# Review of commercial flexibility products and market platforms

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***Abstract*— The European Union is pushing its members states to implement regulations that incentivize distribution system operators to procure flexibility to enhance grid operation and planning. Since flexibility should be obtained using market-based solutions, when possible, flexibility market platforms become essential tools to harness consumer-side flexibility, supporting its procurement, trading, dispatch, and settlement. These reasons have led to the appearance of multiple flexibility market platforms with different structure and functionalities. This work provides a comprehensive description of the main flexibility platforms operating in Europe and provides a concise review of the platform main characteristics and functionalities, including their user segment, flexibility trading procedures, settlement processes, and flexibility products supported.**

***Index Terms*— digital platforms, distributed energy resources, flexibility markets, flexibility products, systems services**

## I. Introduction

The decarbonisation of the European power sector [1] is driving large investments in renewable energy sources (RES), the integration of distributed energy resources (DERs), a growing adoption of electric vehicles (EVs) and energy storage systems (ESS), the development of communication, metering technologies and smart devices, and more climate-aware consumers [2]. As the reliance on renewable and distributed generation and the electrification of energy consumption increase (such as in heating and mobility sectors), power systems are becoming more decentralised and dynamic, with increasing complexity [3]. In fact, DERs cause reverse power flows, voltage drops, congestions, and can increase losses [2].

Against this backdrop, flexibility, defined as the ability to adjust generation or consumption patterns in response to external signals [2], can contribute to the stable operation of power grids in a cost-effective manner [2]. The Clean Energy Package requires system operators (SOs) to procure flexibility via market-based processes and include it in the planning and operation of their grids [4]. EU DSO and ENTSO-E entities recently released a draft of the Network Code on Demand Response [6], outlining obligations for SOs and Local Market Operators (LMOs). Specifically, it mandates SOs to publish information on their needs for congestion management and voltage control, including details on product needs (up or down regulation, utilization patterns, volume, and time horizon), locational information to enable asset participation, product characteristics, bid selection criteria, and pricing mechanisms. In turn, LMOs, are required to provide details on market sessions, including structure, gate closure times, and bid assessment criteria. Regulatory authorities should require SOs to publish these data on a single national platform to facilitate access and increase transparency.

In this context, digital flexibility platforms (FPs) can support different phases of the flexibility usage, including direct support or interaction with flexibility market platforms (FMPs) where flexibility service providers (FSPs) can offer their flexibility to distribution system operators (DSOs) and/or transmission system operators (TSOs). FPs, however, not only address FSPs qualification, flexibility procurement and market clearing, but also activate flexibility and settle transactions [5].

Some studies have focused on flexibility markets, products and FMPs, such as [2] that provides an in-depth review of flexibility products and market mechanisms. In [6], [7], [8] the authors review several platforms, but considering the publication date they may no longer reflect current commercial trends, and they do not tackle standardized products. In [9], the authors examine market models, flexibility needs, TSO-DSO coordination, and identify numerous projects and flexibility platforms, but the review is limited to the objective, ownership, and pricing method of each platform, and may also no longer reflect the current commercial trends.

This paper reviews FMPs and flexibility products with special focus on commercial or operational platforms, going further than other reviews by identifying relevant gaps. This work was the basis for the design of the Grid Data and Business Network (GDBN), part of the BeFlexible project [10], a digital platform to support the entire value chain of flexibility provision described in [11]. The main contributions are:

- Analysis of standardized flexibility products used in FMPs and European projects and comparison with non-standardized products.
- Review of commercial or in-development FMPs, identifying the countries where they operate, traded products, flexibility requesting parties (FRPs) and FSPs profile, qualification, market structure, products, validation

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and settlement, and alignment with other markets.
- Identification of common FMP gaps to improve the GDBN design and support to the flexibility value chain.

Section II summarizes flexibility products, section III the revised FMPs, and section IV concludes.

## II. Standardized Flexibility Products

Flexibility products for distribution grids are used to activate flexibility resources to mitigate congestions and voltage issues [12]. Part of the ongoing discussion is whether they should be standard or not [13]. ENTSO-E advocates for product standardization at EU-level to cut market costs [14], while CEER suggests that a standard approach is unfeasible [15]. In fact, most platforms described in this paper do not include normalized products. Even without standardized products, several projects and initiatives in different countries are developing and testing flexibility markets. These initiatives usually involve several stakeholders, including DSOs, TSOs, aggregators, and regulators, using various market mechanisms to procure and activate flexibility.

### *A. Flexibility products in European projects*

The OneNet project [16] distinguishes between frequency control and non-frequency control products, focusing on the later for enhancing distribution grids flexibility. It introduces three key non-frequency control products [17]:

- Corrective local product for immediate response to unforeseen incidents.
- Predictive short-term local product for managing forecasted system needs with monthly procurement.
- Predictive long-term local product to prevent or postpone the need for grid reinforcements over several years.

The EUniversal project [18] expands the scope of flexibility products to include solutions for congestion management, voltage control, network planning, islanding, and black start capabilities [19]. These products are designed to adjust power flows and voltage levels to maintain grid stability, anticipate and address grid capacity needs, enable a part of the grid to operate independently during outages, and restore power supply following blackouts without external assistance, respectively.

The ongoing BeFlexible project [10] proposes to test two products to provide short-term flexibility to DSOs [20]:

- Short-term Scheduled: when the DSO has a high certainty that flexibility will be needed, the selected FSPs are informed after the market clearing to adjust their assets to provide the selected flexibility, to avoid thermal limits or high/low voltages.
- Short-term Dispatched: when the DSO is not certain that flexibility will be needed, it contracts the option to activate a pre-agreed change in the FSP's output based on its forecasted network conditions. The activation is decided closer to real time according to actual grid condition.

### *B. ENA proposal for flexibility products*

The Energy Networks Association (ENA), proposed four standardized products: Sustain, Secure, Dynamic, and Restore, designed for various grid scenarios from pre-fault management to post-fault restoration [21]:

- Sustain procures flexibility over defined periods to prevent overloading, with dispatch agreed in advance.
- Secure procures flexibility based on grid conditions closer to real-time, possibly including availability (capacity) fees and utilisation (energy) fees, with varied dispatch timing.
- Dynamic is for flexibility during network abnormalities or outages, typically dispatched at short notice with a focus on utilisation fees.
- Restore aids in post-fault scenarios, instructing flexibility service providers (FSPs) to adjust supply or demand to expedite grid restoration, again typically with short-notice dispatch and utilisation-focused payments.

Although ENA is a British agency, their products are being used in platforms in multiple countries, as described next.

### *C. Commercial platforms with standardized products*

From the revised FMPs, Piclo Flex and Flexible Power are the only ones using standardized products (based on the ENA proposal [22]). The remaining platforms adopted non-standard products based on broader use-cases, such as defer grid investments, manage congestion or enhance reliability [23].

Both alternatives have advantages. Standardized products facilitate common terminology, they help entities active across multiples countries and FMPs, and benefit markets with low liquidity and competition. Standardization also supports inter-zonal dispatching and improves TSO-DSO coordination by limiting conflicting rules. Conversely, supporters of non-standardised products highlight that markets can respond better to a dynamic product parameterisation, which also promotes innovation by allowing to test multiple designs [5]. Intermediate proposals recommend defining a minimum set of attributes as a template for all products, with the opportunity to add ad-hoc attributes for specific needs [24], balancing the benefits of standardization with the adaptability of non-standardized approaches.

## III. European flexibility market platforms

This section reviews multiple FMPs operated or developed in Europe. Aspects such as their presence across different countries, FRPs and FSPs profile, qualification process, market structure, products, validation, settlement, and TSO/DSO coordination are reviewed. Before delving into the intricacies of FMPs, it is pertinent to overview aggregator platforms, that serve as the initial interface connecting consumers with flexibility markets.

### *A. Aggregator platforms*

Consumers often engage with aggregators to access flexibility markets. The aggregators manage the resources, expanding and diversifying their portfolio. Currently, several aggregators' platforms operate in Europe.

For instance, Centrica is a UK-based company that owns REstore, a demand response aggregator platform, managing around 1.7 GW of peak load across Belgium, UK, France and Germany [25]. Another aggregator platform is TIKO, that leverages on a virtual power plant (VPP) and a smart home energy management system, connecting residential and enterprise assets [26]. In Switzerland, TIKO provides primary and secondary frequency regulation by aggregating behind-the-meter assets in low voltage grids [6]. Next Kraftwerke operates an aggregator platform through a VPP made of producers, consumers and ESS [27]. Active across 7 TSO areas, it offers ancillary services and facilitates market access for day-ahead and intra-day at the EPEX SPOT [28]. Finally, Flexitricity is the first demand response aggregator platform in the UK, a VPP-based aggregator that offers multiple services involving

demand response, ESS, distributed generation or EVs. These services include frequency response, balancing mechanisms, capacity market and DSO services [29].

### *B. Piclo Flex and Flexible Power*

Developed by Piclo and launched in the UK in 2018, Piclo Flex is now available in five European countries (Ireland, Italy, Lithuania, Portugal and UK) and in the USA [30].

The FRPs are DSOs buying flexibility to cut long-term reinforcements [6]. Regarding FSPs, only large commercial entities can participate directly, as residential consumers must have their assets managed by aggregators [31]. When needed, a DSO starts a flexibility procurement process (tender), where it specifies the needed product (Piclo Flex supports the 4 ENA products [22]) and delivery periods (moments where flexibility shall be provided). FSPs wishing to join this tender must complete qualification, split in [32]: company qualification (the DSO assesses the FSP company profile [33]) and asset qualification (FSPs send assets' data [34], [35]). Qualified FSPs can ten join a tender [36]. Often, qualification lasts from weeks to months, but sometimes it stays open for years [37].

Once qualification is over, the market session opens and FSPs submit bids. Each bid has a capacity (MW), maximum run time (the time that the bid capacity is available for) and fees, which depend on the product [37]. The duration of the sessions, as organised by DSOs, vary, ranging from weeks [38], [39] to months [40]. Besides, tenders are scheduled by DSOs with seasonal or annual frequency [41], [42], and flexibility is procured for the long-term, up to 4 years ahead [39], [43].

After the market session ends, the DSO evaluates the bids based on their prices (pricing is pay-as-bid [37]) and ability to meet flexibility needs. Finally, contracts are signed between the DSO and FSPs [44]. After the delivery period is over, the DSO validates the provision of flexibility and settle it with the FSPs. Validation can be done off-platform [5], but Piclo also developed APIs [45] which can send dispatch orders, invoices and create reports [46].

In the procurement process described above, Piclo Flex does not include TSO-DSO coordination. Still, the British TSO chose to use this platform for its first local constraint market, started in 2023. There, FSPs can join day-ahead and intra-day sessions [47] so they can intake wind generation that would be curtailed due to transmission lines being at their limits [48].

Meanwhile, Flexible Power was developed for and is used by four British DSOs [49]. It is not a standalone platform and relies on Piclo Flex for the procurement process, inheriting many of its characteristics, such as products, qualification, market frequency, bid's structure. Still, Flexible Power adds some features such as requirements identification (detect flexibility needs), contract management, forecasting (estimate constraints and flexibility usage) [50], dispatch (send automatic signals [51] to FSPs using Flexible Power APIs [52], which also send metering data [53]), and settlement (verify delivery using metering data and settle transactions [50]).

The integration of Piclo Flex into Flexible Power in the UK shows the benefits of integrating existing FMP into FP. Similarly, the GDBN is designed to interface with existing FMP enhancing other less supported activities of the flexibility value chain. For instance, since Piclo Flex restricts direct participation of commercial consumers, mandating residential consumers to engage through aggregators, the GDBN addresses explicit support, facilitating matching consumers and aggregators [11]. The GDBN streamlines dispatch and settlement mechanisms, not yet supported by Piclo Flex or other FMPs, particularly relevant for DSOs, enhancing the overall efficiency of the end-to-end flexibility procurement process.

### *C. Enedis*

In 2020, Enedis, the largest French DSO, launched a FMP of the same name [23]. The FSPs are suppliers, aggregators, and large MV sites, while the FRP is a DSO [54] requesting long-term flexibility (procurement horizon up to 44 months) [23].

These tenders are open annually [23] and follow the steps described next. First, the DSO opens a preliminary tender to asses market liquidity [55]. FSPs wishing to join must complete qualification, simpler than in Piclo Flex. FSPs open the platform and check if they are inside a congestion zone. If so, they list their assets and respective characteristics [23]. If there are enough FSPs, the DSO starts a market session [56] with an eligibility zone, capacity, and activation periods [23], [57]. Products do not have standard characteristics, instead the DSO procures flexibility using high level uses cases (e.g., defer investments, plan maintenance) [55], and there are 2 markets: with capacity reservation (FSPs guarantee availability for a certain period) and without capacity reservation (FSPs commit to deliver flexibility only after accepting an activation request from Enedis) [54]. The pricing mechanism is pay-as-bid for energy, while reservation/capacity is paid at a fixed price [23].

Bidding windows last around 2 months [58], and bid selection depends on economic and technical factors [56]: when flexibility is used for congestions, bids are evaluated based only on their prices, but for voltage constraints, sensitivity factors per connection point are used [23]. After bid selection, contracts are signed, usually with a length from 1 to 3 years [58], [59]. At last, activation signals are sent via email or phone call (APIs under development) and settlement is done monthly [23], [56]. As for TSO-DSO coordination, Enedis and the French TSO do not yet anticipate upstream network issues caused by flexibility activations, so significant imbalances are not expected [23].

It is noteworthy that most of the flexibility tenders issued by Enedis so far have experienced a very limited participation, which is a significant concern. In 2020, only 2 offers were submitted across 5 locations, leading to the awarding of 2 contracts. 2021 saw an absence of offers, and in 2022 only 1 offer was submitted and 1 contract awarded. There was an increase in 2023, with Enedis receiving 6 offers across 11 sites [60]. Various factors can contribute to this situation. First, the perceived value of flexibility might be too low to attract FSPs. Moreover, a general lack of awareness or understanding among consumers about the importance of flexibility can delay participation, an issue that can be intensified with too complicated participation processes, specifically for residential consumers in need of an aggregator.

The GDBN may potentially contribute to a platform like Enedis and increase participation rates, reducing barriers by matching them with aggregators, or with consumer education programs disseminated through the GDBN to clarify the benefits of providing flexibility, not-only economic, but also for a successful decarbonization of the energy system.

### *D. NODES platform*

Launched in 2018, NODES has been deployed in multiple countries and used in projects such as IntraFlex (in the UK, deployed by a DSO) [61] and NorFlex (in Norway, deployed by DSOs and a TSO). The operation of this platform across all

projects it is involved in is not uniform, with different features and operation modes. Thus, this review focuses on general aspects of its implementation.

Regarding participants, NODES admits SOs and Balance Responsible Parties (BRPs) as FRPs, while FSP can be aggregators, microgrids and, again, BRPs [62]. The platform hosts FSPs registration and qualification [5], where the FMO (NODES) verifies regulatory compliance and financial aspects of the FSPs, while the SO qualifies the assets based on their technical details and tests. Depending on automation levels of FSPs and SOs, qualification takes about 1 day. While the other revised FMPs also check FSPs company and assets details to complete qualification, NODES does not impose a minimum capacity limit for the assets providing flexibility [23].

Similar to Enedis, there are no standard products [13]. Instead, the services offered include congestion management for DSOs, balancing for TSO, and portfolio optimisation for BRPs. All FRPs should compete for the available flexibility, but in many pilots the DSO has priority over the TSO. Products are procured in long-term and short-term markets, as described next [23]. In the long-term market (LongFlex) market, availability (capacity) products are traded, with possible activation (energy) components, with products having seasonal (2-4 months) or weekly availability [5]. The short-term market (ShortFlex) is a continuous, pay-as-bid market. The FRP publishes flexibility needs in advance so that FSPs can send offers, where trading opens 7-10 days and ends 1-2 hours before delivery [23]. Unlike platforms where SOs filter and select offers (Piclo Flex), NODES provides central matching without the direct involvement of SOs. Dispatch orders are sent automatically and, validation and settlement are based on metering data collected on a minute-by-minute basis. After validation, penalties are imposed if the offered and delivered flexibility differ [5].

In NorFlex, each DSO collects metering data to its own private platform. This was identified as a non-scalable solution due to the large number of DSOs in Europe, suggesting that a unique platform for each market can hinder FSPs engagement [63]. The cornerstone of the GDBN lies in the adoption of existing standards (e.g., CIM), extending them under a unified data modelling scheme that caters to multiple sources across stakeholders in the value chain. Moreover, the GDBN is future-proof in the European setting, including by design enablers for data spaces, allowing participation in the European Energy Data Space, scoping flexibility data and alignment with Gaia-X for the federation of stakeholder identity schemes [64]. This strategy can prevent and reduce data fragmentation and ensure that core information is handled and managed on a common platform, reducing boundaries associated with independent data sources and facilitating data exchange. Thus, by providing a unified data management solution, the GDBN simplifies FSPs' engagement with multiple DSOs, contributing to increase their engagement in FMPs.

### *E. OMIE platform*

OMIE is working on a FMP for the Iberian peninsula [65] based on the work carried out in Iremel [66], DRES2Market [67], and OneNet [16]. It allows DSOs to acquire flexibility from aggregators, commercial and industrial consumers, and EV charging points [68]. To join, FSPs must complete a qualification process split in grid qualification (done by the DSO to ensure the FSPs' assets meet requirements such as capacity, response time, maximum delivery time), and product qualification (done by OMIE to ensure the FSPs can provide flexibility considering market and product design aspects) [69]. Also, FSPs must have an OMIE account and fill required documentation [24].

There are 4 market types for DSOs to procure flexibility: long-term, mid-term, day-ahead and intra-day. Both long and mid-term markets deal with planned flexibility, helping DSOs in grid planning and DERs integration, while day-ahead and intra-day markets deal with sudden issues. Long-term markets focus on years-ahead planning, mid-term markets on monthly planning, day-ahead on next-day procurement, and intra-day address same-day needs [24].

Since the traded products include capacity (availability) and energy (activation), FSPs providing long or mid-term flexibility are paid for both energy and capacity, while short-term (day-ahead and intra-day) only pays for energy. Moreover, all markets are based on tenders started by DSOs and use pay-as-bid except the intra-day market that employs a continuous clearing algorithm [24]. According to the product procured, DSOs monitor the grid and send the activation signals to the FSPs committed in the market phase [68]. As the platform is not yet operational, it is not clear how activation orders are sent.

TSO-DSO coordination mechanisms are being considered in the development process [68], and it is also being prepared to integrate with other markets, like the intra-day wholesale continuous market (XBID) [69].

This platform will possibly be used in BeFlexible, and the GDBN will have to interact with it in several pilots. The GDBN will support the activation of the flexibility traded in the OMIE platform by forwarding dispatch notices from DSOs to FSPs. Then, after flexibility delivery, the GDBN will provide tools for verification and settlement, at least for smaller DSO that do not own or want to sub-contract that service, in a similar way as Flexible Power does for Piclo Flex. For those, the GDBN retrieves the baselines previously stored, compares them to metering data and computes the delivered flexibility and the remunerations and/or penalties for FSPs, facilitating the settlement process between the DSO and the FSPs.

### *F. GOPACS*

GOPACS acts as an intermediary platform to link market platforms in the Netherlands, notably ETPA which operates both intra-day and day-ahead markets in this country. It deals with congestion across all voltage levels, enhancing flexibility for re-dispatch and improving TSO-DSO coordination [70]. SOs use it to forecast, publish and manage congestion, enabling FSPs to submit offers via GOPACS. Validated offers are called Intra-day Congestion Spread (IDCONS), and include a location tag, which is crucial due to the congestion-focused nature of the product [71]. The bidding process is continuous, FSPs are charged with an entry fee, monthly fee, and a fee per interchanged MWh, and SOs pay a fee for use of IDCONS [6].

### *G. eSIOS-CECRE-CoordiNet*

This platform, consisting of eSIOS (Balancing Market Information System) and CECRE (Control Centre for Renewable Energy), provides market insights and supports RES control in Spain. Developed by the Spanish TSO (REE), it facilitates communication between market participants and REE to submit bids for buying/selling energy and receive notifications of bid acceptance/rejection. Then, eSIOS publishes results from various markets and schedules, ensuring

transparency and confidentiality in market operations. CECRE, created in 2006, addresses the surge in wind energy by monitoring RES and Combined Heat and Power generation in real-time. The data is collected by the RES control centres (RESCC) and transmitted to the CECRE. The RESCC serves as the sole intermediary between RES producers and the TSO, managing set-points and ensuring compliance for non-manageable plants. This setup allows for rapid response to unexpected events, with the system under TSO control to restore balance within 15 min. and preserve N-1 security [72].

## IV. Conclusion

This paper provides a comprehensive review of FMPs and products across Europe, describing both in-development and commercially operational platforms. One finding is the variability in products definition, with numerous proposals being found in the literature. While standardization enables inter-zonal dispatch and helps to set a common terminology, non-standardization allows for dynamic responses to market needs and innovation. Since it is complex to assess the most beneficial alternative, an intermediate approach is suggested, combining benefits from both strategies. In the reviewed platforms, standard products are less common, except in Piclo Flex (and Flexible Power), which is, in fact, the most widespread of these platforms.

The emergence of new FMPs, while indicative of a growing sector, can also lead to challenges related to market liquidity and fragmentation. With many competing platforms, the risk of diluting consumer focus and participation becomes stronger. From a regulatory perspective, this fragmentation is also undesirable. This is why the Network Code on Demand Response requires SOs to publish flexibility needs on a single, national-level platform. The GDBN can also mitigate these issues and foster a more consistent environment, facilitating access to all consumers, increase participation in flexibility market through new value propositions and the simplification of process like dispatch and settlement, and streamlined data exchange. This approach does not only tackle low market liquidity and operational inadequacies, but also encourages broader participation from FSPs by offering a centralized hub for flexibility trading and information exchange, while complying with the regulatory framework and preserving data privacy. By adopting the GDBN to support FMPs, the platform promises to enhance market functionalities, accessibility, and efficiency, leading the way for the growth of flexibility.

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