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ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

Flexibility needs in the future power system

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ISGAN webinar

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iea Energy Technology Network

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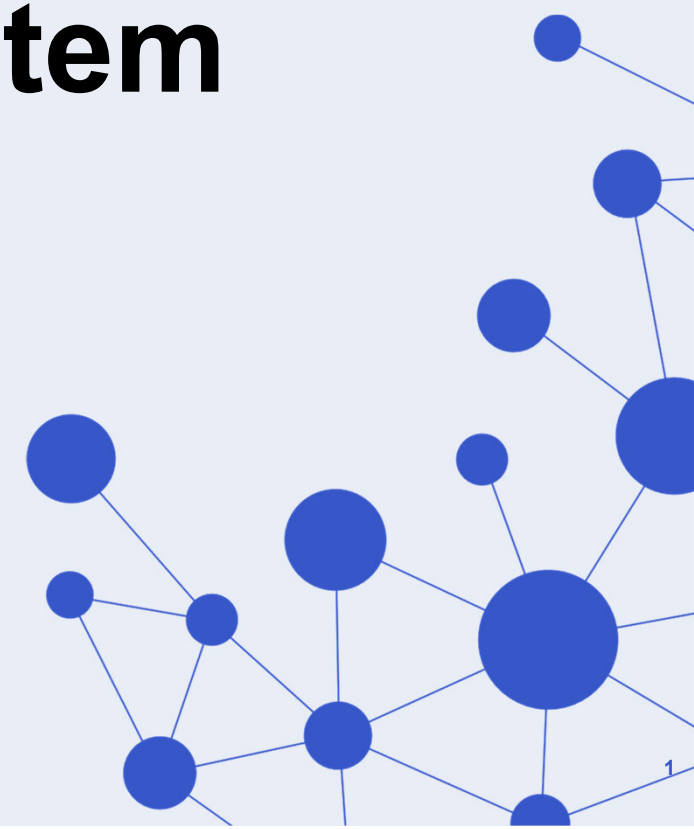


Overview of ISGAN Annex 6 activity on Flexibility needs

- What is power system flexibility?
- Analysis of flexibility needs, resources and definitions
- Categorization of flexibility needs
- Flexibility needs in time and space
- Summary

What is power system flexibility?

Flexibility relates to
the ability of the power system to manage changes

Flexibility as a term is used as an umbrella covering various aspects
➔ complicating the discussion on challenges and needs of the power system

To support communication within and outside the power system community,
Annex 6 of ISGAN (The International Smart Grid Action Network)
propose the categorization of flexibility needs

5 Trends influencing the powers system

Trends of flexibility needs :

Decarbonisation decreasing the carbon footprint from electric power production

Decentralisation transition from few and large, centralize plants to many smaller, decentralised, power production units

Integration increasingly integrated electricity marke interconnection of previously independent grids, and more integrated energy systems including sector coupling

Digitalisation extensive implementation of and deper information and communication technologies and solutions

Inclusion increasing demand for sustainable, affo accessible energy for all including increased electrification of e.g. industrial processes and transport

Increased volatility and uncertainty of the production and availability of electricity

operation and planning closer to the system limit

Definition of flexibility

"the extent to which a power system can modif
production or consumption in response to variab
or otherwise. In other words, it expresses the ca
power system to maintain reliable supply in the
and large imbalances, whatever the cause."
2011, International Energy Agency - IEA

"the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system."
2014, EURELECTRIC

cost, to any change,
h prevailed at the time it
was planned."

■ ■ ■

"the capability of a power system to cope with the variability and uncertainty that VRE (variable renewable energy) generation introduces into the system in different time scales, from the very short to the long term, avoiding curtailment of VRE and reliably supplying all the demanded energy to customers".
2018, International Renewable Energy Agency - IRENA

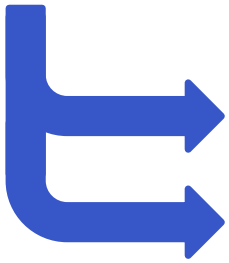
"the ability to adapt to dynamic and changing conditions, for
and demand by the hour or minute,
and transmission resources over a
od of years."
arch Institute - EPRI

"all
the
uncertainty in both supply and demand."
2018, International Energy Agency - IEA

ctricity system to respond to changes
nce of supply and demand at all times."
uropean Energy Regulators - CEER

Analysis of flexibility needs

Flexibility needs have to be considered from:



overall system perspective (maintain stable frequency and secure energy supply)

local perspective (maintain bus voltages and secure transfer capacities)

Flexibility needs are considered for both **operation** and **planning** of the power system, with flexibility support required in the timescales of:

fraction of a **second**
e.g. stability and frequency support

minutes / hours
e.g. thermal loadings and generation dispatch

months / years
e.g. planning for seasonal adequacy and planning of new investments

Flexibility needs and resources

Flexibility Solutions are **not limited to modification in supply and demand**

- many different type of solutions may provide value to increase the flexibility
- including solutions to influence rules and regulations in operation and planning

Flexibility may be found in the whole power system

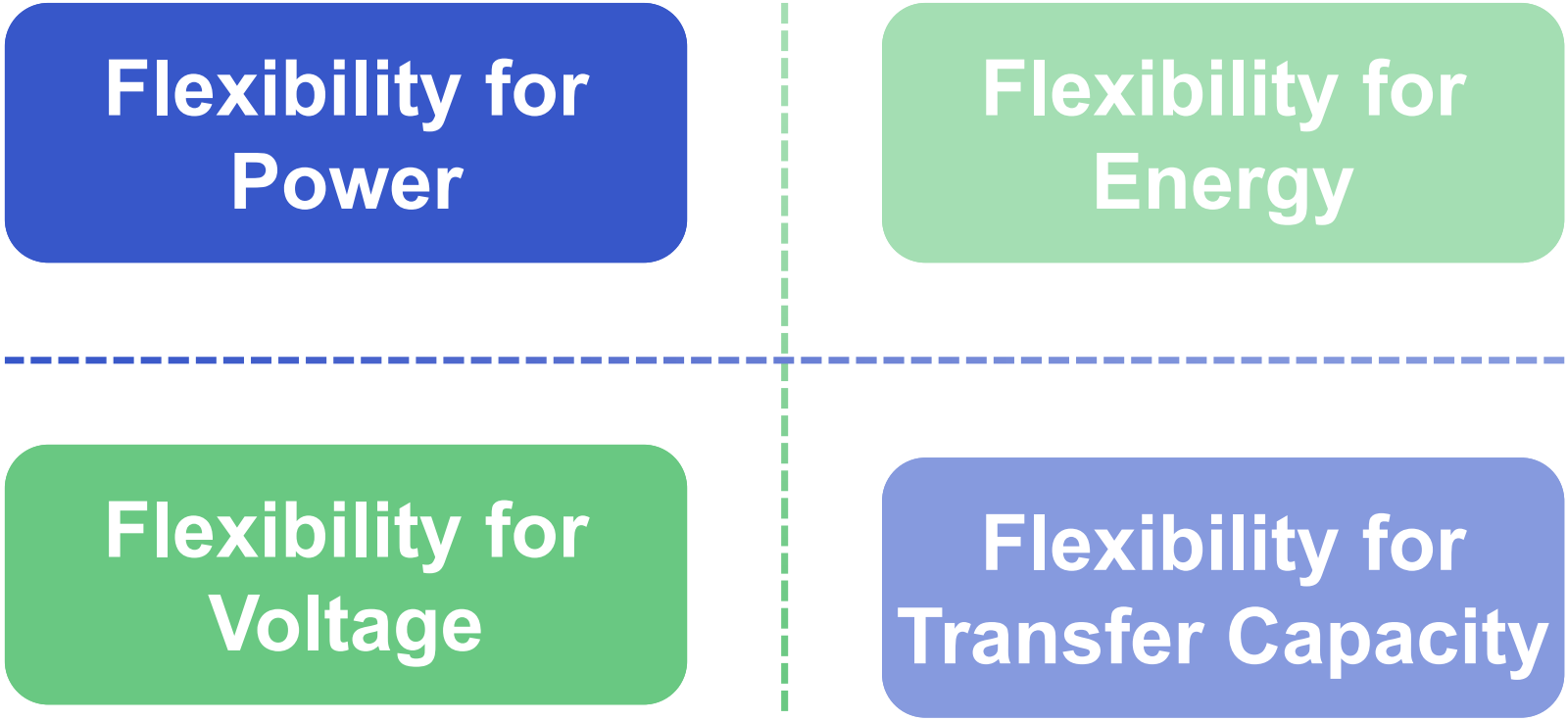
Needs for flexibility are **not limited to the balance of supply and demand**

… needs also refer to maintaining of voltages and securing transfer capacities

Flexibility resources include:

- Sector coupling
- Demand
- Energy storage
- Synchronous conventional power plants
- Power electronic interfaced renewable power plants
- Grid infrastructure primary/secondary equipment
- Operational and planning procedures

Categorization of flexibility needs



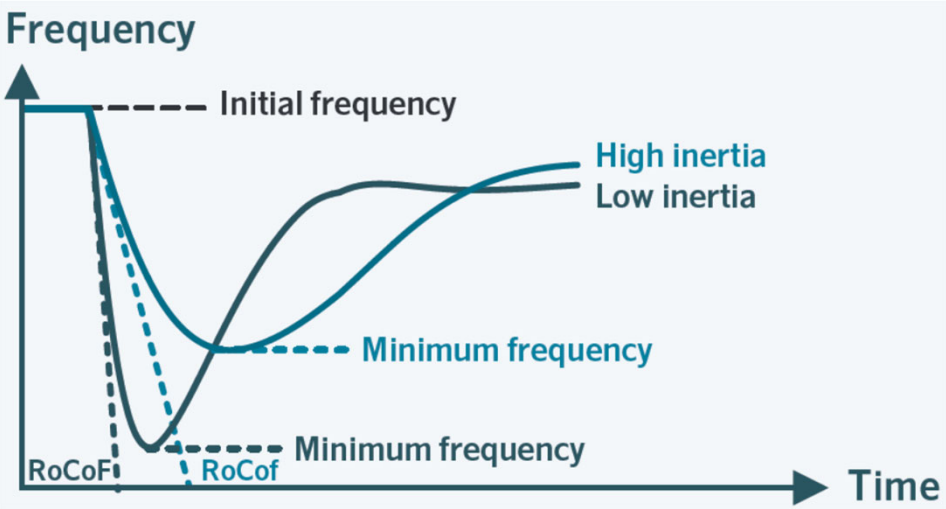
Flexibility for: ***Power***

Need description:	Short term equilibrium between power supply and power demand, a system wide requirement for maintaining the frequency stability
Main rationale:	Increased amount of intermittent, weather dependent, power supply in the generation mix
Activation timescale:	fractions of a second up to an hour

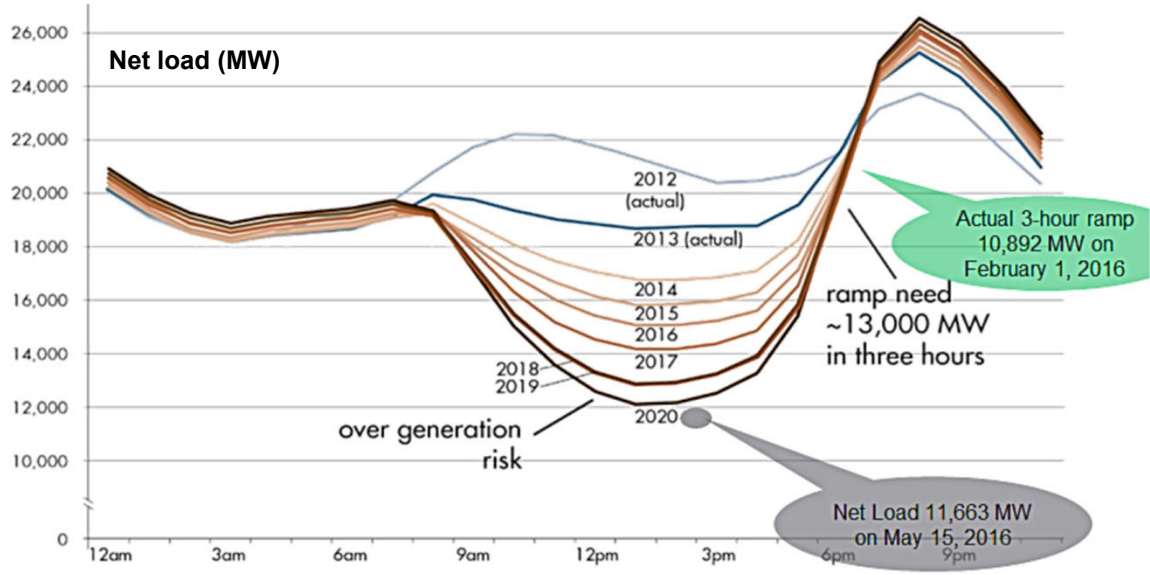
Example of flexibility solutions

- upward and downward balancing capability of RES
- aggregated control of supply and demand
- short-term storage units
- interaction between multi-energy carrier systems
- Increase operational limits of frequency deviations

Flexibility for: ***Power***



Power Electronic Interfaced Generation (PEIG) impact on frequency event *Source: NORDIC TSOs*



PV impact on other production units *Source: California ISO*

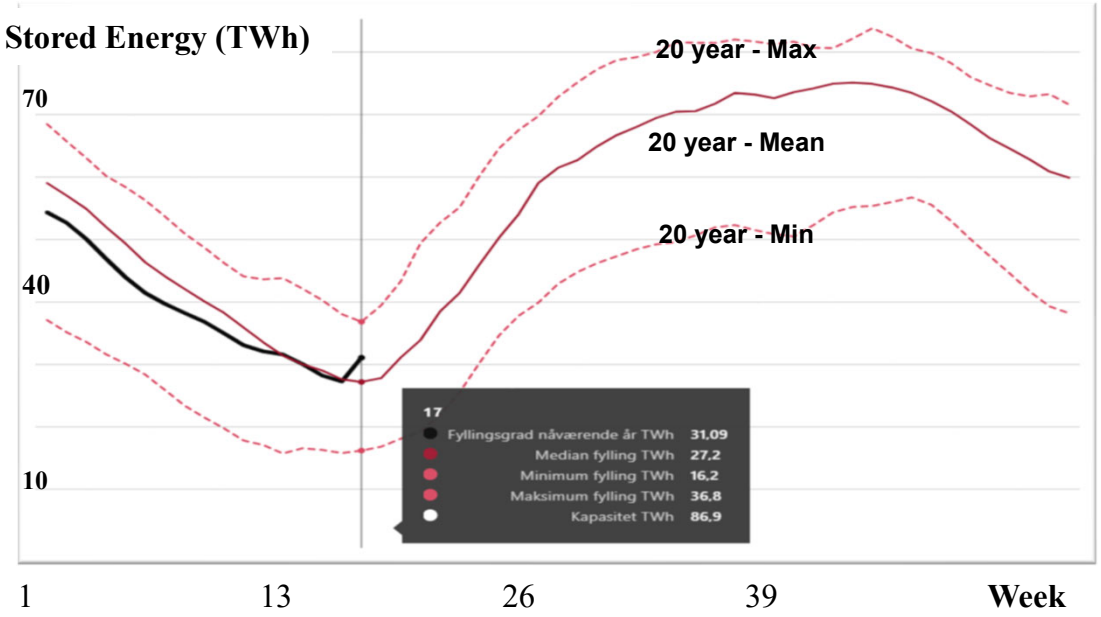
Flexibility for: *Energy*

Need description:	Medium to long term equilibrium between energy supply and energy demand, a system wide requirement for demand scenarios over time
Main rationale:	Decreased amount of fuel storage-based energy supply in the generation mix
Activation timescale:	hours to several years

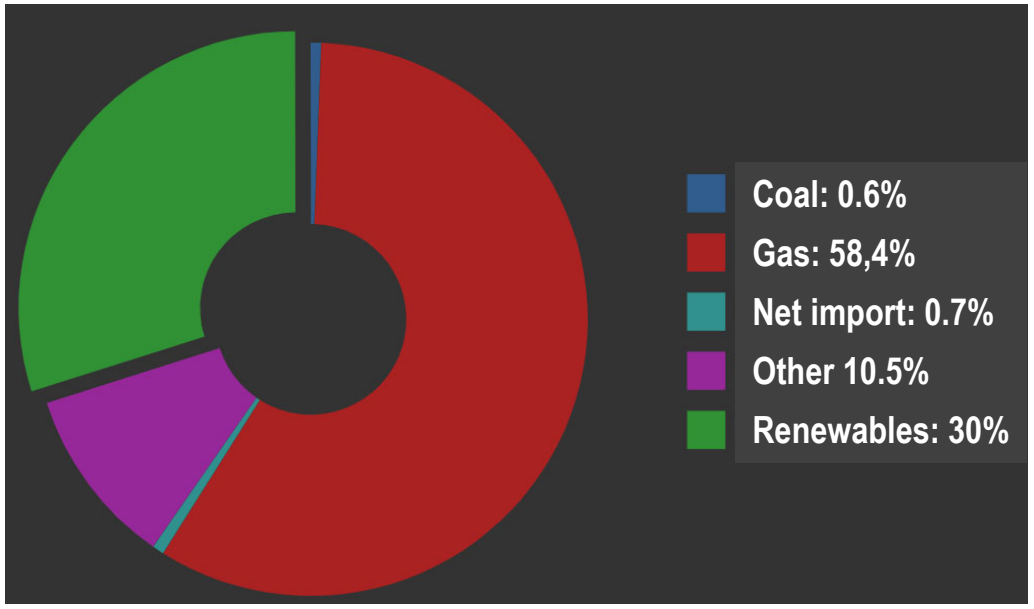
Example of flexibility solutions

- optimisation of the value of stored energy
- pumped hydro power plants
- altering demand behaviour to follow variations in supply
- increased interconnections between systems

Flexibility for: *Energy*



Reservoir energy content Norway *Source: NVE*



Irelands power system average generation mix April 2019 *Source: EirGrid*

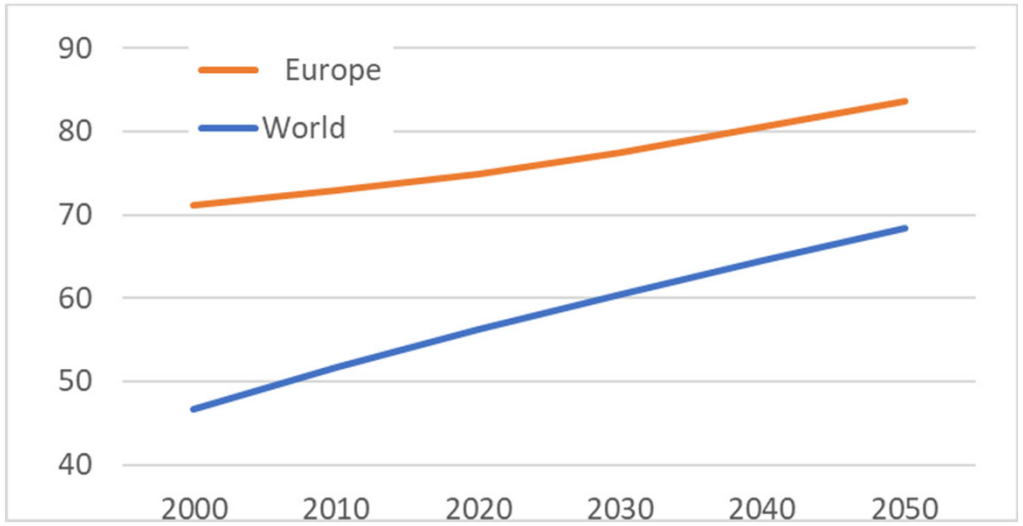
Flexibility for: *Transfer Capacity*

Need description:	Short to medium term ability to transfer power between supply and demand, where local or regional limitations may cause bottlenecks resulting in congestion costs
Main rationale:	Increased utilization levels, with increased peak demands and increased peak supply
Activation timescale:	minutes to several hours

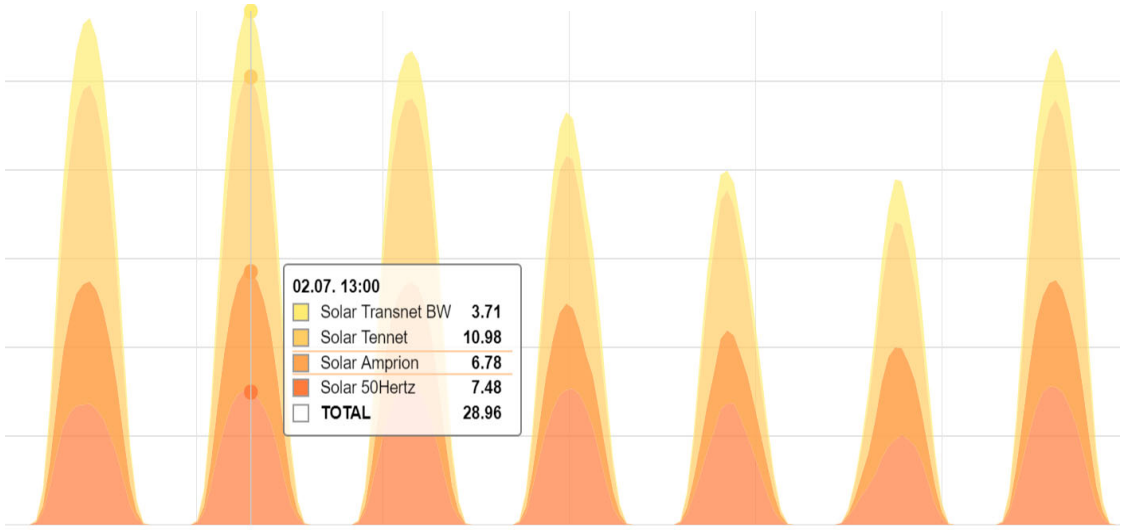
Example of flexibility solutions

- Topology changes
- Increasing nominal voltage levels
- Dynamic rating of overhead lines and other equipment
- Time variable transfer tariffs to influence behaviour
- Risk based operation/planning criteria (instead of N-1)

Flexibility for: *Transfer Capacity*



Percentage of population in Urban areas *Source: UN*



PV production Germany 1st week July 2018 *Source: Fraunhofer*

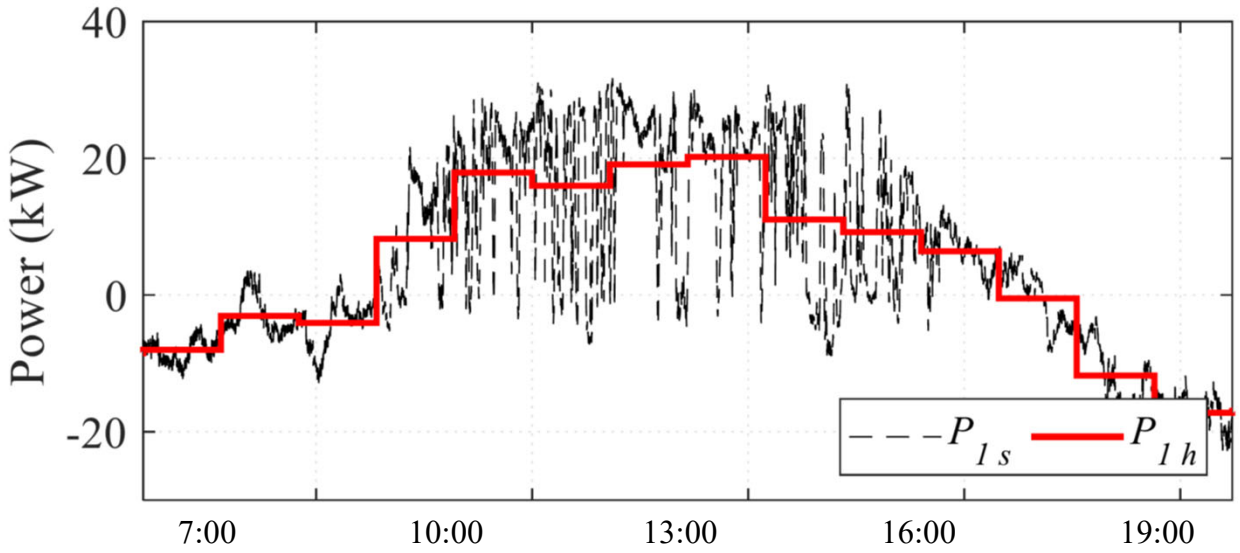
Flexibility for *Voltage*

Need description:	Short term ability to keep the bus voltages within predefined limits, a local and regional requirement
Main rationale:	Increased amount of distributed power generation in the distribution systems, resulting in bi-directional power flows and increased variance of operating scenarios
Activation timescale:	seconds to tens of minutes

Example of flexibility solutions

- Coordinated voltage control
- Voltage support from distributed generation, storage and demand
- Flexible AC Transmission Systems (FACTS)
- Voltage boosters
- Broadening of acceptable ranges for power quality

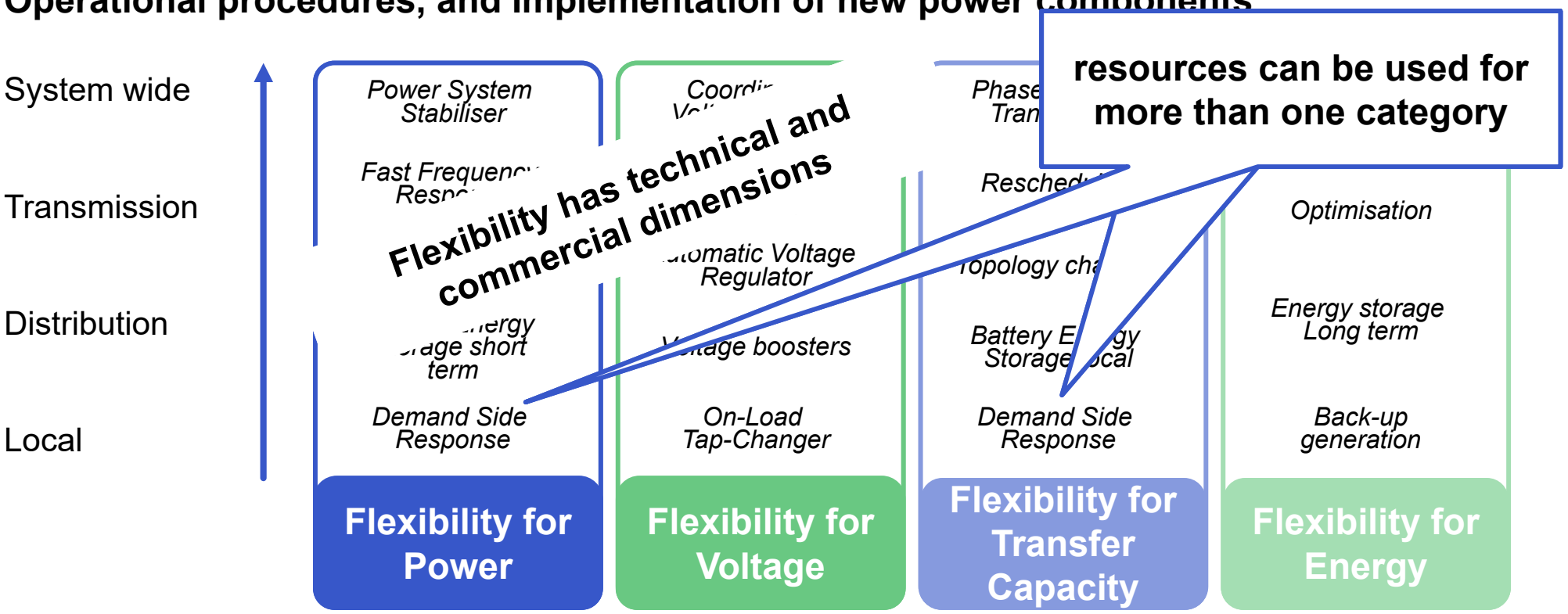
Flexibility for *Voltage*



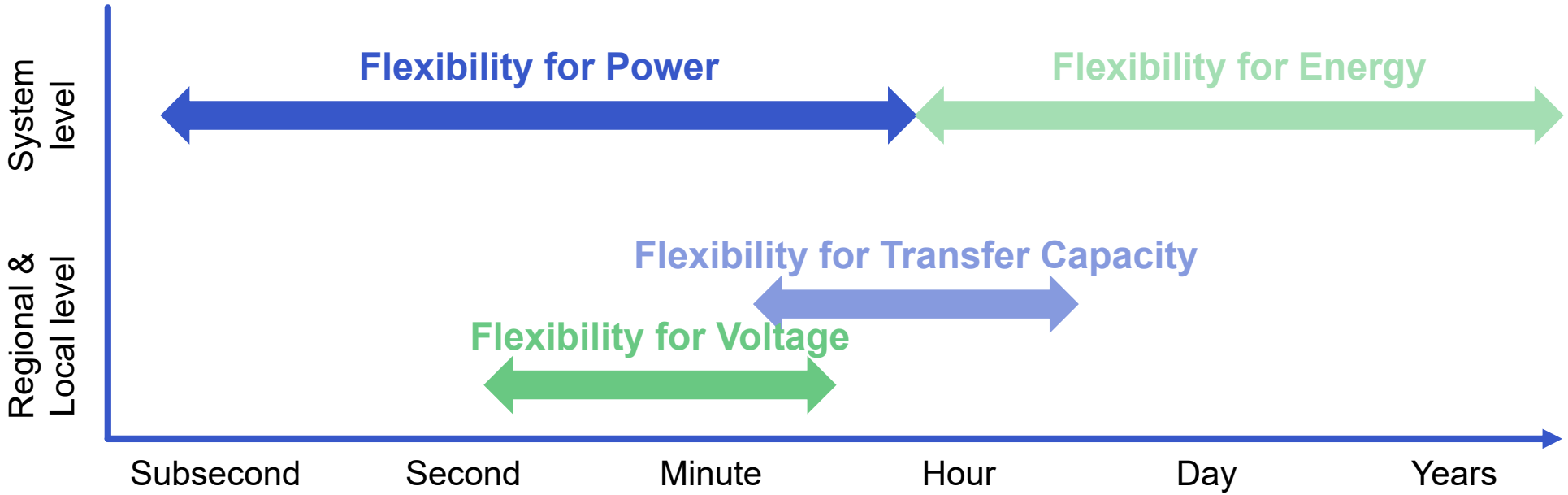
Distribution transformer net load in system with PV (positive=overproduction) *Source: RISE*

Flexibility providers

Examples of flexibility solutions involving: **System services, Control-based responses, Operational procedures, and Implementation of new power components**



Flexibility needs in time and space



Summary / Conclusion

Power system flexibility: **the ability of the power system to manage changes**

… a broad concept!

Thus, it is highly recommended to explain which kind of flexibility that is in question.
This work proposes the categorization of flexibility into four needs:

- **Flexibility for Power**
- **Flexibility for Energy**
- **Flexibility for Voltage**
- **Flexibility for Transfer Capacity**

For further reading, download the full report: iea-isgan.org/flexibility-in-future-power-systems

iea-isgan.org

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Thank you

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