APPUNTI DI ENERGIA

# DIGITAL PLATFORMS FOR LOCAL FLEXIBILITY MARKETS

July 2026

## What is it about?

APE LFM

GME (*Gestore dei Mercati Energetici*) is the Italian Nominated Electricity Market Operator (NEMO).

This APE is dedicated to the **digital platforms** that enable the operation of **Local Flexibility Markets (LFM)**: these represent the technological infrastructures through which Distribution System Operators (DSOs) acquire flexibility services from aggregators, known as Flexibility Service Providers (FSPs). LFM platforms collect network requests, manage offers from operators and **determine which services are activated and at what price, according to previously established rules (market design)**. The implementation of pilot projects aimed at the buying and selling of local flexibility services has grown significantly in recent years: internationally, **13 distinct platforms** operating in **18 countries** have been identified, supporting **41 pilot projects** and **90 flexibility services**. This APE describes how they work, compares their features and delves into the Italian context, where the platform managed by GME (MLF Platform) is the reference tool for ongoing experiments.

## Context

National Integrated Plan for Energy and Climate (PNIEC)

*Did you know that…*
The flexibility required in a LFM can take many different forms: a solar panel that generates slightly less power during peak hours, an electric car that waits until nighttime to recharge, a heat pump that reduces its output by a few degrees, or a home battery that feeds energy back into the grid. These small actions—often imperceptible to those who perform them—allow the DSO to avoid costly infrastructure projects.

ARERA Resolution 352/2021

The energy system is currently experiencing a significant transformation, driven by European decarbonization targets, the expansion of renewable energy sources, and the gradual electrification of end-use consumption. The most evident manifestation of this evolution is in distribution grids, which are designed to transmit energy in a single direction. However, they are now host to a growing variety of **Distributed Energy Resources (DERs)**, including solar power systems, energy storage systems, heat pumps and electric vehicles. These resources feed into, store or consume energy according to increasingly variable patterns.
This evolution has concrete consequences for grid operators, such as: **local congestion** when a high number of systems feed energy into or draw energy from the same section of the grid; **issues related to voltage control** during peak photovoltaic production hours; and **reverse power flow** when excess energy flows back from the low-voltage grid to the transmission grid. For a considerable number of years, the sole response to the issue has been to upgrade the infrastructure. This has taken the form of the introduction of new lines, higher-capacity transformers, and structural upgrades. This approach is effective but increasingly unsustainable, especially when the challenges to be resolved are limited to a few hours per day or are concentrated in just a few days per year (Figure 1).
In this context, **Local Flexibility Markets (LFM)** emerge as instruments through which Distribution System Operators (DSOs) can procure power **modulation services from DERs** in order to address network-related criticalities. The legal basis lies in Directive (EU) 2019/944, which requires Member States to establish a regulatory framework enabling DSOs to procure flexibility services through market-based mechanisms; in Italy, it has been transposed through ARERA Resolution 352/2021. Flexibility thus becomes a novel energy service, complementary to traditional infrastructure-based interventions (Figure 1).

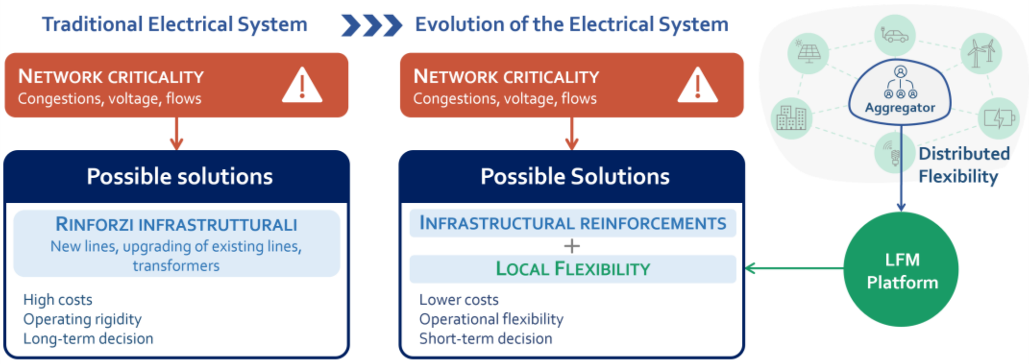


**Figure 1 – From the traditional grid management paradigm to local flexibility: the role of LFM platforms in overcoming network criticalities.**

This paradigm is built around the **digital platforms for Local Flexibility Markets (LFM)**, the technological infrastructures that enable the coordination of diverse actors, complex processes, and market dynamics within a **transparent, structured, and replicable**

**environment**. Their role is central to the market architecture: beyond serving as the meeting point between flexibility demand and supply, platforms are the instrument through which market rules are enforced and the system by which delivered flexibility is measured and verified.

## Key Functions of a LFM Platform

A LFM platform performs functions that go well beyond simply matching demand and supply:

- it **integrates** coordination, verification, and control tools among market actors;
- it **standardizes** the participation of heterogeneous resources, from residential photovoltaic systems to industrial-scale batteries, through common rules;
- it **translates** network needs into an orderly and transparent market process.

The platform is operated by a central figure: the **Local Flexibility Market Operator (LFMO)**, the entity responsible for collecting orders, applying market rules, and determining accepted volumes and prices. Depending on the context, this role may be performed by the DSO itself or by a neutral third party. Three main actors gravitate around the platform, each of them with a clearly defined function. The **DSO** is the entity that expresses flexibility demand: it identifies criticalities on its own network and translates them into market requests. **Aggregators** (Flexibility Service Providers – FSPs) collect and coordinate the flexibility of numerous diverse resources, enabling even small-scale assets to reach the minimum volumes required by the market. Finally, the **Transmission System Operator (TSO)** ensures that local activations are consistent with the overall operation of the transmission network. The TSO may also procure flexibility from DERs to meet system balancing needs, but it normally does so through a separate market, the Ancillary Service Market (ASM). The market process is structured into **six stages**, each with its own time horizon (Figure 2):


- **Pre-qualification (Step 0):** before being able to offer flexibility, each FSP must demonstrate that it possesses the technical capabilities and the reliability required to provide the service. Pre-qualification takes place either once or on a periodic basis (typically annual), well ahead of market opening.


- **Order submission (Step 1):** Qualified FSPs submit their orders to the platform, specifying volumes, prices, activation conditions, and location within the network. Orders may relate to different services: load reduction to relieve a congestion, reactive power modulation to stabilize voltage, or bidirectional flexibility (upward and downward) to contribute to system balancing. In forward markets, orders are submitted weeks or months in advance; in spot markets, the window narrows to a few hours or the day before delivery.


- **Validation (Step 2):** submitted orders are analyzed to verify that they are technically feasible and compatible with the current state of the network. This stage is crucial: an order that is economically advantageous but physically unfeasible, or that solves one problem while creating another elsewhere, is discarded before reaching the market. Validation takes place immediately after order collection, within a timeframe ranging from a few hours to a few days, depending on the complexity of the network verifications required.


- **Activation / market clearing (Step 3):** the platform selects the best orders according to economic and technical criteria, determining which are accepted and at what price. This moment coincides with market closure. In forward markets, clearing may take place months ahead of physical delivery (it is the main approach applied to the Italian pilot projects). In spot markets, clearing occurs only a few hours before real time, typically the day before (day-ahead) or in the hours preceding delivery (intraday). In Italy, this method was launched on an experimental basis at the end of 2025 as part of the RomeFlex pilot project.

- **Dispatching (Step 4):** FSPs receive detailed operational instructions and allocate the assigned flexibility across the resources in their portfolio, in compliance with the technical constraints of each device. Dispatching takes place close to or at real time, when the flexibility must be physically delivered.
- **Settlement (Step 5):** after delivery, metering data are compared with the requested activations to verify that the flexibility was actually provided. Based on this verification, the platform proceeds with accounting and remunerating FSPs. A key element of settlement is the definition of the baseline, that is, the consumption or production profile the resource would have followed in the absence of activation. The flexibility actually delivered is then calculated as the difference between the measured behaviour and this reference profile. A clear and shared baseline methodology is essential to ensure correct and verifiable remuneration. Settlement takes place in the days or weeks following delivery.

Figure 2 illustrates the entire process: the operational stages are shown at the bottom, while the network diagram at the top depicts the FSPs connected to the distribution grid and their interactions with the DSO, the TSO, and the LFM platform. The allocation of responsibilities among actors at each of these stages depends on the coordination scheme adopted between the TSO and the DSO, particularly with regard to the validation and activation stages: this aspect is further discussed in the chapter dedicated to governance schemes.

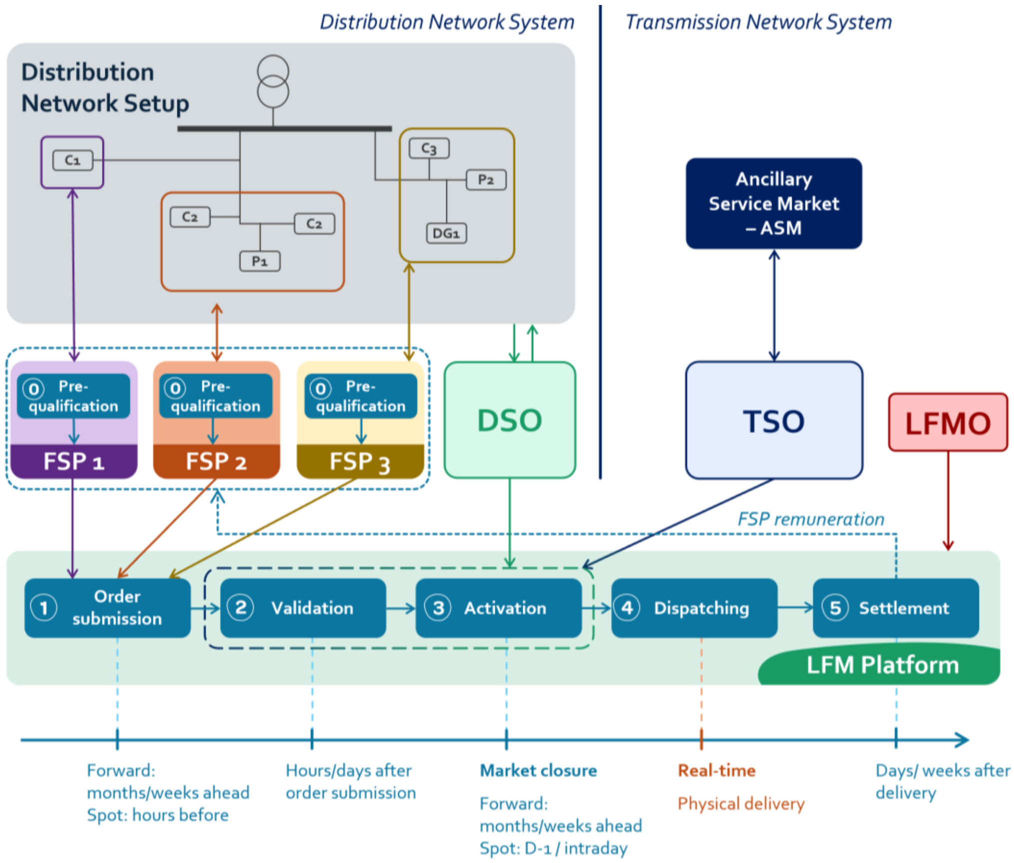


**Figure 2 – Operational process of an LFM platform: the six market phases, from pre-qualification to settlement, and the related time horizons.**

## Enabling technologies

The functioning of an LFM platform relies on a technological ecosystem capable of monitoring the network, forecasting its evolution, coordinating resources, and verifying that the promised flexibility is actually delivered.
These enabling technologies fall into three families, operating at different but closely interconnected levels, as shown in Figure 3.

**Level 1: Communication and measurement infrastructures**

The **first level** concerns the ability to observe the network's condition in real time, a necessary condition for any market decision. **Supervisory Control and Data Acquisition (SCADA) Systems** at the DSO level provide an overall view of the distribution network, such as nodal voltages and currents in lines and transformers, and, combined with the contribution of forecasting systems, enable criticalities to be identified in advance and flexibility needs to be quantified for submission to the market. In the Italian context, **second-generation smart meters** (2G smart meters) can represent an alternative to dedicated solutions for measuring the power exchanged by the end users composing the aggregate, transmitting real-time measurements to the FSP. Furthermore, validated measurements from these meters are essential for verifying the flexibility actually delivered, and therefore for settlement. **Internet of Things (IoT) devices** installed at the resources, such as temperature sensors, systems monitoring the state of energy storage systems and charging infrastructure for electric vehicles, complete the picture, giving aggregators real-time knowledge of the flexibility actually available at the end-user level.
The main challenge at this level is **interoperability**: data originate from different systems, with heterogeneous formats and protocols, and must be integrated reliably and promptly. A second, equally relevant issue is **cybersecurity**: LFM platforms exchange sensitive data and operational instructions among DSOs, TSOs and FSPs, and they must therefore ensure user authentication, traceability of operations, data protection, and service continuity, particularly at the interfaces between different actors.

**Level 2: Management and aggregation systems**

The **second level** concerns the coordination of the resources participating in the market, which takes place across three different scales (Figure 3). At the level of individual buildings or plants, **Energy Management Systems (EMS)** optimize the operation of local resources, such as photovoltaic systems, batteries, and heat pumps, balancing user needs (comfort, self-consumption, savings) with those associated with flexibility services. At the portfolio level, FSP aggregation platforms combine hundreds or thousands of resources into reliable market orders, taking into account the technical constraints of each device, user preferences, and contractual conditions. At the network level, the **Distributed Energy Resource Management System (DERMS)** constitutes the link between the market platform and operational grid management: it receives from the LFM platform the flexibility orders to be activated through the market outcome and it verifies their compatibility with network conditions in real time. Within this architecture, FSPs effectively operate as **Virtual Power Plants (VPPs)**. Heterogeneous resources, geographically dispersed and owned by different parties, are coordinated by a single actor and presented to the market as a unified portfolio.

**Level 3: Forecasting and Optimization**

The **third level** concerns the ability to define the baseline and make optimal decisions (Figure 3). **Forecasting systems**, based on statistical algorithms and artificial intelligence techniques, predict photovoltaic production, consumption, electric vehicle availability, and network conditions in the following hours. The quality of these forecasts is directly reflected in the quality of the market: accurate forecasts translate into more precise estimates of flexibility needs and more reliable orders. At the market level, clearing relies on **mathematical optimization models** that select orders by balancing the economic objective, namely minimizing procurement costs, with technical constraints referred to the physical network, such as line capacity and voltage limits. At the FSP level, **dedicated algorithms allocate the assigned flexibility across the individual resources in the portfolio**, taking into account the current state of each device, technical constraints, and user comfort.
The experience gained from ongoing experimentations has confirmed that the ability to update decisions in real time is among the most critical factors for the success of an LFM: in fact, both

*Did you know that…*
Italy was the first country in the world to install electronic meters on a large scale. Indeed, since 2001, over 30 million of these meters have been installed. This infrastructure, upgraded to the second generation (2G), is a fundamental prerequisite for verifying the flexibility provided in the LFM.

the state of the network and the actual availability of participating resources may deviate significantly from forecasts.

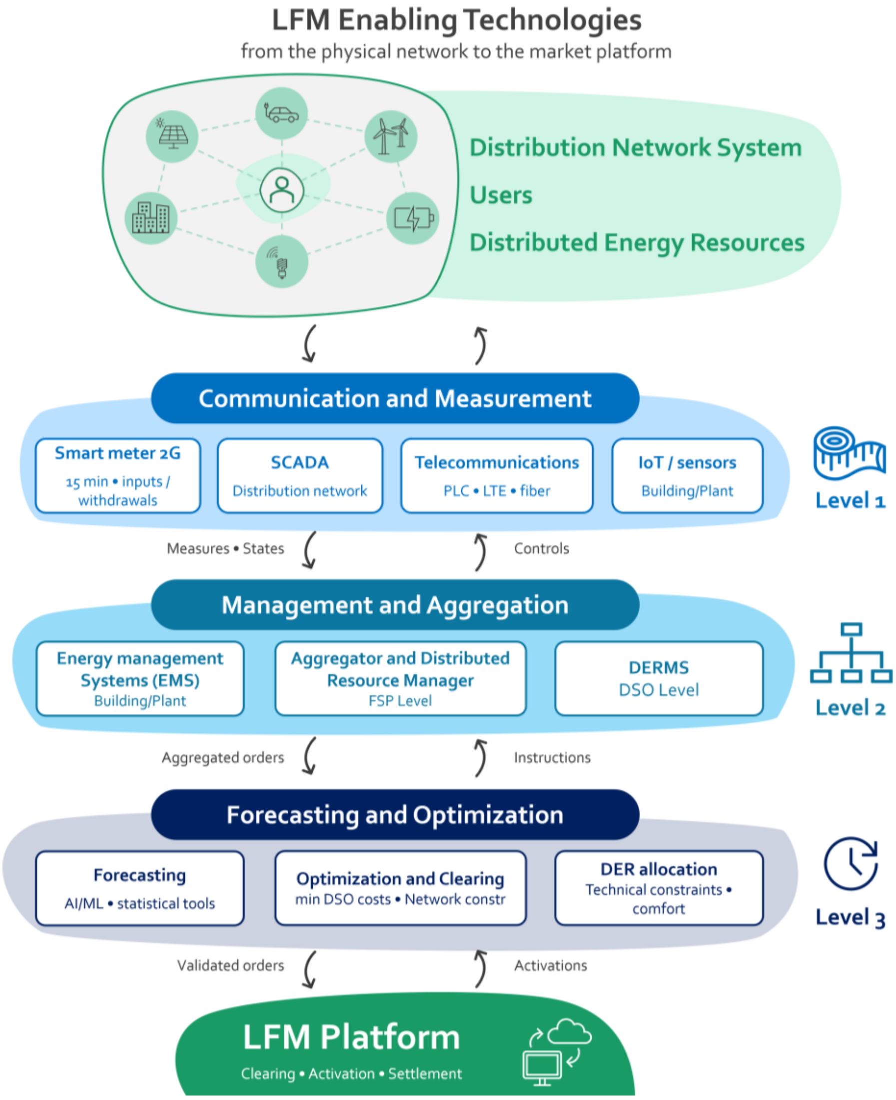


**Figure 3 – Enabling technologies for LFMs articulated in three different levels: communication and measurement, management and aggregation, forecasting and optimization.**

## The main governance schemes

Local flexibility markets involve several actors: DSOs, TSOs, and FSPs. The allocation of operational responsibilities among these actors, from order collection to activation, defines the so-called **TSO-DSO coordination scheme**, which represents the underlying structure on which the LFM platform is built. As the scheme varies, so do the role of the platform, the information it must manage, and the communication flows among actors. Coordination between TSO and DSO is necessary for two reasons. The first is that DERs can offer flexibility both on the local market and on the wider market managed by the TSO (the ASM): the same resource may serve two distinct markets, and in some schemes even the pre-qualification stage can be shared across both. The second is that an activation decided on either market produces physical effects at both network levels: an intervention that resolves a congestion in distribution can create an imbalance at the transmission level, and vice versa.
**Four main schemes** have been identified, differing in their degree of centralization and level of coordination among actors (Figure 4).

**DSO Leader**

**DSO Leader Scheme** is the most decentralized model (Figure 4). The DSO manages the entire process independently: it receives orders from FSPs, validates them, selects the most suitable ones, and arranges their activation. Only aggregated information, such as the total volume of flexibility activated in each area, is sent to the TSO. The advantage of this scheme lies in its efficiency: the DSO has detailed knowledge of its own network and can make fast, targeted decisions, minimizing data exchange between operators. The disadvantage lies in the concentration of responsibility: since the DSO acts simultaneously as network manager and market manager, the DSO could, in theory, fail to ensure fully equitable access to the platform for all participants. Where the DSO Leader Scheme is adopted, clear governance rules and robust transparency mechanisms are therefore required.

**Hybrid Model TSO-DSO**

**TSO-DSO Hybrid Scheme** distributes responsibilities in a more balanced way (Figure 4). Orders from FSPs follow a two-step process: first, the DSO validates the flexibility orders, verifying their compatibility with the local network; subsequently, the TSO selects and activates those that best meet the balancing needs of the system. The process described could result in an optimized outcome for the power system, although the TSO-DSO Hybrid Model Scheme involves greater procedural complexity: the two entities must coordinate on both the timing and the formats of information exchange.

**TSO Leader**

**TSO Leader Scheme** is the most centralized model (Figure 4). In this configuration, there is no truly distinct local market: DERs are integrated directly into the global market managed by the TSO (the ASM), where they compete alongside resources connected to the transmission network, while the role of the DSO is limited to providing operational data on its own grid. The limitation is that the TSO does not have a complete view of the distribution network: an activation that is optimal for national balancing could generate congestion or voltage problems at the local level.

**Common Market TSO/DSO/FSP**

**Common Market Scheme** is the most integrated and ambitious model (Figure 4): a single platform in which TSO, DSO, and FSP interact within the same market environment. Balancing needs and local congestion management needs are expressed in the same venue, with orders evaluated simultaneously against both network levels. Any resource may participate in both markets, as long as it satisfies the eligibility requirements for both services; under this scheme, the pre-qualification stage itself can be shared across both markets. The result, in theory, is maximum transparency and allocative efficiency; in practice, implementation requires advanced digital infrastructure, rigorous interoperability standards, and a regulatory framework that clearly defines the responsibilities of each entity.

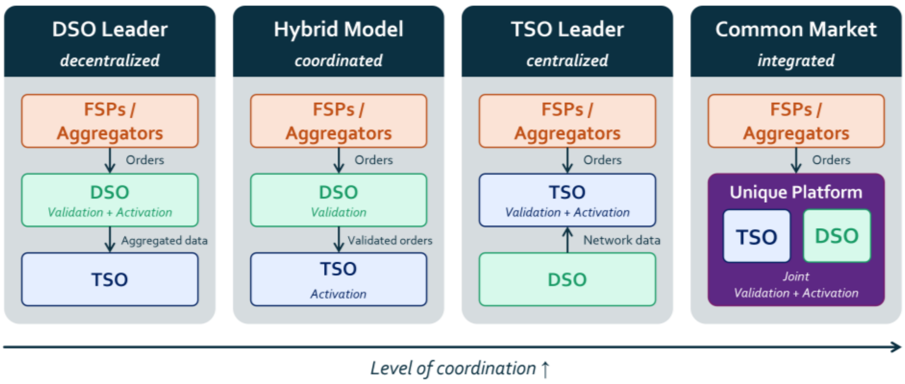


**Figure 4 – TSO-DSO coordination schemes, classified by degree of centralization and level of coordination between actors.**

## Which is the best scheme?

It is important to note that no single model is universally better than the others: the choice depends on the national regulatory framework, the digital maturity of DSOs, network size, and the type of services exchanged. Ongoing experimentation is exploring which architecture works best in different contexts, and in practice, many projects adopt hybrid solutions, adapting theoretical models to local specificities.

ARERA Resolution 484/2023

The **Italian case** is one such example: pilot projects adopt a model that can be traced back to TSO-DSO Hybrid Scheme, with a distinctive feature. In the RomeFlex and MiNDFlex pilot projects, the platform is operated by the national NEMO (*Gestore dei Mercati Energetici* – GME): the DSO identifies criticalities and defines needs, the GME manages the market process, and the TSO validates activations. In parallel, ARERA Resolution 484/2023 regulates the traffic light mechanism, through which the DSO can flag local criticalities related to the participation in the ASM of resources connected to its own network. Both mechanisms are currently under experimentation.

## The main LFM platforms

*Did you know that…*
**Piclo Flex** platform (web link) operates in 6 countries across 3 continents (Europe, North America, and Oceania), giving it the widest geographic coverage of any LFM platform.

**GOPACS** (web link), in the Netherlands, is the only case worldwide where the TSO and the DSOs jointly manage a national flexibility platform, resolving both transmission and distribution congestion within the same market.

In Italy, two opposite models coexist: RomeFlex and MiNDFlex use the **MLF Platform** managed by GME (web link), while E-EDGE relies on PicloFlex.

In Ireland, a dedicated LFM platform has yet to emerge: utilities use **eTenders** (web link), a public procurement tool, to purchase flexibility from commercial customers. In the absence of dedicated platforms, existing procurement tools can be repurposed to serve the same function.

Growing attention to distributed flexibility has led, in recent years, to the **emergence of numerous digital platforms dedicated to LFMs**. These platforms have developed in very different contexts in terms of regulatory framework, network characteristics, and level of digitalization, and consequently show significant differences in functionality, governance, geographic scale, and market architecture. Some platforms cover the entire end-to-end market cycle, from operator admission to settlement, while others support only specific stages of the process. The **characteristics of the main platforms** are summarized in Figure 5: from multi-country solutions managed by third parties (NODES, PicloFlex) to national platforms integrated into the electricity market (the MLF platform in Italy, GOPACS in the Netherlands), through to simpler approaches based on direct procurement (Moj Elektro in Slovenia).

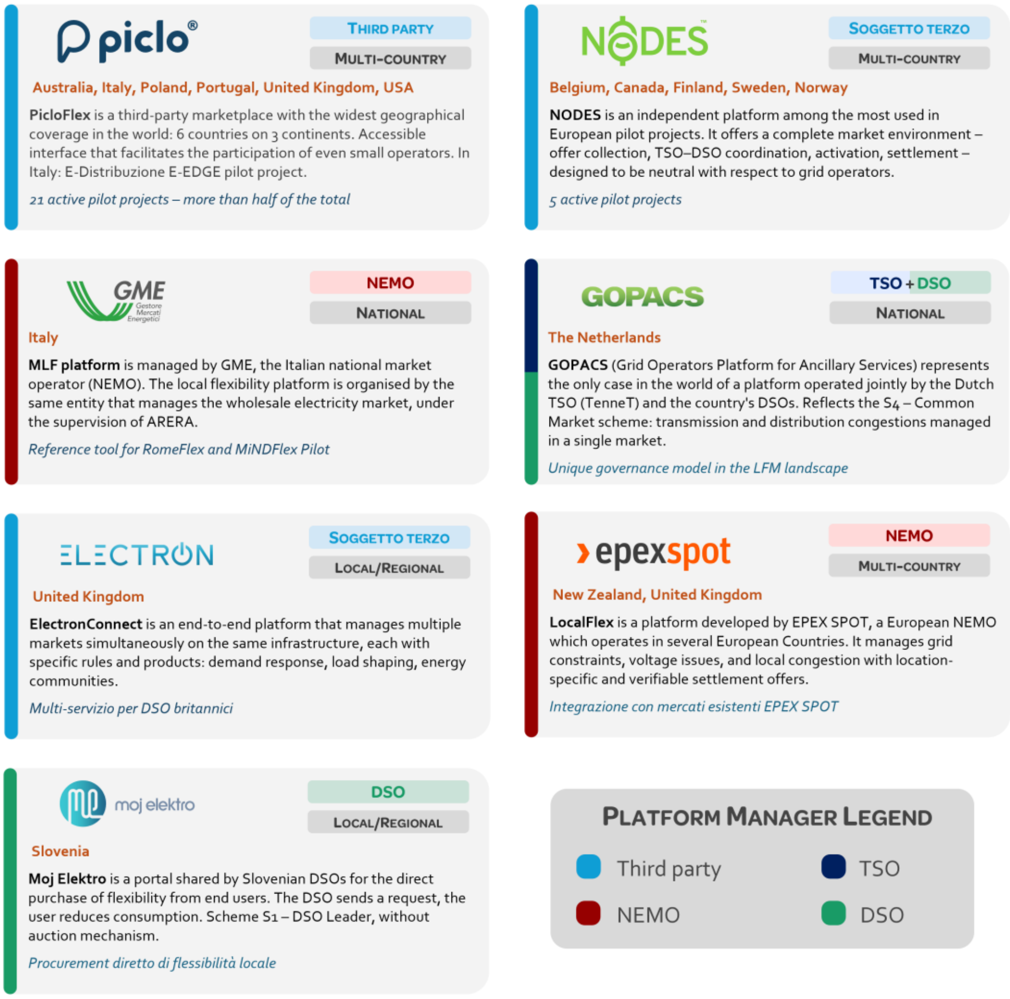


**Figure 5 – Main LFM platforms, characterized by manager, geographical coverage and main features.**

As shown in the diagram in Figure 6, platforms managed by independent third parties tend to have international coverage, while institutional models, such as the market operator or joint TSO-DSO management, mainly operate at national or local scale. This diversity of models reflects the experimental stage of local flexibility markets.

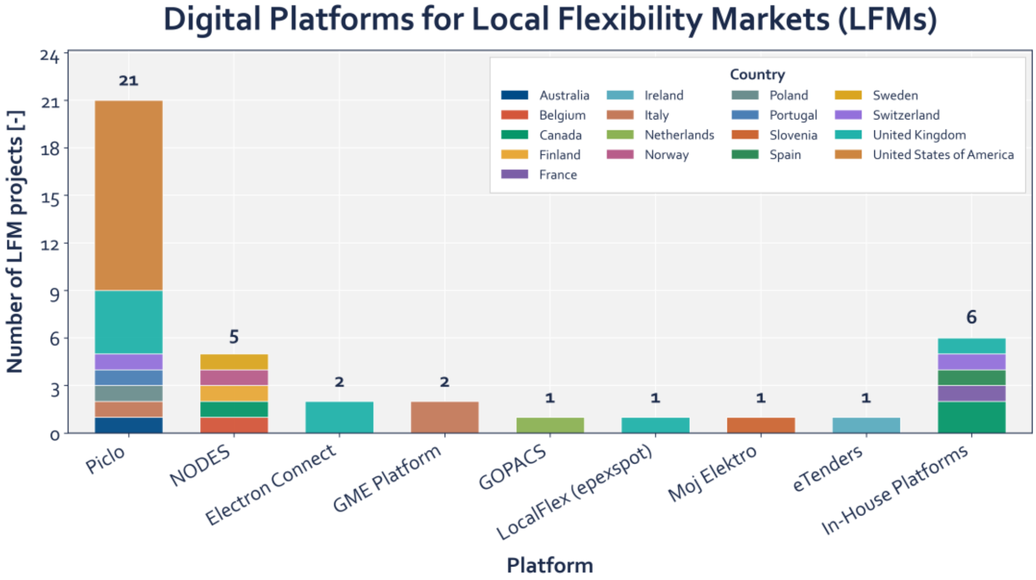


**Figure 6 – Distribution of the 41 LFM pilots by platform and country of implementation: Piclo Flex and NODES are the most widely used platforms internationally.**

## Interaction with global markets

[APE Day-Ahead Market (DAM)]

[APE Intra-day Market (IM)]

[APE Ancillary Service Market (ASM)]

Up to this point, we have described how an LFM platform functions internally. In actual operation, however, the platform must integrate with a complex ecosystem made up of electricity markets, network management systems, TSO procedures, and aggregator platforms, each with its own protocols, formats, and timelines. It is this integration, more than the technology itself, that determines whether an LFM actually works.

Within the Italian regulatory context, electricity is traded through a sequence of markets. The **Day-Ahead Market (DAM)** closes at 12:00 on the day preceding delivery; the **Intra-day Market (IM)** allows positions to be updated through multiple sessions, up to a few hours before delivery; the **Ancillary Services Market (ASM)**, operated by the TSO, procures reserve and balancing services both in scheduling and in real time. LFMs fit into this sequence in a complementary way: forward local markets operate months in advance through availability contracts, while spot local markets, trialled at the end of 2025 solely within the RomeFlex pilot project, operate on a day-ahead or intraday basis.

The LFM platform must interact with four counterparts, as shown in Figure 7. It exchanges data with the **DSO** through SCADA, planning, and metering management systems, as well as the DERMS where available. It engages with the **TSO** for the validation of activations and coordination with the ASM, within the framework established by ARERA Resolution 484/2023. It communicates with **aggregators** to transmit activations, receive execution confirmations, and manage settlement. Finally, it ensures, with respect to the **national electricity market**, consistency between the positions taken across different markets: if a resource is already committed on the IM for a given hour, the same capacity cannot also be offered on the LFM.

In Italy, the fact that the GME manages both the electricity market and the LFM platform represents a significant advantage for integration. Defining **common standards** for all these interfaces, however, remains an open challenge, as well as a prerequisite for future scalability.

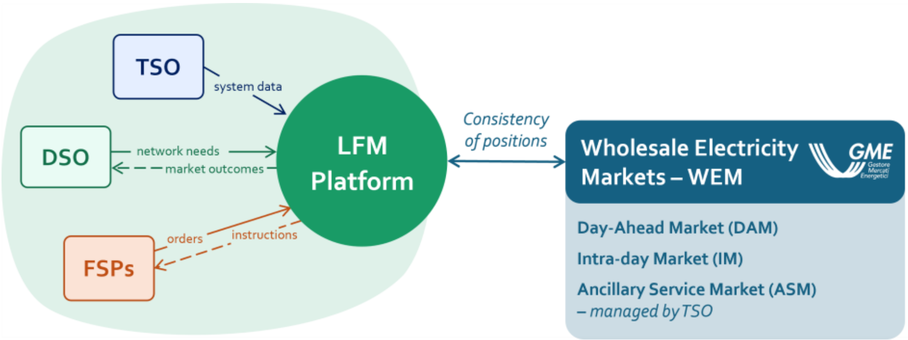


Figure 7 – Interaction between the LFM platform, local market players (TSO, DSO, FSP) and the existing market framework.

## Definition of a roadmap for LFM platforms

Integrated Text on Electricity Dispatching (TIDE)

ARERA Resolution 539/2024

Digital platforms for Local Flexibility Markets are still in a maturing phase. International experimentation has demonstrated their potential, but the transition from pilot projects to structural solutions requires further progress in terms of participation, standardization, integration with existing systems, and operational reliability. This path can be understood through three time horizons, as described in Figure 8.

In the short term, the priority is to learn: completing pilot projects, expanding the base of participating FSPs, consolidating the interfaces between platforms and operational systems, and gathering evidence on prices, volumes, availability, and actual flexibility delivery.

In the medium term, the objective becomes to scale: common standards for data, protocols, market rules, baseline, and cybersecurity need to be defined, interoperability among different platforms must be ensured, spot sessions should be progressively introduced alongside forward ones, and the range of exchanged services should be expanded beyond simple local congestion management.

In the long term, the challenge is to integrate: LFMs will need to become stable components of the national market architecture, used by DSOs as an ordinary alternative or complement to network reinforcements. In Italy, this transition has already been initiated with ARERA Resolution 539/2024, which introduced a transitional phase of the Integrated Text on Electricity Dispatching (TIDE), aimed at testing the new dispatching rules before their full entry into force. The completion of the regulatory framework specifically dedicated to LFMs within the TIDE will mark the definitive shift from experimentation to structural regulation.

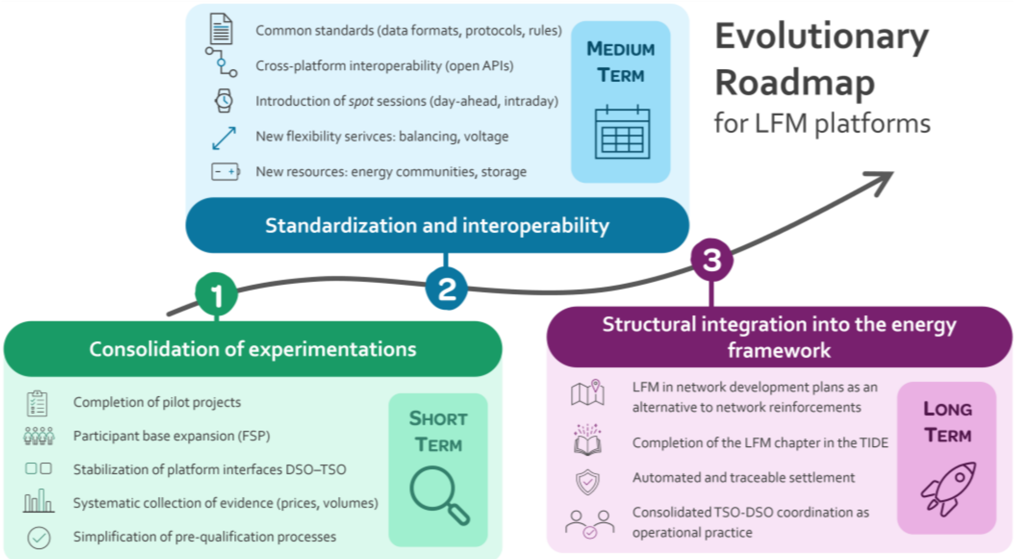


Figure 8 – Evolutionary roadmap of LFM platforms: the three time horizons from the consolidation of experiments to structural integration into the market framework.

## Conclusions

**Digital platforms for Local Flexibility Markets constitute the operational infrastructure that turns distributed flexibility into a service that can be effectively used by network operators.** Through these platforms, distributed resources such as photovoltaic systems, storage, electric vehicles, and flexible loads can be coordinated, activated, and remunerated according to transparent rules, supporting the management of the power system.

The **international experiences** are rich and rapidly evolving: experiences launched in different countries show a variety of technological, regulatory, and governance models. The Italian case stands out in this context, with the MLF platform at the centre of experimentation and a regulatory framework being built around ARERA Resolution 484/2023 and the TIDE.

Significant **challenges** nonetheless remain. Integration among platforms, network systems, and existing markets requires standards that are still being defined, while TSO-DSO coordination needs to be consolidated in operational practice. In addition, shared rules are needed for determining the baseline and for cybersecurity.

**The direction, however, is clear**: from the consolidation of experimentation to the standardization of processes, through to full integration into the ordinary functioning of the power system. LFM platforms do not constitute an exhaustive solution to network criticalities, but rather a complementary tool, whose success will depend on the ability to combine ease of use, operational reliability, and full integration with the existing energy ecosystem.

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