Innovative approaches to unlock flexibility. The experience of EU-SysFlex

Workshop on Energy System Flexibility, INESC Coimbra. 2 Feb 2022

Miguel Marques, EDP NEW

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① **EU-SysFlex Project Overview**

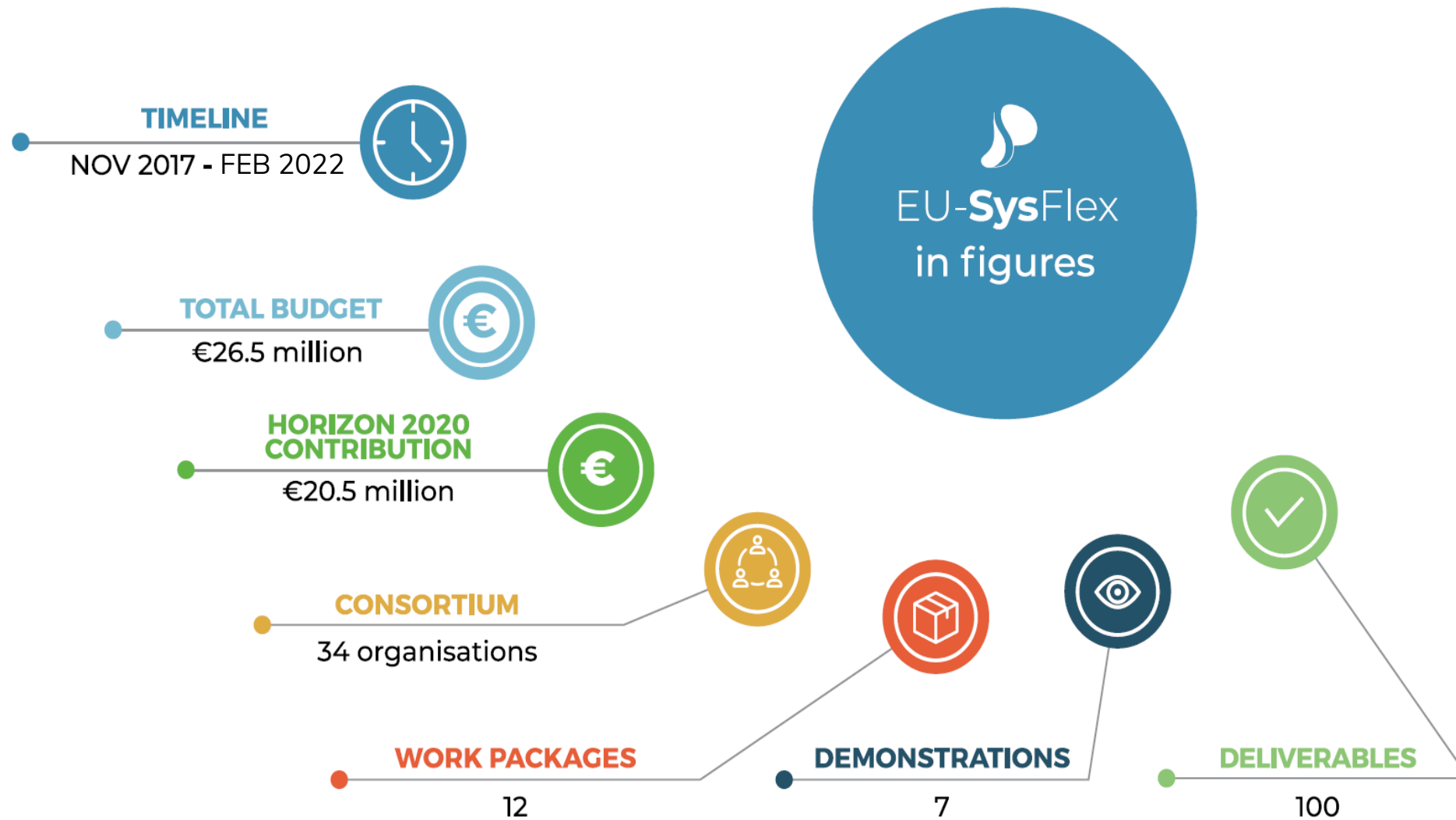② **Virtual Power Plant: Overview and Key Findings**
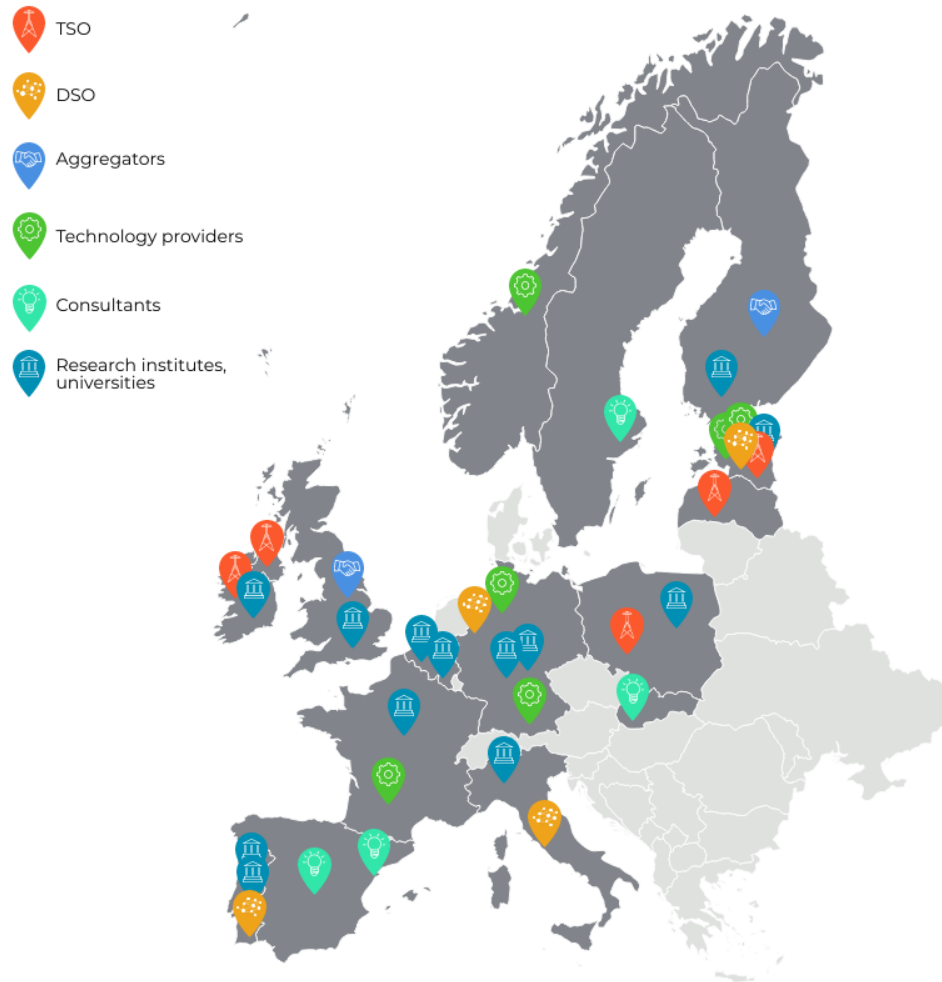
③ **EU-SysFlex: Key messages**

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1 **EU-SysFlex Project Overview**

2 Virtual Power Plant: Overview and Key Findings

3 EU-SysFlex: Key messages

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EU-SysFlex is a very large Horizon 2020 project...

EU-SysFlex in figures

TIMELINE
NOV 2017 - FEB 2022

TOTAL BUDGET
€26.5 million

HORIZON 2020 CONTRIBUTION
€20.5 million

CONSORTIUM
34 organisations

WORK PACKAGES
12

DEMONSTRATIONS
7

DELIVERABLES
100

EU-SysFlex

...Carried out across Europe in a multi-disciplinary consortium

TSO
DSO
Aggregators
Technology providers
Consultants
Research institutes, universities

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EU-SysFlex

The project demonstrates reliable and efficient flexibility solutions to integrate 50% RES in the European Power System...

OVERALL INCREASE IN SYSTEM COMPLEXITY

TODAY...		...2030 >>	
30% RES	SCALE	**50% RES**	
	MIX	GREATER RELIANCE ON VARIABLE SOURCES OF ELECTRICITY	ELECTRIFICATION OF HEAT, COOLING AND TRANSPORT — LARGE-SCALE DEPLOYMENT OF BATTERY STORAGE
PREDOMINANTLY CENTRALISED	SYSTEM STRUCTURE	BECOMING MORE DECENTRALISED	SMARTER LIVING

...2050 >> ELECTRICITY USE IS ESTIMATED TO INCREASE FROM 20% OF THE OVERALL EUROPEAN ENERGY USE TODAY TO 40% OF ENERGY NEEDS.

...in a future power system increasingly reliant on variable and non-synchronous sources of electricity

Energy Transition
52% RES-E for Europe in 2030
Energy Transition
aligned with EU REF 2030

Renewable Ambition
66% RES-E for Europe in 2030
Renewable Ambition
aligned with EU REF 2050

23 % VRES

34 % VRES

% of non-synchronous renewable generation

0%   71%

Share of Non Synchronous Penetration (Wind + PV) (%) in Renewable Ambition scenario (34% VRES)

	Spain	Germany	Italy	France
SNSP max	95	90	84	85
SNSP mean	73	49	43	40

■ SNSP min   ■ SNSP mean   ■ SNSP max

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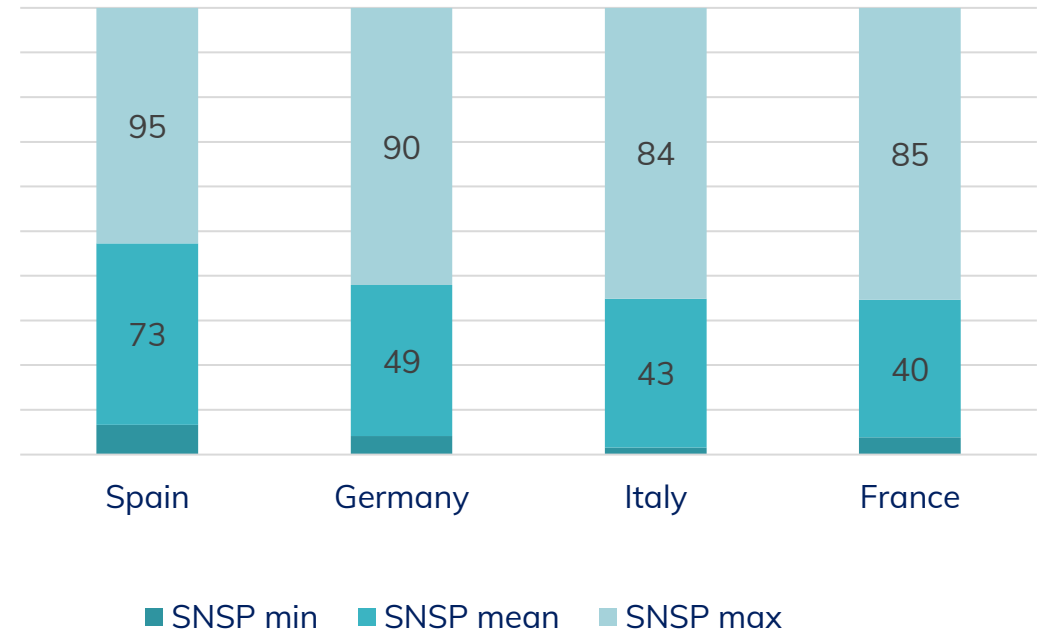
The project delivers a comprehensive roadmap for system flexibility, demos playing a key role testing the various options & contexts for flexibility provision
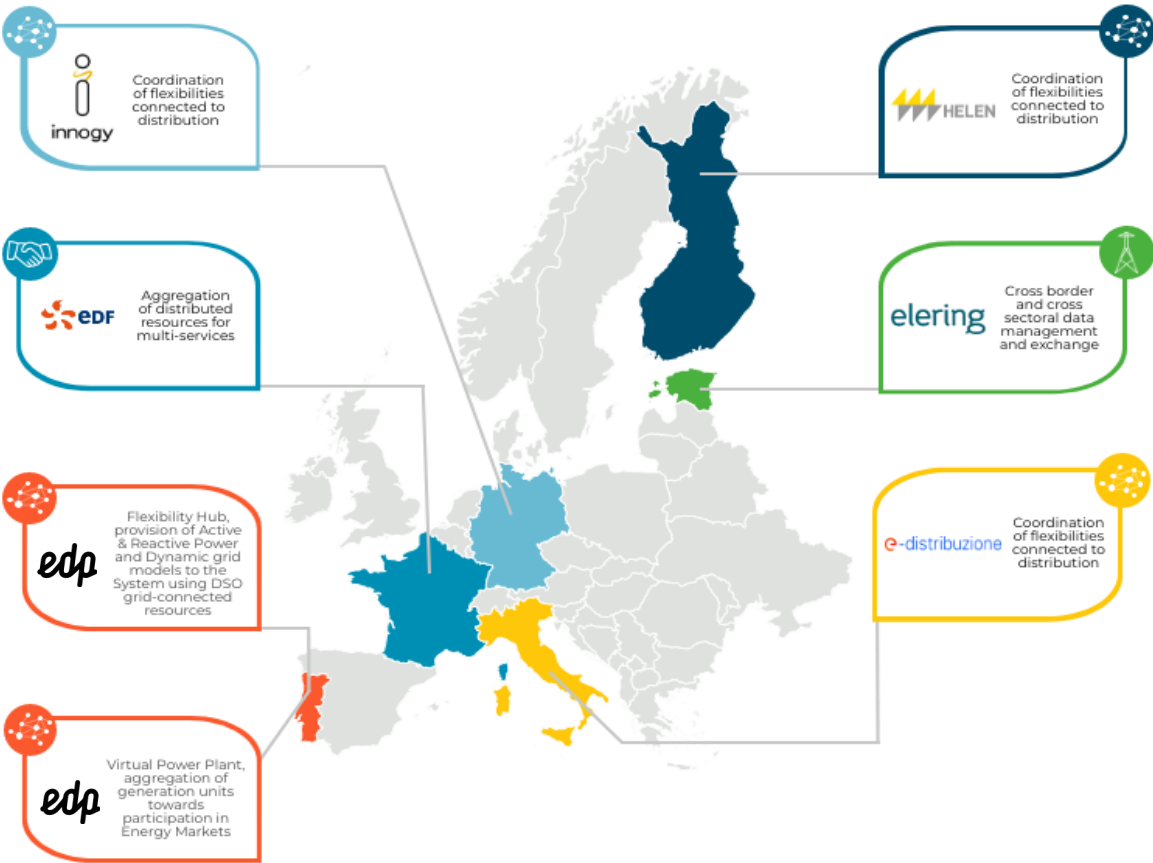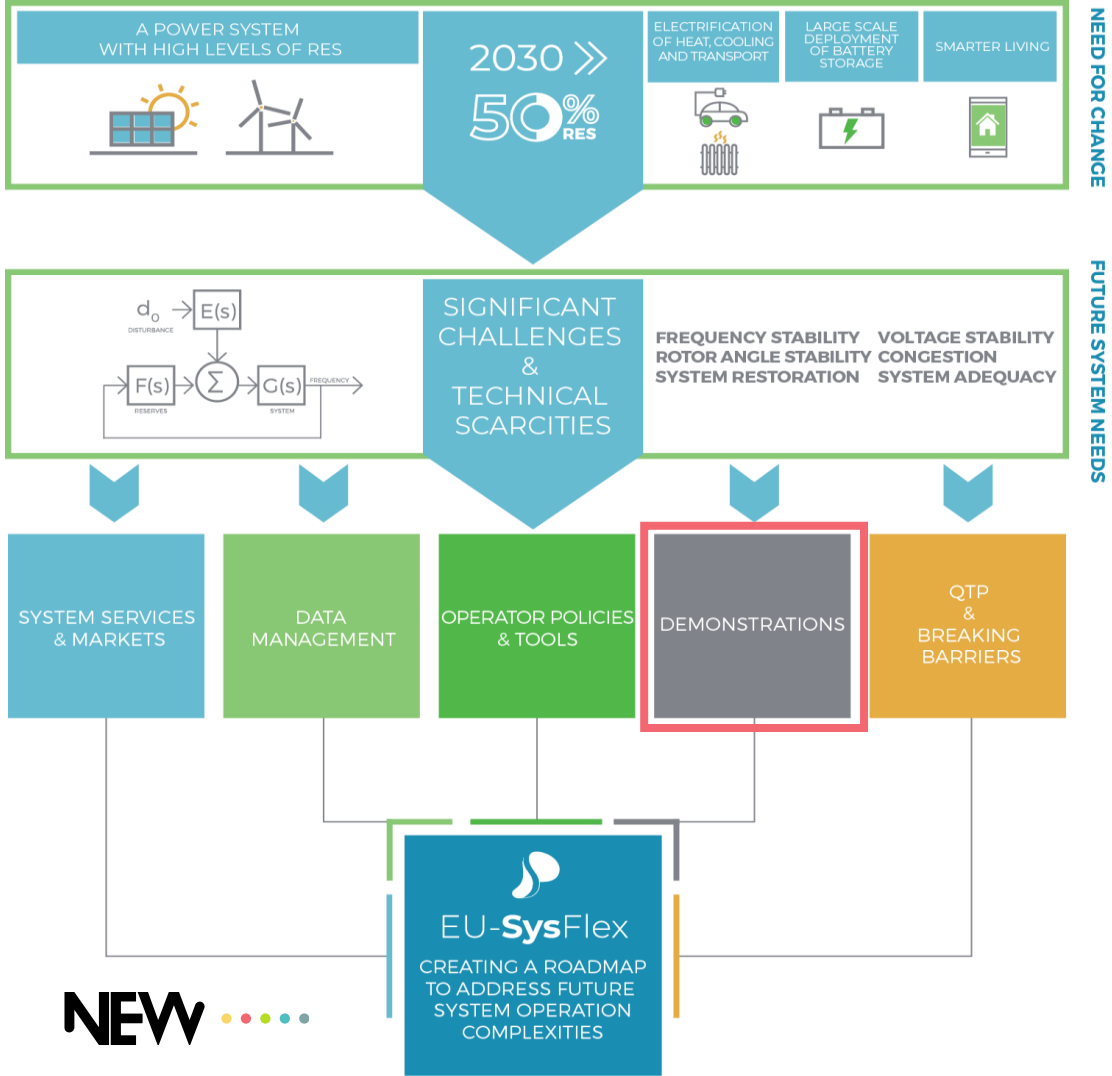
In Portugal we have tested two distinct concepts in two demonstrations

Virtual Power Plant

Flexibility from aggregation of generation technologies

- **Joint operation** & **dispatch** of vRES + dispatchable units
- Demonstrate the technical and economic benefits of **portfolio management of generation** assets
- Demonstrate the possibility of wind farms participating (via VPP) in reserve markets (aFRR, RR)

Flexibility Hub

Flexibility from DSO-connected assets

- Provision of **flexibility** (P,Q) from assets (RES, storage, etc.) connected to DSO grid
- Technical validation of **market flexibility** activated by TSO
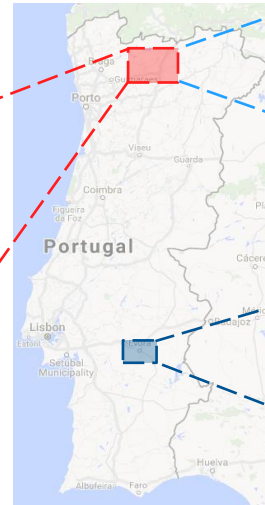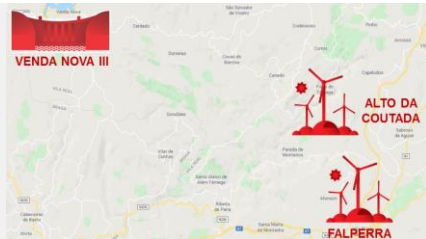- Provision of equivalent dynamic model of the DSO grid to the TSO, for operation and planning

Demo Site

- Venda Nova III Variable Speed Pump Storage Hydro **756 MW**
- Alto da Coutada WF **115 MW**
- Falperra WF **50 MW**

Q market Demo

- In the HV (**60 kV**) distribution grid
- 2 Wind Farms Barroso II **12 MW** & Barroso III **23 MW**
- 2 Capacitor Banks **3.43 MVA**

P market Demo

- In the MV (**15kV**) distribution grid
- PV Monte das Flores **2.5 MW**
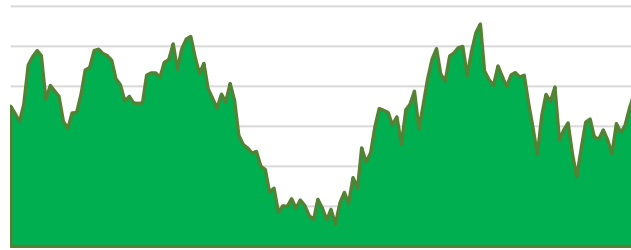- MV Grid Storage Valverde **480 kW / 360 kWh**
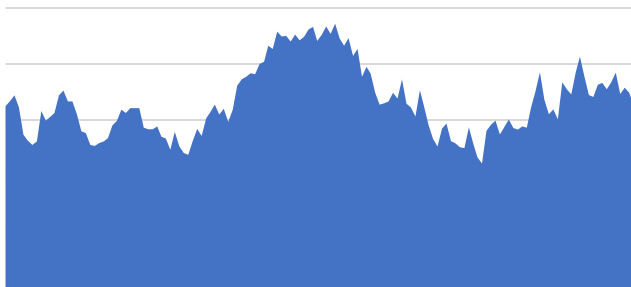
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VPP, the basic idea: aggregation of generation units

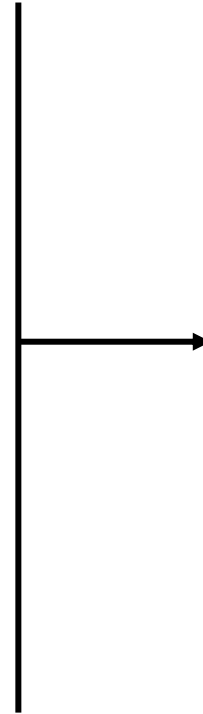## Combining different units' outputs…

Intermittent

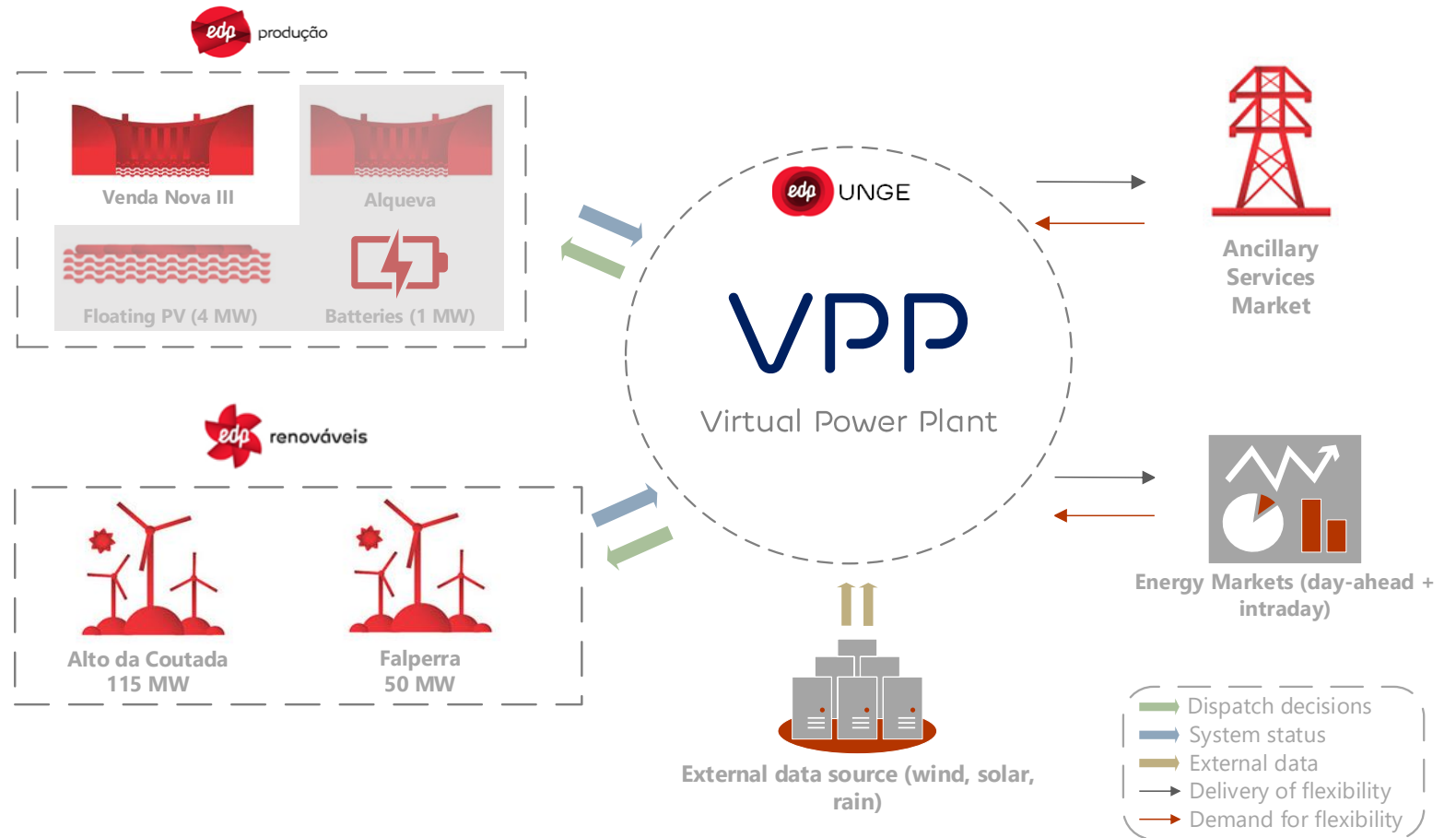Controllable

\+

…to act as one single unit

"Self balanced" unit

The Portuguese VPP: an overview

Flexibility provided by aggregating PSP and RES

- **Joint operation** & **dispatch** of a var. speed pumped storage power plant combined with 2 wind farms

- Demonstrate the technical and economic benefits of **portfolio management of generation** assets

- Demonstrate the possibility of wind farms participating (via VPP) in **reserve markets** (aFRR, RR)

- Show the **replicability potential of the concept**, starting with an offline testing in a Hydro+Wind configuration

edp produção

Venda Nova III | Alqueva
Floating PV (4 MW) | Batteries (1 MW)

edp renováveis

Alto da Coutada 115 MW | Falperra 50 MW

edp UNGE

VPP
Virtual Power Plant

Ancillary Services Market

Energy Markets (day-ahead + intraday)

External data source (wind, solar, rain)

Dispatch decisions
System status
External data
Delivery of flexibility
Demand for flexibility

The Portuguese VPP: the components

Large var. speed storage hydro plant

Venda Nova III

- Variable speed pumped storage Hydro Plant
- **2 x 420 MVA** DFIM motors-generators (Europe's largest of their kind)
- Rated Power: **756 MW (2 x 378)**
- Able to inject 840 MVA in the grid in **2 min**

Two wind farms

Alto da Coutada
Rated power: 115MW
50 x 2,3 MW machines

Falperra
Rated power: 50MW
25 x 2 MW machines

The VPP: architecture of the deployed insfrastructure
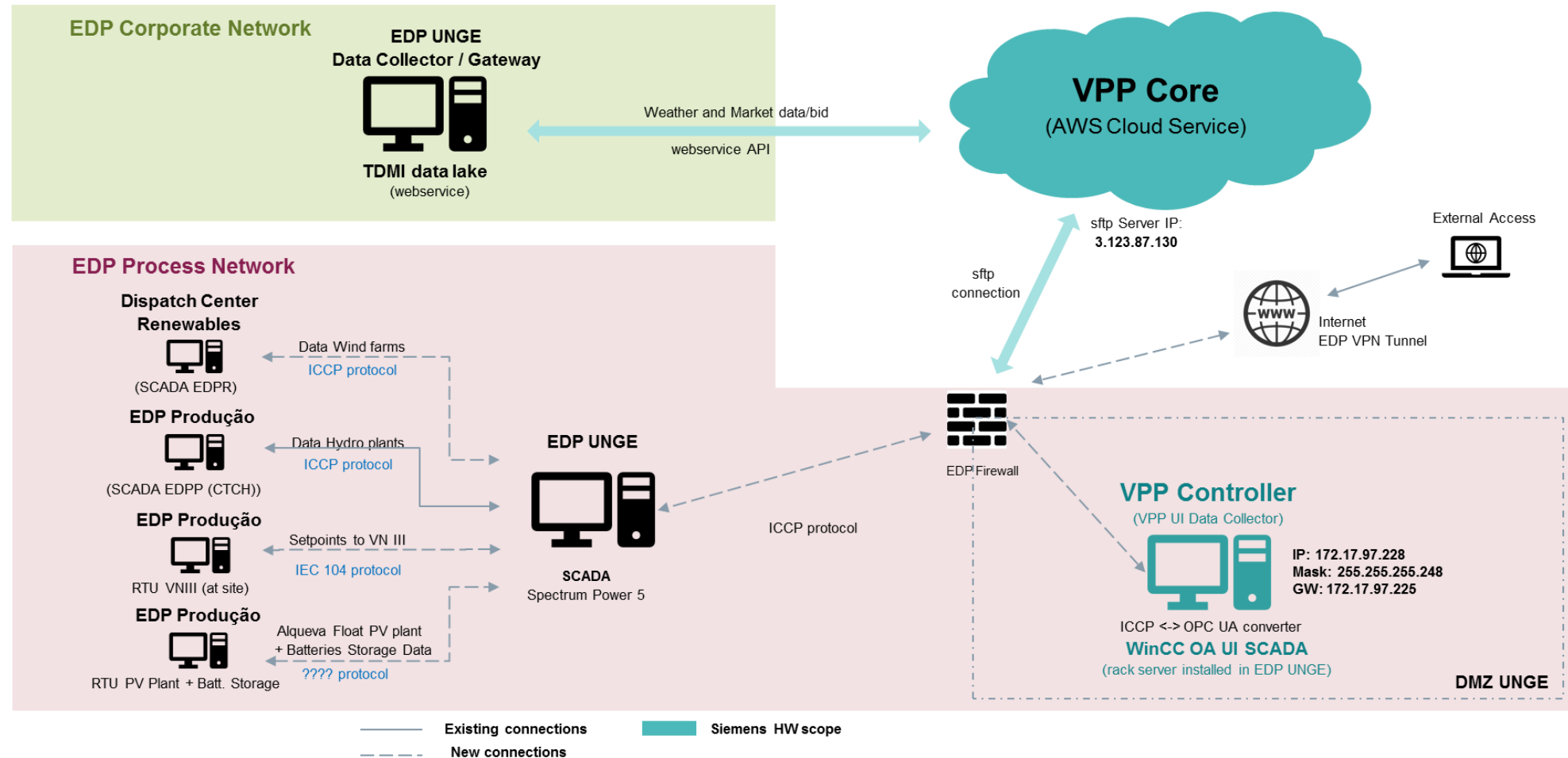
Bidding with the VPP: an optimization problem

Input data

Energy and Ancillary Services Markets (by time to delivery)

HPP availability →

Wind Farm availability →

Weather data →

Historical market data →

| Day-Ahead | aFRR | Intraday | XBID | mFRR/RR |

VPP provides a **decision support tool** to optimize the revenue and the resource use (water) from the combination of the different units

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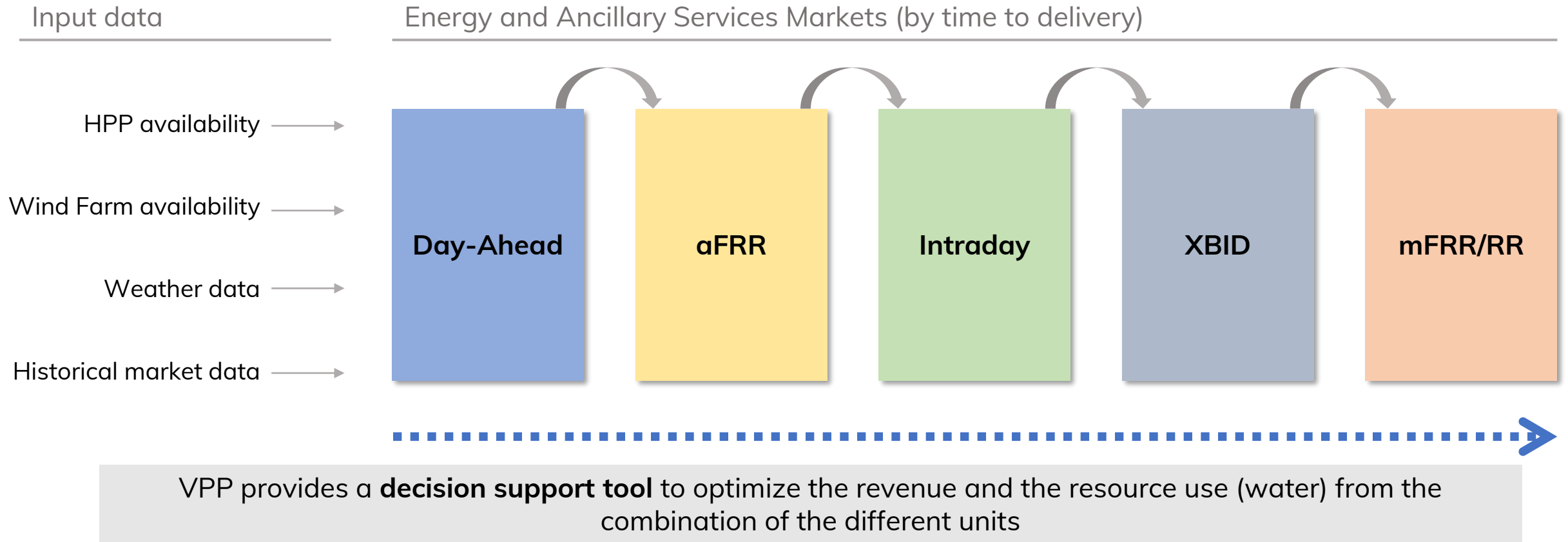
VPP: the Online Demo
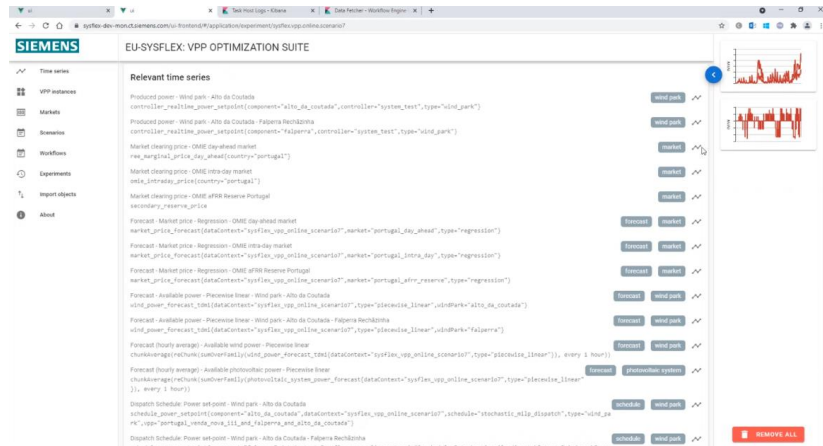
VPP Core
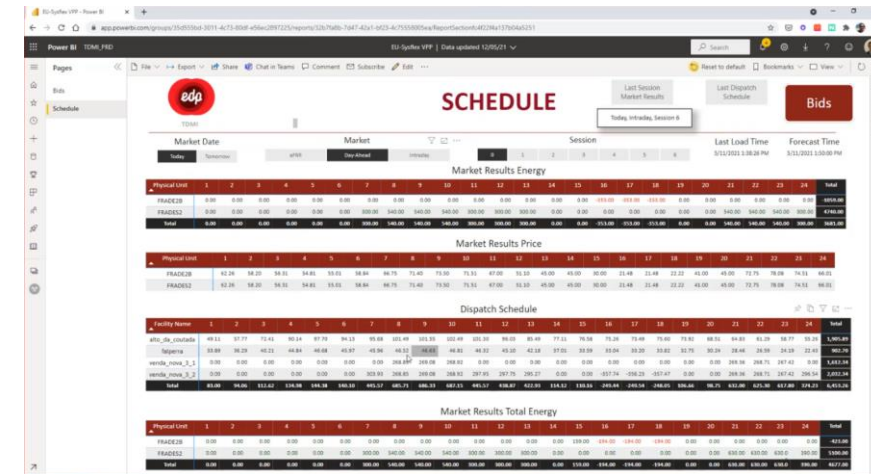
EDP UNGE
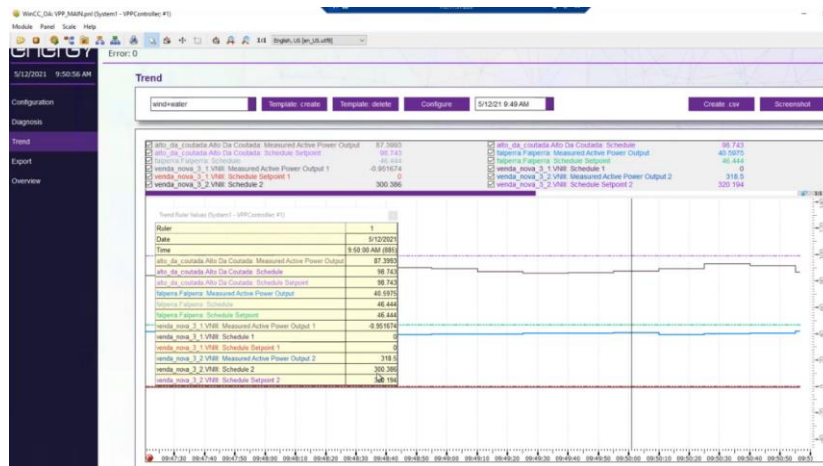
VPP Controller

EDP Produção

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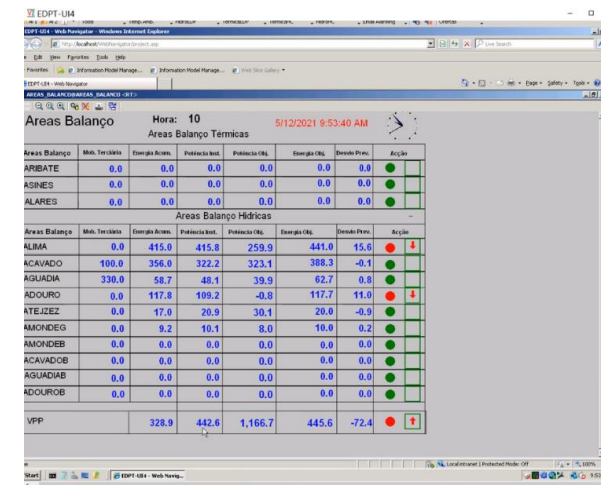
Testing the VPP offline: comparing different scenarios

- **Simulation of performance over one year with VPP Core**
  - Simulation of multiple scenarios for demo site based on 1-year historic input data

- **Result preparation with Tableau**
  - Provide overview on market bidding, power dispatch time series data

- **KPI calculation**
  - Show imbalance reduce with VPP approach

Scenario	Scenario Description	Net Profit Energy [M€]	Net Profit Reserve [M€]	Profit Sum [M€]	Imbalances [GWh]	Imbalance Penalties [k€]
1a	VNIII	11.79	1.75	13.54	55.7	429.9
1b	WPs	11.42	0	11.42	39.1	396.9
1	Sum of VNIII + WPs	23.21	1.75	24.96	84.8	826.8
2	VPP	23.49	1.88	25.37	69.4 **(-18%)**	515.1
10a	Perfect forecast only RES	23.61	1.86	25.47	52.1	360.3
10b	Perfect forecast	31.69	2.21	33.9	10.8	90.8

Scenario Analysis: Tableau
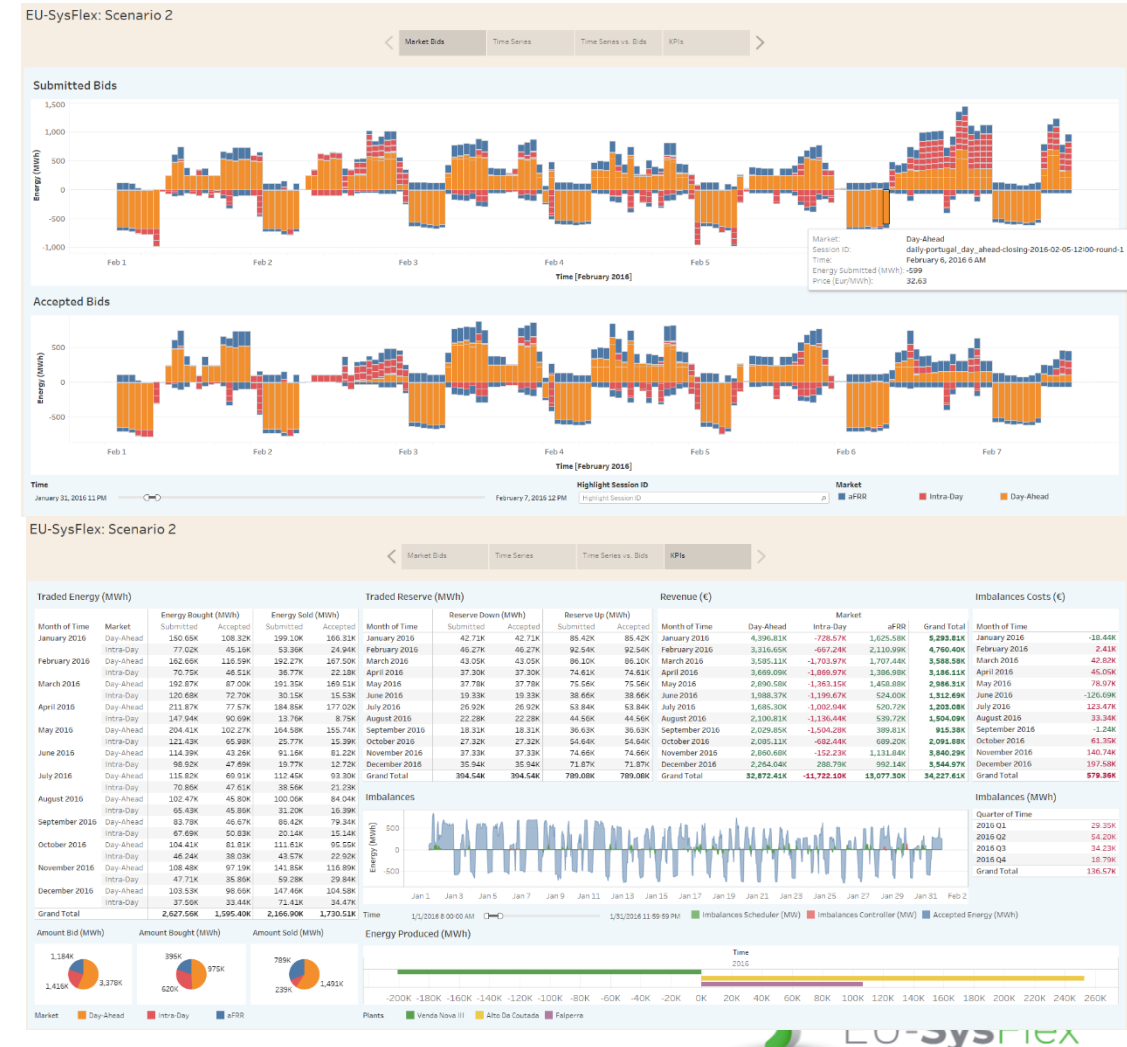
VPP: Key findings

- **Pooling of volatile producers** (renewable energy resources) reduces relative forecasting errors.

- **Pooling of producers and consumers** reduces effects from uncertainty in market price forecast. Local balancing of power generation and consumption reduces the overall capacities to be traded on energy / reserve markets.

- **Energy storage** can shift power production and consumption, do price arbitrage on markets and handle deviations from forecasts.

- One of the main lever for improving overall output of the VPP will be more **accurate forecasting of market prices** as well as further enhancements of the algorithmic features for market bidding strategies.
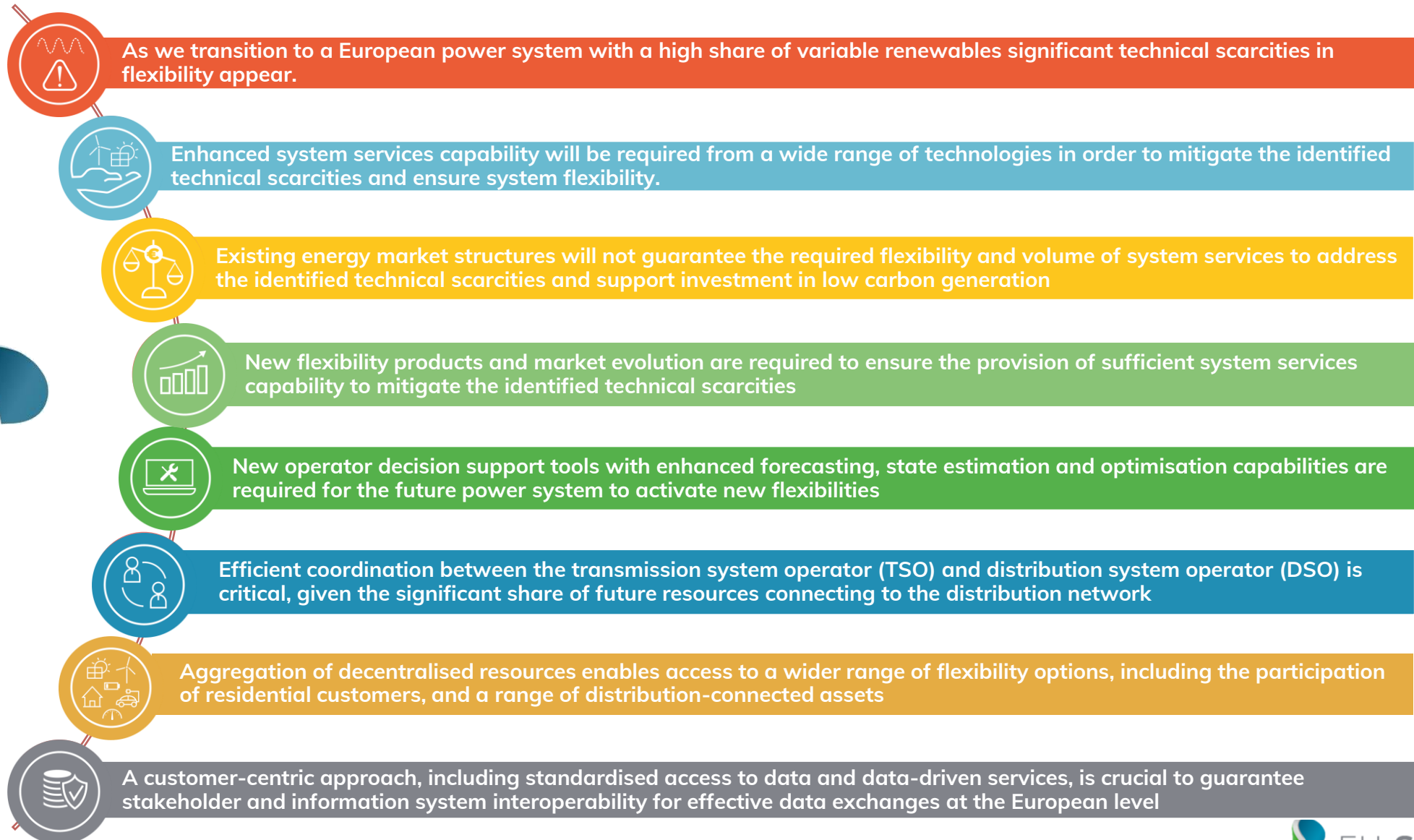
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EU-SysFlex: Key messages

As we transition to a European power system with a high share of variable renewables significant technical scarcities in flexibility appear.

Enhanced system services capability will be required from a wide range of technologies in order to mitigate the identified technical scarcities and ensure system flexibility.

Existing energy market structures will not guarantee the required flexibility and volume of system services to address the identified technical scarcities and support investment in low carbon generation

New flexibility products and market evolution are required to ensure the provision of sufficient system services capability to mitigate the identified technical scarcities

New operator decision support tools with enhanced forecasting, state estimation and optimisation capabilities are required for the future power system to activate new flexibilities

Efficient coordination between the transmission system operator (TSO) and distribution system operator (DSO) is critical, given the significant share of future resources connecting to the distribution network

Aggregation of decentralised resources enables access to a wider range of flexibility options, including the participation of residential customers, and a range of distribution-connected assets

A customer-centric approach, including standardised access to data and data-driven services, is crucial to guarantee stakeholder and information system interoperability for effective data exchanges at the European level

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EU-SysFlex: 2 upcoming final events

>> 7 Feb: Public final online event
Including project summary and main results, introducing the project roadmap, and including a roundtable with high-profile speakers

>> 14 Feb: Final Webinar: Demonstration projects
Presentation of demo projects and their results

>>> Please register at **eusysflex.com**

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