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ISGAN Working Group 9, Task 4: Operational Planning

Stakeholder Opinions on Flexibility Usage in Electric Energy Systems

Technical Report

ISGAN WG 9

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December 2023

Technology Collaboration Programme

by iea

About ISGAN Discussion Papers

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

Disclaimer

Nomenclature or List of Acronyms

aFRR	automatic Frequency Restoration Reserve
AMI	Advanced Metering Infrastructure
BSP	Balancing Service Provider
CA	Consumer Associations
CEP	Clean Energy Package
CM	Congestion Management
DSO	Distribution System Operator
EV	Electric Vehicle
FCR	Frequency Containment Reserve
FSP	Flexibility Service Providers
GCT	Gate Closure Time
GDPR	General Data Protection Regulation
GOT	Gate Opening Time
HP	Heat Pump
ISGAN	International Smart Grid Action Network
M&V	Measurement and Verification
mFRR	manual Frequency Restoration Reserve
PV	Photovoltaic
RD	Redispatch
SCADA	Supervisory Control and Data Acquisition
SM	Smart Meter
SO	System Operator
TSO	Transmission System Operator
VPP	Virtual Power Plant
WG	Working Group

Abstract

The global energy landscape is in the midst of a profound shift towards flexibility markets and distributed solutions, necessitating a nuanced understanding of their impact on operational planning. This research, conducted under the International Smart Grid Action Network's Working Group 9, delves into the intricacies of flexibility within the Austrian, Canadian, and Korean electricity systems. Leveraging prior research, the collaborative effort sets the stage for a comprehensive exploration of flexibility markets across diverse regions.

Employing a multi-faceted methodology, the work was initiated with a thorough review of electricity systems in the participating countries. Based on this review, a targeted stakeholder questionnaire, complemented by in-depth interviews with system operators, aggregators, and consumer associations, facilitated not only insights extraction but also a comparative synthesis of stakeholder views.

It can be acknowledged that barriers to distributed flexibility use range from technical constraints to regulatory hurdles, highlighting the absence of a comprehensive regulatory framework. Smart meters, while ubiquitous, still face technical challenges and regulatory barriers impede Distribution System Operators (DSOs) from accessing flexibility resources, necessitating further clarification.

Globally, a consensus emerges on the imperative for refined regulatory frameworks and clarified roles. Challenges persist in technology and infrastructure for measurement and verification, hindering seamless flexibility integration. It could be demonstrated that flexibility potential as a network reinforcement tool faces unpredictability, mitigated by advancements in predictability and regulatory evolution. European perspectives underscore grid topology's significance in leveraging local flexibilities.

Distinct business models surface across regions, with Austrian Flexibility Service Providers focusing on ancillary services, short-term markets, and Virtual Power Plant (VPP) solutions. Persistent customer engagement challenges highlight the need for education and financial incentives.

In conclusion, the diverse designs of global electricity markets necessitate tailored approaches for the successful implementation of flexibility markets in operational planning. Regulatory clarity and continuous stakeholder engagement emerge as pivotal factors in navigating this evolving energy landscape.

Executive Summary

The global energy landscape is undergoing a transformative shift towards flexibility markets and distributed flexibility, necessitating a deep understanding of their impact on operational planning. Conducted under the International Smart Grid Action Network's Working Group 9, this research examines the intricacies of flexibility in the Austrian, Canadian, and Korean electricity systems. The collaborative effort, building on prior work, sets the stage for a nuanced exploration of flexibility services across diverse regions.

To unravel the complexities, a multi-faceted methodology was adopted. A comprehensive review of electricity systems in the target countries laid the groundwork, providing the essential context for the next phase, drafting a stakeholder questionnaire. Key stakeholders, including system operators, aggregators, and consumer associations, were then engaged through this targeted questionnaire and in-depth interviews. The aim was not only to extract insights but also to compare perspectives, offering decision-makers a comprehensive synthesis of stakeholder views.

The findings reveal a dynamic landscape marked by challenges and opportunities. Barriers to utilizing distributed flexibility include technical constraints, consumer engagement, and regulatory hurdles. While the challenges in the participating countries vary, every stakeholder group highlighted the absence of a comprehensive regulatory framework. Smart meters, while primary in technology use, face limitations in data resolution and transmission frequency. Regulatory barriers hinder the access to flexibility resources for Distribution System Operators (DSOs), and need further clarification in stakeholder interactions. Furthermore, a consensus emerges globally on the need for refined regulatory frameworks and clarified roles. Technology and infrastructure challenges persist in measurement and verification, with smart meters requiring enhancements. Integrated flexibility products face hurdles in standardization, and market complexities hinder utilities from succeeding as ultimate dispatchers.

The usage of the flexibility potential as a network reinforcement tool is prevented by its unpredictability, though advancements in predictability and regulatory evolution may enhance its viability. European perspectives underscore the importance of grid topology in utilizing local flexibilities.

Across regions, distinct business models emerge. Austrian Flexibility Service Providers (FSPs) focus on ancillary services, short-term markets, and Virtual Power Plant (VPP) solutions, highlighting the need for consumer awareness. Customer engagement challenges persist, emphasizing the importance of education and financial incentives.

In conclusion, the diverse designs of global electricity markets suggest a lack of one-size-fits-all solutions. Successful implementation of flexibility markets for operational planning requires tailored approaches, regulatory clarity, and continuous stakeholder engagement.

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1. Introduction

The evolving landscape of energy systems worldwide is marked by a growing emphasis on flexibility markets and distributed flexibility. As part of the International Smart Grid Action Network's (ISGAN) Working Group 9 (WG 9), our research endeavors to unravel the intricate web of influences that flexibility has on operational planning. Specifically, our focus extends to comprehensively examining the Austrian, Canadian, and Korean electricity systems to establish a common foundation for understanding international market dynamics and diverse electricity system designs. This collaborative effort, detailed in our previous work [1], lays the groundwork for a nuanced exploration of the various flexibility services currently deployed in these regions.

Building upon our system reviews, we sought to gain insights from key stakeholders, including system operators, aggregators/suppliers, and consumer associations. To achieve this, we meticulously designed and administered a questionnaire—enclosed in the Annex - Questions for stakeholders—tailored to elicit perspectives on critical issues related to flexibility markets and their impact on operational planning. Our questionnaire examines challenges and opportunities, ranging from barriers inhibiting the increased use of local flexibility in distribution systems to the technologies and infrastructure stakeholders plan to deploy for measurement and verification.

The identified issues serve as focal points for a series of in-depth stakeholder interviews. Engaging with international Transmission System Operators (TSOs), Distribution System Operators (DSOs), Flexibility Service Providers (FSPs), and Consumer Associations (CAs), our aim is to not only extract valuable insights but also to compare and analyze their perspectives. This deliverable provides a comprehensive synthesis of stakeholder views, offering decision and policy makers in partner countries a nuanced understanding of the impact of flexibility markets on planning processes.

In the pages that follow, we present a comparative analysis of stakeholder perspectives, shedding light on the challenges, opportunities, and nuances associated with integrating flexibility into the operational planning of diverse electricity systems. Our findings aim to inform strategic decision-making, facilitating the development of policies that align with the dynamic nature of contemporary energy landscapes across the globe.

2. Methodology

In this report, our methodology revolves around a multi-faceted approach aimed at getting a comprehensive understanding of the influence of flexibility on operational planning within diverse international electricity systems. The first phase involved an exhaustive review of electricity systems in Austria, Canada, and Korea. This detailed examination sought to establish a solid foundation, fostering a shared comprehension of global market dynamics, electricity system designs, and the myriad flexibility services currently in operation. The insights derived from this review provided essential context for subsequent investigative phases.

Following the system review, we crafted and administered a targeted questionnaire, strategically directed to key stakeholders providing the functioning of electricity systems—system operators, aggregators/suppliers, and consumer associations. The questionnaire served as a structured instrument designed to extract nuanced insights on crucial aspects related to the challenges and opportunities posed by flexibility markets in the realm of operational planning. The key areas of exploration included:

- Identifying primary barriers impeding the increased utilization of local flexibility in distribution systems
- Examining the technology and infrastructure stakeholders envision for measurement and verification purposes
- Exploring potential pathways to decrease costs associated with end customer flexibility provision
- Understanding the intricate landscape of incentives for customers as well as regulatory barriers.

The issues identified in the questionnaire were further explored in a subsequent phase through stakeholder interviews. They provided qualitative depth to our findings, offering a more nuanced understanding of the challenges and opportunities inherent in the integration of flexibility into operational planning.

Within the current report, we present a succinct summary of stakeholder responses, organized into 10 distinct thematic categories. Each category captures a cluster of related questions, facilitating a more granular examination of the multifaceted issues at hand. The identified topics include main barriers for utilizing distributed flexibility, the impact of distributed flexibility on operational planning, regulatory perspectives, envisaged technology and infrastructure for measurement, data exchange mechanisms, product design considerations, marketing strategies, roles and responsibilities of the balancing responsible party, aspects of consumer protection, and mechanisms for fostering consumer engagement.

Subsequently, we embark on a comparison and analysis of stakeholders' views within each thematic category. This comparative lens allows for a deeper exploration of convergences, divergences, and unique insights, ultimately contributing to a richer understanding of the multifaceted landscape surrounding flexibility markets and their impact on operational planning within international electricity systems.

3. Views on operational planning

3.1. Main barriers for using distributed flexibility

The main barriers for using distributed small-scale flexibility are perceived similarly in all countries. One major point is the lack of visibility of assets and observability in the low voltage distribution grid as well as real-time information on the distribution grid topology itself. These issues make it hard to verify the actual flexibility demand, let alone to verify or measure the provided flexibility. For distributed resources, minimum bid sizes for flexibility provision on the transmission level are rather high, meaning small-scale distributed resources can only participate if aggregated . This makes it difficult to estimate and identify which combinations of flexibility providing assets could lead to problems in the distribution grid operation.

Some of the interviewed system operators consider customer awareness and willingness to participate as a large bottleneck. Clearly, there are still economic barriers for the onboarding of small assets, since a high effort for changes in operation, organisation and IT-infrastructure is required. Also, different involved stakeholders' actions can highly influence each other, as the flexibility activation and the related catch-up effects, i.e., by the supplier influences the grid operation and the other way around. Especially in highly unbundled systems, the communication and information exchange between these stakeholders is a large challenge. As a basis to overcome this, a strong regulatory framework and robust interoperable network is required.

Furthermore it was mentioned, that the baseline (to proof balancing reserve activation) for pools of smaller assets is not always easy to determine. Also, smaller assets normally do not follow a (planned) schedule of electricity consumption or injection, which would be necessary for some flexibility services (i.e. congestion management). Therefore, the verification process of actually provided flexibility is seen as a huge challenge.

Another opinion was that TSOs and DSOs are still very conservative in their approaches on grids reliability, and that risk management (e.g. safety margins under different conditions and how they are met) needs to be redeveloped. With grid modernization activities underway, digitalization efforts can be leveraged to design new standards of operating the grid, including flexibility as part of the new operational planning processes.

Austrian DSOs state several problems with the implementation of flexibility markets in the distribution grid. They emphasize that the requirements are substantially different to the TSO requirements on flexibility. With non-meshed networks in lower grid levels, there is the problem that network problems are mostly caused by a single or few originators. There is some scepticism on how to circumvent the problem of paying originators to solve a problem they caused themselves, due to the high risk of abuse of this mechanism by gambling/market power. Therefore, flexibility markets for DSO purposes would only be viable for higher grid levels, such as the 110 kV grid in Austria, since the problems that occur at these levels, are more similar to the TSO's congestion problems. One option mentioned for flexibilities in the distribution grid are lower grid connection fees for newly connected consumers, if they are willing to be curtailed in case of emergencies.

Some Canadian distribution networks, particularly those with predominantly electrically heated residential homes, predicted that demand will not increase in the coming years due to stagnant or declining population paired with increasingly efficient appliances. At the moment the use of flexibility is not a compelling cost-benefit-scenario, but this could change with the uptake of distributed generation and electrification deployments.

Korean system operators have stated that the barrier to increase distributed flexibility is the lack of power line capacity. In Korea, the existing power lines were built for conventional generators and not for future distributed resources and flexibility. So sufficient capacity and substations to accommodate large-scale flexibility provision are lacking.

Also, Austrian DSOs have stated that over-dimensioning of newly built grids is definitely a viable solution, since the actual (material) costs for the line itself are only a small part of the costs for building it. Over-dimensioning in the context of grid infrastructure refers to designing and constructing power lines with a higher capacity or capability than is immediately necessary to meet the current demand, in order to anticipate future increases in demand for electricity or potential changes in the energy landscape.

The Austrian concept of energy communities, where grid tariffs are reduced for local consumption, is seen as a viable tool to trigger economic investments for consumers, but not as a technical tool for the DSO. The reason given for this perspective was that only some few peak hours per year are relevant to ensure security of the distribution grid. It was indicated that the load of these peak hours is not reduced by the concept of self-consumption optimization. Still, it triggers investments in renewables, because consumers have an extra incentive by saving grid fees, and therefore it is still perceived as a positive political instrument.

Higher concurrency factors through flexibility activation of other stakeholders are perceived as threat. A suggestion to reduce its impact are power dependent grid fees or other intelligent grid tariffs. From an Austrian DSO perspective, this might be a more viable solution than using local flexibility markets. Moreover, DSOs claim they do not want to interfere with users behaviour, but rather motivate users to act grid friendly. Other options include time-of-use rates, peak-shaving programs, and dynamic rate structures, which Canadian utilities have deployed or piloted.

For TSO purposes, such as congestion management or the provision of balancing reserve, the currently required minimum bid size cannot be fulfilled by small assets, but only by aggregation of assets, which makes it harder for them to participate. The minimum bid size may not be reached by aggregated resources if the allowed geographic area is too small. But also, if the geographical aggregation level is chosen too large, the resources cannot be used for services like CM in the same way since the exact location of the resources highly influences the impact on the grid.

While aggregators play a negligible role in Canada, there are a variety of opinions on whether or not they should play a more important role among stakeholders. In Austria, on the other hand, aggregators are seen as necessary intermediaries. Some of the concerns among Canadian stakeholders is the level of trust in aggregators to remunerate the customers properly for their services. While the role of the aggregator may not be fully aligned between the countries, the need to data protection and data security were both considered to be important topics.

3.2. Impact of distributed flexibility

Concerning the impact of local flexibility services on the grid, and how they could affect the required grid reinforcement, the European perspective is that grid topology plays a very important role in the use of local flexibilities through the general behavior of the grid. In a meshed topology, flexibility activation would not create as many problems as in the case of a radial topology grid. Also, in a meshed topology, congestions can be solved in different ways.

Therefore, a market makes more sense, whereas in a radial topology grid only single assets are eligible to solve the problem at all.

With an increasing share of distributed generation, an incentive for local consumption is to participate in local energy communities. At the moment, there is little knowledge on how the design of local energy communities has effects on the grid, therefore it might change in the future and lacks plannability for consumers. Optimizing self-consumption in the case of energy communities does not really influence the grid operation and planning. The most important task of the DSO is to cope with the most critical hours per year, while the optimization within the energy community happens mostly for the non-critical hours. Therefore, DSOs consider them more as a political instrument to have extra incentives for installing renewables, than as a tool for preventing grid problems.

Alike participating in an energy community, wisely designed network tariffs could also be a motivation for end customers to install renewables. These grid tariffs could act as a counteracting instrument to the phenomenon that grid operators have to go for grid expansion, due to increasing PV installations. In general, the costs for the actual cable are 10-15% of the total costs of building a new line, therefore cables as well as transformers are by default over-dimensioned in order to last for the next 40-50 years, preventing the need for an actual use of flexibility in the distribution network. Therefore, currently, flexibility is not considered in the DSOs' long-term planning. With an increasing amount of distributed generation and consumption peaks from EVs, HPs etc., this could become uneconomical. Currently, there are not sufficient data available for a good overview between grid reinforcement and use of flexibility in the low voltage grid. Only for the 110 kV network it is assumed that the situation would be similar as in the case of flexibility use at TSO level. Although the use of flexibility as an add on to network reinforcements has high potential, it may still be considered as too unreliable for current planning. The use of flexibility is still unknown and may be considered in the future if its predictibility will be more advanced.

Another major problem for the DSO considering increased levels of flexible resources is the maintenance of real-time control. At the same time the risk of artificial peaks created by the market request will increase with the level of flexible resources.

3.3. Regulatory perspective

The overall opinion is that the regulatory framework needs to be further defined in all countries. Depending on ownership structures and the degree of unbundling, system operators are allowed to provide certain services or not. E.g., in Ontario, Canada, regulators do not allow for DSOs to invest in behind-the-meter equipment, but they are allowed to advertise these products.

Also, roles and responsibilities need to be further clarified in all countries. In case of Canada, each province and territory have their unique structure but the regulatory framework is largely missing to enable flexibility services.

Another aspect that has been mentioned is that to accelerate the roll-out and development of distributed flexibility. Further, a suitable trade-off between practicability for system operators/aggregators and on the other hand consumer protection needs to be found and established in the regulatory framework.

European law, concretely the Electricity Directive which is part of the Clean Energy Package (CEP) for all Europeans States, that "[m]ember states shall provide the necessary regulatory framework to allow and provide incentives to distribution system operators to procure flexibility services, including congestion management in their areas […]" (Art. 32) [7]. As for the Austrian case, this has not yet been concretely transferred into national law.

In Austria, the current situation allows for special grid connection contracts that enable the DSO to curtail assets to an agreed power. Furthermore, DSOs can make use of the concept of interruptible tariffs, e.g., for heat pumps.

In Austria, BSPs are required to report their schedules (chronological sequence or timetable of the planned generation or consumption or an entire balancing responsible group) on a daily basis. Contrary to large conventional assets, assets below 50 MW are free to send any schedules in Austria. While system operators would clearly see it as a benefit that also smaller loads provide schedules in advance (easier prediction from system operator (SO) side, and it could be used for verification purposes, …), asset owners often do not have enough knowledge and the ability to share these schedules.

Data management and monitoring of large-scale conventional assets in Austria can be done in a top-down approach by the TSO. The provision of flexibility from lower voltage levels requires a bottom-up approach where asset owners voluntarily offer their flexibility and provide solutions on how to forecast and monitor their flexibility provision.

In Canada, concerning flexible network access agreements, in Ontario there are power contracts for commercial and industrial customers existing. This means that the SO could potentially limit the maximum watts the end user can draw. However, this scheme's potential to access flexibility could be further explored and enforced.

In Austria, the maximum power is fixed for the network connection of distributed generation. Thus, the maximum power is known, and the grid can be built based on the data for maximum power. On the demand side, this is currently not defined. For the distribution operator, the ideal case could be to arrange future grid connection contracts rather based on the maximum power connection than on the exchanged energy. Internet speed could be a nice analogy, so simillarily, the user would pay for the maximum power exchanged with the grid than for the current energy exchange. This would help the DSO to better dimension its grid and increase its accuracy in grid planning.

3.4. Technology and infrastructure for measurement and verification

In terms of investment in equipment or marketing, most European DSOs do not want to interfere with customer behavior. Monitoring equipment is already very relevant for the DSO, but for now there are no concrete plans at the moment to install equipment behind the meter at customer premises. Incentives may be considered in the future, if a business case or necessity arises.

In the case of Canada, regulators do not allow for DSOs to invest in behind-the-meter equipment, but they can market these products. One such example is in the case of Hydro

Quebec Hilo program: This program offers smart home appliances: gateway, smart plugs, smart thermostats, smart electric water heaters and e-mobility controllers[1].

Contrarily, in Korea, it is the responsibility of the utility to invest in equipment at the end of customer premises.

The main equipment in Canada that is used for verification of flexibility provision are smart meters, but these technologies may not offer the time interval reporting necessary for shorter flexibility events (e.g., frequency regulation). It has also been stated that current/voltage transducers or customers smart home energy management systems could be a viable technical solution given their increased capabilities of measurement and verification (M&V) reporting frequency (note, that this is dependent on the specifications of the deployed smart meters). One of the challenges in adapting these technologies is that measurement equipment (like smart meters) used for verification needs to be approved, which is currently not the case for any of the home equipment. With an increase in small-scale assets, M&V concepts will need to be adapted accordingly in Austria. System operators state that new market roles in the context of measurement data may be emerging. KEPCO set a plan to expand smart meters and Advanced Metering Infrastructure (AMI). The goal of Korean System operator KEPCO AMI (smart meter) installation shows 20 million units by 2024. They shall collect, transmit, store, and utilize metering, billing, and customer information. Also, there is a plan to install PMUs (Phasor Measurement Unit) for stable operation in the power system in Korea.

While smart meters are widely deployed in Canada, some jurisdictions were earlier to deploy and hence have different capabilities. The majority of smart meters were procured only for billing purposes and therefore, show minimal capabilities (in terms of data resolution, frequency of data transmission etc.) to be integrated in system control, for applications like verification of flexibility provision. The consensus is to focus on advanced functionalities like tracking injection into grid rather than on the exact type of technology.

One method used in Canada to verify flexibility provision is to create an average baseline from metering data, and then look for noticeable changes in consumption. Companies are able to use smart meter data to de-aggregate consumption of different types of equipment. Backend systems (distributed energy resources management system, cloud systems, energy management systems) need to be developed and improved for the new computational requirements of small-scale flexibility, e.g. to gather data to calculate prices (e.g., locational marginal price). In Europe, platforms need to evolve (e.g., equigy [8]), that enable easier data transfer and data handling via online access, contrary to the classical Supervisory Control and Data Acquisition (SCADA) systems.

3.5. Data exchange

In Austria, there are no regulatory requirements to pass on market signals to customers. In general, spot price-indexed tariffs are seen as an incentive for customers to follow market price signals according to the flexibility available, also known as real-time pricing. This requires continuous monitoring of the load profile, for example through smart meters with opt-in activated[2].

[1] https://www.hiloenergie.com/en-ca/solutions/starter-kit/

[2] [for Austria] With the opt-in option you can track your electricity consumption at short intervals. The electronic electricity meter measures your consumption every 15 minutes and sends this data to the DSO once a day. Thr data is stored in the meter for a maximum of 60 days. This information can be viewed in the Smart Meter web portal from the following day for up to three years.

3.6. Product design

In Europe, markets for primary, secondary, and tertiary control are standardized and open for participation, with the requirement that minimum bid sizes and product requirements can be fulfilled by the aggregate. Furthermore, a growing number of countries tries to include distributed assets in their redispatch processes.

Flex services offered to customers through IESO (Independent Electricity System Operator of Ontario) are e.g., the Peak Shaver program bulk system services.

Aggregators in Austria already offer services for aggregation for provision of flexibility for ancillary services or at short term markets. This can be combined with providing services for the optimization of energy demand from end users with the goal of energy savings.

The target group of aggregator products can either be suppliers or end customers. Suppliers can for instance use their service to support balancing reserve provision and connect to the markets. Smaller end user flexibility resources on household level can be also targeted, and aggregators (plan to) offer the option to participate in energy markets and profit from reduced energy costs as a product for these customers. The profits are shared based on previously agreed conditions.

DSOs in Canada, as well as the Korean SO KPX would like to work with aggregators, but the aggregator needs to share the type and location of all their customers, which is currently not the case for most of them. It has been stated by a Canadian DSO that an aggregator does not necessarily have to be a separate entity/organization. Still, the process of aggregation is perceived as necessary. It seems cumbersome to talk to individual loads but have a (home/building/facility) energy management system to interact with the distribution substation, then the transmission substation, and then the system operator. One suggestion, which needs to be further investigated according to the interviewee is to have the same reliability framework at every level. Hierarchy communication between levels exchanging only necessary data and each node having the methodology to aggregate/compile/distill data are necessary. System operators can be the central controller points of the entire system that would have information on what flexibility is available in the time frames of minutes, hours, days, months .

European regulation is harmonized for FCR, aFRR and mFRR markets and has similar pre-requisites and product types for spot markets. In Canada, each system is unique depending on the jurisdiction and economic development (e.g. customer break down). Peaks are not a global thing, unique demographic will have different peaks. There is further a need to understand customers in order to develop further flexibility products. Also, it could be worth evaluating competition vs vertical integration.

The introduction of integrated flexibility products would aim at an efficient provision of flexibility for all grid operators within the balancing market, as well as a potential RD market. Potentially, the liquidity on the different markets would increase, as well as the number of eligible flexibility providers. On the other hand, finding a standardized product as a “one-fits-all” and “one-fits-everything” solution in terms of aggregation, bid size, lead time, etc. can be extremely challenging. Individual products have the advantage of allowing for a more localized product design. This can imply lower entry barriers for small local market parties or aggregators. From TSO perspective, separate markets for congestion management and balancing allow for clear separation of balancing and RD costs. Currently, there are different prequalification requirements, timelines (GOT, GCT) and baseline requirements for the different flexibility services (FCR, aFRR, mFRR and redispatch). There are some discussions though, if the prequalification processes should be harmonized for a common flexibility platform.

According to a Canadian stakeholder, markets need to get better at dispatch signals, they need real time APIs (call for resources) as things need to be faster. The perception is that no or too little money is spent on this, but tools are absolutely required.

Another factor that hinders distribution operators, which could be the ultimate dispatcher, is that they have all the tools but the policy is missing. The market structure is difficult for utilities to succeed.

In identifying the required volume of flexibility for a certain grid area under consideration of the potential funds that would be available to access it, the Canadian stakeholder evaluated a fictitious scenario assuming that the communication infrastructure is given, as well as the flexibility below each node is known, the probability and risk assessment must be understood. This could happen as follows:

From the lowest point on the hierarchy (device level), knowledge of how consumption curves can be forecasted and planned needs to be given. These curves must update continuously. They should also include the minimum level of power to consume/generate and maximum power to consume/generate. These values then determine the flexibility where you can play with flexibility to the grid. This potential needs to be aggregated upwards from devices to define the usable flexibility at the system operator level.

When deploying flexibility, ramping and other grid operation parameters need to be considered. The objective function needs to be formulated to be at the least cost and supporting environmental concerns.

Concerning the preferred scheme of consumers providing flexibility, the Austrian consumer association stated that some form of aggregation is needed for consumers, either through energy communities or the aggregation of service providers. It requires effort to understand the technical and economic intricacies of flexibility markets, which probably few consumers would be willing to go through. Therefore, in their view, easy-to-install and operate technical solutions (plug and play) and trustworthy aggregators to market the offered flexibility on behalf of consumers are needed.

3.7. Marketing

Austrian FSPs see Business Models and Use Cases in providing ancillary services, using flexibility in short term markets and in providing services for optimizing the energy demand from end users (energy sharing). This could be achieved by aggregating small end-user flexibility resources on household level and to offer them the opportunity to participate in energy markets and/or profit from reduced energy costs.

Further, the focus area of virtual power plant (VPP) solutions is mentioned. Here, Austrian FSPs identified two business cases: 1) providing VPP solutions to energy suppliers and 2) offering VPP solutions to end users with flexibility resources and taking charge of the operation of the VPP. In the second case, the FSP would market the capacities at flexibility markets and the profits would be shared to previously agreed conditions.

On the issue of investment in equipment/marketing at end-user premises, Austrian FSPs have so far reported different experiences. Some FSPs are already actively investing in hardware to make flexibility from end-users useable for their trading processes. This mainly involves the installation of 'smart boxes', which are used to connect end users' flexibility resources and provide metering data for billing processes.

Other Austrian FSPs indicated that investment efforts in this area were limited, mainly because the customers are energy suppliers and FSPs themselves do not have direct contact with the end customer. Instead, potential customers contact the company itself.

Another point of view of Austrian FSPs is that the demand for flexible tariffs has been very limited so far. Their impression is that in many cases customers are not yet aware of the potential of flexible tariffs, or of the opportunity to offer flexibility and get compensated for this offer. The issue is also complex and difficult to understand for the average customer. As consumers are becoming more aware, FSPs believe that the demand for flexible tariffs will increase. In addition, customers primarily want tariffs with low consumption prices and high feed-in prices. If flexible tariffs support this to some extent, customer demand will increase.

In Canada, utilities do not have programs to encourage investments into flexibility equipment (e.g., smart thermostats), but some provinces do. As in Canada, in Austria there are no incentive schemes from the SO side in place. This is likely to remain the case as the SOs see the responsibility for investment in flexibility equipment with the FSPs or end users themselves. It was mentioned that SOs generally do not want to interfere with consumer behavior.

There are contradicting opinions on how to decrease overall costs for end customer’s flexibility provision. While one Canadian system operator suggests capital expenditures for high growth and to invest in new substations, lines and transformers, others suggest using the current network more efficiently, identify pain points and consolidate system structures as much as possible to avoid inefficiencies. While aggregators are wished as intermediators in Austria, some Canadian SOs suggest saving costs by surpassing (independent, third-party) aggregators and address utilities directly. Still, in Ontario (non-vertically integrated utility), from a regulatory aspect there is an environment for an aggregator market to tap into behind-the-meter flexibility resources since system operators are not allowed to install equipment behind the meter. The new capabilities of smart home appliances could also be used to help customers to better manage their assets, e.g., provide other functions, such as monitoring and maintenance services and therefore generate some added value.

3.8. Balancing responsible party

On the topic of potential punitive measures for not delivering the flex product, Austrian FSPs agree that such penalties are likely to discourage end-users from providing flexibility. As it is already difficult to encourage end-users to participate in flexibility schemes, the introduction of fees or similar mechanisms that would lead to additional costs for consumers would further reduce the willingness to participate. A more likely solution would be for the FSP to bear the default risks. Therefore, the FSP needs to implement sufficient back-up to compensate small end users who fail to deliver. It was also mentioned that, in the case of larger flexibility resources, punitive measures would be necessary, as the consequences of non-delivery could be more severe.

3.9. Consumer protection

From the perspective of an Austrian consumer association, the GDPR[3] requirements that have to be met by law are considered sufficient with regard to data protection. The technical requirements must be such that they represent only a very low barrier to enter. Any installations to be made at the consumer's premises must be 'plug and play', without the consumer having to make any adjustments to the equipment or software installed. Once installed, the whole system must run in the background without the need for maintenance or interaction from the consumer. Thirdly, it was mentioned that if the system is cheap and easy to install and operates without requiring constant attention, the incentives for consumer participation do not need to be huge. Incidental rewards for using consumer flexibility are generally sufficient. As noted above, this assumes that there are no upfront costs to consumers and that there are no consumer resources required to operate the flexibility provision.

Austrian consumer associations highlighted that it is essential to obtain the informed consent of consumers to participate in the provision of flexibility. Moreover, means to monitor the activities of flexibility aggregators and traders are needed. If the consumers' flexibilities were to be used without their prior consent or without remuneration, this would be a serious breach of trust causing a negative impact on further consumer engagement.

3.10. Consumer engagement

The Austrian consumer association interviewed believes that financial incentives play an important role in customer engagement. Even if the compensation would be rather low, the lack of a monetary incentive would give the impression that consumers have to give something away for free, a feeling that most people are not comfortable with.

Furthermore, in Austria, the consumer association interviewed considers opt-outs to be essential, as they give consumers a strong sense of control. It has to be taken into account that providing flexibility means that consumers have to give up a certain amount of autonomy to the flexibility system (if it is automated). The possibility to opt out at any time is a means to counteract the feeling of partial loss of control.

The opinion of an Austrian consumer association on preferred flexibility provision schemes of consumers is that consumers would need some form of aggregation, either through energy communities or aggregation service providers. It requires an effort to understand the technical and economic intricacies of flexibility markets, which probably few consumers would be willing to go through. There is therefore a need for technical solutions that are easy to install and operate (plug and play) and for trustworthy aggregators to market the flexibility offered on behalf of consumers.

[3] EU General Data Protection Regulation

4. Conclusion

As more and more decentralized energy sources and flexible end-consumer assets are installed in the distribution grid, the current basis for long-term and operational planning of grid operators needs to change. In conclusion, our comprehensive exploration of the challenges and opportunities in the realm of distributed flexibility markets has unveiled crucial insights into various facets of operational planning. The analysis of stakeholder perspectives, grouped into distinct thematic categories, has provided a nuanced understanding of the intricate dynamics within the evolving energy landscape. The following key findings across different domains can be summarized:

According to the interviewed SOs the main barriers identified for using distributed flexibility can be grouped into three sub-categories 1) technical barriers, 2) consumer engagement, and 3) regulatory barriers. The lack of visibility of assets in the low voltage distribution grid, coupled with real-time information constraints, poses a significant challenge. Furthermore, as the grid structure is completely different at the distribution level compared to the transmission level, flexibility markets for DSO purposes need to be designed differently to TSO markets. Also, other mechanisms (e.g. flexible grid tariffs) should be considered. Additionally, minimum bid sizes for flexibility provision on the transmission level hinder the participation of small-scale distributed resources. Communication barriers in highly unbundled systems underline the need for a robust regulatory framework and interoperable networks.

The European perspective emphasizes the importance of grid topology in utilizing local flexibilities. While flexibility holds potential as an add-on to network reinforcements, its current unpredictability hinders widespread integration. As predictability advances and regulatory frameworks evolve, the use of flexibility may become more viable for future planning.

Across countries, a consensus emerges regarding the need for further defining regulatory frameworks and clarifying roles and responsibilities. In Canada, unique structures across provinces and territories underscore the absence of a comprehensive regulatory framework supporting flexibility services.

As for technology and infrastructure for measurement and verification, smart meters are the primary used technology. It is found that their capabilities need to improve in terms of data resolution, frequency of data transmission etc. Regulatory barriers hinder DSOs from accessing flexibility resources at end customer premises. Stakeholder interactions concerning the use of this flexibility require further clarification. Most European DSOs refrain from intervening in customer behavior regarding investment in equipment or marketing.

The introduction of integrated flexibility products aims at efficient provision but faces challenges in standardization. Market structure complexities hinder utilities from succeeding as ultimate dispatchers.

Austrian FSPs envision business models in ancillary services, short-term markets, and optimizing energy demand. Virtual Power Plant (VPP) solutions emerge as key focus areas, highlighting the need for consumer awareness and understanding of flexible tariffs. Spot price-indexed tariffs are seen as incentives for customers to align with market price signals, promoting real-time pricing and flexibility responsiveness.

On the side of customer engagement, SOs claim that there still has to be a lot of work done in terms of customer education, i.e., making customers aware of their flexibility as well as introducing incentive schemes to increase consumers' willingness to participate in flexibility markets. Financial incentives play a pivotal role in customer engagement, with opt-outs providing consumers a sense of control and fostering active participation. The opinions on how to decrease the costs for end consumer flexibility provision differ. Suggestions range from capital expenditure for high growth and investment in new substations, lines and transformers, to increasing the efficiency of the current network.

In conclusion, we find that the design of European and non-European electricity markets, and therefore the issues that the individual countries are facing, differ significantly, implying that there cannot be a one-fits-all solution for the successful implementation of flexibility markets related to operational planning.

Annex - Questions for stakeholders

For distribution system operators (if DSO and TSO are separate stakeholders)

1. In your opinion, what is the main barrier for increasing the use of local flexibility in the distribution grid?
2. In order to make local flexibilities accessible and use them, would your company like to work directly with end users, or use the services of an aggregator?
3. What do you think is the impact on the grid of local flexibility services and how could it affect the required grid reinforcement/operational planning? (technical/economically)
4. How do you think about the tradeoff between costs of reinforcing the grid – activating flexibility?
5. What flexibility services do you already offer/use? Required characteristics of a flexibility service (now/in the future)? (time until activation, ramp rate, minimum power, duration,…)
6. Is your company open to invest in equipment/marketing (e.g. to inform users concerning the available products) at the end customer premises in order to enable their ability to increase their flexibility (e.g. smart thermostats, gateways, etc.)?
7. What technology/infrastructure/systems do you plan on using for measurement & verification for operational planning in the future (e.g. smart meters)? If, how do you plan to use smart meters for operational planning? (Only for enhanced forecasts or also integration of live-data?)
8. Where do you see the potential to decrease overall costs for end customer's flexibility provision?

Optional Questions:

9. What are the challenges for the DSO in regard to the increased level of flexible resources?
10. Do flexible network access agreements exist in your country (e.g. a certain amount of power is fixed, everything above can be curtailed by the SO)? How do they work? Do you see this kind of active network management as a barrier in providing flexibility?
11. How are DSOs presently (or plan to) baseline the volume of (end customer) flexibility dispatched?
12. From a regulatory perspective, what type of flexibility resources will your utility be able to access (regardless of your technical capacity to do so)? Are there any regulatory limitations holding back its full potential and, if so, what are they?
13. Does your utility have programs to encourage investment into flexibility equipment (e.g., smart thermostats)?

For transmission system operators (if DSO and TSO are separate stakeholders)

1. In your opinion, what is the main barrier for increasing the use of distributed flexibility (including resources in the DSO grid)?
2. From a technical perspective, is your company able to harness end user flex resources? What are the technical barriers, how is it done or could be done?
3. Where do you see the pros and cons of the harmonization of requirements (e.g. infrastructure/APIs)? What is the status-quo? Are the requirements for different flexibility products/applications currently similar?
4. At what times of day/year is flexibility deployed (GOT/GCT/other internal processes), and how will it change in the future with different/more flexibility products?
5. What's the current and the planned interaction between capacity markets, energy markets and among themselves (e.g. primacy rules, management of service conflicts across markets)?
6. What technology/infrastructure/systems do you plan on using for measurement & verification for operational planning in the future (e.g. smart meters)? If, how do you plan to use smart meters for operational planning in the future? (Only for enhanced forecasts or also integration of live-data?)
7. Where do you see the potential to decrease overall costs for end customer's flexibility provision?
8. From a regulatory perspective, what type of flexibility resources will your utility be able to access (regardless of your technical capacity to do so)? Are there any regulatory limitations holding back its full potential and, if so, what are they?

Optional questions:

9. Is your company interested in investing in equipment/marketing at the end customer premises in order to enable their ability to increase their flexibility (e.g. smart thermostats, gateways, etc.)
10. Status and plans of TSO-DSO coordination scheme/interaction

For system operators (if DSO and TSO are one stakeholder)

1. In your opinion, what is the main barrier for increasing the use of distributed flexibility (including resources in the DSO grid)?
2. In order to use local flexibilities would your company like to work directly with end users, or use the services of an aggregator?
3. Is your company open to invest in equipment/marketing (e.g. to inform users concerning the available products) at the end customer premises in order to enable their ability to increase their flexibility (e.g. smart thermostats, gateways, etc.)?
4. From a technical perspective, is your company able to harness end user flex resources? What are the technical barriers, how is it done or could be done?
5. What technology/infrastructure/systems do you plan on using for measurement & verification for operational planning in the future (e.g. smart meters)? If, how do you plan

to use smart meters for operational planning in the future? (Only for enhanced forecasts or also integration of live-data?)

6. If applicable, how will you identify the required volume of flexibility for a certain grid area and considering the potential money that would be available to access it?
7. What do you think is the impact on the grid of local flexibility services and how could it affect the required grid reinforcement/operational planning? (technical/economically)
8. Where do you see the pros and cons of the harmonization of requirements (e.g. infrastructure/APIs)? What is the status-quo? Are the requirements for different flexibility products/applications currently similar?
9. Where do you see the potential to decrease overall costs for end customer's flexibility provision?

Optional questions:

10. At what times of day/year is flexibility deployed (GOT/GCT/other internal processes), and how will it change in the future with different/more flexibility products?
11. What's the current and the planned interaction between capacity markets, energy markets and among themselves (e.g. primacy rules, management of service conflicts across markets)?
12. Do flexible network access agreements exist in your country (e.g. a certain amount of power is fixed, everything above can be curtailed by the SO)? How do they work? Do you see this kind of active network management as a barrier in providing flexibility?

For aggregators/suppliers

1. From a technical perspective, is your company able to harness end user flexibility resources?
2. Is your company interested in investing in equipment/marketing at the end customer premises in order to enable their ability to increase their flexibility (e.g. smart thermostats, gateways, etc.)
3. What business models and use cases are you interested in, which ones are currently in use?
4. Are there any incentives or (regulatory) requirements to pass on market signals to the customers? If yes, which ones?
5. Do a lot of customers ask for flexible tariffs? What are customer's wishes?
6. Are potential punitive measures for not delivering the flex product a barrier or incentive? Who carries the risk of not providing flexibility?
7. What technology/infrastructure/systems do you plan on using for measurement & verification of flexibility activation in the future (e.g. smart meters)?
8. Where do you see the potential to decrease overall costs for end customer's flexibility provision?

For consumer associations

1. What aspects are important for consumers in order to participate in flexibility provision? (in terms of privacy, incentives, technical requirements)
2. If such a market is emerging, are you thinking about a kind of code of conduct? (to prevent that flexibilities might be used and customers not informed (and paid) …)
3. Do you think consumers need to get a monetary incentive to participate?
4. Are opt-outs wished for?
5. Is there any preferred scheme of consumers providing flexibility? (local energy communities, being directly called, via an aggregator…)
6. Is there any preferred flexibility provision scheme of consumers? (e.g. local energy communities, being directly called, via an aggregator…)