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Flexibility needs in the network and in the future power system

Werner FRIEDL, ISGAN Operating Agent

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iea Energy Technology Network

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

ISGAN's worldwide presence

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ACTION NETWORK

ISGAN in a Nutshell

International Smart Grid Action Network is the only global government-to- overnment forum on smart grids.

Power Systems (Annex 6)
Power Transmission & Distribution Systems

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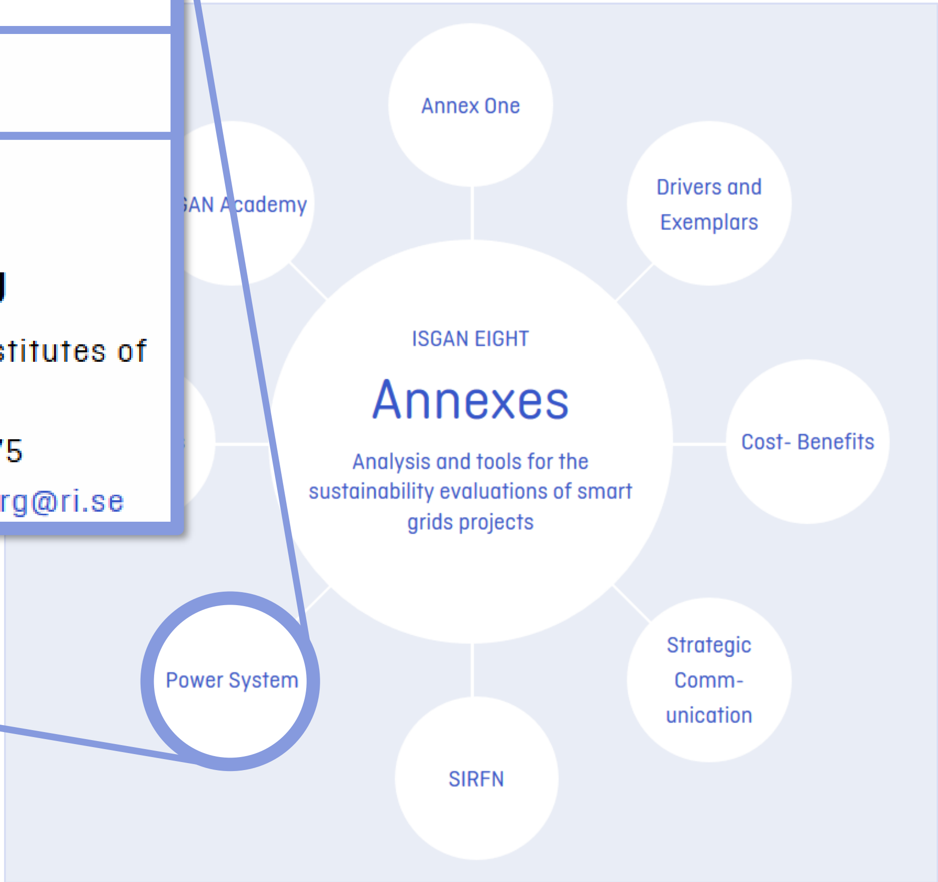
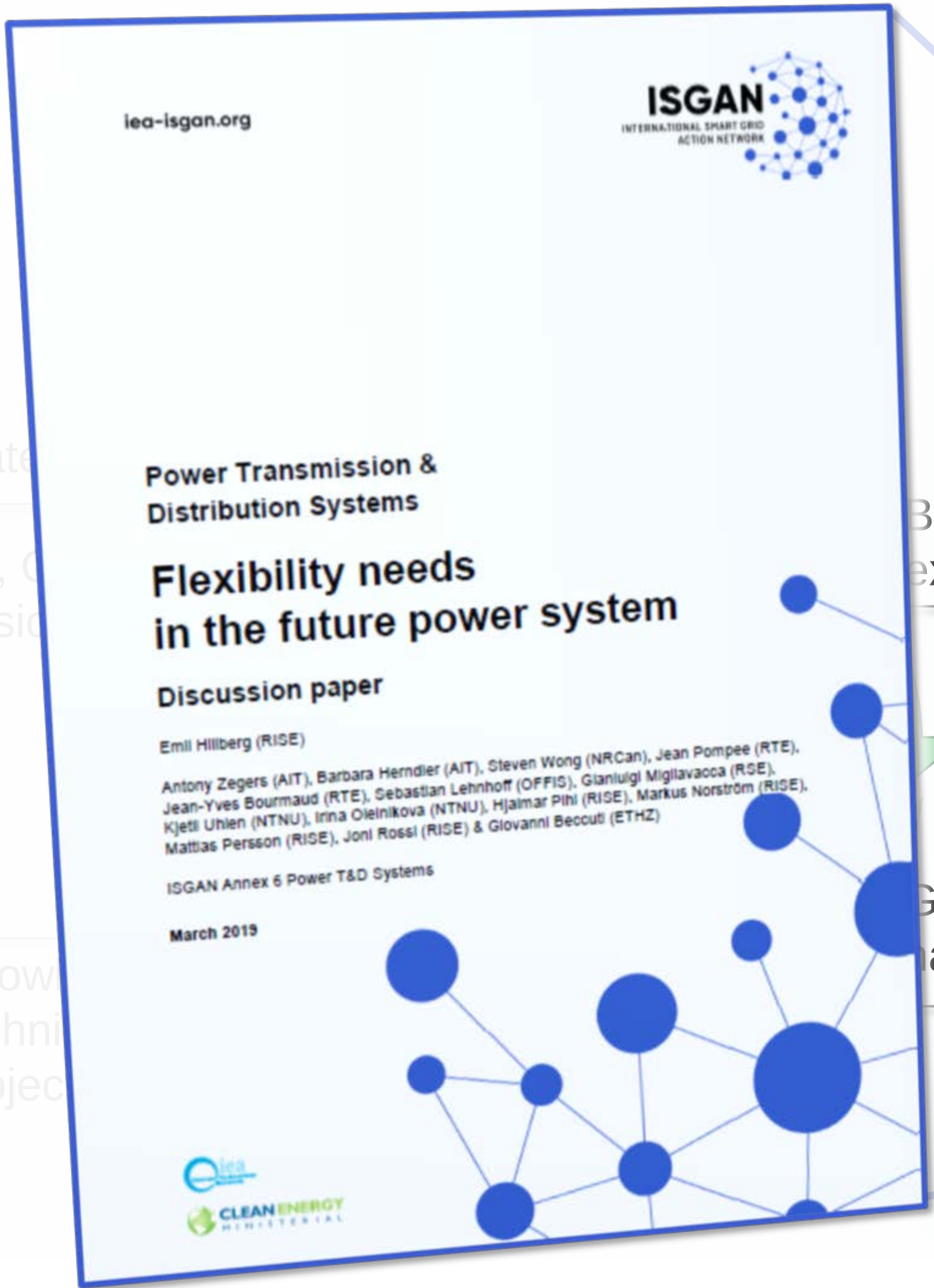
Strategic platform to support high-level government knowledge transfer and action for the accelerated development and deployment of smarter, cleaner electricity grids around the world

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Power Transmission & Distribution Systems

Flexibility needs in the future power system

Discussion paper

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ISGAN Annex 6 Power T&D Systems

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CLEAN ENERGY MINISTERIAL

Broad international expert network

Global, regional & national policy support

Definition of flexibility

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"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

"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

[...] cost, to any change, [...]h prevailed at the time it was planned."
1995, CIGRE thro[...]

...

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

"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

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

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

What is power system flexibility?

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

… flexibility is still not a unified concep
“flexibility term” is used as an umbr ering
various needs and aspects in th system

ISGAN Annex 6 has made an effort to increase the understanding of different flexibility needs, in order to support the communication of flexibility within and outside the power system community

The outcome of **ISGAN ANNEX 6** work is a proposal on categorization of flexibility needs

… this complicates the discussion on flexibility and craves for differentiation to enhance clarity

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[d] plants to many smaller, decentralised, power production units

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

Digitalisation extensive implementation of and depe[ndence on] information and communication technologies and solutions

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

volatility and uncertainty of the production and availability of electricity

operation and planning closer to the system limit

Source: ISGAN and the Swedish Smart Grid Forum, "Opportunities to Accelerate Smart Grid Deployment through Innovative Market Design" 2018

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**	**minutes / hours**	**months / years**
e.g. stability and frequency support	e.g. thermal loadings and generation dispatch	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

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Flexibility for Power

Flexibility for Energy

Flexibility for Voltage

Flexibility for Transfer Capacity

Flexibility for: Power

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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

- widen operating ranges (e.g. ramping rates) and shorten start-up time of thermal power plants
- aggregated control of supply and demand
- upward and downward balancing capability - implying curtailment of renewable energy.
- utilisation of short-term storage units and interaction between multi-energy carrier systems

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

- seasonal optimisation of the value of stored energy (including forecasted outage periods for power plant maintenance, future load scenarios)
- stockpiling of fuels for thermal plants
- appropriate timing for the maintenance of the traditional base-load thermal units
- use of hydro reservoirs to reduce the impact of seasonal variations in precipitation and load

Flexibility for: <u>*Transfer Capacity*</u>

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

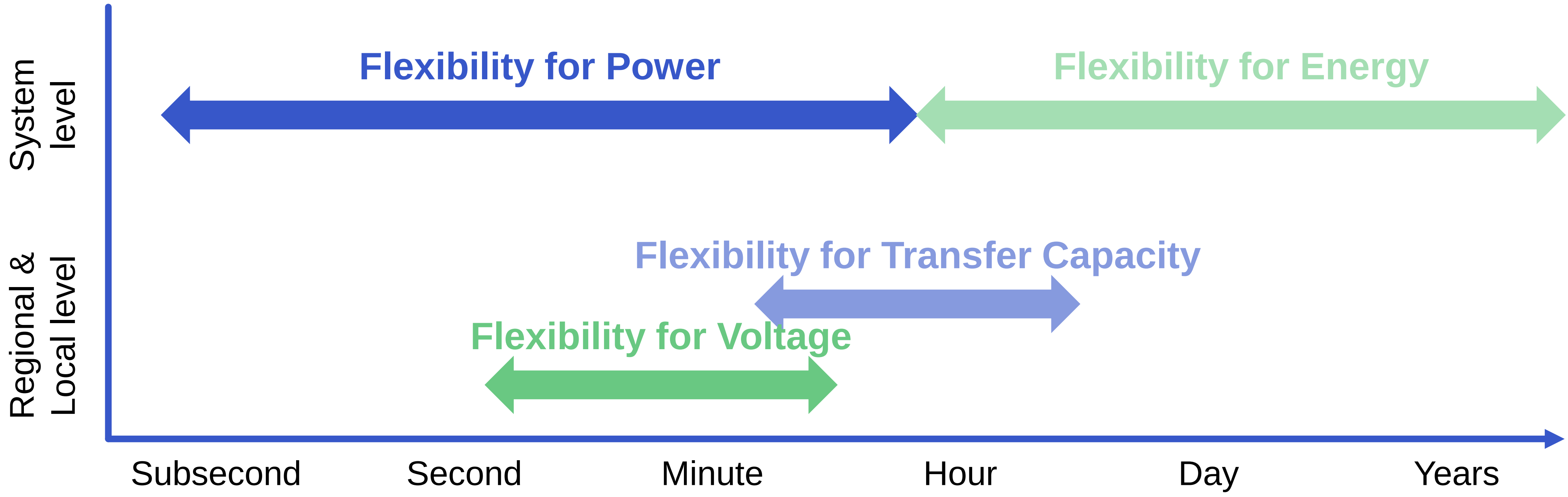
- to a certain extent, a built-in functionality in the power grid itself
- time variable transfer tariffs
- increased transfer by increasing nominal voltage levels
- use of phase-shifting transformers / series-compensation / power electronics based Flexible AC Transmission Systems (FACTS) devices
- dynamic line rating (DLR) for overhead lines

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

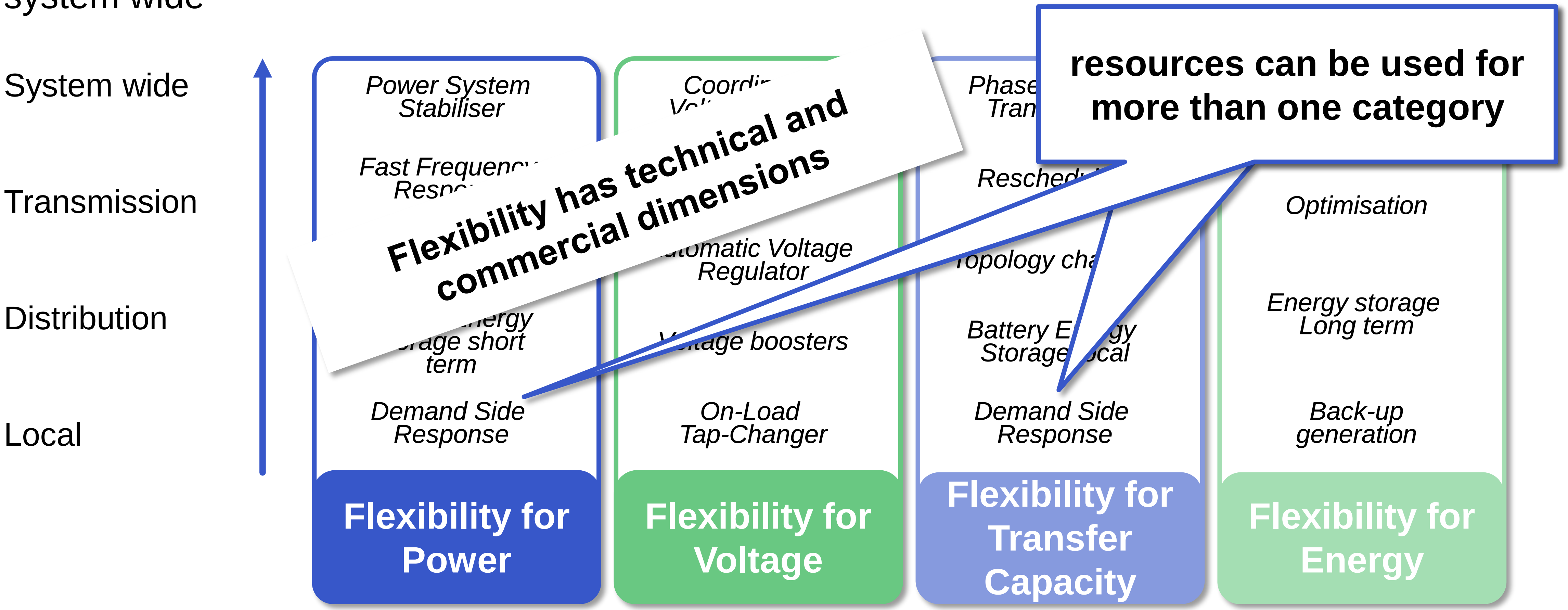
- FACTS devices, such as static var compensators (SVC) or static synchronous compensators (STATCOM) - Independence from generators
- broadening of acceptable ranges for power quality
- ancillary services from distributed generation and storage

Flexibility needs in time and space



Flexibility providers

Examples of flexibility solutions for each category with implementation levels from local to system wide



Summary / Conclusion

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

… a broad concept!

This work intend to support understanding and communication of flexibility, through 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

Thank you!

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