“Integration of Renewable Energies by distributed Energy Storage Systems”
Paris, 18th September 2012

Electrical Storage – A Survey about flexibility options

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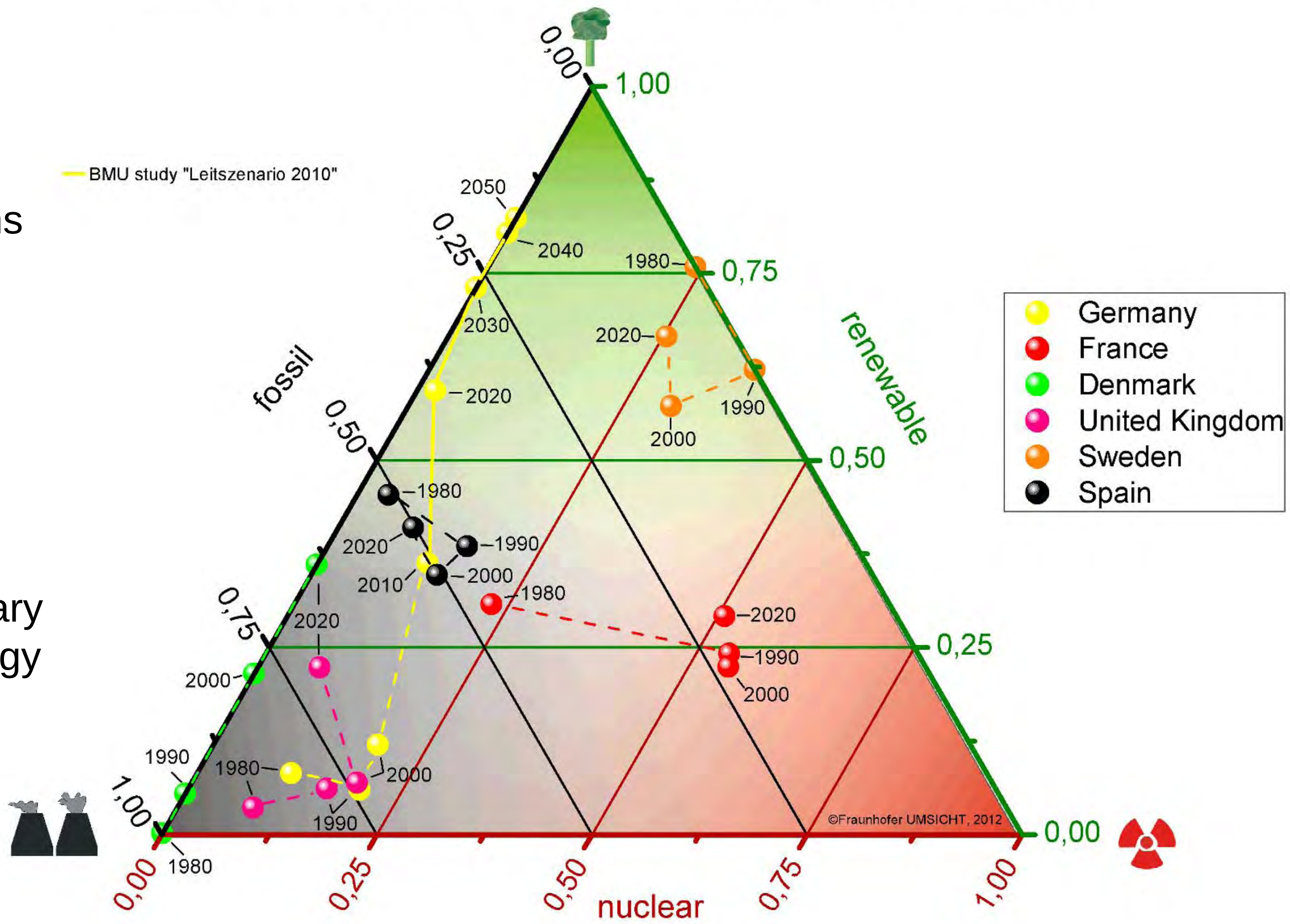
Change of the electric energy system

- **Energy System**
  - change to renewable energies
  - much more fluctuations
  - less base load power plants
- **Challenges**
  - balancing the grid at each time
  - managing the temporary surplus or lack of energy

Need of energy balancing devices

Installed electricity generation power in different european countries



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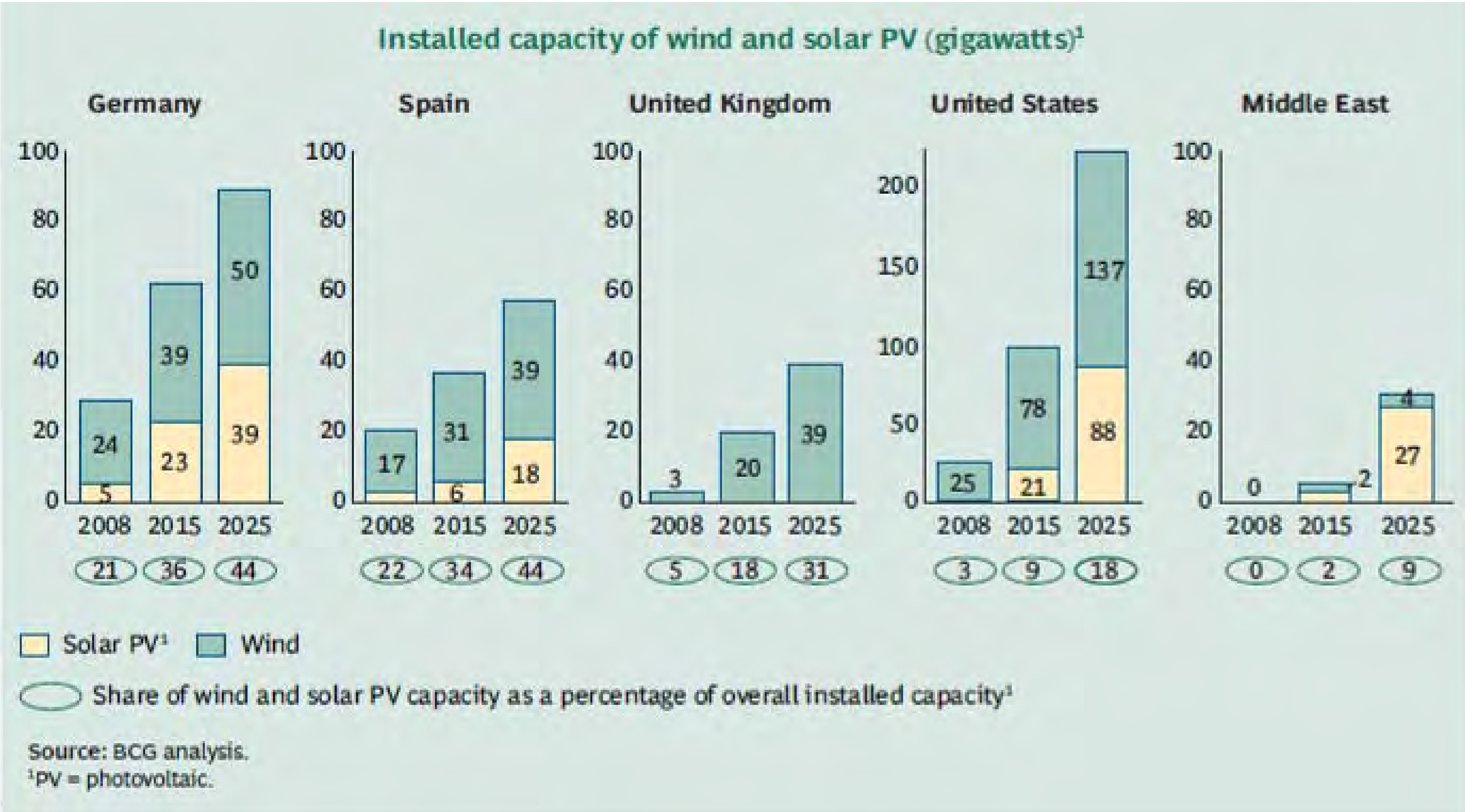
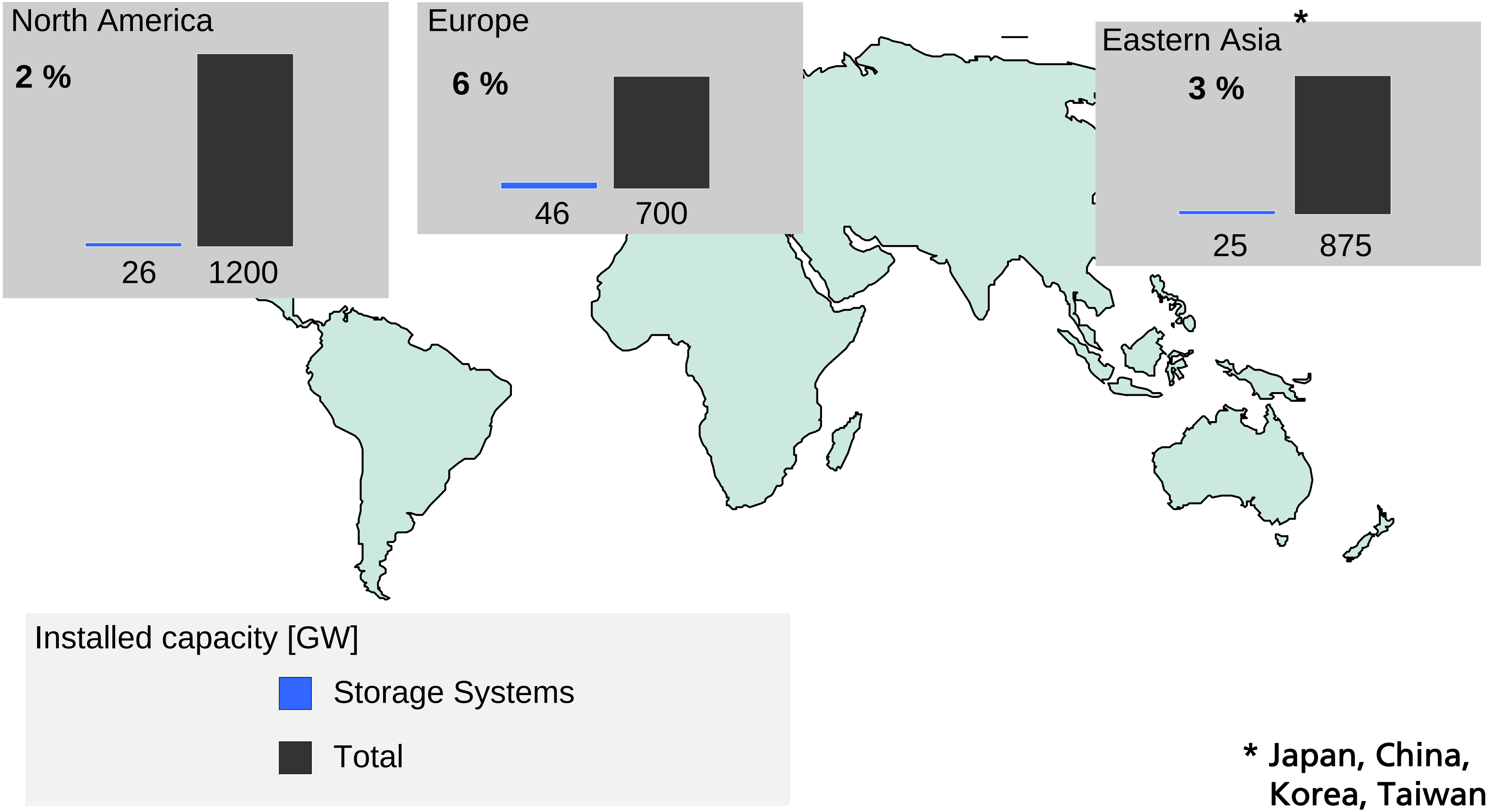
Growth in Demand for Wind and Solar PV Will Likely Be Strong Across All Major Regions Through 2025



Installed energy storage system vs. installed generation capacity



* Japan, China, Korea, Taiwan

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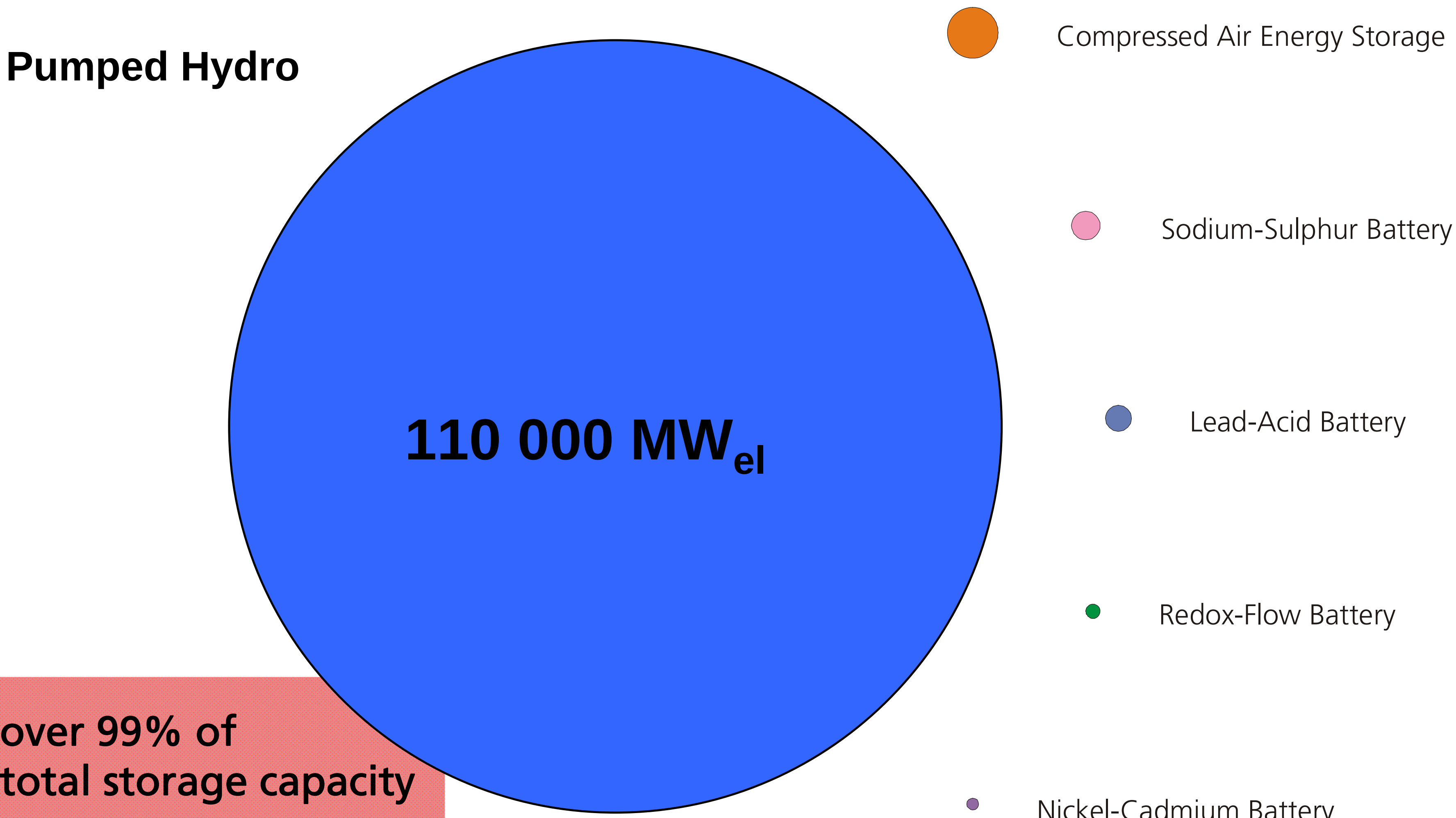
Worldwide installed storage capacity for electrical energy (2010)

CAES	**477 MW_{el}**	Compressed Air Energy Storage
NaS	**302 MW_{el}**	Sodium-Sulphur Battery
LA	**125 MW_{el}**	Lead-Acid Battery
Redox	**38 MW_{el}**	Redox-Flow Battery
NiCd	**26 MW_{el}**	Nickel-Cadmium Battery

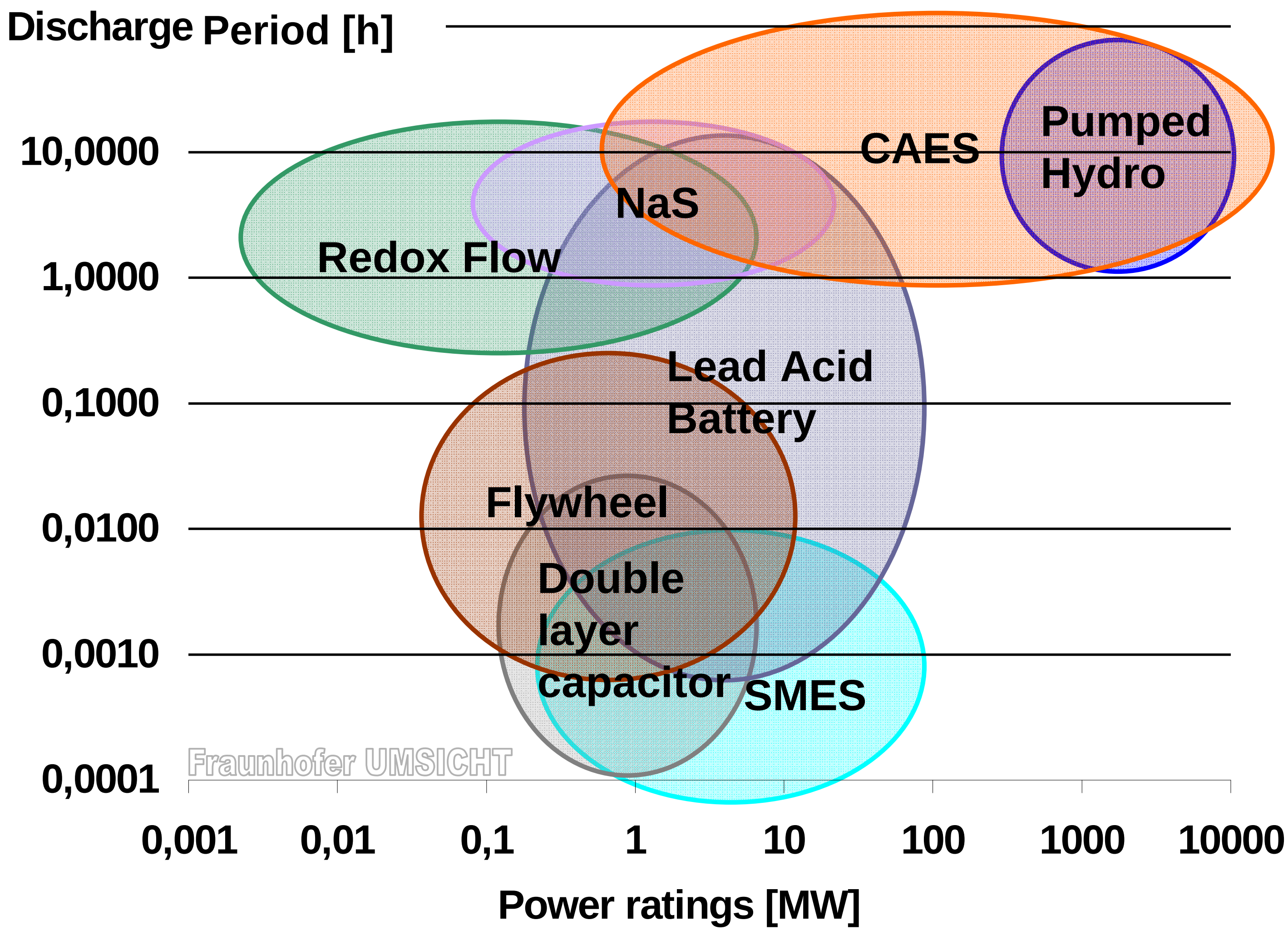
Worldwide installed storage capacity for electrical energy



over 99% of
total storage capacity

Survey Electric Energy Storage Technologies

- **Medium-/long term**
  - Pumped Hydro
  - Compressed Air Energy Storage
  - Redox-flow and NaS-Batteries
  - Lead Acid Batteries
- **Short term / power quality**
  - Lead Acid Batteries
  - Flywheels
  - Double layer capacitors
  - SMES



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Survey Electric Energy Storage Technologies – to integrate RE

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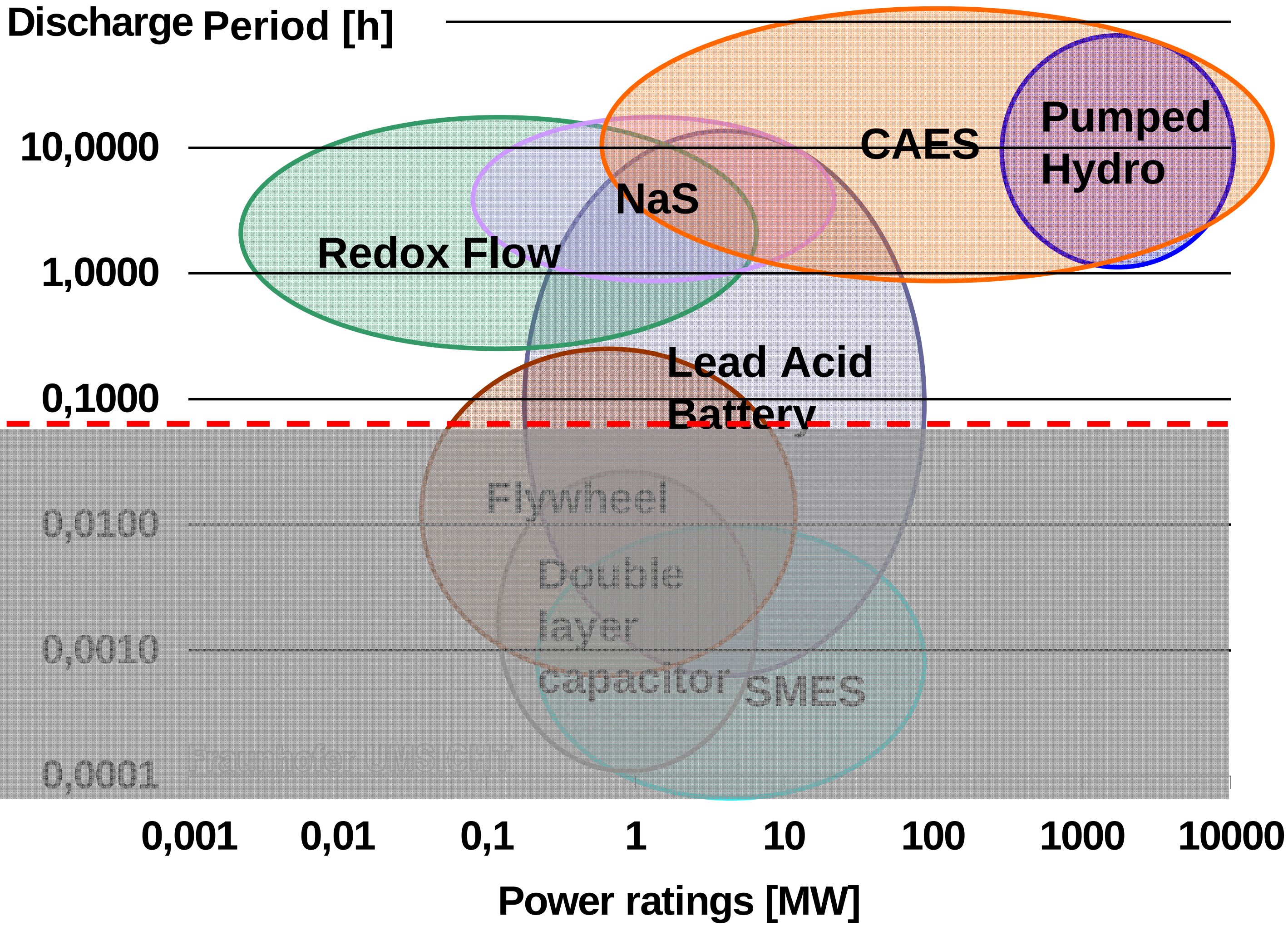

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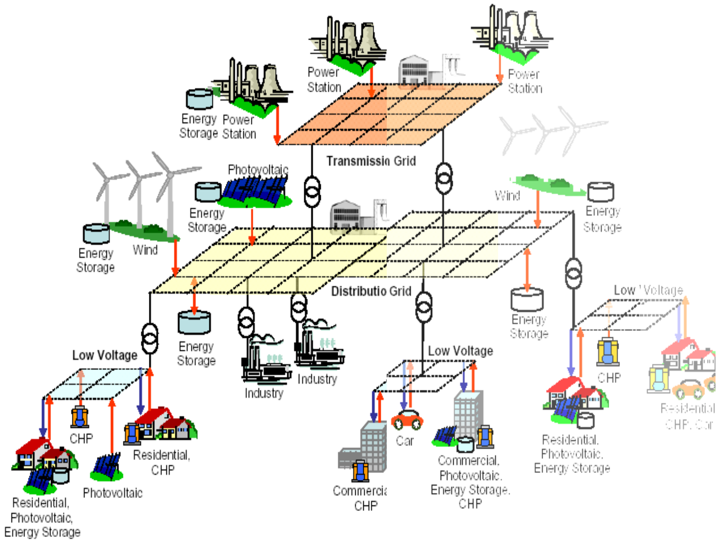
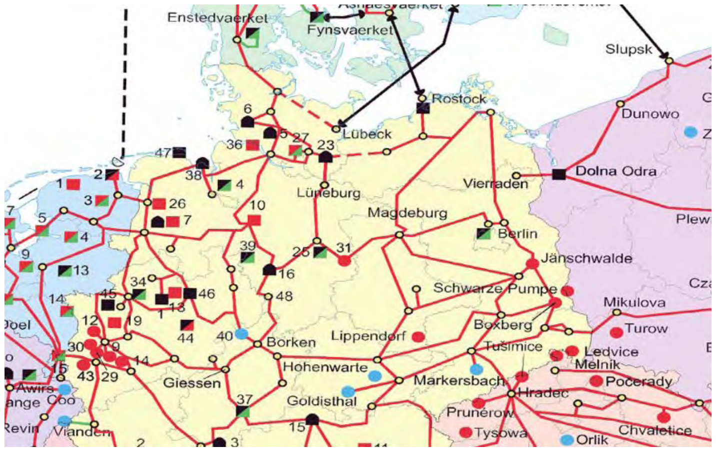
Basic technical framework



► **there is always a real grid no ideal grid**
- fluctuations are local (e.g. PV) or central (e.g. wind)
- demand fluctuations are local (household) or central (industry)
- storages, DSM etc. are always local or central options



► **Germany was, is and will be no island**
- grid connections to European neighbors
- embedded to the European grid
- important for 100% renewable energy scenario

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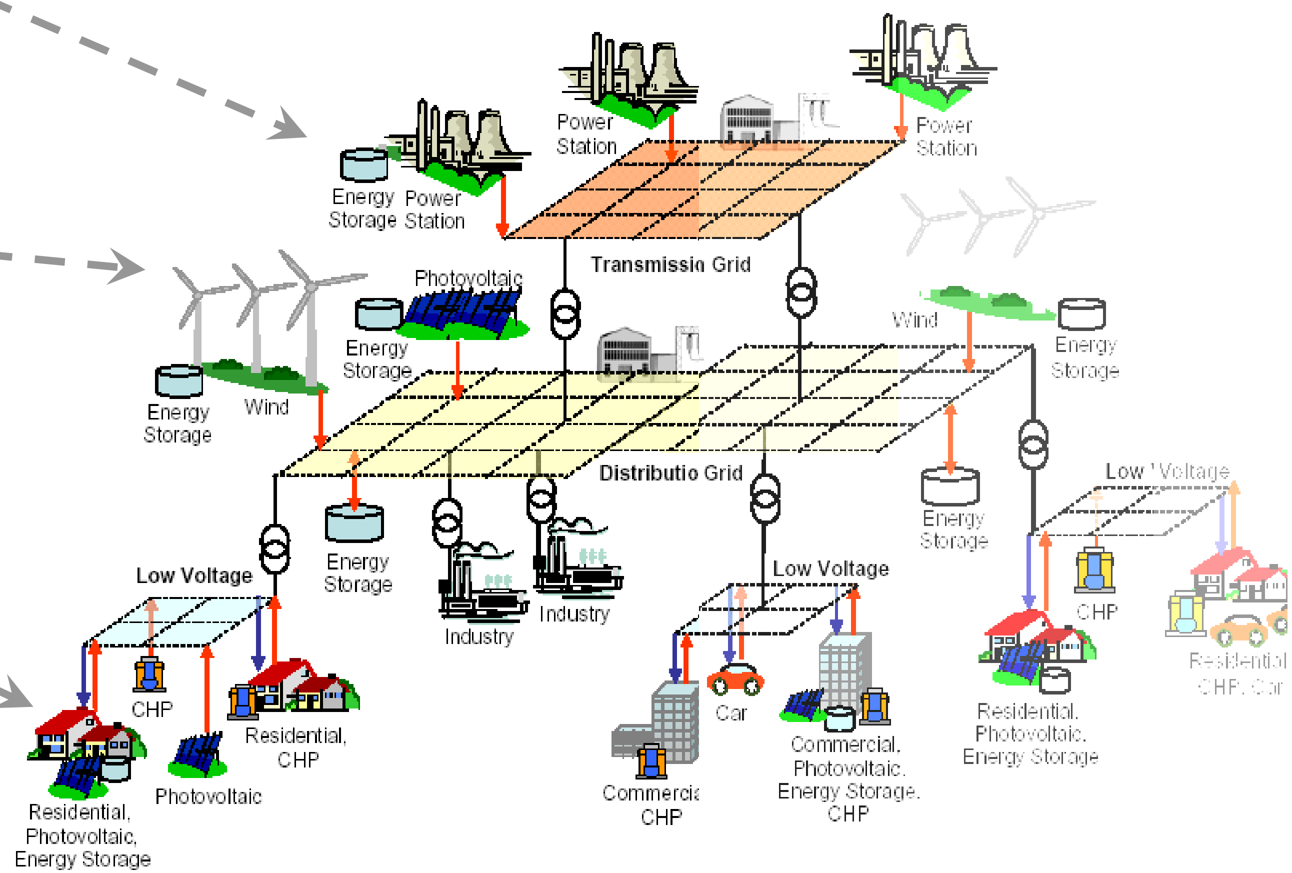
Where (grid-level) could this systems be located ?

- **central electric storages**
  - pumped hydro
  - hydrogen generation
  - compressed air energy storage
- **decentralized huge batteries**
  - lead acid batteries
  - NaS batteries
  - Redox-Flow batteries
- **local batteries**
  - lithium-ion batteries
  - lead acid batteries
  - NiMh-, NiCd batteries
- **virtual storages**
  - HP + thermal storage
  - µCHP + thermal storage



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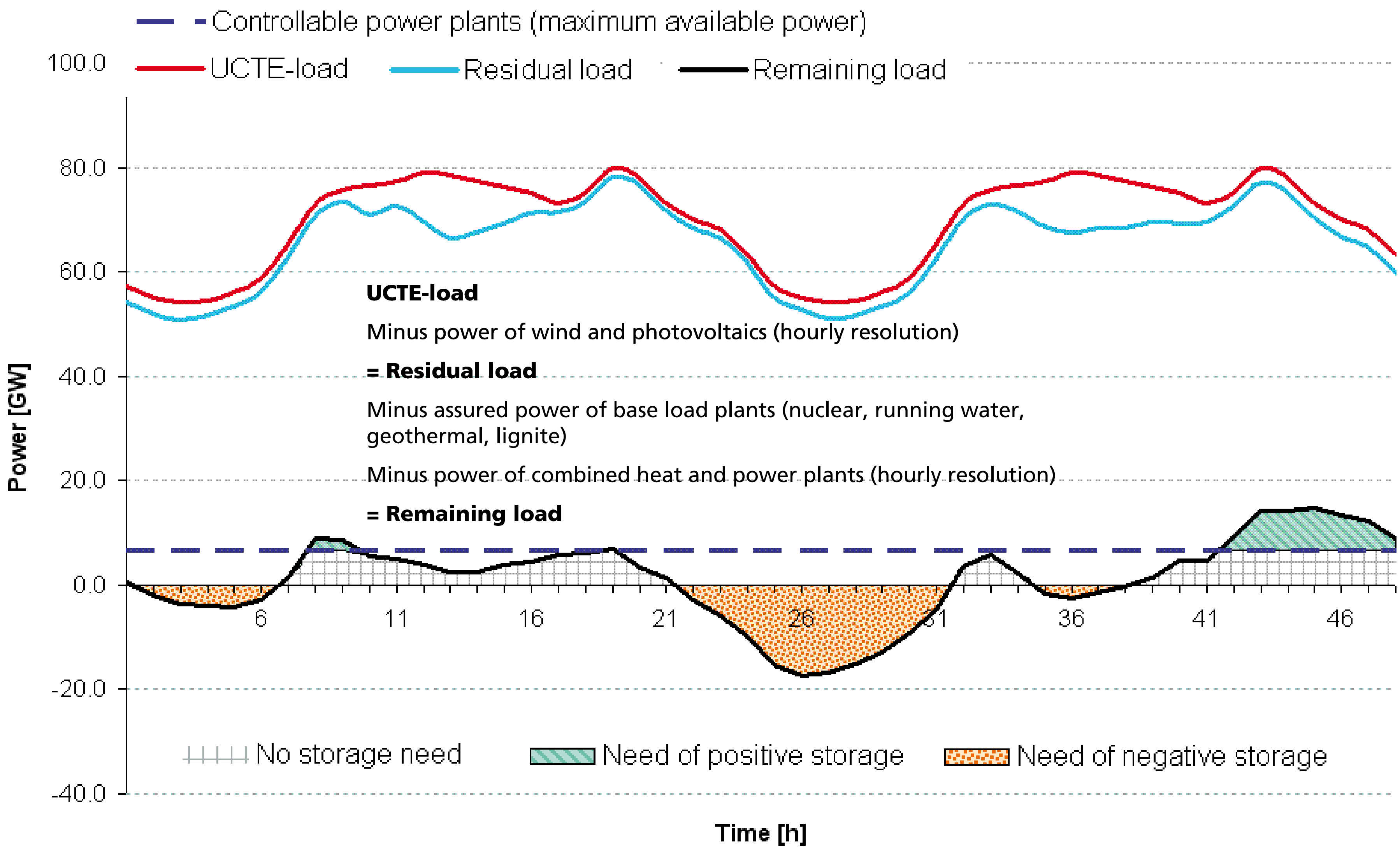
Positive and negative storages are needed…



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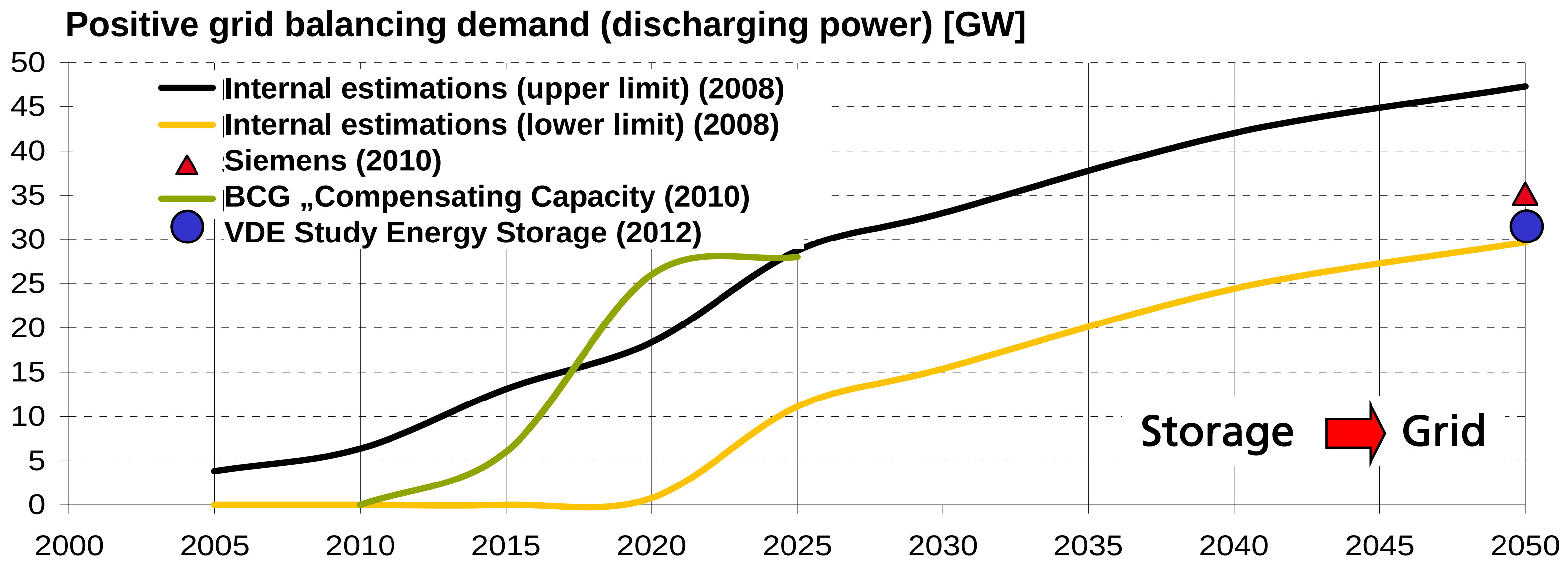
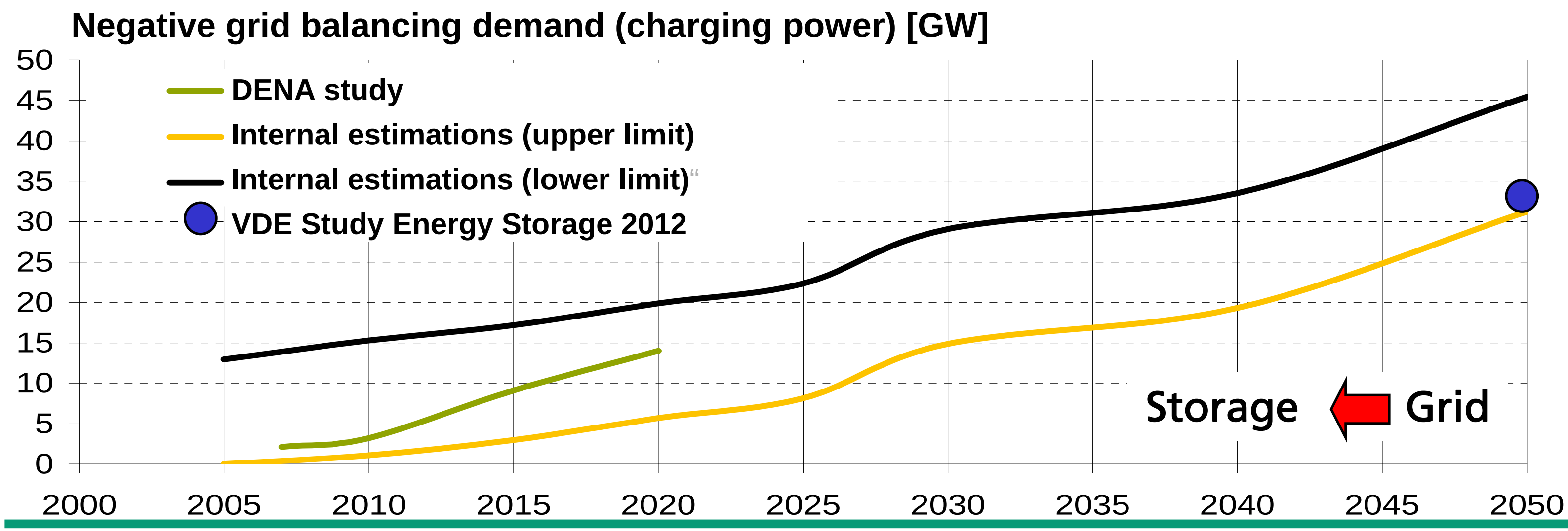
Estimations for Grid Balancing Demand (Germany, Peak Load 90 GW)





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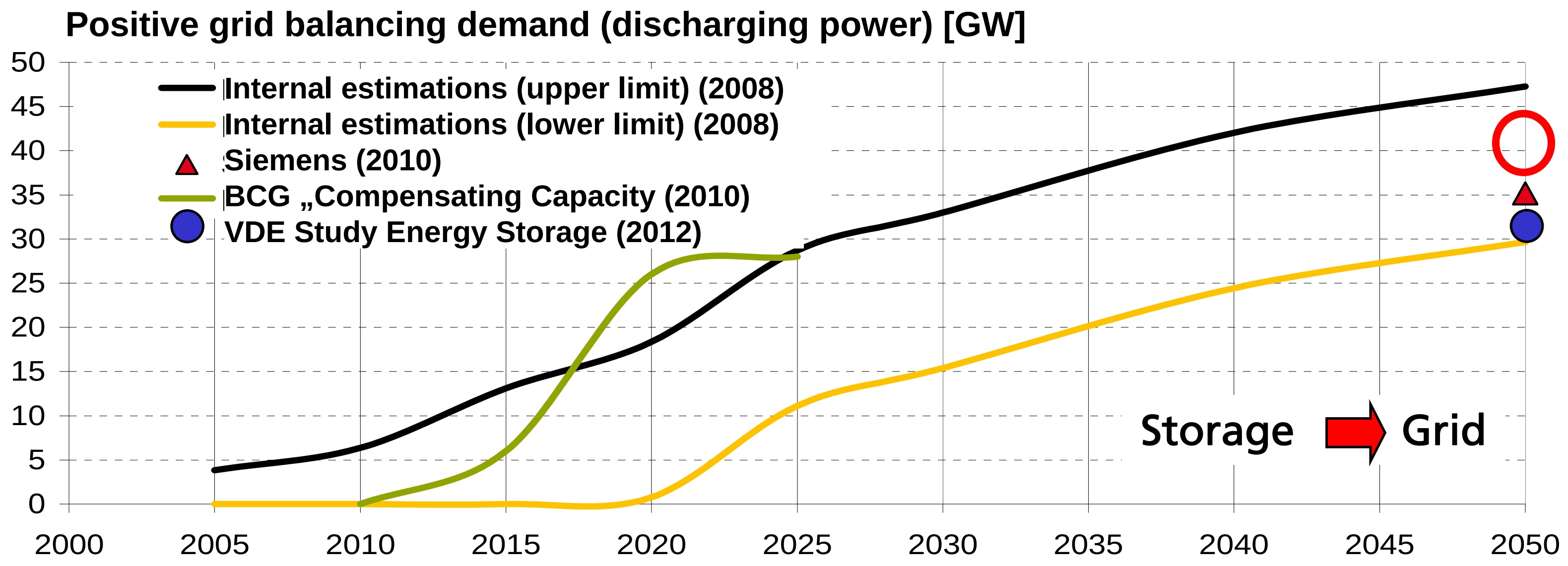
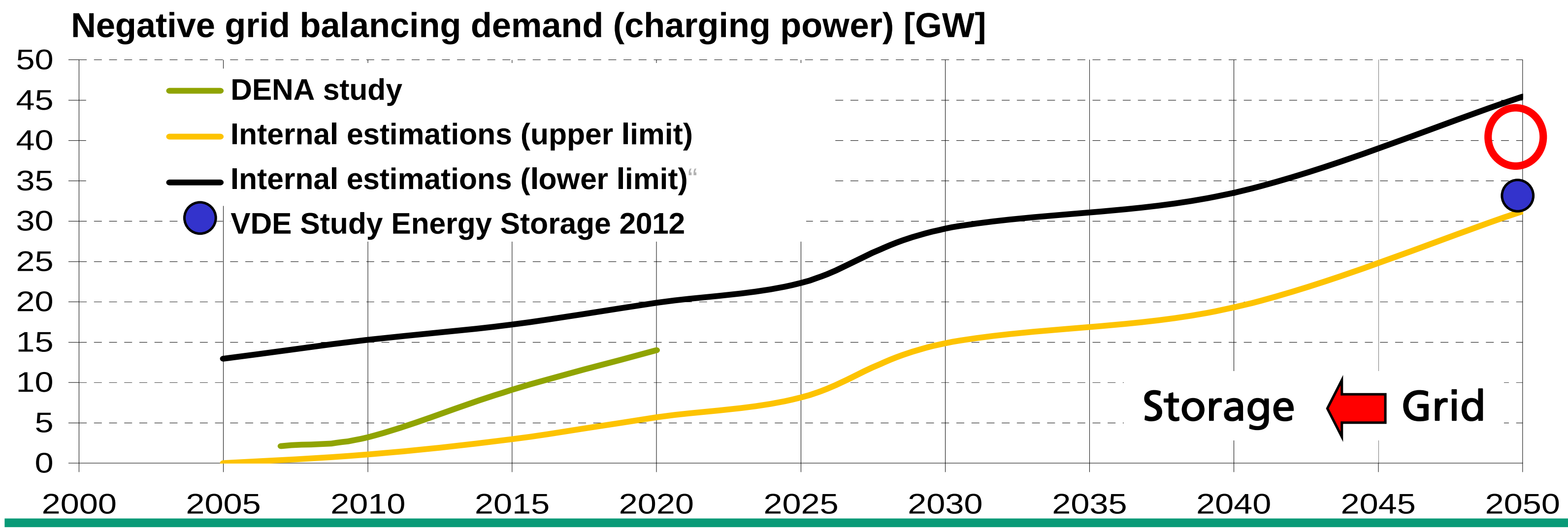
Grid Balancing Demand: Power [GW] vs. Stored Energy [GWh/a]





Example:

Grid Balancing Demand 2050

positive: approx. 40 GW

negative: approx. 40 GW

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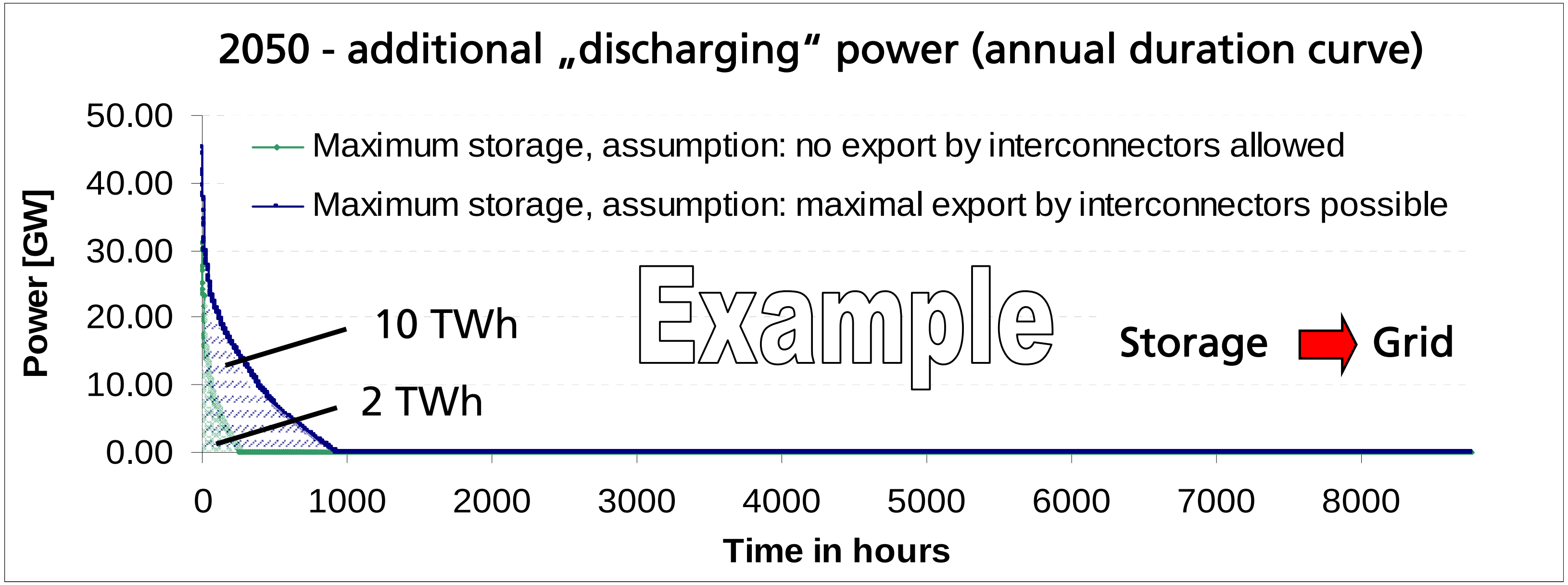
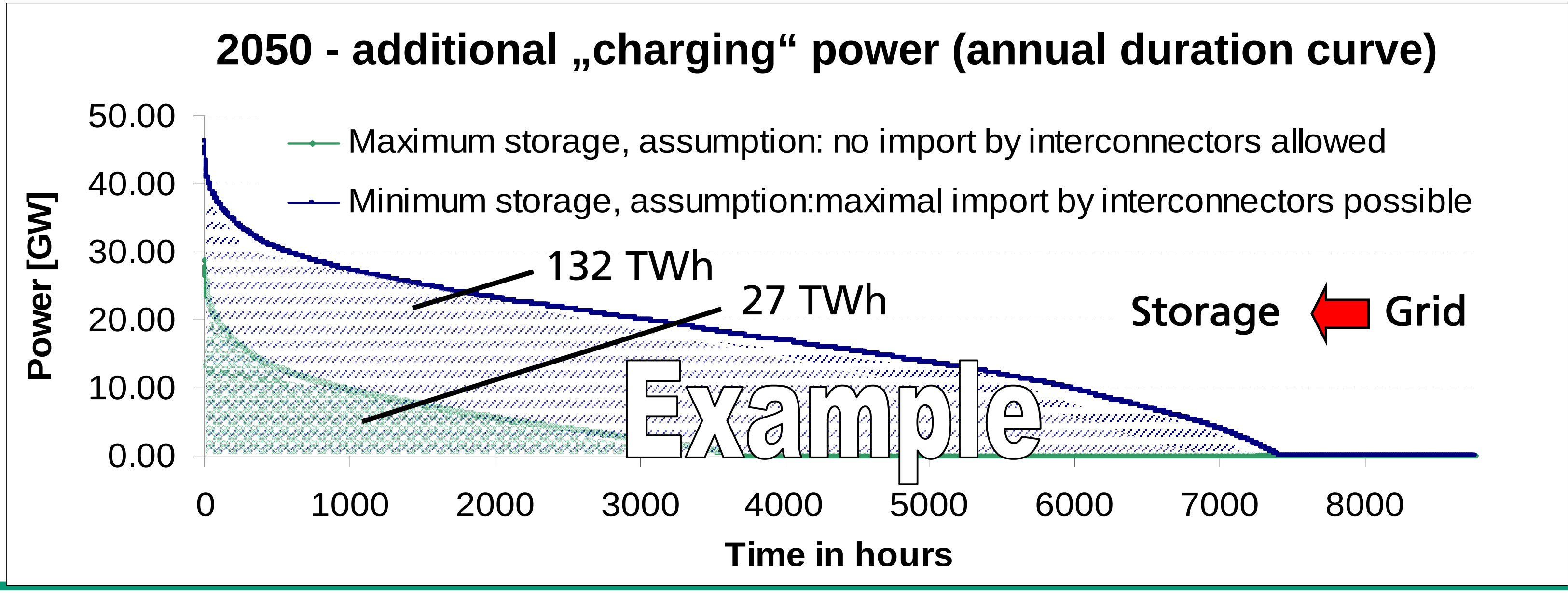
Grid Balancing Demand Analysis: Power vs. Yearly Stored Energy





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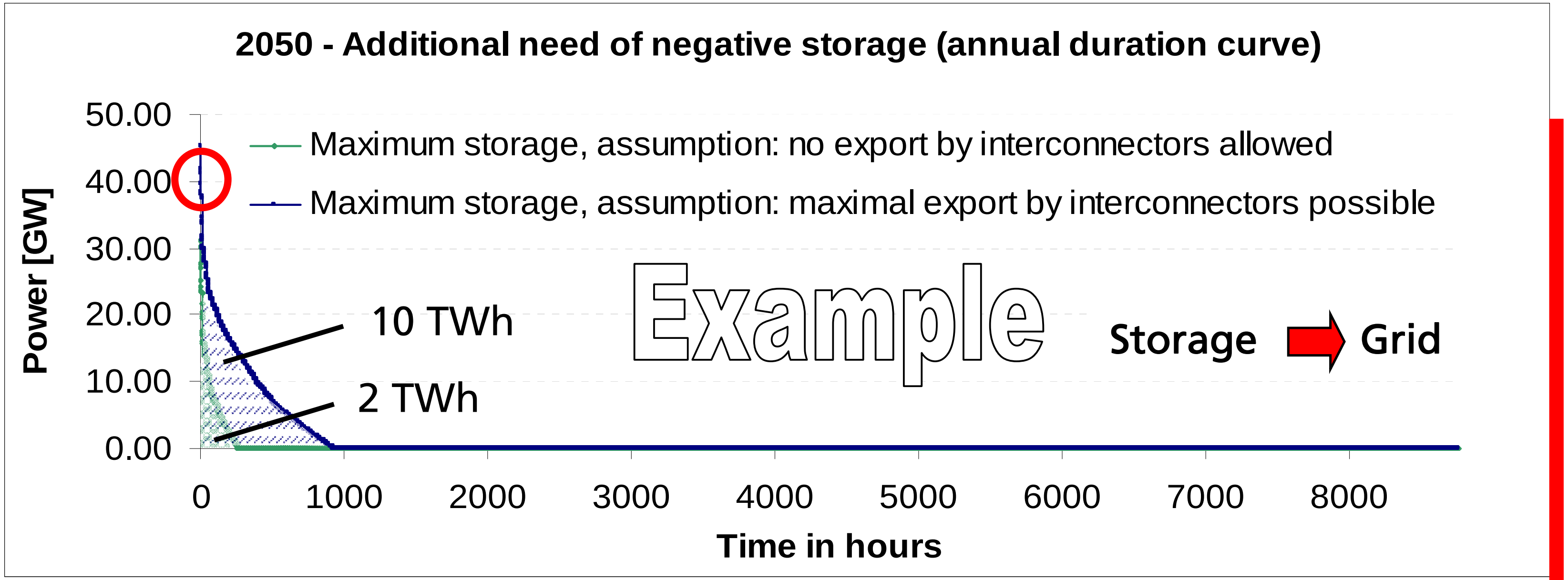
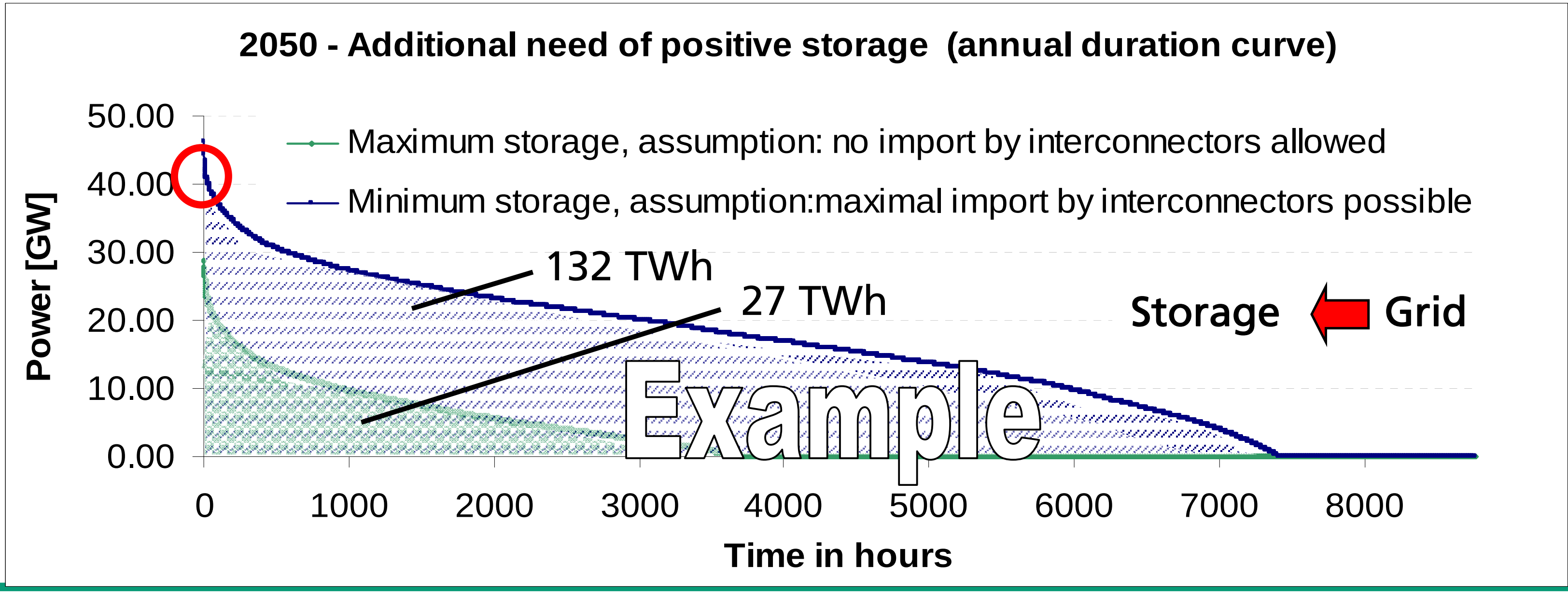
Grid Balancing Demand Analysis: Power vs. Yearly Stored Energy





Example:

Grid Balancing Demand 2050

Discharging: 2-10 TWh

Charging: 27-132 TWh

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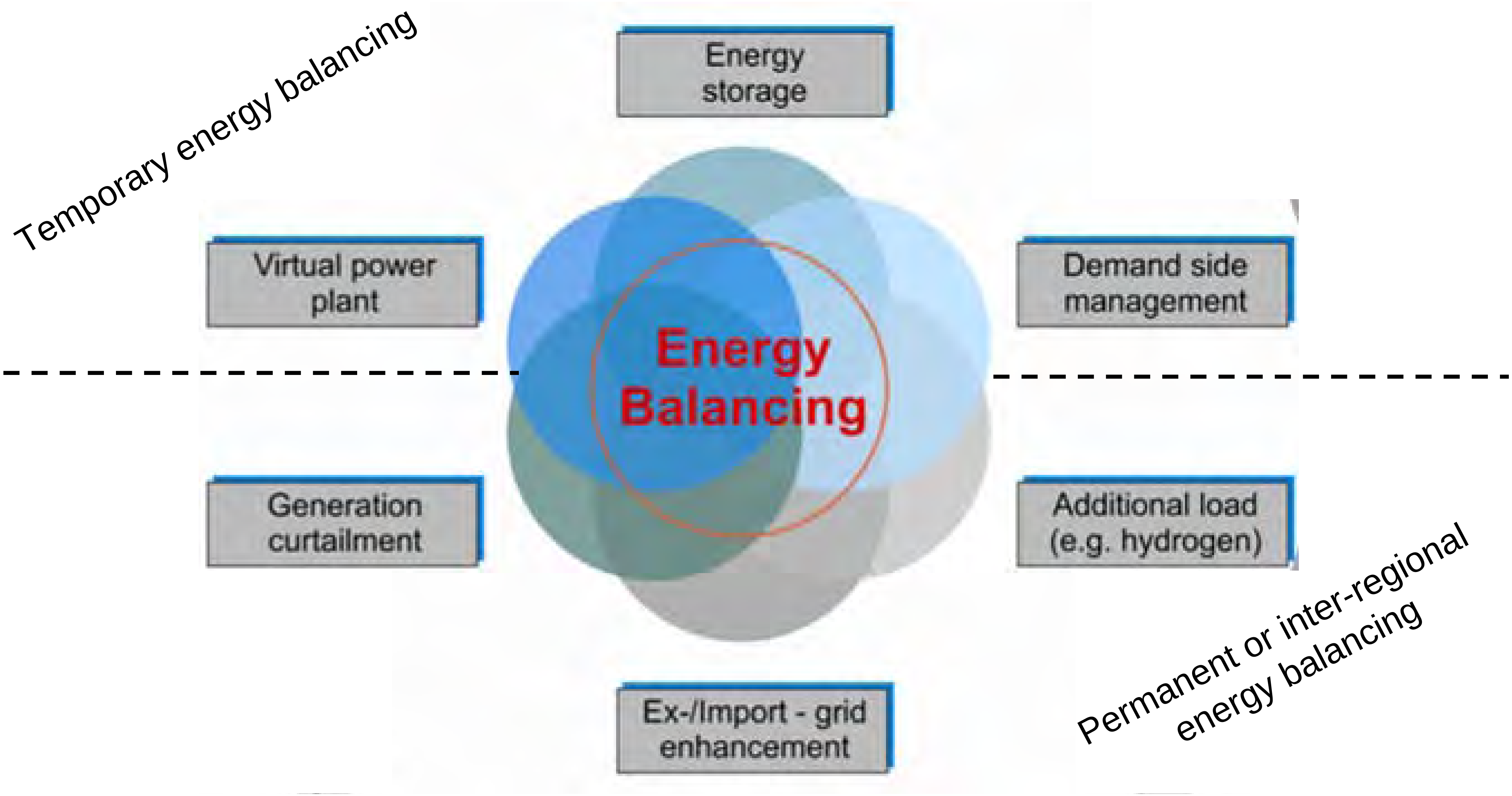
That means:

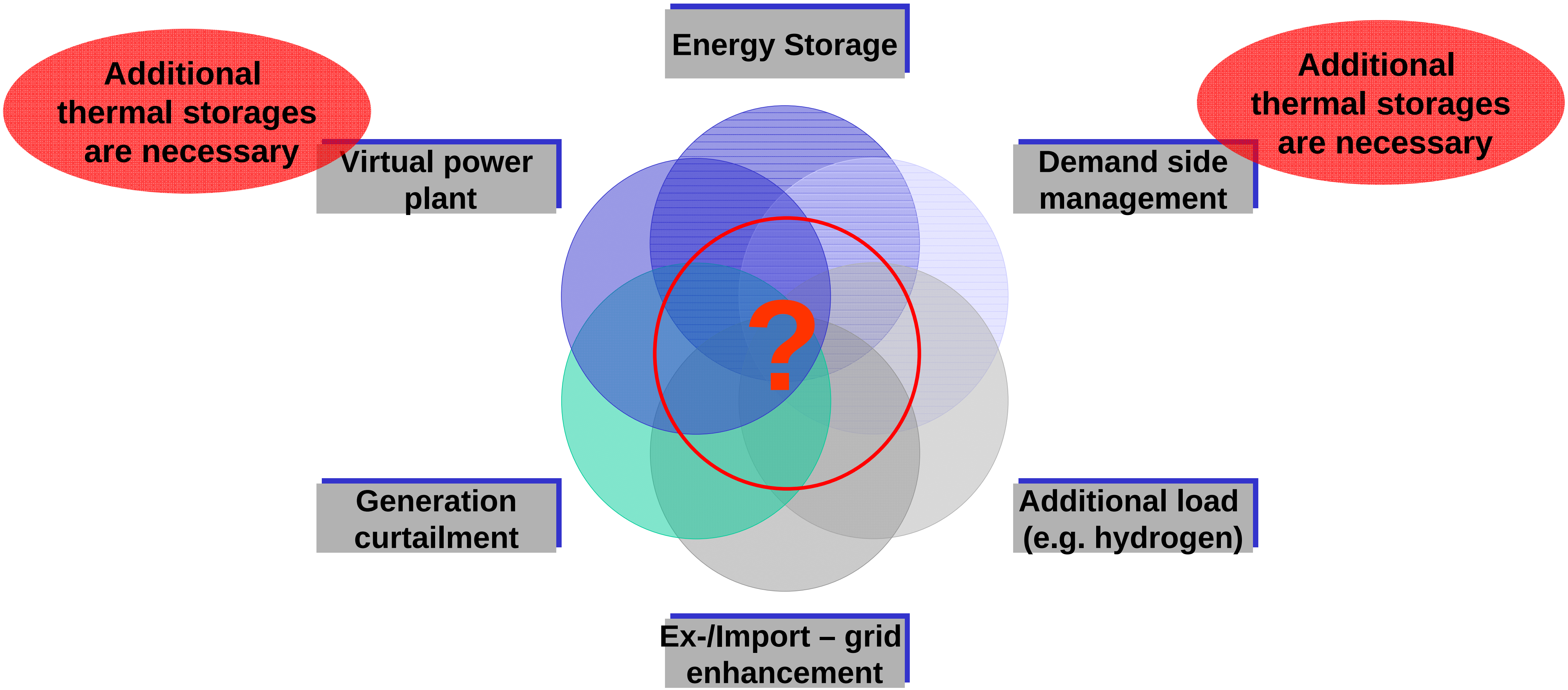
Electric storages are only an opportunity, if charging and discharging amount fits together.

For other situations different grid balancing measurements has to be taken into account.

Measurements for “Grid-Balancing”



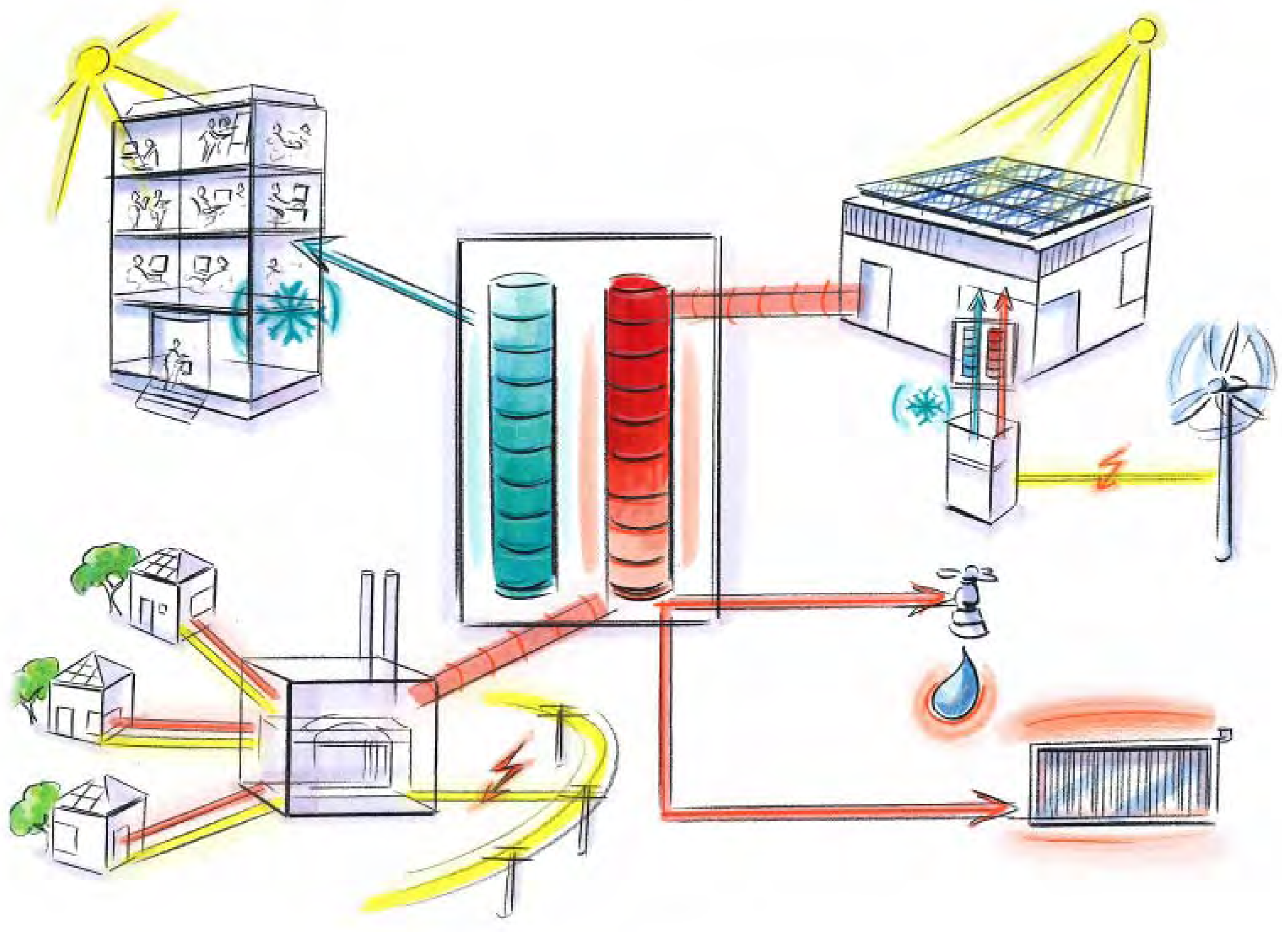
Measurements for Grid-Balancing



Thermal storages as additional „electric“ storages

Thermal storages with

- heat pumps
- combined-heat-and-power
- district heating
- domestic hot water
- HVAC



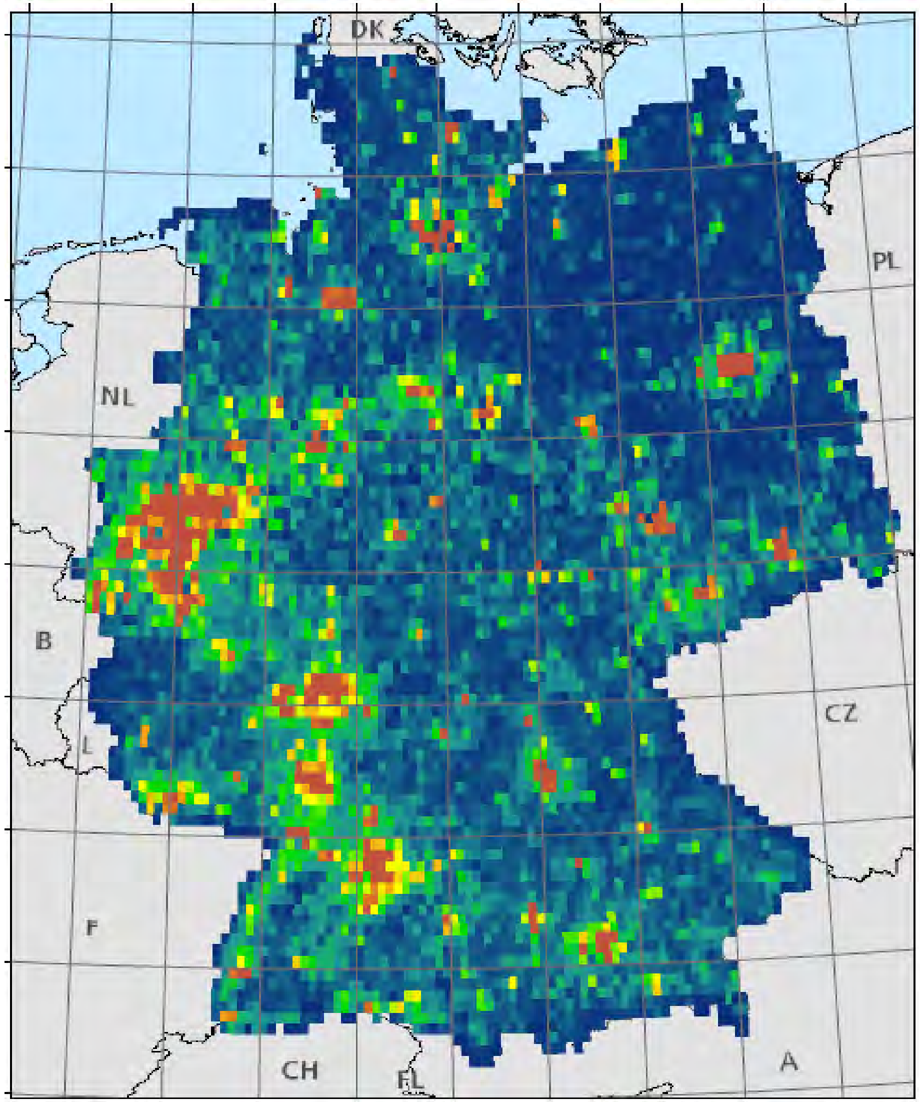
…decouples electric and thermal energy fluxes

…and enables this units to be flexible and to work as “electric” storage

Where (regional) could this systems be located ?

- Most of these systems (µCHP, HP etc.) are located in regions with high energy demand… cities

- Many thermal storages, which allow to use these devices as "electric" storage have to be installed in cities



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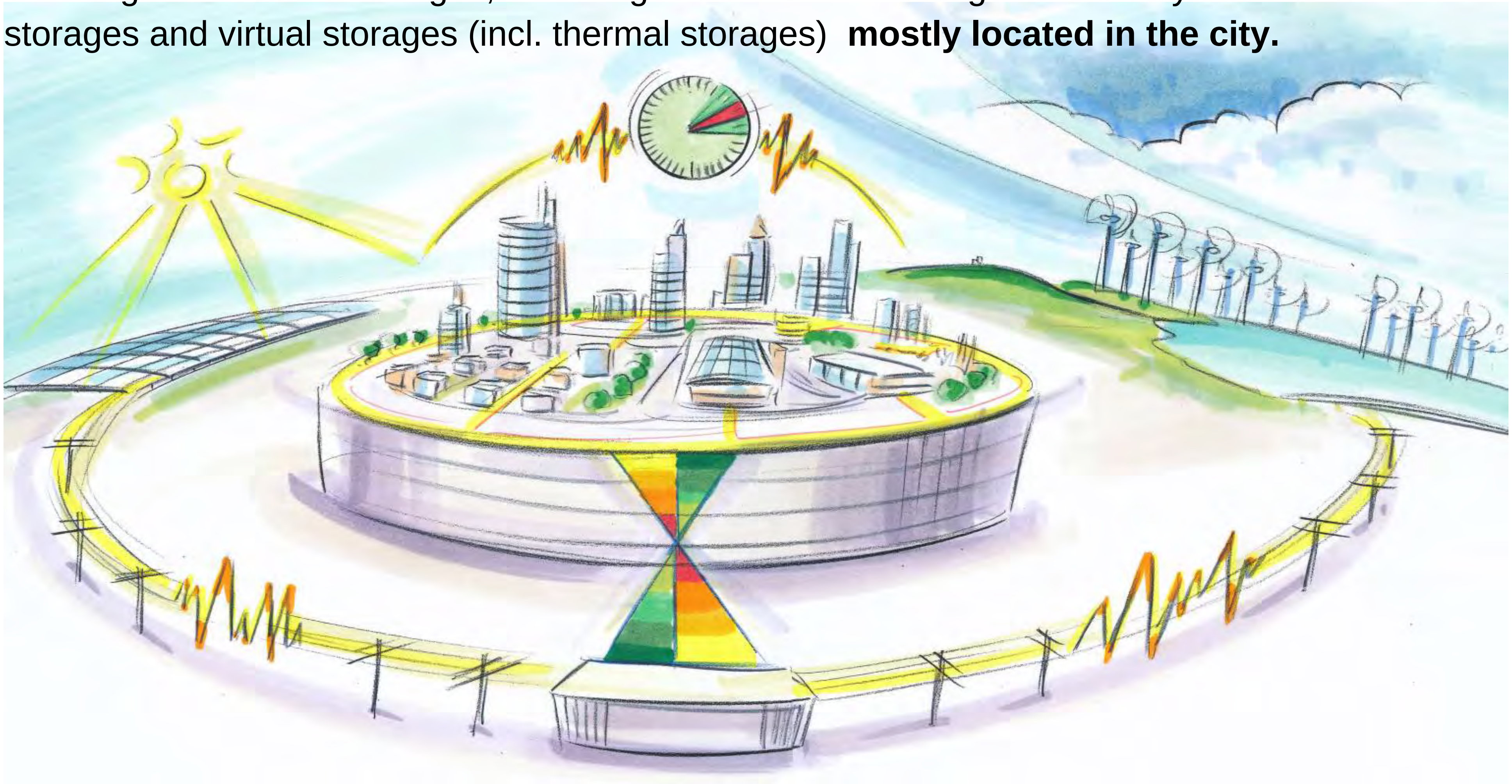
Vision

Realization of high shares of renewable energies by a smart combination of different storages: Few huge centralized storages, some big decentralized storages and many small decentralized storages and virtual storages (incl. thermal storages) **mostly located in the city.**



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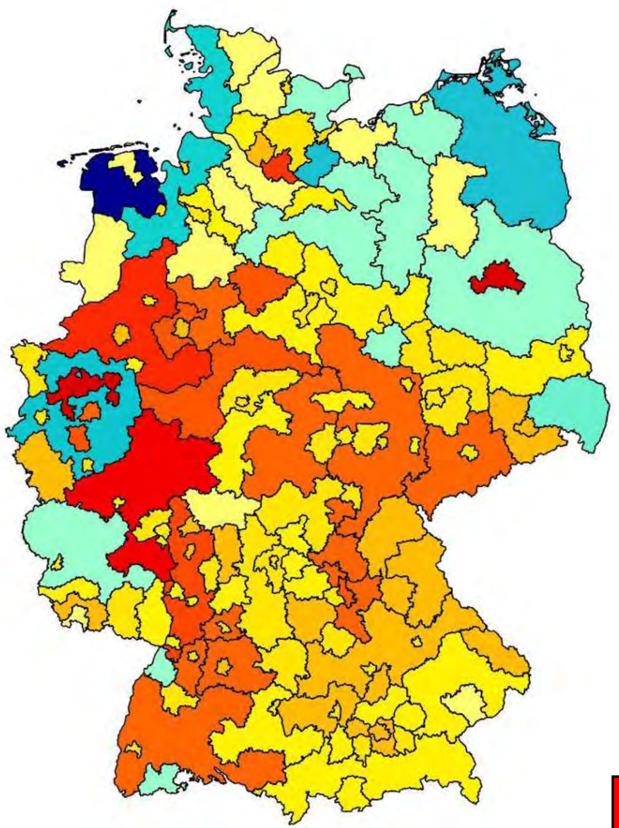
Conclusions



- energy balancing demand will increase due to higher penetration of fluctuating renewable energies
- different storage technologies will be located at different points of the grid and will solve different problems
- Germany has a good but no ideal grid (restrictions) but is embedded in the European grid
- energy balancing demand ≠ energy storage demand
- many different measurements for grid balancing, virtual (e.g. DSM) and real storages must be aggregated and operated in a coordinated way
- economical regulations must support these operations modes

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IEA - ECES 26 »Future Electric Energy Storage Demand« - Preface

The main objective of this task is to develop a method or approach to calculate the **regional energy balancing demand** and to derive **regional storage demand** rasterizing the area and taking into account that there are competitive technical solutions.

Additionally there are two important aspects. On the one hand an overview about the different technical and **economical and legal framework requirements** in the different countries.

Case Studies: Running projects, planned projects and future projects for stationary energy storage systems.

And on the other hand **typical operation modes for energy storages** and derived from this typical charge/discharge curves, needed for future standardizations.

Next Meeting 6th Nov 2012 Brussels

Thanks to all participants of eces26

[2012-May-14/15 4th Meeting, Lleida Spain]

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