

Survey Results on Local Markets to Enable Societal Value

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Abstract—To collate best praxis and ideas on local electricity markets, this paper surveyed a number of pioneering initiatives in local market design and implementation. The survey focused on the definition of the market itself and the roles and responsibilities of actors within, the distribution of the value of local markets, as well as challenges and current barriers. The results indicate that the main value of a local market is related to the benefits for society as a whole and to a lesser extent individual actors. The main benefits are expected to derive from deferred network investments and reduced network costs. Moreover, local markets are expected to allow for higher shares of clean energy integration and generate positive environmental impacts. Nonetheless, a number of regulatory, economic, stakeholder-related, and other barriers risk obstructing the operation of local markets in the short term and inhibit their adoption in the long run.

Index Terms— flexibility, local markets, market design, societal value.

I. INTRODUCTION

The increasing amount of renewable energy sources in the form of distributed generation, together with changes in demand (e.g. electrification of mobility, heating and cooling), causes volatility in power flows and results in increased challenges for the operation and planning of the local electricity grids. Furthermore, temporary congestion and voltage fluctuations are becoming more frequent, and solutions to these issues are required to be implemented in a shorter timeframe than conventional grid development typically allows. To cope with these challenges, local markets can support the power system to become more agile and flexible by enabling the use of available flexible resources within the local network.

An increasing number of studies have defined concepts, designs, and market clearing methods of local markets. For example, in [1] the authors reviewed existing local flexibility markets and summarized key elements, technologies, and participants, and classified potential designs and market clearing methods. The authors in [2] give a systematic comparison of current flexibility market proposals in Europe based on interviews of 12 examples. In [3], flexibility markets are analysed in four pioneering projects considering the roles of market participants, the level of integration into other markets, the market mechanisms, and the way the cooperation between the

transmission system operator (TSO) and distribution system operator (DSO) has been implemented.

This paper aims to go beyond the existing overviews in literature, seeking to address how society at large may benefit from local markets and identify the main challenges and limitations. To achieve this goal, ISGAN (the International Smart Grids Action Network) Annex 6 (Power Transmission and Distribution Systems) [4] and CoordiNet project [5] carried out a survey to gather experience and knowledge from 19 participants actively involved in initiatives on local market design, research projects, commercial platform development, and market implementation.

This paper outlines the results of the survey and is organized as follows; Section II defines local markets and describes the roles and responsibilities of their agents. Section III identifies what is the value of local markets, Section IV examines challenges and limitations in creating a local market, and Section V summarizes the conclusions. Moreover, an overview of the survey questions and the list of the selected initiatives are included in the Appendix section.

II. WHAT ARE LOCAL MARKETS ?

A. Definition of a Local Market

In the literature, different definitions and concepts are being used to illustrate the term “local markets”. In a wider view, such as in [6] and [3], local markets include both the exchange of energy and/or network capacity (e.g. peer-to-peer, peer-to-pool) as the provision of flexibility either for local portfolio balancing services or network management services, since both types of trading activities can take place on the same platform. Other studies describe local flexibility markets as a tool to provide flexibility for the DSO, which is used for voltage control, congestion management, and loss reduction. In [7], local congestion markets are reported as markets through which distributed network users can provide flexibility to the (distribution) network operators to avoid network congestion.

Noticeably, consensus on the definition of a local market or on the motivation for implementing such a solution is yet to be agreed. Therefore, this paper has collected input from the survey regarding the definition of local markets and their underlying justification.

The responses regarding the definition of a local market consist of a variety of considerations, concurring with the initial findings in the literature. However, respondents generally contemplated four aspects to describe local markets: product to be traded, (limited) geographical area, purposes, and agents of the market. Therefore, these aspects provide a framework for the definition of a local market, which could broadly be defined as a **marketplace that enables buyers and sellers to trade energy and/or flexibility within a limited geographical area.**

Almost 90% of the respondents claim that local markets are justified due to technical aspects as a result of the new trends in the electricity system, as well as the limits brought by environmental restrictions (e.g. parks, protected areas) on the building of new network assets. Approximately 83% of the participants reported that the high economic cost of investing in new network assets is an argument for creating local markets. Moreover, a significant number of participants highlighted that the need for tailored services to be adapted to specific DSOs needs (78%) and the urban restrictions to build new network assets (70%) are justifications to create these markets. However, some respondents indicate different social motivations for the development of local markets. For instance, social motivation to trade electricity locally (40%), and the societal opposition to build new network assets (35%).

B. Roles and Responsibilities in a Local Market

The traditional roles and interactions between market actors are altered in local markets, while additional roles emerge, such as prosumers, aggregators, and local market operators. This has an impact on the intensity of coordination between existing parties, the level of interaction between regulated and market parties, and the coordination with other markets. Several authors [1], [8]–[10], have looked at different actors and potential roles in local markets, including buyers, sellers, and operators. Therefore, this section examines the roles and responsibilities of the agents involved in a local market and the ways of coordination between local and existing markets, based on both the survey and the existing literature.

In a local market, different market actors buy energy or services, these agents are known as **procurers or buyers**. For example, the TSO/ISO (Independent System Operator) makes use of different markets to procure ancillary services for system balancing and congestion management. It might seek local flexibility to support the wider electricity system. The DSO is responsible for reliable operation of the distribution grid and can procure flexibility for different operational (e.g. congestion management, voltage control, losses minimization) and planning purposes (e.g. deferring the need for network investment).

On the other hand, Balancing Responsible Parties (BRPs) are responsible for balancing the energy schedules and could procure flexibility for optimizing their portfolio to meet their energy obligations. Retailers/suppliers can buy local energy or flexibility to reduce peak loads and optimize all their generation assets, thereby preventing the dispatch of more expensive generation units and reducing their balancing costs.

The **providers or sellers** in a local market will act directly or on behalf of the owners of the assets, who want access to new revenue streams for their flexibility. For instance, aggregators

accumulate the flexibility they obtain from several flexibility providers and turn it into products to serve the needs of the various stakeholders. Moreover, retailers/suppliers, microgrids, and local energy communities can all act as sellers. Energy Services Companies (ESCOs) provide ancillary energy-related services to end-users and could directly manage customer demand to sell flexibility in the market.

Local **market operators** are those managing the market. The local market can be operated by an independent third party, a DSO, a group of network operators [9], an aggregator, or even members of a local community [11]. According to the survey, the functions of the local market operator are essentially the same as those of the traditional market operator such as receiving bids, performing the market-clearing, or financial settlement. Additional functions that are not traditionally the role of market operators are also performed such as participation in the prequalification of the resources, activation of the flexibility, or determining network problems, see Fig. 1.

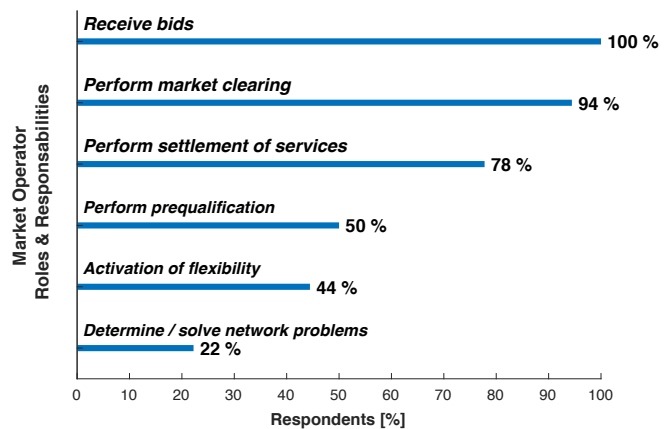


Fig. 1. Roles of local market operator reported in the survey

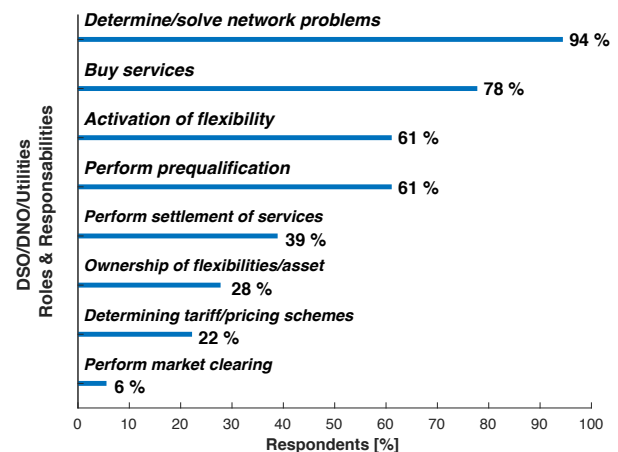


Fig. 2. Roles of DSO/DNO/Utilities reported in the survey

Different roles may also be assigned to one actor, for example, the DSO [9] could be a buyer (among different network operators) or potentially the single buyer at a local congestion

market, the platform owner, and the market operator. Other businesses might combine the ESCOs, BRP, or retailer and aggregator roles. The questionnaire showed that in the surveyed projects, the DSOs can have different roles and responsibilities as shown in Fig. 2. These roles vary from traditional roles such as determining network problems, procuring and activation of flexibility services, and performing the prequalification process.

Different ways of coordination between local and existing (central) markets are possible, therefore discussions on how such coordination should take place have led to different proposals. For example, the SmartNet project proposed five coordination schemes to enhance the interaction between TSOs and DSOs, which are characterized by a specific set of roles taken up by system operators, and a detailed market design [12]. SmartNet is taken as a basis for the CoordiNet project which defines seven groups of coordination models between the TSOs and DSOs for procurement and activation of the flexibility, [13].

In addition, the survey gives an overview of the coordination process between local and existing markets based on current pioneering projects. Out of 19 responses, only 6 projects state that there is no coordination with other markets. The other projects all have a form of cooperation with the TSO. The main reason for this cooperation is to determine the common needs of the market, enable the participation of resources connected to the DSO level on TSO markets, account for impacts on system balancing, activate the service, determine the market-clearing, perform prequalification, perform the settlement among others. The reason for cooperation with wholesale markets is, in most cases, to determine the market-clearing and to perform the settlement.

III. WHAT IS THE VALUE OF LOCAL MARKETS ?

Depending on the type and aim of the local market, benefits are created for the participants that are directly involved but also for others that are not directly involved in the market. This in turn creates benefits for a wider group of stakeholders including the owners of the flexibility or other assets, final customers, and energy providers.

Different studies give an overview of the benefits of local markets for the participants. For example, [14] describes benefits for customers, network operators, and technology and energy providers, [15] divides the values for stakeholders from integrated local energy systems in private and system interests, and [16] describes concepts of local energy markets related to different stakeholders and the local community. From those studies, it can be concluded that local markets bring individual as well as combined benefits.

Traditional network operators can benefit from market services and efficiency gains, for example through reduction of network costs, network investment deferral, improved power quality, improved security of supply and reliability, increased utilisation of existing network assets, and support from increased flexibility. Local markets can also open new opportunities for innovation and new business models, creating added value for the network operators. The suppliers or retailers benefit by optimizing their portfolios.

For customers (consumers, producers, or prosumers), participation in the local market can bring financial and non-financial gains. Local markets open the door to a democratisation of the electricity provision, providing a solution where a larger part of the responsibilities, risks, and opportunities are shifted to the local community, which in turn will gain independence, involvement, and control. Participants in local markets may be motivated by their own contribution to a sustainable transition and a clean energy system and can reach those goals faster. By participating in the market, participants can also reduce their energy costs and increase their own efficiency. Larger energy providers can get value from the local market (for example medium-size renewable energy power plants facing less competition than on wholesale markets). Finally, local markets bring value to a new range of service and technology developers, such as new market actors and developers of new products.

In the survey, the answer to the question of ‘What is the expected value of the local market?’ led in the same direction. The respondents, who are all actively involved in local market activities and pilots, concluded that local markets bring benefits to those who participate in it: directly for the network operator through investment deferral, reduction of network costs, increased utilisation of existing network assets, and indirectly for the producers or consumers connected to that market. 74% of the respondents also think that customer engagement is increased, while only 42% see the reduced environmental impact as a direct result of the local market, see Fig. 3. This is a logical consequence of the technical rather than social justification of those markets in the survey (see Section II).

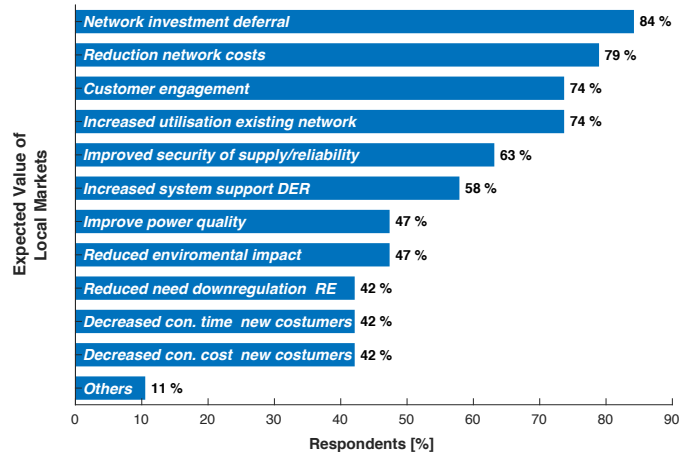


Fig. 3. What is the expected value of the local market?

However, despite the technical gains and the reduced economic costs for the grid operator, according to the respondents (see Fig. 4) it is not the DSO or even the market participants that benefit most in the end, but society at large. First, respondents argue that by optimizing the planning and operation of the grid, the benefits are distributed equally among all market participants. The increased collaboration between citizens and other entities in the energy domain is valuable for all of them and higher awareness in society on energy-related topics can help grid operators and end-users at the same time. Second, even those connected to but not participating in the grid gain due to decreased time and cost of connection and potentially lower

tariffs. Third, respondents argue that society at large can potentially benefit from the increased clean energy generation in the system and reduced losses, leading to lower local as well as global emissions. Reduced grid expansion can also result in reduced environmental impact, enabling alternative use of spatial structures and landscape.

Moreover, DSOs revenue is generally determined by a strict regulatory framework, traditionally biased towards capital expenditures. As a result, the DSO might not benefit from the decreased costs, rather, it would lose out, and the advantages are mostly translated to the end customers in that grid.

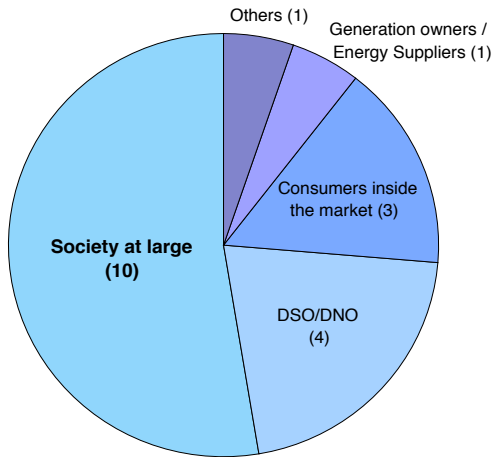


Fig. 4. Who benefits the most from local markets?

IV. WHAT ARE THE CHALLENGES AND LIMITATIONS IN CREATING A LOCAL MARKET ?

This section highlights a range of challenges and limitations for the development of local markets. The barriers faced by these markets, ranging from technical, regulatory, economic, and stakeholder related to environmental aspects, could obstruct its operation in the short term and inhibit local markets from being adopted more extensively.

Regarding the main challenges and limitations reported for creating a local market in the survey, the majority of respondents (78%) stated that the regulation and the lack of regulatory incentives is the principal barrier to creating a local market, see Fig. 5. **Regulatory and legal barriers** are already described in the literature as important barriers in local markets which will require well-established and balanced regulatory frameworks, which currently vary significantly across the European Union and globally and therefore affect local markets development on a case-by-case basis. For instance, legislation can put limitations in combining loads and generation units with storage in the customer premises or export of local electricity to the grid [14]. Additionally, taxation issues are of high relevance, particularly in countries where taxes represent a significant part of the electricity bill, as in Denmark, Germany, and Belgium, [17]. Furthermore, taxes may affect some business models specifically, for example, in Finland where owners of energy storage assets pay taxes for the charging storage units, [14].

As stated in Section II-B, coordination between the different actors is of high complexity and requires, among others, the definition of roles, responsibilities, and standards for data exchange. The coordination with existing markets managed by the TSOs and energy markets is key. Regulatory clarity over data ownership, which can only be shared as appropriate between TSO, DSO, suppliers, and platforms at adequate granularity, is required. Regulatory barriers to demand-side resources and independent aggregators need to be removed for these resources to participate in the wholesale and ancillary services markets. There is uncertainty regarding what services the DSOs will be able to procure from the market and what they will be managing themselves as the operator, thus clarification should be made regarding DSO activities to ensure a competitive marketplace.

Uncertain benefits were reported by 67% of the respondents as a limitation. Some of these **economic barriers** include high upfront costs related to the installation cost of less market-mature technology. For local markets to reach their full potential, a fair distribution of value among their participants is key. DSOs may be impacted by their revenues from grid fees, this creates risks leading to financial unpredictability. Therefore, a remuneration mechanism based on win-win principles for DSOs should be designed. Traditional energy market actors show resistance to local markets because of fear of loss of market shares and positioning [14].

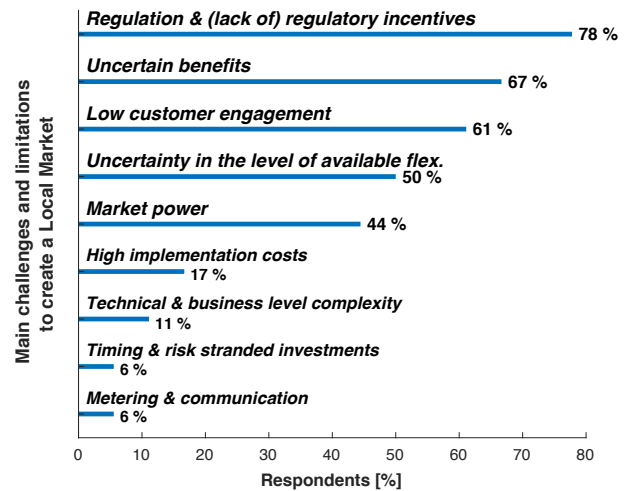


Fig. 5. What are the main challenges and limitations to create a local market?

Other barriers selected by a lower number of respondents include uncertainty in the level of available flexibility, market power, high implementation costs, technical and business level complexity, and others, see Fig. 5. The reasoning from respondents' view is that all these challenges may present, but they could be overcome with suitable pilot projects.

Technical barriers could be on the level of new technologies that participate in local markets, which are not fully matured and have not yet been widely adopted. Examples of these barriers are: energy storage and microgrid operational aspects, smart metering, secure and transparent local trading platforms, scalability of the solutions, secure data, cybersecurity, [14].

Environmental barriers: Some environmental effects of local markets depend on new technologies used. For instance, in the case of batteries, toxic properties of batteries if not properly managed can be a concern. Additionally, geographical dependency and the land requirement for medium-sized power plants are concern issues during the installation of some renewable power plants. The noisy operation of wind turbines and pollution from the small fuel-based power plant are examples of local environmental impacts [16].

Several policy and regulatory barriers need to be resolved to enable the full operability of local markets. When we asked about how the regulatory framework impacts the development of local markets, the majority of the respondents stated that regulatory exceptions or sandboxes, where actors can operate out with the regulatory framework for a limited period, can support the development of local markets (Fig. 6). Additionally, 4 participants indicated that the local markets are not considered yet by the regulator while 2 of them indicated the local market is already in place and recognized by current regulation.

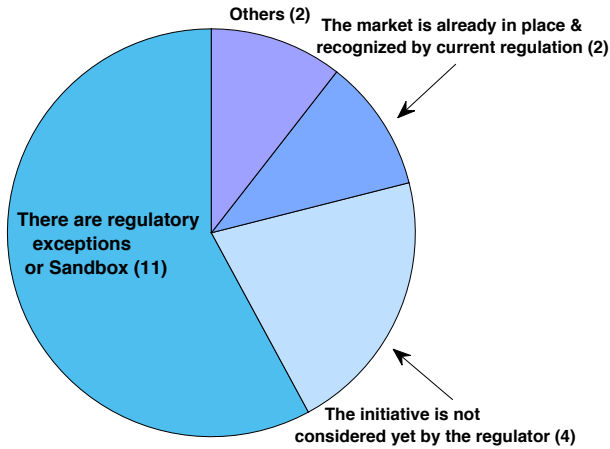


Fig. 6. How does the regulatory framework support and/or prevent the development of local markets?

V. CONCLUSIONS

Local markets are emerging in many countries through pilot and demonstration facilities. An important reason for the interest in local markets is to meet the increased needs and challenges in local electricity grids, where new and agile solutions are needed to complement conventional grid expansions.

This paper reviews the development of local market initiatives in different pilots and projects. Through surveying 19 different initiatives, an understanding of key aspects of local markets has been developed. In general, the respondents contemplated four aspects to describe local markets, product to be traded, geographical area, objectives of the market, and agents of the market. Therefore, a local market could be broadly defined as a marketplace that enables buyers and sellers to trade energy and/or flexibility within a limited geographical area.

A large proportion of the respondents justify the creation of a local market based on the high cost of investments in new network assets and environmental or urban constraints for network development. On the other hand, a significant number of participants indicate different societal motivations for the development of local markets and the majority of the participants agree that the benefits of local markets are for society as a whole. These benefits are reported mainly from network deferral, reduction of network costs, and higher utilization of existing infrastructure, which indirectly provides benefits for all market participants and network users. Higher customer engagement is also seen as an important benefit. Society at large could benefit from lower local, as well as global, emissions and reduced environmental impact if local markets provide more efficient alternatives to traditional network expansions. However, these are potential benefits, and they require further research and proof for reaching precise conclusions.

The role of the different agents involved in local markets still needs to be defined, specifically of DSOs and platform operators. The coordination between DSOs, TSOs, market operators, and aggregators is in the process of being defined and evaluated in the current initiatives.

The implementation of local markets encounters several challenges which vary from technical (data management, operational advancements), regulatory (remuneration schemes, coordination schemes, relation with existing markets, definition of new agent roles), economic (viability of new business models, efficient price signals), stakeholder (customer engagement and definition of roles) and environmental barriers (from batteries and renewables sources). These challenges and limitations were also reported in the survey, where the majority of respondents stated that the regulation and the lack of regulation incentives is the principal barrier to create a local market.

APPENDIX

TABLE I: OVERVIEW OF SURVEY QUESTIONS

Objective	Question's topics
1. What are local markets?	1. Characterisation of pilot projects for local markets
	2. Definition of local market
	3. Justification for creation of a local market
	4. Services in local markets
	5. Definition of Aggregator role
	6. Regulatory context of local markets
	7. Coordination between markets
2. What is the value of local markets?	8. Value of a local market
	9. Societal Value of a local market
3. Which are the challenges and limitations in creating a local market?	10. Challenges and Limitations
	11. Regulatory Impact

TABLE II: PIONEERING INITIATIVES IN LOCAL MARKETS DESIGNS

Pilots & Projects	Location
ANM4L [18]	Sweden, Hungary
CLUE [19]	Austria, Germany, Sweden, and the UK
CoordiNet [5]	Spain, Sweden, Greece
Enera [20]	Northwest Germany
FlexiGrid [21]	Sweden. Other pilots in Turkey, Switzerland, Bulgaria.
GOPACS [22]	Netherlands
IESO - York Region Local Electricity Market	Ontario - Canada
IREMEL [23]	Spain
NODES [24]	Norway, UK, Germany
Piclo Flex [25]	The United Kingdom
Platone [26]	Italy - Rome
Potential project	Switzerland
Regional Markets for Switzerland, (future project)	Switzerland
Several (regional) Electricity Communities	Germany
shlmflex	Stockholm region, Sweden
SmartNet [27]	Italy, Denmark, Spain

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