# Local Flexibility Markets in Europe: a Review of Flexibility Products, Services, and Potential Improvements

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***Abstract*— With the increasing need for flexibility to ensure the safe and secure operation of electricity grids, Local Flexibility Markets (LFMs) are expected to become a key tool for mobilizing flexibility from resources connected to distribution grids. This paper reviews existing LFMs in Europe, highlighting the situation in countries such as the United Kingdom, France, the Netherlands, Norway, Italy, and Spain, which already have fully operational markets or in a precommercial stage. The analysis covers the characteristics of flexibility products, the services provided, and the market architectures. Additionally, the authors analyse the main challenges faced by LFMs and propose potential enhancements to improve various aspects of these markets.**

***Index Terms*-- Aggregation, Congestion Management, Demand Response, Distributed Energy Resources, Local Flexibility Markets**

## I. Introduction

The increase in renewable generation penetration at both the transmission and distribution levels, as well as the electrification of final energy uses such as electromobility and heating systems, represents a major step towards the decarbonization of the economy. These efforts align with the European Union's agenda for transitioning to a climate-neutral economy with net-zero greenhouse gas emissions by 2050 [1]. The European Climate Law [2]and the Fit for 55 package [3] are the main legislative measures promoting the decarbonization process.

This transition to clean energy poses significant challenges to the operation of electricity grids, which are the primary carriers of green energy. Typically, renewable energy is not as manageable as conventional power plants, leading to higher levels of intermittency and variability in energy production. Additionally, the expected increase in electricity demand due to new end uses (such as electric vehicles or heat pumps) is putting more pressure on distribution networks. Both aspects can create new problems that impact the operation of electricity networks. At system level, there is a greater need for flexibility to counteract the intermittency of renewable generation and maintain the balance between supply and demand. At local level, there is a greater need for flexibility to avoid network congestions or voltage limit violations. In this context, flexibility from demand-side resources is very valuable and needs to be efficiently exploited.

One of the main mechanisms for mobilizing demand-side flexibility is through Local Flexibility Markets (LFM) [4], [5]. These markets allow end users to sell the flexibility of energy resources connected at the distribution network level. In this way, agents interested in that flexibility can buy it from the LFMs as a complement to traditional mechanisms such as acquiring flexibility from large power plants or reinforcing the networks. Countries such as United Kingdom (UK), France, the Netherlands, and Norway already have fully operational LFMs while others such as Italy and Spain have very advance LFM setups. Their development process has been directly linked to the creation of a sound regulatory framework for the optimal use of local flexibility.

This paper reviews existing LFMs in Europe and identifies and compares their most relevant aspects such as the characteristics of the flexibility products, services provided, and market architectures. Previous analyses of LFMs in Europe have been conducted, the work in [6] includes pilot projects in France, Germany, Netherlands, Norway, Sweden, and UK and analyses the markets from a regulatory perspective as well as

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form the point of view of the used LFM platforms. In [7] the study is focused on the Nordic countries. Other reviews are more focused in research projects, [8], or specific aspects such as the characterization of flexibility products [9] and modelling aspects [10], [11]. This paper includes, on the one hand, the analysis of new LFMs (e. g. the ones currently under development in Italy and Spain) and, on the other hand, the most recent updates implemented as result of learnings from LFMs already in operation (e. g. in UK and France). In addition to the analysis performed, the authors propose potential enhancements to improve different aspects of these markets.

The paper is structured as follows, Section I introduces the topic, Section II describes the LFMs in different European countries, Section III identifies potential improvements to the existing markets and finally Section IV describes the main conclusions from the work.

## II. Commercial Local Flexibility Markets in Europe

This section describes the different products, market platforms and other main characteristics of the analysed LFMs.

### A. United Kingdom

The UK is one of the most advanced countries in the deployment of LFMs. The electricity sector regulation in the UK promotes innovation through various mechanisms, including the RIIO model (Revenues = Innovation + Incentives + Outputs) from Ofgem [12], [13], the Flexibility Innovation Program from the UK government [14], and the Open Networks Programme from the Energy Networks Association of the UK and Ireland (ENA) [15].

With the aim of optimizing the management of the electrical grid and avoiding congestions in the distribution system, ENA has defined various flexibility products [16]:

1. *Peak Reduction*: This product seeks a reduction in peak power usage over time. This response can manage peaks in demand and could be provided by long-term energy efficiency activities.
2. *Scheduled Utilisation*: The delivery time for flexibility is pre-agreed between the DSO and FSP. It benefits FSPs that can't respond in real-time. DSOs use this service to manage peak demands and delay network upgrades. Compensation is through utilization payments.
3. *Operational Utilisation*: This product enables flexibility delivery closer to real-time, allowing FSPs to adjust demand based on current network conditions. DSOs can use it to restore supply after outages. Compensation is based on flexibility delivery.
4. *Operational Utilisation + Scheduled Availability*: This product ensures an FSP can deliver agreed changes in response to network issues, with availability set at procurement. Assets are dispatched based on real-time data. DSOs use it to plan flexible contracts based on short-medium term forecasts. It includes both availability and utilization payments.
5. *Operational Utilisation + Variable Availability*: This product is like the *Operational Utilisation + Scheduled Availability* product but in this case the DSOs can refine the availability requirements closer to the congestion event. The product is paid both for availability and utilisation.

The *Peak Reduction* and *Scheduled Utilisation* products are agreed at trading time and do not have defined activation timings. *Operational Utilisation* products have activation times of 2 minutes, 15 minutes, day ahead, and week ahead, depending on the specific product type. Availability in the products that consider it, is determined at trading time, with possible refinements week ahead or month ahead.

The mentioned products are traded by means of flexibility tenders implemented through two main market platforms: the Piclo Flex platform [17] and the Flexible Power platform [18] . Both platforms have similar functionalities, including the publication of flexibility requirements by DSOs. The platforms allow Flexibility Service Providers (FSPs) to submit their bids, receive activation signals from DSOs, and access performance reports. These reports measure the level of service delivery, which is used to determine payments [19].

As an example, the tenders published in the Piclo Flex platform includes the following information:

- Bidding period: indicates the start and end times when bids can be submitted.
- Product type: Name of the product being traded.
- Need direction: Upwards or downwards flexibility.
- Connection: Voltage level to which the energy resources are connected.
- Buyer: Name of the DSO buying flexibility.
- Maximum yearly budget: Maximum amount of money that the DSO will employ in this trade for the year.
- Availability guide pricing: Used as a guide to help FSPs price availability bids.
- Utilisation guide price: Used as a guide to help FSPs price utilisation bids.

### B. Norway

The LFM in Norway is called Euroflex and is implemented through the NODES LFM platform [20]. The NODES platform is being deployed in several pilot projects in other countries, including Sweden, Finland, Belgium, and Canada.

There are three flexibility products traded in the Euroflex LFM [21]:

1. *LongFlex*: This NODES product reserves flexibility capacity through seasonal and week-long contracts. LongFlex contracts require FSPs to bid flexibility into ShortFlex, using the same activation mechanism. The goal is to ensure DSOs have sufficient flexibility when needed.

2. *ShortFlex*: The ShortFlex market product opens one week ahead and has a gate closure of two hours before delivery. Orders may have durations of 1 hour, 30 minutes, and 15 minutes.
3. *MaxFlex*: This product sets a maximum power consumption for an FSP. The main advantage is that it avoids needing a baseline, making its delivery verification much simpler than the LongFlex and ShortFlex products.

In LongFlex and ShortFlex products, baselines are calculated by FSPs using their own methods. This has the drawback that they may manipulate their baselines. A solution is to evaluate the accuracy of the proposed baselines during times when no activations are performed. The MaxFlex product avoids this problem, making it best suited for smaller FSPs, as smaller resources usually have more stochastic behaviours.

Each tender is published by the corresponding DSO for the network area where congestion problems are foreseen. The tender contains information about:

- Timeline of the tender: Indicates the start and end times of bid submissions for the tender as well as the start and end times for the activation period.
- Tender type: The NODES product type being traded.
- Regulation type: Upwards or downwards flexibility.
- Quantity: Amount of flexibility required.
- Reservation price: Estimated price for capacity.
- Activation price: Estimated price for each activation.
- Estimated reservation value: Total potential earnings based on an estimated number of activations.
- Reservation schedule: Months, days in the specified months, and hours in the days when the product might be activated.

The Euroflex products are for upwards flexibility, meaning that they intend to reduce consumption or increase generation in specific areas of the distribution grid. They are designed to solve congestion problems in the distribution grids. The minimum amount of flexibility to trade is as low as 1 kW, allowing very small resources to participate.

Conceptually, the NODES platform allows any kind of flexibility buyer (DSOs, Transmissions System Operators (TSOs), Balance Responsible Parties (BRPs)) to compete for flexibility. However, in the current commercial deployments of NODES, only DSOs are participating.

At the time of writing this paper, there were 314 open tenders in 306 network areas, summing up to 1134 MW of requested flexibility capacity.

### C. *The Neteherlands*

The Grid Operators Platform for Ancillary Services (GOPACS) is the LFM platform in operation in the Netherlands. The platform is owned by the seven Dutch grid operators. It is intended to provide congestion management services to grid operators [22]. FSPs participating in GOPACS need to be market agents (suppliers, aggregators, or large consumers), meaning that small consumers cannot participate directly in the LFM.

The GOPACS platform supports trading three products:

1. *Capacity Restriction Contract*: Allows limiting the import or export capacity of the FSPs participating in the contract. These contracts are agreed bilaterally between the DSO and the FSP and may include specific time periods when flexibility activations would be called. The bids are placed the day ahead in the time periods agreed with the DSO.
2. *Redispatch*: This product allows bidding in the LFM without any previous contract with the DSO. The DSO publishes its flexibility needs within the intraday period, and FSPs can place their flexibility bids on a supported trading platform.
3. *Bidding Obligation Contract*: This product requires FSPs to bid at specified times as per their contract with the DSO. The DSO ensures market flexibility when needed. For short-term needs, DSOs request FSPs to place bids on the trading platform. FSPs are paid for capacity and activation of flexibility.

For participating in the redispatch and bidding obligation contract products negotiated in intraday periods, FSPs need to use an energy trading platform (currently EPEX Spot [23]and ETPA [24] are supported). Participation in the trading platform is done as a Congestion Service Provider (CSP) agent. The GOPACS LFM automatically rebalances the congestion energy by buying bids on the trading platform in the opposite direction to the congestion requirement outside the congestion area.

The flexibility needs are published in GOPACS with the following information:

- Date and Timeframe: Date and period when flexibility is needed.
- Compliance: Indicates if the bids are on a voluntary basis (redispatch product) or on a mandatory basis (bidding obligation contract).
- Bidding Period: Bidding opening and closing window. The bidding gate closure ends one hour before the start of the flexibility need.
- Congestion Area: Network area where the participating FSPs need to be connected.
- Maximum Power: Maximum power requested during the flexibility time.
- Power Profile: Requested flexibility profile with a time resolution of 15 minutes for the whole flexibility period.

In 2024, 7,408.7 MWh of flexibility energy was traded through GOPACS with a total value of more than €4 million. Since the beginning of operation in 2019, the highest needs for flexibility were in 2022, with 181,958.4 MWh of traded flexibility and a value of more than €59 million [25].

### D. France

The main French DSO, ENEDIS, periodically opens different calls for tenders (since 2020) to procure flexibility in areas where potential congestions are foreseen. The publication of the flexibility needs is done through a web platform where applicants can view the characteristics of the requested flexibility products [26].

The flexibility products are defined according to the following parameters:

1. *Product validity period*: This is the period during which the flexibility product needs to be available. The duration of the product may span several years depending on the DSO's needs (up to four years of validity periods were announced in the last call for tenders of 12/11/2024).
2. *Type of contract*: The contract may include capacity payments and utilisation payments or only utilisation payments.
3. *Flexibility blocks*: Indicates the volume of each power block to bid (500 kW in the last call for tenders).
4. *Duration of the activations*: The duration in minutes of each activation (30 minutes in the last call for tenders).
5. *Activation periods*: Defines the months, days of the week, and hours of the day when the activations might be requested.
6. *Estimated activations*: Estimated number of activations per volume range, as well as the total amount of energy to be activated and the maximum power per activation.

The products may also indicate the time between consecutive activations to allow demand-side resources to recover their initial status. The time between activations is only applicable to products with capacity reservation. For products with no capacity reservation, consecutive activations are not expected.

ENEDIS allows FSPs to decline flexibility activation requests within 15 minutes without penalty. If accepted, activation occurs within 25 minutes. Validation measurements must have a one-minute resolution. For the calculation of the baseline, five methods are defined, based on the measurement of power injection or production before and after the activation of the product, on mean historical values, on measuring similar energy resources, or on the FSPs' own forecasts [27].

In 2024, 46 MW of flexibility were contracted from three FSPs for 51 local products.

### E. Italy

The Italian Regulatory Authority for Networks and the Environment (ARERA) opened the possibility to develop LFM pilot projects in Italy in 2021 (Resolution 352/2021) [28]. Following this opportunity, e-Distribuzione (one of the biggest DSOs in Italy) and the Italian Market Operator (GME) started the development of LFM projects oriented to solve congestion problems in the distribution grids. E-Distribuzione is using the PicloFlex platform to deploy its LFM solution, while GME is using its own developed LFM platform. Since the PicloFlex platform has been already described in the section related to UK, the following analysis is focused on the platform by GME.

The LFM platform developed by GME considers the following types of flexibility markets [29]:

1. *Local Forward Flexibility Market (MLT-Flex*): Intended to trade forward capacity products over long-term time horizons. The MLT-Flex trading sessions are activated by GME upon the request of the DSOs.
2. *Local Spot Flexibility Market (MLP-Flex)*: The spot market is divided into the *Day Ahead Flexibility Market (MGP-Flex)* and the *Intraday Flexibility Market (MI-Flex)*. The MGP-Flex market consists of a single market session for the next day. The MI-Flex market is divided into several market sessions on the following or same day when the trading takes place.

The products traded in the MLT-Flex market are characterized by:

1. *Flexibility perimeter*: Indicates the network area where the flexibility is needed.
2. *Capacity*: The flexibility capacity requested by the DSO.
3. *Maximum purchase price*: Maximum price that the DSO will pay for availability.
4. *Activation price range*: The minimum and maximum price range for the activated power during the service delivery.
5. *Utilisation factor*: The utilisation factor estimated by the DSO.
6. *Availability window*: The start and end dates when the product might be activated.

The activation of the accepted capacity in the MLT-Flex market can be made both through a direct request by the DSO to the corresponding FSP or by the obligation of the FSPs to participate in the MLP-Flex markets.

Currently, there are two pilot projects in operation: RomeFlex in the area of Rome with ARETI as the DSO, and MindFlex in the area of Milan with UNARETI as the DSO. As an example, in the RomeFlex LFM, the time resolution is 15 minutes, with a minimum bid quantity of 300 kW, a price cap for availability of €30,000/MW/year, and a maximum activation price of €500/MWh.

### F. Spain

The Spanish market operator OMIE (Operador del Mercado Ibérico de la Electricidad) [30], together with the Spanish energy agency IDAE (Instituto para la Diversificación y Ahorro de la Energía), are designing the Spanish LFM system. The project where the design of the LFM is being done is called IREMEL [31]. The main objective of IREMEL is not only the creation of LFMs but also the facilitation of the participation in conventional electricity markets (except for ancillary services markets) of renewable generation and consumption resources connected to distribution networks. It must be noted that these developments are in a prototype phase, but it is expected that they will be the basis for the LFM market in Spain soon.

For the participation in day-ahead, intraday auctions, and continuous intraday markets, the IREMEL project considers both the possibility of direct participation if the minimum requirement of 0.1 MWh volume is met, or participation through an aggregator agent summing up the energy of multiple small-scale resources.

Two operational scenarios are considered:

1. Energy trading in non-congested areas: In this case, no restrictions are placed on the bids and the aggregation of resources can be done independently of the location of the resources.
2. Energy trading in potentially congested areas: For distribution network areas where congestions are expected, aggregators need to aggregate resources in the corresponding area.

The first scenario does not consider any limitations in the energy traded in the day ahead and intraday markets. In contrast, the second scenario considers three mechanisms for a secure operation of the network. From these three mechanisms, the last two are based on the use LFM products:

1. *Limitation of trades*: The DSO will be informed about the schedules resulting from the day-ahead and intraday clearings and might impose limitations on those schedules to avoid congestions.
2. *Utilisation of local products*: The market operator, following the guidelines of the DSOs, creates local flexibility products. Each local product is associated with a certain congestion problem and defines the energy resources that contribute to the resolution of the problem. Aggregators need to create their bids according to the resources in each local product. Both continuous and auction-based market mechanisms are being considered.
3. *Capacity-based flexibility products*: The DSO can contract long-term capacity products with FSPs in an auction-type market. Activation requests can be direct from the DSO or a commitment by the FSP to provide minimum flexibility in the local LFM. Payments are made for capacity based on the auction and for activation based on the local LFM.

The advantage of having the current market operator OMIE also managing the new LFM models is that it will be relatively easy to integrate the LFM mechanisms into the current processes, including coordination with the TSO, calculation of settlements, etc.

OMIE is developing the LFM concept through various European and national projects. As result, two market platforms have been created: one for local product-based LFM and another for capacity-based LFM. Next phases include pilot projects under regulatory sandboxes. In November 2024, IDAE accepted three sandboxes: FlexAbility, S2F, and Energía del Prat.

## III. Potential Improvements

There are two main aspects that could be improved to increase volume of the flexibility traded in LFMs. One is promoting the participation of small-scale FSPs by reducing the minimum bid requirements, and the other is adding more value to the flexibility traded in LFMs by contributing to more flexibility services.

Most LFMs have a minimum bid size of several kWs. This means that many potential flexibility resources, such as those in the residential sector, have no access to the LFMs or need to access them through an aggregator agent. To increase the number of participants, the market liquidity, and reduce intermediation costs, it is beneficial to reduce or eliminate the minimum bid size requirement. This introduces additional complexities, including the need for clearing algorithms capable of handling large amounts of offers and automation systems at the end-user level for controlling energy resources and implementing automated trading bots.

Another aspect to consider is that current LFMs are used to provide congestion management services in distribution grids. However, there are other services, such as system-level frequency balancing, where additional flexibility would be highly valuable. Providing flexibility from small-scale resources for services beyond congestion management will benefit both end users, who will increase their revenues, and TSOs and DSOs, who will have additional sources of flexibility to operate the networks.

Current research projects are addressing these aspects, among others. One of the main research projects dealing with advanced mechanisms for improving LFMs is the GlocalFlex European-funded project [32]. In this project, entry barriers for small-scale consumers are removed by implementing automated trading mechanisms. The market is also open to any type of flexibility buyer (DSOs, TSOs, aggregators, BRPs) that can buy flexibility under equal conditions.

## IV. Conclusions

As the analysis of currently existing LFMs in Europe shows, there is a high interest in acquiring flexibility from small-scale resources to solve potential congestion problems in distribution grids. Many countries in Europe, such as the UK, France, the Netherlands, Norway, Italy, and Spain, have fully operational LFMs or are conducting pre-commercial level pilot projects.

There is a high variability in the definition of flexibility products among the analysed LFMs. Most of them support both capacity-based products and utilisation-based products. Capacity-based products are intended to solve long-term or structural network problems, while utilisation-based products are more for real-time congestion problems in specific network situations.

The verification of service delivery is also a crucial point. Most of the analysed LFMs rely on trusting the baselines provided by the participating FSPs, while others implement verification mechanisms, including specific methods for baseline calculations or eliminating the need for baselines with products that limit the maximum import/export of the FSPs.

Current LFMs could be improved in several ways, including reducing the limitations on minimum bid quantities and adding support for agents other than DSOs to buy flexibility in these markets. Research projects such as GlocalFlex are investigating these aspects, among others.

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