear the regulatory consequences.

Other informants stress the complexities in the construction of such market-based coordination mechanism for flexibility. As they see it, there should be different levels of operations depending on the degree of urgency, similar to the different levels in the reserve markets.

Even though the current regulatory framework does not facilitate the development of this business model, interviewees in different countries report initial conversations and deployment of pilot studies to test this solution. This is largely motivated by the Clean Energy Package that foregrounds flexibility provision as a potential alternative to grid enforcement, and by the need to expand the grid capacity. Yet, this call implies revisiting the role of DSOs and TSOs in ensuring grid firmness, since ensuring transmission is part of the TSOs' role. Yet, the responsibility is unclear as DSOs are also responsible for any shortage. Clarifying the role of TSOs and DSOs in flexibility provision and responsibility over the grid is fundamental to ensure the feasibility of this business model.

Slovenia and Sweden are using CHP agreements as form of flexibility provision; especially in Sweden these CHP schemes are fundamental to address the consumption peaks occurring typically in the afternoons of the coldest months. This policy is part of a larger set of incentives so that users are compensated for reduced energy losses and for energy generation. However other governmental policies (e.g. the strategy for circular economy) are likely to lose the local effect from the CHP plants, according to informants. Thus, they are negotiating other solutions that involve a different role from the DSO in order to secure access.

In Spain, a similar solution currently in operation are the interruptible contracts[10]. Although the DSOs may request the activation, the economic incentives are awarded by the TSO, as the DSOs is not formally entrusted with this role. Yet, stakeholders from these countries cast doubt of the sustainability of DER as a

[10] Traditionally, interruptible contracts for industrial consumers were used as a last-resource mechanisms for security purposes. Nonetheless, a regulatory change enabled the TSO to activate these contracts under "economic reasons", i.e. to reduce system operation costs.

mechanism for feasibility provision, given the decreasing incentives paid to industrial consumers, or the demands for growing capacity to either serve more customers or to provide more capacity to existing consumers.

Some DSOs suggest that there are other existing technical solutions that are not fully locked. For instance, industrial consumers could resort to the storage of thermal energy and the heat-electricity decoupling or the use of electric batteries. Storage of thermal energy is already implemented in industrial consumers and thus would not demand extra investments (other than the communication and interoperability between DSOs and consumers).

Third, attitudinal constraints cannot be overlooked: inertia and resistance from end users (especially in residential markets) is often mentioned by interviewees, as the following quote illustrates: "The response of the people is very slow. So, we need more time to see the changes*".* Other DSOs echoes this fear of end users' reluctance to engage in flexible-demand contracts and pricing ("[This business model demands] involving domestic consumers in it... assuming that they will be willing to change their behaviour which I am very sceptical about"). Thus, some informants point out that this flexibility should be automatized and not reliant on an active role on the consumer's side; nonetheless this also demands that consumers accept the flexibility in the first place.

Northern-European interviewees recognize that there could be drivers other than prices, such as addressing sustainability challenges. This result could point to sociocultural differences in motivations for energy management. Furthermore, as solar panel systems get mainstreamed in the market, thanks to the participation of large retailers in their commercialization, residential consumers may become more mature and able to produce part of their own energy (thus, reducing transmission needs) and/or to sell their spare capacity, enlarging the grid capacity without further grid investments. If EV also mainstreamed, households would have a means to storage spare capacity in their vehicles.

Although interviewees point to regulation as a major barrier for the development of this business model, and foreground the slow pace at which regulatory change occurs, regulators and policy makers can act as facilitators of the business model by enabling pilots to test the technology and managerial practices that can facilitate adoption of this business model.

The third business model (BM3) - **providing data to third parties**- is unanimously deemed non feasible due to regulatory issues. Smart meter data can only be used for billing purposes and current regulation prevents DSOs from selling the information to third parties, in order to secure data privacy. DSOs cannot analyse the data to gain more knowledge about end users' energy consumers. One of the interviewees complained in these terms:

> *What's the purpose in implementing this technology if you are not allowed to use the information or even collect it?*

Obviously, consumers could permit other parties to use this information but DSOs recognize that there is limited economic value in this information. As one of the interviewees said: "Who would pay for this information? What's the value in this information? Value lies in the software that analyses the information". It is not surprising that DSOs see limited value since this information would be more useful for other agents in the market, such as retailers or ESCOs (e.g. for segmentation, customer scoring, balancing portfolios).

DSOs suggest demarcating the sensorial and the management functions of smart metering, so that other parties can access the information and provide data-driven services. This goes beyond the DSO's role, who is actually in charge of managing the metering. Thus, regulators are encouraged to create a data hub with tight governance system to simultaneously protect privacy and facilitate data-driven innovation in energy management. As one of the interviewees put it: "More actors need to have access to this information so that they can innovate!". Thus, they call for regulators to find a solution so that data privacy is protected without jeopardizing innovation.

Table 2: List of barriers raised by DSOs

Main Barriers	Technological	Regulatory	Organizational/ behavioural
BM1 (flexibility provider)	Missing communication and interoperability mechanisms facilitating flexibility	DSOs' role in demand flexibility buying is not enabled by current regulation. Lack of economic incentives and financial compensation for flexibility procurement Uncertainty about grid firmness force them to invest in grid reinforcement instead of pushing for flexibility.	Corporate inertia
BM2 (predictive asset maintenance)	Costly data infrastructure, especially in low voltage	Time-based maintenance is required by regulation even if predictive maintenance is in place	Distrust between DSOs and regulators due to information asymmetries
BM3 (data provider)	-	Prohibition of data use and data sharing	Limited value of information for DSOs

4.3.2. Industrial consumers

Industrial consumers were questioned about their perceptions of two business models: (1) energy management to maximize self-consumption and self-sufficiency and (2) management of internal process flexibility to minimize energy costs according to market-driven mechanisms and system operator requests.

The consultation unveiled two segments of industrial consumers whose views of the business models differ markedly. The first segment (**frontrunners**) is comprised of large companies, heavy consumers of electricity, representing energy a great percentage of their production costs. Thus, a more efficient energy management can be a source of competitive advantage. These firms have built-in expertise about energy, usually with a person or team dedicated to managing energy. These frontrunners were represented in this consultation by industry associations. The second segment (**laggards**) are smaller companies, light users of energy, where energy is a small fraction of their production costs and usually lacking expertise and a dedicated function to deal with energy. Laggards were represented in the consultation by smaller industrial consumers.

The first segment has been investing in efficiency gains for some time, typically when the crisis[11] reduced their income and the only way to maintain benefits was to reduce the costs. They are open to innovations,

[11] In reference to the financial crisis of 2008.

have dedicated persons in the company that understand how the energy market works and the innovations brought in the market, perceive less risk in adopting these innovations since they have expertise to assess the advantages and disadvantages for their firms. For all these reasons, they are more open to new business models that can reduce energy costs. As one of the interviewees explained:

> *(…) concerning energy efficiency I suppose they have done a lot... to give you an idea... this group, I mean our associations mainly 10 companies, they have invested in recent years above 70 million euros of energy efficiency measures. In the end in the last two or three years from these 70 million forty five millions were spent on energy efficiency.*

However, the second segment see more risks in investing in efficiency gains for several reasons. (1) energy represents a small fraction of their costs and it is not deemed worthy; (2) given the limited budget, investments in energy efficiency would detract from investing in their core business which is considered unacceptable; (3) they are unsure as to the impact of these investments on the bottom-line; (4) they lack expertise to identify and assess potential innovations. For these reasons, their assessment of this business model is tainted with resistance or negativity.

Even though frontrunners are more open to explore energy management innovation, these informants exhibit some degree of resistance to the most innovative practices of energy management. This resistance is due to several reasons that often combine accruing resistance to business model innovation, such as:

- uncertainty about potential profitability (“It is not that they don’t have interest, it is the uncertainty about the impact on the bottom-line. How much money is going to cost and how much money am I making with it [selling flexibility]? If profitability is good enough, they will be interested”);
- missing built-in capacity that explain their difficulties in understanding pricing mechanisms and its potential impact on the bottom line (“[in the firms people] are not able to handle it and they don’t have knowledge”;
- growing human decapitalization – as firms have less human resources, they find more difficulties in embracing new tasks or roles;
- eroded trust in energy-related companies. Interviewees share a perception that DSOs are self-oriented and not customer oriented. This mistrust is heightened by the perception that the energy market lacks a governance system that can harmonize the needs of all stakeholders; moreover, the lack of transparency in the market is interpreted as further evidence of a “visible hand” trying to control the market for the benefit of a handful of firms (“The it is still the game for four of the rich companies; there is no money for small firms”). This mistrust is even more prevalent among residential consumers: a barrier for increased engagement is that consumers resist acting on the information they receive from market actors as they perceive this information as biased to their corporate interests.
- concern about their core business; energy concerns are secondary or non-existent insofar as they are viewed as detrimental to their core business (“I mean companies that are struggling to survive. some of them... so energy efficiency it's less important”). Unless these companies are given a “push”, as said one interviewee, it is unlikely that they address the necessary investments. Similarly, interviewees recognize the need for greater incentives that encourage industrial consumers to invest in renewable generation;

- the limited inflow due to the billing structure. Given that regulated fixed costs (i.e., taxes) account for most of the energy billing, adoption of energy management innovations may limitedly impact the bottom-line (a DSO said: “taxation kills any other incentive”). Thus, the time length for seeing the return on investments is longer and is thus incompatible with the liquidity profile of these companies. An industrial association representative suggests that to reduce the perceived risks, consumers may be offered to outsource the energy management equipment and once they have observed the financial results, they may be more willing to adopt it.

These reasons combine creating a dynamic of resistance, as explained next. Since energy management is not viewed as a source of competitive advantage, laggards do not have a dedicated role or function within the firm. As they do not have built-in capacity to manage energy internally they need to outsource this service to aggregators or energy consultants, who are mentioned as key actors in the system. However, they are reluctant to share information with them. They demand some form of evidence that they can reap the benefits. This evidence can also be provided if, first, they share information with the external firms. As several of the interviewees recognized:

> *They are very, very touchy concerning information. I once again from my own experiences as the executive director of this association I cannot be the only be that I don't have any interest in one of the companies I know the disaggregated electricity consumption of the different industrial sites. I mean they, they are particularly touchy that they don't want to share that with me. Even though they are in the same association. So this is very... And, and, some of them are extremely touchy. And also all the other data that we publish in the reports is always aggregated so that you cannot identify per se that our associates of course this is.*

> *We would need some numbers to tell. What the advantages are. And also to understand it to what extent the data is being shared or what information is being shared.*

Thus, their resistance creates a failed market as they cannot find a common ground where the goals of both parties converge. As one of the interviewees put it: “Promoters want to maximize their sales. We want to pay as little as possible. We don’t find a common ground”.

These different approaches between frontrunners and laggards to energy management may create a vicious dynamic, where frontrunners are more and more efficient, more knowledgeable and more open to innovations, whereas laggards are perpetually behind them. Consequently, the gap between the two widens and the difficulties in bringing laggards to the level of efficiency of frontrunners are ever growing and with it the perception that the market is being designed for the benefit of energy firms and frontrunners and that laggards are intentionally left behind.

In addition to efficiency measures, industrial associations discuss the potential benefits of a transition from centralized buying to providing flexibility to aggregators. Industrial firms, especially big firms, have already implemented centralized energy buying to reduce costs. Within current regulatory framework, these firms could sell their flexibility to aggregators, reducing outflows/increasing inflows. Aggregators could also serve as best practice disseminators among their customer base. Yet, industrial consumers are reluctant to do so for the reasons said above. However, they also recognize that, given the billing structure of energy and the high weight of regulated costs on billing, industrial consumers do not see much value in energy efficiency measures. Indeed, they identify other avenues as most effective to reduce their energy costs. For instance, some industrial consumers are taking advantage of loopholes in the system to reduce their costs (e.g.,

changing the voltage level there are connected to profit from network cost differences) or are pressing regulators to reduce the regulated costs (especially the network costs in Spain, levelling them with the rest of Europe).

Whereas adoption of efficiency-led and energy management measures varies widely between frontrunners and laggards, these differences are not observed in relation to the adoption of the other envisioned business model (obtaining extra income by selling flexibility). Adoption of energy demand flexibility depends on internal factors, such as the production cycle, and external factors, such as the technological, managerial and regulatory framework for demand flexibility.

Regarding **internal factors**, some industries are *de facto* excluded from this business model if their operations cannot be interrupted at all or at a short notice. Interviewers suggest that industrial firms prefer delaying operations rather than interrupting operations as the former is less costly. Others can only engage in this business model if the interruptions are communicated in advance, which is often not the case. The need for advanced planning is incompatible with the working of the system. Thus, the production or operational profile influences the disposition to adopt this business model.

Regarding **external factors**, interviewees acknowledge the need for appropriate incentives that can compensate for the increased production and operating costs associated to flexibility. At the moment, in two of the countries, the TSO provide incentives to industrial firms via subsidies for their flexibility. However, these incentives are being reduced and this reduction demotivates industrial firms from flexible-energy management.

> *All [associates] were involved in the interruptible market, they paid XX euros per megawatt-hour[12]. Now it is 40-50% of that per megawatt -hour. In the future it is likely to be around 15% of the initial amount. Then it is not worthy. Some are opting out this market.*

This quote shows that for industrial consumers the flexibility business model is not attractive unless accompanied by a well-designed compensation package via pricing mechanisms. Otherwise, the transaction and operational cost associated to the flexibility business model will outweigh the potential benefits. It is apparent that TSO are no longer providing these incentives. Interviewees recognize that there is a need to fill the blank the TSO's diminishing incentives TSO is producing. Thus, informants reckon that, unless another agent in the market provide these missing incentives, industrial firms may not find profitable to adopt this business model. One of such agents is the DSO who could pay their customers for flexibility, but as aforementioned DSOs are not enabled to perform this role. In sum, although it is agreed that the grid could benefit from the flexibility business model, it is unclear how this flexibility "sales" are going to be ordered, processed and paid. Hence, there is a need for better pricing and operating models that can compensate adequately each agent for their services.

A second external factor is the available technology. To reap the full benefits of flexibility it is fundamental the digitalization of the market. As one of the interviewees acknowledge, "I don't think we're using available flexibilities now. Just do a physical monitoring here, not digital monitor". Even the industrial consumers

[12] The exact amount has been remove to avoid tracing back the respondent based on this information.

that are already providing some sort of flexibility (e.g. to TSO) mentioned that procedures are totally manual as of today (e.g. activations are requested via phone). This lack of digitalization prevents from creating a market for selling operational flexibility. There is a need to create secure interfacing and communication platforms, inter-operability mechanisms, and a governance system for these platforms, said one of the interviewees, so that the flexibility market could work. In countries where digitalization lags behind, this business model is more difficult to implement.

It is important to bear in mind that industrial consumers do not want this market to be designed solely by DSOs: industrial consumers demand the chance to co-create a market (or a set of markets) that can meet the requirements of all stakeholders. In fact, some DSOs also recognize that "the user must be awarded participation in this flexibility".

Participation in pilots that may serve to identify the conditions for such a market to work. Also, participation in pilots is regarded as a capacity-building strategy that increase the willingness of industrial consumers to adapt their operations to the system needs.

> *So, they have to create routines internally (…) providing that say that the next day forecast of consumption though and to check with the guys of production. -Do you think in these hours that we can if it is needed we can increase or decrease our consumption? I am optimistic about it.*

The adoption of the flexibility-centred business model demands a different operational dynamic, both internally and externally. Operations managers need to interact with roles/firms that they have not been used to, in a context of governance uncertainty. Interviewees suggest that participation in pilot projects may reduce this uncertainty by creating expertise within the companies and working procedures and routines with energy-related firms.

In addition to internal factors, contextual factors pose a challenge to the feasibility of this business model. Industrial consumers refer to current regulation as a constraint, notably the weight of regulated costs in the bill, the removal of incentives to CHP schemes so rendering the CHP unattractive, or the reduction in the subsidies for interruptible contracts.

Table 3: List of barriers raised by industrial consumers

Main barriers	Technological	Regulatory	Organizational/behavioural
BM4.1 (energy management)	-	High regulated costs	Limited impact of energy costs on total costs Lack of built-in capacity Distrust of energy operators (including aggregators and ESCOs).
BM5.3 (flexibility provider)	Missing communication and interoperability mechanisms facilitating flexibility	Limited incentives and market development for procuring flexibility.	Reluctance to adapt operations to system needs. Impossibility of operational adaption in certain industries (flexibility activated on a short notice).

4.3.3. Residential consumer representatives

Regarding residential consumers, consumers' organizations believe there is a growing interest in electricity, mostly motivated by economic factors (reduce the electricity bills). Contrary to the extended belief that consumers would only react to price signals if they observe a sensible increase in their bill, consumers' associations reckon that their associates call them for increases as small as 0.03 kilowatts per hour. This would suggest that consumers are indeed price sensitive.

Yet, they are not price sensitive enough to accept flexibility. Consumers want to maintain control and economic incentives may not be enough to shift demand to flexible contracts. Notwithstanding, there could be other reasons for this shift that have gone unexplored, such as environmental reasons or hedonic gains (using gamification, for instance).

There is an agreement that two barriers prevent consumers from being more engaged in this market: the difficulties in understanding how the market works and how the price is calculated, and the mistrust on companies. Consumers receive contradictory information about prices and environmental impacts of different sources of electricity and appliances. When they turn to the DSO for information, the organization is unable or unwilling to explain how prices are calculated or what the impacts of behavioural change, in simple terms. Thus, consumers' organizations advocate tools that can make this understanding easier for consumers. Regarding trust, the limited confidence in market actors creates a sort of lemon market: consumers need this information, but any information provided by market actors is mistrusted and resisted.

Paradoxically, this mistrust is not a barrier for data sharing. Consumers are willing to share their electricity consumption with market actors as they do not see a major risk in sharing this information.

Table 4: List of barriers raised by residential consumer representatives

Main barriers	Technological	Regulatory	Organizational/ behavioural
BM4.2 (flexibility provision)	-	-	Not very price sensitive segments Difficulty in understanding electricity markets Mistrust in electricity companies

4.3.4. DER owners

Two DG owners/operators were consulted within the scope of this stakeholder consultation. Although both agents share some characteristics in their business, they actually have different profiles. The first interviewee is the owner and operator of DG, more specifically small hydro power plants. The second interview is operating DG connected at MV and HV.

Interviewee 1

Interviewee 1 commented more on the barriers and drivers for BM4, focusing on the adoption of DG and the DER participation in the provision of grid services.

When asked about the possibility for DG owners to participate in balancing markets, the participant mentioned that balancing markets are still very limited, and some balancing products (FCR, for instance)

are not remunerated. But he believes this scenario is about to change soon, giving an opportunity for new agents.

> *And I think that this will be an opportunity for batteries. An opportunity for aggregators, which are still in, let's say, a standby mode*

The participant also mentioned the misalignment of some renewables policies. It could be the case that policy makers give a strong incentive for a specific type of RES (wind or solar), while there is still a big potential for another RES (e.g. small hydro power plants in Slovenia).

> *We did the same like in Spain. We put a lot of money on the beginning for PVs systems. And as I read, Germany and Spain made a mistake here, because they started when the technology was too expensive.*

Again, the market structure and the power of existing players is mentioned as a barrier for DER participation.

> *Then it is still the game for four for the rich companies. There is no money for a small number.*

Another critique from the participant lays on that fact that bigger power plants are still more convenient for system operators to provide flexibility:

> *As I see, they have a big pool of power plants and for the center, it is easier to call someone which is, I don't know, five megawatts.*

When asked about the participation in a VPP, he also mentioned technology as something to be improved.

> *As far as I know, they're still calling, it's not real virtual power plant, when someone starts your energy remotely. All my machines are ready for virtual power plant and I would like that, someone driving my engine, between the set points.*

This opinion, of course, cannot be generalized. This DG owner is in favor of giving some degree of control to the VPP, but that might not be the case for all DG owners.

Finally, a concern for the DG owner is the market condition and capacity for the VPP to be developed.

> *From my point of view, I always ask myself. How many VPP, How many companies which puts let's say drive your top power plants are necessary or should be in place? It's a place for 10 companies? It's only 1?*

Based on this comment, the participant specifically mentioned his concerns regarding market concentration in the future, if not many companies are in place. This could lead to a weak position for the DG owners with regards to the VPP operators, reinforcing the power and market structure of the energy market which is mentioned by other stakeholders as a barrier for innovative processes and products marketed by other players, such as aggregators.

Interviewee 2

Interviewee 2 focused on commenting on BM3, as well as BM4, from the perspective of a DER owner providing services to grid operators. He/she started by mentioning that DG still faces barriers for its development:

> *In order to increase distributed generation, we have to be fairly compensated and create investment and business models that encourage generation from renewable generation.*

The participant identified the grid cost as an important barrier, mentioning that it is still not modeled properly. Associated to that is the lack of information from the DG standpoint with regard to the possible constraints on the grid:

> *There is no visibility as to the grid constraints and of course the grid operator is not willing to provide that information. Because it means that they've inadequately managed with the grid. If we have grid constrains, you cannot get information. So, what I've proposed is that the grid operators should be disclosing the information transparently as to decrease constraints on the regional level.*

Also, the interviewee identified the lack of a local grid pricing model. He advises for grid operators to disclose and clearly make public the needs for flexibility in the grid, and that should be open for DG to be able to provide that as *a service* and not as a mandatory provision.

> *The generation has to come as a good investment. Otherwise there won't be any investment. So in order to have the good investment you have to have an adequate model. The financial model should include income from the generation, from the liquid market participation here, which the wholesale prices should be reflecting the reality. And the adequate compensation for the services that they could provide based on the explicit demand declaration from the grid operator.*

When presented with the gm-hub idea, the DG operator presented a relevant critique to overall architecture of BM3. They highlighted the overall trend for a bottom-up approach in the CEP and in the overall European effort towards decentralization. To them, the gm-hub seemed to be still designed around the idea of a top-down approach. Their view is that in the longer term, decentralization of services may reach a point in which peer-to-peer and techniques like “web-of-cells” can decentralize not only the generation, but also the processes and services in power systems. They suggested that instead of a single platform for the facilitation of service trading, there should be multiple platforms that are interoperable.

> *The DSO has a simple platform to procure the flexibility and the providers in the market can have their platforms that connect to that, to the aggregators or energy communities or whoever, multi-platforms. And they all interface interoperability and can do their work and procure.*

They recognize that this would also involve challenges like defining the proper governance for this multi-platform environment.

> *This process should evolve based on the right governance models. That cannot be just the grid operator saying ‘I'm going to set up everything this way’. This process has to evolve jointly so with the stakeholders on one side, with the consumers on the other side and on the grid operator on this side. This is this is iterative thing. It cannot be one way.*
>
> *It's not going to be one marketplace. It's going to be many marketplaces, because they are going to be complementary marketplaces.*

Regarding aggregation, the interviewee identified two main barriers, namely communication and transaction technologies.

> *Communication rate readiness is not only for the interface, but also transaction. And I know for a fact that transaction is not in place. So we have to do a lot of work on the DLT level and on*

blockchain. Not only, there are other mechanisms but that's what we need to explore. If that's not coming the whole market is going to be killed, because you cannot wait for six months to get paid for services. That is a major issue.

Expounding on the aggregation, automation is deemed as a necessary process to unlock the potential of demand response.

And then you have a human component in these operations. Maybe we need to automate it, also on the settlement side.

Nevertheless, the informant recognized that independent aggregation can be economically viable if both distributed generation and distributed grid management are in place. One important barrier is the connectivity, but the 5G technology can help mitigate that.

Finally, the informant highlighted the importance to have a proactive regulation with regards to new business models. It was noted that regulation is often lagging with respect to commercial and technological developments, and this may be a big risk for the timely development of the adequate business models, with the risk of being over-come by other initiatives, coming from outside of the sector.

Lots of companies are ready with the solution. One switch away and we just lose the market, so you better consider that. (…) When others come over and go directly to their consumers, it can be too late. We've already lost the data to Google and Facebook. We are just one step away from the same thing happening while we're trying to figure out [the best model].”

Concluding on that, they also mention that most of data can be already being collected outside the smart meter environment:

This fight around smart meters is trivial. I can get all the information bypassing this market.

Table 5: List of barriers raised by DER owners

Main barriers	Technological	Regulatory	Organizational/Behavioural
BM1 (flexibility procurement from the DSO)	-	Lack of appropriate information regarding grid constraints Lack of proper local flexibility pricing	-
BM3 (data provider)	Interoperable protocols that can link different platforms Communication and settlements (P2P)	The gm-hub should not be a single platform, but rather an environment of multiple interoperable platforms Regulation tends to be reactive, and slower than technology and market initiatives.	Other players (e.g. data companies) may take this market over with faster and more dynamic BMs
BM4 (consumers providing flexibility)	Communication has to be improved	For balancing participation, markets are not completely open or appropriate for DER. Misalignment of support schemes	
BM5 (aggregation)	Communication has to be improved	-	Market conditions may be a challenge for the VPP

4.3.5. Policy makers

One local policy maker[13] was questioned about its perceptions related to the concept of the grid and market hub of data and the different business models which could be feasible thanks to it. The overall approach is viewed as a very interesting initiative, even more from the perspective of a municipality committed with transforming of local energy systems and meeting climate goals. Besides, it is said the system would be enormously useful for universities and even government organizations, in order to find innovative solutions. The gm-hub and the derived services from it could provide additional intelligence and information that could translate in better decision-making. Indeed, policy-makers are investing in unveiling opportunities for innovation in the grid.

The policy maker explained that different neighbourhoods have different load-profiles, which makes detailed data necessary for these purposes. Thus, they are currently working with universities to understand better the electricity use and potential shortcomings of the grid.

> *It makes it much easier to try to do or make changes when we have that kind of visibility, and data is enormously useful.*

The policy maker recognizes however that doing a granular, individual-level analysis is neither prudent nor necessary: "I don't need to necessarily go down to an individual, I don't care about the individual. Because I know that in terms of personal integrity, I shouldn't be looking at individual power demands, but for neighbourhoods and blocks, that would be enormously interesting".

However, it points out it is very difficult, since the end users are the ones that own their own data. The **scarcity of data** limits their view when we are trying to work with innovative solutions.

As local policy makers, they find obstacles when trying to get that data from their DSO. The DSO say they are not able to share information due to security reasons or that they are not allowed (even when that aggregated data would give a number for the entire region, or from neighbourhoods or blocks, and not individual's data/power demand).

As of today, the most important advancements being made, allowing third-party to have more visibility, are in terms of regulatory sandboxes. The energy regulator in Sweden is promoting sandboxes so innovative solutions can be tested, and these initiatives are seen by the interviewee as very positive, considering that they will allow the policy maker to have more information to base their decisions. The participants also recognize the importance of research projects like the ones from the H2020 programme.

There are **two big obstacles** to the expansion of smart grid solutions and data hub associated to them: the first one is the **taxation policy**, and the second one is the **price**. The first is related to the way they tax things and how taxation policy slows the Smart and flexible projects. The second one, the electricity prices are low relatively to other parts of Europe, thus the price incentive is low.. One solution is the public sector which do things in the good of the public and do not need to make a profit, being able to show other actors, maybe private actors, that stuff is possible. Another solution is providing flexibility to the DSO, but as it was mentioned before, prices are so low that there will not ever be a proper price incentive.

Users **predisposition to innovation** and **environmental consciousness level** are also relevant to promote changes. Individuals and organizations want to start providing flexibility to the network but those are the

[13] Involved in policy making at municipality level.

ones that are just excited to try new things (the so-called innovators). To reach a majority and scale up the flexibility model, a different approach is needed. This majority comprises more conservative and cost sensitive population and they need guarantees that they will not lose money. As changes in the system require investments, potential participants expect to reach breakeven point in a reasonable period (five or six years). There is interest in the municipality area of the respondent in participating in flexibility provision, but it certainly helps when there is some economic incentive, so more actors are interested.

One big opportunity for flexibility provision in Sweden are the penalties that are charged to DSOs by TSOs if they don't meet the amount of power subscription[14]. These penalties are very expensive. DER flexibility and aggregators could provide the necessary power to DSOs in order to reduce their subscription penalties, reducing the overall cost of the deviation.

Finally, there are **two main risks** in these new approaches to the electricity market. First, **there needs to be more actors**, such as ESCOs or aggregators. And that will depend on both how much flexibility is needed and what can you get reimbursement wise; furthermore, it also depends on how much you need to get paid in order to attract actors that are interested.

Another risk could be that **a large actor comes in** and tries to kill the market. This could lead to an energy monopoly which is not desirable from a policy maker perspective, not only due to price increase, but also due to the customer perception of wanting another option. Also, competition helps to regulate all the actors and to check that what they are doing is reasonable.

Table 6: List of barriers raised by policy makers

Main barriers	Technological	Regulatory	Organizational/behavioural
BM1 (flexibility procurement by the DSO)	-	Subscription penalties may be an opportunity (in Sweden)	No economic incentives for investments due to very low electricity prices
BM3 (data provider)	-	Prohibition and security reasons block data use and data sharing, even at a non-individual level	Consumers are the only data owners, limiting data access for research, even if provided aggregated and not at individual level. Weak signals of change and opening
BM4 (consumers)	-	-	Economic incentives would help for more intensive development

4.3.6. Data service provider

A data service provider was questioned about its perception related to the grid and market hub of data and the different business models which could be feasible thanks to it. The overall approach is viewed as very useful, since there are a lot of agents in the market who could be benefiting from this data. First, and foremost, retailers, who nowadays are running blind and only know the information of their customers, but don't know the customers themselves, what kind of flexibilities they have, etc. Furthermore, it would also

[14] In Sweden, the DSOs have a "power subscription" agreement with the TSO. Based on their forecasts, they have to inform their expected energy withdraw from the transmission grid, and they are subject to penalties in case of deviations.

be beneficial for consumers. If consumers provide their data, they could receive a better service at a lower price range. However, the majority of consumers at the moment choose to opt out the supplier, meaning they do not provide any useful individual behaviour information; rather the supplier only knows the weekly, monthly and yearly consumption, which does not provide any helpful evidence for the retailer. Nonetheless, he feels very positive about the future: *I am convinced that in five or ten years those customers that provide all the data will get a better rate and cheaper electricity than those which opt out*. Data-based added-services could create a market for consumers' energy consumption data[15].

Indeed, consumers vary in their resistance to share their data. For example, among residential consumers the informant identified three types: a) the consumers who will never share their data since they do not trust suppliers; the estimation is that they account for 10 to 20 percent of ; their major concern is that energy data may be used by third parties to know their habits, when they are or are not at home, etc.; b) the second group which makes up the gross majority does not really care about providing or not their data; and, c) there is a yet small group, which accounts for around 5 to 10 percent of the total, who actively seek this opportunity to obtain the best deal.

When talking about the commercial sector, there are less constraints since, in his view, all suppliers will agree to use the data as soon as they see some business opportunity and profitability in these services. Due to the high competition and high number of suppliers, plus the low margins of the business (supply of electricity), suppliers seek becoming more effective than their competitors, and having access to data from consumers would allow them to avoid big imbalances and so reduce the costs of power purchasing which leads to a portfolio optimization.

The main barrier for this business model is the fragmented regulation for the energy market across Europe, which is deemed as a national strategy to protect national markets from the entry of foreign competitors. However, this fragmented regulation in fact punishes small companies since they must develop specific products for each market which is very costly. He also explained that the potential profits of a data-service provider is on scale of operations, as profits per service will be very low; thus, fragmented regulation would become an important barrier as it would prevent scaling up the product-service to different countries.

When asked if he envisioned any other possible service that could be profitable, he responded that it would be difficult for several reasons. One of them since providers of these services have to share their online data in one minute interval with all the parents groups and all these households are active and there's a huge amount of data and the only way this could work is through a hub. The problem is, again, that due to national regulations there will be many different gm-hub solutions in every European country, and there are no prospects of this changing. As he said, "that's the main risk that I see that we will again have a huge number of national solutions". However, the ongoing European market integration, which is starting now with ancillary services, could be a way to mitigate this risk. Hence, the unique solution is to find a way to get some harmonized solution for Europe.

He feels sceptical about this statement: *from the European perspective there is some push to harmonize and integrate internationally basically for ancillary service markets*.

[15] This respondent may be pointing out to a vicious circle in which consumers are unwilling to share the data as they do not see the added value, but this value is not provided because there is no data available. The question would then be how to break this circle.

Finally, he highlighted the importance of the forecast provision, and that it will develop new business models when there is newly available data since there are already a lot of algorithms on the market.

Table 7: List of barriers raised by data service providers

Main barriers	Technological	Regulatory	Organizational/ behavioural
BM3 (data provider)	-	Many different national regulations	Difficulties in overcoming the resistance of (some) consumers Reluctance of a segment

4.3.7. Retailers and ESCOs

After asking several retailers about the different business models and their possible viability, these are the obstacles that stand out.

When focusing on the different business models for retailers and aggregators, they were asked about the viability of **reducing imbalance costs by using the flexibility of their clients**. Different retailers share a negative expectation about it but based on diverse arguments. One retailer has no doubt: this model would not work. He explained that in the case there was a deviation in the portfolio, the most cost-effective solution is to go to the market and try to minimize it. The only option where he sees this model working is where there is no market session, plus if the deviation is very big and that means is going to cost a lot of money. With all these premises, the only available action that he could have was to ask the consumers to release or increase power, but at the end, this is the most expensive option. Furthermore, he does not see this situation changing in the future no matter the market changes or new regulations; he strongly believes that buying from the market is always cheaper than buying the energy from the consumer.

As an additional insight, two retailers highlighted the increasing importance of flexibility and avoiding energy imbalances when trying to introduce more renewable energy in the mix. The reason is that the structure of electricity generation in each country, together with the level of price volatility and the existence (or not) of negative prices, influence whether price differentials are attractive or not to industrial customers. In countries such as Spain, with overcapacity for generation and low need for flexibility, with low price volatility and without negative prices, there are no economic incentives for the participation of such customers. A change in the generation structure, with a greater weight of renewables, will mean more price volatility and a greater incentive for industrial customers to participate in the future.

One proposal to facilitate demand participation and to generate interest in such models are pilot projects, "controlled environments" in which the flexibility of the system and regulation is simulated, to test how they would work and where the profitability would lie for the different stakeholders, if those conditions eventually came to be implemented.

A complementary perspective emphasizes the cost of forecast devices as other obstacle to overcome. It is pointed out that the systems that allow for the use of flexibility, especially of home users, are additional devices that cost money. Nonetheless, there can be easy solutions such as the possibility to add an interface to the smartphones so they can measure the energy management on the house level.

Another possibility to obtain data are smart meters which allow real time observability of voltage level for residential consumers. However, this is not a reality yet. Every country in Europe is deploying smart grids: including not only smart meters but also the concentrators and the whole flow of information. Retailers recognize that every country is at their own speed but there are set targets and soon they will be deployed.

When dealing with the **remuneration for the clients for their flexibility**, a retailer believes there will be some groups of costumers that will not have to be remunerated. In other cases, the way to remunerate the client is by reducing the final fee the customer must pay for their energy consumption. Final clients find it very complex to understand the energy service system, so instead of being remunerated for the energy power that they produce they receive a constant reduction from their energy consumption fees.

A common problem for retailers is the obstacle to access to data, especially from end users. In some countries, retailers cannot collect this data unless they obtain permission of the end user, plus the DSOs are not allowed to provide this data to retailers, even if they have an arrangement or contract[16]. One of them highlights the regulatory barrier that poses the new data protection policy and he states that this policy is hindering the development of new future services. Furthermore, this policy makes much harder to serve European markets than American or Asian markets.

Moving to the **data-service provider business model**, a retailer says they are already implementing a similar business model through a start-up that collects the information form the consumer. However, the aim for consumers is to use energy efficiently, so far it has been implemented only in the business-to-business (B2B) market. Nevertheless, he does foresee other agents who in the future could buy these services from this data service provider, such as energy communities.

He explains the role of the DSO, in some countries such as Portugal, where quarterly it publishes a lot of data from the consumption of every costumer, so it allows more competition among retailers. It has been proven that ensuring competition by providing the retailers with better information allows market growth, since they can build a most accurate and attractive offer for the customers.

The viability of a business model with the final consumers as the main economic agent, selling their own information to companies, was questioned by retailers. The problem is the selling price for this data. One of the retailers commented that data would not provide revenue for the consumer. He believes clients should give their information freely, so they get proposal for a new service, a cheaper energy offer from the retailers, for instance.

Retailers' vision of the participation and incentives of **industrial consumers**, whether large or small, diverges from the end consumer. These agents have an evidence interest in options for self-management of power, including photovoltaic plates and storage solutions for self-consumption. However, in those two directions of action, the assessment is different. With regard to the installation of photovoltaic plates, there is clarity as to the interest and profitability for the industrial consumer. However, when it comes to battery-based storage for internal flexibility, that interest is not accompanied by profitability. This is a very relevant cost barrier.

And that potential cost barrier has to do with the existing tariff structure in each country. In countries where you pay a lot for contracted power, with unfavorable access tolls, adjustment prices are very low, which clearly discourages battery storage solutions.

Besides, there are barriers because balancing services are considered an additional revenue stream by generators, complementary to other revenue streams, so they can offer lower prices than an industrial consumer. Additionally, due to the design and definition of the balancing services as a more short-term product, an industrial consumer is less interested in than if it were a longer-term product.

[16] This data can correspond to metering data from consumers supplied by other retailers, or to historical data from their own customers, i.e. additional data neyond the strictly required for billing.

There are other factors that influence the level of interest of industrial consumers in participating in the different proposals to bring flexibility and efficiency to the system. Their environmental commitment stands out among others. Either as a consequence of a more demanding regulatory environment on this issue, or of corporate commitment and their positioning in corporate social responsibility, there are industrial customers interested in solutions that allow them to improve the management of their energy demand, options in storage or generation (as photovoltaic) or self-consumption proposals. This is the essential driver that drives their interest in these alternatives, because, today, there are countries where these solutions are not profitable for them due to the market structure and the prices of the system.

When asked if **independent aggregation** would be a feasible business model, one retailer answered that the only problem they see is how the independent aggregator and the supplier are going to interact with each other and other agents. He declared they are looking up the European regulation, more specifically, the Clean Energy Package for clear guidance between aggregators and retailers. Even though it already gave some direction, it was not very clear and has not solved any problem.

Finally, the importance for retailers to provide additional services that add value to the client was emphasized, since in the future service companies such as Google or Amazon could start retailing and providing energy services as retailers as well. The main threat of retailers are not other retailers but big and disruptive service companies that could enter the market.

Table 8: List of barriers raised by retailers and ESCOs

Main barriers	Technological	Regulatory	Organizational/ behavioural
BM1 (flexibility provider)	Additional devices are required Some measurements remain out of the system	No data from end users Different paths of development between European countries	Price differentials are not attractive to industrial customers
BM3 (data provider)	Communication infrastructure	Data protection policy	-
BM5 (aggregation)	-	Uncertainty about how regulation is going to guide relationships between suppliers-aggregators-others Expectation of no profitability from aggregation of consumers' flexibility for imbalance reduction	Threat of entry of new players, notably big and disruptive service companies (like Google or Amazon)

4.3.8. Aggregator

The consultation carried out included one company that has been classified as an aggregator in this report. More specifically, this company has developed a technology that allows exploiting detailed consumption data from end-users and load controlling devices, with a focus on commercial and residential consumers, to aggregate and manage demand in order to provide different services to TSOs, DSOs or directly to end users. Therefore, this company would not directly act as an aggregator but provide this technology to other companies acting as market agents. Thus, it could be equally categorised as data service provider.

This aggregator considered that a centralized data hub or similar platform enabling access to metering data would not be relevant or valuable for its business. Firstly, because their solution requires a high level of disaggregation of the consumption data, e.g. at appliance level, something which is not captured by metering data. He mentions that, whilst this breakdown of consumption can be estimated through software tools, this does not provide results that are reliable enough for their activities. Thus, they would have to deploy additional metering devices at the customers' premises anyway. Secondly, they perceive a risk of relying on an external platform run by a third party to obtaining the data (communication failures, problems with data updating, etc.). This is particularly relevant when providing services that require a (close-to) real-time communication/response, such as balancing services. Lastly, this interviewee showed concerns about the high cost of deploying and maintaining such data platforms.

Overall, the aggregator´s conclusion is that a data hub or metering data platform would not be particularly useful for this type of business (aggregators). Nonetheless, from his viewpoint, it may be indeed be valuable for other types of services that do not require real-time information, for certified billing systems or validation of service provision (run by TSOs in the case of balancing services),or for end customers themselves. Moreover, he mentioned than other types of data service providers could indeed be interested in the development of a data hub or metering data platform such as the gm-hub, including software companies, forecasting firms, or city halls. In essence, services requiring only offline analysis.

Among the barriers for the development of the gm-hub, this aggregator mentions first an economic barrier, as he believed that a sound cost-benefit analysis for these data platforms is still missing. Additionally, the development of this platform could clash, from the aggregator's perspective, with the resistance of some stakeholders such as DSOs who would have no interest in the development of data hubs because they value in managing the metering data and would be losing control over this data. Nevertheless, he believes that the most relevant barriers are related to data privacy and protection, as this issue is yet unsolved. A very transparent system for the user about when he/she is granting access to his/her data, to whom and for what, should be developed. This system should also be user friendly and fast.

The aggregator is asked about how this authorization system could be articulated. If the model finally responded to what appears to be the intention of market regulators, the user's data would be in the hub and the customer would receive a request to access them with standard templates of legal clauses. Then, the customer may or may not authorise whether he/she gives access to his/her information online, to whom specifically and for which use. In its opinion, the barriers are very clear, especially if data hub managers offer nothing in return. Giving access to data to a third party requires that customer knows very well what he/she is going to receive as compensation. The fact that many end-users nowadays are used to sharing data and personal information on the Internet and Social Media could facilitate the process. However, there are many customers wary of exposing their information in these media who will also be reluctant to provide access to their consumption data.

The conversation then turned to the **provision of flexibility services to DSOs and TSOs**. Overall, although he believes that these services will eventually develop in the medium to long term, he is rather sceptical about the viability of this activity in the short-term. When they will materialize essentially depends on the regulatory conditions in each country. In the meantime, the main added value, in his opinion, is the provision of energy management services directly to end users. Specifically, he mentions energy management to increase the ratio of self-generation and minimize energy costs, both at the level of individual consumers as well as for citizen energy communities. The viable business model, in his opinion, is that the aggregator/DSP provides the control and metering solution to a managing company (ESCO, building or facility manager, aggregator, city hall) and receives a fee in exchange.

A clear barrier he foresees is the lack of information and awareness of potential data-based services that result in reduced motivation from most end consumers. He believes this will change in the future, but nowadays an appropriate marketing strategy is essential. In any case, the main barrier to face in the short term would be the regulatory uncertainty. A clear and well-designed regulatory environment is required, including metering, technical and administrative requirements, different stages foreseen, etc. Furthermore, when discussing the possibility to expand their operations internationally across Europe thanks to the progressive market integration, the aggregator mentions, as other DER-related stakeholders have said-that lack of homogenization/standardization of market interfaces across countries is an important barrier for this expansion of the business that would allow them to gain in size and exploit economies of scale.

Concerning flexibility resources at the end-user premises, he believes that small-scale storage is not economically efficient. Thus, only certain consumers, either very environmentally friendly or seeking energy independence, would purchase this equipment in the short-term. On the other hand, electric vehicle storage capacity could be available in significant amounts at a reasonable cost shortly.

Table 9: List of barriers raised by aggregators

Main barriers	Technological	Regulatory	Behavioural/Institutional
BM3 (DSP)	Metering data is insufficient for some data services (need for greater disaggregation)	Regulatory uncertainty Data protection and privacy barriers	Reluctance from DSOs to lose control over metering data management End user reluctance to provide data in a data platform without a clear return Perceived risk of relying on a data platform operated by a third party for critical aspects of your business
BM4.2 (residential consumer)	High storage costs	Uncertainty over self-generation, energy communities, and local markets regulation	Lack of motivation and awareness from most end consumers; more economically attractive for community users, but this requires a deeper change in end-user behaviour /organization
BM5 (flexibility provider)	Need for real-time data for certain services (e.g. balancing) Lack of standardization in markets access interfaces across Europe	Wide variation in national market rules and design	-

4.3.9. Regulators

National Regulatory Authorities (NRAs) are, together with DSOs and end consumers, one of the most relevant stakeholders concerning the BMs addressed in this report. They play a central role in the regulation of monopolistic network companies, the definitions of market rules and supervising their adequate

functioning[17], data management model definition, or tariff setting. The viewpoint of regulators is therefore relevant for all BMs. Nonetheless, it is particularly relevant for those BMs that may not be possible to implement under current regulation in some countries, such as those involving the provision of flexibilities to DSOs, the participation of demand-side resources in balancing markets, or the adoption of new roles by DSOs (i.e. BMs 1, 3, 4, and 5).

They were asked about the BMs created value and for what stakeholders, the potential effect of the BMs on competition and consumer awareness, the feasibility under existing regulation, their short-term priorities as regulators, and the risks they envision if the BMs were implemented. Representatives from regulators in the four target countries participated in the consultation. In most cases, more than one member of the NRA was interviewed, either simultaneously or in separate interviews, since each person specialized in different regulatory topics. They were generally asked about all the BMs; however, some of the contributors decide to focus on some specific aspects, which were more closely related to their individual responsibilities.

On the use of flexibility by DSOs (related to BM1 and BM 5.4):

Regulators generally agree that promoting the use of flexibility by DSOs is necessary if DER is to keep increasing as expected. However, in spite of what the Clean Energy Package states, important regulatory challenges are foreseen for its materialization and no clear solutions are yet available. Additionally, both DSOs and network users should be made aware of this need and that a business-as-usual situation will not result in an efficient or desirable outcome.

The existing CAPEX bias in current DSO revenue regulation (also relevant to preventive maintenance) is recurrently raised as a key barrier and one of the regulatory priorities for regulators. However, they generally expressed that it is unclear where regulation should go to. One regulator phrases it as follows: "I think it the wording in the clean energy package places a pressure on the member states to try to rethink CAPEX-based regimes."

One regulator mentioned that explicit flexibility mechanisms need to be coordinated or consistent with implicit flexibility mechanisms embedded in network tariffs (e.g. critical peak tariff). He described it as "When designing explicit mechanisms, it is important to consider the effect on the implicit mechanisms, so one doesn't jeopardize the expected effects of the other."

Another one mentions they are aware regulation needs to be adapted, but there is not agreement as to which regulations needs changing and where. They are probably moving towards TOTEX regulation. However, he stressed the need to assess new types of regulation to get better insights and improve the regulator's knowledge. This is becoming urgent as the grid is entering a new investment cycle and acting late may result in significant stranded or unnecessary costs. Consumers may miss the benefits from flexibility. Another potential challenge is that if regulated costs increase a lot, and off-grid solutions become a viable alternative, the problem may worsen. Consumers should see an advantage to remain connected to the grid even providing a service to the network operators. Citizen energy communities are mentioned as an additional threat to grid operators. If people see the alternative to being flexible is paying more, then they might start changing their behavior.

[17] Market supervision responsibilities may be shared between sectorial NRAs (e.g. responsible to deal with network access conflicts) and national competition authorities (e.g. responsible to monitor market power abuse or cartel issues). In some countries, such as Spain, the same institutions acts both as sectorial NRA and competition authority.

Another regulator mentions that they have reward/penalty incentive schemes for smart grids. One incentive scheme incentivizes lower losses. The other is to flatten the utilization of network assets. However, it is known that some of these incentives can go against the development of the smart grid, e.g. if you have something that increases the losses (e.g., use of flexibility) and you are penalized for it. Nonetheless, the CAPEX bias is the strongest incentive against it. TOTEX regulation is again mentioned as a potential solution, it is unclear yet how the solution looks like. The regulator mentions that grid elements are more robust/reliable than the use of flexibility, even if it could be more cost efficient than to use flexibility. They mention that they have started a project that is ongoing which aims to look at a longer-term perspective, to see how regulation should develop.

Another open issue is how to set the required flexibility mechanisms:

- One mentioned they are undertaking a public consultation on how to implement flexibility market mechanisms for DSOs.
- Another mentions the need to run pilots related to the use of locally geographically located flexibility provision at the level of the DSO.

As in the previous topic, a clear way forward is not in place.

One regulator illustrated the problem by using the example of EVs. Some of the new loads, such as electric vehicles, present a higher simultaneity factor that conventional loads. Under slow home charging, one may expect that most vehicles will be charging starting from the evening and through the night. However, the grid has been dimensioned considering a conventional simultaneity factor. The question is that under the new situation, consumers may not be exceeding their contracted capacity, but the grid is overloaded due to an increase in the simultaneity factors. Whose responsibility is it? Should the DSO reinforce the grid and charge to consumers even if they did not exceed their contracted capacity (again this would definitely anger consumers) or should the DSO bear the cost, jeopardizing its financial status? Now, even if the consumers agree to pay for this in the beginning, eventually, the network constraints will spread throughout the grid from the LV feeder to the transformer, to the MV grid (causing investment costs to increase more and more).

> *What is a good alternative? Smart charging. The DSO must enable this business model, for example through a local market. So we must look for this kind of solutions and we need more pilots and have more experiences about this. For me, electric vehicles will be the first type of consumption that will require business model 2 to be put in place and smart charging is a good solution*.

TSO-DSO cooperation (related mostly to BM5.3)

One regulator said that indeed TSO-DSO cooperation is needed when distributed flexibilities are widely used. He saw this cooperation as hard to achieve because these two operators have very different “operational cultures” and are used to living “in isolation”. Nonetheless, he states that the reality and technology changes will force them to get closer and their boundaries may become less clear.

Incentives to improve reliability (mostly related to BM2: preventive maintenance and, especially, fault location)

Several regulators mention they already have in place incentive to promote continuity of supply improvements and that this is a mature regulatory mechanism. This is seen as a complement, many times small in comparison to the overall DSO revenues, but that provides a clear signal regarding where DSOs

should orient their efforts. Indeed, one of them mentions that this incentive allowed reducing continuity of supply indicators from being twice the European average, to this average in a period of 15 years. In the regulator's viewpoint, this is a success story of how a modest monetary incentive as compared to the overall revenues can drive an important change simply by giving a clear direction of where DSOs should orient their efforts.

On end-user flexibility and prosumers (relation to BM1.2, and BM4, especially BM4.2)

The discussion on this topic focuses on the functioning of retail markets and the potential/interest of end-user to adapt their consumption to prices signals, considering both ToU tariffs and dynamic tariffs. All regulators agreed that this is a complex problem to solve. In fact, one representative said that "unlocking end-user flexibility is probably the hardest change to materialize."

Generally, all regulators acknowledge that this is a particular challenge for residential consumers. Larger consumers, such as industrial consumers are normally quite responsive to price signals. As on NRA representative said, large industrial consumers have proven their flexibility in the past, when after a change in the tariff structure, the industrial demand adapted to follow the new time of use periods. Thus, industrial demand can be considered to be optimized.

Overall, regulators raised similar **barriers** to unlock the flexibility of residential consumers. Three different NRA members agreed that the change requires a push from market agents (retailers/ESCOs/aggregators). Nonetheless, not all of them shared the same view of the current situation in their countries.

- One of them said that, whilst small new entrants where the main driving force in the retail market at the moment, the largest retailers are also very active, possibly to avoid losing market share. Thus, they believe that market concentration is not a barrier to innovative energy services. In this case, they believed that the main barriers are related to end consumers themselves. Nonetheless, they believed that this is also changing as shown. For instance, the increase in the price of guarantees of origin points to an increase in consumer awareness and interest in sustainability.

- However, another NRA representative had a more negative view of the situation in his country. He stated that retailers are rather passive so far, and that even new entrants were not very innovative. What is more, this regulator mentioned that retailers have even created obstacles to enable the participation of consumers in pilot projects or to introduce some regulatory changes. From his viewpoint, it is newcomers with disruptive business models (digitalization, load automation), such as independent aggregators offering, that will drive changes in the retail market. Nonetheless, he mentions they are aware they face relevant barriers that need to be overcome over the next ten years.

- Equally pessimistic, a third NRA representative mentioned that promoting end-user flexibility is central. In fact, based on a study performed, they see a huge technical potential in the automatic control of the heating systems of residential consumers. What is more, the study showed that this is cost-efficient, bringing benefits both for consumers and the power system. However, from his viewpoint, two things are missing: the interest from end consumers, and a well-developed ESCO or aggregation sector.

  They described the situation as a vicious circle. New companies fail to have a viable business case due to insufficient customer engagement or interest. Since these consumers are not offered an easy and beneficial service, they do not become interested in participating. In order to break this circle, the regulator is thinking about the possibility to implement measures to enhance end-user

information and awareness, as well as possible subsidies for the required control equipment. Additionally, in order to make it more beneficial for consumers, they are also working on reforming the electricity tariffs.

A barrier to the development of the retail sector that is usually mentioned is that the existence of default or last resources tariffs can be an unfair competition to retailers. One regulator mentioned that this is held by several of their national stakeholders. However, the regulator representatives believe this is not a major issue as the existing default tariff leaves significant room for retailers to offer alternative tariff structures that end consumers may see more attractive.

Another topic that was addressed by two representatives from NRAs is that of **self-generation**. One of them mentioned that, in spite of an increased end-user interest in sustainability, they believed that the potential of residential self-generation is moderate and its impact at system level will be rather limited. Another NRA representative, focused on collective self-generation. He deemed reasonable to allow it as a step forward in the development of citizen energy communities. However, net-metering ought to be avoided. In his opinion, the balance between local generation and demand must be made with a high time granularity accounting for the value of the energy in each moment. Additionally, he sees net-metering as a barrier to flexibility, and storage in particular.

On tariff design (related to BM4, specially BM4.2)

Tariff design, and specifically the design of the regulated component of retail tariffs, is a key topic across several business models. Nonetheless, it is particularly relevant for BM4 and especially BM4.2 as residential consumers usually bear a larger share of regulated costs both network-related and otherwise. These regulated costs include both network costs and other regulated costs, i.e. fees and policy costs, which largely correspond to RES costs.

Overall, regulators coincided in the need to revise how tariffs are set to ensure they are suited to promote demand flexibility. One regulator even summarized the main short-term changes they would like to see implemented: i) excluding policy costs from regulated tariffs to avoid distortions, and ii) introduce a time-discrimination in the LV tariffs (capacity component). Two other regulators, on the other hand, specifically referred to the need to implement dynamic tariffs to unlock demand flexibility.

However, they all mentioned in one way or another that changes should be progressive and well supported with studies to prevent unexpected or undesired effects. In fact, at least two regulators mentioned the need to carry out pilots with alternative tariff designs to learn more about the behavior of end consumers. In this regard, dynamic tariffs were mentioned as interesting by two regulators, which again mentioned the need to perform pilots with this type of tariffs.

Nonetheless, they mentioned several barriers to achieve these changes:

- Lack of adequate data to perform the required analysis and calculations. In particular, since the roll-out of smart meters is relatively recent or incomplete, historical data is limited to ensure a robust tariff design.
- Most regulators mentioned different types of institutional barriers such as the lack of resources to make sound analysis supporting change in the tariffs or legal limitations in what they can do as a NRA. Either because they do not have legally the responsibility or capability to set the tariffs or at least detailed guidelines on how to design them. Other types of institutional barriers that were

mentioned include the resistance or lack of interest from policy-makers, concerned about the impact of tariff changes on some consumer groups, or incumbent retailers, interested in retaining the status quo. This last idea was expressed as follows:

"Do they (conventional retailers) want to have dynamic tariffs? No. They think it would be better If they were able to have their margin without having to change or implement actions."

- Another regulator mentioned that some large consumers complain that setting regulated tariffs on consumers and not on demand can create barriers for their participation in balancing markets. However, they did not consider this topic very relevant, partly because they see a limited potential of demand in balancing markets (as discussed below).

On metering data management (relevant to all BMs, but in particular for BM3):

This topic addresses the possibility to grant access to metering data to different companies who would exploit these in order to provide data-based energy services to consumers as well as other stakeholders, i.e. using metering data for more than merely billing end consumers.

Overall, granting access to metering and other consumer-related data is seen as a positive step to promote well-functioning retail markets and enabling innovative services for end consumers; some countries are already in the process of creating a central data hub. A key benefit mentioned by several NRA representatives is that these platforms remove unfair advantages for incumbents and level the playing field for retailers and ESCOs regardless of their size. However, the discussions with regulators showed that they perceive important barriers.

Several coinciding in referring to the European GDPR as a very important barrier. In fact, nowadays even regulators and incumbent retailers have important limitations in accessing certain type of data. Thus, a NRA member said that, from his viewpoint, it will be hard for the role of the data service provider to develop. Yet, this could be changed provided that metering data is anonymized and aggregated so that players can use it.

When asked who could act as data service provider, ESCOs are the first type of stakeholder that comes up. In fact, one regulator specifically stated that they have received a lot of interest from ESCOs to access the metering data. In addition to ESCOs, one regulator stressed that the role of data service provider could be perfectly played by retailers, aggregators, or even new entities with disruptive business models. However, a different NRA representative stated that they do not find much interest from the incumbent energy companies in the development of a data hub. This person believed that the data hub would particularly useful for new entrants. However, since this sector is not fully developed in their country and could not contribute to the process, there is a risk in developing the hub and its specifications without a clear view of what they may actually need. This reinforces the idea, mentioned by other stakeholders, of enabling participative fora where the requirements of all incumbents are taken into account.

Another issue that some regulators mentioned is that some stakeholders would require more than simply the metering data to correctly fulfil their goals. One of them remarked that some BMs, e.g. some aggregators providing services to the DSO, may require locational information, which is in the hands of DSOs, together with metering data. On the other hand, another NRA representative said that the main benefit for retailers lies not in accessing the metering data, but in receiving information about the specific tariff of each consumer to be able to prepare better commercial offers. At the moment, due to the lack of

such information, retailers make these offers exclusively based on the wholesale market price, which is not the actual price seen by end consumers.

A last relevant topic is who should be the data manager operating these hubs or platforms. In one case, the decision had already been made and it is the TSO. In another case, the regulator stated that this role does not necessarily need to be within the DSOs. This NRA representative considered that an independent company, provided it hired the adequate know-how, could do it as the ownership of the smart meter (by the DSO) is not a requirement to perform this role.

Opening balancing markets to demand and DER/aggregation (BM4.1, BM5.1 and 5.3)

Regulators generally saw opening the balancing markets to demand-side participation as a positive and necessary step. In fact, in all cases, balancing markets are either already open to demand, even if only as a pilot experience, or will be open very soon. A first question that is relevant is **what type of demand** may be more willing or have the biggest potential to provide balancing services.

The interviews showed that the answer to this question depends on the conditions in each country. Two regulators pointed to industrial consumers before commercial or residential ones. One of them stated that "*industrial consumers will be the first ones to participate. This may be different in other countries with a higher electrification rate of heating demand or a less flexible generation mix."* This regulator seemed to be right as another NRA representative, on the contrary, stated that in their country the biggest potential was to be found in residential heating demand, as discussed before.

The next topic addressed in the interviews was whether this business model was seen as viable or promising, as well as the **outstanding barriers that exist today**. The responses from the regulators showed that, even if regulation opens demand-side participation, the appropriate **market conditions** for demand flexibility will not be achieved immediately.

- One regulator expressed serious doubts about the potential for demand participation to develop and be competitive against generators in balancing markets nowadays. Firstly, the national balancing market is quite competitive due to the high ratio of installed generation capacity over peak demand and the high share of flexible generation. Because of these, balancing prices remain rather low. Thus, demand-side providers would have to compete and fund the required investments with a low and uncertain income. However, they think that when the security margins are adjusted following the European regulation and when RES penetration grows, the need for flexibility will increase, offering a chance to demand-side providers.

  The same regulator acknowledged that part of the problem is that existing balancing products are essentially designed for large generators. In this regard, an open question is whether ad-hoc balancing products for demand should be defined or whether they should be technology neutral to let all flexibility providers compete on equal grounds. The have received requests from industrial consumers naturally to do the former as they would like to have long-term procurement process as well as longer delivery periods. However, the NRA representative said that, in their opinion, balancing products should be technology neutral and tailored for the needs of the power system not specific agents. For instance, procurement periods for balancing products are actually becoming closer to real-time, as opposed to what industrial demand requires. This regulator expressed that demand may be better suited to provide congestion management services instead.

- Another regulator, in spite of clearly stating that this is a necessary step, mentioned several challenges when discussing their national experience. Opening balancing markets has been a long process. They first tried on their own initiative to run a pilot a few years back, but failed to achieve it due to the lack of interest from industrial consumers. Large industrial consumers had adapted their consumption to ToU tariffs, but saw no benefit in adapting their systems again for a service that is much more complex and uncertain. Additionally, other stakeholders did not seem to support this change, from his viewpoint, due to reluctance to change and conservatism.

  They finally tried again and succeeded recently. The trigger this time was an industrial consumer asked for this possibility who saw it as a potential revenue stream after losing others. At this point, they prioritized simplicity. Thus, industrial consumers may provide in upwards reserve, no aggregation permitted at this point, competing against generators under the same rules. So far, the participation rate is even higher than expected. If the experience turns out to be positive, the next step would be to accept aggregation.

The Clean Energy package promotes the creation of **independent aggregators** operating alongside conventional retailers. All the regulators interviewed had this topic in their minds and said it was among their short-term priorities. However, several of them expressed some concerns about opening this possibility.

- One NRA member mentioned that they perceive interest in some national stakeholders to develop this figure. However, the regulator is a bit reluctant to act fast on this topic. On the one hand, they mentioned that the fact that some countries already created this agent in their national legislation is hampering the harmonization of electricity markets. Moreover, they are concerned that, given the importance and complexity of allocating balancing responsibility, if they opened the possibility to have independent aggregators, it would be hard to revert this decision if it does not work as expected.

- Another NRA representative stated that they would develop the legislation concerning independent aggregators in the short-term, clearly differentiating the figures of BRP and BSP. Nonetheless, he stressed the need to ensure that balancing responsibility is properly allocated. From his viewpoint, any piece or regulation can be revisited as long as three pillars are maintained: all stakeholders must pay the corresponding share of taxes, network tariffs and imbalances.

- A third NRA representative stressed that they are working intensively at the moment, including consulting with national stakeholders and other NRAs, to develop the regulation on independent aggregators. However, they expressed several concerns to ensure they work properly alongside conventional retailers without undue costs for new market agents. In fact, this regulator used the terms “worried” and “nervous” as they see it difficult to transpose the contents of Directive 944/2019 without disrupting the electricity market. They are concerned that after a long and hard process, in the end there will be no significant benefits for the system. Thus, they would like to create a simple and sensible framework; in other words, *“something that could work for consumers and enable aggregators achieve savings for the system”.* Nonetheless, they also mentioned that after solving this issue, additional work will be needed to ensure that the aggregation market actually develops.

On pilots and sandboxes (cross-sectional topic)

When this topic was discussed in the interviews regulators agreed that pilot and sandboxes are useful for them. In fact, some of them had already implemented some pilots. The sandboxes/pilots mentioned

addressed two topics, which are intimately related to the Integrid BMs: innovative tariff designs, and demand-side participation in balancing markets.

Regulators expressed their interest in being legally entitled to set up sandboxes. Even one regulator who already may implement some pilots stated that they would like to extend these to other topics or implement them at a larger scale, but they are legally limited to do so. In order to change this situation, at least two regulators mentioned that they were discussing this topic with their governments.

One regulator expressed a couple of concerns concerning sandboxes, especially when these are related to sharing metering data among stakeholders using platforms similar to the gm-hub. It is important to ensure consumers do not oppose the idea. Electricity costs are a sensitive issue for the public opinion and problems should be avoided in this regard (either due to privacy or fears of potential increase I the price). However, at the same time, if implemented correctly, sandboxes could be used to overcome these barriers.

On challenges and barriers to do their job as regulators (cross-sectional topic)

Several regulators mention different challenges when trying to adapt national regulation in line with the European legislation and the requests from agents. They all state the clear need to facilitate the energy transition and the BMs described in the project, but they raise several difficulties:

- Regulation moving faster than its actual implementation. For instance, one regulator mentioned that their main concern in the short-term was how to implement fully the third energy package from 2009 and the network codes. This interviewee also claimed that some of the business models are too advanced as compared to the reality of the system functioning. They phrased it as follows[18]:

  "*we are sometimes asked to regulate based on expectations rather than on realities*".

  Another mentioned that the Clean Energy Package is trying to anticipate this future, which is necessary. However, he mentioned that it is important to connect the reality of the sector and what is expected to happen in order to prevent barriers to the future. He described their role in this process as not being a barrier for the future changes.

- Another mentioned that their responsibilities as regulators are growing, but they are not allocated enough resources to carry them out as desired.

In another case, the regulator claimed that they would like to have more competences in some regulatory aspects, e.g. enable pilots/sandboxes or provide guidelines for regulated tariff design.

Main takeaways and barriers

Overall, the regulators interviewed mentioned very similar challenges to the ones already discussed for the development of the BMs. The most relevant differences were essentially related to the characteristics of national wholesale and retail markets, i.e. the characteristics of generation and demand in each country, and the attitudes of incumbent electricity companies. Three most common challenges that popped up repeatedly were to remove CAPEX bias in DSO revenue regulation, adapt tariff design to enable/promote flexibility, and enable independent aggregators whilst preserving balancing responsibility.

Nonetheless, regulators raised several institutional barriers for them such as the uncertainty about a clear way forward for some regulatory topics (e.g. DSO revenue regulation or independent aggregation), or the

[18] Quote edited for readability.

challenges to perform their duties (legal or resource limitations). Lastly, several mentioned the need for a progressive implementation of the regulatory changes, particularly when this affects sensitive issues such as the tariffs or balancing market functioning.

Table 10: List of barriers raised by aggregators

Main barriers	Technological	Regulatory	Organizational/ Behavioural
BM1 (DSO)	-	CAPEX bias in DSO revenue regulation Lack of local flexibility mechanisms (coordinated with grid tariffs)	-
BM2 (DSO)	-	-	-
BM3 (DSP)	Metering data is insufficient for some data services (need to include tariff or network information)	Strict data protection regulation hampers data access	Lack of interest from incumbents and immature market for data
BM4.1 (ind. Cons.)	-	-	-
BM4.2 (resid. Cons.)	Lack of historical metering data to support tariff design changes	Tariff structure that does not promote flexibility Limited potential for self-generation	Consumers not interested in changing their behavior: lack of information, small benefit perceived Static/conservative retail market and reluctance of incumbents to change Limitations to test and implement innovative tariff designs
BM5.3 (cVPP)	-	Balancing products and procurement unfit for demand-side resources Undeveloped framework for independent aggregators Insufficient or uncertain revenues due to market conditions	TSOs and DSOs used to operate without coordination Regulatory changes need to be progressive and carefully implement to avoid distorting the markets
BM5.4 (tVPP)	-	CAPEX bias in DSO revenue regulation Lack of local flexibility mechanisms (coordinated with grid tariffs)	-

Cross-sectional	-	Rapidly changing regulation that goes ahead of the market development	Legal limitations for NRAs to set-up pilots and sandboxes Limited resources for NRAs

4.3.10. TSOs

Although TSOs are not directly researched within the scope of InteGrid, they are an important stakeholder in several HLUCs, and therefore, BMs. In some of them, they are a central player, as in BM5.1, for instance, in which the commercial VPP participate in balancing markets. In other BMs, the TSO may not be directly involved, but still be impacted in its operations. That is the case of BM1, for example. When the DSO procures and activates local flexibility for its own grid management, this may indirectly impact the TSO.

For this stakeholder consultation, professionals from the four TSOs in the four target countries[19] were consulted. As with all other stakeholders, their opinions do not represent the TSO's positions, but rather express their concerns and expectations as senior professionals in their companies.

Firstly, the TSOs were asked about the impact that the BM1 could pose to their operations. BM1 was described to them as the procurement of local flexibility by the DSO for grid management purposes, being those local congestion management and voltage control, mainly. In broad terms, it was explained this procurement could happen both in the low and medium voltage. Among the benefits of this BM1, is the fact that DSO could be able to manage some level of constraint in the grid by the procurement of local flexibility, allowing the DSO to differ investments in the grid, leading to an overall positive benefit[20]. The four TSO considered this BM1 relevant for them, although they are not directly involved. They mainly expressed their concerns and the need for an enhanced coordination as the DSOs start implementing this BM.

Firstly, TSOs expressed their concern regarding the market mechanisms used for the procurement of the local flexibility by the DSOs. Two participants expressed their skepticism regarding local markets to solve local congestion specifically by the procurement of active power (upwards or downwards). Both interviewees mentioned that congestions should be exceptional, and not part of the daily operation of grid operators.

> *In my opinion, the networks can accept a certain level of congestion. But in reality, I don't believe that it is possible to manage the network where we have congestions every day. It must be exceptional.*

Another interviewee also mentioned that creating a situation where congestion is common actually goes against high principle goals of the EU Internal Energy Market. He mentions that it is true that the Clean Energy Package (CEP) tells that DSOs should aim at procuring resources at the distribution to solve congestions and manage the grid, but it says to do so when this is economically efficient, this imposes an important nuance to the problem. In Europe, the higher-order goal is the building of a single internal energy market. Therefore, it is important to reduce congestions, in order for units to be able to participate in a single market. Therefore, congestion management markets and mechanisms should be the last resort. He

[19] Only one TSO exists in each of the four countries.
[20] For a numerical analysis of this BM1, we refer the interested reader to InteGrid's deliverable D7.4, in which a CBA is calculated for this BM1.

also mentioned that when DSOs reduce their investment on network, counting on the flexibility for congestion management, they are also reducing the future possibilities for DER to provide balancing services in a much larger, competitive market.

Considering that congestions, and therefore procurement of flexibility for congestion management, are exceptional, one interviewee also questioned the economic viability of this BM, specifically regarding local congestion management. The first problem would be the low liquidity of such local markets.

> *The market for flexibility is in balancing. The TSO is already are using balancing markets to balance the system. And of course, we perform congestion management. But the congestion management part is a very small part of the global use of flexibility*.

But beyond the problems that the local flexibility markets may face themselves, the TSOs also commented on the challenges the implementation of such markets would pose to the already existing markets. One concern for them, extensively mentioned by three interviewees, is on the liquidity of all markets. One interviewee mentioned that by creating more local markets, liquidity will be even more fragmented. He says:

> *You are adding even more market layers to the already existing day-ahead, intraday, mFRR, aFRR and RR. So, what I think could be a challenge is that we split the liquidity.*

Another participant also mentioned this problem, as he reckoned that, in some way, we could be exchanging the DER participation in European markets for DER participation in local, illiquid markets, therefore reducing the overall efficiency. We could be creating some benefits at the management of distribution grids by differing some investments but creating a deeper inefficiency for the whole system. Another participant also noted that, in a way, there is sort a paradox in the sense that the Electricity Balancing Guidelines are aiming at European balancing markets, but at the same time we are proposing local, fragmented markets.

The discussion over BM1 also led to the topic of security of supply. As of today, the TSO is the responsible to ensure the security of supply, and for that matter conducts daily forecasts and studies (power flow, N-1 assessments) to ensure that operation is secure. With that regard, one participant mentioned that once DSOs start using flexibility, the TSO will have less certainty on the future grid conditions, and therefore, it may become harder for the TSO to ensure this security of supply. In this context, TSO-DSO cooperation becomes very important. This responsibility for ensuring security of supply will be share by the TSO and the DSO.

In addition to the discussion on local congestion management, it is important to notice that one participant mentioned that voltage control is something that makes much sense for the DSO to procure from local providers. He mentioned that TSOs and DSOs are responsible for the voltage at the interface substation, and that local voltage control is something that would not impact so much the operation of the TSO. Nevertheless, he also questioned the financial viability of this type of procurement, mentioning that in most countries this is still a non-remunerated service.

The four TSOs were also asked about BM4, more specifically on the participation of demand response in balancing markets. One participant clearly stated that from the TSO perspective, it is important that demand response and active consumers provide balancing services. This will bring more players to the markets, and hopefully more efficiency. Nevertheless, the same participant said the way it is being done

poses challenges. He commented that the EBGL[21], for instance, aims at a fair treatment of generation, demand for balancing for participation in balancing, although these sources are very different. Also, demand participation, however, will not be homogenous across participants, with different models coexisting. Industrial consumers are expected to have an easier integration, while small consumers will be harder to integrate. For consumers, especially residential, electricity is not their core business or a fundamental part of their households' costs. Another important point raised by this participant is that balancing is a critical service for the system, and once it is procured, its delivery must be fulfilled. This may be seen as risky by the consumers and therefore affect their willingness to participate.

Regarding the difference among different types of DER, one interviewee pointed out that it is important to think is on how TSOs and DSOs will combine their needs, as they may need very different things in terms of flexibility. DSOs may want flexibility for some hours, while for the TSO the speed of activation is very important: "maybe it's not always easy to use the same flexibility for both the TSO and the DSO".

Another participant also commented on the need for the TSO to be able to verify if the demand response is providing balancing or not. For this participant, it is essential that the TSO is provided with sufficient **observability.**

> *We need observability of resources. And we need to check if the balancing service providers are doing what we expect them to do (…) So we need more data from the consumers and from the producers. The DSO needs it and also the TSO*.

A third participant also commented extensively on the need for enhanced observability, so that both DSOs and TSOs can procure services from DER. For the TSO particularly, the granularity of the information must be increased. According to him, even for the provision of tertiary reserve, a time resolution of 1h is not enough, it would have to be around 5 minutes to ensure that the TSO can cope with its main task that is ensuring the system's security of supply. Another participant also said something very similar, reinforcing the need for observability with a fine time resolution:

> *I don't like the idea of activating that resource and I don't see what the resource is doing. But I believe they actually are doing what I said, they have to do. But I don't see that. And I want to see it immediately. I mean, immediately. As immediately as in one minute*.

According to the first participant, smart meters alone cannot provide the required data at the required speed. And replacing all of them will be costly and will take time. He mentions that achieving complete observability of the distribution grid is probably not possible. However, he suggests that good observability could be achieved with a combination of the input from several sources of measurements: AMI, smart meters, pseudo-measurements like load profiles, and for accuracy, maybe the most relevant one can be micro-PMUs (phasor measurement devices) that can measure near real-time. This combination can enable near to real-time solutions, necessary for balancing services.

Given these difficulties imposed by observability, one participant mentioned that tertiary reserve would be the most appropriate product to "start with". Secondary reserve can be considered a somewhat more "complex" services, as more complex hardware (automatic regulators) is involved. Therefore, in addition to the additional hardware and software, the participant mentioned that some internal resistant could take place in the TSOs, as changing the architecture is not trivial and involves risks for a more sensitive service.

[21] Electricity Balancing Guideline.

Finally, the discussion on the participation of demand response in balancing markets automatically led to topic of **aggregation,** and therefore to BM5. Participants mentioned that aggregators are necessary to enable the participation of DER in balancing markets. However, they also identified the challenges for this new agent.

Firstly, two interviewees mentioned the necessity of better definition of roles for aggregators, BRP, and BSPs, and that regulation plays an important role in this definition. Secondly, one interviewee expressed his worries regarding aggregation of resources very disperse among each other. This way, this would also make the forecasting more difficult for the TSO, as the break-down of aggregation would not be seen by the TSO. Maybe a "zonal aggregation" would be better for the TSO, according to this participant. If the TSO cannot know where the generation/flexibility is coming from, it is much harder to forecast the grid.

> *For me, it's strange to have a virtual power plant with a wind farm in Paris and an industrial consumer in Marseille*[22].

Big VPPs may also be a challenge for the TSO, according to this participant. As of today, retailers and generators have to submit their daily programs. If aggregators are not obliged to submit their programs (assuming that do not have one, but rather operate close to real-time), a big aggregator could have a big impact over daily programs calculated by the TSO. In this context, with poor forecasts, the TSO will be obliged to adopt a completely reactive position[23]: do nothing and wait for the real-time. And that is probably not the most efficient solution, according to the interviewee.

Another participant also expressed concerns about forecasting difficulties, but this time from the VPP point of view. He mentions that with more active consumers in the grid, forecasting will be more difficult, and aggregators may have more difficulty in properly forecasting and biding into the market. His concern is due to the fact that balancing is a critical service for the system, and once it is procured, its delivery must be fulfilled.

One participant also expressed his concern about the prequalification process. If various DERs are aggregated, it is complicated to prequalify these assets. New and easier solutions are needed, according to him. Not only to provide the TSO with the necessary security, but also not to be a burden to the aggregators.

> I would like to have a focus that it should be as easy as possible for the provider to participate in the markets

For that reason, he mentioned that there is need for enhanced coordination between TSO and DSO in prequalification process.

Finally, participants also agree on the need for enhanced coordination between TSO and DSO in the operation as well. The TLS was recognized by one interviewee as an interesting mechanism that could help in this coordination. He mentioned, for instance, that the DSO will not be able to validate activations in real-time, given that balancing products are very fast.

[22] The names of the cities were changed to avoid the identification of the respondent.
[23] TSOs approach on balancing is usually classified as proactive or reactive. For a better explanation on this concept, we refer the reader to the Deliverable D7.2, on the regulatory barriers and recommendations.

Table 11: List of barriers raised by TSOs

Main Barriers	Technological	Regulatory	Organizational/ behavioural
BM1 (procurement of flexibility by the DSO)		- Inefficiency of local markets for congestion management - Split of liquidity between TSO and DSO markets - Forecasting becomes more difficult for the TSO - Sharing security of supply responsibility between TSO and DSO	
BM4 (DR participation in balancing markets)	Lack of observability of the DR as BSP	- Prequalification needs - Product definition	Reluctance to incorporate DR in sensitive and more complex services (aFRR, FCR)
BM5 (Aggregation - VPP)		- Unclear or unspecified role definitions for VPP/BRP/BSP - VPPs may create difficulties for TSO's forecasting	

4.4. Other actions where institutional stakeholders were engaged

The personal interviews and their analysis, as presented in the previous sections, constituted the central means for consultation among institutional stakeholders. Nonetheless, inputs and feedback of relevant stakeholders was also collected through the organization of some events throughout the consultation process. In particular, a European workshop about business models was specifically organized for this purpose as requested in the DoA. This section presents a summary of these workshops and the key conclusions.

4.4.1. Workshop in Ljubljana in June 2019

In June 2019, an InteGrid workshop was conducted in Ljubljana, presenting the project to several local stakeholders, including industrial consumers, DSOs, retailers, and one representative from ACER, apart from the InteGrid consortium partners. In this occasion, a presentation on the InteGrid business models was made, to which participants could give their feedback.

In order to initiate a discussion, polls were used, and the opinion of participants collected. In total, 21 attendees voluntarily participated in the polls. Four multiple-choice questions and one open question were used during the workshop. Each multiple-choice question had four possible options. After having the results from each question, a live debate was proposed and participants engaged in a joint discussion. On the ensuing, the results of the polls, which reflects the opinions of participants in high level aspects of several business models, are presented. Note that not all stakeholders answered all the questions.

- Question 1 (BM1, BM4, BM5): What is the main challenge to be overcome for end-users to provide their flexibility?

Table 12: Workshop Ljubljana June 2019 – answers Q1

Answer options	Results
Regulation is not well defined yet	7
Aggregation is needed to unlock the DER flexibility potential	4
Volatility and uncertainty of markets	2
Others	3

- Question 2 (BM1): What is the main barrier for DSOs to use the potential of DER flexibility?

Table 13: Workshop Ljubljana June 2019 – answers Q2

Answer options	Results
Economic incentives for DSOs are still not in place	10
Coordination between TSO and DSO must be enhanced	1
Difficulties in defining local markets (unit size, liquidity)	1
Still very few DER flexibility providers	2

- Question 3 (BM5): What is the main roadblock for the development of aggregation, especially, the VPP concept?

Table 14: Workshop Ljubljana June 2019 – answers Q3

Answer options	Results
Little money in aggregation (very large portfolio is needed)	4
Undefined rules between aggregators and BRPs	1
Infrastructure between meters and aggregators' systems	1
Aggregation of different types of DER is still not allowed	0

- Question 4 (BM3): What are the barriers to common platforms (grid and market hub) to deliver their potential?

Table 15: Workshop Ljubljana June 2019 – answers Q4

Answer options	Results
Cybersecurity issues	0
Low interest by end-users to use the platform \ provide data	6
Privacy data compliancy	2
Other	6

Despite the limitations in the sample and number of questions posed, taking together, the outcomes of this poll reinforces the conclusion of the stakeholder consultation. The main barrier for the development of the business models related to the use of flexibility are deemed to be related to regulation. This seems to be particularly noticeable when referring to the lack of incentives for DSOs to resort to flexibility in order to avoid or defer grid investments, i.e. the aforementioned CAPEX bias.

Another key takeaway from this poll is that, whilst aggregation is seen as a key activity to unlock the flexibility potential, respondents mention that market conditions, more than regulation of technical challenges, hamper its development. The reason would be that the revenues from providing flexibility services through aggregation are deemed insufficient unless a very large portfolio is managed.

Lastly, this poll, similarly to the viewpoints of some of the stakeholders interviewed, shows that even if central data platforms are set-up in order to foster the creation of new data-driven business models, the reluctance or lack of interest from end-users to provide the data and/or receive the corresponding services can render them useless.

4.4.2. Workshop with AEGE (Spanish Association of Large Consumers of Electricity)

On September 26 2019, Comillas and AEGE (Spanish Association of Companies with a Large Energy Consumption)[24] organized a workshop about the new opportunities for industrial demand in the areas of decarbonization and the provision of flexibility services to grid operators. In this workshop, InteGrid members presented some of the new opportunities that industrial demand may find in the provision of services to TSOs and DSOs as well as some of the solutions tested in the project for these purposes. Particular emphasis was placed on the work done in relation to regulation and business models and how these may evolve in the next years.

This topic was particularly timely in the Spanish context due to the combination of several factors: the remuneration of interruptibility services procured by the TSO has been progressively declining and it is expected to disappear in the near future, the Spanish TSO planned on opening balancing services to demand-side participation in the first semester of 2020, several Spanish industries were interested in knowing more about the Portuguese pilot experiences, and the government was developing a new set of rules for large electricity consumers (in order to enhance the competitiveness of the national industry).

The event had around 40-50 registered participants including large industrial consumers, academics, and other stakeholders of the Spanish power sector (retailers, utilities, ESCOs). The following bullet points summarize the main feedback provided during the Q&A session held at the end of the event:

- In general, the industrial representatives seemed favourable to decarbonization and the provision of flexibility services within their capabilities. Representatives from cement companies were particularly interested in this possibility due to their low activity rate and large flexibility potential. However, the participation in balancing markets, at least under the existing rules, was generally deemed too complex and far from their core activities by all industries.
- This reluctance to participate in balancing markets was mostly related to concerns about the negative impact this participation may have on their processes. Several industrial consumers mentioned that some market rules are not well suited for them and the balancing products specifically tailored to the possibilities of the industry should be implemented. This raised a dilemma on whether balancing products should be standardized to create a level playing field or whether this should be adapted to the needs of each provider. This is a particularly hot topic in Spain because interruptible demand contracts, being phased out, used to provide large industrial consumers with significant cost reductions.

[24] The list of speakers included Tomás Gómez, Timo Gerres, José Pablo Chaves, and Rafael Cossent from Comillas University, and Teresa Rasero (President) and Fernando Soto (Director General) from AEGE.

- In fact, participants said that demand may require specific products indefinitely, i.e. not only at a transition stage, and that creating a level playing field may not work for demand. One participant used the example of an arc furnace that could not participate in the pilot project in Portugal because the bids needed to be divisible, whereas the arc furnace could only be switched on and off and this would represent a flexibility of 80MW up or down all at once.
- Grid/regulated tariffs were also seen as a potential barrier by some participants. These tariffs are usually paid by demand only, and this fact could affect the potential competition between generation and demand in the balancing markets. This strict regulatory differentiation between generation and demand could also affect investment decisions in storage technologies.
- Lastly, one participant mentioned the need for regulatory sandboxes in some cases. Otherwise, some consumers, according to current regulation, could even be penalized from providing grid services, e.g. deviating from setpoints of power factor in order to provide voltage control services.

4.4.3. European workshop

According to the DoA, a European workshop had to be organized. It was initially planned to organize this workshop in the context of the European Sustainable Energy Week on June 2020 (EUSEW 2020). However, due to the COVID-19 situation and the subsequent cancellation of all physical events, it was necessary to develop an alternative plan. Instead, a webinar was organized on May 19th 2020. In order to maximize the attendance and dissemination of the event, it was organized as an ISGAN activity.

This event was organized with the title *"New business models to distribution grid stakeholders under high penetration of DER"* and had speakers from EDP Distribuição, Comillas and INESC TEC. The agenda of the webinar is shown in Table 16.

Time:	New business models to distribution grid stakeholders under high penetration of DER	Presenter	Afiliation
10min	InteGrid – Addressing the challenges of the DSO	Ricardo Prata	**EDP-D**
20min	InteGrid – New business models for distribution grid stakeholders	Rafael Cossent	**Comillas**
10min	InteGrid - Network operation tools enabling the use of flexibility	Ricardo Bessa	**INESC TEC**
20min	**Q&A**	-	-

Table 16: Agenda of the European workshop

Overall, 244 participants joined the Webinar out of 464 registrations from 58 countries in all five continents. The registrations included representatives from academia, research institutions, governmental agencies, industry, consultancy, manufacturing, grid operators, utilities, technological companies, and regulators.

Two forms of consultation were implemented in the webinar (further details can be found in Annex III):

1. Several questions were prepared in advance so that the audience may address them in advance or discuss them during the Q&A at the end of the webinar
2. An online survey was created and participants were invited to fill it in.

Given that this workshop was organized in the final stages of the consultation process, around 1.5 months before the expected end of the project, it gave us an opportunity to collect feedback on some of the most innovative/incipient BMs that, as a consequence, were not fully developed at the time of the previous

consultation. In fact, most of the examples of companies exploiting these BMs that were found correspond to firms active outside the four target countries included in the interviews. Due to this, some of them were identified or become more relevant later in the project.

These BMs correspond to i) companies, which could be assimilated to ESCOs or aggregators, that exploit behavioural demand response strategies to participate in electricity markets, ii) VPPs active in balancing markets, iii) platforms for metering data sharing and iv) platforms for managing local flexibility markets.

4.4.3.1. Q&A in the European Workshop

The Q&A session held at the end of the webinar provided some insights about some of the key potential barriers to the BMs discussed during the webinar seen by the participants. These are summarized in the following bullet points[25]:

- **Q:** Several questions were related to the **reluctance or lack of interest of some key stakeholders** in the adoption or participation in the BMs. More specifically, the questions expressed doubts or concerns about i) the involvement of end consumers, especially small ones, ii) the lack of support of some policy-makers to the regulatory changes needed, or iii) possible barriers posed by incumbents wishing to maintain the status quo.

  A: Indeed these are some of the barriers already identified, especially during the stakeholder consultation. Integrid addresses in particular proposes several solutions to facilitate the participation and engagement of end-consumers. On the one hand, the HEMS/BMS and active house solutions implemented in Portugal and Sweden aim to make things easy for consumers through load automation. On the other hand, the Local Life platform tested in Integrid explores the potential of behavioural demand response to drive end-users response through gamification, non-monetary rewards or environmental signals. The outcomes of both approaches will be compared to draw lessons learnt.

- **Q:** The **need to change regulation** was another relevant topic raised; more specifically, how to achieve these changes or how the role and business case for energy storage will be affected by regulation.

  A: In the European context, national regulation must be adapted to the Clean Energy Package in the short-term, and Integrid is aligned with it. Thus, the fact that regulatory changes do not happen is not a major concern, although the detailed implementation and lack of harmonization across countries might indeed be a barrier.

- **Q:** The topic that drew the highest number of question was, without a doubt, the **development of platforms to enable local flexibility markets and data exchange**. More specifically, questions addressed what the role of DSOs will be concerning the operation of these platforms and the level of integration of metering and network data.

[25] Note that this is only a high-level summary of the key discussions. The Q&A discussions comprised additional topics such as the CBA methodology followed, the future of CECs, or some details about the Portuguese experience integrating RES or deploying smart meters. Since these do not directly address barriers or drivers to the BMs, these are not described in detail herein.

A: Under the Integrid architecture, the gm-hub of serves both as a local flexibility platform and a data exchange platform and it is under the domain of the DSO for demonstration purposes. However, as shown during the presentation, this is not necessarily the case. In Europe there is a trend to adopt centralized and regulated data hubs not necessarily operated by different stakeholders different to the DSO. In this case, the DSO role, as the metering operator, is to provide the meter readings to the platform which manages the access. In the case of local flexibility platforms, these are still rather immature, so general conclusions cannot be obtained. Nonetheless, it was mentioned that an independent platform, acting as intermediary between DSOs and flexibility providers/operators, could facilitate the participation, especially when there are many different DSOs within a country.

- **Q:** Lastly, a couple of participants were interested on how to solve potential **interoperability and standardization issues** in relation to the development of the **data and market platforms**, as well as the data exchanges through them.

  A: The data exchanges in the gm-hub and the platform development are indeed based on standard formats to the extent possible. However, currently available standards do not cover all the required aspects of these platforms. The need of such standards is a lesson learnt of Integrid.

4.4.3.2. Feedback received through the on-line questionnaire

Webinar participants were asked to answer an online questionnaire about the feasibility of some of the BMs discussed and the barriers they believed were more relevant in each case (the complete questionnaire is provided in Annex III). In order to avoid having a very long questionnaire, the focus was placed on the most uncertain aspects of the BMs discussed:

Overall, a total of 18 complete and valid answers were obtained (approximately 7.5% of the attendees), which comprised participants mostly from Europe (78%), but also from the Americas, Oceania, and Asia. Almost half of the respondents work for an academic or research institutions, whereas the rest is distributed across ESCOs, grid operators, regulators, policy-makers, equipment manufacturers, utilities, and software companies.

On the use of flexibility by DSOs:

The first groups of questions addressed the feasibility and barriers for the use of flexibility by DSOs. In this regard, the first key question posed is whether respondents believe that DSOs will be able, and are actually willing, to procure flexibility services to defer network investments within a time horizon of 5-10 years (see Figure 6). Whilst most respondents do believe in this happening in the short-medium term, the ones who answered no indicated the reasons why they believe this. One of them mentions a long list of reasons, which include the technical complexity, the regulatory barriers, and the lack of interest from both DSOs and potential flexibility providers. The remaining ones believe the main reason why this will not happen is simply that DSOs will not rely on flexibility services as an alternative to grid reinforcements.

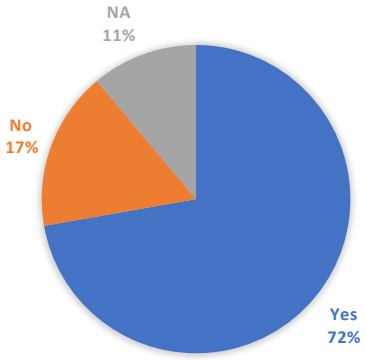


Figure 6: Will DSOs be able and willing to procure flexibility services in the next 5-10 years?

In fact, the reasons stated above by respondents who believe DSOs will not be procuring flexibility roughly match the most relevant barriers perceived by those who, in spite of these barriers, this will be a reality. It is relevant to note that all respondents who filled-in this question do see important barriers for the use of flexibility services to defer or avoid grid investments. The most relevant barrier pointed out, with a large margin, is the lack of regulatory incentives for DSOs to avoid grid reinforcements (i.e. CAPEX bias). Next, respondents pointed out to the cost and complexity of the communications and interoperability requirements and the reluctance of DSOs to adapt their operational and planning practices.

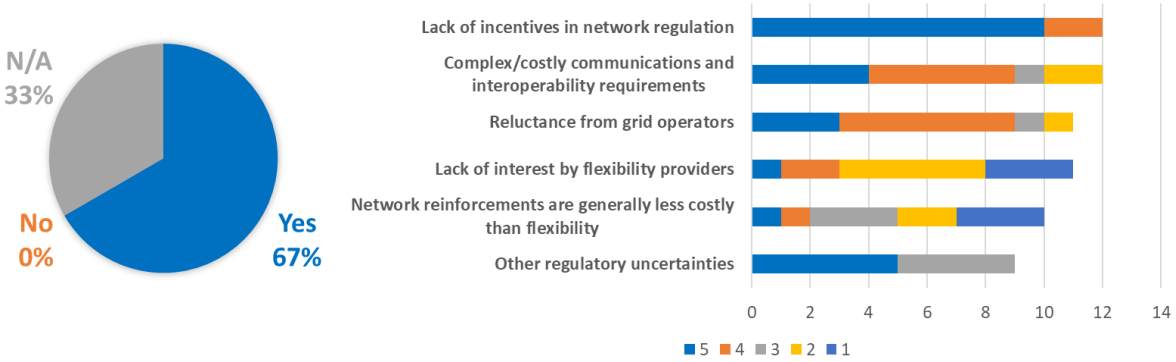


Figure 7: Barriers to the use of flexibility by DSOs

Local platforms for flexibility and data exchange:

The development of new platforms to exchange local flexibilities and/or data, as well as the new roles and business opportunities this could enable, was one of the key topics discussed during the webinar presentation and the Q&A session. A vast majority of the respondents believed these platforms can indeed create new business opportunities. What is more, most respondents believe these new business models could be based both on the use of local flexibilities and exploitation of data-based services (one respondent believed the BMs could only be based on local flexibilities and another one that these would be based only on data services).

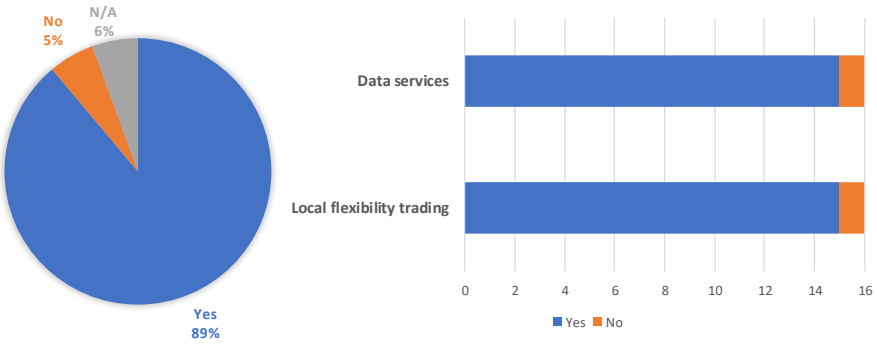


Figure 8: Potential of local platforms to enable new BMs and which ones

It is worth noting that Integrid focused on the use of these platforms to support grid operation and provide B2B and B2C data-based services. However, local platforms may also be used for local energy trading, e.g. under models like Citizen Energy Communities (CECs) or Closed Distribution Systems (CDSs). This is why two respondents mentioned additional business opportunities based on this concept local trading, i.e. EV charging management, local industry-based services, and P2P energy trading.

Aggregation through BDR:

Most of the respondents do see potential in the development of BDR aggregation business models (around 72%). However, when these respondents were asked about the services that could be provided through BDR (see Figure 9), not all of the potential services previously identified are deemed equally likely or feasible. Whilst all of the respondents think that energy management services to end users could be provided through BDR, the respondents were more skeptical about the remaining potential services, especially concerning balancing services.

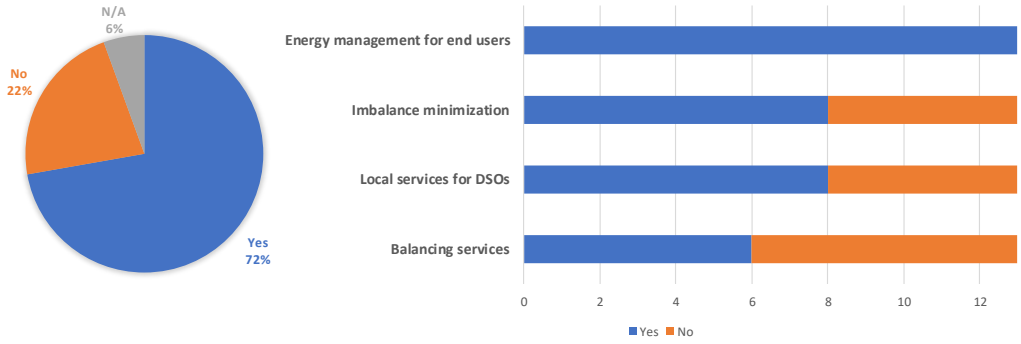


Figure 9: Potential and services to be provided through BDR

Regarding the barriers foreseen for a BDR aggregator (see Figure 10), respondents, both those that see potential in BDR and those who not, believed that the lack of customer response without price signals was deemed the most relevant, followed by the limited benefits and the reluctance of grid and market operators to rely on the BDR aggregator services. Interestingly, data access and data privacy limitations were not generally seen as a critical barrier. In addition to the options included in the survey, two respondents mentioned as additional barriers or conditions: i) end-users may not respond without some automation, and ii) without a large pool of consumers engaged, BDR will not be sufficiently reliable; thus, BDR is better suited for system-level services rather than local flexibility services.

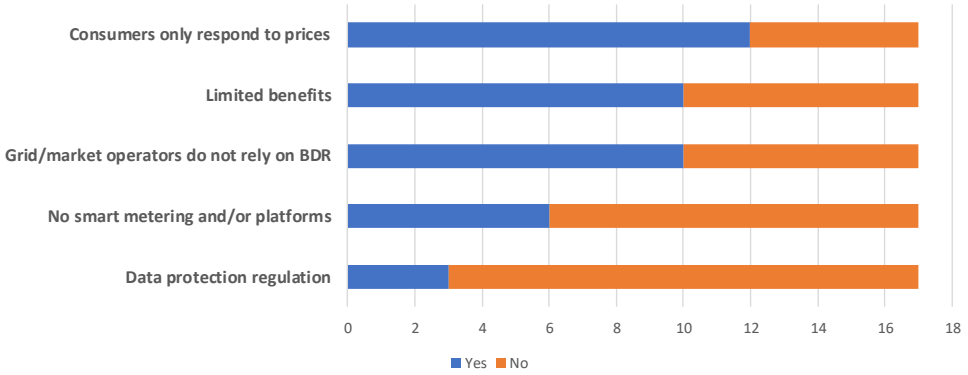


Figure 10: Barriers/drawbacks to BDR BMs

Conclusions:

On the use of flexibility by DSOs: most respondents believe that DSOs will be using flexibility as an alternative to grid reinforcements in the next 5-10 years. However, all of them still see important barriers for this to happen. Regulation is generally seen as the biggest hurdle for this BM. Moreover, respondents showed concerns about the techno-economic requirements in terms of communications and interoperability. However, it is particularly noticeable that the reluctance of DSOs to adopt these practices is seen as a major barrier, virtually as relevant as the previous ones. In fact, two respondents provided very critical comments about the role of DSOs:

> "One of the biggest challenges for Distribution Grid Stakeholders to enable new business models is to convince the System Operators such as local DSOs to pay for the services that will be enabled using solutions such as flexibility etc. Until and unless DSO sees a big value for their grid they are not willing to pay for it. This is one of the limiting factors for different stakeholders to start investing and creating business models for local DSO solutions."

> "DSO never put the client in the center of the question"

On local platforms for data and flexibility exchange: respondents showed a high level of consensus about the fact that these platforms enable the creation of new business models both related to the use of flexibility and data-based services. What is more, some respondents show local platforms also as a way to trade energy-based services locally.

On BDR aggregation: again the majority of participants believed that this is a feasible BM. However, whilst they see this as a clear possibility to provide services to end consumers, this is not as clear concerning the participation of a BDR aggregator in local flexibility markets or to provide balancing services. In this case, the lack of interest of consumers to respond to signals other than prices is seen as the major barrier. Nonetheless, respondents also expressed doubts about the potential benefits that could be obtained or the reliability of the challenges to achieve reliable demand reductions so that grid and market operators rely on these services. In line with this, one of the respondents stated that "the main barrier is the minimum savings individual users can get from offering flexibility services".

4.5. Summary of stakeholder feedback per business model

This section combines the feedback presented in sections 4.3 and 4.4 and presents it organized by BM instead of stakeholder category so as to obtain a general overview. For each BM, a summary table is presented containing the barriers and drivers mentioned by the different stakeholders. In these table, a "level of consensus" is also presented, indicating if participants agree on the same drivers/barriers, or if diverging opinions were mentioned.

Considering the methodology of the conducted interviews, statistic inferences are not appropriate, taking into account that for most stakeholder the sample of answers is small and therefore not statistically significant. The interviews aimed at covering a limited number of participants, but providing an in-depth discussion for each BM. Additionally, it is important to mention that the interviews did not follow a completely rigid interview script. Although the initial questions were the same, the conversation often lead to the spontaneous identification of drivers and barriers by the participants.

Therefore, a high level of consensus means that most or all participants agree with the driver/barrier. A medium level of consensus means that two or more participants mentioned/agreed on the same barrier. A low or contradictory level of consensus means that a certain driver/barrier was mentioned by one or more participants, but other driver/barriers on the opposite direction was mentioned by one or more participants. Finally, a dash mark indicates that the driver/barrier was mentioned by only one participant, and therefore no consensus can be inferred. TTT summarizes the "level of consensus" approach.

Table 17: Level of Consensus

Level of Consensus	Overall approach
High	Most or all participants agree with the driver/barrier.
Medium	Two or more participants mentioned/agreed on the same barrier.
Low or contradictory	The certain driver/barrier was mentioned by one or more participants, but other driver/barrier was mentioned on the opposite direction by one or more participant.
-	The driver/barrier was mentioned by only one participant, and therefore no consensus can be inferred

4.5.1. BM1: DSO procuring local flexibility for grid management

Business model 1 has an important impact for several different stakeholders, and therefore received comments on many interviews, including DSOs, TSOs, Regulators, and Policy Makers.

Firstly, DSOs themselves commented extensively on BM1. In general, DSOs share the idea that the procurement of local flexibility will be part of the DSO's operation, and most of them commented that the companies they work for are already considering this procurement. Nevertheless, DSO's professionals also expressed many concerns on how this procurement will affect them. It seems a consensus that regulation still does not provide the certainty DSOs need to change the way they operate their networks. Firstly, there are not economic incentives or even recognition of the costs incurred in local flexibility procurement. Secondly, by regulation DSOs are still responsible for quality of supply indicators. Not reinforcing the grid today hoping that DERs will be present in five years to provide services to the grid is a risk that the DSO cannot take according to the current regulation. In addition to the regulatory concerns, the DSOs also mentioned the need for enhanced communications and also internal resistance on adopting this business model.

Regulators generally agree that promoting the use of flexibility by DSOs is necessary if DER keep increasing as expected. They also mentioned that the current CAPEX-oriented regulation is an important barrier for DSOs to adopt BM1. However, they generally expressed that it is unclear where regulation should go to (e.g. TOTEX approach). The lack of local flexibility mechanisms was also mentioned by interviews as an important barrier. Some participants mentioned public consultations and pilots as a way to overcome this lack of procurement mechanism, while one interviewee remarked the importance to coordinate local flexibility procurement (explicit flexibility) with the already existing implicit flexibility mechanisms (e.g. dynamic tariffs).

TSOs also commented on BM1. Although they are not directly involved in this business model, they may be affected once the DSO adopts BM1. In general, TSOs expressed their concern about the idea in BM1. Firstly, the efficiency of local procurement mechanisms, especially local markets, was questioned, considering that liquidity is expected to be low, and that will be even more fragmented among the different TSO and DSOs markets. From the operation of the grid standpoint, TSOs mentioned that congestions in the grid should be the exception, and not the norm. Additionally, they mentioned that forecasting will become more difficult for the TSO, and that TSOs and DSO will have to share the security of supply responsibility.

Besides DSOs, TSOs, and Regulators, other stakeholders also commented on the implementation of BM1. For instance, one DER owner commented on the difficulty for providing flexibility to DSOs, given that they do not know where the grid needs or will need the flexibility to be provided, beside that fact the there is no proper pricing mechanism for the flexibility as of today. One policy maker also commented on BM1, mentioning that incentives are lacking for both the DSO and the consumers. Retailers and ESCOs also mentioned that additional hardware and communication would be necessary from their side to provide aggregated flexibility to the DSO. The also show concern regarding the deployment of different solutions across Europe, jeopardizing the scalability potential of their tools and operations, something essential in the aggregation business, according to respondents.

Table 18: List of drivers and barriers for BM1.

Stakeholder	Driver or Barrier	Level of consensus?
DSOs	(D) BM1 is considered relevant and DSOs are already considering it	High
	(B-R) Lack of economic incentives and financial compensation for flexibility procurement	High
	(B-R) DSOs' role in demand flexibility buying is not enabled by current regulation.	High
	(B-T) Missing communication and interoperability mechanisms facilitating flexibility	-
	(B-I/B) Corporate inertia	-
Regulators	(D) Local flexibility procurement will be necessary in a scenario with DER penetration	High
	(B-R) CAPEX bias in DSO revenue regulation	High [26]
	(B-R) Lack of local flexibility mechanisms (coordinated with grid tariffs)	-
TSOs	(B-R) Efficiency of local markets for congestion management	High
	(B-R) Split of liquidity between TSO and DSO markets	Medium
	(B-R) Forecasting becomes more difficult for the TSO	High
	(B-R) Sharing security of supply responsibility between TSO and DSO	Medium
DER Owners	(B-R) Lack of appropriate information regarding grid constraints	-
	(B-R) Lack of proper local flexibility pricing	-
Policy Makers	(D) In some countries, certain regulatory mechanisms can create opportunities for the DSOs to use local flexibility (e.g. subscription penalties in Sweden)	-
	(B-R) Lack of proper local flexibility pricing	-
	(B-I/B) Little economic incentives for consumers to provide flexibility	-
Retailers / ESCOs	(B-T) Additional devices are required	-
	(B-R) Different BM1 solutions across Europe may limit the replicability of solutions developed by aggregators	-

Legend: (D) Driver; (B-R) Barriers, Regulatory; (B-T) Barriers, Technological; (B-I/B) Barrier, Institutional/Behavioural

4.5.2. BM2: DSO improving fault location and asset management

The development of BM2 is mostly an internal process for DSOs, with less external stakeholders involved. Therefore, the opinions on this BM are mostly restricted to the ones of the DSO professionals that participated in this stakeholder consultation.

In general, DSOs recognize that improving maintenance procedures and fault location can lead to cost savings and benefits for the DSO. Nevertheless, there is not a clear consensus on how this should be done.

[26] This barrier presents a consensus among regulators. However, they do not share a common opinion on how the CAPEX-biased mechanism should evolve.

On predictive maintenance specifically, some DSOs do not see the need for additional hardware in their networks. They mention that the necessary data is already available with the current infrastructure and that what is needed are algorithms that can cope with this "big data" in order to allow data-driven predictive maintenance. Also, one participant commented on the high cost that predictive maintenance and fault location can reach if deployed to the LV grid

On the regulatory side of this BM2, participants identified some important barriers. Firstly, they mention that even if they want to adopt predictive maintenance, regulation may still require them to do regular time-based maintenance. Additionally, some regulatory frameworks do not allow the DSO to extend the life of asset (and therefore the remuneration), limiting the incentives for this BM2. One participant concluded that these regulatory characteristics are due to the asymmetry of information between regulators and DSOs, and that regulation is usually risk averse, reason why changing the maintenance procedures still faces some resistance.

Finally, they also highlighted the organizational aspects of implementing this business model. On the positive side, one participant mentioned that the BM2 can be beneficial in the coming years, when the older generation of engineers, used to operate based on a large accumulated experience, will be substituted by a younger generation, more used to data-driven processes.

Table 19: List of drivers and barriers for BM2.

Stakeholder	Driver or Barrier	Level of consensus?
DSOs	**(D)** DSOs recognize the relevance of BM2 and mention that their institutions are looking into those solutions (although the format may vary)	High
	(D) BM2 (especially fault location) can be beneficial in a moment of change of generations of maintenance personal	-
	(B-R) Time-based maintenance is required by regulation even if predictive maintenance is in place	-
	(B-I/B) Distrust between DSOs and regulators due to information asymmetries	-
	(B-T) Costly data infrastructure, especially in low voltage	-
Legend: **(D)** Driver; **(B-R)** Barriers, Regulatory; **(B-T)** Barriers, Technological; **(B-I/B)** Barrier, Institutional/Behavioural		

4.5.3. BM3: Data Services and platforms

The BM3 could be considered the business model with more innovative aspects in the InteGrid project, and therefore received many comments from interviewees of different stakeholders, including DSOs, industrial consumers, policy makers, retailers/ESCOs, aggregators, regulators, and a possible data service provider (DSP).

The DSP mentions that overall approach is viewed as very useful, since there are a lot of agents on the whole market who could be benefiting from this data. The biggest barrier is the access to the data so that

DSPs can provide services. Most of this data will require an explicit consent given by consumers, which may be a barrier for the development of BM3, given resistance or lack of interests to provide this data. On this topic, the opinion of stakeholders varies. The DSP estimates that consumers that allow for their data to be used will be better off (given the remuneration retailers may offer through discounts for instance), and that only a minority with be completely against. On interviewee also mentioned that consumers would not oppose to data sharing, but because they could be misinformed or mislead in complex agreement, which can be an important risk for them. On the other hand, some stakeholders, such as aggregators, see an active resistance from consumers in providing their data.

What seems to be a consensus across stakeholders is that data protection and privacy barriers may limit the potential of this BM3. Some stakeholders also mentioned that this situation will limit data service opportunities to the already existing ones, with reduced lack of interest from incumbents. For instance, some data services are already being provided by businesses that already have access to data (e.g. retailers to consumers).

Besides the data access problem, two other important aspects were raised by interviewees. Firstly, a potential DSP mentioned that data access and procedures are not expected to be harmonized in the EU. That means that DSP will have to create different solutions in different countries, which constitutes as major barriers, considering that data service provision will be a low-margin business and will need to be scalable. In this context, a DER owner questions the model of gm-hub and data service provision itself. This stakeholder advocates for a more decentralized approach, in which interoperable platforms can communicate between each other, leveraging on new technologies such as P2P, and possibly creating a more dynamic environment for business and services, including data service provision. This stakeholder also identifies another risk for BM3, namely the fact that companies from the IT sector are already gathering electricity-related data (or inferring this data) outside the metering infrastructure. That means that these companies will soon be able to offer very similar services in a much more dynamic business model.

Table 20: List of drivers and barriers for BM3.

Stakeholder	Driver or Barrier	Level of consensus?
DSOs	**(B-R)** Prohibition of data use and data sharing	High
	(B-I/B) Limited value of information for DSOs	-
DER Owner	**(B-R)** The gm-hub should not be a single platform, but rather an environment of multiple interoperable platforms Regulation tends to be reactive, and slower than technology and market initiatives	-
	(B-T) Interoperable protocols that can link different platforms Communication and settlements (P2P)	-
	(B-I/B) Other players (e.g. data companies) may take this market over with faster and more dynamic BMs	-
Policy Maker	**(B-R)** Prohibition and security reasons block data use and data sharing, even at a non-individual level	-
	(B-I/B) Consumers are the only data owners, limiting data access for research, even if not at individual level Weak signals of change and opening	-

Retailers / ESCOs	**(D)** Attractiveness of better offers for customers thanks to more information and competition	-
	(B-R) Data protection policy	-
	(B-T) Communication infrastructure	-
Aggregators	**(B-R)** Regulatory uncertainty	-
	(B-R) Data protection and privacy barriers	-
	(B-T) Metering data is insufficient for some data services (need for greater disaggregation)	-
	(B-I/B) Reluctance from DSOs to lose control over metering data management	-
	(B-I/B) End user reluctance to provide data in a data platform without a clear return	-
	(B-I/B) Perceived risk of relying on a data platform operated by a third party for critical aspects of your business	-
Regulators	**(B-R)** Strict data protection regulation hampers data access	-
	(B-T) Metering data is insufficient for some data services (need to include tariff or network information)	-
	(B-I/B) Lack of interest from incumbents and immature market for data	-

Legend: **(D)** Driver; **(B-R)** Barriers, Regulatory; **(B-T)** Barriers, Technological; **(B-I/B)** Barrier, Institutional/Behavioural

4.5.4. BM4: Consumers reducing electricity bill and providing flexibility

The BM4 was mostly discussed with industrial consumers and the residential consumers' association, as they are the main actors in this business model. Nevertheless, the BM4 was also discussed with DER owners, policy makers, retailers and ESCOs, aggregators, regulators and TSOs.

This business model considers two different aspects for two different stakeholders. On one hand, it considers both the internal management of electricity usage for consumers and the provision of explicit flexibility to grid operators. On the other hand, the BM4 looks at the perspective of both residential and industrial types of consumers.

From the industrial consumer's standpoint, the interviews showed mixed opinions on the interest and possibilities for this BM4. Some industries, usually the large and energy-intensive ones, are already very advanced in terms of internal energy management, exploring technical solutions and even regulatory "loopholes". Other industries, smaller and less dependent on energy, are less concerned about optimizing energy usage, either because it is less relevant for them, or because the lack the resources (e.g. personal) to do so. These industries also see energy services with some scepticism. High fixed regulated costs are also mentioned as a reason for the lack of interest in this BM.

On the provision of services to grid operators, the industrial consumers also see different barriers. Some interviewees said they would participate in service markets, and some already do it (e.g. in tertiary reserve). However, others mentioned that they would not participate, as this would imply them changing their

production schedules for a small benefit. Also, some industrials mentioned that they could not change their consumption on a short notice.

The residential consumer's association that participated in this stakeholder consultation mentioned three main barriers for this BM4, especially on the idea of flexibility provision. Firstly, it was said that consumers are not very price sensitive. Secondly, consumers have a difficulty in understanding electricity markets. Finally, there is a mistrust in electricity companies in general, being those DSOs, retailers, or aggregators. Therefore, consumers would be less willing to give away the control of their consumption for a very reduced economic benefit.

The other stakeholders also expressed their opinions and concerns about this business model. DG owners, for instance, highlighted that energy and service markets (e.g. balancing) are not completely open yet for DR participation. It was also mentioned the need for enhanced infrastructure (communication) for these services to be provided. Aggregators mentioned that individual consumers are less aware or motivated regarding new possibilities, but that it could be more attractive for community users. On that regard, however, the aggregator sees regulatory uncertainty over energy communities as a barrier.

Regulators also commented extensively on BM4, particularly on the need to re-design electricity tariffs to promote an efficient behaviour from end-users. Interviewees recognized that current tariff structures do not promote flexibility, but several mentioned different barriers, such as the lack of sufficient historical metering data to support tariff design changes due to the recent smart metering deployment, fear of causing unintended consequences or complaints from end-users, or even the reluctance from some incumbents or policy-makers to these changes. Additionally, regulators identified aspects already mentioned before, such as the low interest from the consumer's side to adopt advanced tariff schemes due to the small benefit perceived.

Finally, TSOs also expressed their expectations and concerns. They recognize that DR participation will be very beneficial to overall efficiency. However, they expressed the possible internal resistance in TSOs regarding the ability of DR to participate in complex and sensitive services for the system, such as fast balancing (e.g. aFRR, FCR). Observability would also have to be enhanced. Also, prequalification and product definition are identified as barriers.

Table 21: List of drivers and barriers for BM4.

Stakeholder	Driver or Barrier	Level of consensus?
Industrial consumer	**(D)** Important business model for large and energy-intensive industry	-
	(B-R) High regulated costs	High
	(B-R) Limited incentives and market development for procuring flexibility	-
	(B-T) Missing communication and interoperability mechanisms facilitating flexibility	-
	(B-I/B) Limited impact of energy costs on total costs	-
	(B-I/B) Lack of built-in capacity (e.g. personal)	-
	(B-I/B) Distrust of energy operators (including aggregators and ESCOs)	-
	(B-I/B) Reluctance to adapt operations to system needs.	-

	(B-I/B) Impossibility of operational adaption in certain industries (flexibility activated on a short notice).	-
Residential consumers	**(B-I/B)** Consumers are not very price sensitive	-
	(B-I/B) Difficulty in understanding electricity markets	-
	(B-I/B) Mistrust in electricity companies	-
DER Owner	**(B-R)** For balancing participation, markets are not completely open or appropriate for DER	-
	(B-R) Misalignment of support schemes	
	(B-T) Communication has to be improved	-
Regulators	**(B-R)** Tariff structure that does not promote flexibility	-
	(B-R) Limited potential for self-generation	-
	(B-T) Lack of historical metering data to support tariff design changes	-
	(B-I/B) Consumers not interested in changing their behaviour: lack of information, small benefit perceived	Medium
	(B-I/B) Static/conservative retail market and reluctance of incumbents to change	-
	(B-I/B) Limitations to test and implement innovative tariff designs	-
TSOs	**(D)** More market players are welcome to increase efficiency	-
	(B-R) Prequalification needs	
	(B-R) Product definition	-
	(B-T) Observability of the DR as BSP	-
	(B-I/B) Resistance to incorporate DR in sensitive and more complex services (aFRR, FCR)	-
Legend: **(D)** Driver; **(B-R)** Barriers, Regulatory; **(B-T)** Barriers, Technological; **(B-I/B)** Barrier, Institutional/Behavioural		

4.5.5. BM5: Flexibility provision through aggregation

The BM5 was mostly discussed with aggregators and retailers, the main actors for this business models. Regulators and TSOs also showed interest in the BM5.

Retailers showed different opinions regarding the concept of using their customer's flexibility to reduce imbalances. While some retailers confirmed that it could be something interesting in the future, others mentioned that other types of position adjustment (e.g. trading in the intraday market) will be always more efficient. Retailers also showed concern on how the independent aggregator and the supplier are going to interact with each other and other agents.

The independent aggregator interviewed acknowledges that service provision to DSOs and TSOs will be a viable business in the future, but not in the short term. He mentions the wide variation of national market rules and designs as an important barrier, as aggregators are limited in replicating their tools. With that regard, lack of standardization of market access interfaces is also a problem. Finally, he mentions the need for real-time data for certain services (e.g. balancing).

Regulators see different barriers for the cVPP and the tVPP concepts. Regarding the former, they mention that balancing products are still not completely adequate for DR participation. Also, that the framework for independent aggregators is underdeveloped, and that revenues from balancing markets may be limited.

Moreover, TSO-DSO coordination should be enhanced, in their view. Regarding the tVPP, the barriers identified by regulators are similar to the ones for BM1. Firstly, the revenue regulation for DSOs is still CAPEX-based, and, secondly, local flexibility mechanisms are not in place yet, limiting the amount of flexibility that DSOs are willing/can procure.

The TSOs also mentioned the lack of role definitions for VPPs, BRPs and BSPs as a barrier. Also, they mention that VPPs may make the forecasting process more difficult, especially if these VPPs are large and resources are scattered across different regions.

Table 22: List of drivers and barriers for BM4.

Stakeholder	Driver or Barrier	Level of consensus?
Retailers	**(D)** Reducing imbalances by using customers flexibility could be possible	Low or contradictory
	(B-R) Expectation of no profitability from aggregation of consumers' flexibility for imbalance reduction	Low or contradictory
	(B-R) Uncertainty about how regulation is going to guide relationships between suppliers-aggregators-others	-
	(B-I/B) Provide additional services to fight against the threat of big and disruptive service companies (like Google or Amazon)	-
Aggregators	**(B-T)** Need for real-time data for certain services (e.g. balancing)	-
	(B-T) Lack of standardization in markets access interfaces across Europe	-
	(B-R) Wide variation in national market rules and design	
Regulators	**(B-R)** cVPP: Balancing products and procurement unfit for demand-side resources	-
	(B-R) cVPP: Undeveloped framework for independent aggregators	-
	(B-R) cVPP: Insufficient or uncertain revenues due to market conditions	-
	(B-R) tVPP: CAPEX bias in DSO revenue regulation	-
	(B-R) tVPP: Lack of local flexibility mechanisms (coordinated with grid tariffs)	-
	(B-I/B) cVPP: TSOs and DSOs used to operate without coordination	
	(B-I/B) cVPP: Regulatory changes need to be progressive and carefully implement to avoid distorting the markets	-
TSOs	**(D)** More market players are welcome to increase efficiency	-
	(B-R) Role definitions for VPP, BRP, and BSP	
	(B-R) Difficulty VPP may impose to TSO's forecasting	-

Legend: **(D)** Driver; **(B-R)** Barriers, Regulatory; **(B-T)** Barriers, Technological; **(B-I/B)** Barrier, Institutional/Behavioural

5. Conclusions

The identification of disruptive business models is one of the core objectives of InteGrid. The successful development and implementation of these business models strongly depend on i) appropriate regulatory conditions, ii) their economic feasibility, and iii) the direct or indirect involvement of several stakeholders. This report addresses the last of these aspects by presenting the methodology, scope and outcomes of a consultation carried out among key stakeholders who were asked about their views on the BMs proposed. It is relevant to note that this consultation addressed exclusively institutional stakeholders and not residential consumers, as the latter are targeted within the demo activities and require alternative means of engagement.

The stakeholder selection was based on the mapping exercise that had been previously performed and is presented in D7.5. Accordingly, the list of participants included 31 representatives from industrial consumers, energy regulators, policy-makers, DER owners, TSOs, DSOs, retailers, aggregators, ESCOs and data service providers. The consultation covered experts from four European countries, namely Portugal, Sweden, Slovenia and Spain; i.e. the three demo countries as well as Spain as an additional consortium country.

The method of consultation consisted in personal interviews, either in person or via web conference. Each interview followed a semi-structured questionnaire adapted to each type of stakeholder so as to focus on the BMs more closely related to their expertise. The general structure of the interviews was as follows: first, the Integrid business models were presented; then, informants were asked about their perceived drivers and barriers for each business model, their financial, regulatory or social feasibility and the expected adoption by other stakeholders in the short, medium or long term. Lastly, the stakeholder feedback was analyzed using a qualitative methodology for each stakeholder group. This analysis aims to assess the drivers and barriers for each business model perceived by the different stakeholders.

Whilst the personal interviews and their analysis constituted the central means for consultation among institutional stakeholders, feedback was additionally collected through the organization of some events throughout the consultation process. In particular, a European workshop about business models was specifically organized for this purpose. The input gathered in these events was used to complement the barriers and drivers identified in the interviews.

The main lessons learnt for each BM are summarized below:

BM1: DSO procuring local flexibility for grid management

DSOs agree that procuring flexibility services will be part of their future. However, they believe that regulation does not provide the certainty DSOs need to change the way they operate their networks. Firstly, the necessary economic incentives to promote the use of flexibility are missing. Secondly, they currently bear the full risk in case flexibility providers fail to provide the service, leading to grid problems and/or interruptions. Lastly, on the institutional realm, DSOs mentioned that they may face some internal resistance to adopt this business model.

Regulators generally agree that promoting the use of flexibility by DSOs is necessary if DER keep increasing as expected. They mentioned that the current CAPEX-oriented regulation is an important barrier for DSOs,

but did not have a clear view of where future regulation should go. The lack of local flexibility mechanisms was also mentioned by interviews as an important barrier. Some participants mentioned public consultations and pilots as a way to overcome this, while one interviewee remarked the importance to coordinate local flexibility procurement with tariff schemes.

TSOs expressed their concerns about the inefficiencies of local mechanisms, especially market-based ones, due to their lack of liquidity. From the grid operation standpoint, TSOs mentioned that congestions in the grid should be the exception, and not the norm. Additionally, they mentioned that forecasting will become more difficult for the TSO, and that TSOs and DSO will have to share the security of supply responsibility.

Other stakeholders also commented on BM1. For instance, one DER owner deemed it difficult to provide the service to the DSO as they have no visibility over where and when flexibility will be needed, and the absence of clear pricing schemes. One policy maker mentioned that incentives are missing for both the DSO and the consumers. Retailers and ESCOs stated that additional hardware and communication would be necessary from their side. Likewise, they were concerned about the lack of harmonization across Europe, jeopardizing the scalability potential of their tools and operations, something essential in their business, according to respondents.

BM2: DSO improving fault location and asset maintenance

This is mostly an improvement of the internal DSO operations, with little interaction with external stakeholders. Therefore, most feedback was provided by DSOs alone.

In general, DSOs recognize that improving maintenance procedures and fault location can be beneficial. Nevertheless, there is not a clear consensus on how this should be technically done. On predictive maintenance specifically, some DSOs do not see the need for additional hardware in their networks as the necessary data would be already available; it is the appropriate algorithms able to cope with “big data” that would be necessary. Additionally, one participant said that, if extended to the LV grid, these solutions could be excessively expensive.

Concerning regulation, participants identified some important barriers. Firstly, they mention that even if they want to adopt predictive maintenance, regulation may still require them to perform time-based maintenance. Additionally, some regulatory frameworks fail to encourage DSOs to extend the life of assets. One participant concluded that due to the risk aversion of regulators, caused by information asymmetries, they are reluctant to allow for changes in asset maintenance practices.

Finally, they also highlighted the organizational aspects of implementing this business model. On the positive side, one participant mentioned that predictive maintenance can be beneficial in the coming years, when the older generation of engineers, used to operate based on experience, will be replaced by a younger generation, more used to data-driven processes.

BM3: Data services and platforms

This could be considered the most innovative BM identified and, therefore, received many comments from different stakeholders, including DSOs, industrial consumers, policy makers, retailers/ESCOs, aggregators, regulators, and a possible data service provider (DSP).

Whilst they all agree that data platforms will necessarily develop and some stakeholders believe this will be useful, some stakeholders are sceptical of the value data platforms will create. The most relevant barrier,

on which there is a general consensus, is the difficulties in accessing the data as required to provide data-driven energy services. The first reason may be the refusal or lack of interest of many end consumers to share their data. This can lead to a vicious circle in which consumers are not offered value due to the limited access to data, and consumers do not accept to sharing the data due to the low perceived value. In this regard, the DSP believed that some early consumers who allow for their data to be used will benefit as this will progressively lead to a change in their behaviour. Another reason, which draws a very high level of consensus across stakeholders, is that data protection regulation seriously limits innovative data service opportunities.

Besides the data access problem, two other important aspects were raised by interviewees. Firstly, a potential DSP mentioned that data access and procedures are not expected to be harmonized in the EU. That means that DSP will have to create different solutions in different countries, which constitutes as major barriers, considering that data service provision will be a low-margin business and will need to be scalable.

Another risk for BM3 identified by one stakeholder is that IT companies are already gathering electricity-related data (or inferring this data) outside the metering infrastructure. That means that these companies will soon be able to offer very similar services in a much more dynamic business model.

BM4: Consumers reducing electricity bill and providing flexibility

The BM4 was mostly discussed with industrial consumers and the residential consumers' association, as they are the main actors in this business model. Nevertheless, DER owners, policy makers, retailers and ESCOs, aggregators, regulators and TSOs, also provided their viewpoints.

From the industrial consumer's standpoint, the interviews showed mixed opinions on the interest and possibilities for this BM. Some industries, usually the large and energy-intensive ones, are already very advanced in terms of internal energy management, whereas smaller and less energy-intensive industries are less concerned about optimizing energy usage (low benefits, or lack of resources to do so). These industries also see energy services with some scepticism. High fixed regulated costs are also mentioned as a reason for the lack of interest in this BM.

On the provision of services to grid operators, the industrial consumers also see different barriers. Some interviewees said they would participate in service markets, and some already do it (e.g. in tertiary reserve). However, others mentioned that they would not participate, as this would imply them changing their production schedules for a small benefit. Additionally, some industrials mentioned that they could not change their consumption to comply with balancing products requirements (traditionally tailored to centralized generators).

The residential consumer's association that participated in this stakeholder consultation mentioned three main barriers, especially about flexibility provision: i) low price elasticity of consumers, ii) difficulty in understanding electricity markets, and iii) general mistrust in electricity companies. Therefore, consumers would be less willing to give away the control of their consumption for a reduced economic benefit.

Other stakeholders also expressed their opinions and concerns. DG owners, for instance, highlighted that energy and service markets (e.g. balancing) are not completely open yet for DR participation. It was also mentioned the need for enhanced infrastructure (communication) for these services to be provided. Aggregators mentioned that individual consumers are less aware or motivated regarding new possibilities,

but that it could be more attractive for community users. However, the aggregator sees regulatory uncertainty over energy communities as a barrier.

Regulators also commented extensively on BM4, particularly on the need to re-design electricity tariffs to promote an efficient behaviour from end-users. Interviewees recognized that current tariff structures do not promote flexibility, but several mentioned different barriers, such as the lack of sufficient historical metering data to support tariff design changes due to the recent smart metering deployment, fear of causing unintended consequences or complaints from end-users, or even the reluctance from some incumbents or policy-makers to these changes. Additionally, regulators identified aspects already mentioned before, such as the low interest from the consumer's side to adopt advanced tariff schemes due to the small benefit perceived.

Finally, TSOs also expressed their expectations and concerns. They recognize that DR participation will be very beneficial to overall efficiency. However, they expressed the possible internal resistance in TSOs due to doubts about the ability of DR to participate in complex and sensitive services for the system, such as fast balancing services (e.g. aFRR, FCR). Technical requirements about observability, prequalification and product definition are identified as barriers too.

BM5: Flexibility provision through aggregation

The BM5 was mostly discussed with aggregators and retailers, the main actors for this business models, as well as regulators and TSOs.

Retailers showed different opinions regarding the concept of using their customer's flexibility to reduce imbalances. While some retailers confirmed that it could be something interesting in the future, others mentioned that other types of position adjustment (e.g. trading in the intraday market) will be always more efficient. Retailers also showed concern on how the independent aggregator and the supplier are going to interact with each other and other agents.

The independent aggregator interviewed acknowledges that service provision to DSOs and TSOs will be a viable business in the future, but not in the short term. He mentions the wide variation of national market rules and designs as an important barrier, as aggregators are limited in replicating their tools. With that regard, lack of standardization of market access interfaces is also a problem. Finally, he mentions the need for real-time data for certain services (e.g. balancing).

Regulators see different barriers for the cVPP and the tVPP concepts. Regarding the former, they mention that balancing products are still not completely adequate for DR participation. Also, that the framework for independent aggregators is underdeveloped, and that revenues from balancing markets may be limited. Regarding the tVPP, the barriers identified by regulators are similar to the ones for BM1. Firstly, the revenue regulation for DSOs is still CAPEX-based, and, secondly, local flexibility mechanisms are not in place yet, limiting the amount of flexibility that DSOs are willing/can procure.

The TSOs also mentioned the lack of role definitions for VPPs, BRPs and BSPs as a barrier. Also, they mention that VPPs may make the forecasting process more difficult, especially if these VPPs are large and resources are scattered across different regions.

References

InteGrid Documents

[DoA] InteGrid Description of the Action

[REF D1.2] Use Cases and Requirements

[REF D1.4] Consumers' engagement strategies

[REF D6.1] Concept of the Market Hub, Central Platform and Services

[REF D7.2] Regulatory barriers in target countries and recommendations to overcome them

[REF D7.4] Cost-benefit analysis: methodology and results

[REF D7.5] Business models to support the developed concepts

External Documents

[1] MIT Energy Initiative, "UTILITY OF THE FUTURE An MIT Energy Initiative response to an industry in transition In collaboration with IIT-Comillas," 2016.

[2] IndustRE H2020, "Business models and market barriers," no. March, p. D2.4, 2016.

[3] NobelGrid, "D2.3. Business Models & Incentive Schema Definition," 2016.

[4] C. Zott, R. Amit, and L. Massa, "The business model: Recent developments and future research," *J. Manage.*, vol. 37, no. 4, pp. 1019–1042, 2011.

Annex I – Interview script

Different scripts were prepared for different stakeholders. For each type of stakeholder, different BM were emphasized during the interview. This follows the matrix the importance methodology explained in section 2.1, and developed in the deliverable D7.5.

This script was used as a starting point for the interview and to ensure that key questions were covered equally among stakeholder. Nevertheless, interviews were also conducted in a way that stakeholders were free to express their opinions outside the scope of these questions.

For each interview, a full presentation of the project was made, followed by a presentation of the relevant BMs for the particular type of stakeholder being interviewed.

Conversation guide with DSOs

We would like to discuss your views on some of the business implications of this project, in particular the implications in cost reduction for the DSO thanks to three mechanisms: less maintenance costs in infrastructure and reduced failures (BM1), reduced investments using the flexibility provided by the end-user (BM2) and the exploitation of the metering data (BM3).

What are your views in this development?

More specifically,

On asset management:

What is your view on predictive maintenance? Is your company considering investments in additional equipment for this purpose? Do you see it economically viable?

On procuring flexibility:

Do you think it is feasible to use flexibility mechanisms as compared to grid reinforcements? If s/he thinks that it is, what regulatory mechanisms should be in place to enable the user to procure these services? Which mechanisms would you consider to procure flexibility? (e.g. interruptible contracts, some form of local market etc.). How would you remunerate the provision of flexibility?

On using metering data:

Do you see any possibility of using metering data to provide additional services to (B2B or B2C) while complying with GDPR? Do you think that customers will be willing to share information for such services? What will they ask in return? What risks do you anticipate if any? Do you think that in 5-years' time regulation will allow these operations with data? What risks do you anticipate if any?

Would your company adopt this innovation? If not, why?

Can it add value to your firm in the way it is described? Can you think of other forms of value creation for your firm?

Conversation guide with Industrial consumer

We would like to discuss your views on some of the business implications of this project, in particular the implications in cost reduction and/or revenue enhancement for the consumer thanks to two mechanisms: demand management (BM4.1.) and providing services to grid operators (BM4.1). Also, we would like to hear your views on your disposition to data sharing with third party operators.

What are your views in this development?

More specifically,

On selling flexibility:

Would you be willing to sell your flexibility to power companies (TSOs, DSOs, Aggregators?). To accrue these benefits, possibly a preliminary investment is necessary: Installation of new meters and communication devices. In exchange, you may get additional revenues for providing balancing services while decreasing consumption for a limited period of time.

Are you aware that this is a potential source of extra revenue for the company? Would this add net value to your firm? What are the risks for your company if any? Do your industrial processes allow for a reduction in electricity consumption for a short period of time? What changes you deem necessary to hedge the risks associated to your participation in these markets?

On installing DG:

Would you consider installing or have you installed renewable energy generation resources for self-consumption and for selling to the market? What are the main advantages and risks associated with this infrastructure? What kind of changes are required in the system (e.g. regulation, institutional arrangements) so that you are able and willing to do it?

On providing metering data:

Would you be willing to share your electricity consumption data (anonymized) with third parties? What risks do you anticipate if any? What about privacy or security-related risks associated with the use of data by third parties? How willingly would your company share data with these third parties? Under what conditions would your firm do it? Would you demand anything in return?

Would your company adopt this innovation? If not, why?

Can it add value to your firm in the way it is described? Can you think of other forms of value creation for your firm?

Conversation with ESCOs

We would like to discuss your views on some of the business implications of this project, in particular the implications in revenue enhancement and service improvement by using customer data to provide more value to consumers.

What are your views in this development?

More specifically,

On data service provision

What are your views about this business model? Do you see business potential in providing residential consumers with automation devices small scale generation and storage infrastructure?

How feasible is it taking into account residential consumers' disposition or the maturity of the market? Who do you think it is more likely to be your customer, i.e., individual consumers, building owners, SMEs (not industrial)?

What barriers do you anticipate that may prevent the operationalization of this business model?

Do you see additional business opportunities based on exploitation of meter data?

Access to meter data is essential to enable this business model. Do you think that customers will be willing to share this information? Do you think that different types of residential consumers will react differently? What will they ask in return? What risks do you anticipate if any? Do you think that in 5 years time regulation will allow these operations?

Conversation with potential data service providers

We would like to discuss your views on some of the business implications of this project, in particular the implications in revenue enhancement and service improvement by using customer data to provide more value to consumers.

On data service provision

What are your views about this business model? What is the business potential for your firm? Who would be your customer and what type of service they would be willing to pay for?

What barriers do you anticipate that may prevent the operationalization of this business model? Do you see additional business opportunities based on exploitation of meter data?

Access to meter data is essential to enable this business model. How feasible is it taking into account existing regulation? Do you think that in 5 years' time regulation will allow these operations?

Conversation with Regulator

Present the whole project. Explain all the business models.

On all BMs in general

Do you think these business models may add value to all actors in the industry, including consumers? Do you think the adoption of these business models may ensure a fairer competition in the energy markets and greater awareness and engagement of consumers with energy?

Do you think these business models are feasible with existing regulations?

What are the regulatory priorities in the next five years? What barriers do you see to enact such changes in regulation?

What risks do you anticipate if any, if these business models are implemented?

Conversation with Policy makers

Present the whole project. Explain all the business models.

On all BMs in general

Do you think these business models may add value to all actors in the industry, including consumers? Are they aligned with the energy transition goals? Do you think the adoption of these business models may raise the competitiveness of the industry?

Do you think these business models are feasible with existing regulations?

What are the regulatory priorities in the next five years? What barriers do you see to enact such changes in regulation?

What risks do you anticipate if any, if these business models are implemented?

Conversation guide with Retailers

We would like to discuss your views on some of the business implications of this project, in particular the implications in cost reduction by means of reducing imbalance costs. We would like to know your views on this development.

On using flexibility to reduce imbalance costs

How feasible is it to use flexible demand to reduce your imbalance costs?

Compared to the main alternatives (buying intraday or paying deviation costs), how likely is that this business model provides more value to your firm?

How likely is it that consumers will adjust? What type of incentives can be used to encourage this change on the consumer's side - i.e., change in tariffs, alert sending…?

On data services

Additionally, this hub may facilitate that you provide new services to TSOs and DSOs and other parties. Do these services may bring extra revenue for your organization? Which services would you consider most promising? What are the barriers to implement such business model in the organization? What are the potential risks during/after implementation? What changes should be implemented in the system to enable the implementation of the business model?

Conversation guide with Aggregator/VPP

We would like to discuss your views on some of the business implications of this project, in particular the implications in revenue enhancement by providing services to grid operators. We would like to know your views on this development.

On data services and aggregation through the gm-hub

This hub may facilitate that you provide new services to TSOs and DSOs. May these services bring extra revenue for your organization? What are the barriers to implement such business model in the organization? What are the potential risks during/after implementation? What changes should be implemented in the system to enable the implementation of the business model?

Annex II – Example of email invitation sent to potential participants in the consultation

Dear Mr./Ms. _____,

My name is _____, I am a researcher at Comillas University in Madrid, a partner in the EU Horizon 2020 InteGrid project (https://integrid-h2020.eu/). We are currently researching the new business models that may arise from the concepts developed within the project, and as part of this research, we are conducting a stakeholder consultation. Therefore, we would like to invite you for a quick interview about future business models at the distribution side of the power sector..

The InteGrid project is researching innovative solutions and business models for DSOs, aggregators, retailers, consumers, and flexibility providers, having the DSO as a market facilitator and a data-hub as an enabler for new services. To test these new ideas, demonstrations are being conducted in Slovenia, Portugal, and Sweden. Here at Comillas University, we are currently researching the new business models that may arise from the concepts developed within the project. And that would be exactly the topic of our conversation. We are now interviewing stakeholders to exchange ideas with practitioners on the importance of these business models and the challenges ahead of them.

Considering your expertise and current position in (COMPANY NAME/STAKEHOLDER CATEGORY), we would like to invite you for a discussion on some of these new business models. This short Skype interview (30 to 40min) will feed our analysis and conclusions within the InteGrid project.

We highlight that this interview will be done under complete confidentiality. No personal information about you or information about your company will be made public. Moreover, we highlight that we seek your personal opinions as a professional in the industry. We understand that this Will not be the official position or view of institution.

I send you attached a short paper we wrote on these new business models, in case you want to take a look. I am also at your disposal to clarify any doubts you may have.

Thank you very much.

Best regards,

Interviewer name

Annex III – Dissemination and consultation material for the European Workshop

Webinar Preparation Form

Subject:	New business models to distribution grid stakeholders under high penetration of DER
Speaker(s):	Ricardo Prata, EDP Distribuição (Portugal) Rafael Cossent, Comillas University (Spain) Ricardo Bessa, INESC TEC (Portugal)
Pictures	  
Further reading:	https://www.cired-repository.org/bitstream/handle/20.500.12455/336/CIRED%202019%20-%201192.pdf?sequence=1&isAllowed=y https://integrid-h2020.eu/

Summary of the presentation:

In a context with high penetration of distributed energy resources, the smartening and digitalization of distribution grids enable unlocking the potential of distributed flexibilities. However, new business models are necessary to make this a reality. This webinar will explore some of these new business models, with a focus on four main agents, namely DSOs, aggregators, end-users, and data service providers. The challenges and opportunities for these stakeholders are discussed, with an emphasis on perspective of the DSO as neutral market facilitator and distribution system optimizer.

The work presented in this webinar is part of the European H2020 project Integrid (https://integrid-h2020.eu/).

Intended audience:

The webinar aims to target all types of stakeholders with an interest in the topics of smart distribution grids, local flexibility services and aggregation. These includes, but is not limited to: DSOs, regulators, academics and researchers on these topics, retailers, aggregators, VPP service providers, and data service providers.

Key messages:

- New business models and solutions are necessary to unlock the full potential of distributed flexibilities and metering data.
- These business models open both new challenges and opportunities for several stakeholders such as DSOs, end-users, aggregators or data service providers.
- The DSO in particular will have a central role as market facilititator and system optimizer.

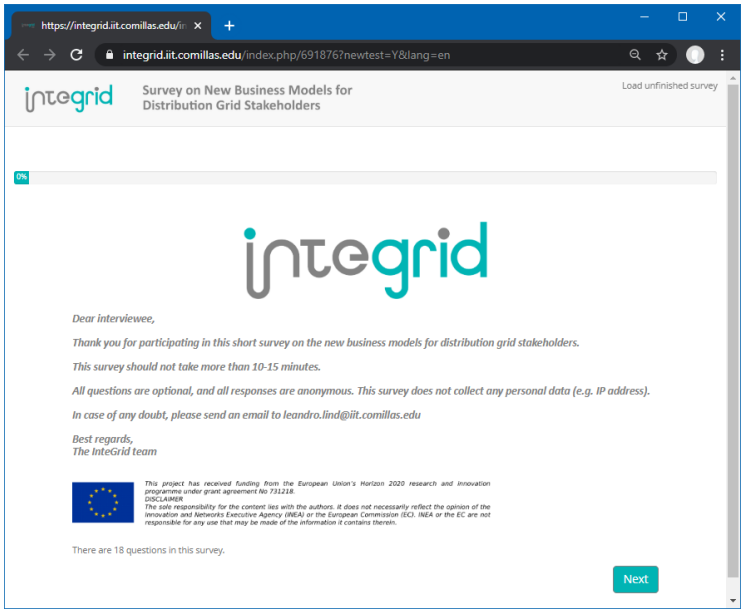
Questions:

In order to foster discussion and gather the participants' feedback, we would propose the following questions:

- Which are, in your opinion, the most promising business models around the topics addressed in the webinar?
- When do you think these promising business models could be in operation (short-term - less than one/two years; medium-term – 5 years from now; long-term – 10 years from now)?
- What are, from your viewpoint, the most relevant barriers for the development of the business models and solutions discussed? Are these mostly economic, regulatory, social, or of other type?

Online survey for consultation

Online survey prepared with the open source software "LimeSurvey"[27], hosted in the servers of Comillas University.



[27] https://www.limesurvey.org/

Page 0 Introduction text

"*Dear interviewee,*

Thank you for participating in this short survey on the new business models for distribution grid stakeholders.

This survey should not take more than 10-15 minutes.

All questions are optional, and all responses are anonymous. This survey does not collect any personal data (e.g. IP address).

If you have any doubt, please send an email to leandro.lind@iit.comillas.edu

Best regards,
The InteGrid team"

Page 1 Respondent profile

0001 Which type of Company/Institution you work for?
0001.a Academia/Research Institution
0001.b DSO/Distribution utility
0001.c TSO/ISO/Transmission company
0001.d Retailer/Supplier/Aggregator
0001.e Energy service company
0001.f Policy maker
0001.g Independent regulatory commission
0001.h Software developer/provider
0001.i Equipment manufacturer
0001.j Other: Open field

0002 In which region you work in?
0002.a Africa
0002.b Americas
0002.c Asia
0002.d Europe
0002.e Oceania
0002.f If you do not mind mentioning the specific country, please do so: Open field

Page 2 New business models for existing players: The Active DSO

0003 Do you think DSOs will be able and willing to procure flexibility locally and therefore defer investments in the near future (next 5 to 10 years)?
0003.a Yes
0003.b No

If "Yes" is selected in question 0003:

0004 What will be the most viable/likely services DSOs for to procure from local resources?
0004.a Short-term local Congestion management
0004.b Voltage control

0004.c Islanding operation

0005 Others: Open field

0006 Which would be the most common/viable procurement mechanism?
0006.a Short-term local markets
0006.b Long-term procurement (e.g. non-firm capacity contracts)
0006.c Pre-defined regulated payments
0006.d Other: Open field

0007 Do you see important barriers for DSOs to start procuring local flexibility?
0007.a No
0007.b Yes

If "Yes" is selected in question 0007:

0008 In your opinion, how relevant are the following barriers?
0008.a Lack of incentives in network regulation (e.g. CAPEX-oriented)
0008.b Network reinforcements are generally less costly than flexibility
0008.c Lack of interest by flexibility providers
0008.d Reluctance from network operators (corporate inertia, reliability concerns)
0008.e Complex and costly communications and interoperability requirements
0008.f Other regulatory uncertainties

0009 Any additional barrier? (open field)

If "No" is selected in question 0003:

0010 Why?
0010.a It is not economically viable
0010.b It is technically too complicated
0010.c Lack of interest by flexibility providers
0010.d Reluctance of network operators to rely of flexibility services
0010.e Regulation imposes too many barriers
0010.f Others (Open field)

If choice 0010.e is selected in question 0010:

0011 Which regulatory barriers do you find relevant?
0011.a Lack of incentives in network regulation (e.g. CAPEX-oriented)
0011.b Network reinforcements are generally less costly than flexibility
0011.c Lack of interest by flexibility providers
0011.d Reluctance from network operators (corporate inertia, reliability concerns)
0011.e Complex and costly communications and interoperability requirements
0011.f Other regulatory uncertainties

Page 3 New business models for new players: Local Flexibility Markets

0012 Do you think local market platforms could lead to new business models?
0012.a Yes

0012.b No

If “Yes” is selected in question 0012:

0013 Which ones (multiple choice)?
0013.a Local flexibility trading only
0013.b Data services
0013.c Others: Open field

If “No” is selected in question 0012:

0014 Why not?
0014.a These platforms would not be economic
0014.b If these platforms are developed, they will be regulated activities
0014.c Other reason (Open field)

Page 4 New business models for new players: Behavioral Demand Response

0015 Do you see potential in the Behavioral Demand Response (BDR) concept?
0015.a Yes
0015.b No
0015.c No answer

If “Yes” is selected in question 0015:

0016 What services could be provided through BDR?
0016.a Imbalance minimization for retailers or balancing responsible parties
0016.b Balancing services to system operators (TSOs/ISOs)
0016.c Local services for distribution grid operators
0016.d Energy management services for final consumers
0016.e Others: Open field

If “Yes” or “No” is selected in question 0003:

0017 What are the main barriers/drawbacks of BDR?
0017.a Consumers do not respond to signals other than prices
0017.b Grid and market operators are not willing to rely on BDR
0017.c Limits imposed by data protection regulation
0017.d Lack of available data: no smart metering deployed, no metering data platforms…
0017.e Limited benefits out of this type of demand response
0017.f Others: open field

Page 5 Additional comments

0018 Would you like to provide any other comment? (open field)

Page 6 Thank you for participating

“Dear participant,

Thank you for participating in this survey. Your responses will be considered on an upcoming report discussing the views of distribution grid stakeholders on new business models.

This report, along with all other reports from the InteGrid project can be found in the link below:

https://integrid-h2020.eu/

Once more, thank you for your participation.

The InteGrid team.
(You can close this page now)"