CLEAN ENERGY MINISTERIAL

iea-isgan.org

ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

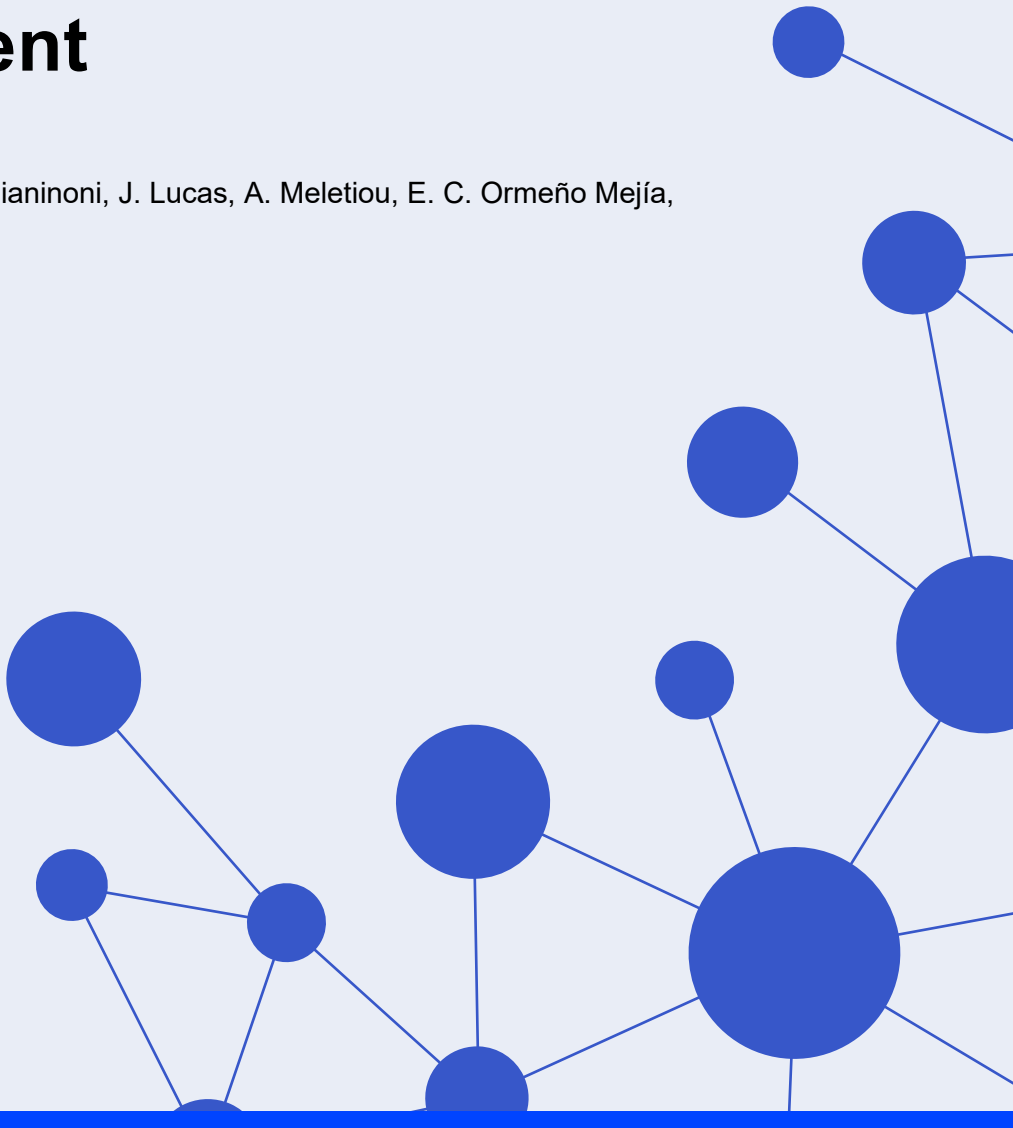
Power Transmission & Distribution Systems

Survey on Flexibility Market Implementation and Development

Report

S. Ruggeri, S. Cianotti, I.M. Gianinoni, J. Lucas, A. Meletiou, E. C. Ormeño Mejía, M. Troncia
ISGAN WG3

September 2025



About ISGAN Discussion Papers

ISGAN discussion papers are meant as input documents to the global discussion about smart grids. Each is a statement by the author(s) regarding a topic of international interest. They reflect works in progress in the development of smart grids in the different regions of the world. Their aim is not to communicate a final outcome or to advise decision-makers, but rather to lay the ground work for further research and analysis.

Disclaimer

This publication was prepared for International Smart Grid Action Network (ISGAN). ISGAN is organized as the Implementing Agreement for a Co-operative Programme on Smart Grids (ISGAN) and operates under a framework created by the International Energy Agency (IEA).The views, findings and opinions expressed herein do not necessarily state or reflect those of any of ISGAN's participants, any of their sponsoring governments or organizations, the IEA Secretariat, or any of its member countries. No warranty is expressed or implied, no legal liability or responsibility assumed for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, and no representation made that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring.

Preface

The increasing penetration of renewable energy sources, alongside growing policy support for decarbonization and decentralized energy systems, has heightened interest in local flexibility markets across Europe. Within the framework of the EU's Clean Energy Package—particularly Directive (EU) 2019/944 and Regulation (EU) 2019/943—Distribution System Operators (DSOs) are encouraged to explore flexible solutions at the local level to efficiently manage their networks and maintain grid stability.

In this context, local flexibility markets represent structured mechanisms through which DSOs can procure variations in electricity consumption or generation from distributed energy resources (such as demand response, distributed generation, storage systems, and aggregators). These resources are activated to relieve local grid constraints, optimize asset utilization, and defer network reinforcements, while ensuring secure and reliable operation of the distribution grid.

The present report offers a descriptive analysis of the questionnaire results, with a primary focus on local flexibility markets. However, given the diversity of responses and the varying stages of market development across countries, the analysis also includes TSO-related mechanisms where relevant. Through the lens of these survey findings, this report aims to provide insights into current practices, perceived challenges, and opportunities for further advancement in flexibility market implementation.

By highlighting key trends and areas for improvement, the report seeks to support DSOs, policymakers, and industry players in shaping effective strategies for flexibility market development, in line with the broader goal of building a reliable, cost-efficient, and low-carbon energy system—both within and beyond the European context.

Ten professionals responded to the questionnaire, sharing their experiences, motivations, and lessons learned regarding local flexibility in their respective countries. Some respondents were directly involved in pilot projects, while others worked in related areas of the energy sector.
To get this information, general and detailed questions to address the interests and curiosity of potential local flexibility market developers were developed. Such questions cover the following main sessions:

- Respondent Background
- Market Overview
- Market Details
- Technical Challenges
- Validation Studies
- Customer Participation and Uncertainty

It should be noted that the findings presented in this report derive solely from the projects that questionnaire respondents were familiar with, and therefore may not fully represent all local flexibility initiatives currently underway in each country.

Acknowledgments

The authors wish to express their sincere appreciation to all the experts who participated in the questionnaire and to ISGAN WG9 and its manager, Charmalee Jayamaha, for their invaluable support throughout this activity. Special thanks go to C.Y. Evrenosoglu (ETH), Yuka Ogasawara (NEDO, Japan), Paloma Ortega Arriaga (Energy Systems Catapult, UK), and Steven Wong (Natural Resources Canada, CanmetENERGY) for their fruitful insights on the topic.

Nomenclature or List of Acronyms

AT	Austria
BE	Belgium
CA	Canada
DFS	Demand Flexibility Service
DSO	Distribution System Operators
ES	Spain
FR	France
FSP	Flexibility Service Provider
GME	Gestore Mercati Elettrici
IN	India
IT	Italy
JP	Japan
KR	South Korea
KPX	Korea Power Exchange
NEMO	Nominated Electricity Market Operators
NESO	National Energy System Operator for Great Britain
TSO	Transmission System Operators
UK	United Kingdom

Abstract

The increasing penetration of renewable energy sources, along with the drive towards decarbonization and decentralized energy systems, is prompting Distribution System Operators (DSOs) to explore local flexibility markets as a tool for efficient grid management. Under the EU's Clean Energy Package—specifically Directive (EU) 2019/944 and Regulation (EU) 2019/943—DSOs are encouraged to integrate market-based flexibility at the distribution level to optimize network operations and defer infrastructure investments.

This report presents the findings of a survey administered to ten professionals across Europe (Austria, Belgium, France, Italy, Spain, and the United Kingdom), Asia (India, Japan, South Korea), and North America (Canada). The survey, comprising around 50 questions, examines key aspects of local flexibility markets, including platform use, market design, services offered, coordination with Transmission System Operators (TSOs), and data exchange processes.

Although the survey was initially designed to focus on DSO-led local markets, several responses referred to national-level or TSO-led mechanisms. These responses were retained when relevant to the understanding of flexibility procurement at the distribution level or to highlight potential integration paths. Countries primarily discussing TSO-driven mechanisms are marked with an asterisk (*) throughout.

The collected answers reflect a wide range of maturity levels, from pilot projects to fully operational market structures. Common objectives include congestion management, voltage control, and the integration of renewable energy resources to lower grid reinforcement costs. Despite these benefits, respondents highlight several barriers, such as regulatory limitations, limited market liquidity, and concerns regarding privacy and cybersecurity. Additionally, the need for robust ICT infrastructures and standardized data-sharing protocols is emphasized to ensure market efficiency, system reliability, and consumer trust.

Executive Summary

This report presents the findings of a survey conducted to assess the state of local flexibility markets across multiple countries, focusing on their development, operational structures, challenges, and future prospects. The survey gathered responses from professionals in Europe (Austria, Belgium, France, Italy, Spain, and the United Kingdom), Asia (India, Japan, South Korea), and North America (Canada), providing insights into the current status of market-based flexibility mechanisms at the distribution level. The survey results reflect project-level insights rather than national frameworks, which may limit the comparability of implementation maturity across countries.

The primary motivations for developing local flexibility markets include the need to manage network congestion, reduce grid reinforcement costs, and support the integration of renewable energy resources through market-based procurement. However, the survey reveals significant differences in the maturity of these markets. While France and the United Kingdom have established market frameworks with active participation, other countries, such as Austria, Belgium, Italy, and Japan, remain in the pilot or early development phases. South Korea does not currently have a local flexibility market.

Flexibility market services primarily focus on congestion management, voltage control, with different pricing models in place. The pay-as-bid approach is the most commonly used, followed by pay-as-clear mechanisms in specific markets. Market integration and coordination with Transmission System Operators (TSOs) vary widely. Some countries have strong integration between local flexibility and wholesale markets, while others operate independently from broader electricity market mechanisms.

Despite progress, multiple challenges hinder the full deployment of local flexibility markets. Regulatory uncertainty remains a major barrier, as many countries lack a well-defined market framework to facilitate efficient operations. Data exchange issues and ICT infrastructure limitations further complicate the process, as secure and standardized communication channels between DSOs, flexibility providers, and market platforms are not always in place. Market liquidity is another key issue, with some regions struggling to attract enough participants to create a competitive and reliable market environment. Additionally, concerns related to privacy and cybersecurity are frequently mentioned as barriers to broader adoption.

The survey also investigated how uncertainty is considered in flexibility market studies. Responses indicate that different methodologies exist for integrating uncertainty into market and grid planning models. Some respondents, such as from France and Italy, use probabilistic load curves or consider uncertainty in flexibility service availability and grid constraints. Others, such as Canada, assess uncertainty in distributed energy resource (DER) operations and power system modeling. However, in several cases, uncertainty integration remains limited or underdeveloped, potentially affecting the accuracy of planning and operational decisions.

Furthermore, the survey examined the types of studies conducted to validate local flexibility market implementation. Responses show that most countries perform both market and network simulations, using tools such as Digsilent PowerFactory, PSSE, Python-based frameworks, and proprietary DSO tools. Some markets, such as Spain, conducted comprehensive analyses that included pilot tests, scalability assessments, and modeling of flexibility resource integration.

The findings of this survey provide valuable insights for policymakers, DSOs, and industry stakeholders in refining local flexibility market structures and addressing key barriers to implementation. By overcoming regulatory, technical, and market challenges, local flexibility markets can play a crucial role in enhancing grid efficiency, supporting decarbonization, and promoting a cost-effective energy transition.

Table of content

1. Survey Description 8

2. Analysis of Results 9

2.1. Respondents Overview 9

2.1.1. Participants' Distribution 9

2.1.2. Level of Expertise 9

2.2. Market Overview 10

2.3. General Information 11

2.3.1. Main Motivations 12

2.3.2. Rise of Flexibility Market Development 13

2.3.3. Voltage Levels Covered 14

2.4. Market Details 15

2.4.1. Stakeholders Involved 15

2.4.2. Services and Products Traded 16

2.4.3. Pricing Methods 18

2.4.4. Service Availability, Trading, and Activation Times 19

2.4.5. Integration with Other Markets and Coordination with TSOs 20

2.5. Data Exchange 21

2.5.1. Data Exchange between DSOs and Flexibility Providers 21

2.5.2. Types of data exchanged 21

2.6. Studies and Model Validation 22

2.6.1. Studies Carried Out 22

2.6.2. Tools Used for Studies 23

2.6.3. Penalty Scheme for Not Providing the Committed Flexibility 23

2.7. Additional Considerations on Flexibility Market Design 23

2.7.1. Pricing 24

2.7.2. Uncertainty Integration in the Market 24

2.8. Preliminary Results 25

2.8.1. Providers Involved and the Contracted Agreements 25

2.8.2. Customer Participation Model 27

3. Identified Challenges and Policy Recommendations 29

3.1. Challenges 29

3.2. Main Findings 29

3.3. Policy Recommendations 31

4. Conclusions 32

5. References 34

1. Survey Description

This report leverages the survey findings to offer stakeholders a comprehensive understanding of current practices, challenges, and opportunities in local flexibility markets. By identifying key trends and areas for improvement, it aims to support DSOs, policymakers, and industry participants in developing effective strategies that align with evolving European legislative frameworks and the broader objective of a low-carbon, integrated energy market.

The survey consists of approximately 50 questions, structured into the following main sections:

- **Respondent Background** – Includes information on the participant's country of residence, sector affiliation, level of expertise, and motivations.
- **Market Overview** – Identifies the country where the flexibility project was developed.
- **Participation of Flexibility Providers** – Evaluates the involvement of different stakeholders, including residential, commercial, and industrial consumers, as well as generators, energy storage systems, and EV charging stations.
- **Market Operations** – Covers key aspects such as market features, services offered, platforms used, and pricing mechanisms.
- **Technical and Implementation Aspects** – Examines challenges, penalty schemes, and other operational considerations.
- **Lessons Learned and Documentation** – Provides insights into project outcomes and references to publicly available documents.

This report primarily focuses on flexibility mechanisms implemented at the distribution level. However, certain national or TSO-led initiatives have been included where they directly impact or interact with local flexibility markets. These cases offer valuable insights into coordination schemes, overlapping competencies, and potential synergies between TSOs and DSOs. To maintain clarity, countries where the responses refer predominantly to TSO-driven systems are marked with an asterisk (*) throughout the report.

The varying depth of responses, particularly regarding the integration of uncertainty and the design of penalty frameworks, reflects the different institutional roles and responsibilities of respondents within their respective projects or organizations. In many cases, the insights provided are based on hands-on involvement with specific stages of flexibility market development, including platform design, operational piloting, and stakeholder engagement.

It is important to highlight that the reported approaches reflect either practices directly implemented by the respondents or cases they are aware of, and do not necessarily correspond to methodologies formally endorsed or standardised at the national level.

This diversity enhances the value of the collected evidence and underscores the need for more coherent, cross-cutting approaches in key areas such as risk allocation and performance accountability.

2. Analysis of Results

2.1. Respondents Overview

2.1.1. Participants' Distribution

Various countries participated in the survey: from Europe (Austria, Belgium, France, Italy, Spain, and the United Kingdom) to Asia (India, Japan, and South Korea) and North America (Canada). The majority belong to research institutions and Distribution System Operators (DSOs).
Figure 1 shows the participating countries.

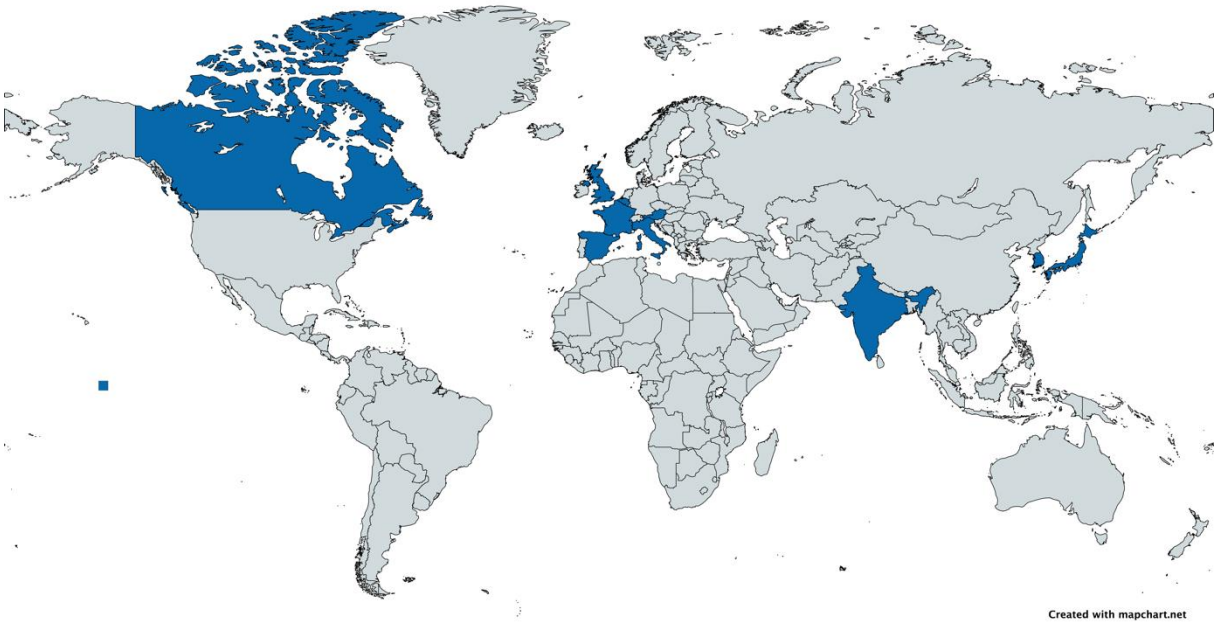


Figure 1: Geographic distribution map of respondents.

2.1.2. Level of Expertise

Participants rated their expertise in the flexibility market on a 1–5 scale, with most indicating levels 4 or 5 (Figure 2), thereby reflecting advanced knowledge.

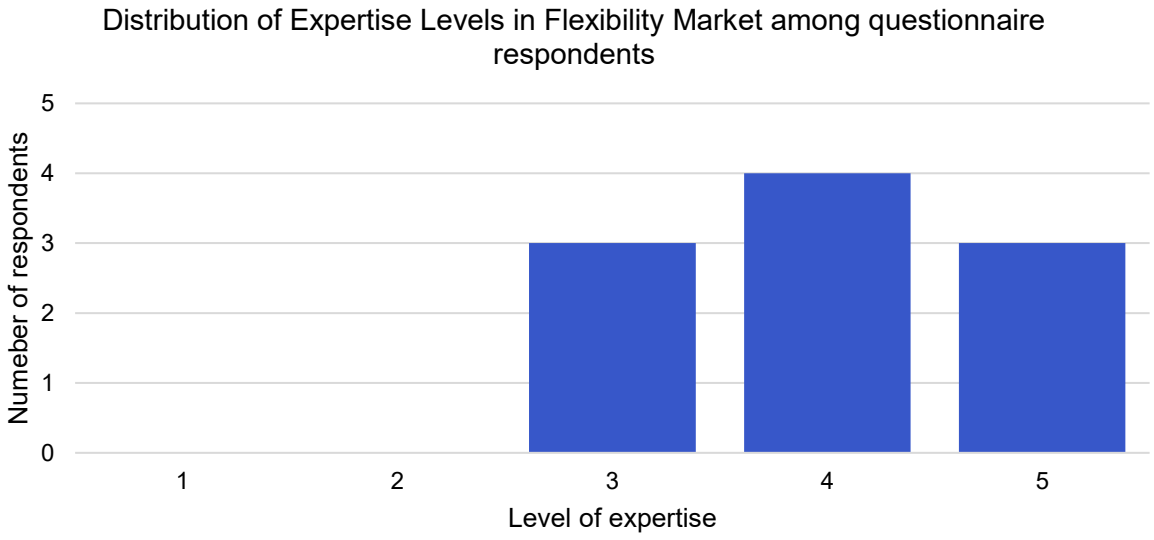


Figure 2: Histogram showing the distribution of expertise levels.

2.2. Market Overview

Five out of ten respondents provided answers concerning local flexibility market initiatives. This limited engagement can be attributed to the fact that not all surveyed countries have an unbundled electricity system, and in many cases, the development of local flexibility markets is not yet under consideration.

Nonetheless, some countries exhibit noteworthy developments. Austria, for instance, is actively engaged in the Industry4Redispatch initiative—a pilot project led by the TSO (APG) that aims to integrate distributed flexibility resources into redispatch operations. The project focuses on the activation of industrial and commercial loads, primarily connected to the distribution grid, to alleviate congestion in the transmission system. As such, it anticipates future challenges related to TSO–DSO coordination, given the increasing role of flexibility originating from distribution-connected assets.

In Japan, the NEDO[1]-led Connect and Manage 2.0 Project (2024–2028) aims to develop technologies to support grid flexibility, manage integration costs, and facilitate the connection of renewable energy sources.

The United Kingdom represents a particularly advanced case, having launched local flexibility markets as early as 2018 [1]. This report devotes special attention to two complementary developments. First, the Piclo Flex market platform used by many DSOs to procure local flexibility services through a digital marketplace for DERs registration and economic competitions management. Second, the Demand Flexibility Service (DFS)—initially launched as a pilot in 2022 and formally implemented during the winter of 2022/2023—illustrates how flexibility can also be mobilized at the national level by the TSO to address peak demand events. The DFS scheme engages residential and small business customers via aggregators or suppliers, providing financial incentives to voluntarily reduce consumption during specific time windows.

To avoid confusion, countries whose responses primarily relate to TSO-driven mechanisms are marked with an asterisk (i.e., Austria, India, Japan, South Korea, and the United Kingdom).

[1] NEDO (New Energy and Industrial Technology Development Organization) is a Japanese public agency under the Ministry of Economy, Trade and Industry (METI), supporting research, development, and demonstration projects in energy and industrial technologies.

2.3. General Information

Table 1 summarizes the name of the market platform under analysis.

Table 1. General information about the local flexibility market platform

Country	Market platform name	Local / TSO
Austria*	No name	TSO
Belgium[2]	NODES (for Power Congestion Management Market)	Local
Canada	In-house solution (provincial pilot)	Local
France	No official name	Local
India*	Grid controller own model	TSO
Italy	Picloflex, GME	Local
Japan*	No name	TSO
South Korea*	KPX	TSO
Spain	Spanish NEMO (OMIE) participates in pilots developing the market platform	Local
UK*	Different market platforms for local flexibility (e.g., Piclo, Electron, EPEX SPOT)	TSO (DFS) Local + TSO

Table 2 shows the websites of the projects mentioned by participants.

Table 2. Website of the local flexibility market

Country	Website
Austria*	https://www.nefi.at/de/projekt/industry4redispatch https://stromausgleich.at/#c1907420
Belgium	https://partner.fluvius.be/nl/flexibility-service-provider/fluvius-zoekt-flexibiliteit
Canada	• https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/IESO-York-Region-Non-Wires-Alternatives-Demonstration-Project • https://www.alectra.com/nwa
France	https://flexibilites-enedis.fr/ Flex policy for Enedis detailed in our NDP : https://www.enedis.fr/sites/default/files/documents/pdf/network-development-plan-2023-preliminary-document.pdf?VersionId=Gi0l0XONdb_HdXpaTxeSxTLeCh7TUE5M
India*	https://posoco.in/en/market/ancillary-services/
Italy	https://www.e-distribuzione.it/progetti-e-innovazioni/il-progetto-edge.html
Japan*	https://www.nedo.go.jp/english/activities/activities_ZZJP_100237.html https://www.nedo.go.jp/english/activities/activities_ZZJP2_100353.html
South Korea*	https://new.kpx.or.kr/powerinfoJeju.es?mid=a10404040000
Spain	https://www.onenet-project.eu

[2] Belgium in this case is “Flanders”. In Wallonia, they are considering setting up a LFM as well, but it is not yet clear which platform they will use.

UK*	• DFS market:
	  ○ https://www.neso.energy/industry-information/balancing-services/demand-flexibility-service-dfs
	  ○ https://www.energy-uk.org.uk/publications/energy-uk-explainer-demand-flexibility-service-dfs/
	  ○ https://www.neso.energy/news/new-look-demand-flexibility-service-go-live-next-week
	• Piclo:
	  ○ https://www.piclo.energy/
	  ○ https://www.piclo.energy/about
	  ○ https://www.piclo.energy/flex

2.3.1. Main Motivations

Participants in the questionnaire were provided with a list of reasons for the development of the flexibility market, among which they could select the most relevant. Table 3 reports the answers provided for each country. The most frequently cited motivations for implementing the flexibility market (both at pilot and real operational) include:

- Supporting congestion management for Distribution System Operators (DSOs).
- Reducing the need for grid reinforcement.
- Mitigating renewable generation curtailment.

Additional motivations mentioned by several respondents include the need to align with regulatory frameworks and the opportunity to explore innovative solutions, recognising that a learning period is essential for the development of effective approaches.

Table 3. Motivations

	AU*	BE	CA	FR	IN*	IT	JP*	KR*	ES	UK*
Develop and implementing new business models,	✓		✓							
Enabling distributed energy resources aggregation	✓		✓		✓		✓	✓		✓
Enabling flexibility providers at lower level	✓				✓					✓
Fostering the cooperation between TSO and DSO	✓		✓							
Help DSOs with congestion management	✓	✓	✓	✓		✓	✓		✓	✓
Identification of a set of technology solutions for distributed flexibilities,					✓		✓			
Increasing hosting capacity				✓					✓	
Reducing generation curtailment of renewable energy					✓		✓	✓	✓	
Reducing the need for grid reinforcement	✓	✓	✓						✓	
To defer investment, optmize solution to connect a given customer				✓			✓			
LEGEND: ✓: Yes Empty: No.										

Additionally, the UK stated that the motivations for implementing a flexibility market include:

- Serving as an enhanced mechanism alongside the normal electricity market to access additional megawatts (MW) during periods of high national demand, particularly on days when the system is under stress.
- Mitigating risks to the electricity grid and reducing costs for consumers.

2.3.2. Rise of Flexibility Market Development

Local Flexibility market initiatives have been developed in France, Italy, Spain with some pilot projects (Table 4).

In South Korea, the real-time market operates exclusively on Jeju Island, where a wholesale balancing market ensures supply and demand equilibrium. However, there is no local flexibility market at the DSO level.

In Canada, initiatives are limited to the Province of Ontario. In Belgium, flexibility market developments are specific to Flanders and do not extend to the entire country.

In Japan, local flexibility markets for distribution grids have yet to emerge. In the UK, several Distribution Network Operators (DNOs) began flexibility initiatives around 2018, often in the form of pilot projects or experimental tenders. In contrast, the Demand Flexibility Service (DFS) was introduced at the national level by National Grid ESO during the winter of 2022/2023 as a demand-side management tool to address potential supply shortages [2]. The DFS has been implemented, primarily covering England, Scotland, and Wales, while it is not available in Northern Ireland.

Table 4. Year of development

Country	Year
Austria*	2024
Belgium	2024 = start testing
Canada	2020
France	2020
India*	2022
Italy	2024
Japan*	Considering possibilities through the NEDO FLEX DER project from 2022
South Korea*	2024 .
Spain	Market not yet developed, but in study
UK*	Piclo: 2013: Company founded in London 2018: UK Power Networks opens the first flexibility auctions on Piclo Flex (first official tender). 2022: First TSO market 2025: Launches Piclo Marketplace US-wide, connecting DER buyers and sellers across all 50 states. DFS market: 2018: First local flexibility market tender 2022: Demand Flexibility Service (DFS) launched as a pilot by National Grid ESO. 2022/2023 (winter): DFS officially implemented across England, Scotland, and Wales.

The implementation of flexibility markets varies significantly across surveyed countries. Implementation types reported include pilot projects, research-oriented initiatives, and established market frameworks, as reported in Table 5.

Table 5. Market implementation type

Country	Implementation type
Austria*	TSO-DSO coordination mechanismtested in a demo, flexibility platform (currently for participation in balancing services) available and should be extended to other markets in the future
Belgium	pilot phase
Canada	pilot phase
France	Some flexibility services are used/requested business as usual
India*	study/investigation but the model has not yet been implemented pilot phase
Italy	pilot phase
Japan*	pilot phase some flexibility services are used/requested business as usual(in existing market or individual contracts) but the local flexibility market model has not yet been implemented
South Korea*	some flexibility services are used/requested business as usual
Spain	pilot phase
UK*	Piclo: Some flexibility services are used/requested business as usual via Piclo Flex (UK DSOs, fully commercial since 2019); Some flexibility services are used/requested business as usualInitially it was implemented during the winter months. From November 2024, the DFS has been extended to run all year round

2.3.3. Voltage Levels Covered

Figure 3 shows the voltage level covered by the flexibility market. The majority of the analyzed flexibility markets cover both low voltage (LV) and medium voltage (MV), with some cases focused exclusively on medium voltage (Austria, Belgium and India).

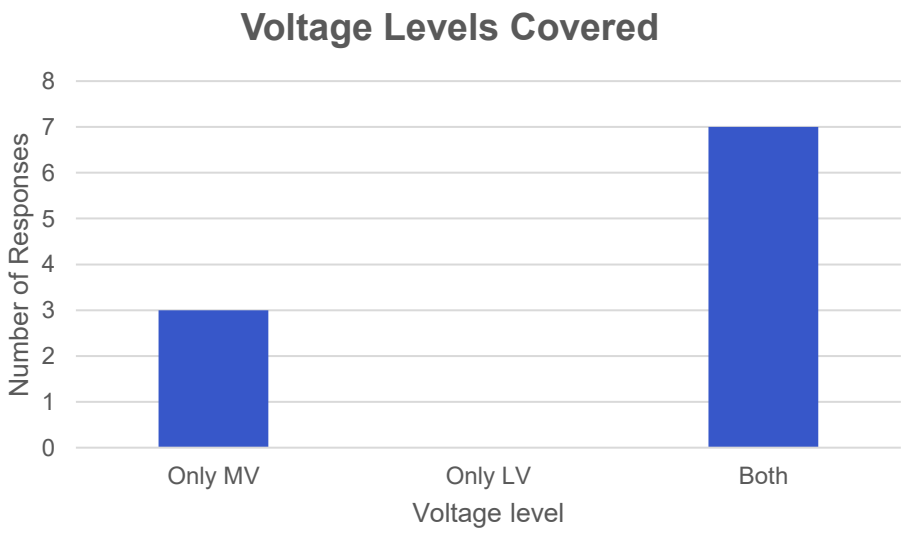


Figure 3: Bar chart showing voltage levels covered.

2.4. Market Details

2.4.1. Stakeholders Involved

Local Flexibility services are procured by DSOs at the MV and LV levels, with TSOs also participating in some cases (Table 6). Providers include generators, energy storage systems, EV charging stations, and industrial and commercial customers

Table 6. Who buys the flexibility services?

Country	DSO at MV level	DSO at LV level	TSO can also participate	TSO only
Austria*				✓
Belgium	✓			
Canada	✓		✓	
France	✓			
India*				✓
Italy	✓	✓		
Japan*	✓		✓	
South Korea*				✓
Spain	✓	✓		
UK*	✓	✓	✓ (Piclo, DFS)	

LEGEND: ✓: Yes Empty: No.

Participants in the questionnaire were provided with a list of resources providing the flexibility services, among which they could select the most relevant. Table 7 provides an overview of the responses by country. In UK, also Energy suppliers and app-based providers sell flexibility services. A list of the registered providers is provided by the National Energy System Operator [3].

Table 7. Who sells the flexibility services

Country	INDUSTRIAL CUSTOMERS	COMMERCIAL CUSTOMERS	RESIDENTIAL CUSTOMERS	GENERATORS	ENERGY STORAGE SYSTEMS	DISTRICT HEATING PROVIDER	AGGREGATORS	EV CHARGING STATIONS
Austria*	✓							
Belgium		✓						
Canada	✓	✓	✓			✓	✓	
France				✓	✓		✓	✓
India*				✓	✓			
Italy	✓		✓	✓			✓	
Japan*				✓			✓	
South Korea*	✓	✓	✓		✓			
Spain	✓	✓	✓	✓				✓
UK*	✓	✓	✓	✓ (Piclo	✓ (Piclo)		✓	✓ (Piclo)

LEGEND: ✓: Yes; Empty: No.

2.4.2. Services and Products Traded

Participants in the questionnaire were provided with a list of services and products traded, among which they could select the most relevant. Services primarily include congestion management and voltage control (Figure 4), while products traded involve active power, capacity, and activation (Figure 5). The inclusion of balancing services in the responses is consistent with the fact that some respondents described TSO-driven mechanisms rather than purely DSO-led local flexibility markets, as noted earlier in the report.

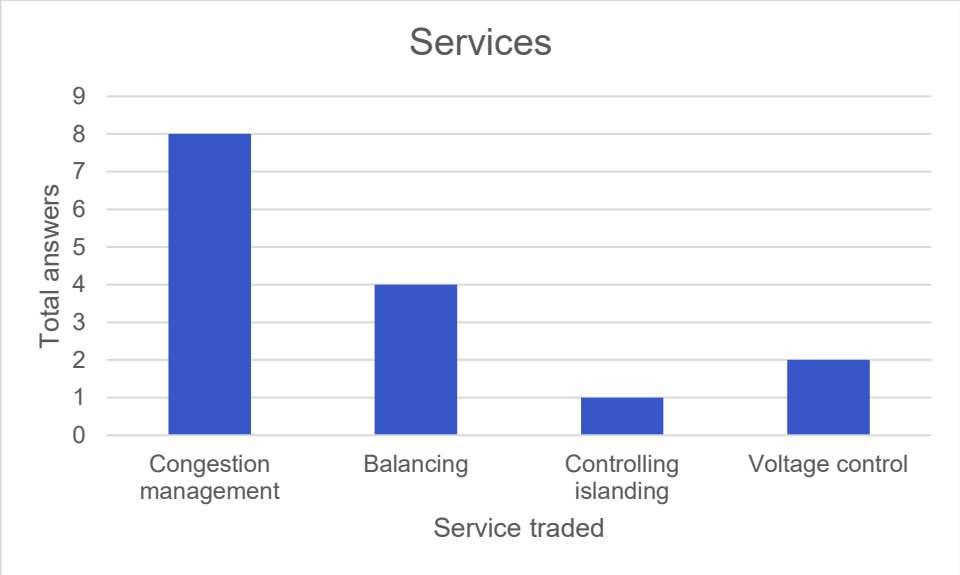


Figure 4: Bar chart illustrating services offered across different markets.

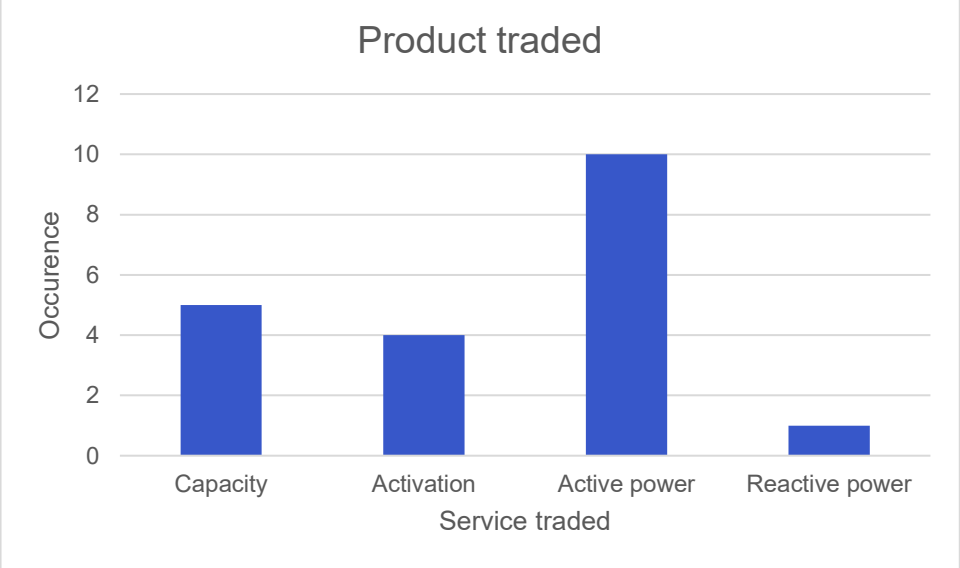


Figure 5: Bar chart illustrating products offered across different markets.

Table 8 provides an overview of the responses by country.

Table 8. Traded services

Country	Traded services
Austria*	Congestion management (in the course of research project) Balancing (via Stromausgleich Österreich Platform)
Belgium	Congestion management Voltage control
Canada	Congestion management
France	Congestion management, Controlling islanding
India*	Balancing
Italy	Congestion management, Voltage control
Japan*	Balancing, Congestion management
South Korea*	Balancing
Spain	Congestion management
UK*	Balancing, Congestion management

Table 9 shows the summaries of country-level responses concerning the different types of products offered in flexibility markets. These products, covering capacity, energy, active and reactive power (Belgium), are subject to distinct design frameworks and technical specifications, particularly with regard to activation modalities, delivery conditions, and aggregation rules.

Table 9. Details of the product traded and specifications

Country	Products traded	Product specifications
Austria*	Active power	direction (up or down), maximum/minimum amount of capacity and/or power, starting time and duration, location, response time
Belgium	Capacity Activation Active power Reactive power[3]	direction (up or down), maximum/minimum amount of capacity and/or power, starting time and duration, response time, location
Canada	Capacity Active power	maximum/minimum amount of capacity and/or power

[3] In the reactive power market, a single product is offered, procured on a long-term basis—typically ranging from six months to one year in advance. Once reserved, the DSO (Fluvius) has the right to activate the resource directly as needed..

France	Active power Activation Capacity	direction (up or down) maximum/minimum amount of capacity and/or power starting time and duration, response time, location
India*	Active power	direction (up or down)
Italy	Active power	direction (up or down), maximum/minimum amount of capacity and/or power, starting time and duration, response time,location
Japan*	Active power Capacity Activation	direction (up or down), maximum/minimum amount of capacity and/or power, starting time and duration, response time,
South Korea*	Active power	direction (up or down), starting time and duration
Spain	Capacity Activation Active power	maximum/minimum amount of capacity and/or power, starting time and duration, Location response time
UK*	Active power	DFS: maximum/minimum amount of capacity and/or power, starting time and duration, Piclo: direction (e.g. generation turn-up / consumption turn-down), maximum / minimum capacity or power, starting time-window and duration, location (constraint area / postcode), 15-minute response time, minimum run-time and aggregate size

2.4.3. Pricing Methods

Platforms used include proprietary solutions and public platforms such as Picloflex. The most common pricing method is “pay-as-bid” while some cases use “pay-as-clear” method.

Table 10. Pricing method

Country	Pricing method
Austria*	Pricing method has not been determined yet
Belgium	Pay-as-bid
Canada	Pay-as-clear
France	Pay-as-bid
India*	Pay-as-bid
Italy	Pay-as-bid
Japan*	Pay-as-bid/ Pay-as-clear
South Korea*	Pay-as-clear

Spain	Pay-as-bid
UK*	Pay-as-bid

2.4.4. Service Availability, Trading, and Activation Times

Table 11 provides an overview of the availability, trading, and activation times of flexibility services across different countries, highlighting the variations in market design and operational frameworks.

Concerning the availability time of the service procurement, some countries, such as Canada and Italy, have long-term procurement frameworks, with availability extending up to six months or seasonal durations, respectively. In contrast, France, Spain, and the UK operate on a shorter-term basis, typically allowing flexibility services to be available on a daily or weekly schedule.

Regarding trading time, Spain mainly relies on day-ahead markets, while Belgium and France operate within a short-term trading framework, often responding to grid needs as they emerge. The UK allows within-day procurement. Initially, DFS included day-ahead procurement, but NESO moved to within-day procurement only to secure the necessary volumes with good accuracy and competitive prices [4].

Concerning the activation time, most European countries (Belgium, France, Italy, Spain, and the UK) require activation within one hour. However, some systems have more flexible activation times: Canada allows two or more hours for activation, while Austria and Spain specify activation occurring either the day before or within an hour, depending on the product.

Table 11. Time specifications

Country	Availability time of the service procured	Trading time	Activation time
Austria*	Bid offer period	Day-ahead	Day before
Belgium	Active Power (MaxUsage, LongFlex, ShortFlex) 1 hour blocks Reactive Power 6 months to 1 year	MaxUsage & LongFlex: 1 week ahead; ShortFlex: 12h ahead Long-term procurement	No additional signal; activation occurs as per cleared schedule Direct control by DSO (Fluvius)
Canada	6 months	Capacity - 6 months	2 hours
France	Flex service available during a few hours. Contract validated during 3 years	Short term : once failure occurs or planned the day before Long-term (tenders to cover the planned needs as seasonal availability)	one hour
India*	A day	Day ahead and intra day	one hour
Italy	seasonal availability in detailed weekly days / hours	Long-term (tenders to cover the planned needs as seasonal availability)	one hour
Japan*	One year (period during which flexibility services are required under a directive in a single contract)	First announcement: 3 years ago Additional announcement: 1 year ago	More than 30min

South Korea*	A day	Short-term	few hours
Spain	Depending on the product, from 1 day to more than one week	short-term	day beforeone hour
UK*	A day Piclo: Service windows of a few hours per day, bundled into winter- or summer-season contracts that can run 6 – 18 months	Within-day procurement. Piclo: Day ahead and intraday	within-day activation

2.4.5. Integration with Other Markets and Coordination with TSOs

Survey responses reveal notable differences regarding integration with other markets and coordination with TSOs. The integration of flexibility markets with other energy markets varies across surveyed countries. Austria, Spain, the UK[4] and Canada report having integration with other markets, allowing interaction between flexibility mechanisms and broader market structures. In contrast, France, Italy, Spain, South Korea, and Belgium explicitly report no integration, indicating that their flexibility markets operate independently. For India, integration was either not specified or not applicable in the responses. For Japan, a simultaneous market with wholesale and balancing is considerd. Also, a system is considered that will enable TSOs to coordinate and utilize local flexibility in balancing supply and demand of entire balancing areas and congestion management in a NEDO pilot project.

Coordination with Transmission System Operators (TSOs) also differs by country: some flexibility markets closely coordinate operational activities and procurement decisions, while others exhibit limited or no interaction. Detailed answers are reported in Table 12.

Table 12. Overview on coordination with TSO

Country	Coordination with TSO
Austria*	At the moment only TSO is able to activate bids, DSOs are able to "block" bids (announce grid restrictions to TSO)
Belgium	TSO does not participate to in the market
Canada	In collaboration with Independent System Operator
France	TSO currently does not participate. Willing to have a TSO/DSO market
India*	Only at TSO level
Italy	TSO currently does not participate
Japan*	Not applicable (No flexibility market)
South Korea*	Not applicable
Spain	TSO does not participate to in the market.
UK*	Through NESO's work on the 'Open Networks' programme, NESO is delivering more standardised and coordinated processes for the alignment of their network operations and market development with DNOs

[4] NESO enabled the opportunity to stack DFS with the Capacity Market and DNO flexibility markets in 2024, moving to an in-merit service.

2.5. Data Exchange

The exchange of data plays a fundamental role in enabling the use of flexibility at the distribution level. According to the CEER report [5], data exchange practices vary significantly across countries, reflecting both the differing levels of maturity and implementation of flexibility mechanisms, as well as the varying responsibilities assigned to DSOs in each national context. CEER's assessment shows that flexibility data exchange is still in its early stages, and no common standards or widely adopted practices have yet emerged from the procedures implemented by DSOs or other designated entities. For this reason, respondents were asked to provide information on data exchange, if applicable in their national context.

2.5.1. Data Exchange between DSOs and Flexibility Providers

The survey investigated the type of data exchanged between Distribution System Operators (DSOs) and flexibility providers, including stored and shared information. Participants in the questionnaire were provided with a list of exchanged data, among which they could select the most relevant. Table 13 reports the answers.

The responses indicate significant variability in data handling.

Table 13. Data are exchanged by the DSO to flexibility providers

Country	Anonymized and pre-processed metering data	Amount of flexibility and capacity needed	Geographical and Location Data	Specific periods when flexibility is needed	Technical Constraints and Grid Conditions
Austria*	✓		✓		
Belgium	✓	✓		✓	✓
Canada		✓		✓	
France				✓	
India*		✓			
Italy		✓		✓	
Japan* **(pilot)**		✓	✓	✓	✓
South Korea*				✓	✓
Spain				✓	
UK*		✓	✓ (Piclo)[5]	✓	

LEGEND: ✓: Yes Empty: No.

2.5.2. Types of data exchanged

Table 14 provides an overview of the responses by country concerning the exchanged data.

Table 14. Data exchanged (data stored and/or exchanged between the parties)

[5] https://support.picloflex.com/article/247-system-operator-data-access
https://support.picloflex.com/article/126-dso-flex-market-data

Country	Data
Austria*	Flexibility resource identifiers/IDs Metering and verification data Duration Available flexibility
Belgium	Flexibility resource identifiers/ID Contractual limits of each device s
Canada	participant information, quantity, price, and timestamps
France	Duration
India*	Duration Available flexibility Flexibility resource identifiers/IDs
Italy	Flexibility resource identifiers/IDs DER power/capacity ratings Available flexibility Duration
Japan* (pilot)	Available flexibility Flexibility resource identifiers/IDs DER power/capacity ratings Duration
South Korea*	not at all
Spain	Flexibility resource identifiers/IDs Available flexibility
UK*	Available flexibility DER power/capacity rating Duration

2.6. Studies and Model Validation

Countries were asked to provide details on the studies conducted to validate the implementation of flexibility market models and tools adopted.

2.6.1. Studies Carried Out

Most countries carried out both market and network simulations, including France, South Korea, and Japan, where studies were conducted within the NEDO FLEX DER project. Italy DSO did not perform preliminary studies on the market model, as its implementation was based on National Regulatory Authority (NRA) request. However, a periodic report is submitted to the NRA. Similarly, no preliminary studies were conducted in India.

Spain provided a comprehensive analysis, covering model implementation, network studies, market simulations, pilot tests and evaluations, as well as scalability and replicability assessments.

In Austria, the participant reported a quantitative comparison of historical redispatch demand with industrial flexibility potential, which indicated insufficient liquidity for a fully competitive market. As a result, potential constraints, such as bid price limits and proof of actual costs, may be introduced, though these aspects were not considered in the demonstration phase.

In Belgium, the participant described the pilot as a learning process, emphasizing that the DSO is implementing it to assess its feasibility.

In the UK, the Demand Flexibility Service (DFS) was developed based on a turn-down pilot conducted by NGESO in collaboration with Octopus Energy and 100,000 households in early 2022 [6]. Details about Canada are available in [7].

2.6.2. Tools Used for Studies

Both proprietary and open-source tools were employed in the studies. Among the proprietary tools, Digsilent PowerFactory and PSSE were commonly used. Additionally, a new tool was developed to identify network criticalities, such as current and voltage issues, as part of short-term forecasting and to define flexibility services for activation based on seasonal contracts in the Italian pilot project. In Spain, a combination of open-source software, including Python, Pandapower, and Gurobi, was used alongside proprietary tools such as Digsilent PowerFactory, Matlab, and in-house software. In Belgium, DSO tools were applied, with specific areas selected based on critical zones identified in DSO investment plans. In Japan, the ANSWER (Active Network System with Energy Resources) power distribution system simulator at Waseda University was utilized for distribution grid studies [8].

2.6.3. Penalty Scheme for Not Providing the Committed Flexibility

The survey results reveal a diverse range of approaches to penalty schemes for non-compliance with committed flexibility provisions. Some markets have implemented strict penalty mechanisms, while others have opted for leniency to encourage participation. Below is a summary of the responses:

In France, a penalty scheme has been designed to address systematic deviations from the reported schedules. In the Indian Pilot, similar to France, a penalty scheme is implemented based on systematic deviations from scheduled commitments. In Japan, imbalance fees must be paid if the committed flexibility is not provided. In Japan's pilot project, imbalance fees are assumed to be paid if the committed flexibility is not provided (overcontrol is acceptable, which does not have to be paid). In the UK, the penalty arrangements aim to prevent strategic non-delivery under the "opt-out rule." The penalty is capped at the contracted quantity bid in the opposite direction of the contract. For instance, if a participant was contracted to reduce demand by 10 MW but instead increased it by 20 MW, they would only be penalized for 10 MWh of the increase. In Canada, penalties are applied based on availability, capacity, and dispatch performance.

On the other hand, Italy, Austria, and Belgium currently do not have a penalty scheme in place to avoid discouraging potential participants. Additionally, the penalty scheme is not applicable in Spain and South Korea.

2.7. Additional Considerations on Flexibility Market Design

The survey explored various design elements of flexibility markets, including minimum price policies, environmental impact considerations, service structuring, and selection criteria for flexibility services. Responses highlight key differences across countries.

2.7.1. Pricing

2.7.1.1. Minimum Price Assigned to the Flexibility Product

The presence of a minimum price policy varies across countries. Canada a ceiling was set, while France, Italy, Austria, Spain, South Korea, Belgium, India, and Japan reported that no minimum price was established for flexibility services. the UK reported that in the“turn down pilot”, alternative incentive based on p/kWh credit for turn down saw higher participation and depth of response. On average, successful customers on the standard incentive received a payment of £0.22, whereas those on the alternative incentive received £0.30. £0.20 was set as a minimum payment.

2.7.1.2. Consideration of CO_2 Emissions in Flexibility Services

Survey responses indicate that all countries reported CO_2 impact is not considered in their flexibility service procurement.

2.7.1.3. Fixed and Variable Components in Service Pricing

The structure of payments for flexibility services varies across markets. France, India, Italy and South Korea reported that a structured division between fixed and variable components in their flexibility pricing is considered. India specified that As per market design, yes, but at present only Regulated, so no fixed amount for availability. Also, in Spain, one product is formed by an availability and activation component. In the UK, NESO does not intend to introduce an availability payment because they do not have a need for a fixed volume of the service, nor do they consider it would represent good value for consumers.

2.7.1.4. Criteria for Selecting Flexibility Services Compared to Standard Solution

The responses show a variety of approaches to determining how flexibility services are selected in comparison to conventional solutions such as mobile generators or planned outages. Austria, India, and South Korea indicated that selection is based on price, with the cheapest solution being chosen first. France referred to the criterion of achieving the best gain for the collectivity. In Italy, preliminary cost-benefit assessment is performed and no selection process is required later, as the service was contracted per grid portion in the pilot project. Spain reported that the issue was studied during development planning, both on a case-by-case basis and within a broader framework; however, it is not expected to be addressed on a case basis once the market is functioning. The United Kingdom indicated that the question was not applicable.

2.7.2. Uncertainty Integration in the Market

The survey also investigated the inclusion of uncertainty in the studies, particularly regarding scenarios such as no service provision, variations in customer behaviour, or changes in RES (Renewable Energy Sources) production. Table 15 summarizes how uncertainty is currently addressed. It highlights a mix of approaches, ranging from probabilistic modeling to simplified security margins, and in some cases, a lack of explicit treatment.

Table 15. Uncertainty implementation in validation studies

Country	Answer
Austria*	Security margins for calculations of DSO grid constraints need to be considered (since we don't know the exact load and demand in the grid, and use simplified grid models)
Belgium	
Canada	DER operational uncertainty tracked
France	Yes, using probabilistic load curves
India*	RES uncertainity is captured
Italy	Uncertainty in FSP availability, uncerteinty in grid issues occurrence and magnitude
Japan*	The operating margin considering uncertainty and that should be set is considered for DER utilization.
South Korea*	Due to the current market environment, a definitive answer may not be applicable.
Spain	Not applicable
UK*	Not applicable

2.8. Preliminary Results

2.8.1. Providers Involved and the Contracted Agreements

Respondents were asked to specify the connection level or substation at which flexible resources need to be located to qualify for providing the service. Seven out of ten countries stated that Flexibility Service Providers are connected at MV level. Table 16 summarizes the responses by country.

Table 16. Connection area for flex resources to be candidates for providing the service

Country	Connection area
Austria*	HV/MV substation
Belgium	HV/MV substation
Canada	LV or MV
France	MV/LV substation
India*	HV/MV substation
Italy	MV feeder
Japan*	HV/MV substation and feeder
South Korea*	not related to location
Spain	HV/MV substation and MV/LV substation
UK*	MV/LV substation

Table 17 provides an overview of the estimated volumes of contracted flexibility in each country, including comparisons to maximum peak demand (where available) and the number of participating flexibility providers. Some countries are still in pilot phases or have only partial data, so the figures represent the best estimates or, in some cases, are not yet available. The high number of participants in the UK reflects the earlier establishment of its flexibility market compared to other countries, where initiatives are still in pilot or early development stages. The list of the registered providers (domestic households and industrial & commercial) taking part in the DFS can be found in [9].

Table 17. Estimate of the contracted flexibility: flexibility providers involved and the contracted agreements

Country	In comparison to maximum peak demand, what is the average estimated volume of the contracted flexibility?	Number of flexibility providers involved	Implementation type (from Table 4)
Austria*	-	4 providers have participated in the demo	Demo TSO
Belgium		Low for Now as they are just starting	Pilot phase
Canada	15 MW	9 participants	Pilot phase
France	-	20	Business as usual (some services)
India*	max 5 GW while Peak demand is arond 220 GW-250 GW	50	TSO level: Study/investigation but the model has not yet been implemented
Italy	no comparison useful (pilot is ongoing just a limited portion of the grid is involved)	25	Pilot phase (under investigation)
Japan*	Currently under study at NEDO pilot project.	There are many aggregators that bundle DER providers.	Pilot phase + investigation
South Korea*	The market operation period is too short to make an appropriate estimation.	The market operation period is too short to make an appropriate estimation.	TSO level: Business as usual (some services
Spain	A realistic figure is not available	Not available	Pilot phase
UK*	Over the last two years the Demand Flexibility Service has seen over 2.6 million households and businesses take part, saving over 7,000MWh of electricity.		TSO level: Business as usual (extended scope)

2.8.2. Customer Participation Model

The implementation of customer participation models in flexibility markets varies significantly:

- **Countries assuming full participation of all users in a given area:**
  France, Italy, Spain: Market mechanisms are designed under the assumption that all consumers within a specified area are eligible to participate.
- **Countries where a defined percentage of users is expected to participate:**
  Austria, Canada, Belgium: Participation is assumed to be limited to a specific subset of users, either through voluntary enrollment or regulatory constraints.

It was requested to rate the level of participation of flexibility providers. Table 18 summarises the responses, showing a variety of different participants across countries. Some countries have included energy storage systems and EV charging stations among potential flexibility providers, whereas others have no data available or classify them as not applicable (not involved). In Spain's case, the uniform rating of "5" across all participant categories likely reflects a scenario-based simulation in which participation is assumed at a maximum level, rather than actual market data.

Table 18. Flexibility provider participation (1 represents a low level of participation and 5 represents a high level of participation)

Country	Residential customers	Commercial customers	Industrial customers	Generators	Energy storage systems	EV charging station
Austria*	Not Applicable	Not Applicable	5	Not Applicable	Not Applicable	Not Applicable
Belgium	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
Canada	3	3	3	3 Some participants were CHP	Not Applicable	Not Applicable
France	1	1	1	4	5	1
India*	Not Applicable	Not Applicable	Not Applicable	5	1	Not Applicable
Italy	1	4	4	5	Not Applicable	Not Applicable
Japan* pilot)	1	2	3	5	5	2
South Korea*	2	2	2	4	4	1
Spain	5	5	5	5	5	5
UK*	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available

3. Identified Challenges and Policy Recommendations

3.1. Challenges

Reported barriers in implementing flexibility markets include regulatory barriers and ICT infrastructures and trust issues (privacy/security/…) and Japan reported Increase in procurement costs, safety net during DER reactivity (Table 19). In Canada, although no structural barriers were reported, preferences emerged for fewer activations, longer advance notice, and greater certainty through long-term commitments—highlighting design aspects relevant to stakeholder engagement.

Table 19. Challenges

Country	Custumer engagement	Data management	Lack of ICT infrastructure	Lack of regulatory framework	Lack of transparency	Trust issues (privacy/security/…)
Austria*			✔	✔	✔	✔
Belgium	Just starting the Pilots, detailed evaluation will follow					
Canada	Lack of desire to be activated					
France		✔	✔			
India*	quantity available at peak hours					
Italy	Not Applicable					
Japan* (pilot)	✔	✔		✔		✔
South Korea*						
Spain	✔		✔	✔		
UK*	Not Applicable					

3.2. Main Findings

The survey confirms that local flexibility markets are emerging as a critical tool for optimizing grid operation and supporting the energy transition. While the level of maturity varies widely across countries, some common patterns clearly stand out. India, Japan, and South Korea are still in the evaluation phase, meaning that no pilot projects have been implemented yet, and discussions are ongoing about the feasibility of local flexibility markets. Japan is still compiling findings from initial assessments through NEDO pilot projects, South Korea states that its current market environment does not yet allow for definitive conclusions, and India highlights the need for greater participation and market integration as part of its early considerations.

Belgium, Italy, and Canada are in the pilot phase, though at different stages. Belgium has recently started pilot activities and remains in an early phase of implementation. Italy highlights structural challenges, particularly the issue of low market liquidity due to the limited number of aggregated resources capable of providing flexibility services at the medium-voltage feeder level. Canada has initiated pilot activities and recognizes the economic value of DERs, but its flexibility market remains in development.

Enedis, the main French DSO, has implemented a flexibility market and runs tenders for services. Its operation is only partially effective due to issues related to market design and participation. Although flexibility is valuable for integrating renewable energy and balancing supply and demand, its current use is often viewed as an ad hoc solution rather than a fully integrated market mechanism. IT infrastructure is also highlighted as a key factor.

Spain provides the most detailed insights, having implemented a structured demonstrator project with defined services, market rules, and platform development. Lessons learned from Spain include defining standardized products, designing local market characteristics, engaging a diverse range of customers, and ensuring accurate service delivery. Challenges include customer engagement barriers, cybersecurity requirements, and the need for a more detailed assessment of baselining methodologies.

In Spain, a demonstrator from the OneNet project [10],[11] made key contributions by defining standardised services, designing local market features, developing a transparent market platform, and engaging a diverse range of participants. Its main outcomes include:

1. Definition of services and products for local flexibility markets, with two Spanish DSOs agreeing on product attributes for congestion management.
2. Specification of core local market features such as prequalification processes, locational granularity, market clearing rules, and activation and measurement procedures.
3. Development of a local market platform by the Spanish NEMO for both long- and short-term products.
4. Involvement of various resources—industrial facilities, educational buildings, and aggregators—as flexibility service providers.
5. Successful activation and measurement of services, effectively preventing congestion limit breaches.

These outcomes provide a solid basis for integrating flexibility products into DSO operations.

1. Customer engagement: Participation in System Operator services faces behavioural, economic, technical, and legal barriers.
2. Platform integration: Ensuring interoperability standards remains complex.
3. Baseline calculation: Defining accurate baseline methodologies requires further field testing to establish suitable criteria.

The United Kingdom's experience with the Octopus trial and DFS highlights the effectiveness of agile development, minimal bureaucracy, and rapid implementation, enabling a successful trial within eight weeks. The initiative demonstrated the importance of scalability in flexibility solutions and lowered entry barriers for households and businesses, receiving industry recognition for its innovation.

Across countries, some cross-cutting issues clearly emerge. Flexibility markets are at very different stages of maturity, ranging from exploratory studies to advanced pilots. Common barriers include regulatory uncertainty, insufficient market liquidity, lack of standardized data exchange protocols, and heterogeneous approaches to baseline definition. Another recurring theme is the need to explicitly account for uncertainty in demand, generation, and flexibility availability. Finally, the survey highlights that coordination between TSOs and DSOs is inconsistent across countries: while some initiatives operate entirely at the distribution level, others show varying degrees of integration with transmission-level mechanisms.

This heterogeneity represents a challenge for scalability and for the design of coherent flexibility procurement frameworks.

3.3. Policy Recommendations

Based on the survey results, the following recommendations aim to support policymakers, regulators, and system operators in the evolution and scaling-up of local flexibility markets:

- **Enable Structured TSO–DSO Coordination Frameworks**

In the development of a flexibility market, both at the local and system levels (i.e., ancillary services), coordination between TSO and DSO should be considered by design. While several countries are exploring flexibility services at both the transmission and distribution levels, formal frameworks for cooperation (especially regarding procurement coordination, data exchange, prequalification, and service stacking) remain underdeveloped. In this context, policy support is essential to define shared responsibilities, interfaces, and co-optimise the procurement of flexibility services across grid levels.

- **Standardize Communication Protocols and Data Models**

Harmonized digital infrastructures are key for enabling interoperable and scalable markets. The lack of standardisation regarding data formats and communication protocols is a significant barrier to the growth of local flexibility markets, resulting in information gaps, increased complexity, and higher costs. The development or adoption of standard communication protocols (e.g., IEC 61850, CIM) and common data models for availability, activation, metering, and settlement should be essential for national regulators, Service Providers, DSOs, and TSOs.

- **Clarify Baseline and Verification Methodologies**

The way in which baseline behaviour and service verification are measured is still heterogeneous across pilot projects. Common methodological guidance or standardized frameworks could enhance trust, comparability, replicability, and scalability. Regulatory authorities should encourage and support the development of shared guidelines and, where possible, provide access to open-source or certified tools for consistent and transparent verification.

- **Promote the Integration of Uncertainty in Market Design and Grid Planning**

Many flexibility market pilots still rely on deterministic assumptions regarding demand profiles, resource availability, and participation. Only a few explicitly incorporate uncertainty (such as forecast errors, probabilistic delivery, extreme events, or user behavior variability) into their preparatory studies, planning models, or market mechanisms. Regulatory and technical frameworks should encourage the integration of uncertainty into both the design and operation phases, to improve system robustness, supply reliability, optimize procurement strategies, and better reflect real-world conditions.

- **Support Scalable Pilot Projects and Regulatory Sandboxes Addressing Real-World Complexity**

To enable the development of operational flexibility markets, it is essential to promote pilot projects and regulatory sandboxes that address the technical, market, and regulatory challenges emerging in real-world scenarios. The outcomes of regulatory sandboxes are essential for designing solutions that can be effectively implemented in the real world. Regulatory sandboxes, in particular, provide an opportunity to test innovative roles, procedures, services, and business models in a controlled environment, even when current regulation would not normally allow such experimentation.

4. Conclusions

The analysis of survey responses confirms that flexibility markets are at different stages of development across the surveyed countries. While some markets have established mechanisms for procuring and activating flexibility services, others remain in the exploratory or pilot phase. The findings indicate that local flexibility markets are primarily used for congestion management and voltage control with varying degrees of integration into broader energy markets. For instance, some countries, including Austria, France, India, Italy, and South Korea, currently have no direct link between their local flexibility markets and other energy markets. In contrast, Canada's market is integrated with wholesale, and the UK has enabled stacking with capacity and DNO flexibility markets. Furthermore, Japan is considering a simultaneous market with wholesale and balancing, while Spain anticipates future possibilities for integration.

Regulatory uncertainty is a recurring challenge in many countries. The lack of standardized rules and clear market frameworks affects investor confidence and limits the participation. Some countries, such as France and the United Kingdom, have taken steps toward regulatory clarity and operational markets, while others, such as Italy and Belgium, continue to operate within pilot projects or experimental frameworks. Spain is still studying the feasibility of local flexibility markets, while Canada has only recently initiated pilot projects. In Austria, the development of a local flexibility market for DSO congestions is under discussion.

Data exchange and ICT infrastructure play a critical role in the effective operation of flexibility markets. However, many countries report difficulties in establishing secure and efficient communication protocols between DSOs, flexibility providers, and market operators. In some cases, inadequate data-sharing mechanisms hinder transparency and market efficiency.

Market liquidity remains a concern, particularly in early-stage markets. Many respondents highlight that attracting a sufficient number of participants is necessary to ensure competitive pricing and reliable service provision. While some countries have introduced market incentives to encourage participation, others still struggle with engagement, particularly from residential consumers and small-scale flexibility providers.

TSO-DSO coordination also varies significantly. Some markets operate independently at the distribution level, while others procure flexibility services in coordination with TSOs. The level of integration between local and national markets remains inconsistent, affecting the scalability of flexibility solutions.

Another key finding concerns the treatment of uncertainty in flexibility market studies. Some countries incorporate probabilistic approaches to account for variations in load demand, renewable generation fluctuations, and flexibility service availability. For instance, France directly integrates uncertainty using probabilistic load curves, and India captures eenewable energy uncertainty. Other countries, such as Austria and Japan, consider uncertainty through security margins, and Canada tracks Distributed Energy Resources operational uncertainty. Italy specifically addresses uncertainty in Flexibility Service Provider availability and grid issues. Others, however, lack structured methodologies for uncertainty analysis, which may impact the reliability of market mechanisms and investment decisions.

Additionally, the types of studies conducted vary significantly across countries. Some, such as Spain, have performed extensive modeling of both market and network impacts, including pilot tests and scalability assessments. Others, such as Austria and Belgium, are still in early exploratory stages and have not yet conducted in-depth studies.

Despite these challenges, the survey findings suggest that local flexibility markets can play a crucial role in optimizing grid operations and supporting the transition to a more sustainable energy system. Addressing regulatory, technical, and market barriers will be essential for unlocking their full potential. Future developments should focus on regulatory harmonization, improved data-sharing frameworks, enhanced uncertainty modeling, and strategies to enhance market liquidity, ensuring that flexibility markets contribute effectively to grid stability and decarbonization goals.

The UK case further illustrates how national-level demand response mechanisms, such as the Demand Flexibility Service, can complement local DSO-led initiatives. This dual approach highlights the importance of coordinated flexibility procurement across voltage levels and institutional responsibilities, paving the way for scalable, resilient, and consumer-inclusive market models.

5. References

[1] Chondrogiannis, S., Vasiljevska, J., Marinopoulos, A., Papaioannou, I. and Flego, G., Local Electricity Flexibility Markets in Europe, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/9977, JRC1300

[2] Demand Flexibility Service (DFS), NESO website, https://www.neso.energy/industry-information/balancing-services/demand-flexibility-service-dfs

[3] Registered Providers List: https://www.neso.energy/industry-information/balancing-services/demand-flexibility-service/registered-providers-list

[4] National Grid ESO, Demand Flexibility Service Terms and Conditions, 2024, available online https://www.neso.energy/document/324081/download

[5] Council of European Energy Regulators (CEER), Paper on DSO data exchange relating to flexibility and NRAs' role, Ref. C23-DS-87-03, Council of European Energy Regulators, 2023. [Online]. Available: https://www.ceer.eu/documents/104400/-/-/a93e5b49-ff02-d4f3-d70e-f3ff6996940c

[6] Octopus-National Grid ESO Domestic Scarcity Reserve Trial Results, July 2022, available online: https://octoenergy-production-media.s3.amazonaws.com/documents/OE-NGESO_Domestic_Scarcity_Reserve_Trial_Results_vSEND_v2.pdf

[7] IESO York Region, Non – Wires Alternatives Demonstration Project Evaluation Report, July 2024, https://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/yrnwa/YRNWA-20240723-Final-Report.pdf

[8] Advanced Collaborative Research Organization for Smart Society (ACROSS) Waseda University website, https://www.waseda.jp/inst/across/en/about/rdcenter

[9] Registered providers list, https://www.neso.energy/industry-information/balancing-services/demand-flexibility-service/registered-providers-list

[10] European Commission, One Network for Europe (OneNet), Project ID: 957739, Horizon 2020, Oct. 2020 – Mar. 2024. [Online]. Available: https://cordis.europa.eu/project/id/957739

[11] J. P. Chaves, M. Troncia, B. Alonso, and C. Vidal, Demo results assessment and data collection report – Spain, Deliverable D9.6, OneNet Project, European Commission, 2023. [Online]. Available: https://www.onenet-project.eu/wp-content/uploads/2023/08/OneNet_D9.6_v1.0.pdf