EU-SysFlex

How flexibility will change the behaviour of distribution grids in the real world

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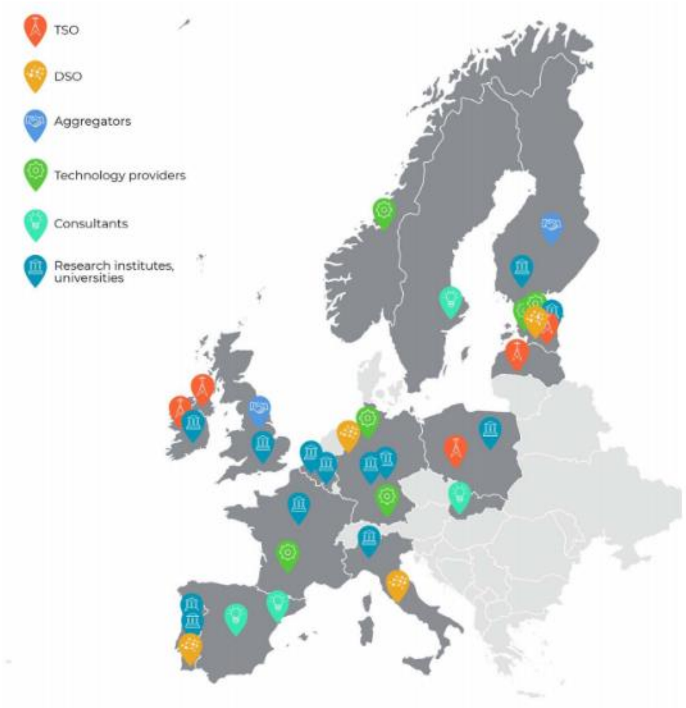
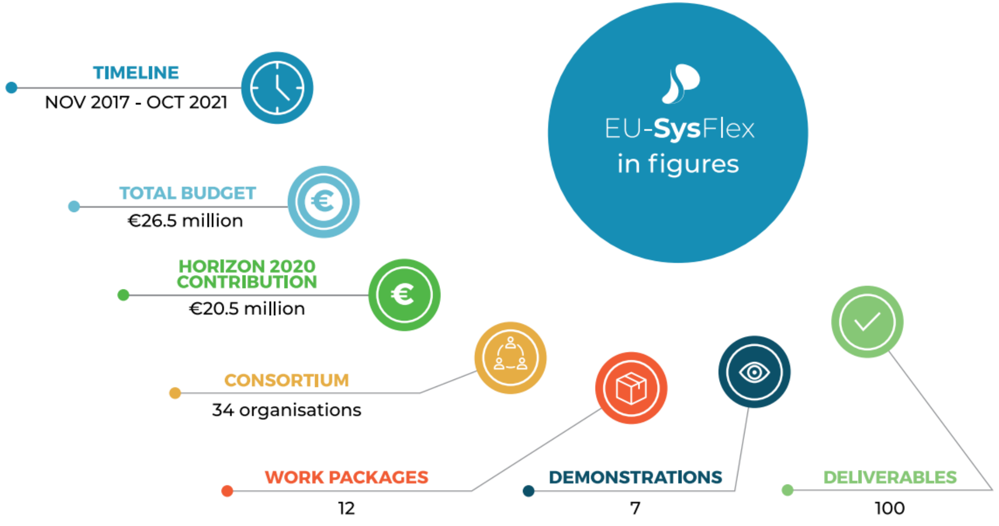
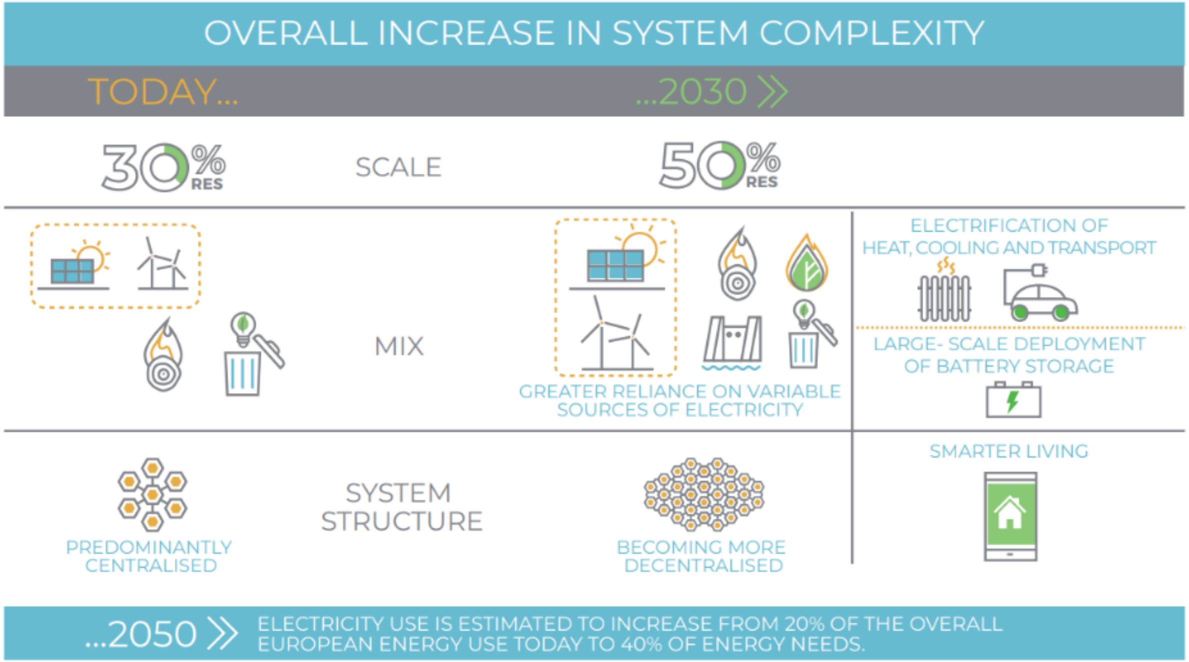
MARKET VIEW AND DATA MANAGEMENT

EU-SysFlex is a Horizon 2020-funded project which identifies and demonstrates new types of system and flexibility services.





Given the ambitious target set by the EU, Europe will go through transformational change over the next decade.



We analyze innovative solutions to facilitate the necessary level of integration of renewable energy sources.

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Demonstrate the secure and cost-effective operation of the power system integrating a large share of RES (> 50%), with smart transmission grid and storage technologies

- Characterize the technical shortfalls of the power system when RES-E exceed 50%
- Enhance the market and regulation to enable new solutions to provide system needs
- Demonstrate the ability of coordinated flexibilities to address future system needs (technologies' performances, aggregation concept, TSO/DSO interaction, ICT tools)
- Provide tools and procedures for TSOs to integrate new services
- Develop a flexibility roadmap
- Maximize the impact of the project

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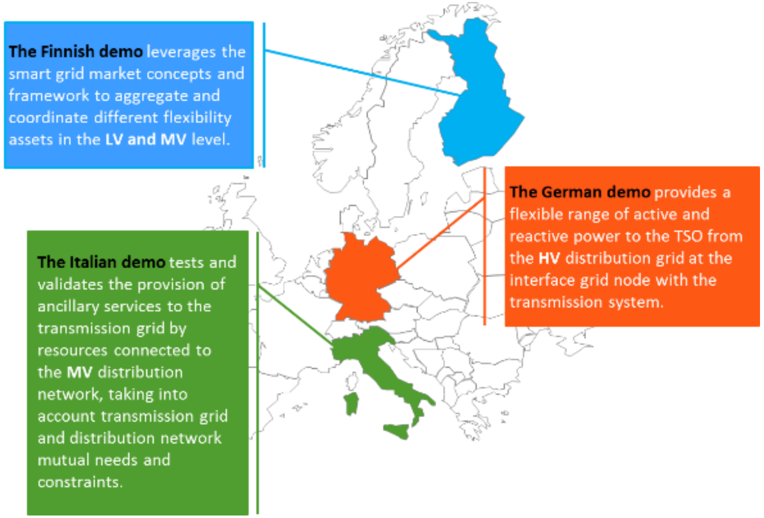
MARKET VIEW AND DATA MANAGEMENT

Within EU-SysFlex we are testing opportunities arising from flexibility resources connected to the distribution grid.

- Three **demonstrators** are being set up in **Germany, Italy and Finland**
- They analyse and test opportunities arising from **decentralised flexibility resources to serve TSO and DSO needs**
- **All three demonstrator have the objective to**
  - Improve TSO/DSO coordination.
  - Provide ancillary services to TSOs from flexibilities connected to distribution network.
  - Investigate how flexibilities connected to the distribution grid can meet the needs of both TSOs and DSOs.



German demonstrator makes use of **flexibilities in the HV distribution grid** to enable active and reactive power management.

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The German demonstrator objectives

- Set-up of a new process and coordination for congestion management
- Development of new automated tool for voltage control and reactive power management.

Environment and scope of the demonstrator

Environment of the German demonstrator

- MITNETZ STROM >6,000 km HV grid
- TSO DSO 16 TSO/DSO interfaces
- >8.7 GW installed RES
- RES/load ratio of 104%

Scope of the German demonstrator

- Assets in HV level used
- 5.3 GW of flexibility potential
- Reactive power flexibility of -350 to +280 Mvar

The Italian demonstrator makes use of **flexibilities in the MV distribution grid** to provide ancillary services to the TSO.

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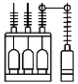
The Italian demonstrator objectives

- Test and validate the provision of ancillary services to the TSO grid by resources connected to the MV DSO network
- Taking into account TSO and DSO mutual needs and constraints

Environment and scope of the demonstrator

Environment of the Italian demonstrator


1 HV/MV (132/15 kV) substation 260 MV/LV (15/0.4 kV) substations


39.8 MWp installed DER Capacity

Scope of the Italian demonstrator


Electric Storage System (1 MVA/1 MWh)


4 PV Generators


On-Load Tap Changer (OLTC) at HV/MV substation

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The Finnish demonstrator aggregates **flexibilities in LV and MV grid** to offer them to the TSO and DSO.

The Finnish demonstrator objectives

- Aggregation of flexibilities from distributed assets in the low/medium voltage level for offering them to the TSO and DSO
- Set-up of new processes and interfaces for flexibility trading of active power to the TSO and reactive power to the DSO

Environment and scope of the demonstrator

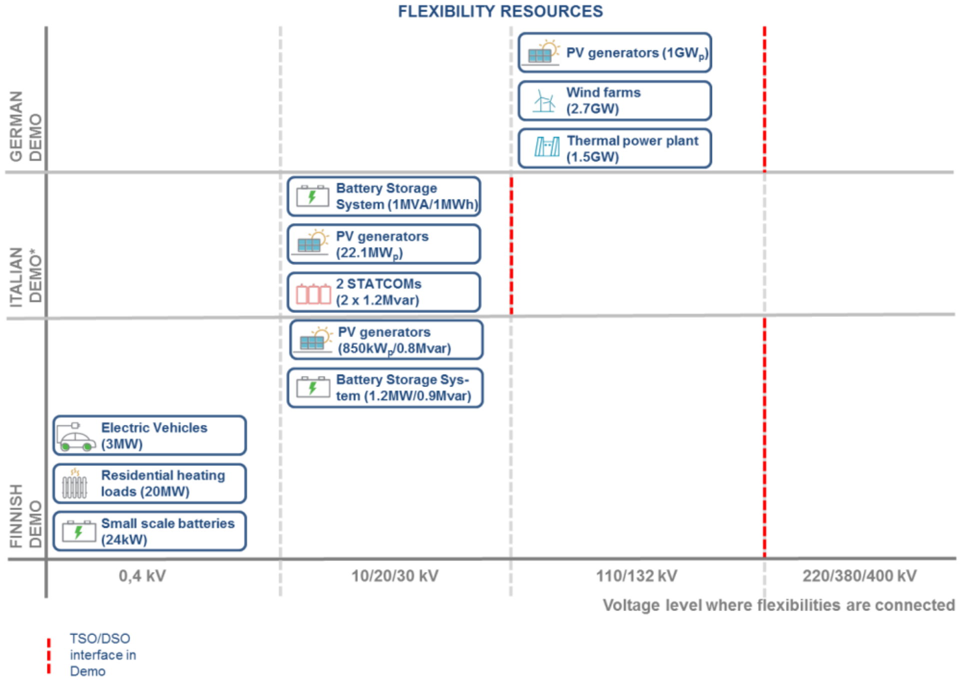
Environment of the Finnish demonstrator

HELEN	Retailer, aggregator
HELEN	Local licenced DSO 3 400/110 kV, 25 110/20(10) kV 1845 20(10)/0.4 kV substations

Scope of the Finnish demonstrator

- Photovoltaic plant (850 kW_p)
- Small battery storages (24 kW)
- Large battery storage (1.2 MW)
- Residential heating loads (20 MW)
- Electric vehicles (3 MW)

The three demonstrators show that flexibility resources in all distribution system voltage levels can be exploited.



*The Italian Demonstration does also include controllable DSO assets which are not listed in this visualisation

Demonstrators complementarity

- The demonstrators **complement each other** by:
  - using varied resources connected to **different voltage levels**
  - in order to provide **different flexibilities**
  - and solve various **scarcities**
  - by respecting different characteristics of the **TSO/DSO interfaces**

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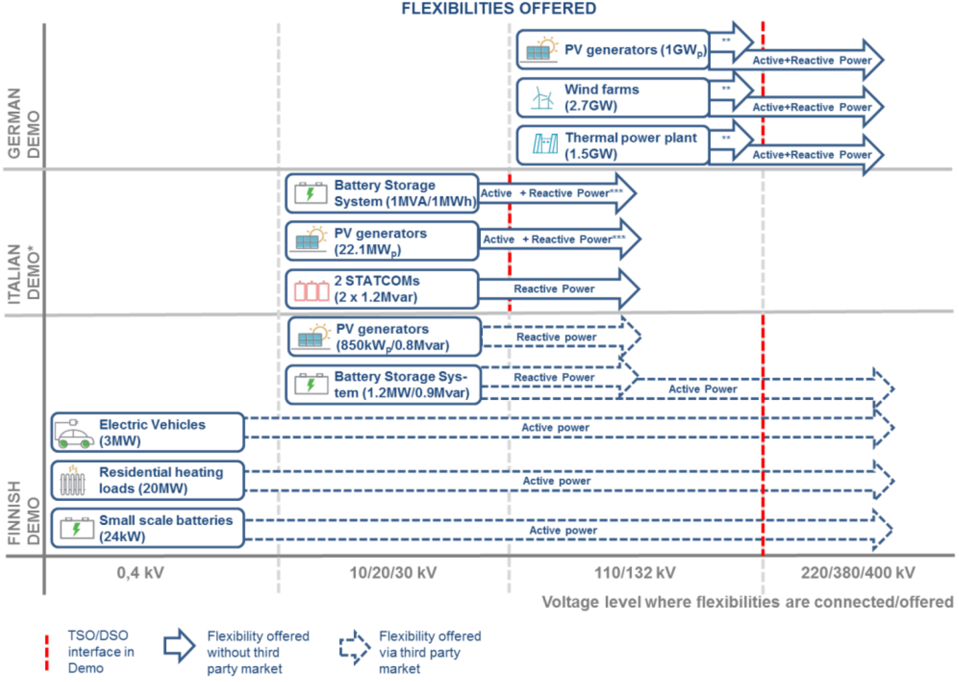

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** The German Demonstrator enables the provision to the TSO and the usage of the flexibilities in its own grid
*** Active Power Modulation will be possible only in case of voluntary participation (for PV) and if allowed by the regulatory framework (for BESS). In any case it will be certainly simulated.

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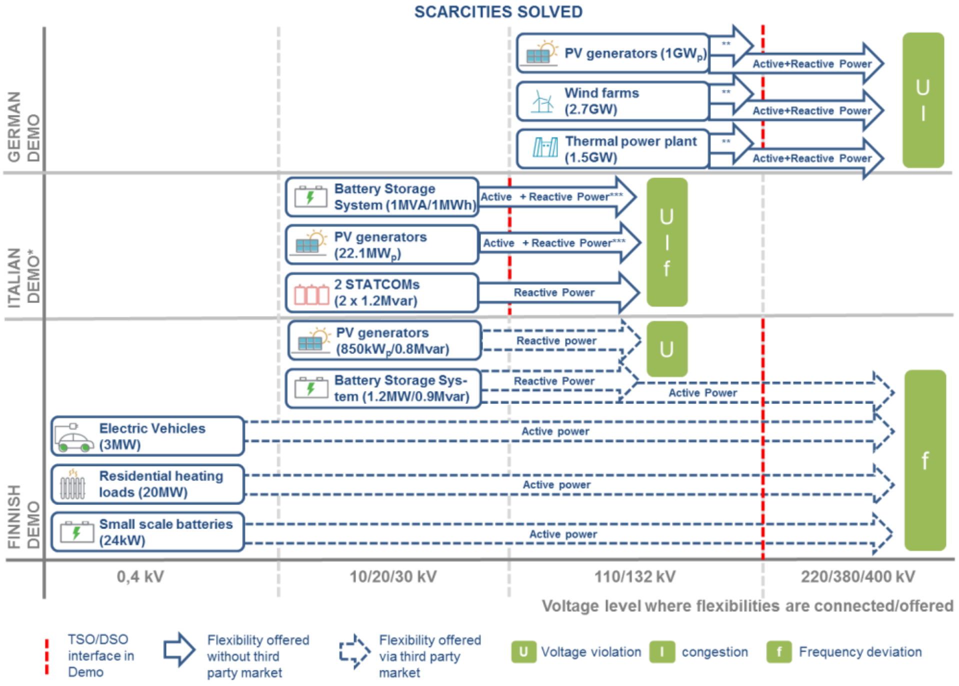

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  - by respecting different characteristics of the **TSO/DSO interfaces**

The three demonstrators enhance TSO/DSO coordination within different technical set-ups.

Italian and German Demonstrations

- Their **approach for TSO/DSO coordination is similar**

1. DSO performs own grid measures
2. DSO sends flexibility potentials to TSO
3. TSO requests needed flexibilities
4. DSO takes care of fulfilment

- **TSO is not directly controlling* any assets** connected to distribution grids, as it may create e.g. congestion in distribution grid.
- DSOs take care that TSO requests are fulfilled, **guaranteeing a congestion free, secure and reliable distribution system operation**.

Finnish Demonstration

- It adds the **retail view**.
- It shows how to **fulfil the needs of TSOs** (active power) **and DSOs** (reactive power) from a **retail perspective**.
- This adds the aspect of dealing with potentially occurring competition between **DSO and TSO having interest in making use of the same flexibilities resources.**
- With the help of reactive power flexibilities the **DSO guarantees** that the **agreed P/Q window is fulfilled at the DSO/TSO-interface**

* Does not apply to frequency products.

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German demonstrator makes use of **flexibilities in the HV distribution grid** to enable active and reactive power management.

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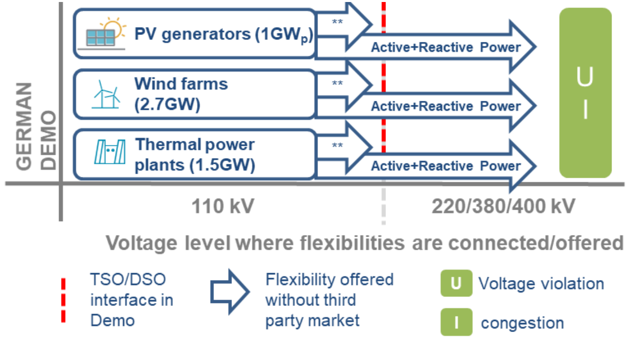
Challenges today

- **Increasing share of RES of > 65 % in 2030 is expected:**
  → Number of conventional power plants is decreasing
  → Redispatch potential of conventional plants in the transmission grid is reaching its limits
  → Higher requirements in congestion management for TSO and DSO arise.
  → Also increasing requirements for reactive power management

Flexibility resources and scarcities solved



Real example

~1 GW infeed was curtailed as emergency measure (10/2018)

- Forecast deviation caused curtailment in HV grid because of voltage violation in transmission grid
- Reactive power flexibility could not be used due to lack of knowledge about flexibility potential in distribution grid.

The German demonstrator objectives

- Set-up of a new process and coordination for congestion management
- Development of new automated tool for voltage control and reactive power management.

Congestion management needs coordinated use of flexibilities connected to distribution grid.

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Active power management today

- **Congestions are managed with redispatch measures**

  → only conventional power plants in transmission grid

- **If redispatch potential is insufficient, curtailment is needed**

  → TSO request DSO to curtail RES as an emergency measure, DSO is responsible of fulfil the measure

Limits of today's active power management

- **Need and costs** of redispatch measures increase.
- Redispatch potential in transmission grid is **reaching its limits.**
- **Risk of countermeasures** increases due to insufficient TSO/DSO coordination.

Active power management in demonstrator

- **Cooperation process between TSO and DSO for schedule-based congestion management is set-up:**

1. DSO performs own congestion management
2. DSO sends flexibility potentials to TSO
3. TSO requests needed flexibilities
4. DSO takes care of fulfilment

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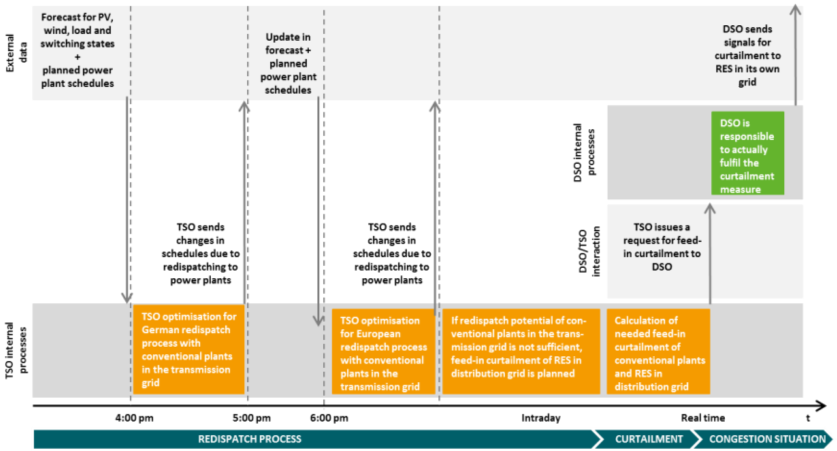
New process was designed due to increasing need of DSO/TSO-coordination in congestion management.

Active power management today



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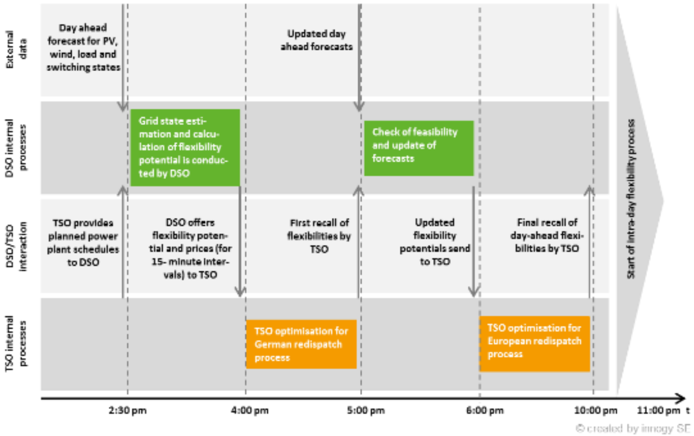
- **DSO not involved** in redispatch process
- **RES in distribution grid are not included** for redispatching

Active power management in demonstrator



- DSO is **involved in day-ahead and intraday redispatch process**

We make flexibilities from distribution grid available for dynamic voltage control in transmission grid.

Reactive power management today

- **Two tools at the TSO/DSO interface**
  - inductors at the interface of EHV/HV.
  - On-load tap changers.

→ Both tools are controlled by TSO and used in coordination with the DSO

Reactive power management in demonstrator

- **Automated tool for dynamic voltage control and reactive power management**

→ DSO calculates the reactive power potentials for TSO

→ in case of voltage limits violations, TSO requests offered potential

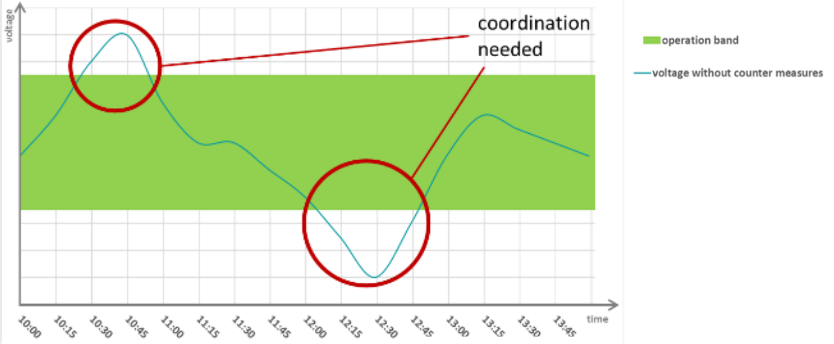
Limits of today's reactive power management

- It depends on availability of a sufficient amount of **reactive power flexibilities of conventional plants in EHV**.

→ **Does not fit to future power system** based on high share of RES in the distribution grid.

- **Limited TSO/DSO coordination** leads to limited settings for voltage control.

Predicted voltage at TSO/DSO interface



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First results show relevance of reactive power flexibilities from the distribution grid at TSO/DSO grid connection points.

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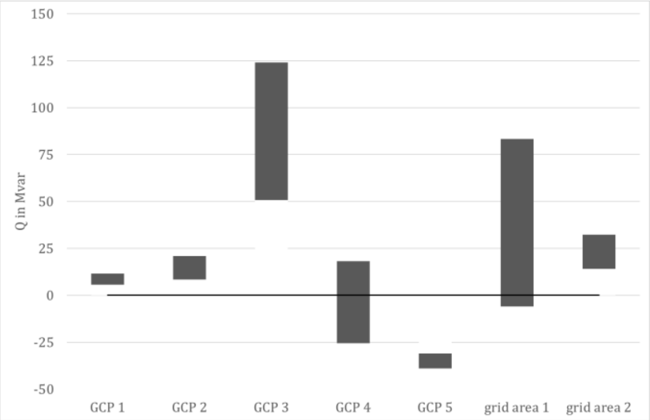
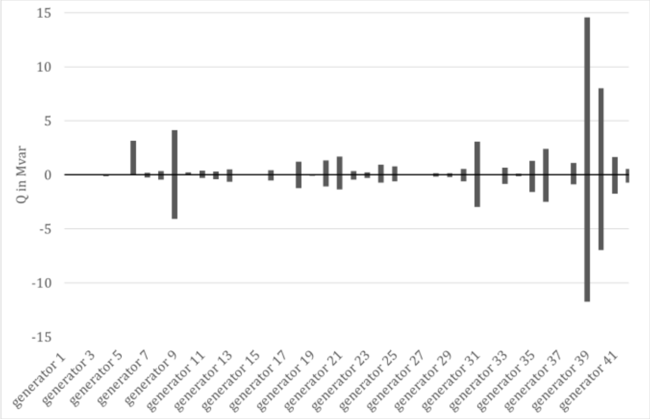
Expected outcome of the German Demonstrator

- Developed **active and reactive power management process to include RES** from the distribution network
- Proof of function of **coordinated TSO/DSO congestion management**
- Feasibility of **fully automated process of a combined grid optimization** (P and Q)

Example of Flexibility Range at TSO-DSO-Interconnection





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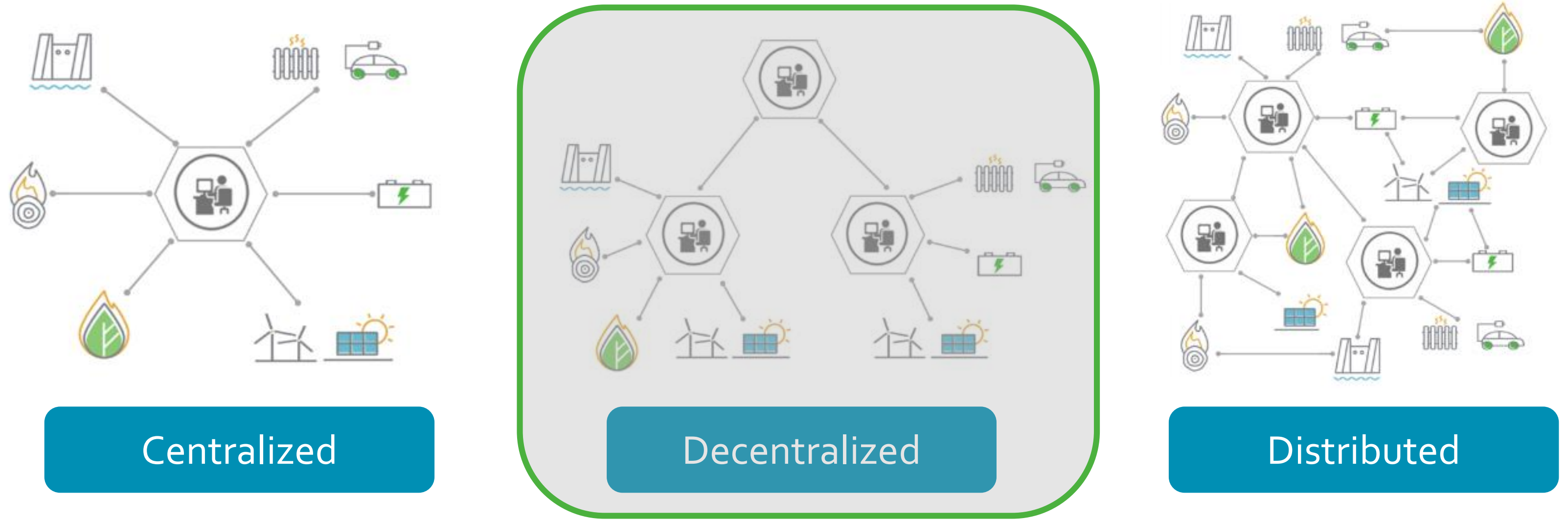
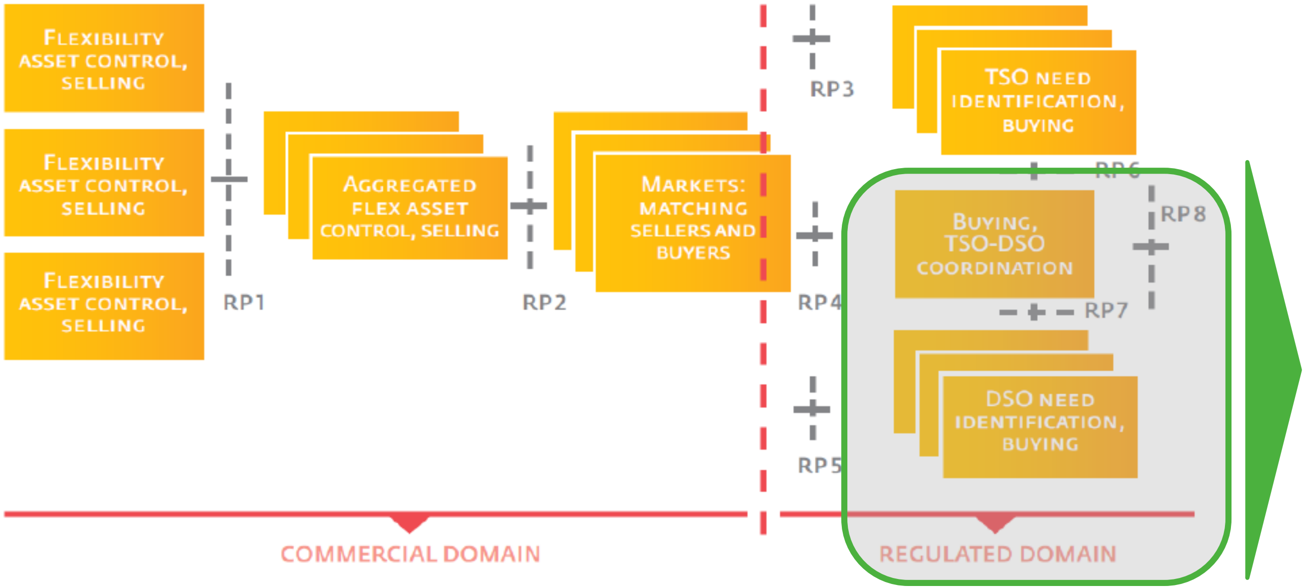
The German demonstrator follows a decentralized optimization approach with subsidiarity of DSOs and TSOs.



In the German demonstrator we follow the decentralized optimization approach because:

- it considers specific voltage level requirements
- it has higher resilience due to distribution of data processing
- responsibilities are clearly allocated bottom-up for keeping the own system secure
- responsibility for bid selection and responsibility for costs are on the same actor

The German Demonstrator fits into the flexibility coordination approach of the TSO/DSO Active System Management report.



Flexibility optimization of German Demonstrator in the regulated domain

In the German demonstrator we test a decentralized optimization:

- this is part of the regulated domain (after ASM report) and independent from the market design approach

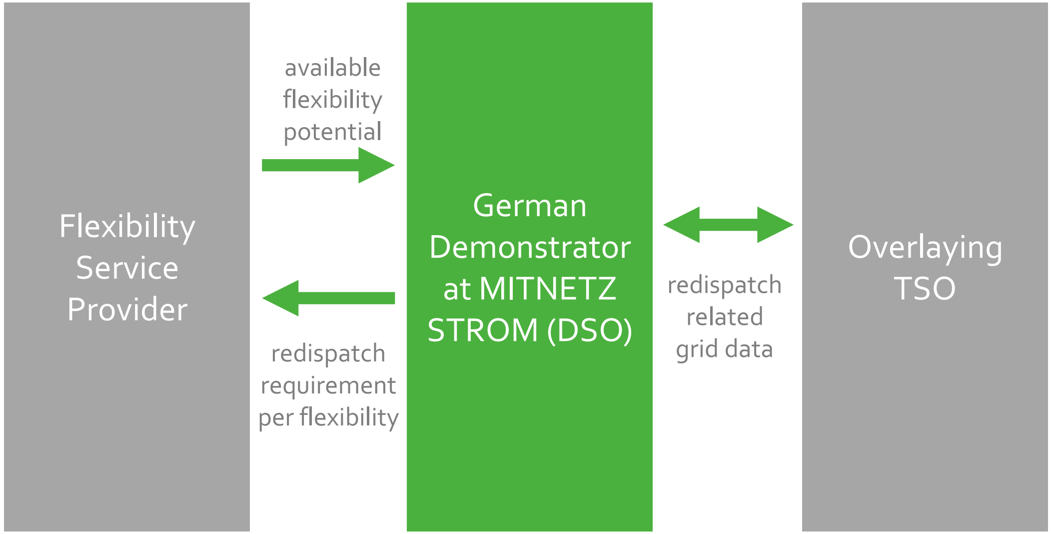
Source: TSO-DSO Report „An integrated approach towards Actice System Management".

Data management in the German Demonstrator enables efficient data exchange and usage for flexibility use.

In the German demonstrator:

- Due to the optimizations principle “local before regional” data exchange is limited.
  - → Avoid unnecessary data traffic
  - → Reduce complexity
  - → Reduce costs
- There is the option of clustering the flexibilities at the TSO/DSO coupling point based on mutually agreed principles.
  - → DSOs selects the right flexibility source within a cluster
  - → DSOs react upon updated forecast
  - → Flexibility potential can be increased

Partial overview of data management within the German demonstrator



How flexibilities will change the behaviour of distribution grids in the real world.

- The system operation is becoming more complex.
- New challenges and opportunities arise from increasing share of RES.
- Less flexibility potential from conventional power plants to support grid operation
- Higher requirements for TSO and DSO arise to deal with the more complex system
- Flexibility from renewables can actively contribute to system stability
- Flexibility services can serve (future) needs of both DSOs and TSOs
- Reinforcements of grids can be limited if we make the "right use" of the flexibilities available in the distribution grid
- We are testing flexibility optimization principle "local before regional"
- For an efficient use of flexibility resources an enhanced DSO-TSO coordination is needed
- Distribution System Operator role is evolving
- New ways of operation, new tools and procedures are required

EU-SysFlex is already testing the solutions for tomorrow!

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THANK YOU!

Find more information: https://eu-sysflex.com/

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