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Cross-border and cross-sectoral data exchange demonstrators

Summary report

EU-SysFlex

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ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
API	Application Programming Interface
B2B	Business-to-Business
CIM	Common Information Model
DEP	Data exchange platform
DSR	Demand Side Response
DoA	Description of Action
DSO	Distribution System Operator
DSR	Demand Side Response
EC	European Commission
EC-GA	Grant Agreement
ECCo SP	ENTSO-E Communication & Connectivity Service Platform
ECP	Energy Communication Platform
EIC	Energy Identification Codes
eIDAS	electronic IDentification, Authentication and trust Services
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCO	Energy Service Company
ESMP	European Style Market Profile
EU	European Union
EU-SYSFLEX	Pan-European System with an efficient coordinated use of flexibilities for the integration of a large share of Renewable Energy Sources (RES)
FSP	Flexibility Service Provider
GUI	Graphical User Interface
IEC	International Electrotechnical Commission
inDEP	Layer for international data exchange
IoT	Internet of Things
IT	Information Technology
KSI	Keyless Signature Infrastructure
PMB	Project Management Board
SO	System Operator
SUC	System Use Case
TSO	Transmission System Operator
UXP	Unified eXchange Platform
VPN	Virtual Private Network
WP	Work Package
XML	Extensible Markup Language
XSD	XML Schema Definition
XSLT	eXtensible Stylesheet Language Transformations

EXECUTIVE SUMMARY

A number of EU-SysFlex data exchanges demonstrators have implemented several data exchange use cases. All these exchanges were built on the concept of Data Exchange Platform (DEP). Summary of takeaways of all individual demonstrators follows.

- To ensure interoperability of flexibility services one needs to focus on data interoperability next to harmonising regulatory/business processes. Therefore, the system use cases designed for "Flexibility Platform" address the issue of homogeneous and secure data management through the concept of Data Exchange Platform. Proper data management contributes to the participation of stakeholders across the geographical borders and of any asset.
- "Affordable Tool" in the role of FSP enables to bring smaller customers actively to the energy market willing to sell flexibility by aggregating such customers, consuming data services provided by DEP, and using market services (e.g. bid submission, asset activation) provided by the Flexibility Platform.
- Residents of one country are able to access their meter data and share the data with other stakeholders using services (e.g. consent management) provided by DEP located in another country, it is possible to remove barriers from accessing meter data from different organizations in different countries. The biggest obstacle is differing level of authentication available in different countries, however this is being solved within scope of eIDAS (European Regulation on electronic IDentification, Authentication and trust Services).
- Data providers and data users connected to different DEPs (ECCo SP, Estfeed) can exchange data by ensuring interoperability of DEPs. This was demonstrated for private data sharing use case whereby on platform benefitted from consent services provided by another platform. The demonstration was able to add value to ECCo SP by using the consent checking capabilities of Estfeed which allowed it to validate that the application behind ECCo SP had data owner's consent to receive some private data.
- Using dedicated privacy-preserving technologies (Sharemind in this case) it is possible to preserve data owner's privacy while allowing a third party application (Flexibility Platform in this case) to receive a calculated result based on such private data (calculation of Flexibility Service Provider's baseline in this case). Use of DEP (Estfeed) ensures that the data owner is aware that the data is used for just given (baseline calculation) purposes but in a privacy-preserving way.
- Cross-sector data exchange was demonstrated which proposed a way to add value to users of one system (meter data hub) with data enrichment from another system (building register). The demonstration showed that if the two systems have not been intended to exchange data then sometimes it can be difficult to reliably link the data – the quality of describing 'customer address' was much lower in one system than in the other.
- DEP can transport to any third-party application results from big data framework, an end-to-end big data process was demonstrated: raw data are collected from external APIs, processed in batch and near-real time with AI algorithms, results are stored in a serving layer and are available through request/response API. This deployed architecture has worked properly at least within a context where the frequency requests were not high, with limited size data results and without specific latency constraints.

- It is possible to integrate alternative signing mechanisms to the critical logs that provide the information about the data exchange and participants. The risk of losing critical data logs was reduced from the three aspects: a) signing with different technology; b) adding additional log storage; c) including anti-tamper infrastructure to an existing solution.
- It would not take much effort to translate the original API of an implementation (e.g. “Flexibility Platform”) into CIM compliant API, and to replace already implemented original API by CIM compliant API.

1. INTRODUCTION

This public report summarizes the deliverables 9.3 and 9.4 of task 9.3 (Cross-border and cross-sectoral data exchange demonstration) of EU-SysFlex project.

According to the DoA (Description of Action) the objective of WP9 is:

> Test and demonstrate the data management solutions for flexibility services, developed in WP5. Three or four demonstrators will focus on aspects of data management, including cross-border communication between different data exchange platforms and with different stakeholders in order to facilitate cross-border exchange of flexibility services with following elements:
>
> - Cross-border communication
> - Affordable application for smaller distributed DSR (Demand Side Response)
> - TSO-DSO flexibility data exchange application
> - Single user interface
> - Combined access to metering and operational data
> - Cross-sectoral data usage

Task 9.3 aims at testing system use cases from task 5.2 with focus on cross-border and cross-sector data exchange. Interaction with demonstrators of task 9.1 (affordable tool for smaller DSR units) and task 9.2 (tool for TSO-DSO flexibility data exchange) is presumed. The task should result in:

- Demonstration of cross-border data exchange.
- Demonstration of synergies from common metering and operational data management.
- Demonstration of synergies from cross-sectoral data exchange.
- Demonstration of single data exchange interface for customers and market stakeholders.

The matching and status of task 9.3 demonstrators according to DoA[1]:

- data exchange between data exchange platforms (DEP) in countries A and B: “ENTSO-E” demo[2];
- data exchange between DEP in country A and system operator (SO: TSO and/or DSO) in country B: “SO Application” integration demo;
- data exchange between DEP in country A and third party (e.g. Flexibility provider) in country B: “Affordable Tool” integration and “Flexibility Platform” integration demos;
- data exchange between DEP in country A and customer (consumer) in country B: “ESO” demo;
- look at existing platforms to combine meter and operational data: ”ENTSO-E” demo;
- create single point of access to meter data and operational data by using single platform for exchanging these data: ”ENTSO-E” demo;

[1] Specific demo partners are here and there different from what was planned in the grant proposal phase. However, this does not impact the results of the project as the primary aim is to test data exchange as such and not the capability of specific counterparts.
[2] Initially (see milestone 17 report) data exchange demonstration between Elering’s and Energinet’s platforms was planned. While Energinet is not formal partner of EU-SysFlex the agreement to cooperate under the umbrella of EU-SysFlex was not reached. However Elering continues to cooperate with Energinet through different initiatives for cross-border data exchange ambition.

- analyse values of combining different data sources from different sectors by making these data available to interested parties via single platform (one-stop-shop principle): ”Building Registry” demo;
- testing of big data collection, storage, processing (from task 5.3): “Big Data Tool” integration and “Baseline Application” integration demos;
- testing cyber security and data privacy requirements (from task 5.4): “Cybersecurity” demo;
- testing new proposed standards and protocols (from task 5.5): “New Standards” demo.

Demos identified and described in this report:

1. “Affordable Tool” integration – affordable tool for smaller DSR units developed in Task 9.1 and integrated with Estfeed DEP
2. “Flexibility Platform” integration – application for TSO-DSO flexibility data exchange developed in Task 9.2 and integrated with Estfeed DEP
3. “SO Application” integration – application to interface system operators with Flexibility Platform developed in Task 9.2 and integrated with Estfeed DEP
4. “ESO” – data exchange between ESO and Elering
5. “Building Registry” – data exchange between Estonian Building Registry and Elering
6. "ENTSO-E" – data exchange between ENTSO-E and Elering
7. “Big Data Tool” integration – specific application developed in task 5.3 and integrated with Estfeed DEP
8. “Baseline Application” integration – specific application developed in task 5.3 and integrated with Estfeed DEP
9. “Cybersecurity” – concept of assuring the processes and logs security developed in task 5.4 and demonstrated as sub-section of “ENTSO-E” demonstrator
10. “New Standards” – CIM (Common Information Model) profiles elaborated in task 5.5 and implemented for Flexibility Platform (FP) data model

Regarding single (or ‘common’) interface DoA states that:

> Another element of this task is to develop a common interface for customers. For example, for the consumers who have consumption points in different countries (precondition for single supplier and single bill); or for the flexibility providers who need access to different data sources and customers; or for any market participant who needs to buy flexibility (or any other) services. How to create value for market participants? Develop the concept for common interface for customer, considering the differences in data exchange platforms across countries.

In terms of terminology it should be noted that:

- “Single” = “Common”
- “User” = “Customer”
- Customers involve consumers, aggregators, ESCOs (Energy Service Companies), system operators and any other stakeholders.
- Customer can be the user of data services as well as of energy services.

Three types of interfaces were identified:

- Data management services
    - for consumers/prosumers – e-Elering (graphical user interface) (“ESO”, “Building Registry”, “Affordable Tool”)
    - for B2B (Business-to-Business) customers – Estfeed API (“Affordable Tool”, “Flexibility Platform”, “SO Application”, "ENTSO-E", “Big Data Tool” “Baseline Application”)
- Energy market services (e.g. flexibility services) – Flexibility Platform interfaces for SOs (System Operators) and FSPs (Flexibility Service Providers), aggregator’s interface for end customers (“Affordable Tool”), interfaces on applications providing specific services (e.g. “Baseline Application”)

An environment for executing demo integration tests was set up – “Estfeed research environment”. It has Estfeed Customer Portal, Estfeed secure adapters for data exchange and either accesses to or demo/test environments for different systems that are included in demos. e-Elering is Elering’s portal for customers. It allows authenticated users to access data related to their own metering points (gas and electricity) as well as services built on this data over a graphical user interface (web page). Estfeed API is secure access point for IT systems to use services over Estfeed DEP (Data Exchange Platform). More information on its components and setup can be found in chapters 2.2 and 2.3.

Existing technologies applied for demonstrators include data exchange platforms Estfeed (including data hub and customer portal), Unified eXchange Platform (UXP), X-Road and ECCo SP (ENTSO-E Communication & Connectivity Service Platform), EMS (Energy Management System) components for flexibility management, Sharemind for privacy preserving data exchange, KSI Blockchain technology stack and Black Lantern anti tamper hardware for cybersecurity, Big Data management components.

The report is structured in two major parts:

- Chapter 2 provides general architectural overview of all demonstrators listed above, explanation of software deployment for demonstration, overview of main software components, and summary of key takeaways.
- Chapter 3 provides the goal, technical description and key takeaways per each demonstrator.
- Chapter 4 explains the user interfaces applied by the demonstrators.

2. GENERAL OVERVIEW OF THE DEMONSTRATIONS AND MAIN COMPONENTS

2.1 OVERVIEW OF DEMONSTRATORS

In WP9 data management for flexibility services were tested and demonstrated. The demonstrations focused on different aspects of data management, including the cross-border communication between data exchange platforms and with different stakeholders in order to facilitate cross-border exchange of flexibility services.

Overview of the components and their interactions is shown in Figure 1. Components include:

- One TSO-s (Elering) and one DSO (ESO) with their data hubs and customer portals
- Operational data platform ECCo SP from ENTSO-E
- Flexibility Platform used by aggregator or flexibility service provider (FSP)
- Affordable tool for flexibility offering
- Building Registry system
- Estfeed secure adapters that enable international[3] data exchange over secured channels and in accordance with authorizations from data owner

While Affordable Tool and Flexibility Platform are major new components developed in WP9, Data Hub, Customer Portal and Data Exchange Platform are existing components of Elering used in demos (see chapter 2.3). However, Elering's DEP has been upgraded to facilitate cross-border data exchange.

[3] The term 'international' used in this context means that DEP is independent of systems which want to exchange data between themselves, either located inside a country or in multiple countries.

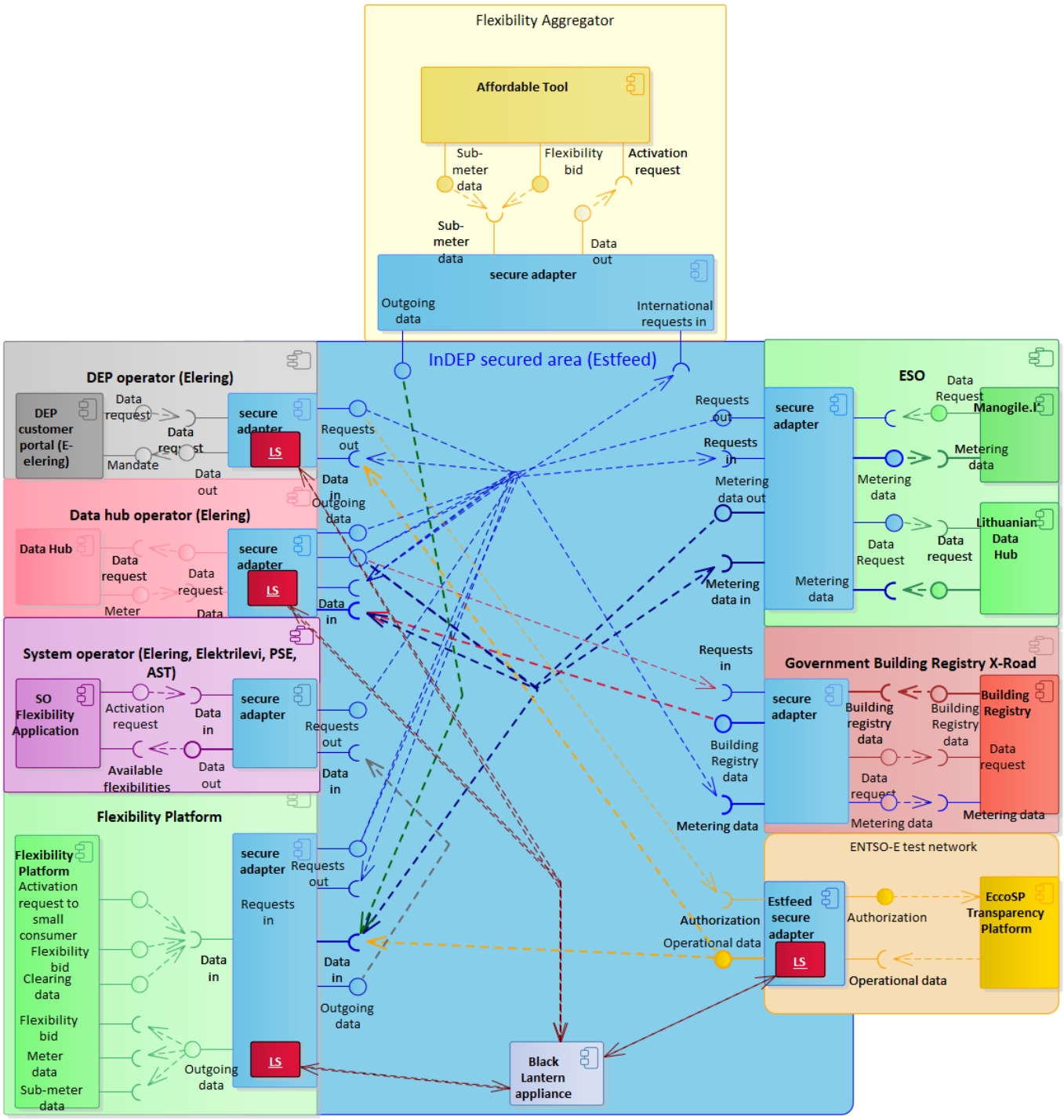

FIGURE 1 COMPONENTS INVOLVED IN CROSS-BORDER DATA EXCHANGE TESTS

2.2 DEPLOYMENT

A separate environment was created to host the demonstrators. The Estfeed research environment relies on Elering's Estfeed components (see Figure 2). Applications and/or data sources are deployed as separate virtual machines in Cloud or in-house applications and integrated to the environment (referred as 'Site' on Figure 2). Components are deployed together with Estfeed Adapter and Security Server (together called Estfeed Secure Adapter). Estfeed Adapter adapts Application/Data Source communication protocol to common Estfeed protocol.

Security Server takes care of secure data exchange and message routing. The sites work in independent distributed manner and loosing connection to Elering site or any other sites does not affect the performance of the full data exchange system.

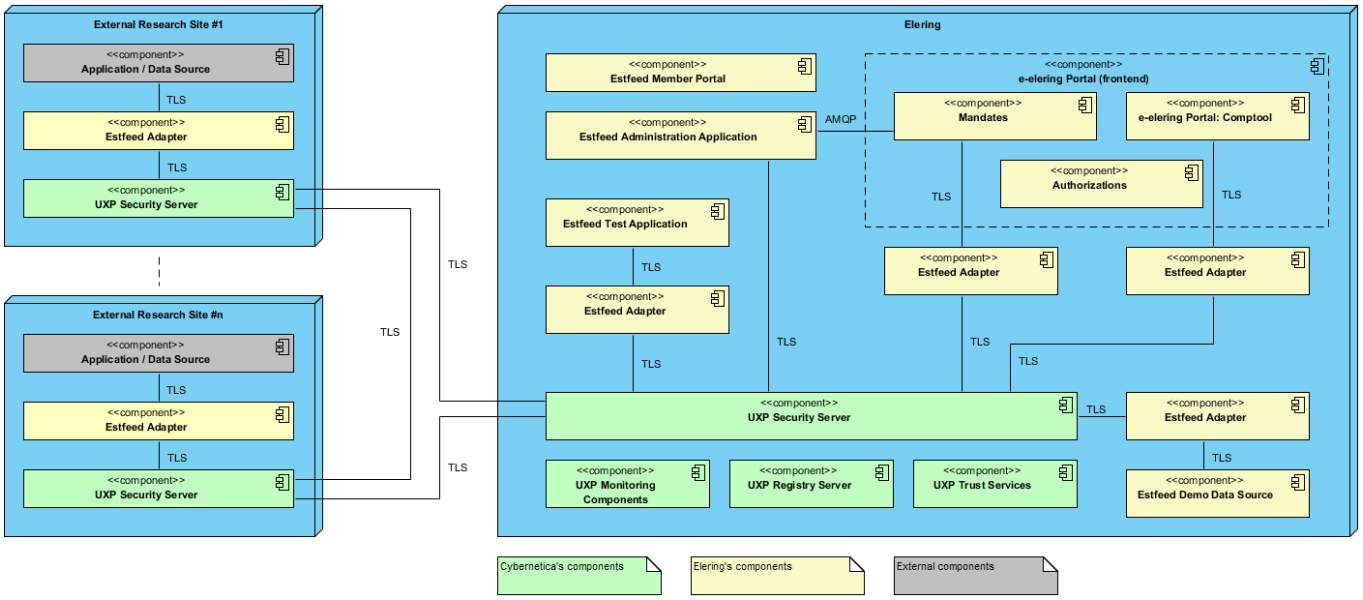

FIGURE 2 THE COMPONENTS OF THE ESTFEED RESEARCH ENVIRONMENT

Elering site provides in addition to applications/data sources administration functions as well as central mandates management and customer portal (e-Elering) functionality.

2.3 OVERVIEW OF MAIN COMPONENTS

Data Hub

The Estonian Data Hub is a digital environment for information exchange in the electricity market for the purpose of changing open suppliers, forwarding consumption meter data between market participants, maintaining the data, performing the obligations imposed on market participants by the law and ensuring the rights granted to them.

The purpose of the Estonian Data Hub is to provide for efficient information exchange in the open electricity market following the principle of equality. The Data Hub provides equal access to consumption meter data to all authorized market participants and enables changing suppliers quickly.

The Estonian Data Hub is developed by Elering who is also responsible for the subsequent maintenance of the whole system. Network operators are responsible for the volume and quality of the submitted data, the accuracy and hourly resolution of consumption meter data, and the validity of the submitted client data. Open suppliers are responsible for the validity of the information found in the submitted electricity sales agreements.

The Estonian Data Hub system is a software/hardware solution that manages the exchange of consumption meter data between market participants, supports the process of changing electricity suppliers, and archives electricity consumption data. The Data Hub contains definitions for all market participants operating in the Estonian electricity market, as well as all metering points tracking the transfer of energy between the market participants. For identification purposes, all market participants and metering points are assigned a unique code (EIC code) by the Estonian Data Hub.

Shared data formats have been established for using the Data Hub.

Customer Portal

Elering's customer portal (e-Elering) gives the market participants access to their meter data and enables downloading the data. The portal also provides the market participants an overview of all information concerning the participant found on the Data Hub: supply agreement deadlines, open suppliers, hourly meter data, the market participant's EIC code, and the EIC codes of the metering points linked to the market participant.

All market participants can provide authorizations for accessing meter data from previous periods via e-Elering portal; this is mainly to enable them to receive personalized offers from electricity and gas suppliers. The market participant's data can be accessed by market participants who have a statutory right to access the data or who have been given authorization to access the data by the market participant themselves. In order to transmit personal data to suppliers (who the private consumer has not signed an agreement with), the person requesting must have the authorization of the private consumer.

Customer Portal also enables to see the list of service providers and to authorize 3rd party applications to have access to consumption data. In addition, representation rights can be given and access to data logs is enabled.

Data Exchange Platform

Elering's DEP Estfeed can interface with various data sources and these data can be used in the applications desired. What Estfeed does:

- Connects data sources, applications and market participants
- Provides secure access and management of consumption data and related rights
- Data sources accessible – Electricity Data Hub, Gas Data Hub, Central Commercial Register, Electricity price (Nord Pool), weather forecast (Foreca)
- Promotes applications that increase energy production, transport and consumption efficiency

Data exchange involves 3 parties (Figure 3):

- Application information system – consumer of data and services; communicates with the Estfeed system using Estfeed protocol;
- Source information system (data source) – provider of data and services; communicates with the Estfeed system using Estfeed protocol;
- Estfeed system – mediator of data and services between applications and data sources.

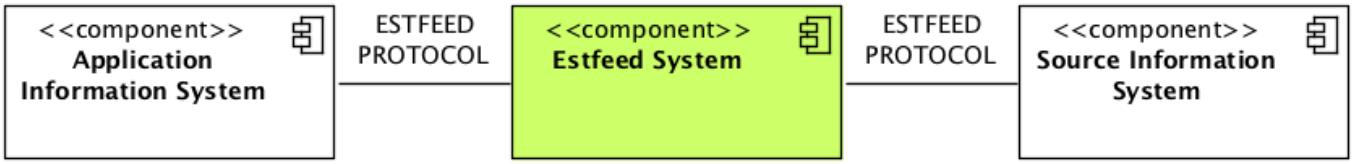

FIGURE 3 ESTFEED PROTOCOL

3. OVERVIEW OF DATA EXCHANGE DEMONSTRATIONS

3.1 DEP INTEGRATION OF AFFORDABLE TOOL FOR SMALLER DSR UNITS

3.1.1 GOAL OF THE DEMO

The aim of Task 9.1 (Affordable tool for smaller DSR units) was to develop a software application ("Affordable Tool") facilitating the availability and collection/aggregation of distributed and small flexibility sources for ancillary services.

Details of this demonstrator are explained in EU-SysFlex deliverable 9.1.

3.1.2 TECHNICAL DESCRIPTION

An interface between Affordable Tool and a data exchange platform was developed to verify the usefulness of such a tool. The tool is highly beneficial for efficient use of flexibilities. Large consumers and suppliers are easy to identify and to handle with Flexibility Platform, however, significant amount of energy volume is found in the high number of small DSR units (households and other small consumers/prosumers.

In addition to the physical units, applications and algorithms were developed to combine the small units efficiently and effectively to the grid. It is evident that the evolving data exchange platforms around EU has made the supplier switching much easier.

Figure 4 explains how Affordable Tool is integrated through DEP with other applications (Flexibility Platform) and displays the components within the tool.

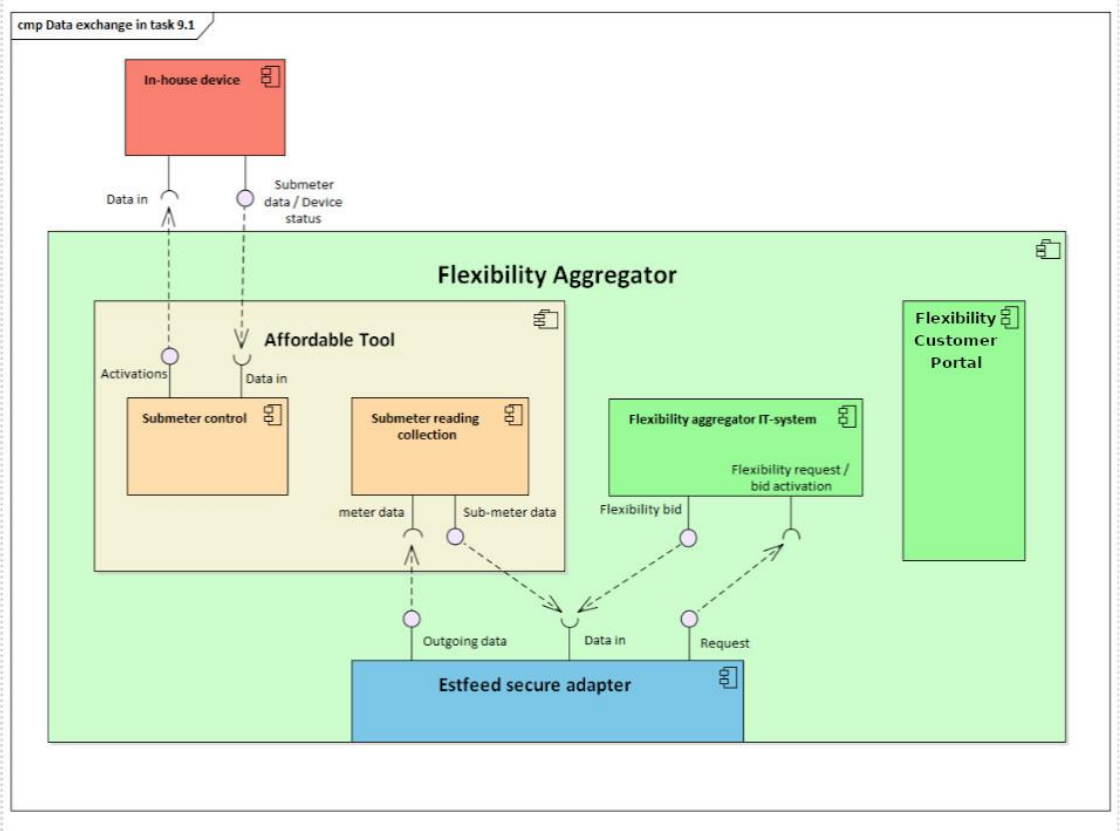

FIGURE 4 ARCHITECTURE OF AFFORDABLE TOOL

Component descriptions:

- **Estfeed secure adapter**: Enables international data exchange over secured channels and in accordance with authorizations from data owner.
- **Submeter control**: Communicates with in-house devices, including receiving sub-meter data, device status and flexibility activations.
- **Submeter reading collection**: Stores meter and sub-meter data, aggregates meter data and exposes interface for reading/sending of sub-meter / meter data.
- **Flexibility aggregator IT-system**: Makes bids and receives activations.
- **Flexibility customer portal**: Gives the small consumers / participants in the aggregated flexibility a GUI (graphical user interface) to view and administrate their flexibility contribution.
- **In-house device**: Sends sub-meter data and device-status, receives device-control commands.

3.1.3 KEY TAKEAWAYS

Low entry barriers (set-up costs, price, bid size etc.) are key elements to reach a critical number of units to be able to fully integrate the decentralized resources in the energy flexibility market.

The main outcome of “Affordable Tool” was the demonstration of the affordable application aiming at bringing smaller customers actively to the energy market through provision of flexibility services. It also resulted in

guidelines for developers for smooth access to and usage of platform services. The practical output was therefore an application that:

- Connects to the Estfeed DEP
- Through the DEP uses services provided by the Flexibility Platform as a FSP
- Provides services required by the Flexibility Platform to submit and activate bids
- Automatically reacts to activation orders submitted by/via the Flexibility Platform

3.2 DEP INTEGRATION OF APPLICATION FOR TSO-DSO FLEXIBILITY DATA EXCHANGE

3.2.1 GOAL OF THE DEMO

Task 9.2 aims at building a Flexibility Platform, i.e. a software application, to investigate and demonstrate data exchanges between different stakeholders participating in flexibility market (SOs as flexibility buyers, FSPs, flexibility platform operators).

Details of this demonstrator are explained in EU-SysFlex deliverable 9.2.

3.2.2 TECHNICAL DESCRIPTION

This demo covers the integration of DEP with "Flexibility Platform" to enable exchange of flexibility information and metering data. The following system use cases (SUCs) were implemented and integrated using Estfeed[4]:

- Manage flexibility bids
- Manage flexibility activations
- Verify and settle activated flexibilities
- Calculate flexibility baseline
- Provide list of suppliers and ESCOs
- Predict flexibility availability

In this report, only a general view of the architecture is presented, highlighting the logical components of the future application as well as the domain model. Deliverable 9.2 of EU-SysFlex project goes more in depth about how the use cases were implemented, data model, etc.

Figure 5 explains how Flexibility Platform is integrated through data exchange platform with other applications (FSP's system, Data Hub, System Operator's system). Flexibility Platform can exchange data with "Affordable Tool", with a TSO or DSO ("SO Application") as well as with a data hub to receive meter data. Estfeed secure adapter needs

[4] Descriptions of all data exchange SUCs are available in deliverable 5.2: https://eu-sysflex.com/wp-content/uploads/2020/10/EU-SysFlex-Task-5.2-D5.2-FINAL.pdf

to be installed within application's VPN (Virtual Private Network) to allow open access to needed components (sub-meter readings, flexibility bids, activation requests, etc.) and enable secure data exchange between these systems.

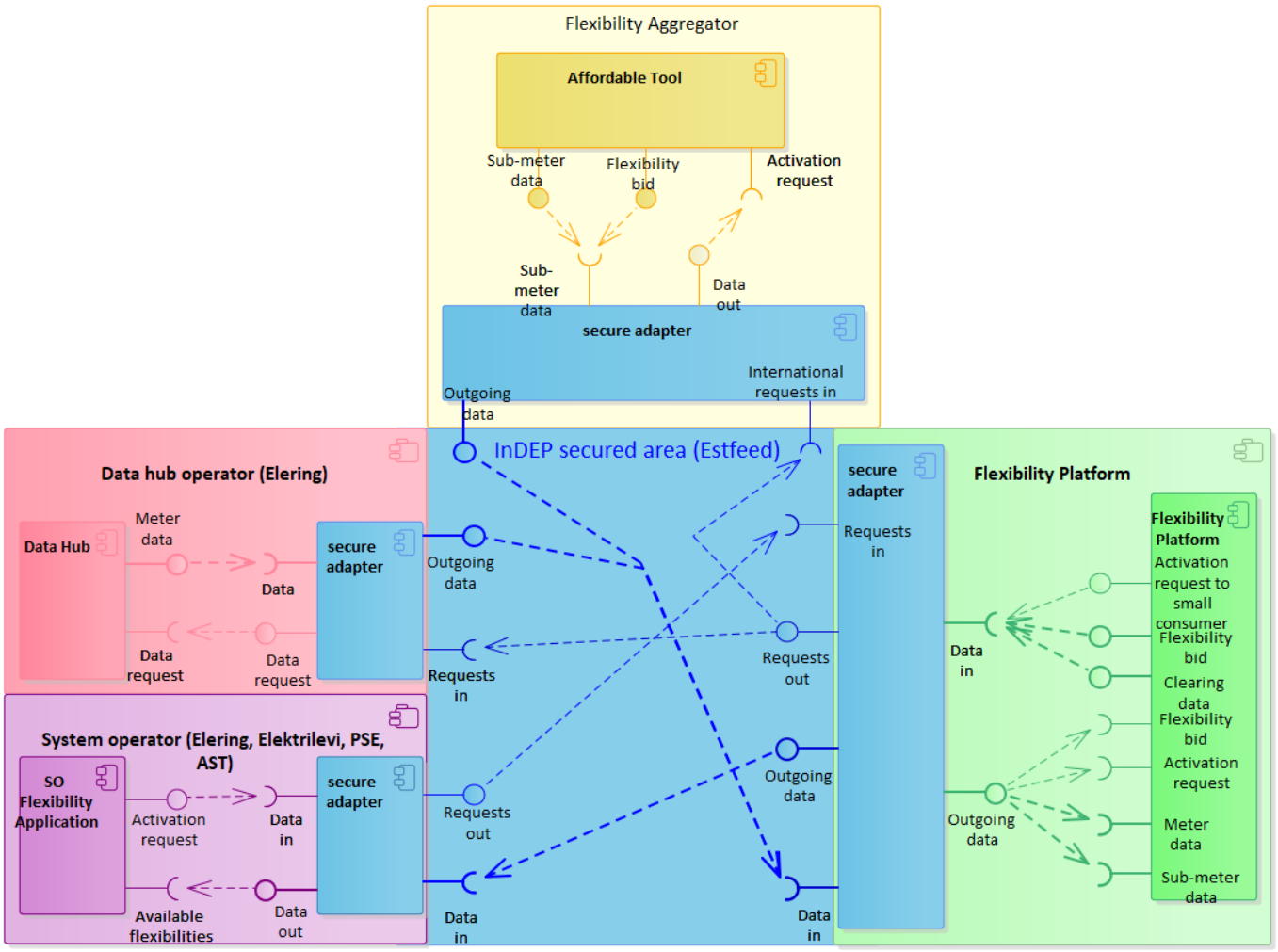

FIGURE 5 COMPONENTS FOR INTEGRATION OF DATA EXCHANGE PLATFORM, FLEXIBILITY PLATFORM, AGGREGATOR AND SYSTEM OPERATOR

Component descriptions:

- **Estfeed secure adapter**: Enables international data exchange over secured channels and in accordance with authorizations from data owner.
- **Flexibility aggregator's system: "**Affordable Tool" explained in chapter 3.1.
- **Data Hub:** System operator's metering data warehouse (integration with Data Hub was no implemented).
- **System Operator's system:** Flexibility application of System Operator (see also chapter 3.3).
- **Flexibility Platform**: Platform for qualifying, trading and activating flexibility offers.

3.2.3 KEY TAKEAWAYS

To ensure interoperability of flexibility services one needs to focus on data interoperability next to harmonising regulatory/business processes. Therefore, the system use cases designed for "Flexibility Platform" address the issue

of homogeneous and secure data management through the concept of Data Exchange Platform. Proper data management contributes to the participation of stakeholders across the geographical borders and of any asset.

3.3 DEP INTEGRATION OF SYSTEM OPERATOR'S APPLICATION FOR FLEXIBILITY MARKET

3.3.1 GOAL OF THE DEMO

As part of "Flexibility Platform" demonstrator the need was identified to develop a SO system simulator to enable the end-to-end data exchanges between some SOs, the Flexibility Platform and aggregators. Details of this demonstrator are explained in EU-SysFlex deliverable 9.2.

3.3.2 TECHNICAL DESCRIPTION

The need has been identified to integrate "SO Application" for flexibility market with DEP to allow exchange of flexibility data, such as flexibility needs and offer acceptance.

Figure 6 explains how SO's flexibility application is integrated through data exchange platform with other relevant applications (Flexibility Platform in this example).

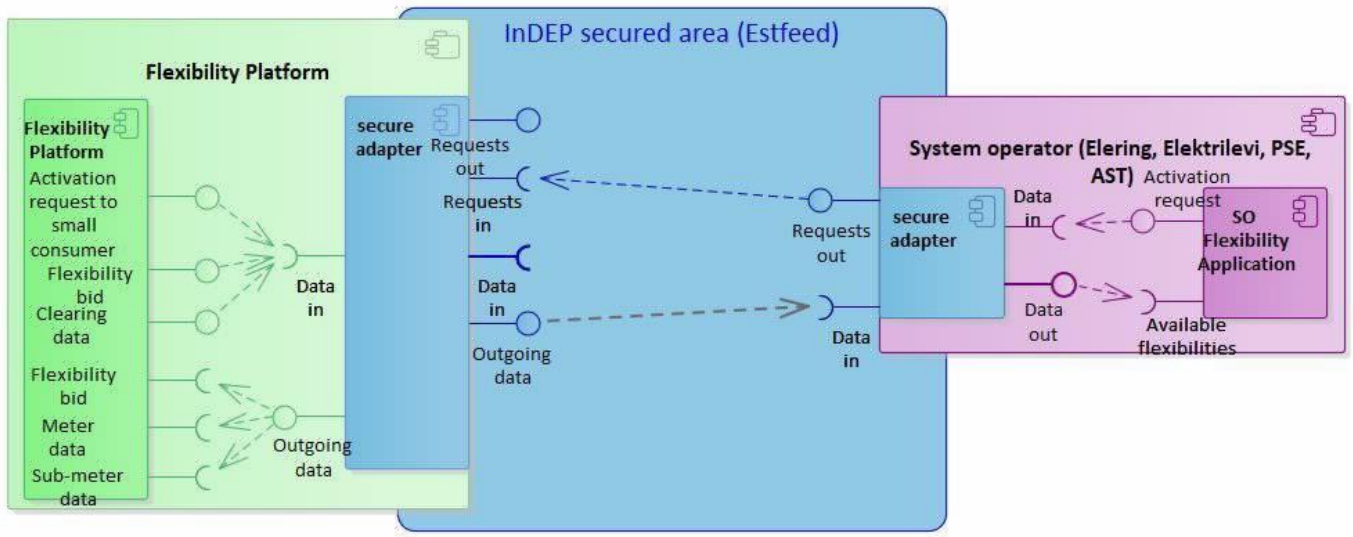

FIGURE 6 COMPONENTS FOR INTEGRATION OF SYSTEM OPERATOR'S FLEXIBILITY APPLICATION

Component descriptions:

- **Estfeed secure adapter**: Enables international data exchange over secured channels and in accordance with authorizations from data owner.
- **System Operator system:** Flexibility application of System Operator.
- **Flexibility Platform**: Platform for qualifying, trading and activating flexibility offers (see also chapter 3.2).

3.3.3 KEY TAKEAWAYS

"SO Application" was developed to demonstrate interface between SO and Flexibility Platform for any relevant processes using DEP as intermediary – e.g. grid qualification, launching of flexibility call for tenders, submission of flexibility activation requests.

3.4 DATA EXCHANGE BETWEEN A FOREIGN DSO AND DEP

3.4.1 GOAL OF THE DEMO

Goal of "ESO" demonstrator is to show cross-border cooperation possibilities between market participants in different countries. Even though European Union imposes a number of standards and common legislation, there are notable differences in the way EU countries apply and implement these. However, free markets and free movement within EU make it more and more common for people and organizations to have metering points and flexibilities in different countries; and they would like to access information about those in a common way, that is also secure.

3.4.2 TECHNICAL DESCRIPTION

In "ESO" demonstrator, it was planned to go through steps to show the evolution of a data hub and data exchange implementation. The "quick win" demonstration was successfully completed, where metering data was exported from ESO IT systems in file format and imported into Elering data hub as data from a separate DSO. End-user was then able to log on to Elering customer portal and data hub relayed them their data. Additional need for secure login to e-Elering for users from other countries (in this case Lithuania) was identified. The options of either integrating Lithuanian identification methods specifically (Mobile ID and Smart-ID) or using eIDAS service were identified.

The chosen identification method was Smart-ID. The Smart-ID authentication method of Elering customer portal was extended to allow people with Lithuanian national identification numbers to identify themselves using the test version of the Smart-ID service. After a successful identification with a Lithuanian test Smart-ID national identification number the person could have equal access to data in the Estonian data hub that a person with an Estonian national ID number could have.

The demonstration was thus successful as metering data import from ESO to data hub was completed, restriction for Lithuanian nationals to access Elering consumer portal was removed and the existing functionalities of Estfeed were able to provide a mandate to access the data and the data hub through an existing Estfeed service was able to provide it.

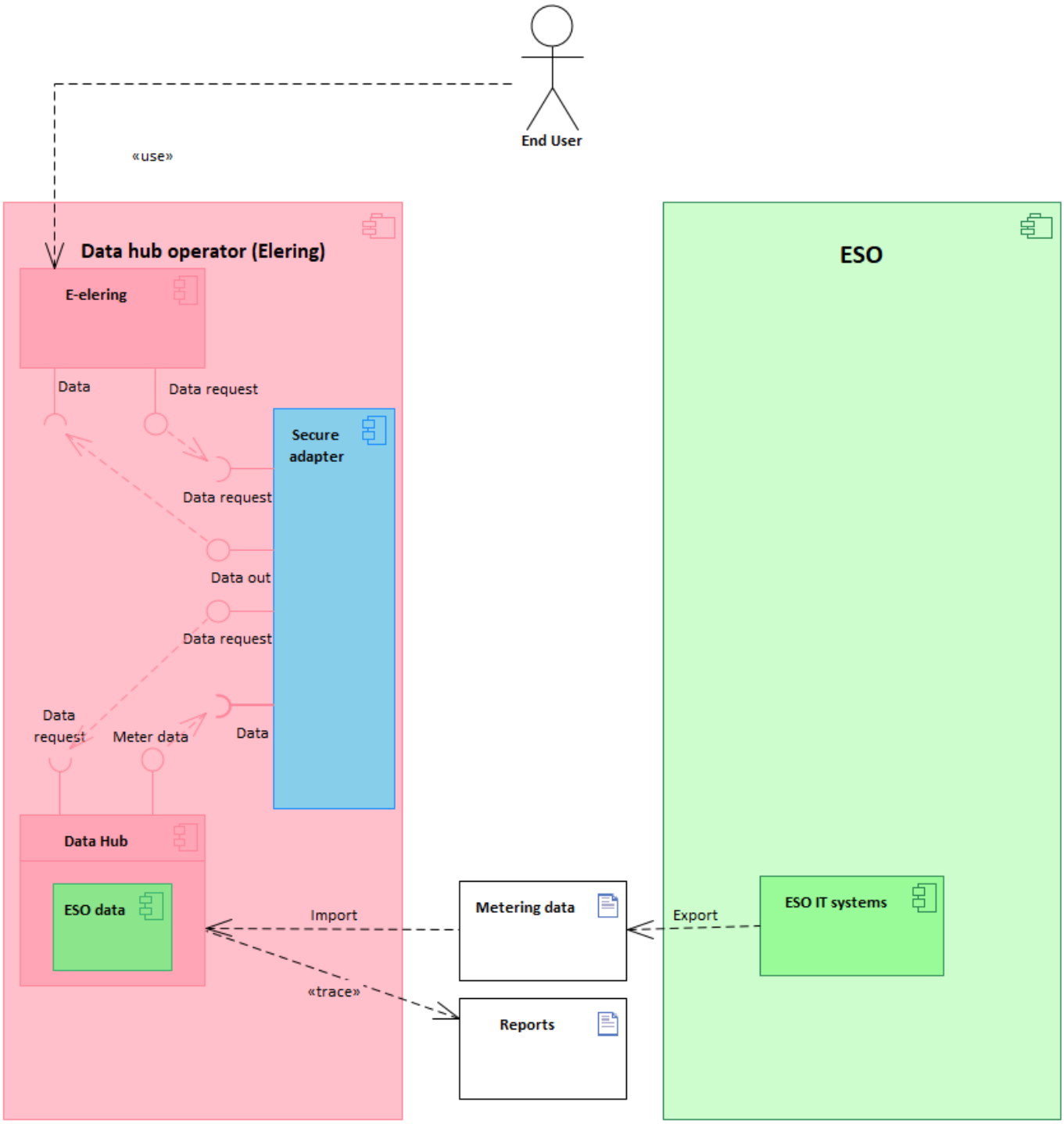

FIGURE 7 COMPONENTS FOR DATA EXCHANGE BETWEEN ESO AND ELERING

3.4.3 KEY TAKEAWAYS

The demonstrator showed how it is possible to use a DEP to import data exchanged from another system and then make it available to anyone using the DEP. The demonstration removed restrictions of Lithuanian nationals accessing the Estonian DEP. They were also able to access the data on Estfeed, demonstrating how it is possible to remove barriers from accessing meter data from different organizations in different countries.

The biggest obstacle is differing level of authentication available in different countries. This is being solved within scope of eIDAS (electronic IDentification, Authentication and trust Services; an EU regulation on electronic identification and trust services for electronic transactions in the European Single Market).

3.5 DATA EXCHANGE BETWEEN ENTSO-E AND ELERING PLATFORMS

3.5.1 GOAL OF THE DEMO

Goal of "ENTSO-E" demonstrator is to show how different market parties can securely exchange data. Both ENTSO-E and Elering have developed their own secure DEP. There are also other market participants, who have used either one of these options or created another type of secure DEP for their own data. Each of those market participants can control access to their own data, yet share it with others for synthesis and benefits above what one or the other could provide alone.

3.5.2 TECHNICAL DESCRIPTION

ENTSO-E has operational data available in their ECCo SP platform. This was integrated with Estfeed secure adapter to enable data exchange with Elering's data hub. Accordingly, it was demonstrated how consumers can log on to e-Elering customer portal and retrieve some operational or market data of interest from a system (e.g. ENTSO-E Transparency Platform) connected to ECCo SP; or log on to ECCo SP and view metering data about their consumption point from data hub connected to Estfeed.

ECCo SP and Elering's Estfeed platform have similarities. To connect external parties that exchange data, ECP (Energy Communication Platform, a component of ECCo SP) has endpoints, Estfeed has adapters. Both have a concept of a service although those are provided differently. On Estfeed a service is provided by an external system. In ECP it is provided by a network's central Broker component. Estfeed platform is more central, ECP network consists of Endpoints, a Broker and a Directory and it is possible to have multiple such networks, in which case the Directories of each network are interconnected and allow the Endpoints from different networks to exchange information.

The Estfeed and ECP integration demonstrated data exchange capabilities between two applications, one connected to an Estfeed secure adapter, another to an ECP endpoint. The application connected to an Estfeed secure adapter was a data source, providing an Estfeed service. It provides data upon a request. The consuming application was connected to an ECP node and initiated a request to receive a reply message from the data source application via Estfeed and ECP. An integration application was added between Estfeed and ECP which was connected to one ECP node and one Estfeed secure adapter. It forwarded all messages received from the ECP node directly to the Estfeed secure adapter. ECP network guaranteed message delivery from and to the receiving ECP endpoint and the application connected to that.

The data exchanged contained private meter data. Data owner's consent to exchange data was checked by the Estfeed Platform. It was important that the application to which the data owner gave consent to and the application behind an ECP endpoint were the same. For this reason, the data should not have been delivered to any other ECP endpoints as in Estfeed it is possible to give consent to only one application which the Estfeed – ECP integration is acting as.

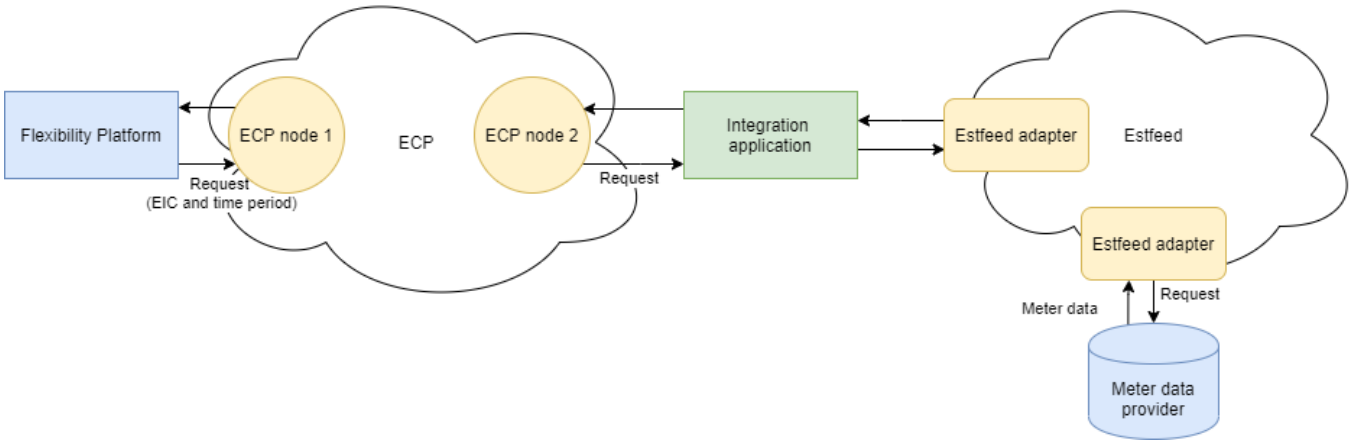

FIGURE 8 DEMONSTRATED DATA EXCHANGE BETWEEN ELERING AND ENTSO-E

The demonstration did not address data exchange initiated from the data source application connected to Estfeed. That would require a different Estfeed service to be used (publish – subscribe type instead of request – response). The integration was not universal in terms of allowing any type of data to be exchanged. The structure of the data was determined by the Estfeed service used and for that reason only data structured in that format could be exchanged. It would be possible to restructure the data in ECP using a custom message handler. The messages received by the application behind an ECP endpoint could actually receive the message in another format if desired. There was no need to demonstrate this at this point though as it is a known capability of the ECP.

The demonstration used private data and this means the data owner's consent was needed and it had to be known beforehand which application would eventually receive and process the private data. This means that the receiving ECP node and application were preconfigured and were not dynamic. The ECP integration to an Estfeed secure adapter was named and registered in the Estfeed Platform as an application with the same name that the consuming application behind the ECP endpoint. To later change the receiving application would require a reconfiguration of ECP, the integration, application name in the Estfeed Platform and data owners would need to give new consents to the new application.

3.5.3 KEY TAKEAWAYS

The demonstration considered different architectures and showed how to achieve data exchange from a system connected to ECCo SP. The demonstration was able to add value to ECCo SP by using the consent checking capabilities of Estfeed which allowed it to validate that the application behind ECCo SP had data owner's consent

to receive that data. The demonstration chose to use private data exchange as an example, for which Estfeed has special support. The demonstration showed that this adds restrictions to how ECCo SP could be integrated as Estfeed has to be aware of the data exchange party behind ECCo SP to check that it has consumer consent. This means that in order to there be a universal data exchange from any party behind Estfeed to any party behind ECCo SP, there should be a sharing and registering of the ECCo SP parties on Estfeed. That would require additional developments for the both platforms.

The data that was exchanged, was restricted to what was presumed by the Estfeed service. Although Estfeed allows arbitrary payloads, it is the intention of Estfeed to have concretely defined services with private data inclusion clearly defined. This further suggests that for each type of data being exchanged between the two networks, the data exchange party behind ECCo SP both has to be known to Estfeed and has to be configured to consume the correct service.

3.6 CROSS-SECTOR DATA EXCHANGE BETWEEN BUILDINGS' AND ENERGY DATA

3.6.1 GOAL OF THE DEMO

In "Building Registry" demonstrator, data exchange between different sectors was tested. Building Registry was chosen, as this kind of cross-sector data exchange provides value for both sides. The target groups (e.g. building designers, energy labellers, authorities responsible for issuing permissions, building developers, building owners) of Building Registry can use energy meter data to make their processes smoother. On the other hand, if energy data accessible via a DEP is enriched with information about the size of the rooms and buildings, energy labels, materials used for building, heating and ventilation systems, then it would be valuable information for energy service providers like, for example, flexibility aggregators.

3.6.2 TECHNICAL DESCRIPTION

Estonian Building Registry gives access to their data through X-Road platform, which is also basis for Estfeed. Data is exchanged over secure channels from X-Road service to International DEP secured area. Secure adapters relay requests and data to either party over secured channels.

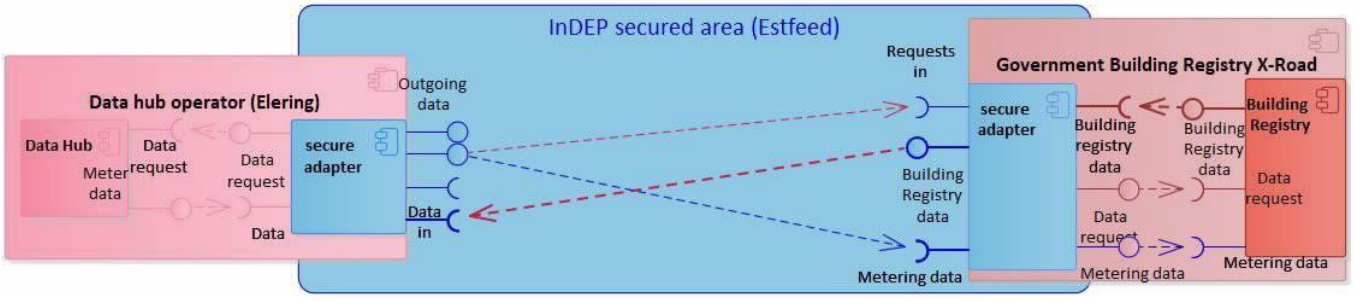

FIGURE 9 COMPONENTS INVOLVED IN DATA EXCHANGE BETWEEN DATA HUB AND BUILDING REGISTRY

Component descriptions:

- **Estfeed secure adapter**: Enables international data exchange over secured channels and in accordance with authorizations from data owner.
- **Data Hub operator**: System Operator's data warehouse for metering data.
- **Building Registry**: State registry for Building structural information.

The demonstration set out to request data from Building Registry and make it available in the Elering's customer portal. The information in the Building Registry is open data so no data owner's consent was required. The most difficult aspect of the data enrichment was making a connection between the data from the two distinct sources. Consumer meter data is linked to metering points and contracts. Building Registry data however can contain information on parts of buildings and is mainly linked to very systematically defined addresses. In data hub where consumer meter data is stored, there are addresses, but those are not systematically defined and not updated or tied to some unique identifiers.

This meant that the best workaround had to be defined for the target users. Since the Building Registry data served an enrichment purpose, it was chosen to provide users all possible matches for addresses rather than trying to guess the correct match. That meant that in some cases users would see information on multiple buildings and had the possibility to choose the correct one themselves.

The final result included a new page into the user interface of Elering's customer portal where energy consumers could comfortably see the most relevant fields in the context of electricity consumption from the Building Registry pertaining to (almost) only to their buildings.

3.6.3 KEY TAKEAWAYS

Cross-sector data exchange was demonstrated which proposed a way to add value to users of one system with data enrichment from another system. The demonstration showed that if the two systems have not been intended to exchange data then sometimes it can be difficult to reliably link the data as was the case here – the quality of addresses was much lower in one system than in the other.

3.7 DEP INTEGRATION OF A FRAMEWORK ENABLING BIG DATA PROCESSING

3.7.1 GOAL OF THE DEMO

The goal is to demonstrate that the big data system elaborated in task 5.3 can be interfaced with the data exchange platform Estfeed to securely serve its calculation results such as electrical consumption predictions to market actors. See also EU-SysFlex deliverable 5.3 for details.

3.7.2 TECHNICAL DESCRIPTION

One of the main components of this demonstration is a big data system which has been designed and implemented as part of the task 5.3. This system is detailed in the chapter "*Development of a big data system for the electricity market*" of the EU-SysFlex deliverable 5.3[5]. Here, this big data system was interfaced with the Estfeed data exchange platform. This has been done for its outbound data flow, i.e. data provided by the big data framework to its customers, applications or users; whereas its inbound data flow, i.e. the data collected by the big data system from the data hubs, IoT is received directly by the big data system without the use of Estfeed.

Three following APIs (Application Programming Interfaces) have been created to allow third parties to obtain the results of the big data processing:

- *GetConsumption*, service to get the real energy consumption data of a set of devices for a given period of time. The provided values represent the energy consumed every 1 minute during this time.
- *GetPrediction*, service to get the predictions of energy consumed by a set of devices for a given period of time. The provided values are the predictions every 15 minutes.
- *GetLoadPrediction* returns a list of load consumption predictions in Norway for a given period and a given region.

These APIs have been tested from a web application of which here are some screens:

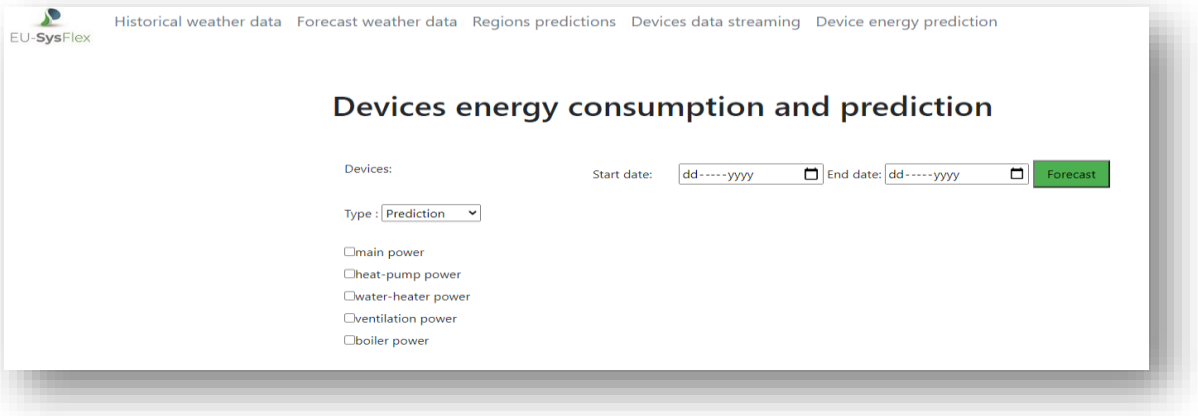

FIGURE 10 FORM OF THE WEB APPLICATION INTERFACED TO THE BIG DATA PLATFORM THROUGH ESTFEED

[5] See chapter 4.7 of the deliverable: https://eu-sysflex.com/wp-content/uploads/2020/10/EU-SysFlex_Task53_deliverable_v1_FINAL.pdf

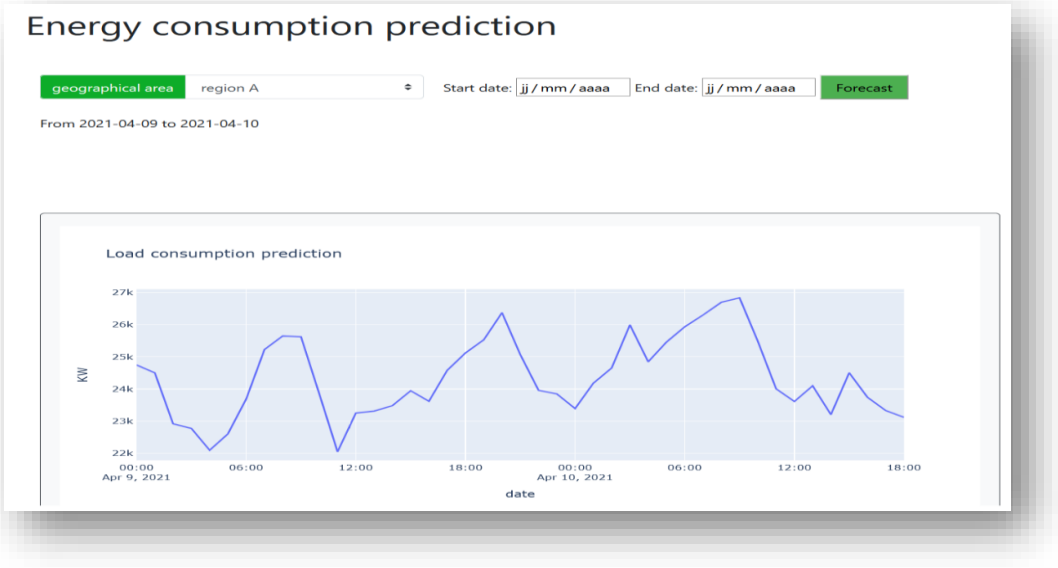

FIGURE 11 EXAMPLE OF RESULTS PROVIDED BY THE BIG DATA FRAMEWORK

The overall architecture of the data exchanges is schematized as follows:

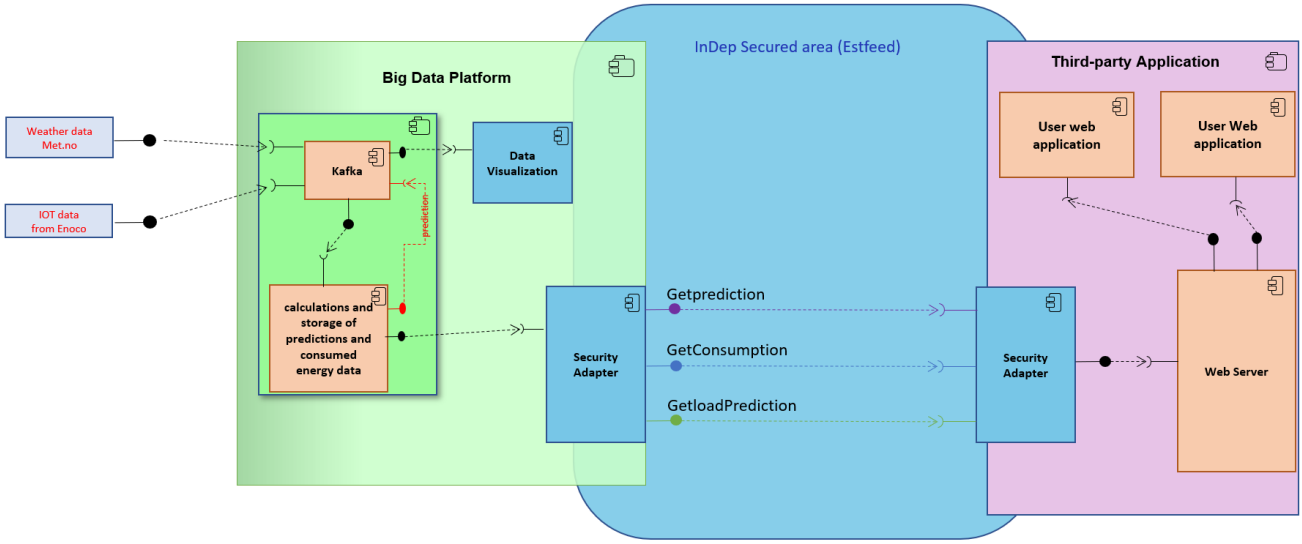

FIGURE 12 COMPONENTS FOR DATA EXCHANGE BETWEEN BIG DATA FRAMEWORK AND A THIRD-PARTY APPLICATION

3.7.3 KEY TAKEAWAYS

In this demonstration, it has been deployed an interface between a big data system and a third-party application consuming the results produced by this system through the data exchange platform Estfeed. Thus, an end-to-end big data process was completed: raw data are collected from external APIs, processed in batch and near-real time with AI algorithms, results are stored in a serving layer and are available through request/response API.

This deployed architecture has worked properly within a context where the frequency requests were not high, with limited size data results and without specific latency constraints. A next step would have been to scale this architecture to determine the limits in terms of performances.

3.8 DEP INTEGRATION OF AN APPLICATION ENABLING FLEXIBILITY BASELINE CALCULATION

3.8.1 GOAL OF THE DEMO

The goal of the demo was to demonstrate how privacy-preserving data exchange can protect private data while allowing systems to calculate results based on that data.

3.8.2 TECHNICAL DESCRIPTION

The demonstrator built upon the "ENTSO-E" demonstrator, although the ECCo SP network part was not important for this demonstration but only the data retrieval from Estfeed. The main idea of the demonstration was to show how a system (Flexibility Platform in this case) could use private data to calculate something (in this case: a baseline for a consumer resource) without ever having access to the source data. This has important implications that in many cases if the source data is really just a means to some end (a calculation result) then the source data does not have to be made available which means more applications could take advantage of it and data owner's privacy is still and better protected.

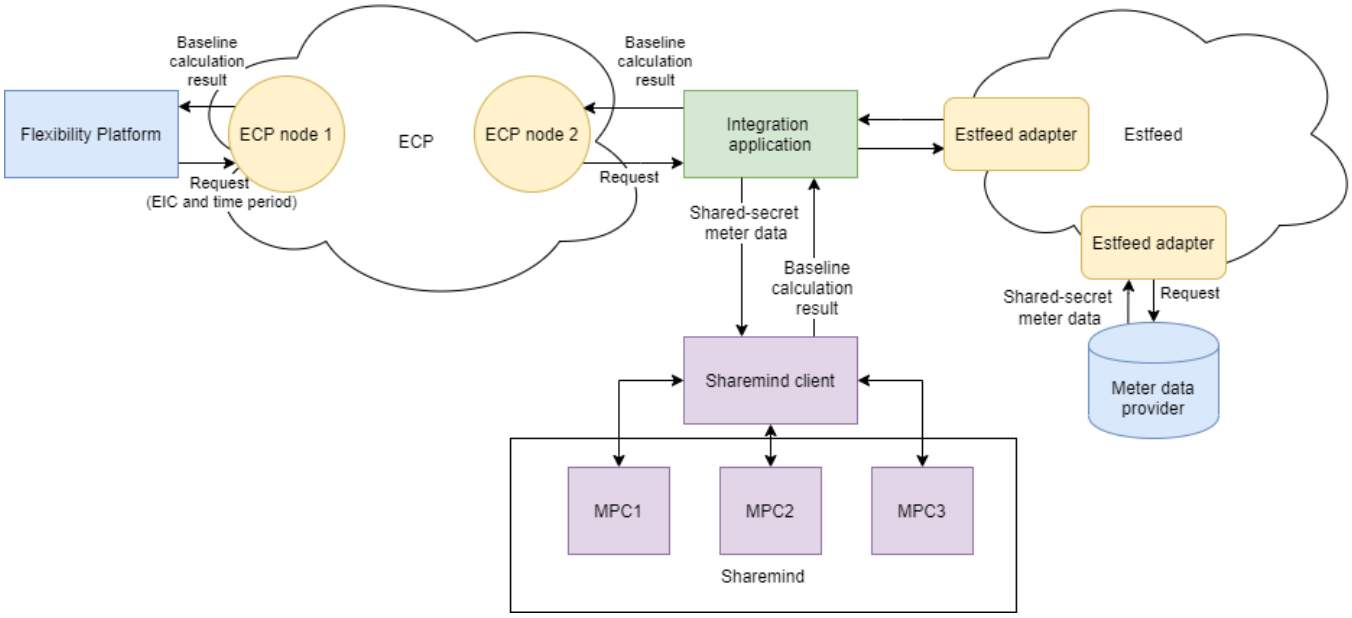

FIGURE 13 DATA EXCHANGE FLOW BETWEEN SHAREMIND, ESTFEED, FLEXIBILITY PLATFORM

The demonstration implemented an architecture that was proposed in the results of task 5.3[6]. It discusses how to connect Sharemind with its split architecture of three distinct servers each processing only a third of the total data to Estfeed which by design has to know which application it provides the data and has no support for sharing different part of the data with different applications. The chosen scenario to demonstrate was baseline calculation which requires historical meter data (from a data hub) which is private data. At the same time the Flexibility Platform does not need access the actual meter data – it only requires the baseline result.

To connect Sharemind with Estfeed, an integration application was created which just forwarded requests and results. On the Estfeed side a special service was added with a feature to divide the requested data into 3 parts, encrypt all the parts with different private keys and then send the encrypted data to the three Sharemind MPC servers. The actual calculation of the baseline was also done on Sharemind. This setup allowed the integration application to only have access to encrypted data and the baseline calculation result and made sure that private data was only processed on Sharemind and nowhere else. A user interface was also developed to imitate an actual Flexibility Platform. It would allow a user to create a request to calculate a baseline between given two dates chosen by the user and visually display the baseline result on a graph.

Estfeed was able to still validate that the Flexibility Platform had data owner's consent to perform the baseline calculation. A special Estfeed service was developed and the data owner was able to specifically provide their consent to the Flexibility Platform so that their data would only be used for just the intended purpose and nothing more.

3.8.3 KEY TAKEAWAYS

The demonstrator was able to preserve data owner's privacy while allowing the Flexibility Platform to receive a result calculated using that data. Use of Estfeed also enabled to make sure that the owner of the data was aware that the data was used for just baseline calculation purposes but in a privacy-preserving way. The demonstrator proposed an architecture that could make every service of the Estfeed DEP preserve user privacy by first encrypting and obfuscating data and only using it in a secure environment for only the intended purposes.

3.9 DEMONSTRATION OF CYBERSECURITY AND DATA PRIVACY REQUIREMENTS

3.9.1 GOAL OF THE DEMO

In "Cybersecurity" demonstrator the goal is to assure the processes and logs security in the situation when there are multiple trusted parties involved between participants that exchange relevant energy data. During the demonstration additional evidence was created for the system logs.

More details about cybersecurity and data privacy are available in EU-SysFlex deliverable 5.4.

[6] See chapter 4.6 of EU-SysFlex deliverable 5.3: https://eu-sysflex.com/wp-content/uploads/2020/10/EU-SysFlex_Task53_deliverable_v1_FINAL.pdf

3.9.2 TECHNICAL DESCRIPTION

The case of data exchange between ENTSO-E's and Elering's platforms was selected ("ENTSO-E" demonstrator) for the demonstration. Both, the ECCo SP test network and Estfeed platform are part of the demonstration.

There are two main building blocks used to run the demonstration: KSI Blockchain technology stack and the Black Lantern anti tamper hardware. In addition to the existing security features provided by the Estfeed secure adapter, the log security component and hardware will be used to offer integrity of security logs.

There are two use cases that are demonstrated during the cybersecurity demo:

- Integrity of logs – Black Lantern infrastructure is deployed and it provides access to the KSI blockchain service to enable KSI (Keyless Signature Infrastructure) functionalities of providing the signatures to achieve log integrity. Besides the log integrity Black Lantern will provide a secure gateway for KSI services and reduce the risk from potential attack vectors. From the end-user perspective, access to log security component via Black Lantern is not visible, as it will be operating in the background. The two participants of this demonstrator can select besides RFC 3161 time stamping service also KSI Blockchain based log security to be used in the Estfeed secure adapter.
- Log storage – In addition to providing KSI Blockchain access, Black Lantern will be used as a secure log storage. The goal is to offer an alternative log protection solution for data exchange in addition to the existing security module running in the Estfeed platform. From the end-user perspective, when this security module is selected for securing the logs, it will provide secure storage of the logs, verification of integrity of stored logs, and export of logs with proof of integrity.

The interaction between the "ENTSO-E" demonstrator and added elements from "Cybersecurity" demonstrator can be seen in Figure 14.

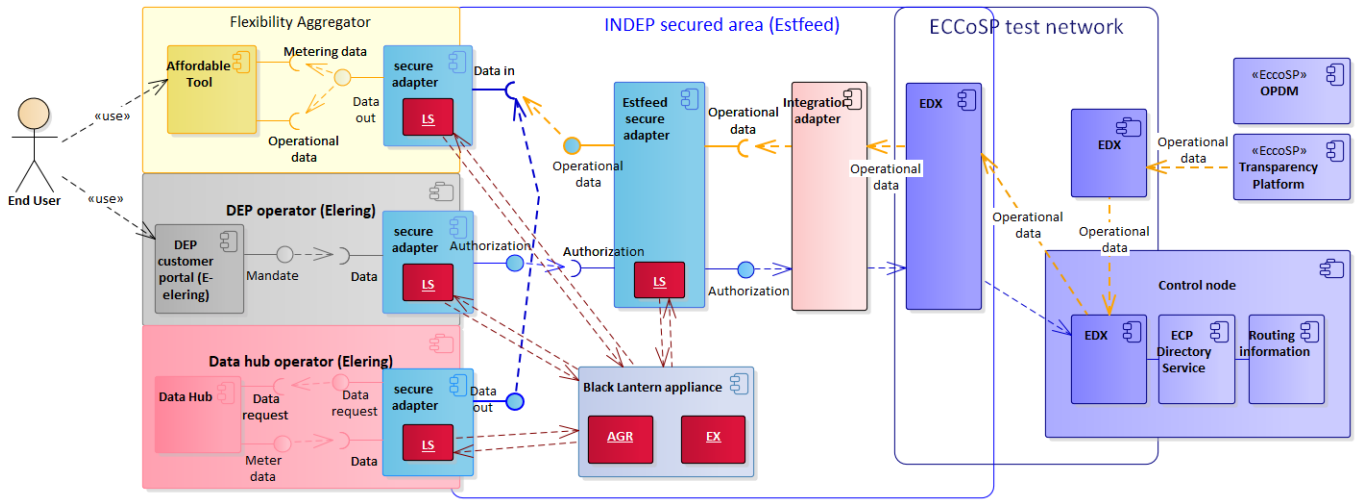

FIGURE 14 COMPONENTS INVOLVED IN "CYBERSECURITY" DEMONSTRATOR

Log Security (LS) components provide the access to additional features for the system operator. Black Lantern appliance provides the secure infrastructure and key functionality described in the two use cases above. The Aggregator (AGR) and Extender (EX) components are vital elements for enabling secure, massive scale integrity verification.

3.9.3 KEY TAKEAWAYS

The demonstration showcased that it is possible to integrate alternative signing mechanisms to the critical logs that provide the information about the data exchange and participants. The third party environment was created, where logs could be recovered by the participants and with the use of an anti-tamper hardware platform the redundancy of the logs and evidence was raised. Eventually the risk of losing critical data logs was reduced from the three aspects: a) signing with different technology; b) adding additional log storage; c) including anti-tamper infrastructure to an existing solution.

3.10 DEMONSTRATION OF NEW STANDARDS

3.10.1 GOAL OF THE DEMO

The initial goal of “New Standards” demonstrator was to test new proposed standards and protocols suggested by task 5.5). In the deliverable of task 5.5 a comprehensive gap analysis of existing data exchange standards and specifications is presented. Based on gap analysis potential areas of missing standards per data exchange SUC were identified. Special focus was given to coverage by CIM standards. However, the specific recommendations for new standards were limited to CIM profiling of two business objects – ‘Flexibility Bid’ and ‘Customer Consent’. Only first of these two CIM profiles was implemented in WP9 – in “Flexibility Platform” demonstrator.

3.10.2 TECHNICAL DESCRIPTION

“CIMification” means transforming original XSD (XML Schema Definition) into CIM compliant XSD. ‘Flexibility Bid’ business object was CIMified in WP5 and CIMified XSD was implemented in “Flexibility Platform” demonstrator. This CIMification started with comparing original XSD with CIM data model standards, such as ESMP (European Style Market Profile) based on IEC 62325.

In order to minimize the impact on the API of already implemented “Flexibility Platform” demonstrator, XSLT (eXtensible Stylesheet Language Transformations) codes were produced to map XML (Extensible Markup Language) documents compliant with original XSD into XML documents compliant with CIMified XSD.

The new CIMSubmitFlexibilityBid API was created and published on the Estfeed platform. This way, the “Flexibility Platform” similarly accepts Flexibility Bids submitted by means of the former API or the standardised (CIM compliant) API.

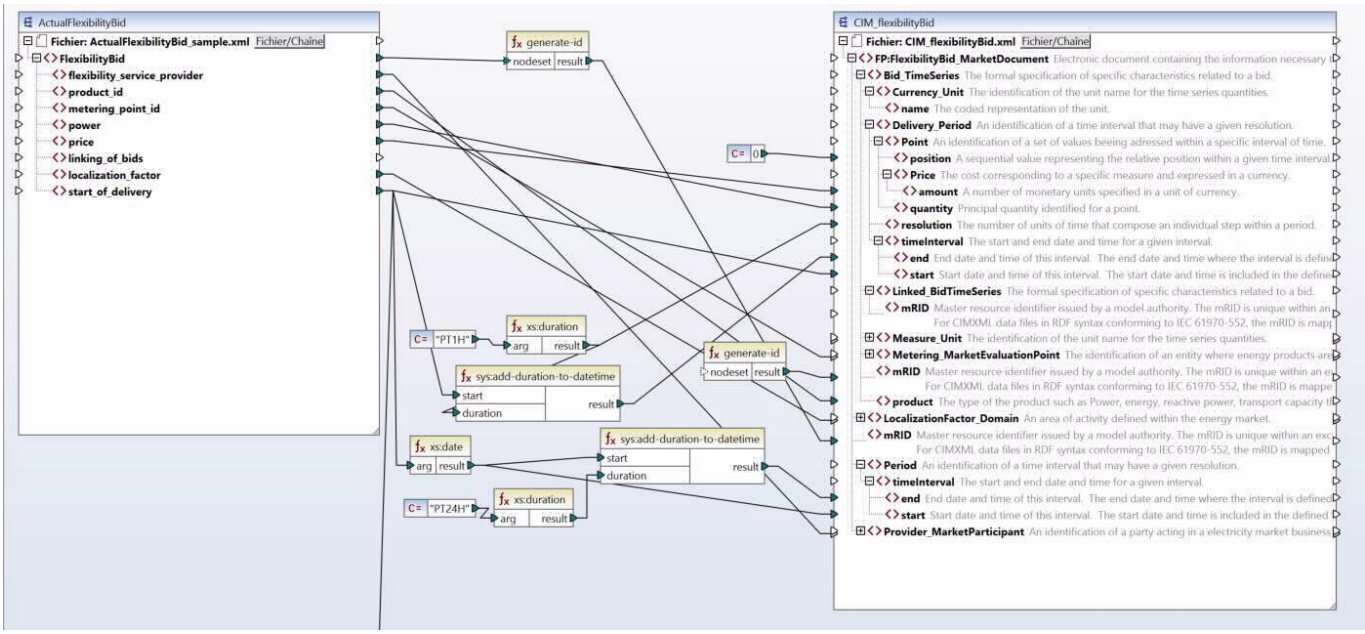

FIGURE 15 XSLT TRANSFORMATION OF 'FLEXIBILITY BID' BUSINESS OBJECT FROM EU-SYSFLEX FORMAT TO CIM COMPLIANT FORMAT

Detailed process of "CIMification" is presented in EU-SysFlex deliverable 5.5 (Proposal for data exchange standards and protocols).

3.10.3 KEY TAKEAWAYS

Even though it was verified through the "CIMification" process that the 'Flexibility Bid' business object does not require CIM extensions, the "New Standards" demonstrator successfully proved that it does not take much effort:

1) to translate the original API into CIM compliant API, and
2) to replace already implemented original API by CIM compliant API.

4. USER INTERFACES

4.1 DATA MANAGEMENT SERVICES

4.1.1 PROSUMERS/CONSUMERS

Prosumers and consumers need convenient graphical user interface to get all available information about their metering point as well as about access to any services.

In the project e-Elering (graphical user interface) was used to provide single user interface for consumers and prosumers to access any information about their metering points.

Mainly 3 demonstrators are concerned:

- In “ESO” demo, it was demonstrated how it is possible to bring into same graphical user interface information from different countries and/or service providers.
- With “Building Registry” demo, bringing information from another sector to the same user interface was demonstrated, providing necessary context for consumption and/or production data.
- With “Affordable Tool” demo, end-customers of aggregators were enable to manage their sub-meter data.

4.1.2 B2B CUSTOMERS

B2B customers need system interfaces to exchange their data as energy market participants.

Estfeed API has been used for several EU-SysFlex demonstrators (“Affordable Tool”, “Flexibility Platform”, “SO Application”, "ENTSO-E", “Big Data Tool” “Baseline Application”).

Estfeed is a secure data exchange platform that is built on X-Road solution. X-Road is promoted by Estonian government and it allows the “various public and private sector e-service information systems to link up and function in harmony”[7]. X-Road’s recent versions use UXP (Unified eXchange Platform) technology. UXP is interoperability platform to facilitate cross-border data exchange[8]. It is in use in Estonia for data exchange (see longer description in chapter 2.3). The main addition to X-Road is that customers can give access to their metering data to any stakeholders that could provide value by combining it with other data sources or make it more valuable by calculations or new ways of accessing the data.

Estfeed API allows access to Estfeed services through standard interfaces. This enables businesses to build applications on consumer/prosumer data or synchronize their own metering points’ data to their internal systems. Main existing Estfeed services concern provision of electricity and gas meter data. Additional services have been

[7] https://e-estonia.com/solutions/interoperability-services/x-road/
[8] https://cyber.ee/products/secure-data-exchange/

developed and implemented in “Flexibility Platform” demonstrator (see Figure 16 and annex III of deliverable 9.2 for more details).

Standardised API access to data management services was demonstrated through following cases:

- In “Flexibility Platform” demo flexibility platform operator’s access to relevant flexibility market data of FSPs, system operators and data hubs was demonstrated.
- In “Affordable Tool” demo aggregator’s access to their customers’ data and to flexibility market data was demonstrated.
- In “SO Application” a single interface for any system operator to act in flexibility market was demonstrated.
- In “ENTSO-E” demonstration business customers’ access to operational and meter data through single user interface was demonstrated.

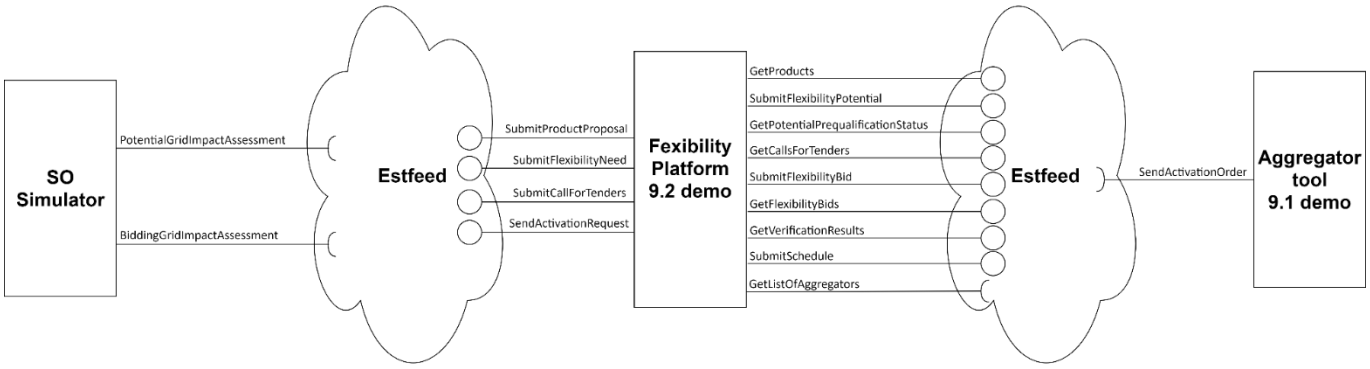

FIGURE 16: DATA EXCHANGE INTERFACES BETWEEN SYSTEM OPERATOR AND FLEXIBILITY PLATFORM, AND BETWEEN AGGREGATOR AND FLEXIBILITY PLATFORM

4.2 ENERGY MARKET SERVICES

Flexibility providers are interested in selling their flexibility on flexibility platform. Flexibility aggregators aggregate a number of smaller flexibility providers to provide a reasonable amount of flexibility to the market. End customers can access this market via aggregators, whereby the aggregator can monitor and control the consumption of individual units. Using “Affordable Tool” it was demonstrated that it is possible to provide access through common user interface to flexibility market.

In “Baseline Application” demonstrator a user interface was developed allowing a user to create a request to calculate a baseline between given two dates chosen by the user and visually display the baseline result on a graph.

For aggregators and bigger individual flexibility providers, as well as for system operators interested in procuring flexibilities, as well as for market operators running the marketplaces, the access to all relevant flexibility market processes (prequalification, bidding, activation, verification) was demonstrated through “Flexibility Platform”,

"Affordable Tool" and "SO Application" interfaces. Figures 17, 18 and 19 depict the sample interfaces of each of these. More details are available in EU-SysFlex deliverables 9.1 and 9.2.

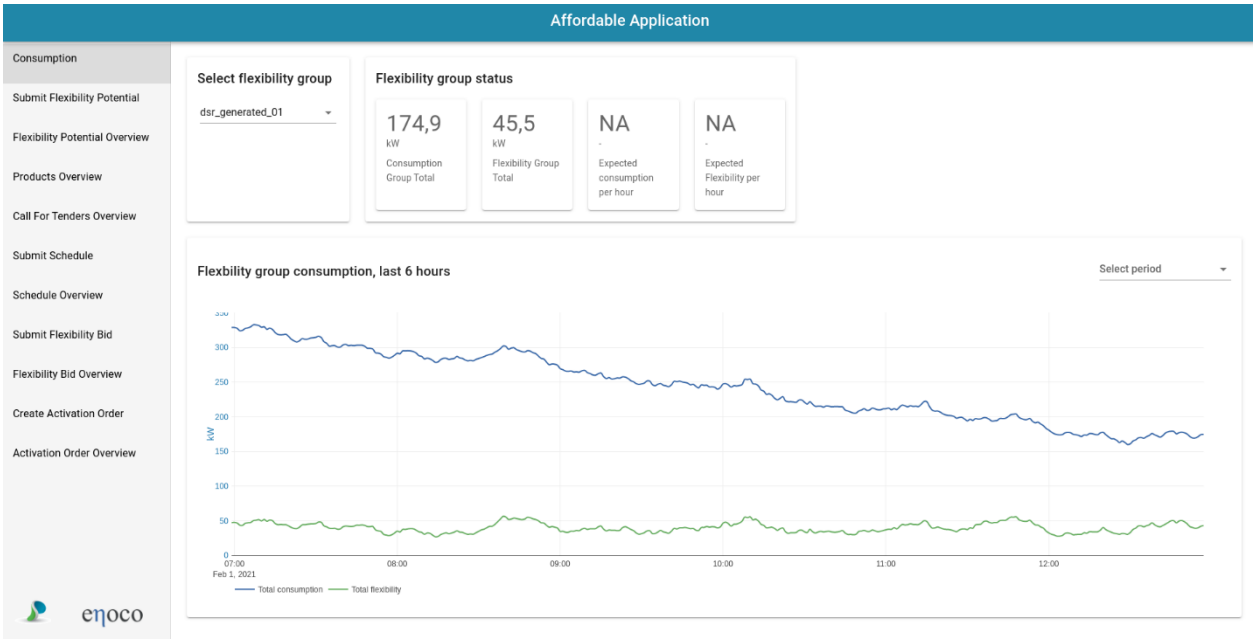

FIGURE 17 EXAMPLE – SCREENSHOT OF "AFFORDABLE TOOL" INTERFACE FOR THE AGGREGATOR

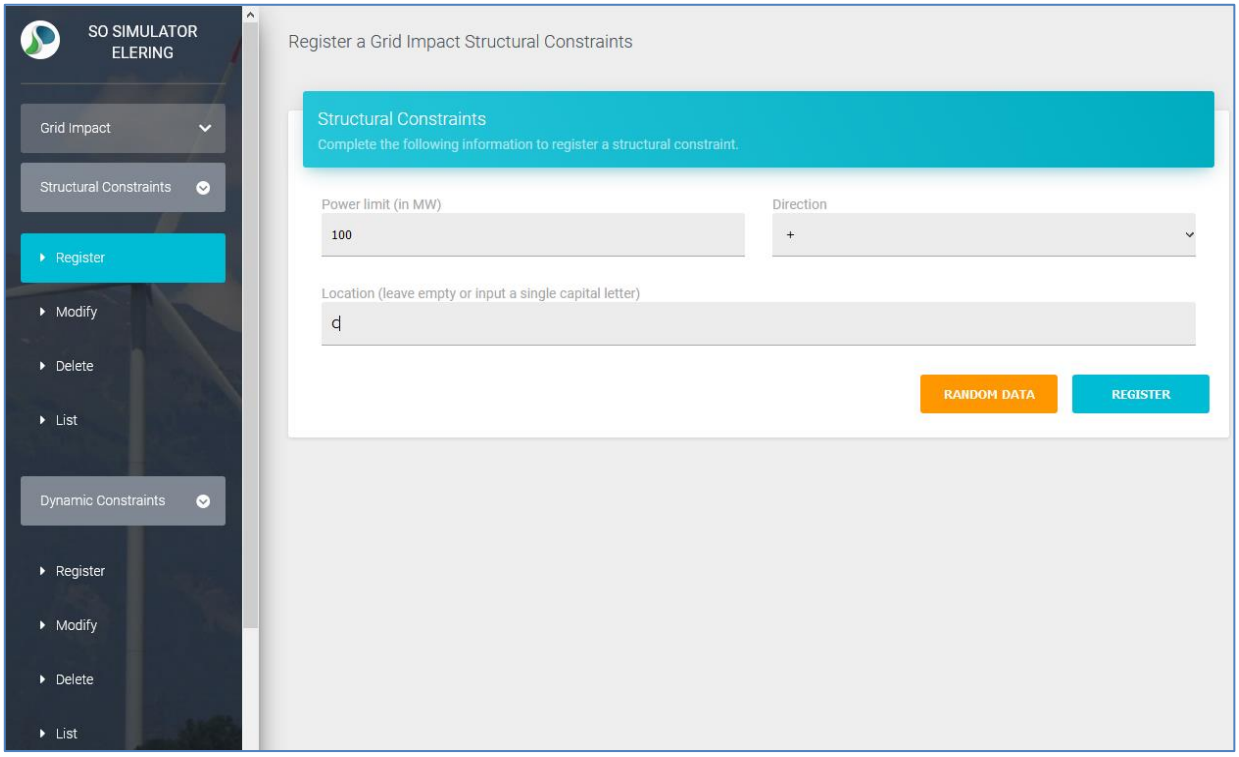

FIGURE 18 EXAMPLE – SCREENSHOT OF SYSTEM OPERATOR'S INTERFACE TO SUBMIT STRUCTURAL GRID CONSTRAINTS TO FLEXIBILITY PLATFORM

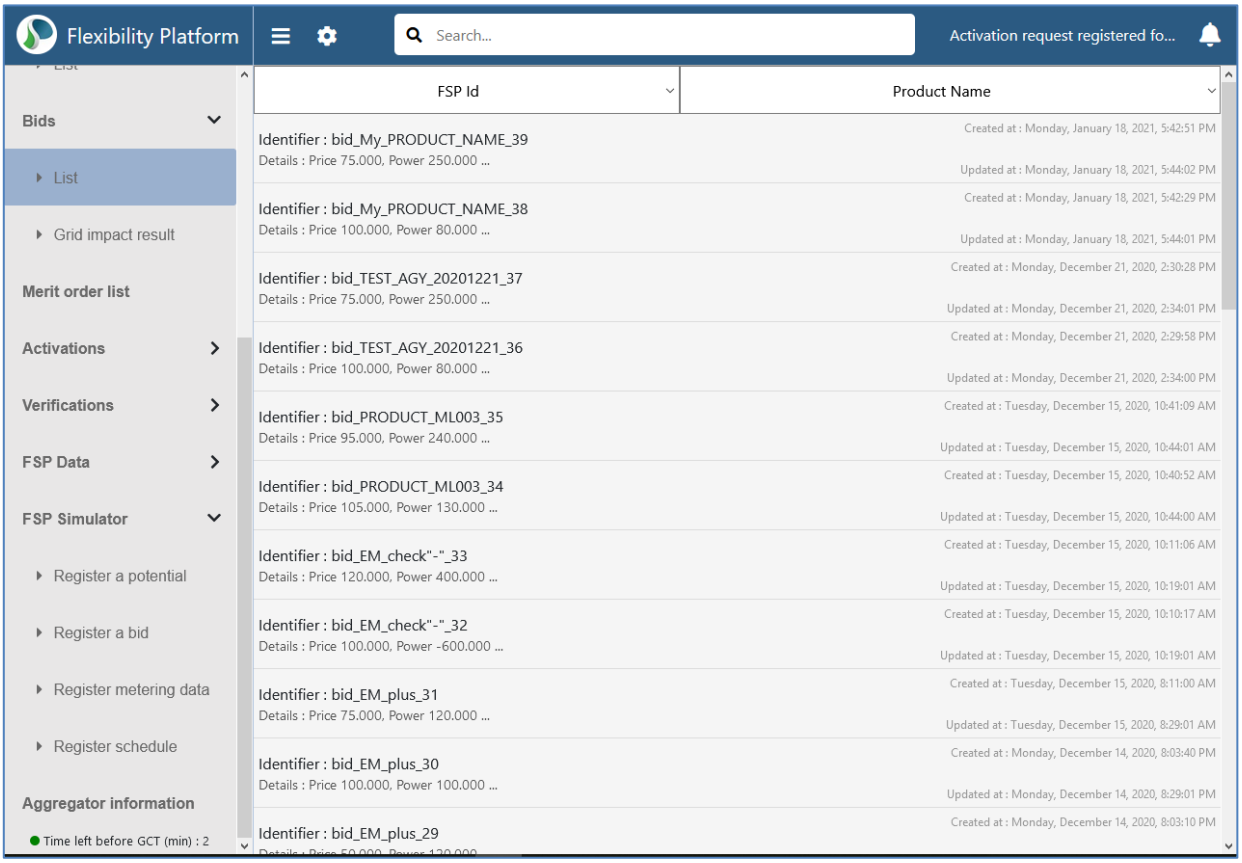

FIGURE 19 EXAMPLE – SCREENSHOT OF FLEXIBILITY PLATFORM INTERFACE OF MARKET OPERATOR TO GET LIST OF FLEXIBILITY BIDS

5. COPYRIGHT

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