INTERRFACE

Single Flexibility Platform Webinar

Harmonized market for flexibility trading in East Baltic Sea region

25 November 2022

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10.00-10.05 Welcome Kalle Kukk, Elering
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- Finland (DSO perspective) – Antti Mutanen, Elenia
- Estonia – Kalle Kukk, Elering
- Latvia – Ivars Zikmanis, AST

11.00-11.15 Technical architecture – Marko Petron, Cybernetica
11.15-11.30 Next steps – Jan Segerstam, Enerim
11.30-11.55 Q&A
11.55-12.00 Wrap up

Introduction

Nikolaos Bilidis
European Dynamics

About INTERRFACE

INTERRFACE

LC-SC3-ES-5-2018-2020: TSO-DSO-Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation

Title: TSO-DSO-Consumer **INTERFAC**E a**R**chitecture to provide innovative grid services for an efficient power system

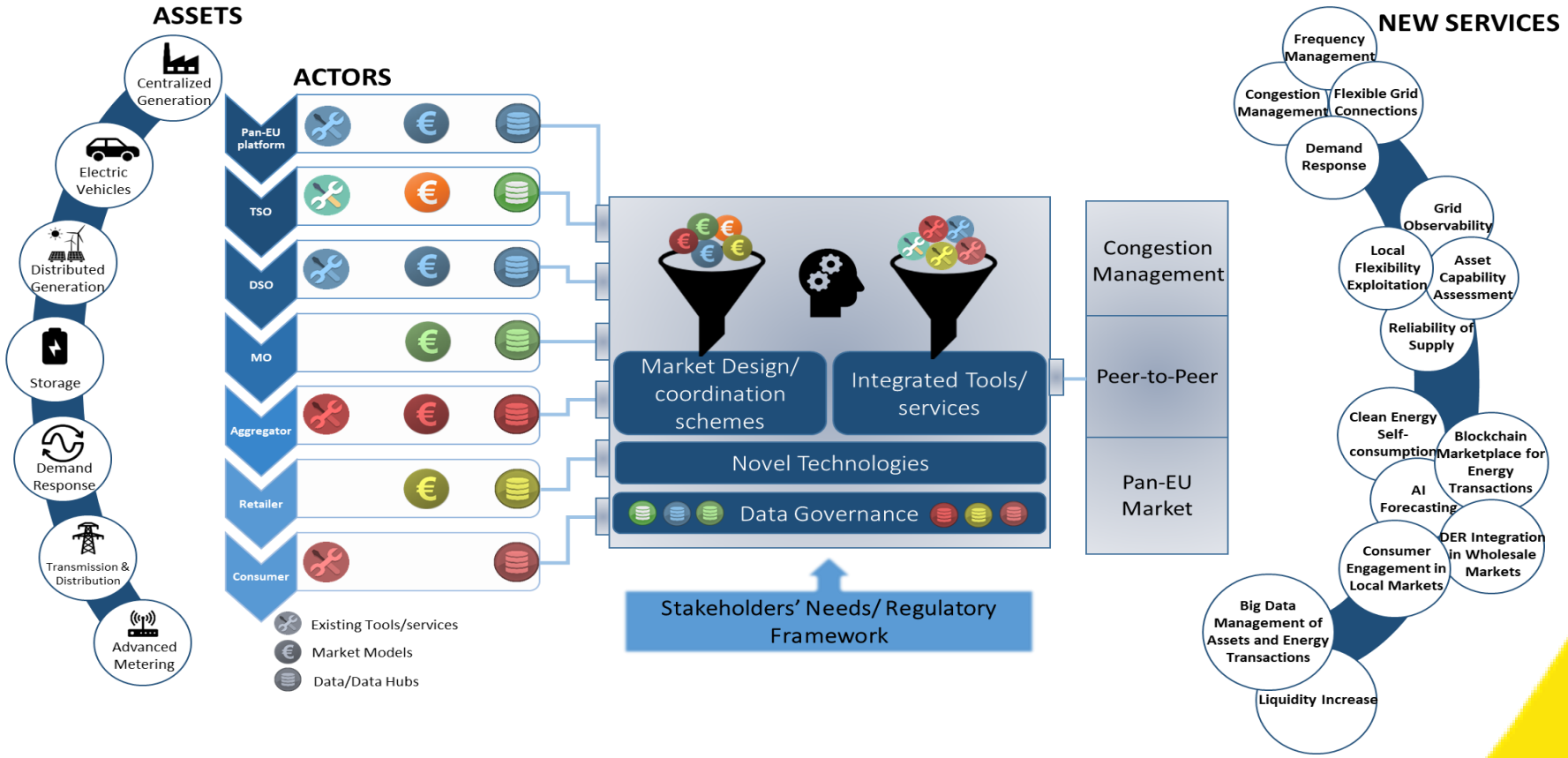
- Project Grant Agreement No. 824330
- Budget: 20.9 M Euro
- Grant: 16.8 M Euro
- Duration: 4 Years

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824330

INTERRFACE Vision

Interoperable pan-European Grid Services Architecture

INTERRFACE



"An open architecture for sharing data among all participants in the electricity system value chain (customers, grids, market), from local, regional to EU level. It will enable TSOs, DSOs and customers to coordinate their efforts to maximise the potential of distributed energy resources (DERs), demand aggregators and grid assets, so as to procure energy services in a cost-efficient way and create consumer benefits"

Strategic Objectives

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- To create a common architecture (IEGSA Platform) connecting market platforms to establish a seamless pan-European electricity exchange linking wholesale and retail markets and allowing all electricity market players to trade and procure energy services in a transparent, non-discriminatory way.
- To define and demonstrate standardised products, market designs and coordination schemes that can be applied and validated through IEGSA
- To integrate small scale and large scale assets to increase market liquidity for grid services and facilitate scaling up of new services which are compatible across Europe.
- To drive collaboration in the procurement of grid services by TSOs and DSOs enabling the incorporation of location information and grid conditions
- To improve market signals, increase transparency and to create strong incentives to connected customers
- To facilitate market processes such as bidding, qualifications, activations and settlement

Demonstrators

Demo Area 1:
Congestion Management and Balancing Issues

- **DSO and Consumer Alliance** (Centralized Energy Management system for microgrids)
- **Intelligent Distribution Nodes** (Grid Services Management system for flexible LV/MV Networks)
- **Single Flexibility Platform** (Exchange Platform for distributed flexibilities in end-to-end electricity networks)

Demo Area 2:
Peer-to-peer Trading

- **Asset-enabled Local Markets** (Microgrid Local Electricity Markets using the assets capabilities)
- **Blockchain-based TSO-DSO flexibility** (Market Platform with Smart Contract and smart billing)

Demo Area 3:
Pan-EU clearing Market

- **DERs into Wholesale** (A retail-to-wholesale Market approach for DERs' integration)
- **Spatial Aggregation of local flexibility** (A EUPHEMIA-based Market Platform to engage local flexibility resources)

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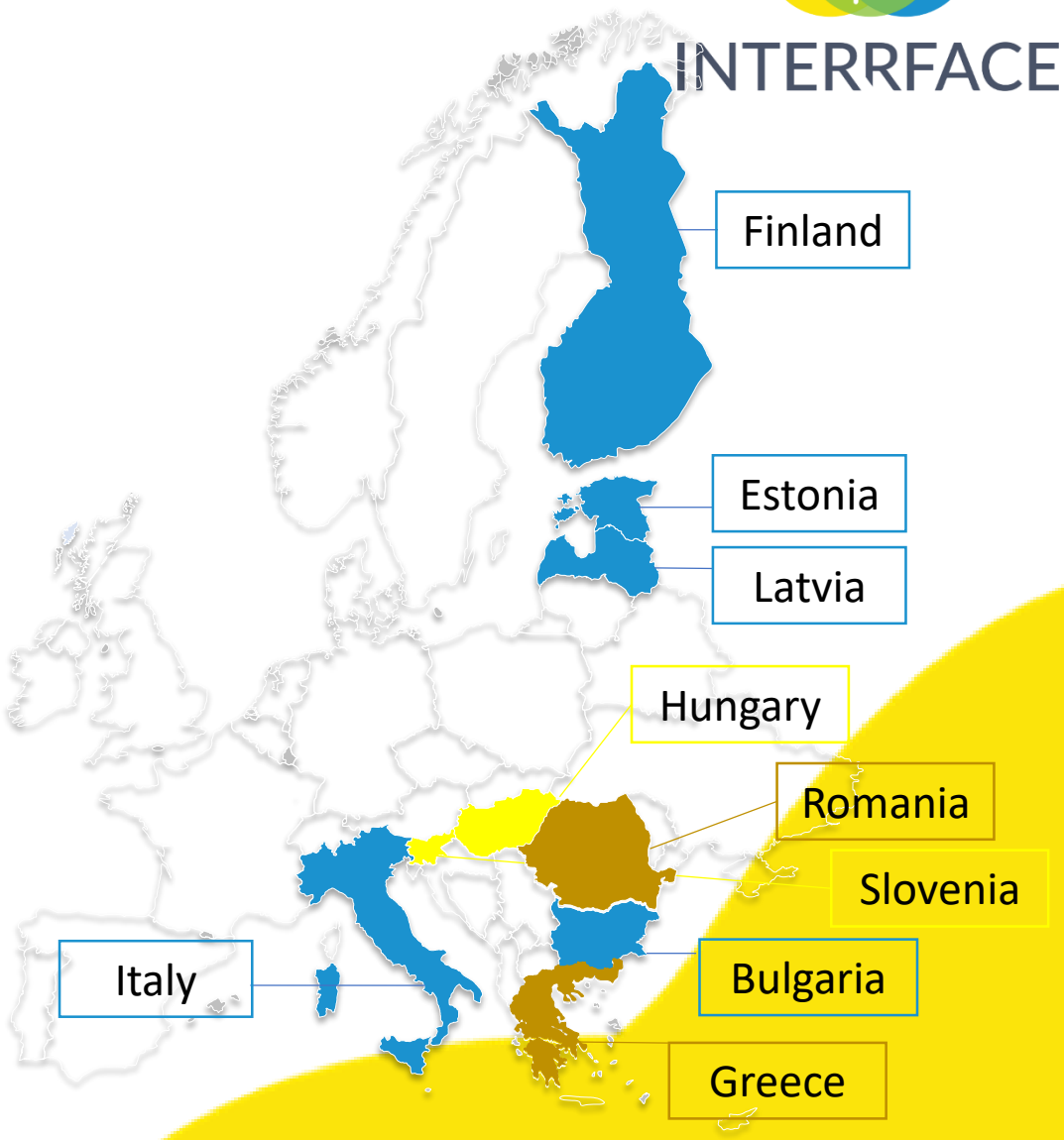
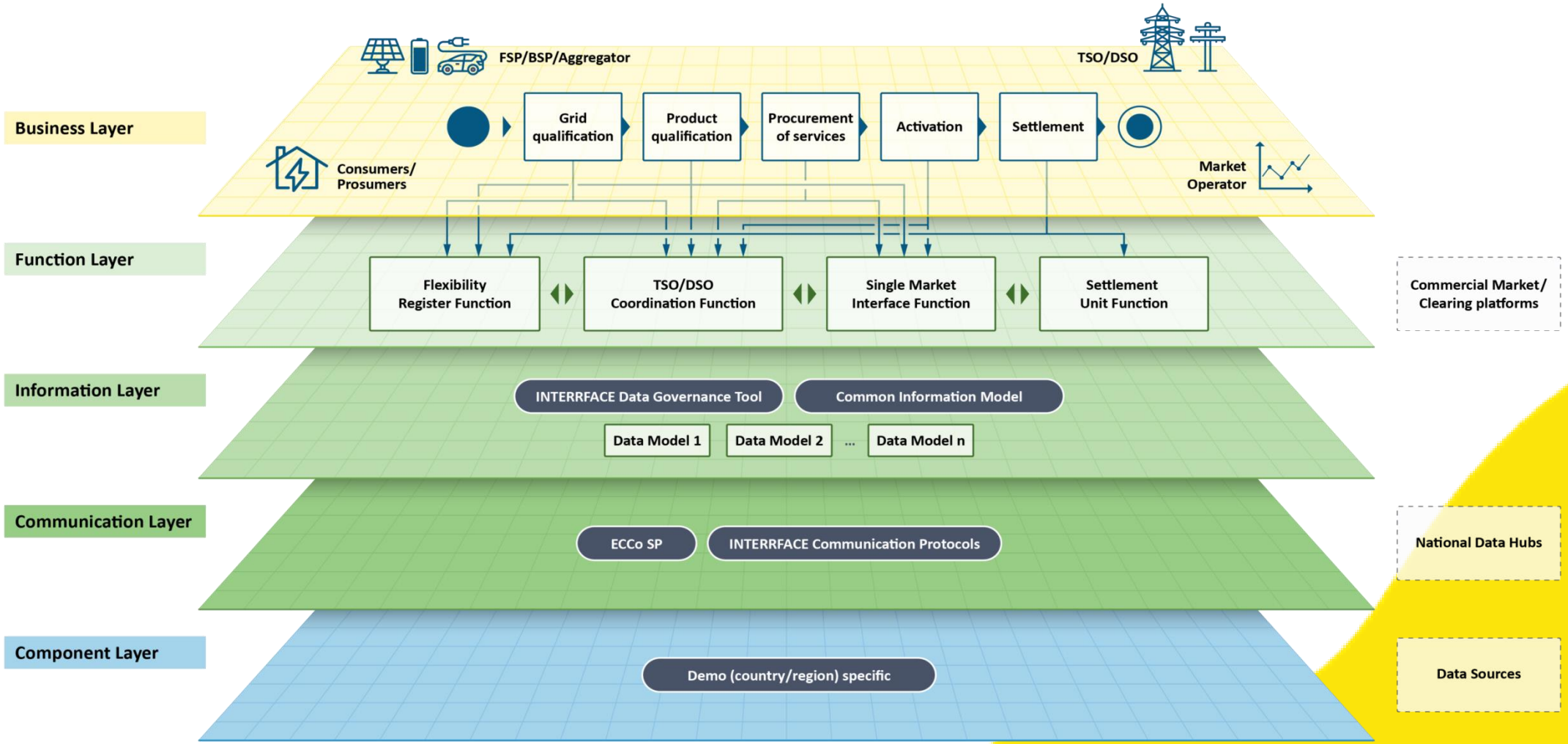


INTERRFACE Product

Interoperable pan-European Grid Services Architecture

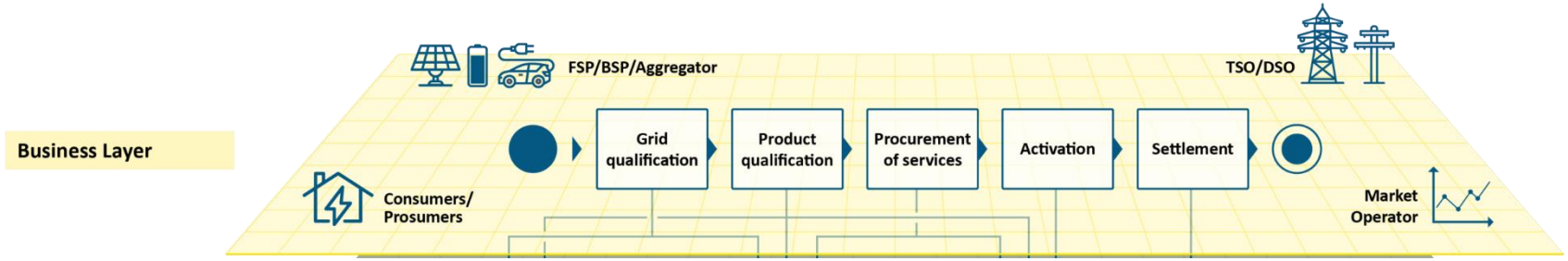
INTERRFACE

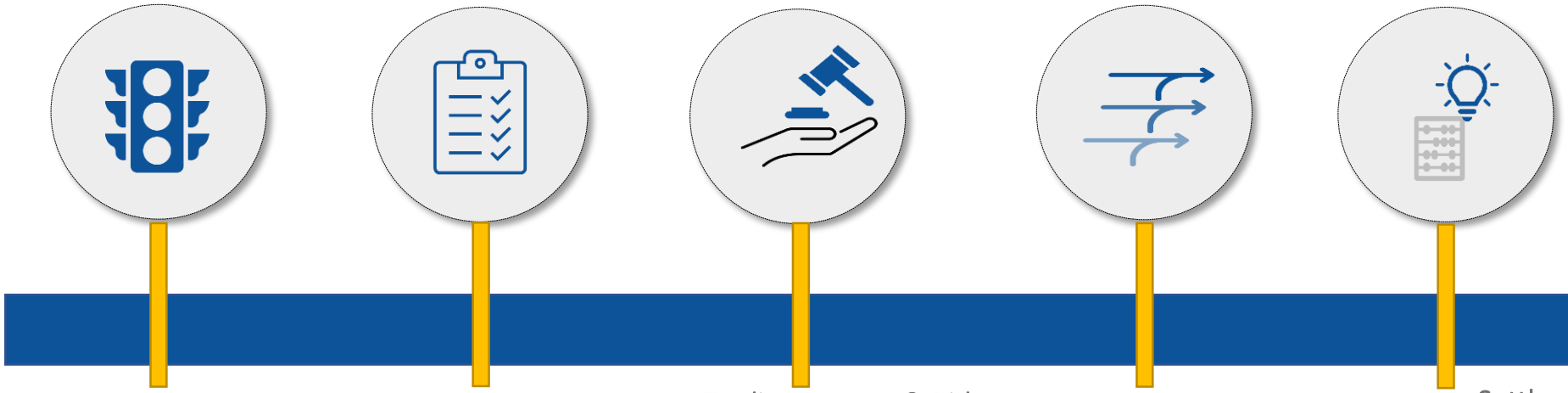


INTERRFACE Product

Interoperable pan-European Grid Services Architecture

INTERRFACE





Grid prequalification

- Custom **automated algorithm** (promoting TSO/DSO coordination)
- Direct **SO involvement**
- *Traffic light* system

Product Prequalification

- **UI Based**
- Automated inference to steer the **process based on product requirements**

Trading Process & Bid Qualification

- **Automated algorithm** promoting TSO/DSO coordination
- Direct **SO involvement**
- Gathering of **qualified bids**
- Issuing for **MOLs**

Activation

- Allowing SOs to **activate bids**
- Synchronization with integrated markets to **keep track of activations**

Settlement

- **Custom** settlement **algorithms**
- Gathering and **organization** of **settlement data**
- **Calculation** of energy settlement

INTERRFACE Product

Interoperable pan-European Grid Services Architecture

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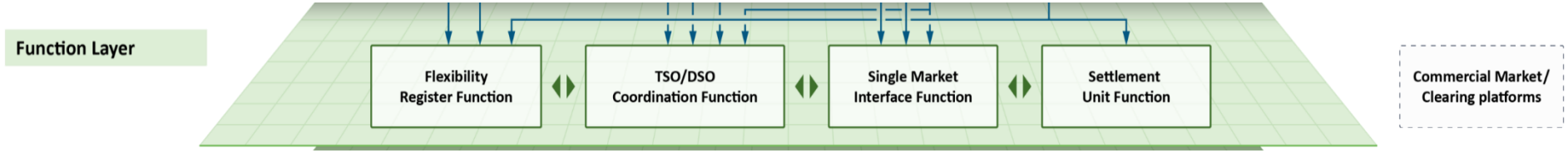

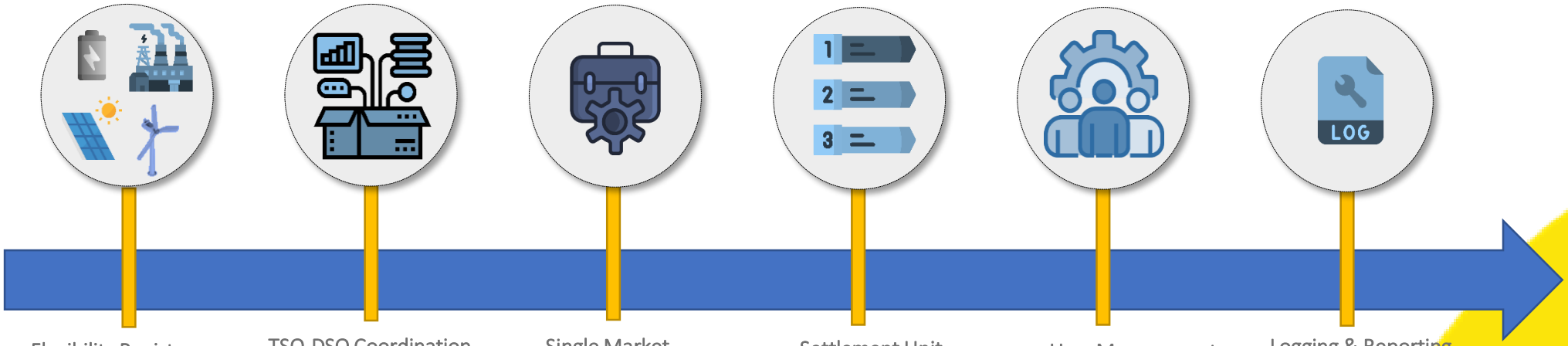

Flexibility Register
- **Repository** for flexibility assets
- **Groups of assets Management** of flexibility assets
- information on **temporal available flexibility**

TSO-DSO Coordination Platform
- **Gateway** for SOs to IEGSA
- information to SOs for **facilitating coordination**
- **Data exchange** with SOs

Single Market Interface
- Integration with **different markets**
- **Data exchange** and synchronization
- Assisting the **trading process** and facilitating **activation**

Settlement Unit
- Gathering of **settlement data**
- Connection to datahubs for settlement data **validation**
- Perform **energy settlement** according to the applied methodology in each case

User Management
- **RBAC** authentication and authorization
- Administration via **global roles**
- Handling of official **EIC codes**

Logging & Reporting
- **Data exchanges & events logging**
- **Reports generation** based on selected parameters
- **Statistics**

Finnish implementation of Single Flexibility Platform (TSO perspective)

Jukka Rinta-Luoma
Fingrid

Finnish demonstration

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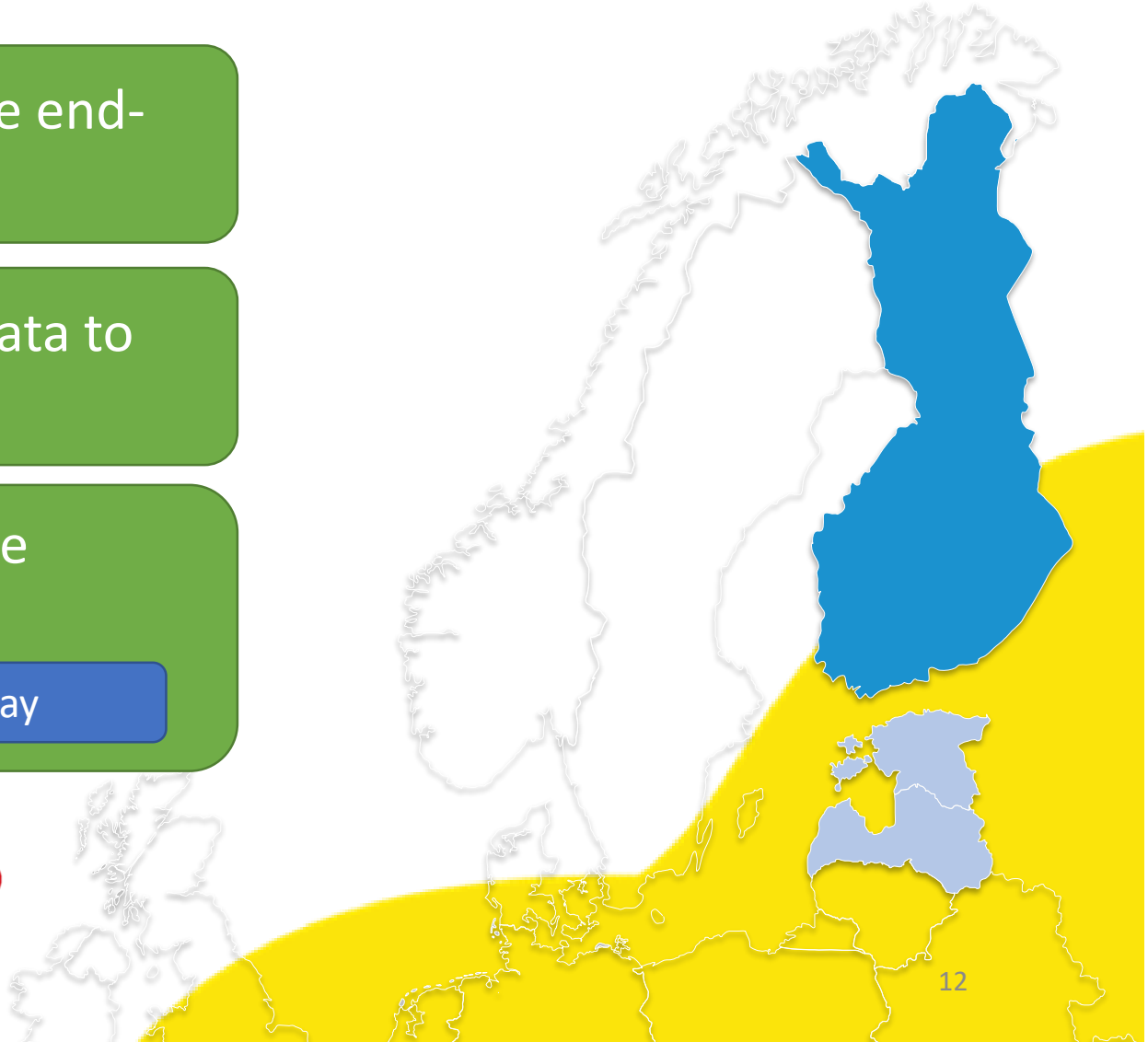
The goal of the Finnish demo was to pilot the end-to-end process of the IEGSA

Elenia and Fingrid provided simulated grid data to test the TSO-DSO coordination process

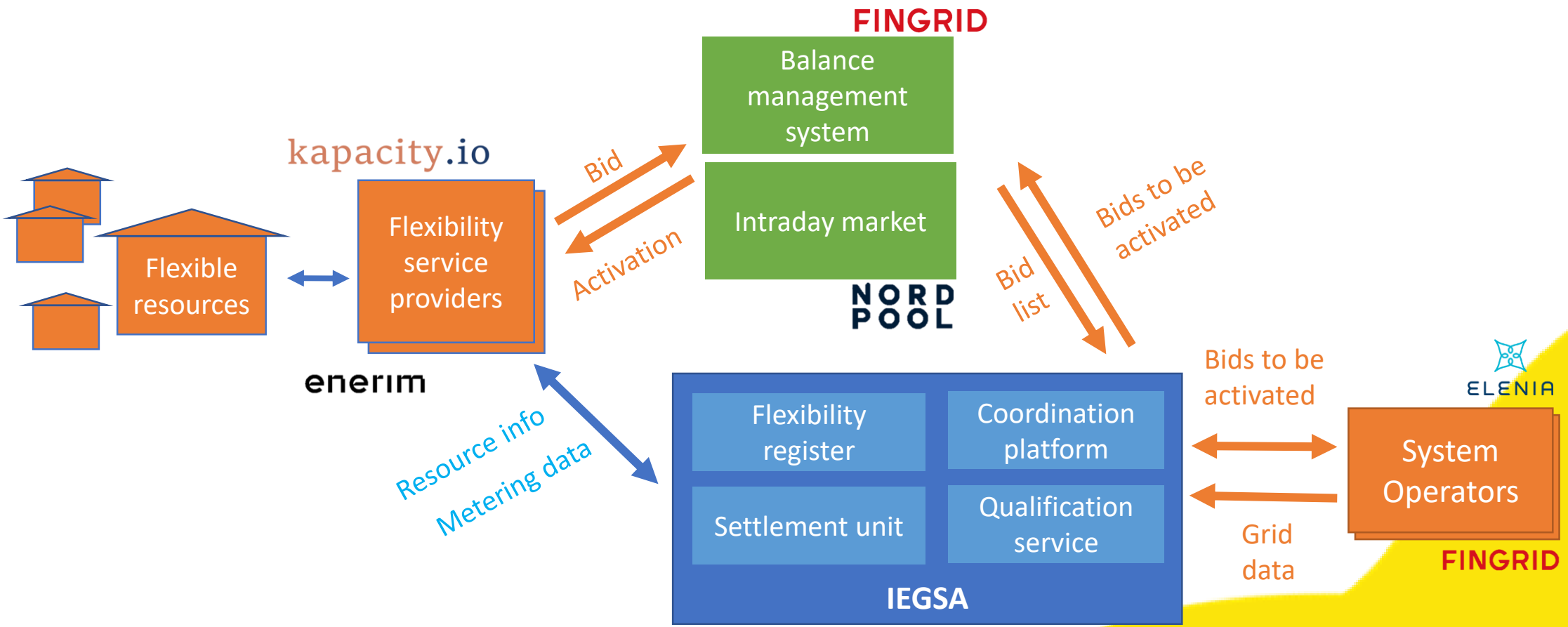
Two market platforms were connected to the system to provide flexibility bids

- Locational mFRR
- Locational intraday

enerim Tampere University ELENIA FINGRID

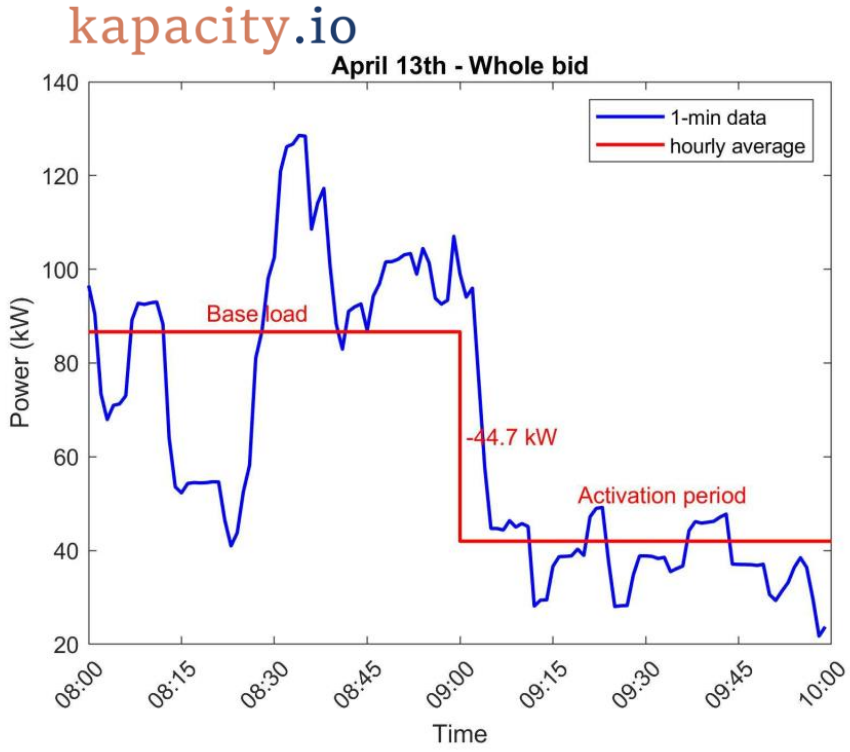


Architecture in the Finnish demonstration



Demonstration scenarios

Scenario	Scenario description	Scenario goal
1	System operator activates a flexibility bid but only part of the flexibility is supplied by the FSP.	Settlement of partial activation
2	System operator activates a flexibility bid for a period shorter than one hour.	Settlement of short activation
3	TSO activates flexibility to maintain operational security during planned outage by procuring upregulation.	Cleared congestion
4	DSO activates flexibility to maintain operational on a backup connection security during planned outage by procuring upregulation.	Cleared congestion
5	Planned maintenance is causing a long-term need for the use of backup connection, which gets congested during the daily peak hour. DSO procures upregulation from the flexibility market to clip the peak and solve the congestion.	Cleared congestion
6	Battery storage system is used to secure MV branch electricity supply during a fault. DSO procures upregulation from the flexibility market to extend the islanding time.	Extended islanding
7	Excessive solar generation is forecasted to cause distribution transformer overloading. DSO procures downregulation (load increase) from the flexibility market to clip the peak caused by solar generation.	Cleared congestion



- You can find more detailed descriptions in the public demo deliverable

Lessons learned – TSO perspective

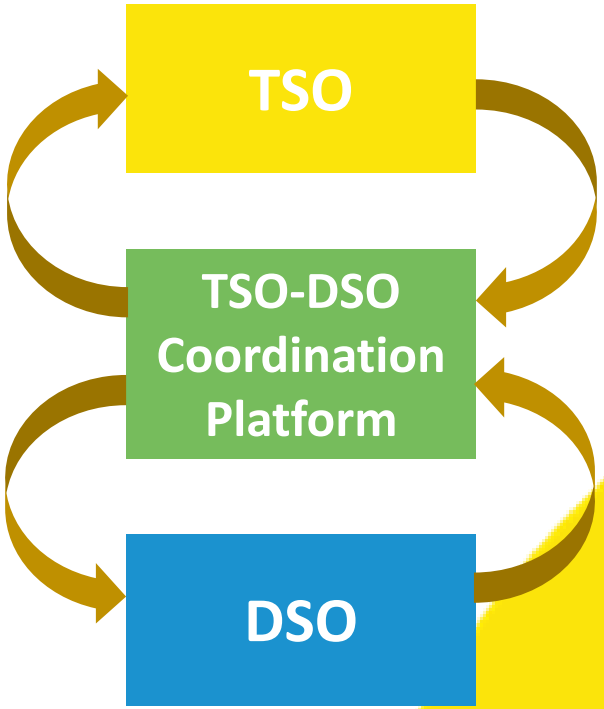
- The project was successful in creating a firm basis for flexibility markets and its core building blocks
- Important viewpoints to TSO-DSO coordination and different technical approaches to implement it
- Congestion management is doable with existing market places – by connecting the physical world to the market processes

Finnish implementation of Single Flexibility Platform (DSO perspective)

Antti Mutanen
Elenia

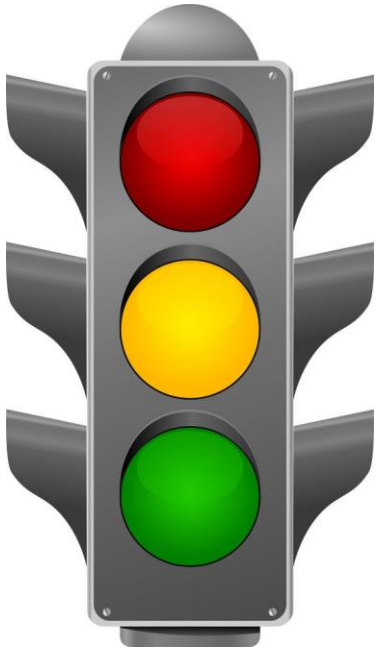
TSO-DSO coordination

- The goal of TSO-DSO coordination is to avoid situations where TSO's flexibility activations cause or aggravate overloadings in DSO network (or vice versa)
- Two-stage coordination process
  Stage 1: Flexibility resource group's *grid qualification*
  Stage 2: Flexibility *bid qualification*
- Three alternative methods for grid and bid qualification
  1) Power limit tables
  2) Network sensitivity matrices (PTDF-matrices)
  3) Qualification outside of the coordination platform



Grid qualification

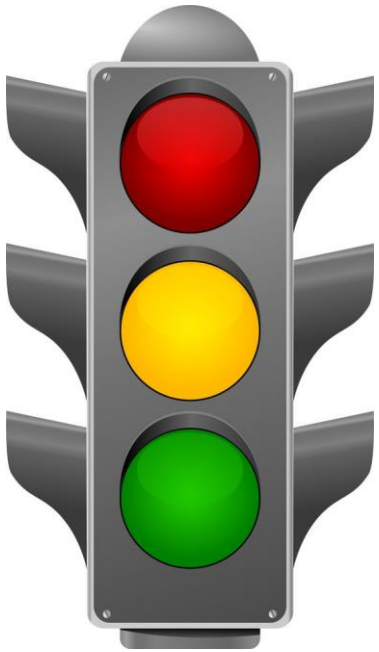
- Preliminary qualification that determines whether or not **simultaneous activation of all flexibility resources** can cause issues to system operators in the worst case situation



- **Not qualified** – Not used in the demonstration
- **Qualified with restrictions** – At times, network can become congested and then resource activation is prohibited
- **Qualified** – Resource activation is always allowed (in normal network switching state)

Bid qualification

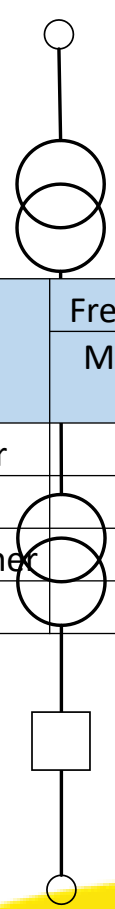
- Final qualification that determines whether or not simultaneous activation of all **locational flexibility bids submitted to market** can cause issues to system operators when activated at their scheduled time periods.



- **Not qualified** – Bid is removed from the merit order list shown to the system operators in IEGSA
- Yellow – Not in use
- **Qualified** – Flexibility bid is allowed to be procured by the system operators using IEGSA

Power limit tables

- Minimum viable product for grid and bid qualification
- System operator sends to TSO-DSO coordination platform a JSON file that contains:
  1) Simplified network topology, e.g.
     - Metering points
     - Low voltage feeder fuses
     - Distribution transformers
     - Medium voltage feeders
     - Primary transformers
     - TSO-DSO connection points
  2) Available free capacity on each of these points (separately for up- and downregulation)

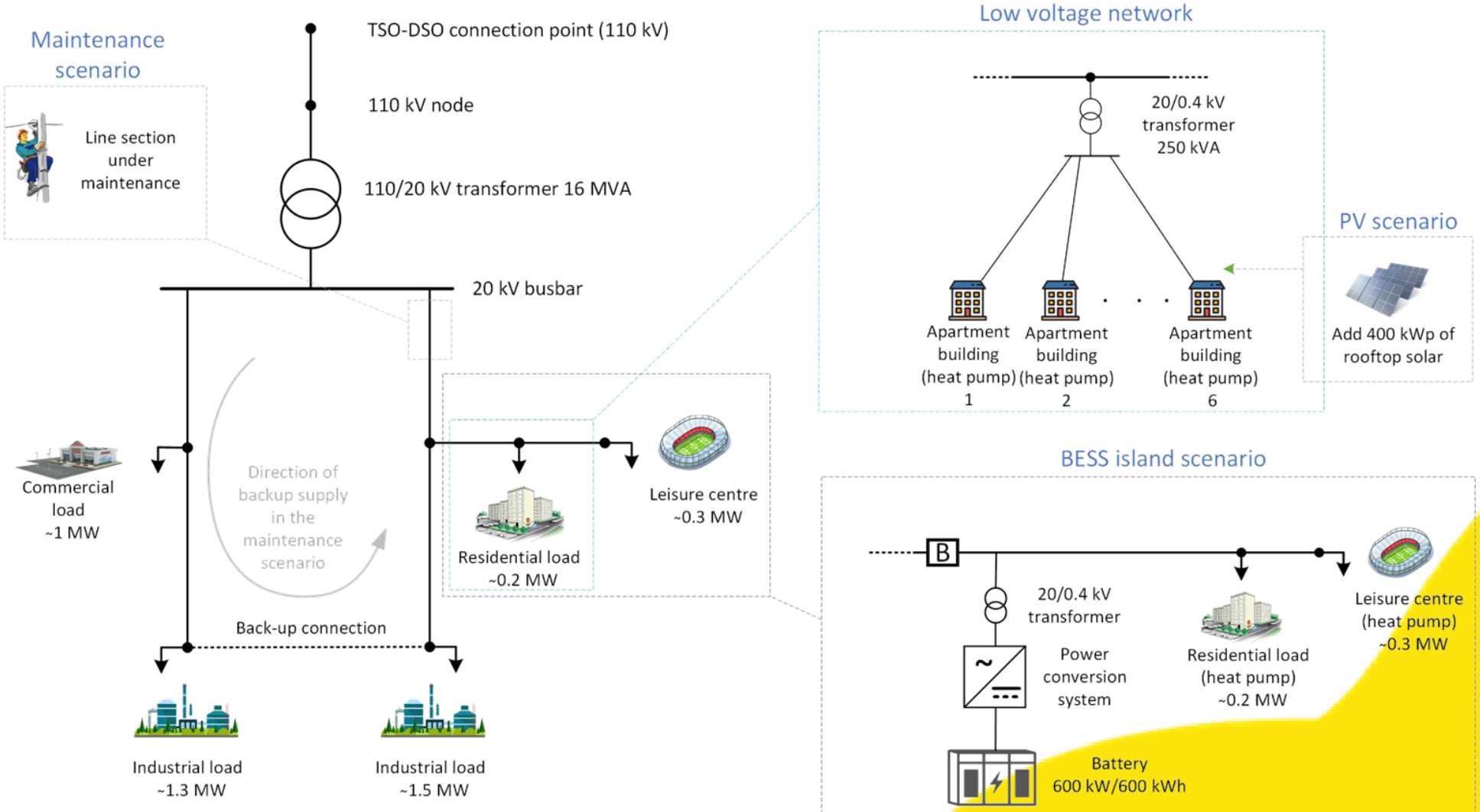


Component	Free capacity available for flexibility (cos φ=1)	
	Max. upregulation (kW)	Max. downregulation (kW)
Primary transformer	19686	1177
MV feeder	15054	9571
Distribution transformer	477,5	163,0
LV feeder	23,5	12,2

Network sensitivity matrices

- Network sensitivity matrices tell us:
  1) How the power flows change when node power injections change (PTDF-matrix)
  2) How the node voltages change when node power injections change (NVSF-matrix)
- These matrices enable fast and accurate grid and bid qualification
  + A lot of potential for further utilization in the qualification process
  - Matrices need to be recalculated each time the network switching state changes
- Requires also:
  - Network component power flow limits and forecasts
  - Node voltage limits and forecasts

Elenia's demonstration network



Lessons learned

- Elenia needs to develop capabilities for probabilistic short-term network state forecasting. This is needed for:
  1) Providing more accurate information for TSO-DSO coordination.
     - Presently, only information for the worst case situation can be provided.
  2) Forecasting network bottlenecks and determining when, where, and how much flexibility should be procured.
     - Specifically, also the uncertainties in state forecasts and flexibility service providers capability to supply flexibility should be accounted for.
- Flexibility service providers should improve their estimates on the amount of the available flexibility.
- Cold load pickup should be accounted for in flexibility procurement

Estonian implementation of Single Flexibility Platform

Kalle Kukk
Elering

Estonian demonstration

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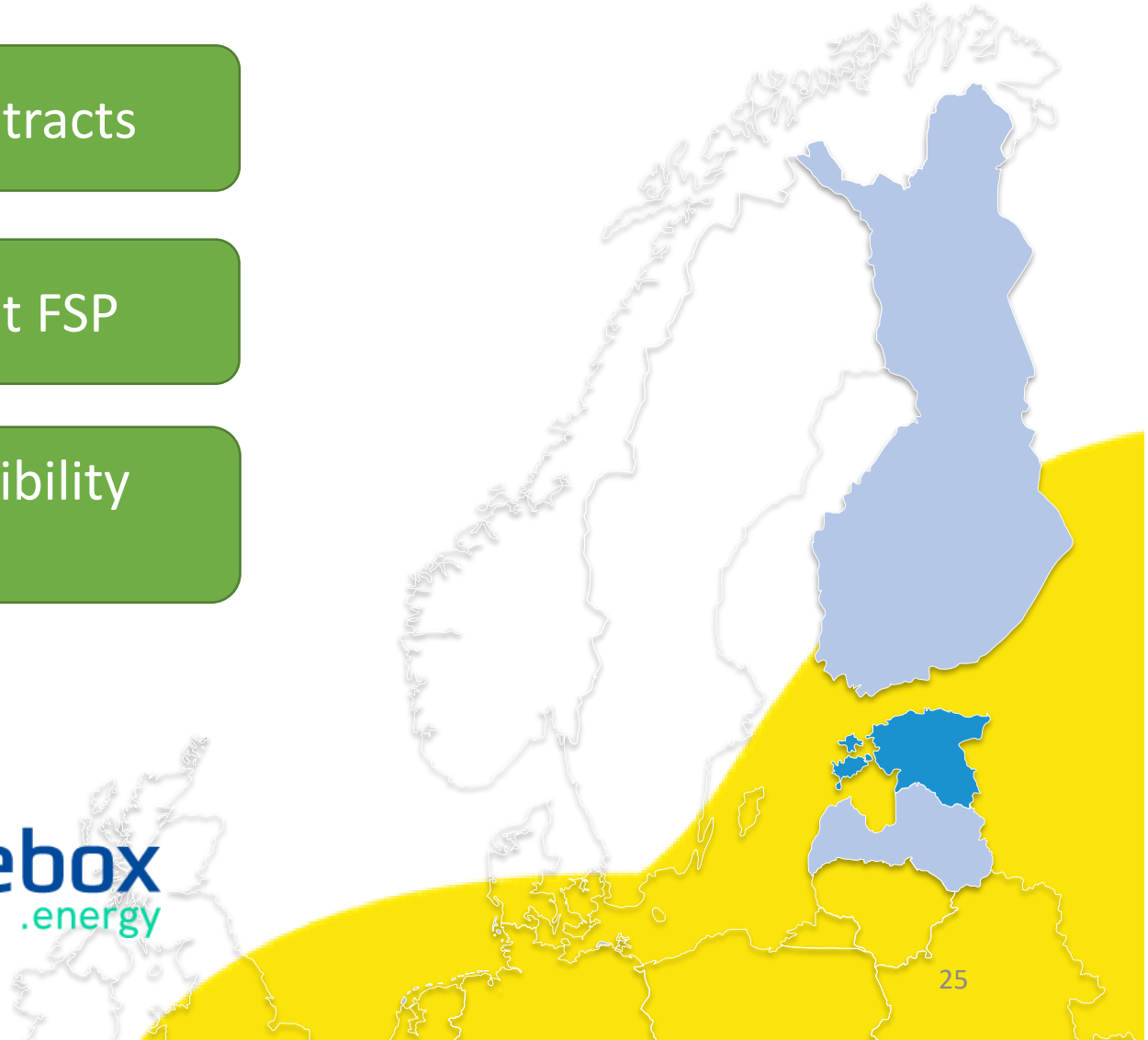
- mFRR, congestion management, flexible contracts
- The solution was tested with an independent FSP
- Standardised data exchange with Single Flexibility Platform



elering GENERATING OPPORTUNITIES

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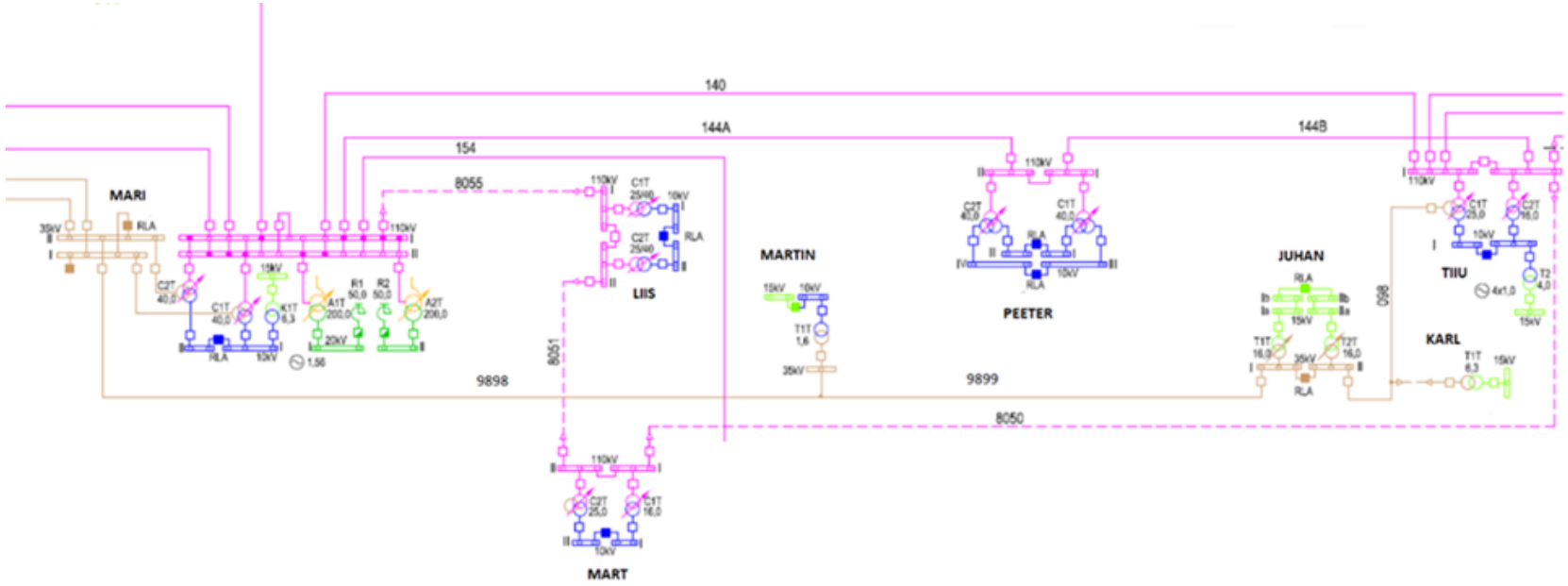
mFRR + congestion management

- Scope: resource registration, resource group building, bid submission, MOL creation, activation order sending, activated volumes sending, settlement results
- Congestion management scenario was similar to mFRR, same messages were used for operational CM product as for mFRR product. This was intentional as the ultimate goal is to use the same product for different purposes – balancing and congestion management.
- In congestion management demonstration, the main and only difference was the inclusion of DSO grid data.
- Eventually all planned steps for mFRR product were successfully performed.

Grid data

- Such grid data may include topologies, node limitations, energy flow estimates, PTDFs, etc., depending on the specific design preference.
- Based on the example of a major town in Estonia the scenario considers a case whereby voltage issues may occur if the reconstruction of an existing substation or investments into new infrastructure would be postponed and if this was not replaced by adequate flexibility measures.



Flexible grid contracts

- During the test case the existing flexible grid connection agreements were converted into hourly short term bids and shared to IEGSA for common MOL.
- TSO has the right to limit the capacity in the amount of flexible capacity by notifying the connecting customer beforehand (at least X hours).
- 0-priced bids might create uneven involvement in the market.
- Real-time measurements needed to understand the amounts available at any MTU.
- The role of the aggregator and balancing responsibility for the flexible grid contracts is not defined currently.

Date **Y-0** - 01.01.2021 00:00 - 01.01.2022 00:00 (EET) Suund Up

TIMESTAMP	PAINDLIK LIITUJA				
	STAATUS	EIC	NIMI	FIRM	FLEX
02.01.2021 00:00 - 03.01.2027 00	1	EIC1	[redacted]	38	2
02.01.2021 00:00 - 03.01.2027 00	1	EIC2	[redacted]	2	7.125

General observations

1. Existing technical solutions have not been designed to facilitate the participation of a high number of FSPs and resources.
2. Also, the EU requirements are changing, potential new network code for demand response is under discussion.
3. The concept and tools developed within INTERRFACE tackle these issues and provide a sufficiently streamlined solution especially for smaller FSPs to enter and participate in the market.
4. The concept also enables the participation of third-party Market Operators.
5. Using same resources simultaneously for different needs (such as balancing and congestion management) will increase the complexity of grid impact assessment.
6. Flexible grid contracts have not found the way to the market even though it is enabled already now.

Lessons learned

1. The processes and technical solution of flexibility market can still be fine-tuned to follow new business requirements.
2. Novel optimisation algorithms will be required, e.g., based on PTDF approach.
3. Proper baselines and access to sub-meter data are needed in case of small, distributed resources to check if they had delivered what they were asked for.
4. Consent management mechanisms need to be in place for private data.
5. Future standardisation with CIM expert group for congestion management product related data exchanges to support interoperability.

Latvian implementation of Single Flexibility Platform

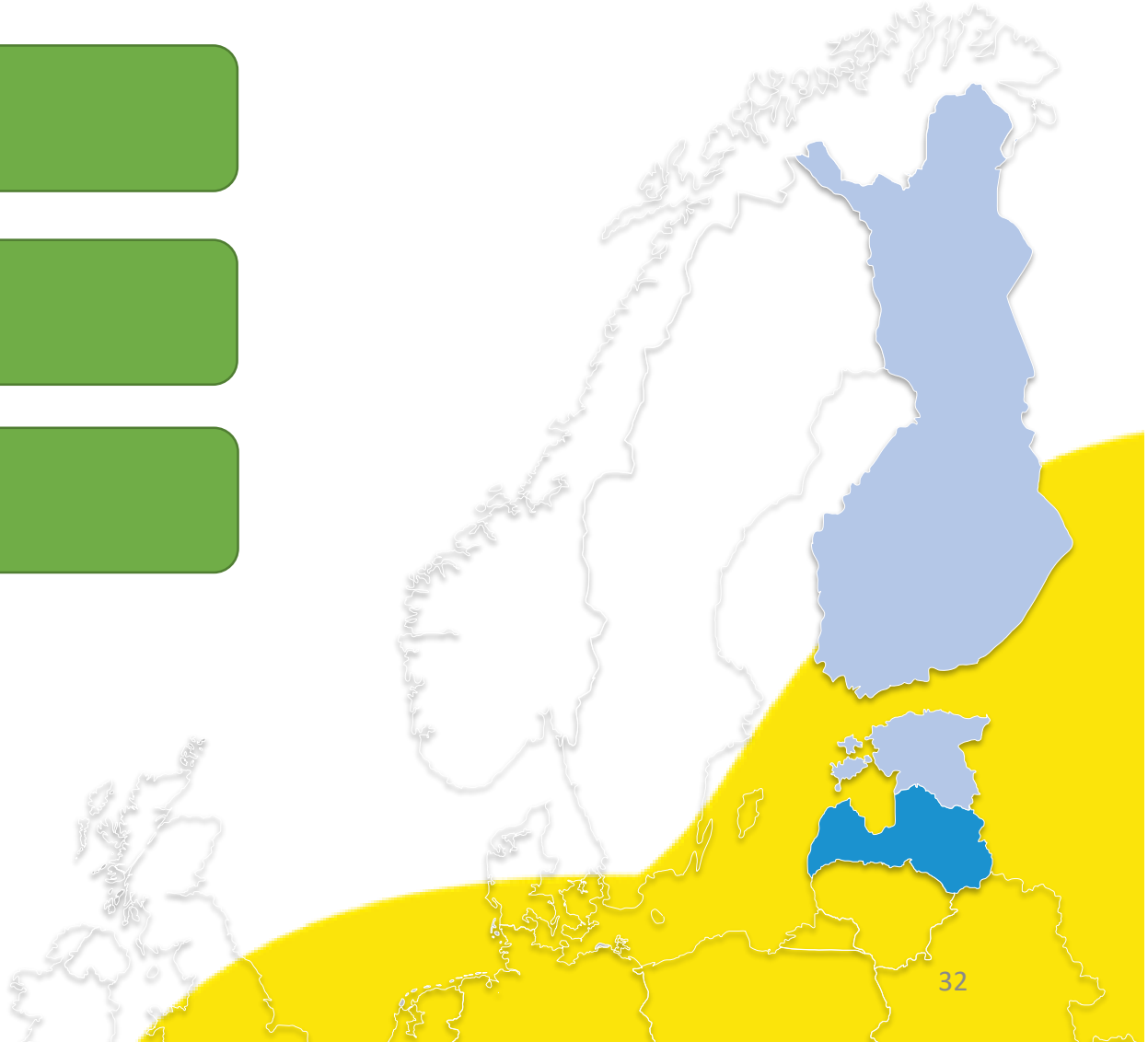
Ivars Zikmanis
AST

Latvian demonstration

INTERRFACE

- Test the end-to-end process of the IEGSA
- Two market products – mFRR and CM
- Combination of real and simulated data

AST



Data exchange

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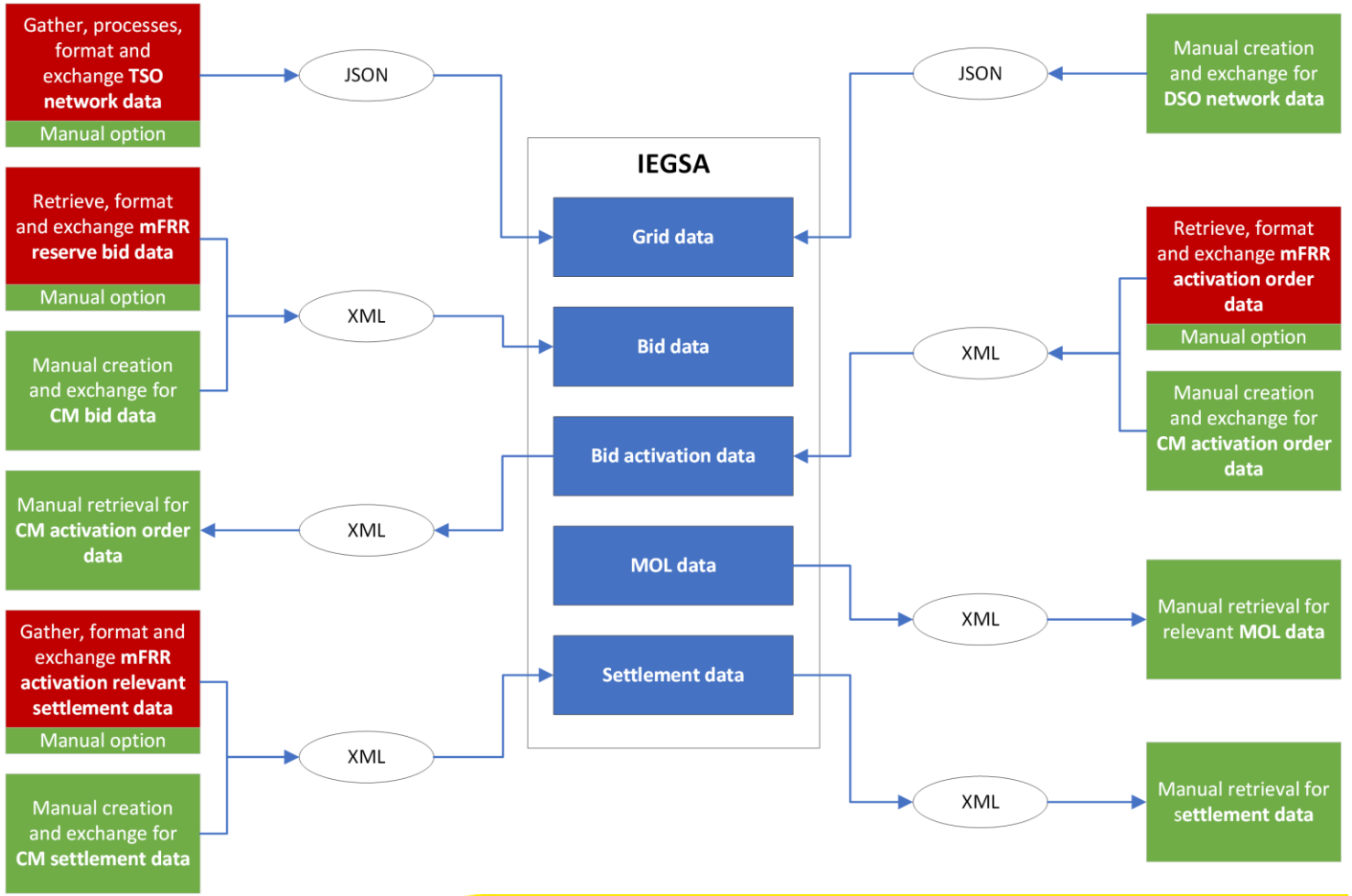
Figure color decipher:

- RED – automated tools;
- GREEN – manual in/out;
- BLUE – SFP (IEGSA).



Grid data

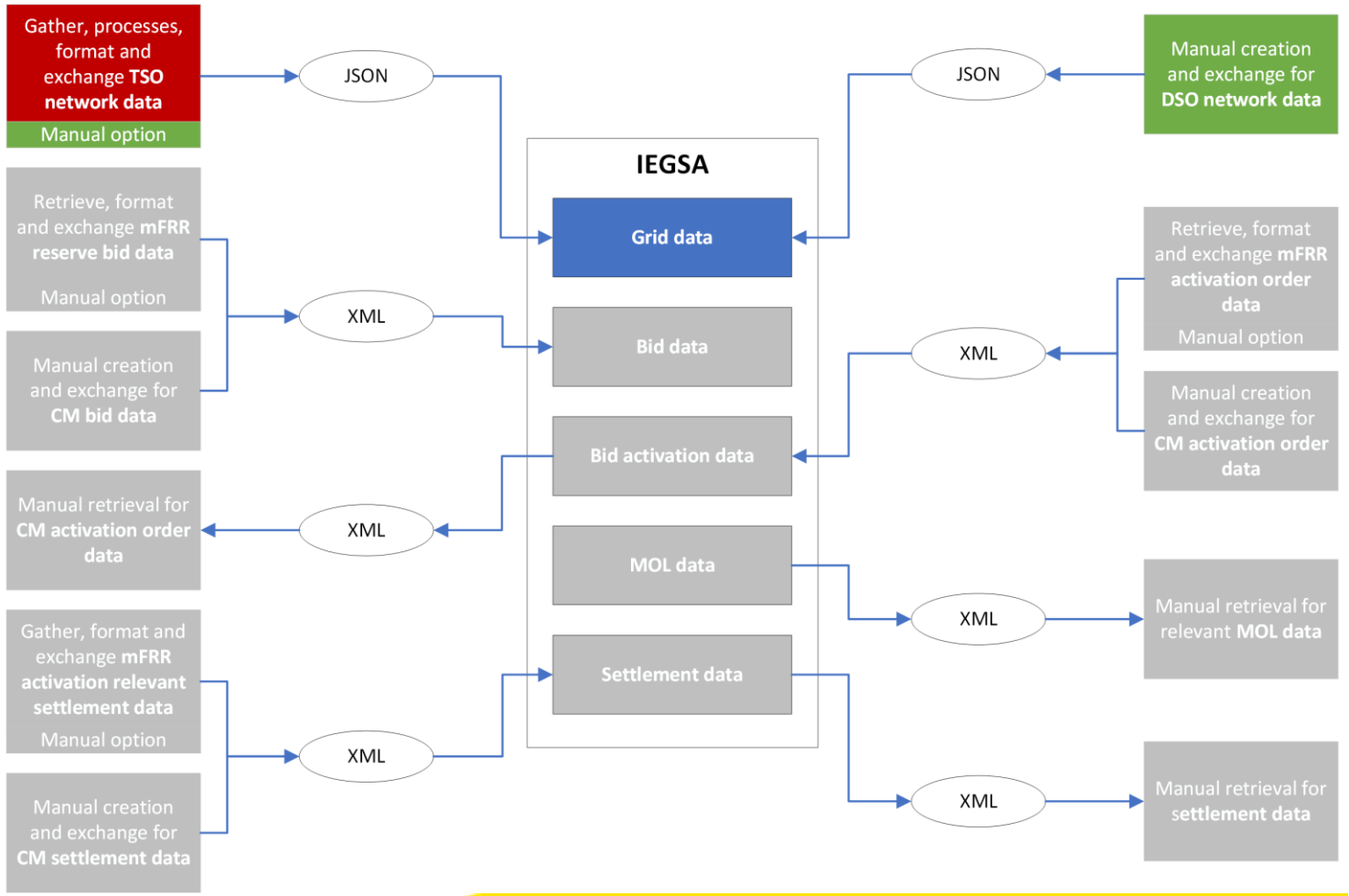
DSO network:

- Test data;
- Scenario molded.

TSO network:

- Real data;
- 62 substations;
- Automated limit forecast.

TSO network limit forecasted based on average power flow data.



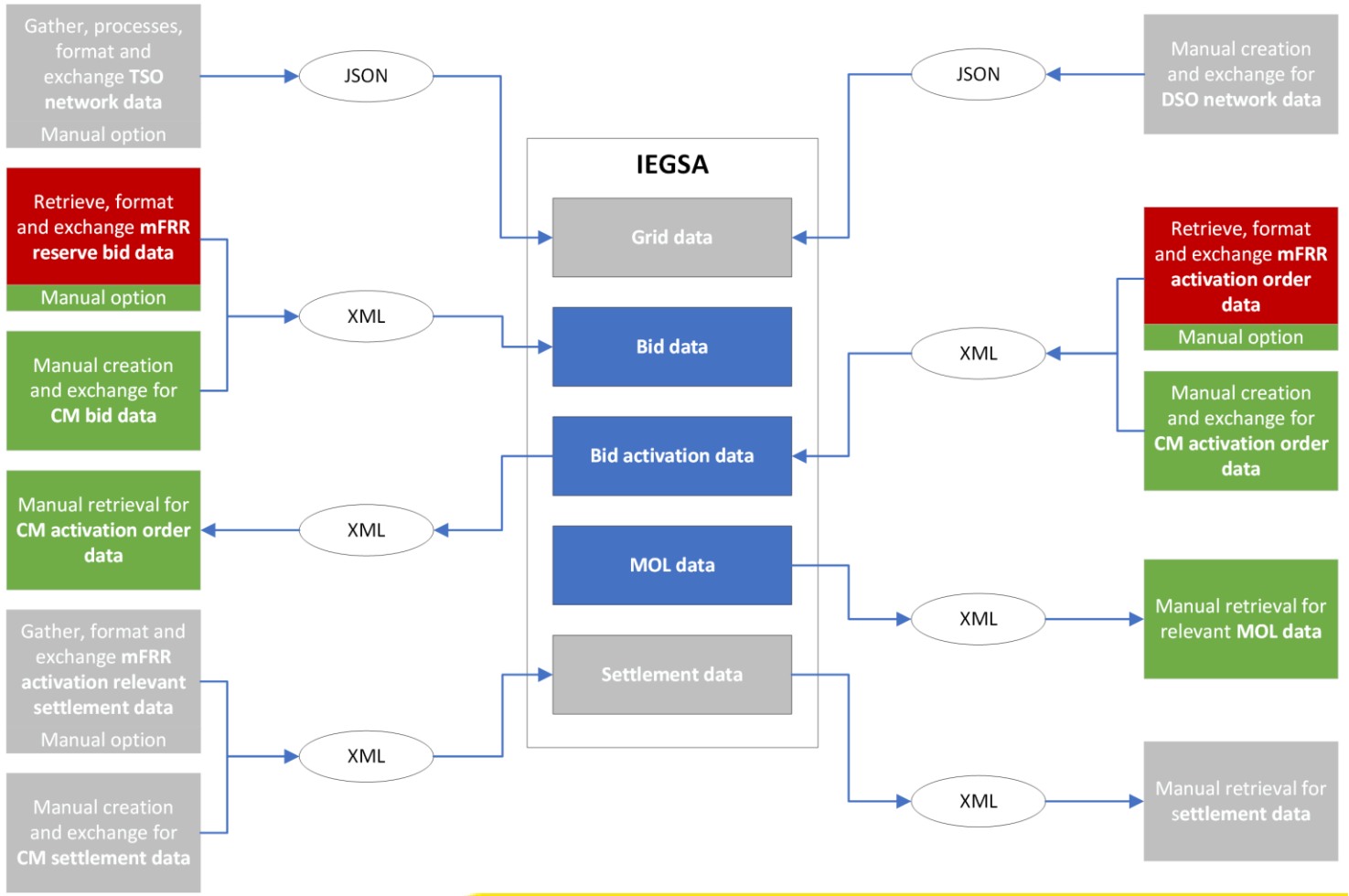
Trade data

Trade data:

- Market bids;
- Market bid activation;
- Merit order list (MOL).

Trade data source:

- Real market data;
- Test scenario data.



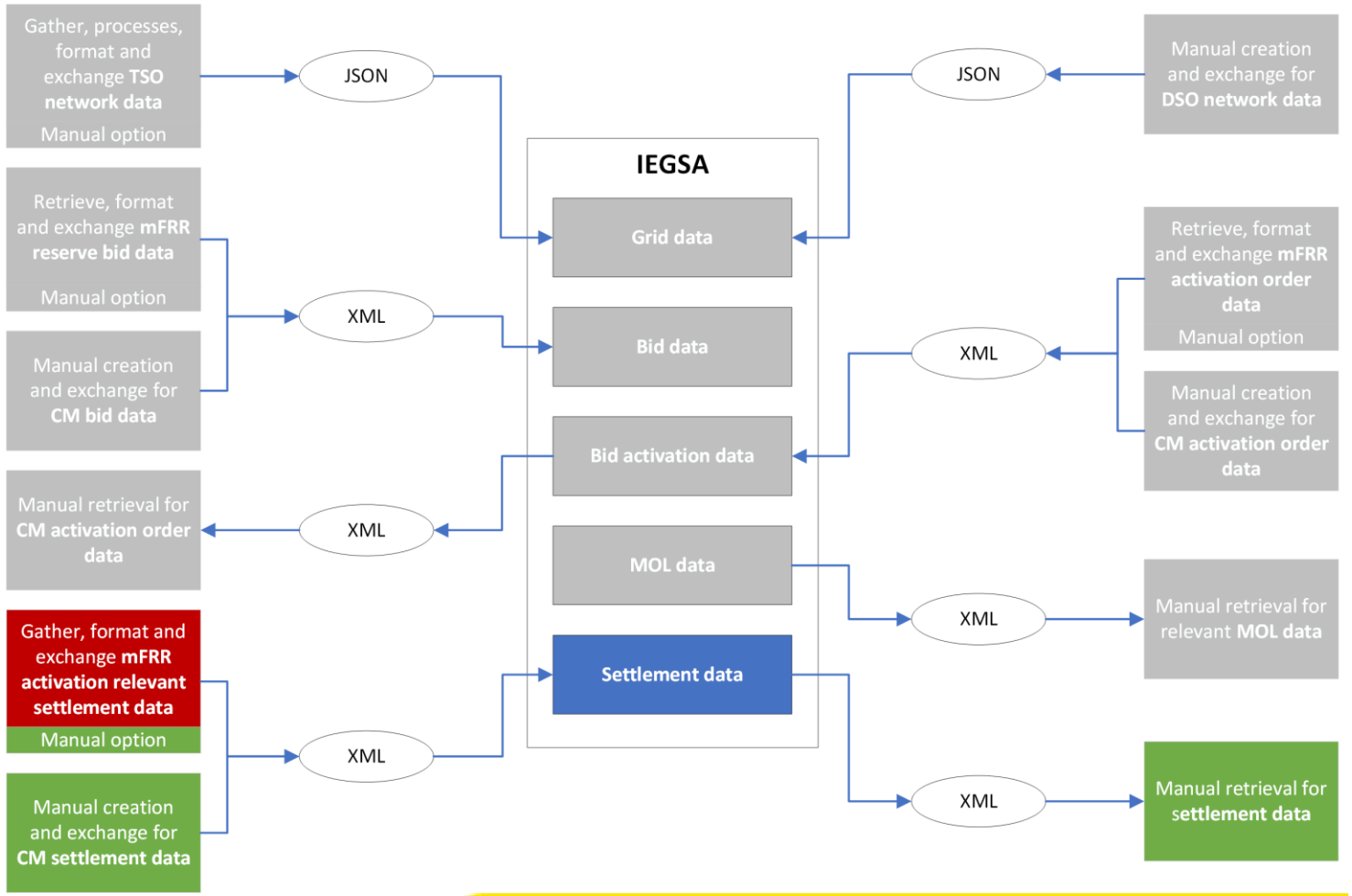
Settlement data

Settlement data:

- Activation confirmation;
- Metering data.

Settlement data source:

- Real metering data;
- Test scenario data.



mFRR scenarios

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Scenario aim – test compatibility with current mFRR processes.

Scenario	Possible?	Outcome expected?	Comment
Partial activation *(volume/duration)*	Yes	Yes	Activations under 60 min cause issues in settlement.
Activation modification *(volume/duration)*	Yes	Yes	Modify after market period has ended.
mFRR continuous process testing	Details in the table below.		

Scenario: mFRR continuous process testing

	Messages exchanged	Unprocessed messages	Unprocessed/ all messages, %
Total	4619	105	2.3%
Daily maximum	241	21	–
Daily minimum	65	0	–

CM scenarios

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Scenario aim – test FSP portfolio management and maintain system stability.

Scenario	Possible?	Outcome expected?	Comment
Multiple FSP registration	Yes	Yes	Up to 20 FSPs.
Large FSP portfolio	Yes	Yes	Up to 100 resources in portfolio.
FSP resource modification outside of grid limits	Yes	Yes	Vague restriction information.
FSP market bid outside of grid limits	No	Yes	Highlights need to inform FSP about network restriction impact on resources.
FSP resource modification after same resource market bid submission	Yes	Yes	Market bids are removed.
SO multiple market bid activation and cause of network congestion	Yes	Yes	Highlights need of further TSO-DSO coordination when activating market bids.

Conclusions

Highly beneficial functionalities:

- FSP portfolio management support;
- Manage grouped distributed resources;
- Maintain TSO-DSO system stability;
- Provides new service 'CM' with future potential.

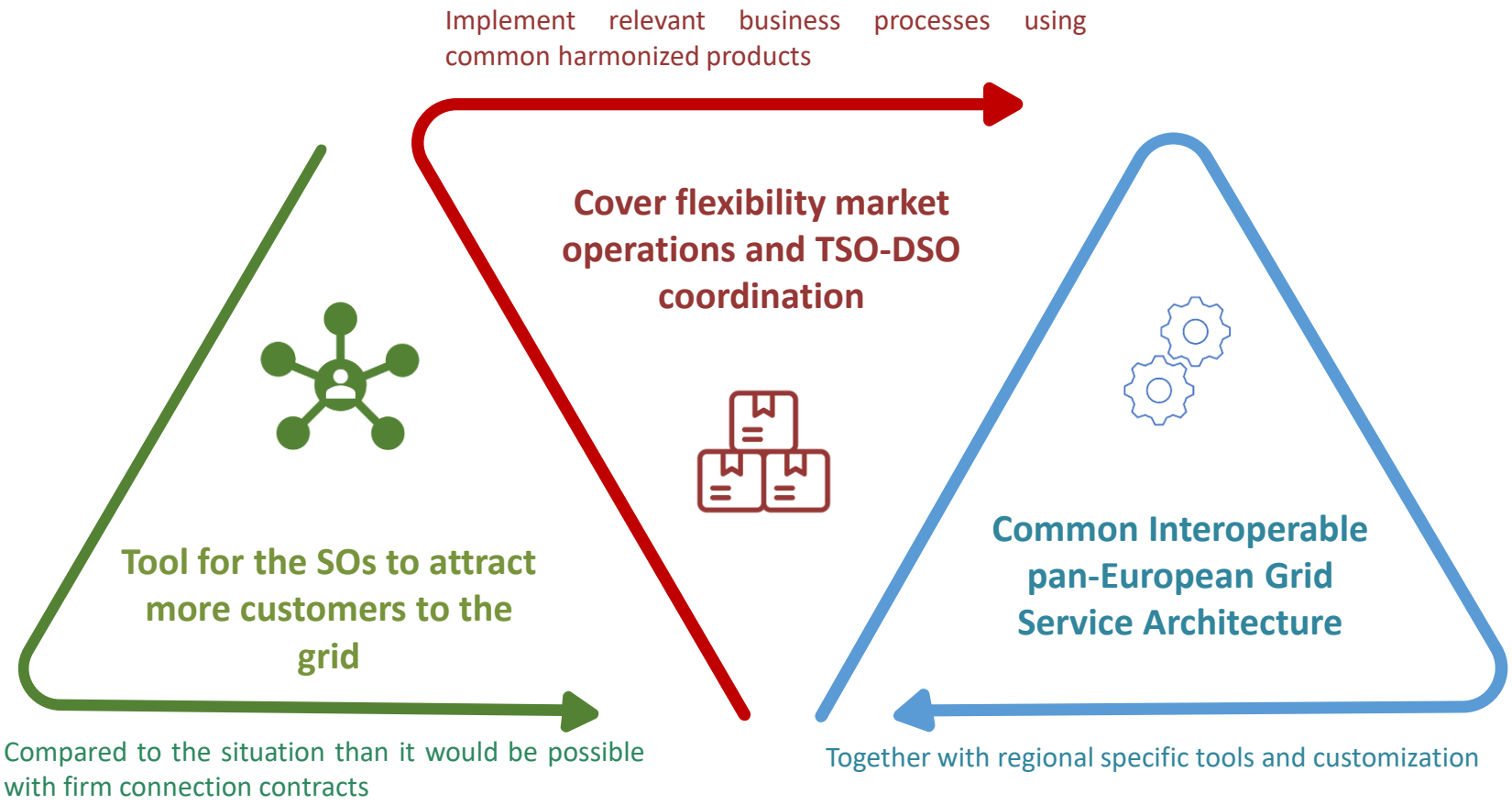
Further development need:

- Improve data processing;
- Maintain TSO-DSO system stability during market bid activation;
- Clarify FSP resource limitation information.

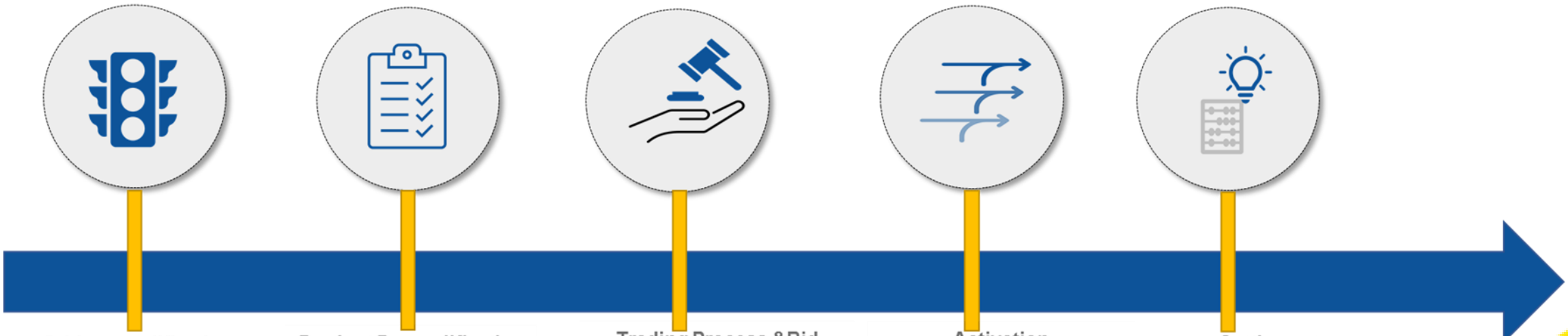
Technical architecture

Marko Petron
Cybernetica

What is Single Flexibility Platform?



Business processes



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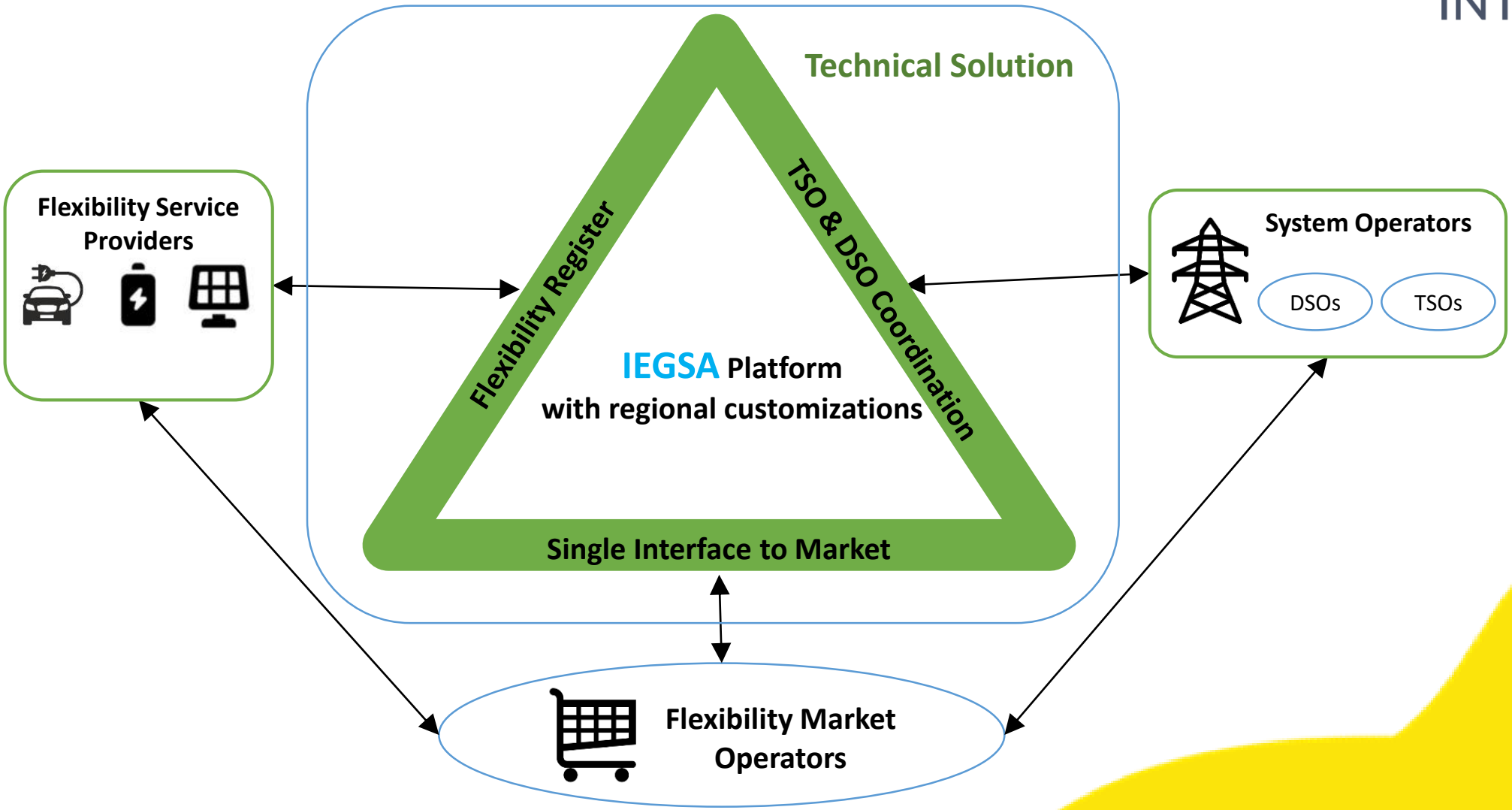
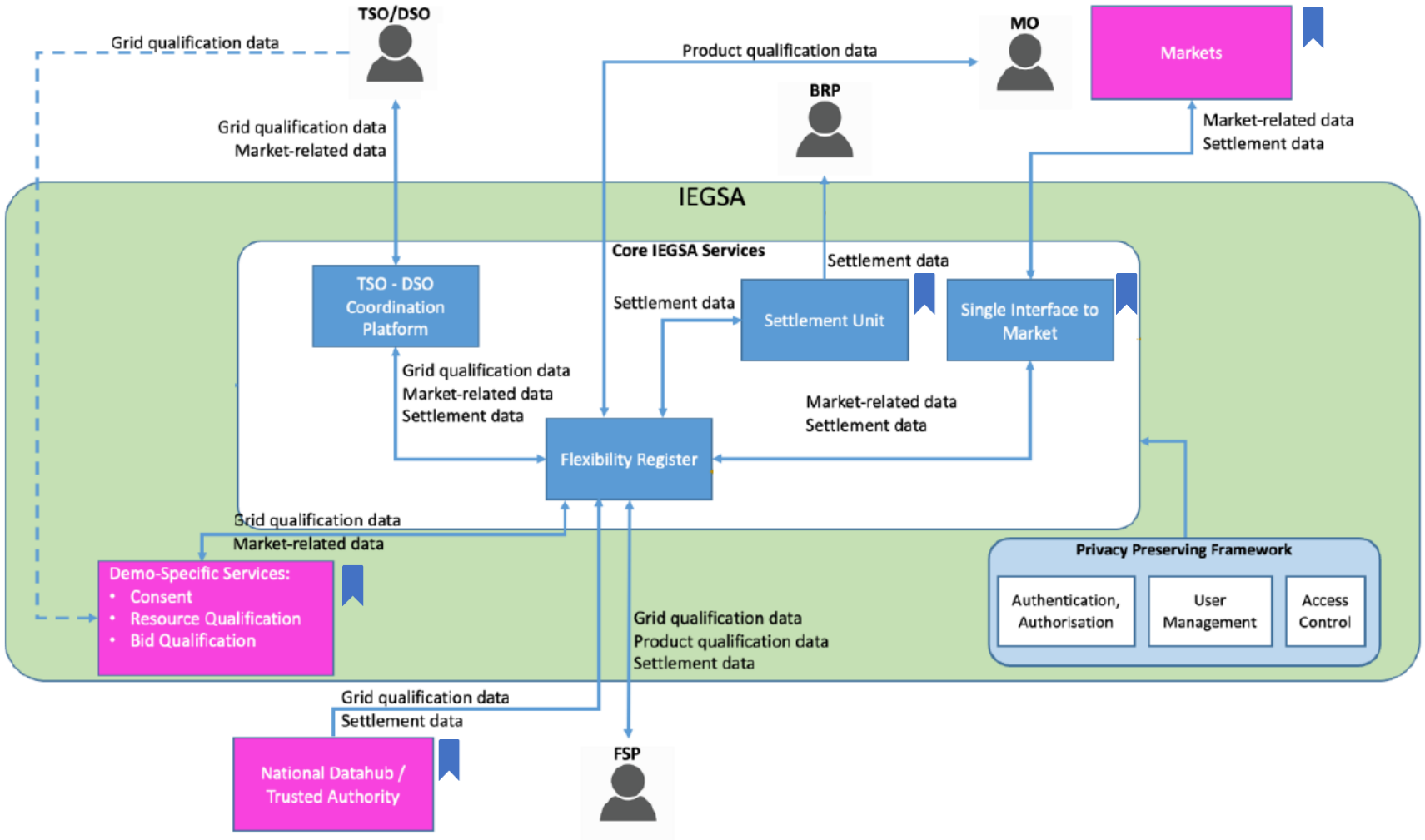
SFP Functional diagram



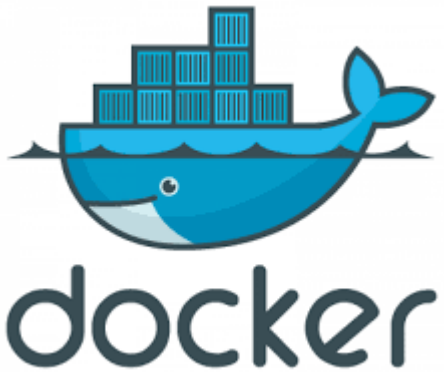
Software architecture



- Common IEGSA platform
- Regional customizations

Architectural stack

Angular
Java 15
spring-boot 2.4.0
spring-framework 5.3.1
spring-framework-security 5.4.1
springdoc-openapi-ui 1.5.0
Tomcat 9.0.53
Orient DB, MariaDB
Docker Compose 1.29.2
Docker Engine 20.10.8
openjdk:15-jdk-oraclelinux7
OrientDB image is orientdb:3.1.2
Estfeed 2 SDK and client



Next steps

Jan Segerstam
Enerim

Beyond INTERRFACE, Next steps

- Flexibility is more important than ever before
  - Energy balance and portfolio optimization create use cases beyond INTERRFACE, benefiting from base mechanisms created in the project

- Network flexibility requirements rise on both DSO and TSO levels as more distributed energy resources are set up and mobile energy use increases
  - Solar and wind power
  - EV Charging
  - Battery operators
  - P2X implementations

Beyond INTERRFACE, Next steps

- INTERRFACE Demonstrations were completed successfully
  - The concepts for the single flexibility platform were validated
  - Lessons learned enabled both market and flexibility access related development to take place
  - National stakeholders are engaged in discussion on setting up the market in the coming years

- The OneNET project is building on INTERRFACE knowledge
  - The flexibility concept is being deepened by working with multiple products and connectivity to overarching markets and emerging TSO collaboration based markets in Europe

- Regulatory steps are underway to enable DSO flexibility in all member states

Beyond INTERRFACE, OneNET

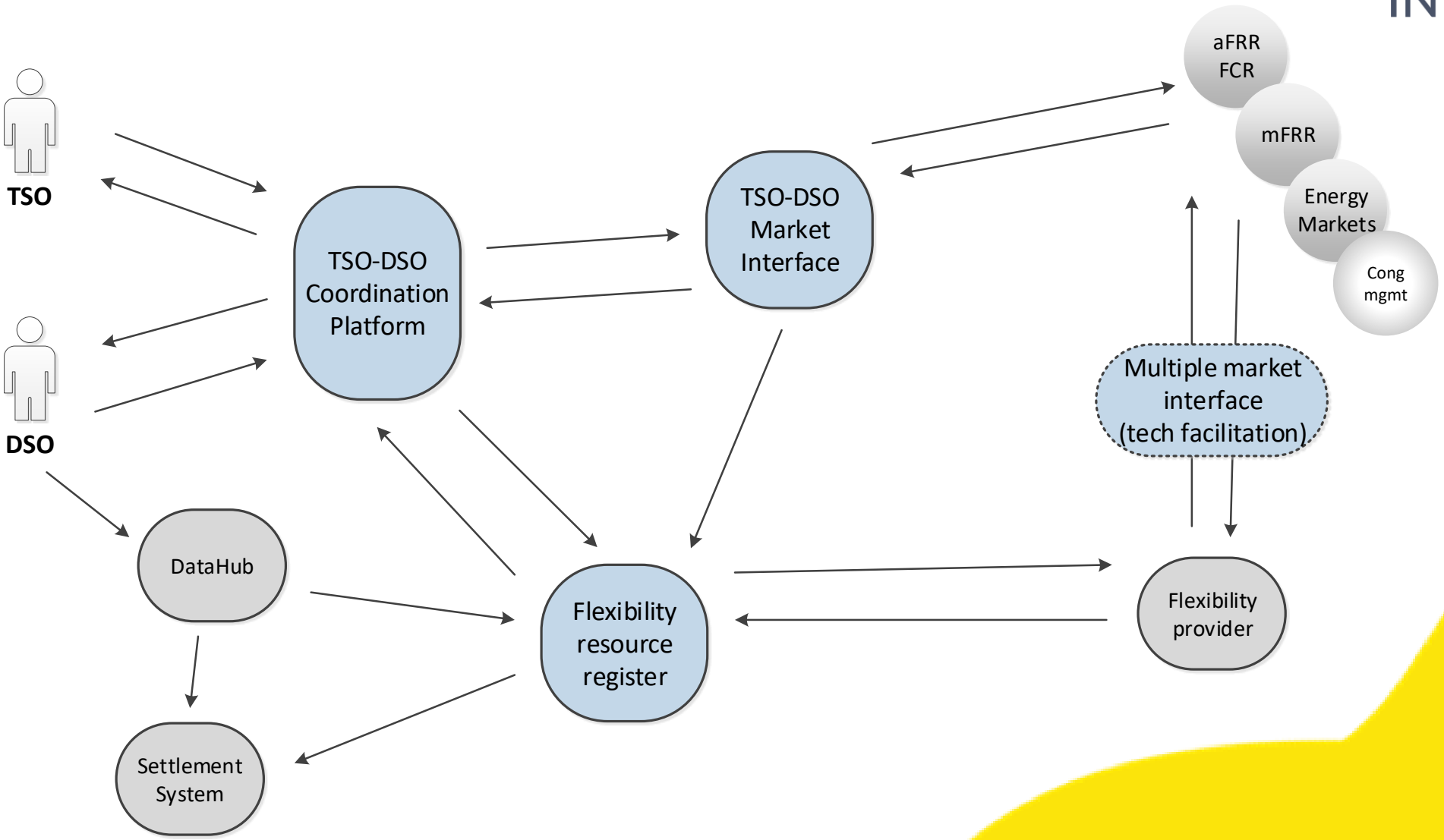
INTERRFACE

- The OneNET project starts concrete online demonstrations in the first half of 2023 and the project runs to 2024
- 72 Partners, 23 Countries, 28 MEUR, 3 years
- Our Northern demo partners are from Ireland, Norway, Sweden, Finland, Estonia, Latvia and Lithuania

- An integrated effort by multiple TSOs and DSOs to enable market driven flexibility uptake in a coordinated way through multiple liquid markets

- Enabled by implementing the framework developed in the INTERRFACE project and scaling up both the number of networks and the capability of the flexibility enabling solution mechanisms

Our future flexibility environment



Beyond INTERRFACE, Next steps

- Member states are now implementing flexibility in their energy systems
  - The Nordic and Baltic states are in a special position to show collaborative capabilities based on already established joint structures

- Flexibility can already be traded on multiple markets, stakeholders can start their journey now on the TSO marketplaces and continue onward as features and functionality develops from both INTERRFACE and OneNET

- National stakeholder and regulatory collaboration in all fields
  - DSO role and procurement rights in flexibility markets
  - Initial information sharing platform for flexibility (Flexibility register)
  - Uptake of TSO DSO coordination capabilities from INTERRFACE and OneNET work

Q&A

Thank you!

Demo report:
http://interrface.eu/sites/default/files/publications/INTERRFACE_D5.5_vPUBLIC.pdf

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