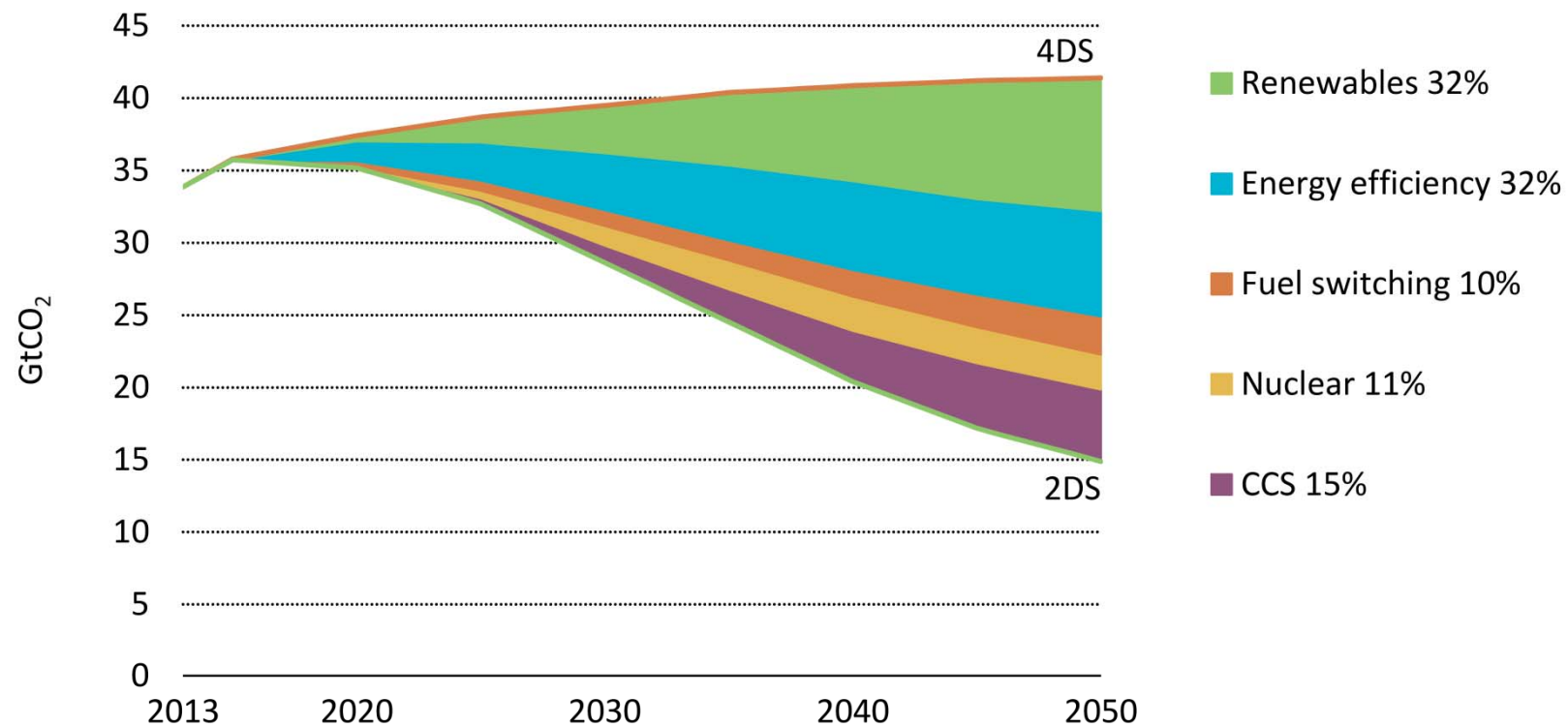


▶ 2 Big Picture

Contribution of technology area to global cumulative CO₂ reductions



The carbon intensity of the global economy can be cut by two-thirds through a diversified energy technology mix

▶ 3 Competitors for Flexibility

Functions and Criteria in a Power System based on Renewables

Flexibility functions

- ▶ energy supply (selling or sel consumption)
- ▶ ancillary services (balancing energy, congestion management, black start, voltage maintenance etc.)
- ▶ reserve capacity (securing power supply in times of longer dark calm)

Competitors

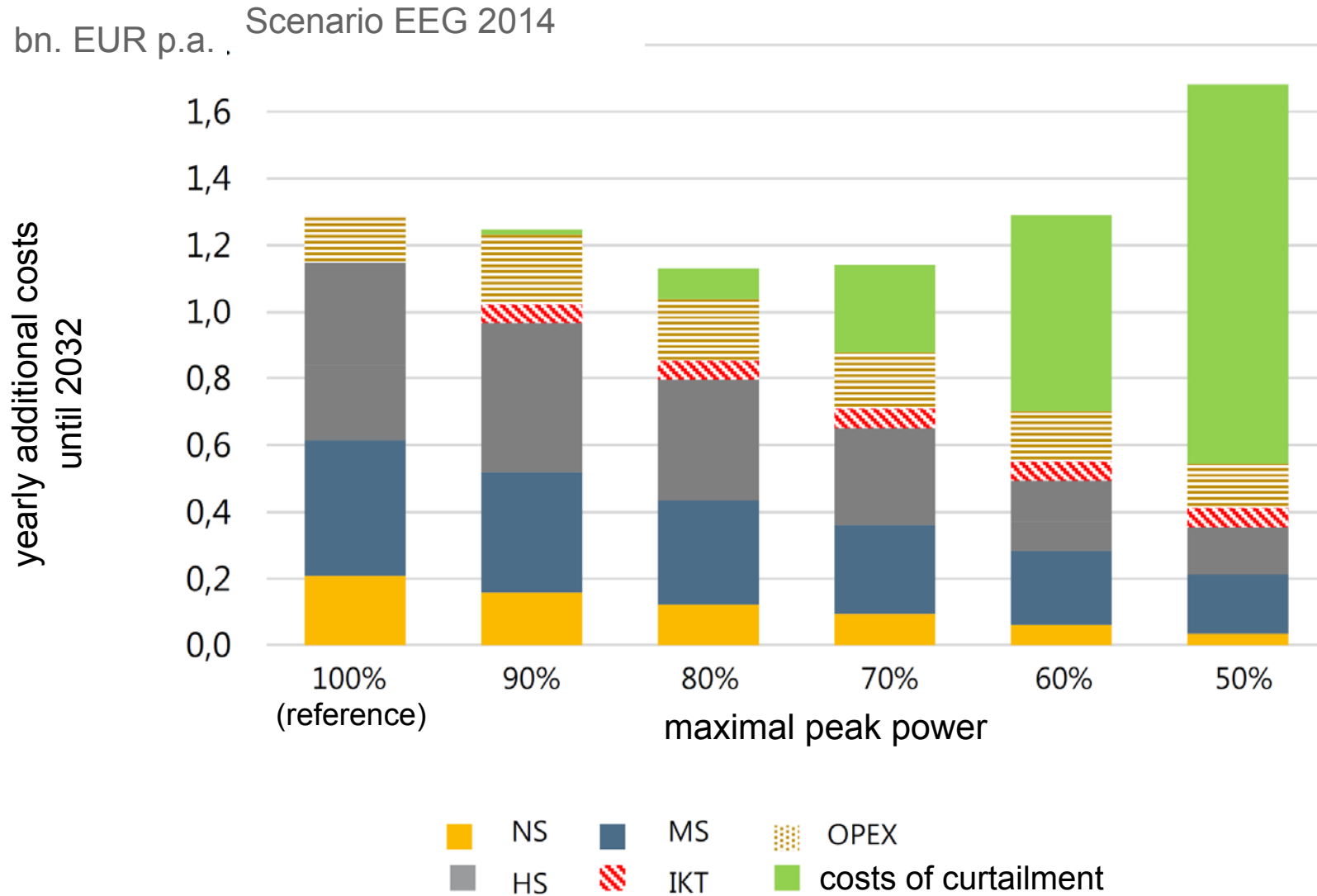
- ▶ large scale
 - ▶ grid expansion/European market integration
 - ▶ (reserve-) power plants
- ▶ small and medium size
 - ▶ flexibility of supply (e.g biomass, curtailment)
 - ▶ DSM (incl. sector coupling)
 - ▶ storage (battery, water pumped hydro, power2gas)

Criteria

- ▶ business model
- ▶ macroeconomic benefit
- ▶ reliability
- ▶ acceptance (self efficacy, infrastructers, behaviour)
- ▶ sociotechnical risks: regulation, acceptance, economics

4 Flexibility of Renewables in the Distribution Grid

Curtailment vs. Grid Expansion



► 5 Thesis 1: DSM and Grid Expansion

DSM and storage will lead to a much higher demand for grid expansion at the MV level. (→ simultaneity factor).

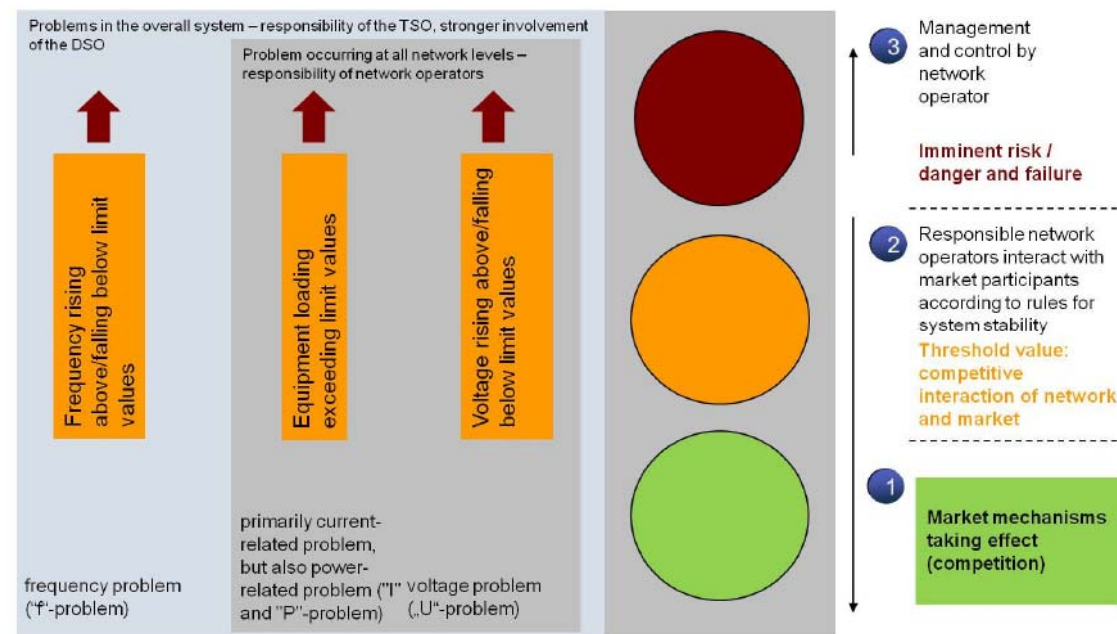
Actions

Regulator:

- inject some kind of variable grid pricing, e.g. traffic light concept

Utility/aggregator:

- develop products



BdEW, Smart Grid Traffic Light Concept, 2015

▶ 6 Thesis 2: Big Data and Consumers

A lot of the new local business models will be data driven.

„Self efficacy“ and trust will be a key factor for acceptance.



Actions

Utility:

- build the new business models around trust
- establish value-added networks

Research:

- understand acceptance



► 7 Thesis 3: New Role of the DSO

The DSO will be a smart grid operator who uses contracted assets from other parties for ancillary services. This will lead to a shift from a CAPEX to an OPEX oriented business model.

The system complexity will increase dramatically.

„Cyber Resilience“ will be the new paradigm of system safety: ICT will contribute to system resilience.

Actions

DSO:

- understand new business model
- build trust to new clients

Regulator:

- establish the new role

Research:

- develop methods and tools for cyber resilience



► 8 Thesis 4: Energy Markets

There is no need for fundamental change. The balancing power markets will be adjusted (e.g. shorter time spans for smaller DSM). Ensuring a level-playing field will be the only key for choosing the right flexibility alternatives.

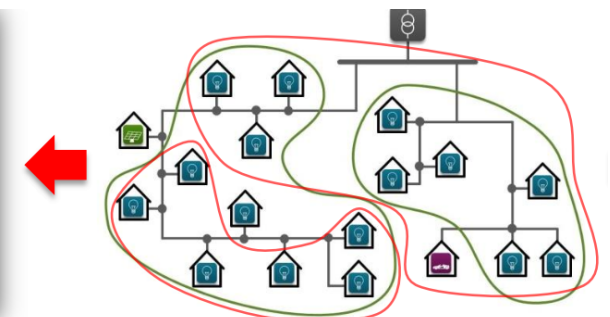
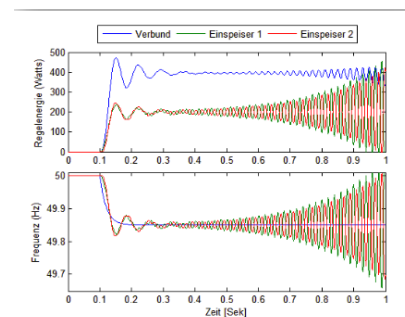
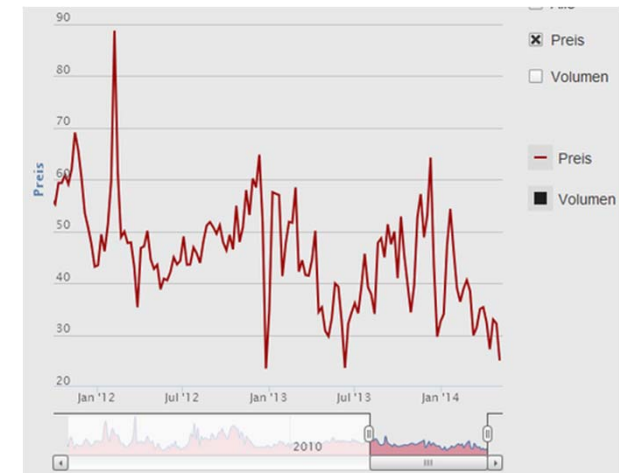
Actions

Markets:

- let markets choose the „right mix“ of flexibility
- adjust balancing power markets
- add new ancillary services products (DSO)

State/Regulator:

- ensure a level playing field
- fund pilots



► 9 Thesis 5: Distributed Storage

In the next 15 year we will see an significant increase in distributed battery storage – e.g. to increase self supply and for electric vehicles. This will create some challenges and some opportunities for utilities.

But: Only in the long-long run storage will play a major role for the system as a counterpart for intermittend generation.

Actions:

Utility:

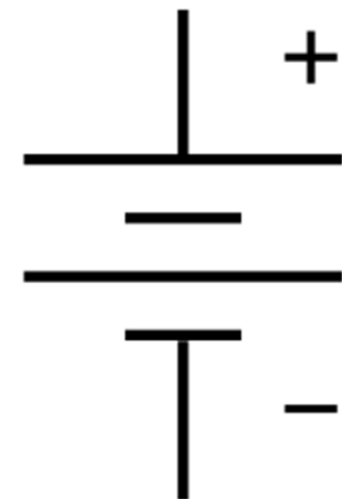
- develop busines models to get a slice of the pie

DSO:

- build smart grid

Regulator:

- evolve regulation



The Missing Link of Flexibility

- Some Remarks on Demand Response and Storage

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