DigIPlat

D3.1 Current framework for the operation and setup of existing flexibility platforms

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With the support from:

FICHTNER IT CONSULTING

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APG

Universität St.Gallen

Funding from:

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

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Smart Energy Systems ERA-Net

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Digital Transformation for the Energy Transition, with support from the European Union's Horizon 2020 research and innovation program under grant agreement No 883973.

Versioning and Authors

Version control Version

Revision	Date	Author	Organization	Comments
R1	12.08.2022	Julia Kumm	TransnetBW	Matrix proposal
R2	19.08.2022	Ksenia Tolstrup	AIT	General document structure, update of the platform matrix and list of platforms
R3	16.09.2022	Julia Kumm	TBW	Addition to matrix and addition of descriptions DA/RE, RES/RAS, BANULA
R4	26.10.2022	Julia Kumm	TBW	Addition of description Equigy/CBP
R5	05.12.2022	Sarah Fanta, Ksenia Tolstrup	AIT	Addition of platform descriptions for GOPACS, NODES, Piclo Flex and Enera
R6	24.02.2023	Maximilian Hödl	TBW	Introduction, Matrix Overview, DA/RE description, timeline regulatory framework
R6	24.03.2023	Maximilian Hödl	TBW	General document structure, chapter on platform interoperability, chapter on regulatory framework, geographical distribution of platforms
R7	27.03.2023	Ksenia Tolstrup, Sarah Fanta	AIT	Review of the general structure, comments and additions
R8		Maximilian Hödl	TBW	Review of comments, additions in chapter Regulatory Framework, description INTERRFACE
R9	05.04.2023	Ksenia Tolstrup, Sarah Fanta	AIT	Second review
R10	21.04.2023	Maximilian Hödl	TBW	Review of comments, Abstract, Kurzfassung, Summary Chapter 4, Conclusion
R11	09.05.2023	Daniel-Leon Schultis	AIT	Discussion of DA/RE's capabilities concerning the management of distributed flexibilities
R11	09.05.2023	Daniel-Leon Schultis, Viktor Zobernig, Sarah Fanta	AIT	Review

R13	12.05.2023	Manuela McCulloch	THU	Review
R14	22.06.2023	Lukas Obernosterer	APG	Review
R15	10.07.2023	Maximilian Hödl	TBW	Review

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Executive Summary

In Deliverable 3.1, we analyzed flexibility platforms in Europe and evaluated their status and modes of interoperability. We furthermore conducted an analysis of the regulatory framework regarding flexibility in general and regarding flexibility platforms. The overview and review of flexibility platforms across Europe has shown that the development stage is still early. The platform landscape may be described as rather defragmented. Many of the currently operated or developed platforms belong to pilot projects and only a few are fully operational. To meet national and European expectations for flexibility usage, more efforts to implement flexibility platforms are needed. We analyzed platform interoperability by means of existing or currently developed platform interfaces such as the pursued interface between the coordination platform DA/RE by TransnetBW and the European Crowd Balancing Platform by Equigy. Indeed, interfaces between platforms are scarce and only partially under development. However, a pilot project employing the NODES marketplace has successfully demonstrated bid forwarding of unused flexibility bids from a local energy market to the national balancing market. Regarding the current regulatory framework, the most important points are that flexibility products shall be standardized, and that procurement shall be carried out in a transparent, non-discriminatory, and market-based procedure. This was stipulated in the EU Directive 2019 and has already been transposed into German law. In the future, the network code demand response and EU proposal for the reform of the European Electricity Market foresee a standardization of products used in congestion management, a decrease of the minimum bid size in markets to boost the participation of small-scale flexibility, and to enable bid forwarding. Overall, the initiatives aim to increase liquidity in the markets and increase the use of flexible assets.

Kurzfassung

Im hier vorliegenden Deliverable 3.1 haben wir Flexibilitätsplattformen in Europa analysiert und deren Interoperabilität im Hinblick auf aktuelle Schnittstellen und Funktionsweisen ausgewertet. Weiterhin haben wir eine Analyse des regulatorischen Rahmens bezüglich Flexibilität im Allgemeinen und Flexibilitätsplattformen durchgeführt. Der Überblick und die Untersuchung von Flexibilitätsplattformen in ganz Europa haben gezeigt, dass sich die meisten Plattformen noch in einem frühen Entwicklungsstadium befinden. Die Plattformlandschaft kann als eher defragmentiert bezeichnet werden. Bei vielen der derzeit betriebenen oder entwickelten Plattformen handelt es sich um Pilotprojekte, und nur wenige sind voll funktionsfähig. Um die nationalen und europäischen Erwartungen an die Flexibilitätsnutzung zu erfüllen, sind weitere Anstrengungen zur Implementierung von Flexibilitätsplattformen erforderlich. Wir analysierten die Interoperabilität der Plattformen anhand bestehender oder derzeit entwickelter Plattformschnittstellen, wie der angestrebten Schnittstelle zwischen der Koordinierungsplattform DA/RE von TransnetBW und der European Crowd Balancing Platform von Equigy. In der Tat sind Schnittstellen zwischen Plattformen relativ selten und nur bedingt in der Entstehung. Ein Pilotprojekt mit der NODES-Marktplattform hat jedoch erfolgreich die Weiterleitung von ungenutzten Flexibilitätsgeboten von einem lokalen Energiemarkt an den nationalen Ausgleichsmarkt demonstriert. Im Hinblick auf den aktuellen Rechtsrahmen sind die wichtigsten Punkte, dass Flexibilitätsprodukte standardisiert werden sollen und dass die Beschaffung in einem transparenten, diskriminierungsfreien und marktbasierten Verfahren erfolgen soll. Dies wurde in der EU-Richtlinie 2019 festgelegt und bereits in deutsches Recht umgesetzt. Für die Zukunft sehen der network code Demand Response und der EU-Vorschlag für die Reform des europäischen

Strommarktes eine Standardisierung der Produkte für das Engpassmanagement, eine Senkung der Mindestgebotsgröße auf den Märkten, um die Beteiligung kleinerer Flexibilitätsanlagen zu fördern, und die Möglichkeit der Gebotsweiterleitung vor. Insgesamt zielen die Initiativen darauf ab, die Liquidität auf den Märkten zu erhöhen und die Nutzung flexibler Anlagen zu steigern.

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List of Abbreviations

aFRR	*Automatic frequency restoration reserve*
APG	*Austrian Power Grid*
API	*Application Programming Interface*
BANULA	*Barrierefreies- und Nutzerfreundliches Laden*
BAL	*Balancing Services*
BMWK	*Bundesministerium für Wirtschaft und Klimaschutz der Bundesrepublik Deutschland*
BSP	*Balancing Service Provider*
CACM-GL	*Capacity allocation and congestion management guideline*
CM	*Congestion Management*
CPB	*Crowd Balancing Platform*
DA	*Day ahead*
DA/RE	*Datenaustausch/Redispatch*
DSO	*Distribution system operator*
EB-GL	*Electricity balancing guideline*
ElWOG	*Elektrizitätswirtschafts- und organisationsgesetz*
EPEX	*European Power Exchange*
ETPA	*Energy Trading Platform Amsterdam*
EU	*European Union*
EV	*Electric Vehicle*
FCR	*Frequency Containment Reserve*
FSP	*Flexibility Service Provider*
IAO	*Fraunhofer Institut Arbeitswirtschaft und Organisation*
IEGSA	*Interoperable European Grid Services Architecture*
ID	*Intraday*
IDCONS	*Intraday Congestion Spread*
LEM	*Local Energy Market*
Mari	*Manually Activated Reserves Cooperation*
mFRR	*Manual frequency resotration reserve*
NABEG	*Netzausbaubeschleunigungsgesetz*
NEMO	*Nominated Market Operator*
OEM	*Original Equipment Manufacturer*

Picasso	*Platfom for the International Coordination of Automated Frequency Restoration and Stable System Operation*
PKNS	*Plattform Klimaneutrales Stromsystem*
RD	*Redispatch*
RES	*renewbale energy sources*
SAAT	*Stromausgleich Österreich (AT)*
SO	*System operator*
TSO	*transmission system operator*

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1. Introduction

In view of the energy transition in Europe, the associated expansion of renewable power generation and the accompanied decentralization of energy resources, accessing the vast potential of demand-side flexibilities is imperative. [1] For grid operators, distributed flexibility options can be used for congestion management, redispatch and balancing services to ease high grid loads during peak hours (along with other strategies such as grid expansion). The procurement of such flexibility options may, in turn, take place on market-based flexibility platforms, providing new incentives for private consumers, aggregators and industry partners, i.e., flexibility service provider (FSP) to participate in these new markets. Indeed, several flexibility platforms have emerged across Europe, covering different functions such as TSO/DSO coordination or trading of flexibility products. This deliverable provides a systematic overview of relevant flexibility platforms in Europe, discussing their general scope as well as details regarding the flexibility products and their purposes (e.g., for congestion management or balancing services).

Following the general overview of the various flexibility platforms, their interoperability is explored and several real-world examples of interoperational platforms are worked out and discussed. This discussion highlights different modes of platform interoperability and gives a more general impression of where current platform development stands.

Meanwhile, the regulatory framework on flexibility is subject to profound development, particularly since the adoption of the Clean Energy for all Europeans Package in 2019. Here, we discuss the current situation with respect to regulations on flexibility platforms by analyzing the EU regulation 2019/943, EU directive 2019/944, the German Energy Act and the Austria ElWOG. In addition, we will briefly review the electricity balancing guideline (EB-GL) and the capacity allocation and congestion management guideline (CACM-GL) that are relevant in this context. To assess future regulations, we use preliminary drafts and position papers on new regulations. In particular, the EU regulation 2019/943 foresees the formulation of a European Network Code on demand response, which is currently being drafted. The corresponding framework guideline document that has been published in December 2022 provides important insights into regulations envisaged for the future. Along these lines, we also briefly discuss the reform of the European electricity market as well as the German platform for a climate neutral electricity system.

1.1. Scope of this Deliverable

In Chapter 2, the relevant flexibility platforms in Europe are reviewed, considering their general scope, status of operation, details of the flexibility products (bid size, aggregation, locational information), as well as activation and remuneration conditions (chapter 2). Here, we will make use of a platform categorization introduced in ref. [2], according to which a platform either belongs to (i) data exchange and coordination platforms, (ii) market intermediary platforms, or (iii) marketplace platforms. The categories are elaborated on in Section 2.1, an overview of the relevant flexibility platforms is given in Section 2.2, their geographical distribution across Europe is shown in Section 2.3, and detailed descriptions of the individual platforms are given in Section 2.4. In Section 2.5, we provide a detailed matrix of the relevant flexibility platforms and their key characteristics, e.g., in terms of bid size, timing, remuneration, etc.

In Chapter 3, the interoperability of the reviewed platforms is analyzed in terms of existing platform interfaces and the discussion of various real-world examples of platform interoperability. At first, based on the aforementioned categories, a multi-level platform diagram is created that allows for

intuitive mapping of the existing platforms. Here, we identify two different modes of platform interoperability – vertical and horizontal – and describe them in more detail (Section 3.1). Finally, Section 3.2 discusses several examples of platform interoperability, i.e., the case where a flexibility product is passed through more than one platform, considering both horizonal and vertical modes.

In Chapter 4, the regulatory framework on flexibility is reviewed. Here, we begin with a timeline illustrating the recent developments since 2019 with regard to European and German legislature (Section 4.1). In Section 4.2, the EU regulation 2019/943, EU directive 2019/944 and relevant sections in the German Energy Act and Austrian EIWOG are briefly reviewed. Finally, in Section 4.3, an outlook is given towards the future regulatory framework on flexibility by analyzing the framework guideline (i.e., public draft) of the network code demand response and ongoing discussions on the platform for a climate neutral electricity system in Germany.

The present deliverable is part of working package 3 and sets the foundation for the standardization of flexibility products and attributes (deliverable 3.2) and the definition of multifunctional use cases (deliverable 3.3). The main references for the overview of existing relevant flexibility platforms, given in Chapter 2 of this deliverable are the "Review of Flexibility Platforms" prepared by Frontier Economics for ENTSO-E from 2021 [2], and the JRC technical report "Local Electricity Flexibility Markets in Europe" from 2022 on behalf of the European Commission [3].

2. Relevant Flexibility Platforms

2.1. Platform Categories

According to ref. [2], a flexibility platform refers to a digital platform that facilitates or coordinates the procurement, trade, dispatch and/or settlement of energy or system services. The procured flexibility products can be used both to resolve congestion and to minimize redispatch demand or as balancing energy, e.g., aFRR or mFRR products. Flexibility platforms typically cover various aspects of the procurement of flexibility products. This ranges from identifying congestion or balancing energy demand to the sale or auctioning of the product. Based on these aspects and functionalities, the authors of ref. [2] suggested dividing flexibility platforms into different categories. Following internal discussions within the DigIPlat project, the proposed categories are slightly adapted to also include aggregators and thus to ensure a more intuitive mapping of existing platforms to the available categories. These are in particular:

1. **Data exchange and coordination platforms**: Facilitate TSO/DSO coordination, help solve grid congestions (current and voltage limits), coordinate redispatch or balancing energy demand, enable data exchange between relevant stakeholders. Platforms of this category typically share an interface to the system operation of T/DSOs.

2. **Market intermediary platforms**: Provide services such as asset registration, prequalification, and aggregation of flexibilities. Platforms of this category often take the role of flexibility service providers (FSPs) and are typically connected to the flexibility assets.

3. **Market platforms**: Running auctions, clearing transactions, and settling payments between buying side and FSPs, respectively.

In certain cases, a rigorous categorization of the existing flexibility platforms reaches practical limits, e.g., when platforms adopt functionalities of more than one category. These cases are described in the platform descriptions in Section 2.4, accordingly.

2.2. Overview of relevant flexibility platforms in Europe

A summary of the relevant flexibility platforms discussed in the deliverable is given in Table 1. The overview deliberately excludes already established platforms of TSO's for balancing energy exchange (e.g., PICASSO, MARI), hence focuses on platforms that can handle locational information and still are not implemented yet (i.e., under development or operate in an early implementation stage). The role of these platforms in the context of flexibility procurement by T/DSOs will be discussed in Section 3.2.

It is important to mention that the flexibility platforms discussed in the present work do not claim to be a complete list of all European flexibility platforms, but rather cover those considered relevant for the DigIPlat project. Table 1 provides an overview of the various platforms including their status of operation (green: operational, yellow: in development, red: planned, grey: a completed project that has not been prolonged to regular use). Moreover, Table 1 indicates the (i) platform category, (ii) the region in which the platform is active, (iii) whether the platform's main purpose is redispatch or balancing service, (iv) whether the flexibility product has a locational information, and (v) if there is an interface to another platform.

Table 1: Overview of relevant flexibility platforms.

Platform	Status	Category	Country	Product	Locational Info.	Interface
Data Exchange & Coordination						
DA/RE	●	1	DE	RD	yes	Equigy ●, RAS ●
GOPACS	●	1	NL	BAL/RD	yes	ETPA ●, EPEX Spot ●
CoordiNet	●	1	ES, GR, SE	BAL/RD	dep. on use case	
INTERRFACE	●	1	EE, LATV, FI	RD	yes	
Market Intermediary Platforms						
Equigy-CBP	●●	2	DE, AT, NL, IT, CH	BAL/ RD	dep. on use case	Nord Pool ID ●
Banula	●	2	DE		yes	
Market Platforms						
EPEX LEM	●	3	Int.	RD	yes	
Enera	●	3	DE	RD	yes	
NODES*	●	3	NO, UK, SE	BAL/RD	yes	
Piclo Flex	●	3	UK, LTU, IRL, USA, PRT	RD	yes	

● Operational ● Under construction/Pilot ● Planned ● Project Completed

1 - Data Exchange and Coordination; **2** - Market Intermediaries, **3** - Market Platforms

* NODES platform used in different pilot projects, e.g. IntraFlex (UK), NorFlex (NO), sthlmflex (SE), that may be completed

RD: Redispatch (inlcudes other products used in congestion management and grid reliability); BAL: Balancing Services

2.3. Geographical Distribution of Flexibility Platforms in Europe

The flexibility platforms analyzed in the present work are spread across Europe, as shown in Figure 1. In fact, some flexibility platforms have been developed jointly by several countries, e.g., CoordiNet or the Equigy Crowd Balancing Platform. These cooperations typically aim at developing the basic architecture of the platform, which is then implemented and adapted on a national level (with regard to existing regulatory and/or political agenda). In addition, these

international cooperations can help achieve standardization of flexibility products to enable cross-country platform interoperability (see project deliverable 3.2 for more detail). Another option is for third parties to develop a flexibility platform, which is then operated in different countries. For instance, the NODES flexibility platform was used in the Norwegian "NorFlex" demonstration, which (among other things) aimed to integrate flexibilities in the TSO's mFRR procurement, as well as in the Swedish "sthlmflex" demonstration piloting the market-based procurement of local flexibilities to ease T/DSO congestion management.

Overall, the present analysis shows that flexibility platforms are being tested, piloted and, in some cases, operated on a regular basis all over Europe. The actual design and goal of these platforms thereby differ among European countries, partly related to the respective energy landscape and grid topology.

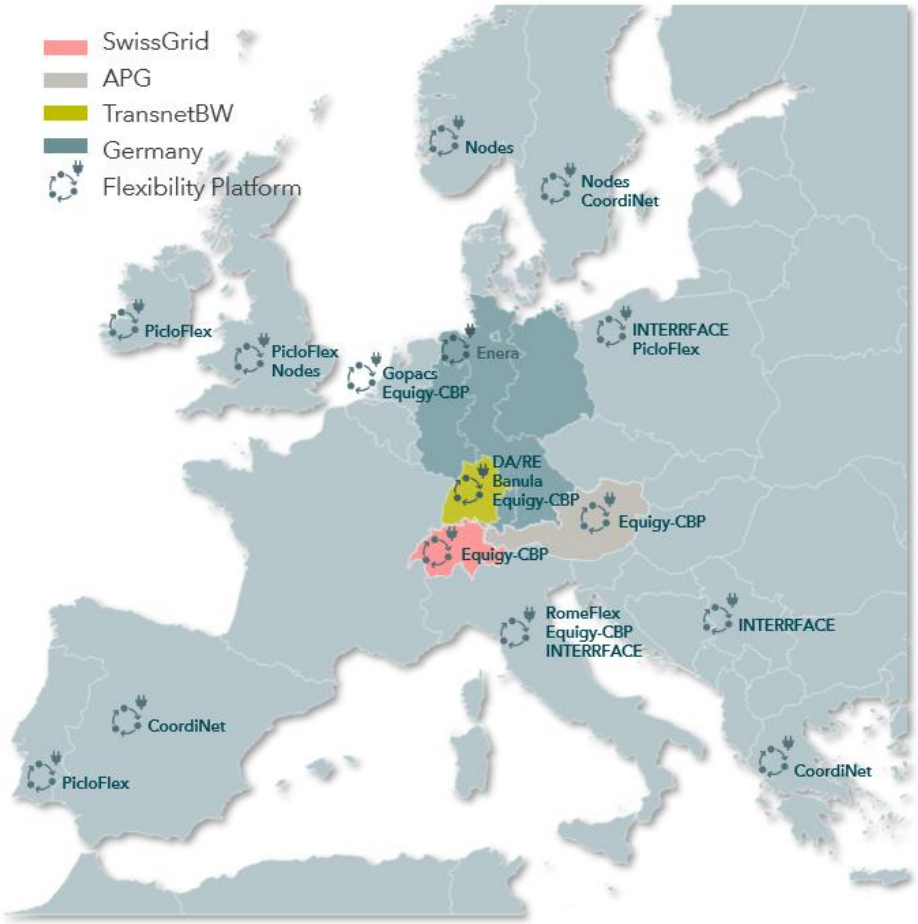

Figure 1: Geographical distribution of flexibility platforms across Europe. The highlighted areas (and TSOs) correspond to the region investigated in the DigIPlat project (DACH region), cf. Deliverable 3.3.

2.4. Flexibility Platforms

2.4.1. DA/RE

General Information

- Status: operational
- Category: Data Exchange & Coordination (1)
- Region: DE
- T/DSO involved: TransnetBW (TSO), NetzeBW (DSO)
- Website: www.dare-plattform.de

DA/RE is an IT platform that focuses on facilitating the participation in the German mandatory 'Redispatch 2.0' process . The Redispatch 2.0 scheme stipulates the participation of renewable energy sources and conventional power plants ranging between 100 kW and 10 MW in the congestion management, in addition to the traditional Redispatch 1.0 scheme, where only power plants above 10 MW take part (see Figure 2). The new Redispatch 2.0 scheme was initiated by the German "Netzausbaubeschleunigungsgesetz" (NABEG) and should be implemented in October 2021 (initial plan).

In more detail, in the first stages of development, DA/RE follows the approach that each of the participating network operators solves its grid congestion independently via communication through DA/RE. In addition, subordinate grids may report technical limitations within which the redispatch requests will not lead to additional congestions in their grid level. DA/RE thus enables efficient network congestion management through coordination and data exchange between the network operators involved. This approach preserves the privacy of DSOs over their assets and grid models while implementing the legal requirements for redispatch 2.0 in a reduced form. For the future, DA/RE also evaluates different approaches to evolve towards a centralized optimization using a (complete) network model including subordinate grid levels. However, a centralized optimization considering current-related distribution network limits through a linearized distribution system model poses a number of challenges. A linearized distribution system model promotes transparency and preserves the privacy of DSOs, however, at the expense of calculation accuracy, as distribution systems contain several sources of non-linearities. [4]

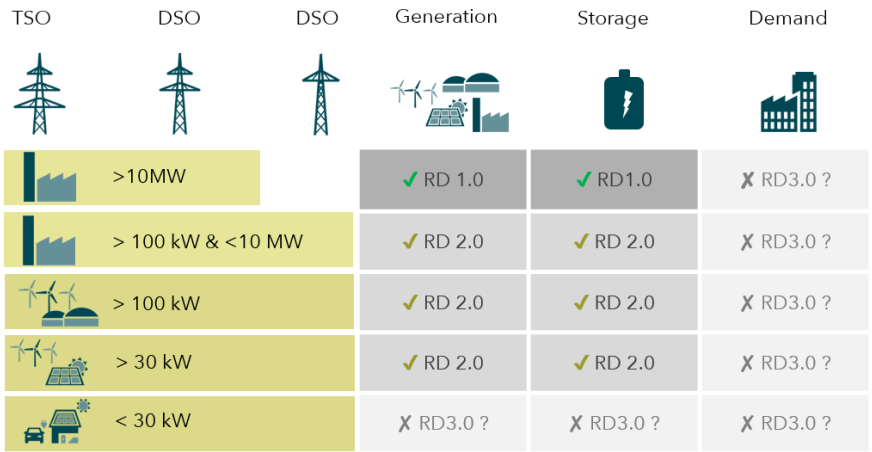

Figure 2: Different redispatch regimes in Germany. The platform DA/RE currently focuses on data exchange and coordination of conventional plants and renewable energy sources in the Redispatch 2.0 regime.

2.4.2. GOPACS

General Information

- Status: Operational

- Category: Data Exchange & Coordination (1)
- Region: NL
- T/DSO involved: Tennet NL (TSO), Stedin, Liander, Enexis Groep and Westland Infra (DSO)
- Website: Home - GOPACS

The goal of the introduction of GOPACS was to increase the number of FSP participating at the RD regime and increase competition by using flexibilities already available at spot markets [5]. If a grid operator identifies a congestion, the congestion situation is entered into GOPACS and a market message is issued. Market participants with a grid connection in the affected area can then place a flexibility offer with locational information on a participating market platform, e.g., EPEX Spot, Nord Pool or ETPA. Currently, the only market platform connected to GOPACS is the Dutch intraday market ETPA, but collaborations with EPEX Spot and Nord Pool are being discussed. Hence, GOPACS itself does not receive flexibility offers. It just links to the ETPA market platform. A central aspect of GOPACS is the TSO/DSO coordination. Grid operators identify locations where flexibility could be needed and forward the requests to the platform. On the platform, the needs of the network operators are centralized and potential conflicts in activations are managed.

A key feature of GOPACS is that only a combination of two flexibility products, inside and outside of the congestion area, is procured by the grid operator. More specifically, a sell order inside the congestion area (e.g., increase in electricity production) is combined with a buy order outside the congestion area (e.g., electricity consumption). By this means, solving the congestion does not cause an imbalance in the national grid. The combined buy and sell order is called IDCONS. The flexibility products on the wholesale intraday markets are standardized 15min and 1h products. The grid operator pays the price difference between buy and sell order, i.e., the spread. The sell order therefore is more expensive since otherwise the trade would have occurred on the wholesale intraday market already. [6,7]

2.4.3. CoordiNet

General Information

- Status: Project completed
- Category: Data Exchange & Coordination (1)
- Region: ES, GR, SE
- T/DSO involved: Depending on demonstration
- Website: The CoordiNet Project on TSO/DSO coordination (coordinet-project.eu)

The CoordiNet project was an EU Horizon 2020 funded project, focusing on TSO/DSO coordination and the use of flexibilities for balancing, congestion management and voltage control services. The duration of the project was from 2019 to 2022 and included three large scale demonstrations in Spain, Sweden and Greece.

In the framework of this project a platform has been developed – the CoordiNet Platform – that facilitates T/DSO coordination when using FSPs to solve grid congestion or for balancing services. [8] The platform essentially identifies which FSPs may be used in the distribution and transmission grids and communicates with the TSO platforms for balancing and congestion services as well as local platforms of the DSO for congestion management at the distribution grid level. [8]

2.4.4. INTERRFACE – IEGSA-Platform

General Information

- Status: Project completed
- Country: European, depends on demonstration area
- T/DSO involved: Depends on demonstration
- Website: Home | INTERRFACE

The project „INTERRFACE – TSO/DSO-Consumer INTERFACE aRchitecture to provide innovative grid services for an efficient power system" was a European Horizon 2020 funded project involving over 40 partners from the electricity sector. [9] One major aspect of the project was the development of the flexibility platform "IEGSA – Interoperable pan-European Grid Services Architecture", which has several core components such as flexibility register, TSO/DSO coordination platform, and single interface to market and settlement unit. [10]. The project covered 3 demonstration areas, each of which with a specific focus: [11]

- Congestion Management and Balancing Issues – In several countries, Finland, Estonia, Latvia, Italy and Bulgaria, the IEGSA platform was tested for the use flexibility for T/DSO services. For example, in the Finnish demonstration, FSPs would send bids to the Nord Pool ID market and IEGSA operated as data coordinator between FINGRID, Finnish TSO, and Nord Pool. [12]

- Peer-to-per Trading – One aspect in this demonstration area, involving Hungary, Slovenia and Bulgaria, was to test the electricity trading in local neighborhoods between consumers and local parties. [13]

- Pan-EU clearing Market – In this demonstration area in Romania, Bulgaria and Greece, local flexibilities were aggregated and integrated into wholesale markets. For this purpose, a specific feature in the IEGSA platform was developed.

2.4.5. Equigy - Crowd Balancing Platform

General Information

- Status: Depends on national implementation, in NL operational
- Category: Market Intermediary Platform (2)
- Region: NL, DE, CH, AT, IT
- T/DSO involved: Tennet, Swissgrid, Terna, APG, TransnetBW
- Website: https://equigy.com/the-platform/

A consortium of European TSOs jointly founded Equigy and created the Crowd Balancing Platform (CBP) to set a European standard for the integration of decentralized flexibility into markets for ancillary services, as well as ID markets [14]. Equigy is a TSO-owned entity with TenneT, Swissgrid and Terna as founding members. Meanwhile, APG and TransnetBW joined, and further partners are envisaged. Equigy was established to support TSOs in their role as market facilitator. The CBP runs in the responsibility area of Equigy with separate, not interconnected instances for each TSO.

The CBP aims to enable small scale flex resources to provide ancillary services for balancing markets, ID markets and congestion management by integrating device data from back-end systems as well as

other additional services. For aggregators and OEMs (Original Equipment Manufacturer) the CBP can provide new opportunities to pool flexibility potentials of individual devices and offer the aggregated flexibility for ancillary services. Additional revenues from ancillary services may not only lower the total cost of ownership for device owners and customers, respectively, but may also engage electricity consumers to actively participate in the energy market.

As an example, TenneT has implemented an alternative for the data flow exchange for aFRR via the Dutch instance of the CBP. The project has been designed with the aim of lowering the communication barriers for BSPs to enter the aFRR market. This is achieved through a single data communication method for all data flows (except aFRR capacity bids). Communication for BSPs with the Crowd Balancing Platform takes place via REST APIs. The interface between CBP (REST API) and TenneT (all other types of formats) is designed in such a way that all data flows can be exchanged with regular TenneT backend systems.

2.4.6. Banula

General Information

- Status: Under development
- Category: Market Intermediary Platform (2)
- Region: DE
- T/DSO involved: TransnetBW (TSO)
- Website: BANULA – Barrierefreie und nutzerfreundliche Lademöglichkeiten

The project "Banula – Barrier-free and user-friendly charging options" was initiated in 2021 by a consortium of TransnetBW (TSO), Fraunhofer IAO, University of Stuttgart (Research institutes), and various industry partners and is funded by the German Federal Ministry of Economics and Climate Protection. The BANULA platform aims to enable simple charging, while ensuring system and supply security. BANULA allows for every electric vehicle (EV) driver to charge her car at every charging point in Germany (long term vision: in Europe) for known and transparent prices. By that, difficulties of finding a charge point of a specific electro mobility provider or one that offers ad-hoc charging is reduced as well as unclear pricing is avoided. Furthermore, grid operators will profit by a safe, reliable and efficient grid operation despite a high penetration of EVs as load profiles can be balanced more accurately. With increasing number of EVs, the power demand for charging rises, which challenges the power grid and its secure and stable operation. With the BANULA concept, unexpected fluctuations in power demand due to electromobility are reduced and thus enable safe and efficient grid operation.

The aim is to balance the charging of EVs based on actual load profiles, as opposed to the widely used method of synthetic load profiles for a given charge point. This shall be realized by 15-min resolved load profiles and the introduction of a virtual balancing area into which the different charge points are mapped. A BANULA platform based on blockchain technology will be implemented to enable the required decentral data exchange. The blockchain enables not only secure and manipulation-free data storage but also quasi-real-time data exchange. Hence, the platform will be a base layer for many future use cases in the ecosystem of electromobility such as green charging or flexibility provision. In the future, the BANULA platform will enable interfaces to independent aggregators or other market intermediary platforms to allow flexibilities of charging electric vehicles to be accessed. Overall, the platform will adopt certain functionalities such as data exchange between charge point operator, E-mobility provider, DSO, and aggregator that fall into the definition of category 1 (cf. Section 2.1). However, due to the proximity to flexibility suppliers, the BANULA platform was considered a platform of category 2.

2.4.7. EPEX LEM

General Information

- Status: Planned
- Category: Marketplace Platform (3)
- Region: Tbd
- T/DSO involved: Tbd
- Website: Tbd

EPEX LEM is a local energy market platform that has been acquired by EPEX Spot. It provides a market-based solution for flexibility trading. The main aim of the platform is to allow system operators the use of flexible resources to manage grid congestions. The LEM processes rely on auction trading, with a state-of-the-art algorithm and an option for flexibility reservation. Thus, better welfare optimization and closer coordination between TSO and DSO is expected [15].

Notably, EPEX Spot's ambition to develop a platform for flexibility trading is far reaching. They were already involved in the Enera project (cf. Section 2.4.8) and developed the marketplace platform used in that project [16]. Moreover, they announced to develop an interface between the Dutch GOPACS platform (cf. Section 2.4.2) and their own wholesale intraday marketplace EPEX Spot. [17]

2.4.8. Enera

General Information

- Status: Project completed
- Category: Marketplace Platform (3)
- Region: DE
- T/DSO involved: TSO: Tennet DE, DSOs: Avacon Netz, EWE Netz
- Website: Startseite - enera (projekt-enera.de)

The Enera project is funded by the German ministry of Economic Affairs and Energy. The platform is a joint project between German TSOs and DSOs and the power exchange EPEX Spot, with the main goal of operating an exchange-based flexibility market for grid congestion management, thereby reducing the need for curtailment of renewable generation [16, 18, 19].

The congestion management process is based on a TSO/DSO grid coordination process, where in a first step, information related to their needs and availabilities of flexibility is exchanged. In the next step, the resulting flexibility demands are forwarded to certified flexibility providers. These providers can submit flexibility bids - each bid requires a quantity, a duration and a location - directly to the Enera market platform where system operators match them to their demands.

2.4.9. NODES

General information

- Status: Operational
- Category: Marketplace Platform (3)
- Region: NO, SE, UK
- T/DSO involved: Depends on national demonstration

- Website: Home - NODES (nodesmarket.com)

NODES has gone commercial in early 2019 and is part of a wide range of demonstrations in Norway, Germany, Sweden and the UK since then. NODES provides a neutral marketplace for trading local flexibility and offers trading as well as financial settlement services. The concept is that grid owners, producers and consumers can trade decentralized flexibility and energy directly on the same platform. In NODES, there is an idea of forwarding flexibility offers, which are not used locally to other market platforms, such as the cross-zonal intraday and balancing markets. [20] Indeed, this bid forwarding was demonstrated in the NorFlex project in 2022 where aggregated flexibility bids were forwarded to the Statnett's mFRR balancing energy market. [21]

2.4.10. Piclo Flex

General Information

- Status: Operational
- Category: Marketplace Platform (3)
- Region: UK, LTU, IRL, USA, PRT
- T/DSO involved: DSOs only
- Website: Piclo Flex

Currently, six DSOs in the UK are Piclo Flex members. Piclo Flex is an already active software platform, that presents an independently operated marketplace that enables flexibility to be traded online between FSPs and DSOs. Grid operators can make use of different services, starting from fully outsourced procurement inclusive transaction clearing, auction facilitation, flexibility requirement visibility and advertisement, to asset and company prequalification and credential certification that in the future, may enable bidding in other markets. Furthermore, Piclo is adapting an API enabled automated end-to-end service for flexibility procurement including settlement, activation and validation and secondary trading markets. Piclo operations are fully separated from the rest of the market operation. [22]

2.5. Detailed Platform Matrix

Following the overview and geographical distribution of the relevant flexibility platforms in Section 2.2 and 2.3, as well as, the platform descriptions in 2.4, we further provide a detailed matrix of the different platforms and their key characteristics, e.g., in terms of bid size, timing, remuneration, etc. The matrix allows for a side-by-side comparison of the different platforms, and allows for an efficient evaluation of specific features and scopes of the various platforms.

Table 2: Detailed Platform Matrix with specific properties.

Platform	Country	Platform scope	Platform type (demo, concept, operational)	Type(s) of Flex	Flex providers	TSO/DSO/both	Region
Data Exchange & Coordination							
DA/RE	DE	Regulated regime, TSO-DSO coordination for Redispatch, cloud architecture	Operational on some functions, under further development	Defined by RD 2.0 regime (will be detailed later)	RD 2.0 EIV (responsible parties for asset usage)	Both	Regional
GOPACS	NL	FSP participation in RD regime, TSO/DSO coordination	Operational since 2019	IDCONS Combined buy and sell order, 15min & 1h	FSPs: Residential, commercial, industry, and energy companies	TSO-DSO	National
CoordiNet	ES, GR, SE	EU Horizon 2020 project, TSO/DSO coordination, flexibility use	Project completed	Depends on demonstration	FSPs	Depends on demonstration	Transnational
INTERRFACE	FI, EE, LV, IT, BG, SI, HU, RO, GR	EU Horizon 2020 project, TSO/DSO coordination,	Project completed	depends on demonstration	centralized generation, Evs, distributed generation, storage, demand response	depends on UC	Transnational
Market Intermediary Platforms							
Equigy-CBP	DE/AT/CH/ NL/ IT	Regulated regime, Data exchange between TSOs and FSPs, Blockchain technology	Operation on some functions, concepts to extend functionalilty	Small-scale flex from Aggregators or OEMs or FSPs	FSPs	TSO are owner, DSO might become user	Transnational
Banula	DE	Demand-based balancing of electrical vehicles, blockchain technology	Concept for demonstrator	Electrical vehicles (EVs)	EMP: electromobility providers with responsibility for balancing	Open/ depending on application	Regional
Market Platforms							
EPEX LEM	FR	Local energy market platform for flexibility trading	So far only intention for development/press release	Tbd	Tbd	Operator: EPEX SPOT	Tbd
Enera	DE	Exchange-based flexibility market for grid congestion management	Pilot 2018-2020	generator side: biogas, photovoltaic and wind; consumer: a power-to-gas plant, industrial customers and small devices pooled via virtual power plants; large-scale storage systems	Aggregators and asset owners	TSO-DSO;	Regional
NODES	NO, SE, DE	Neutral market place for trading local flexibility	Operational	BRP, aggregators and microgrids	BRP, microgrid, and aggregators (prosumers, active demand-supply)	TSO-DSO (BRPs can also be buyers), Operator: Nord Pool	Transnational
Piclo Flex	UK, LTU, IRL, USA, PRT	Market platform for flexibility trading	Operational since 2019	voltage level flexible units: 11 kV or lower; DSO services such as reinforcement deferral or maintenance	Aggregators, asset owners, consumers, community	DSO-DSO	Transnational

Platform	Interface with other platforms	Products Bid Size	Aggregation	Geographical Information	Bid Activation	Timing	Matching/ Remuneration
Data Exchange & Coordination							
DA/RE	TNG system operations, RES/RAS, CBP planned	cf. RD 2.0 regime	Cluster Tool inside DA/RE	Yes, via simplified grid model	Activation document send from DARE to EIV or DSO	Focus is D-1 until close to realtime	Regulated regime, cost-based RD
GOPACS	Fully integrated with ETPA national (ID market)	as of ETPA ID	Yes	Yes	Yes	Before the GCT of the ID market – continuous market with *ad hoc* TSO congestion forecasts	IDCONS (intraday congestion spread), Pay-as-bid
CoordiNet	None	depends on demonstration	Yes	Depends on demonstration	No	depends on demonstration	depends on demonstration
INTERRFACE	IEGSA contains a single market interface	depends on demonstration	Not directly, but via Aggregators/FSPs	Depends on demonstration	No	depends on demonstration	Depends on national implementation
Market Intermediary Platforms							
Equigy-CBP	Depends on national implementation	Depends on national implementation FCR, aFRR, RD, RR	Not directly yet, via aggregator/FSP	Depends on use case	No	Depends on national implementation	Depends on national implementation
Banula	Not yet defined, but interconnection to some 'flex platform' in scope	Tbd	Tbd	Yes, mapping to DSO balancing area, address	Tbd	Aimed resolution shorter than 15 min	Tbd
Market Platforms							
EPEX LEM	Tbd	Tbd	Tbd	Yes	Tbd	Tbd	Auction Trading
Enera	No but timing aligned with the ID market	as of ID market	yes, via VPPs	yes	yes	Continuous bidding & matching in the ID timeframe; GCT 5' before delivery; 15' and 60' products	Pay-as-bid
NODES	No	depends on national product implementation	Not directly, but via Aggregator/microgrid/BRP	yes	no	Depends on region and market (should be aligned with the imbalance settlement period)	Pay-as-bid; automatic matching in the order book
Piclo Flex	No	dep. on service	Yes	Yes	No	Long-term auctions (6 months	Pay-as-bi; includes a dispatch

2.6. Summary

The key results obtained through the analysis of relevant existing flexibility platforms are summarized below:

1) **Status quo** – The current platform landscape may be described as rather defragmented; there are platforms that partially belong to pilot projects, some of which already completed such as Enera or CoordiNet, and others still active such as BANULA or the implementation of the Equigy-CBP in Austria. The most advanced flexibility platforms are GOPACS in Netherlands and the NODES pilot projects such as NorFlex in Norway. These platforms are operational and successfully help solving grid congestions and, in case of NorFlex, already enable bid forwarding of unused flexibility products with locational information to the mFRR balancing market. However, overall, the development stage of flexibility platforms is still early. To meet national and European expectations for flexibility usage, more efforts to implement flexibility platforms are needed.

2) **Platform interoperability** – Most platforms are not connected to the existing horizontally integrated markets (see chapter 3.1). Indeed, interfaces between platforms are scarce and partially under development, e.g., the interface between DA/RE as well as Nordpool Spot and Equigy-CBP, or GOPACS and EPEX Spot. The only case of platform interoperability between local energy markets (NODES) and established balancing markets of Statnett was realized in the NorFlex project. Notwithstanding this encouraging development, this also shows in what early stage the interoperability of flexibility platforms still is.

3) **Responsibilities** – Some of the platforms partially take over the typical aggregator responsibilities (pooling of flexibility). Responsibilities for platform operation are not harmonized. The analyzed platforms are either managed by the network operator(s) involved or by a nominated market operator (NEMO).

4) **Flexibility product** – The design of flexibility products varies significantly across the different platforms, ranging from combined buy and sell orders in GOPACS, to shortflex and longflex options in NODES. Indeed, while balancing energy products are standardized, flexibility products used in congestion management and redispatch typically lack sufficient standardization (see also project deliverable 3.2 for more detail). This not only complicates interoperability among platforms focusing on congestion management services only, but naturally makes interoperability between platforms focusing on balancing and/or congestion management much more challenging.

3. Platform Interoperability

Of central importance for the DigIPlat project is the analysis of platform interoperability among the existing flexibility platforms. For this purpose, the platforms analyzed in chapter 2 are mapped on a multi-level platform diagram (Figure 3). The diagram allows one to clearly localize the previously

defined platform categories along the journey of a flexibility product. To be more specific, each level represents one of the three platform categories – data exchange and coordination (1), market intermediary platforms (2), and marketplace platforms (3). These three levels are embedded between the topmost level, the flexibility service provider including prosumers with electric vehicles (EVs) and heat pumps, but also battery and pump storage facilities. And at the bottom, the demand side of flexibility, which can arise by balancing and redispatch services performed by T/DSOs, or can originate from the private sector, e.g., a balancing responsible party buys a flexibility product on the intraday wholesale market to smooth his balancing group. Vertical bars in Figure 3 represent platform interconnections. Ultimately, a flexibility gets passed from the highest level through the various platform categories to the T/DSO or a private trader.

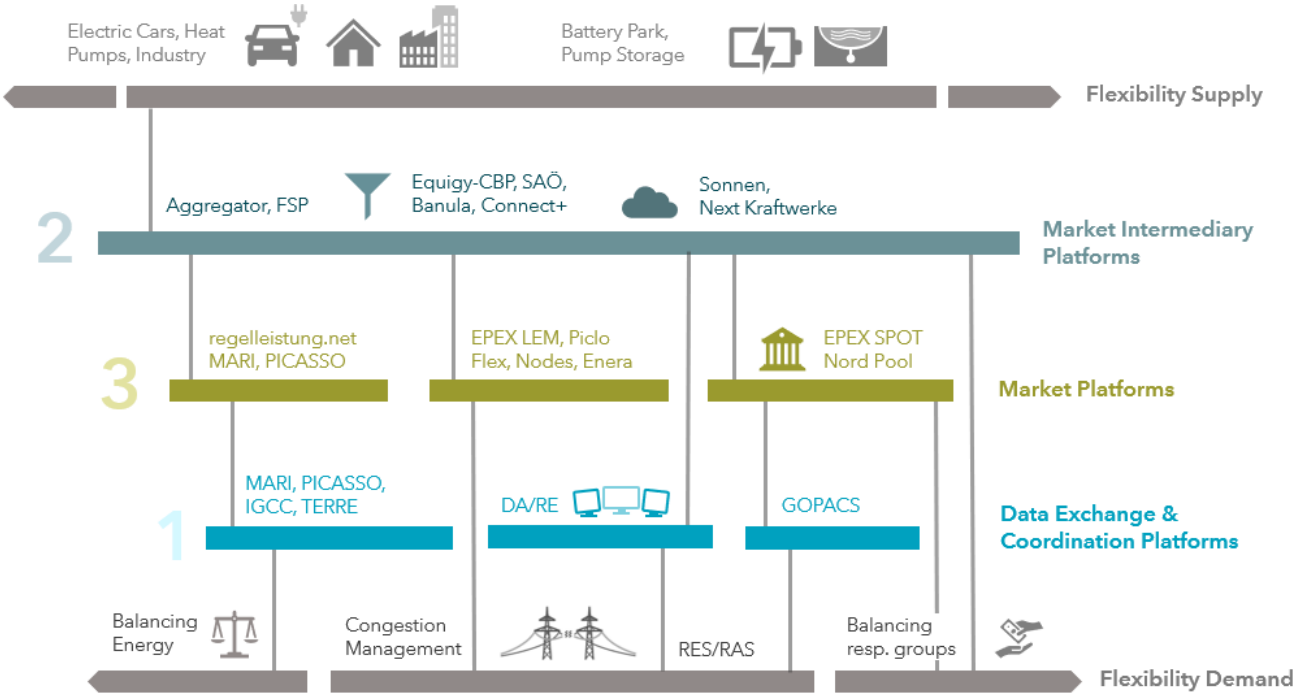

Figure 3: Multi-level platform diagram.

3.1. Modes of Platform Interoperability

Having localized the existing flexibility platforms to the different levels in Figure 3, two fundamental modes of platform interoperability become apparent: vertical and horizontal interoperability.

- **Vertical platform interoperability** involves more than one level in Figure 3, e.g., a flexibility is passed through from an aggregator to a marketplace, or a TSO procures a flexibility from an aggregator via a data coordination platform.

- **Horizontal platform interoperability** occurs within one specific level in Figure 3, e.g., a flexibility bid is offered on two marketplaces simultaneously and, if purchased in one marketplace, the two platforms need to synchronize their bids. Or, alternatively, if a flexibility bid is not purchased before gate closure, it may be forwarded to another marketplace with a

later gate closure time, provided that the flexibility meets the pre-qualification requirements of both marketplaces.

3.2. Examples of Platform Interoperability

In what follows, the multi-level platform diagram in Figure 3, is used to discuss various examples, in which a flexibility product is passed through more than one of the existing platforms. It is important to mention that these examples represent hypothetical scenarios. The examples should facilitate the understanding of how the different platforms are intended to work inter-operational. The level of technology-readiness of the various examples, or whether one of the examples already reflects real-world events, is indicated below.

3.2.1. Example 1: Congestion Management via DA/RE at TransnetBW (DE)

In this example, we assume a multitude of regionally clustered **small-scale flexibility potentials** in the form of electric vehicles and heat pumps registered on the **Equigy-CBP** including automatically updated, predicted charge cycles (in case of EVs) and heating plans (in case of heat pumps). The regionally clustered flexibility products are then sent to the **DA/RE** platform and thereby made transparent to the transmission system operator. If a grid congestion is detected in the transmission grid, which can be (partially) solved most efficiently by using the regionally clustered microflexibility of the Equigy-CBP, the transmission grid operator activates this flexibility via DA/RE platform. This in turn forwards the activation signal to the CBP.

TECHNOLOGY READINESS – At the moment, the Equigy-TSOs are discussing which functionalities will be implemented at the Equigy-CBP. The platform interface between DA/RE and Equigy-CBP is currently under development. In addition, the DA/RE platform would require a grid model that identifies congestions in the transmission grid and an optimizer, able to identify the most efficient combinations of redispatch bids, both of which are not yet fully implemented. In this example, it must also be ensured that the activation of redispatch bids from the distribution grid fulfills the voltage and current restrictions in the distribution grid, a process currently taken care of the participating DSOs.

3.2.2. Example 2: Congestion Management via GOPACS at Tennet (NL)

In this example, we start again by assuming an aggregated **small-scale flexibility** stemming from heating systems or EVs registered on a **market intermediary platform**. We further assume that a grid congestion is identified by the Dutch TSO Tennet NL due to high load in the congestion area. The congestion situation is entered into **GOPACS** and a market message is issued [7]. Market participants with a grid connection in the affected area can then place a flexibility offer with locational information on a participating market platform, e.g., **EPEX Spot, Nord Pool** or **ETPA**.

To solve the congestion, a sell order in the congestion area needs to be realized by the TSO in order to increase the electricity production or to decrease electricity consumption (e.g., the aggregated flexibility). However, in order for Tennet NL not to disturb the electricity balance by resolving the grid congestion, GOPACS combines the sell order with an opposite order outside of the congestion area (here, decreasing the production or increasing the consumption). The individual orders are standardized 15min or 1h products and the combined product is called IDCONS. The TSO effectively pays the price difference between buy and sell order, i.e., the spread. The price of the sell order will be higher than the price of the buy order since otherwise the trade would have taken place in the wholesale intraday market. [3]

TECHNOLOGY READINESS – GOPACS is operational. So far, the only market place participating in GOAPCS is the Dutch Intraday Market Platform ETPA, but collaborations with EPEX Spot and Nord Pool are envisaged.

3.2.3. Example 3: Balancing Services via NODES at Statnett (NO)

Like the previous examples, we start by assuming an aggregated **small-scale flexibility** from heating systems and EVs. An **aggregator** registers the flexibility at the **NODES market place** as a ShortFlex product, which is the product type for physical delivery of the flexibility, as opposed to the LongFlex product for reservation of flexibility. Meanwhile, the **DSO** Agder Energi Nett in southern Norway identifies a high grid load in one of its grid areas and buys a fraction of the offered flexibility on the NODES market place to solve the grid congestion.

However, parts of the aggregated flexibilities remain unused by the DSO's in whose area the flexibilities are connected. Together with other unused bids, these flexibilities are further aggregated and forwarded to Statnett's mFRR balancing market in minimum block sizes of 1 MW. Finally, Statnett buys the offered mFRR product for balancing the transmission grid, and the FSPs eventually are rewarded.

TECHNOLOGY READINESS – DSOs in Norway have traded local flexibilities on the NODES market place (in the NorFlex project discussed here) during 2021. In recent trading periods, EVs constituted the largest flexibility source by traded volume in the NorFlex pilot. [23] In the last year of the pilot, in 2022, the bid forwarding to Statnett's balancing market was realized.

3.3. Summary

The examples discussed in the previous section readily demonstrate the importance of platform interoperability in using small-scale flexibilities for balancing services or congestion management of T/DSOs. The examples moreover reveal different degrees of technology readiness, with GOPACS being the only platform that has switched to normal operation. With respect to the mode of platform interoperability (described in Section 3.1), examples 1 and 2 include a vertical interoperability of the flexibility platforms. Only in example 3, a flexibility bid is actually passed through horizontally from the local flexibility market NODES to the mFRR balancing market of the TSO. This, however, occurs in addition to a vertical interoperability, where the flexibility asset is passed from a market intermediary platform to the market platforms (here the horizontal interoperability occurs) and, finally, to the system operation.

Note that the focus of this project and its Use Cases (see project deliverable 3.3 for more detail) is on vertical market integration. Horizontal interoperability is taken into account from an economic perspective in the sense of enabling the use of flexibility in multiple markets through bid forwarding.

4. Regulatory Framework on Flexibility and Flexibility Platforms

In the following chapter, we analyze the regulatory framework on flexibility and, more specifically, on flexibility platforms. In this analysis, it became evident that – although considerable progress has already been made with regard to the framework on flexibility in general – clear regulations are lacking for the architecture and operation of flexibility platforms. Here, the focus is not on specific IT solutions for platforms, but on practical aspects such as ownership, or rules for data exchange.

In the following sections, we screen the different legislative packages and guidelines for information regarding flexibility in general and, in particular, regarding flexibility platforms and their operation. Here, we address questions like:

- Which entity (T/DSO, third party) is allowed to deploy and operate flexibility platforms? And which entity (T/DSO) is allowed to procure market-based flexibilities on such platforms?

- Are there specific regulations governing the coordination and data exchange among T/DSOs?

Prior to the analysis of the individual regulations and packages, we provide a timeline in the following Section 4.1 for a better understanding of the chronological evolution of the regulatory framework.

4.1. Timeline

The regulatory framework on flexibility has been subject to profound developments in recent years. In our analysis of this development, we use as starting point the release of the EU regulation 2015/1222 on establishing a guideline on capacity allocation and congestion management (CACM-GL), followed by EU regulation 2017/2195 on establishing a guideline on electricity balancing (EB-GL). Going forward, the regulatory framework for flexibility has been substantially further developed with the adoption of the EU Clean Energy for all Europeans package in 2019, including the EU electricity regulation 2019/943 and the EU directive 2019/944 with the respective national implementations (see timeline in Figure 4) At present, the network code demand response is being drafted, which was initiated by the EU regulation 2019/943 and, in Germany, a forum on the development of a climate neutral electricity system has been kicked-off, in which one working package addresses flexibility.

4.2. Current Regulatory Framework on Flexibility and Flexibility Platforms

The details of the individual regulations/directives/guidelines provided in the following sections refer only to aspects that are relevant to flexibility, as well as the design and operation of flexibility platforms and do not represent complete summaries of the respective documents. Indeed, platforms, i.e., IT solutions to handle the coordination, procurement, trade, dispatch and/or settlement of energy or system services are not regulated as such. The different regulations below, however, govern certain aspects that are relevant for the platform architecture and operations, e.g., platform ownership, rules on data exchange and data formats, standardization of flexibility products.

4.2.1. Guideline on Capacity Allocation and Congestion Management (CACM-GL)

The **CACM-GL** provide a framework for the coordination of transmission capacity allocation and congestion management between countries or bidding zones. By coupling individual national electricity markets with each other (market coupling), the CACM-GL foresees a pan-European electricity market which will provide consumers with a reliable and efficient power supply at competitive prices. In coupled day-ahead and intra-day markets, neither the seller nor the buyer of electricity need to worry about transit, i.e., cross-border capacity. Here, the CACM-GL defines rules for the cross-country capacity allocation on the day-ahead and intraday markets. To realize pan-European market coupling, the role of market coupling operators is defined, which will be led by so-called nominated electricity market operators, NEMOs (stock exchange). [24]

With regard to congestion management, the CACM GL, in article 35, foresees the development of a method for the coordinated redispatching and countertrading (i.e. “cross-zonal exchange initiated by system operators between two bidding zones to relieve physical congestion” [25; 26]). The method shall include “actions of cross-border relevance” and enable TSOs to solve congestions regardless of whether the reasons of the congestion are located outside their control area, as stated in article 35, section 2.

Although not explicitly formulated in the context of flexibility, the CACM-GL provides important insights into the process of market coupling, coordination between NEMOs and TSOs, as well as the importance for a standardization of the traded products and common rules for the calculation of cross-country capacity allocation.

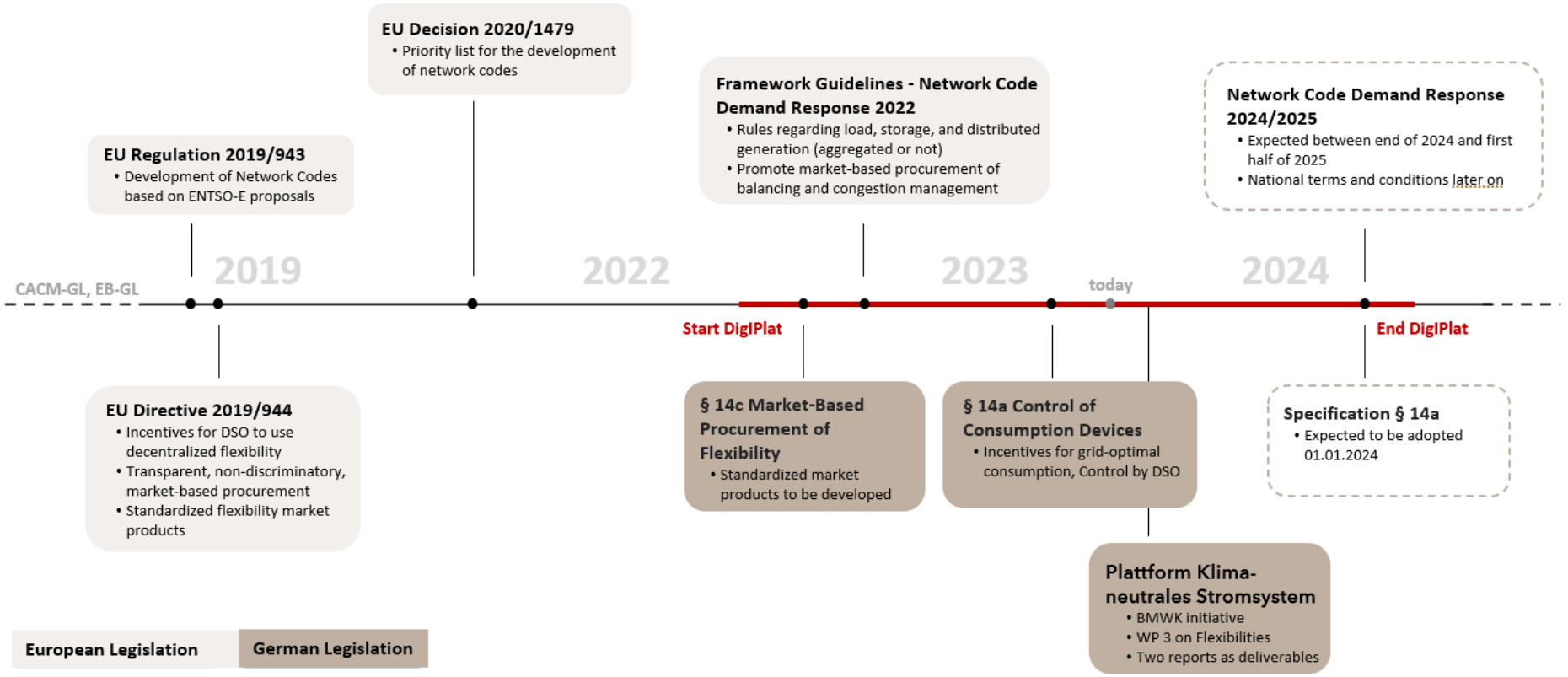

Figure 4: Timeline of regulatory framework on decentralized flexibility and the operation of flexibility platforms in Europe and Germany. Legislation currently being drafted in Austria will be included in the timeline in due course.

4.2.2. Guideline on Electricity Balancing (EB-GL)

The **EB-GL** establishes a framework for the pan-European coordination of balancing services by providing a "set of technical, operational and market rules to govern the functioning of electricity balancing markets" as stated in the EB-GL objective number (5). Indeed, the European wide coordination and exchange of balancing services shall be facilitated with the establishment of common European platforms that, e.g., handle the imbalance netting process. In addition, the EB-GL foresees regulations on the standardization of balancing products so as to increase the liquidity in the balancing markets and allow for the creation of a common merit order list per balancing energy product. In an attempt to boost market liquidity and facilitate the entry of small-scale flexibility, the EB-GL allows potential balancing service providers (BSPs) to offer balancing energy without their prior reservation in the balancing capacity market. However, all BSPs intending to provide balancing energy or capacity still need to pass a prequalification process defined by the TSOs in cooperation with DSOs.

Of particular importance in the context of the DigIPlat project is the EB-GL's set of rules regarding the design and operation of European platforms to handle the exchange of balancing energy, specified in Articles 19 to 22. Balancing product design and the established timeframes for the TSO processes and market gate closure create the framework conditions that will be observed during the Use Case definition in D3.3 and standardization proposal in D3.2.

4.2.3. Clean Energy Package

In article 57 of the **EU regulation 2019/943**, TSOs and DSOs are urged to cooperate in order to ensure cost-efficient, secure and reliable development and operation of their networks. More specifically, the article states that T/DSOs shall exchange all necessary information and data regarding demand side response (Art. 57-1) and that T/DSOs shall achieve a coordinated access to resources such as demand response (Art. 57-2). This article bears direct implications for the design of flexibility – i.e. demand side response – platforms that have to cope with data exchange and coordination between TSO and DOSs, much like the concept of the DA/RE platform (cf. Section 2.4.1).

Article 59 of the EU regulation 2019/943 establishes the development of network codes, which shall contain rules governing, e.g., congestion management, balancing energy, and demand response. Later on, in 2020, an **EU decision paper (2020/1479)** with a priority list for the development of different network codes was released, stating that between 2020 and 2023 a network code governing demand-side flexibility, aggregation, energy storage and demand-side curtailment is to be developed. This, so-called network code demand response is currently being prepared and will be discussed in more detail in Section 4.3.1.

On the other hand, the **EU directive 2019/944** specifies in article 32 that member states shall provide the necessary regulatory framework to allow and incentivize DSOs to procure flexibility services, including congestion management, to improve efficiency in their system. DSOs shall be able to procure such flexibilities from providers of distributed generation, demand response or energy storage. Importantly, the procurement shall occur in a market-based procedure unless the regulatory authorities have identified economic inefficiency or potential market distortions. In addition, article 32(2) foresees the introduction of standardized market products for flexibility services.

In addition, article 17 of the EU directive foresees that the member states allow and foster the participation of demand response through aggregation and that aggregators may participate alongside producers in all electricity markets. Aggregators, which may be independent, shall be financially

responsible for the electricity imbalance they may cause, i.e., shall be balance responsible party (or delegate their responsibility further).

The implications of the EU directive 2019/944 for the design and operation of platforms are that platforms are to be developed that allow procurement of flexibility in a market-based procedure (e.g., Nodes, Piclo Flex) and that aggregator platforms may be independent.

4.2.4. German Energy Act

Pursuant to the EU directive 2019/944, the **§ 14c** of the German Energy Act foresees that DSOs shall procure flexibility to improve efficiency and operation of their grids in a transparent, non-discriminatory, and market-based procedure. DSOs shall moreover develop specifications regarding the flexibility procurement as well as standardization of flexibility products that are to be approved by the authorities. Alternatively, these specifications may be specified by the authorities themselves, i.e. by the Federal Network Agency (ger.: Bundesnetzagentur). In certain cases, the market-based procurement of flexibility can be suspended if economic inefficiencies or market distortions are identified by the federal network agency.

The current version of **§ 14a** of the German Energy Act (01.01.2023) provides for a reduction in network charges for those consumers that have an agreement with the corresponding DSO on the network-oriented control of controllable consumption devices, i.e., heat pumps, electric vehicles, or storage devices. On June 16, 2023, the second consultation of the determination procedures regarding § 14a began. The set of rules proposed for consultation lists three options (“modules”) for a reduction of network charges: (1) a fixed network-charged reduction, (2) a percentage reduction of the energy price, and (3), an incentive module with time-variable network charges.

4.2.5. ElWOG (2010)

Within the Austrian Federal law reorganizing the organization in the field of the electricity industry (ElWOG 2010) (ger.: Elektrizitätswirtschafts- und organisationsgesetz), the term ‚congestion management‘ is defined as “the totality of short-, medium- and long-term measures that can be taken in accordance with the technical system requirements in order to avoid or eliminate congestions in the transmission system, taking into account network security and security of supply”. This definition explicitly focuses on transmission system and therefore does not contain a definition for DSO purposes.

The DSOs roles and responsibilities are specified in the national ElWOG and individually for each DSO in Austria by the federal ElWOGs for each state. As for now, according to Art. 45 ElWOG, the responsibilities of a distribution system operator include, inter alia, provision of required data to carry out the calculation and allocation of balancing energy, measuring the purchases, services, load profiles of the network users, to check their plausibility and to pass on data to the required extent to the balancing group coordinators, concerned network operators and balancing group managers and identification of congestion in the network and taking actions to avoid them. The result of these national requirements is that all federal ElWOGs contain a paragraph requiring secure (and in some implementations reliable) system operation. Most national ElWOGs also contain a paragraph requiring the DSO to detect congestions and take measures to avoid congestions but only three of them contain a regulation similar to the TSOs rights, which would allow the DSO to enter into contracts with owners of generating assets.

Art. 23 (2)(5) ElWOG defines the obligation of a Control Area Operator to detect congestions and taking any measures related to relieving and overcoming congestion in the transmission grid.

4.3. Future Regulatory Framework and Market Design

Based on preliminary publications of regulations such as framework guideline or position papers, it is possible to gain insight into future regulations. These documents, particularly the framework guideline of the network code demand response, a proposal for the reform of the EU electricity market, and first information of the recently initiated platform for a climate neutral electricity system in Germany (ger.: Plattform Klimaneutrales Stromsystem, PKNS), were screened with regard to regulations that are relevant for flexibility platforms.

4.3.1. Network code demand response

The framework guideline for the network code demand response yield principles for the development of the network code, which is expected between end of 2024 and first half of 2025 (cf. Timeline in Figure 4). The network code shall contain rules regarding demand-side flexibility for system operator (including DSOs and TSOs) services such as balancing energy, congestion management and voltage control. In addition, as stated in the framework guideline in chapter 4, regulations shall be specified that govern data exchange and system operator coordination, both crucial for the operation of the respective platforms. In particular, in **chapter 4**, the framework guideline state that

- system operator services – i.e. balancing energy, congestion management, and voltage control – may be procured in dedicated local markets or through locationally tagged bids in wholesale markets (DA, ID, BAL),

- the network code shall provide rules for the coordination of local markets with wholesale markets, promoting the coordination between TSO/DSO,

- It shall be possible to propose bids that are not procured in one market to another market, given they fulfill the respective pre-qualification criteria.

Thus, the network code demand response clearly foresees principles that encourage bid forwarding across different markets, necessitating respective interoperability of the involved platforms. The framework guideline further state in chapter 4 that

- if a system operator is allowed to procure locationally tagged bids from a wholesale market to use for system operator services, the products and pricing mechanism shall be approved by the national regulatory authority. The pricing mechanism may be different from the general pricing mechanism in the wholesale market and take into account the locational information.

In addition to rules regarding data exchange, system operator coordination, and pricing mechanism, the framework guideline in chapter 4 set out principles for the development of rules regarding the operation of local markets for system operator services. The most relevant aspects are that

- a local market may be operated by i) the procuring system operator itself, alone or together with other system operators, ii) a different system operator, iii) a third party who is not an SO,

- the market operator of the local market shall operate and maintain a platform for this market,

- it shall be defined whether a market operator, different from the procuring system operator, is allowed to recombine bids to suit the needs of a system operator, and whether a market operator is allowed to forward bids to other wholesale markets (recombined or not)

In **chapter 3** of the framework guideline, European principles for the prequalification are formulated, in order to smoothen the process and lift any unnecessary entry barriers for the participation of all the resources. More specifically, the guideline aims to

- Avoid duplications in the prequalification processes
- Simplify of the prequalification processes

In **chapter 5** of the framework guideline, new rules are foreseen to standardize products used in congestion management at national level, and that the procurement of these products should occur in a market-based procedure.

4.3.2. Reform of the European Electricity Market

In March 2023, the EU commission published a proposal for a reform of the European Electricity Market, in order to (i) protect consumers from volatile energy prices, (ii) enhance the stability and predictability of the cost of energy, and, (iii) to boost investments in renewable energy [27]. In practice, the proposal aims at amending Regulation (EU) 2019/943 (Electricity Regulation), Regulation (EU) 2019/942 (ACER Regulation), Directive (EU) 2019/944 (Electricity Directive) and Directive (EU) 2018/2001 (Renewable Energy Directive) to improve EU's electricity market design. However, several aspects of the proposal touch upon the integration of demand-side flexibility and thus the design and operation of flexibility platforms. These are:

- The importance for intraday markets is stressed to adapt to the participation of demand side response and storage to increase liquidity of the markets.
- Short-term electricity markets are expected to increase the participation of small-scale flexibility by lowering the minimum bid size.
- A new article 7 might be amended to the EU regulation 2019/943, introducing a peak-shaving product that can be procured by TSOs to call for electricity demand reduction during peak hours. The activation of such a peak shaving product shall take place after the closure of the day-ahead market and before the start of the balancing market.
- The proposal foresees the introduction of so-called regional virtual hubs that cover multiple bidding zones, in order to boost liquidity and create a reference price.

With respect to demand-side flexibility, the objective of the proposal appears to be an increase of liquidity in short-term or intra-day electricity markets through demand-side flexibility products. This could potentially increase competition for these flexibility products between other markets (e.g. local markets for congestion management). However, increased liquidity in the markets is also realized by facilitating platform interoperability, which reflects the importance of the project idea of DigIPlat.

4.3.3. Platform for a Climate Neutral Electricity System (DE)

The platform for a climate neutral electricity system (ger.: Plattform Klimaneutrales Stromsystem) was initiated in February 2023 in Germany and brings together stakeholders from politics, science, industry, and society to work out specific proposal to the following questions: [28]

- How can long-term funding of renewable energy systems be ensured, to achieve their intended installation?
- What is the role of flexibility in the future electricity system and what should be the respective regulatory framework?
- How can sufficient installation and operation of controllable capacity be ensured?
- How can investment and operational decisions by power plants and consumers be incentivized through local price signals?

For this purpose, four working groups were formed (one for each question/topic); first results are expected by the end of 2023. The results of the working group on flexibility will be updated in this deliverable over the course of the DigIPlat project.

4.4. Summary

The main results of the analysis of the regulatory framework are summarized in Table 2. The individual aspects from the various legislative documents are divided into "relevant for flexibility" and "relevant for flexibility platforms" for a better overview. Overall, flexibility platforms are not regulated as such, but several functions and responsibilities are touched upon in the legislative documents. As can be seen in table 2, the framework guideline of the network code demand response contain important points for both, flexibility, and flexibility platforms. Therefore, the regulatory framework will become much more specific with the translation of the Network Code demand response into European and national law, expected in late 2024 to early 2025.

5. Conclusion

The energy transition and massive expansion of renewable power generation are expected – and required by European guideline – to be complemented by demand side management and the use of flexibilities. Such flexibility assets may be used for various system operator services like redispatch, congestion management and balancing services. Alternatively, these flexibilities may be traded on wholesale markets to, e.g., help balancing responsible parties to flatten their balancing groups. The trend towards demand response and the use of flexibility is naturally coupled to the development of flexibility platforms to handle all the necessary processes, such as to register, trade, activate, invoice and balance the flexibility assets. In the meantime, national and European legislation has adapted to this development - albeit with a certain time lag - in order to create a regulatory framework that governs the use of flexibility and flexibility platforms.

The DigIPlat project, initiated in 2021 with a duration of three years, comes at a time when the use of flexibilities is at an early stage; several pilot projects and platform developments are taking place across Europe, and the regulatory framework is being drafted and developed. The project aims to look beyond current developments and to explore the multiple and cross-platform use of flexibility assets. In fact, several use cases are modeled and investigated where, for example, flexibility is offered for redispatch services and, when not needed, forwarded to the balancing market, see Deliverable 3.3 of the DigIPlat

Project. Such use cases, in turn, require a certain interoperability of the participating flexibility platforms. Prior to the investigation of the mentioned use cases, we perform a profound analysis of existing flexibility platforms, their interoperability and the current and future status of the regulatory framework. These topics have been addressed in the present document, the Deliverable 3.1.

In particular, the Deliverable 3.1 has been divided into three main parts: In the first part, an overview of relevant flexibility platforms and their geographical distribution was given. In the second part, an analysis of different types of platform interoperability has been carried out and the status of current platform interoperability has been evaluated. Finally, in part three, the regulatory framework of flexibility and flexibility platforms has been analyzed.

Table 3: Summary of the regulatory framework for flexibility and flexibility platforms.

	Type	General Scope	Relevant for Flexibility	Relevant for Flexibility Platforms
Current Regulatory Framework				
CACM-GL	EU Regulation	Coordination of transmission capacity allocation and congestion management between countries or bidding zones	• Market coupling of national DA, ID markets • Coordinated RD	• Flexibility platforms offering RD services shoud then be connected to coordination platform
EB-GL	EU Regulation	Coordination pan-European balancing services	• Standardization of balancing products • BSPs need to pass prequalification process	• Establishment of common European platforms (MARI, PICASSO)
EU Reg. 2019/943	EU Regulation	Electricity Market Design	• Development of network code demand response	• Data exchange and coordination between T/DSOs • Development of network code demand response
EU Dir. 2019/944	EU Directive	Electricity Market Design	• Incentivize DSOs to procure flexibility services • Standardized products for flexibility services • Flex. procurement via market-based procedure	• Need for market places for flexibility services • Aggregators participate in all electricity markets • Aggregators may be independent
EnWG § 14c	German Law	Market-based procurement of flexibility services	• Market-based flex. procurement by DSOs • DSOs to standardize flexibility products	• Need for market places for flexibility services
EnWG § 14a	German Law	Network-oriented control of controllable consumption devices	• Second consultation proposes introduction of time-variable network tariffs	
ElWOG Art. 45	Austrian Law	Generation, transmission, distribution and supply of electricity		• DSOs to provide data for calculation of BAL
Future Regulatory Framework				
Network Code Demand Response	Framework Guideline	Rules regarding explicit demand-side flexibility	• T/DSO services shall be procured in local markets or through locationally tagged bids in DA, ID, BAL markets • Enable bid-forwarding • Standardization of products in national CM • Simplification of prequalification process	• Rules for coordination of local markets with wholesale markets, promoting T/DSO coordination • Enable bid-forwarding • Local market by T/DSO or third party possible • Local market operator to operate/maintain platform
Reform of the European Electricity Market	Proposal	Protect consumers from volatile prices, enhance cost stability, boost renewable energy investments	• ID markets to adapt to the participation of demand side response and storage • Markets to lower minimum bid size for small-scale flex • Introduction of a peak-shaving product	• Introduction of so-called regional virtual hubs that cover multiple bidding zones.
Plattform Klima-neutrales Stromsystem		Long-term funding of renewables, role of flexibility in the future, installation of controllable capacity, local price signals	• Work package on: What is the role of flexibility in the future electricity system?	

* RD: Redispatch, CM: Congestion Management, BAL: Balancing Services, DA: Day-Ahead Market, ID: Intraday Market

With regard to the first part, we adopted a platform categorization introduced in ref. [2] that turned out to be very useful and which divides flexibility platforms into (1) data exchange and coordination platforms (2) market intermediary platforms and (3) market places. Across Europe, platforms of all three categories are being developed, with market places developed by third parties (not system operators), e.g., Piclo Flex or NODES being most advanced in terms of technology readiness. Data exchange and coordination platforms such as DA/RE that aim to coordinate redispatching including smaller flexibility assets are being further developed. The key results of the analysis of relevant flexibility platforms are:

- The current platform landscape is defragmented; platforms partially belong to pilot projects that may already be completed or are still active. The most advanced flexibility platforms are GOPACS in Netherlands and the NODES pilot projects such as NorFlex in Norway.

- Platform interfaces are scarce and partially under development; hence platform interoperability is largely inexistent or at a very early stage.

- The design of flexibility products varies significantly across the different platforms; while balancing energy products are standardized, flexibility products used in congestion management and redispatch typically lack sufficient standardization (see also project deliverable 3.2 for more detail).

With regard to part three on the interoperability of flexibility platforms, we introduced a platform diagram in which the three different platform categories are visualized. Moreover, the diagram intuitively illustrates different modes of platform interoperability: horizonal, i.e., within one category, and vertical, i.e., across more than one category. Based on the diagram, we discussed a few real-world examples where a flexibility assets is passed through different platforms to finally reach the buyer side, e.g., a network operator or balancing responsible party. In particular, we discussed:

- Congestion Management via **DA/RE** at TransnetBW (DE): A flexibility asset is registered and aggregated on the Equigy-CBP, passed towards the data and coordination platform DA/RE where an optimization algorithm identifies that a certain congestion is best solved using that flexibility. An activation is sent to the asset and the system operation side at TransnetBW.

- Congestion Management via **GOPACS** at Tennet (NL): A flexibility asset is registered and aggregated on a market intermediary platform. Tennet NL identifies a grid congestion and forwards the grid situation to GOPACS, a data exchange and coordination platform, which, in turn, sends a market message to a connected market place, e.g., EPEX Spot or Nord Pool. Now, flexibility service providers can place their flexibility assets with locational information to help solve that particular grid congestion.

- Balancing Services via **NODES** at Statnett (NO): An aggregator registers the flexibility at the NODES market place and DSO Agder Energi Nett in southern Norway identifies a high grid load in one of its grid areas and buys a fraction of the offered flexibility on the NODES market place to solve the grid congestion. The unused fraction of the flexibility is further aggregated and forwarded to Statnett's balancing energy market.

The different examples rather show the potential of using (small-scale) flexibilities rather than reflecting day-to-day activities of T/DSOs. Indeed, the interface between DA/RE and Equigy-CBP is currently being developed and the bid forwarding to Statnett's balancing energy market mentioned in the last example was the first trade of this kind and occurred within a pilot project.

In the last part of this deliverable, we analyzed the current and future regulatory framework regarding flexibility and flexibility platforms. In order to grasp the evolution of the legislative processes, we first provided a timeline that contains recent development since the adoption of the Clean Energy for all Europeans Package in 2019. We then, subsequently, screened the legislative documents for relevant aspects regarding flexibility and the associated platforms. The most important aspects were summarized in table (Table 2).

The analysis showed that the future framework of flexibility and the associated platforms will be much more regulated in the near future when the network code demand response and the reform of the European electricity market are adopted. In particular, the framework guideline of the network code Demand Response include standardizing congestion management products and enabling bid forwarding of uncalled bids. Similarly, the EU's proposal for a reform of the electricity market foresees, among other things, a reduction in the minimum bid size in order to integrate small-scale flexibilities into the markets. In conclusion, the regulatory framework for flexibility and the associated platforms is still insufficient today, but, on a European level, new legislature will be introduced in the near future.

With respect to the DigIPlat project, it became evident from the analysis of the regulatory framework that not all of the use cases described in Deliverable 3.3 are regulated today. However, several aspects relevant for the use cases, such as bid forwarding and product standardization, are already being addressed in the network code demand response. Other aspects of the use cases, such as coordinated procurement of balancing and redispatch services by system operators go beyond current initiatives for the development of the regulatory framework. The lessons learned from the DigIPlat project will therefore enable system operators to quickly adopt the currently drafted regulations and to influence future work on the regulatory framework.

Due to the evolving state of the regulatory framework, this deliverable should be considered a "living document", in the sense that future regulation and changes in the regulatory framework will be updated over the course of the project

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