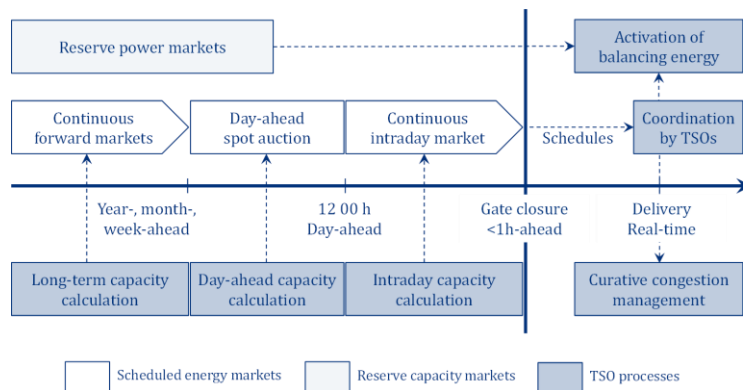


Pillars for a sustainable energy market design in Europe

Session: Policy and Market Requirements for a Resilient and Reliable Low-Carbon Energy System

10th German-Brazilian Dialogue, São Paulo, May 16th & 17th, 2023

European electricity markets in a nutshell



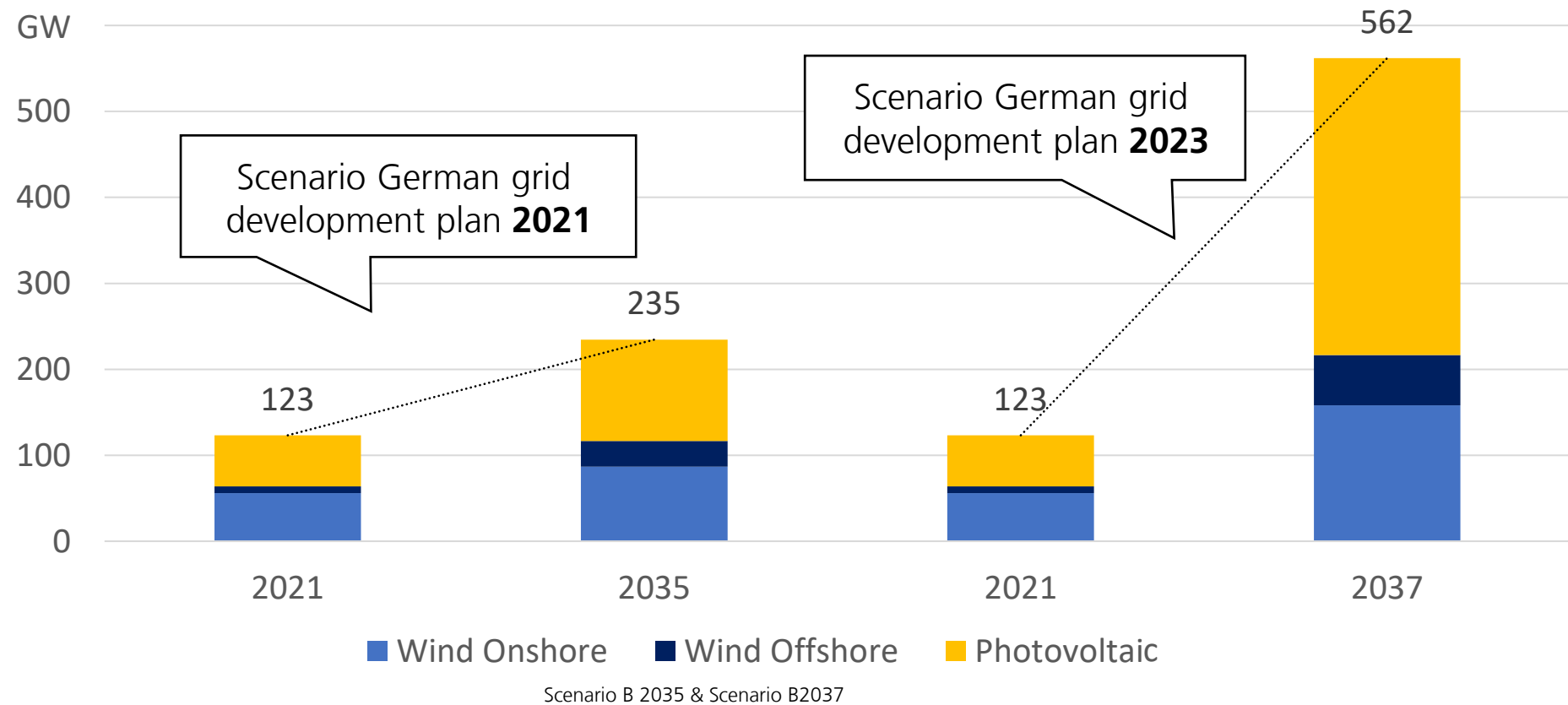
Sequence of deregulated markets

Harmonized Europe-wide zonal markets



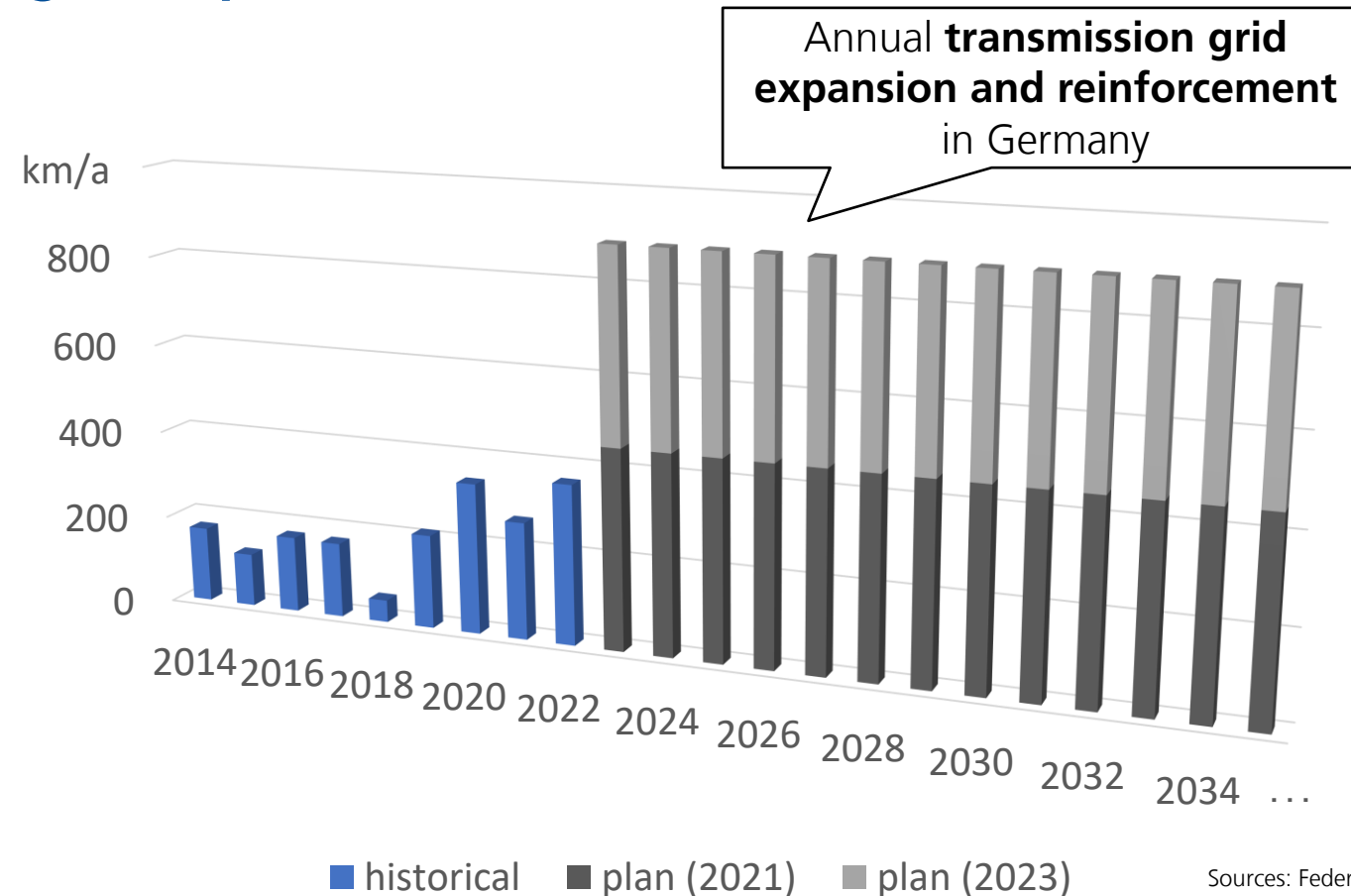
Emissions trading scheme

Moving targets: accelerated RES expansion...



Source: Bundesnetzagentur (2020, 2022)

...increased grid expansion needs



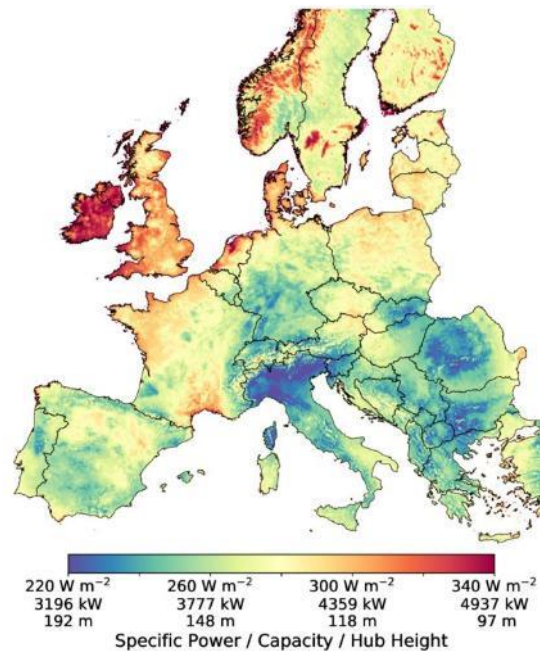
Sources: Federal antitrust agency (2015-2022), German TSOs (2023)

Three pillars

1. Create local incentives
2. Strengthen coordination
3. Enhance participation

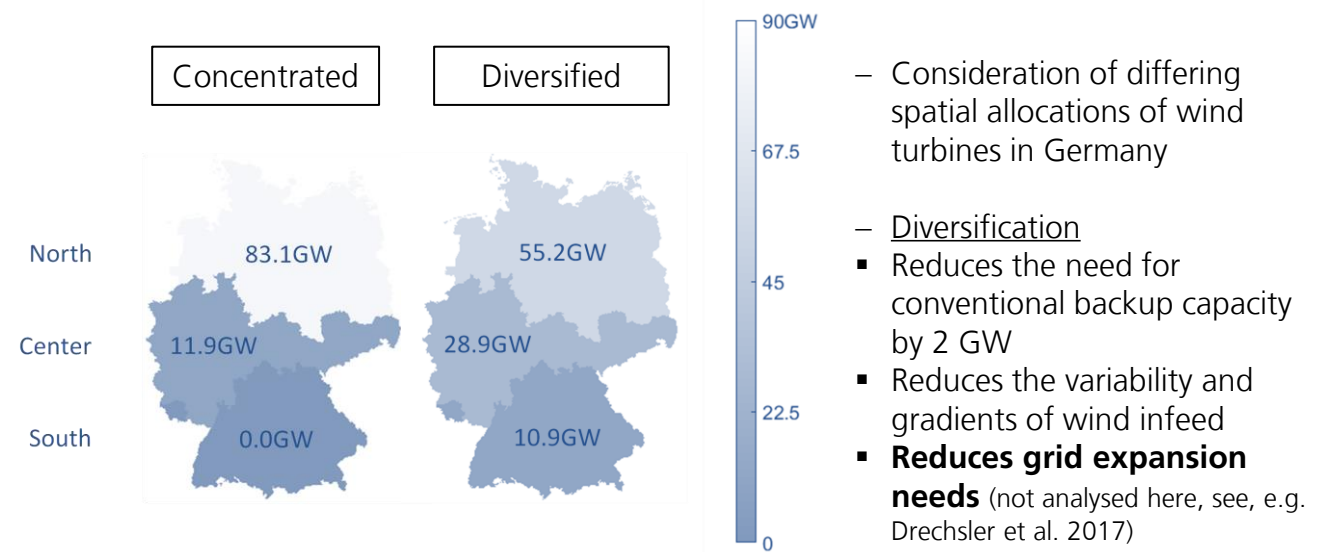
1. Create local incentives

- Output-based renewables support schemes compromise local incentives



Wind onshore potential in Europa, Source: Ryberg et al. (2019)

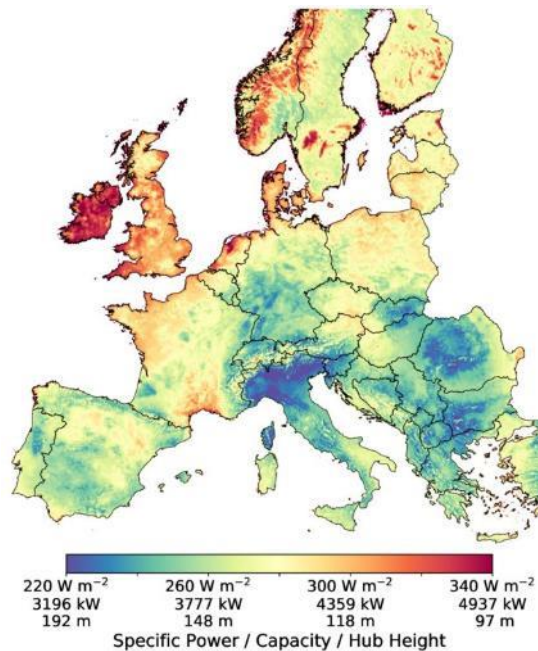
Example: Spatial diversification of wind turbines and generation adequacy



Bucksteeg, M. (2019). *Modelling the impact of geographical diversification of wind turbines on the required firm capacity in Germany*. Applied Energy. <https://doi.org/10.1016/j.apenergy.2018.11.031>

1. Create local incentives

- Output-based renewables support schemes compromise local incentives

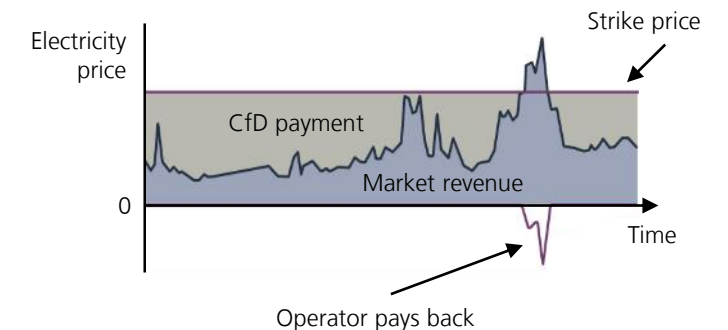


Wind onshore potential in Europa, Source: Ryberg et al. (2019)

Design options: Contracts for difference (CfD) and nodal pricing

„Yardstick CfD“ or „Financial CfD“

- Independent from actual output, e.g. forecast or reference turbine (Newbery, 2022; Schlecht et al., 2023)
- BUT: local disincentives remain



More granular locational pricing

- **Nodal prices** with financial transmission rights → **incentivise diversification**
- Moreover, a limitation of the duration of CfDs by full load hours (and not time) → reduce the concentration

1. Create local incentives

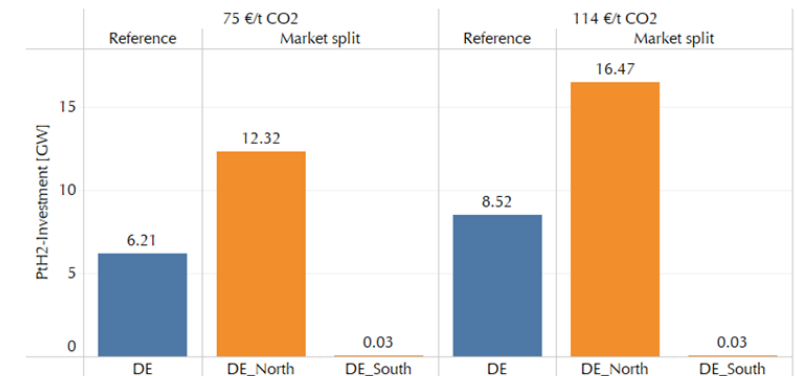
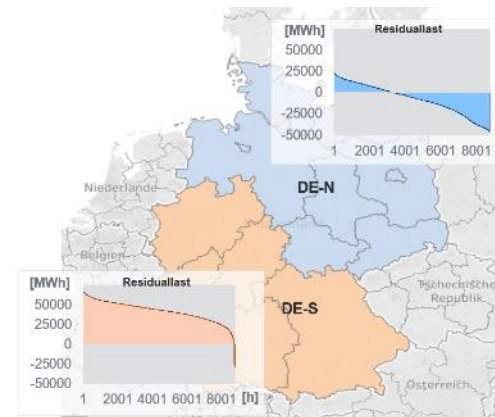
- Large bidding zones in electricity markets weaken local incentives for flexibilities



Bidding zones in Europe

Example: Market splitting and investments in electrolyser capacity

- Splitting of the German bidding zone incentivises investments in the North
- Decrease in north-south transit **reduces grid expansion needs**



Breder, M. S., Meurer, F., Bucksteeg, M., & Weber, C. (2022). *Spatial Incentives for Power-to-Hydrogen through Market Splitting*. Working Paper. <https://doi.org/10.2139/ssrn.4173211>

1. Create local incentives

- Large bidding zones in electricity markets weaken local incentives for flexibilities

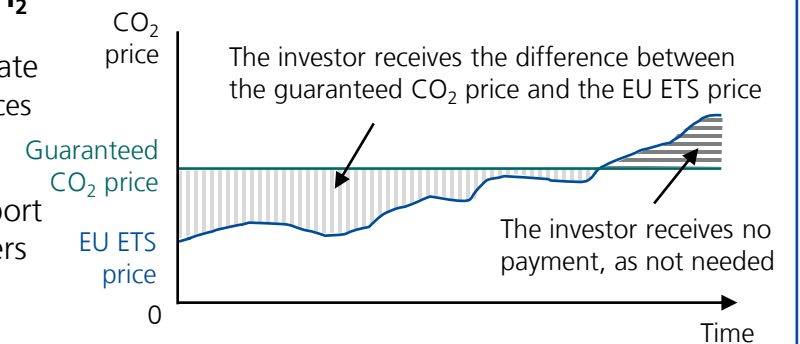


Bidding zones in Europe

Design options: Carbon contracts for difference (CCfD) and nodal pricing

Carbon contracts for difference → H₂

- CCfDs for electrolytic hydrogen relate to the user side (renewable H₂ replaces reference technology)
- BUT: costs for electricity and transport drive local incentives for electrolyzers

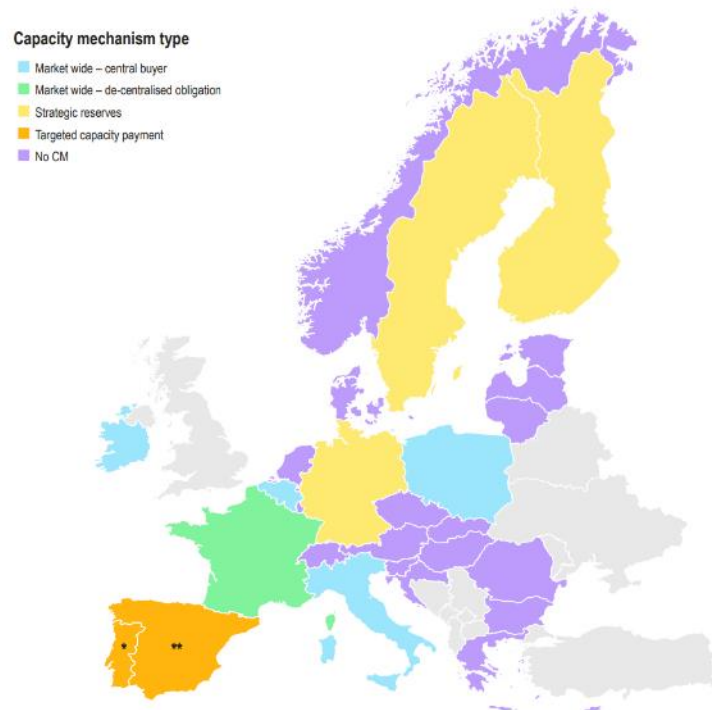


More granular locational pricing

- **Nodal prices** with financial transmission rights, locally differentiated **network charges** or at least **smaller bidding zones**
- Moreover, the regulator may regulate the size, duration and location of investments (e.g. required spatial correlation with renewables infeed)

2. Strengthen coordination

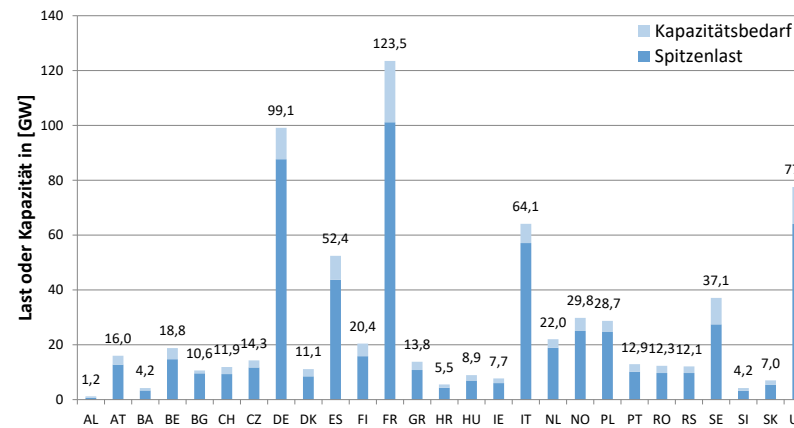
- Status-quo of capacity mechanisms provides a heterogenous picture in Europe



Capacity mechanisms in Europe, Source: ACER (2022)

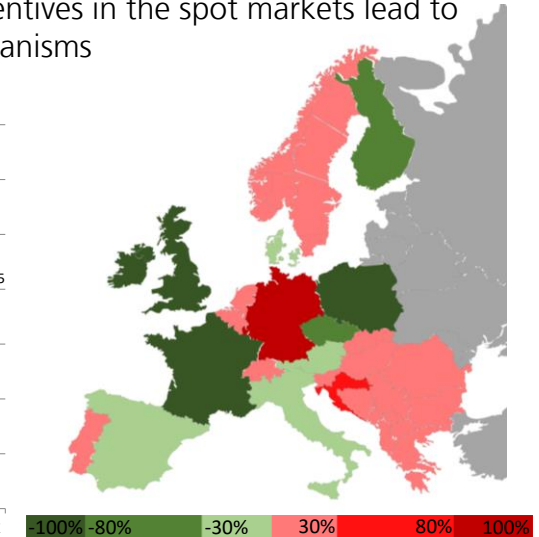
Example: Asymmetric capacity mechanisms and generation adequacy

- In the long run, a lack of efficiency and investment incentives in the spot markets lead to adequacy problems in countries without capacity mechanisms



Capacity requirements per country

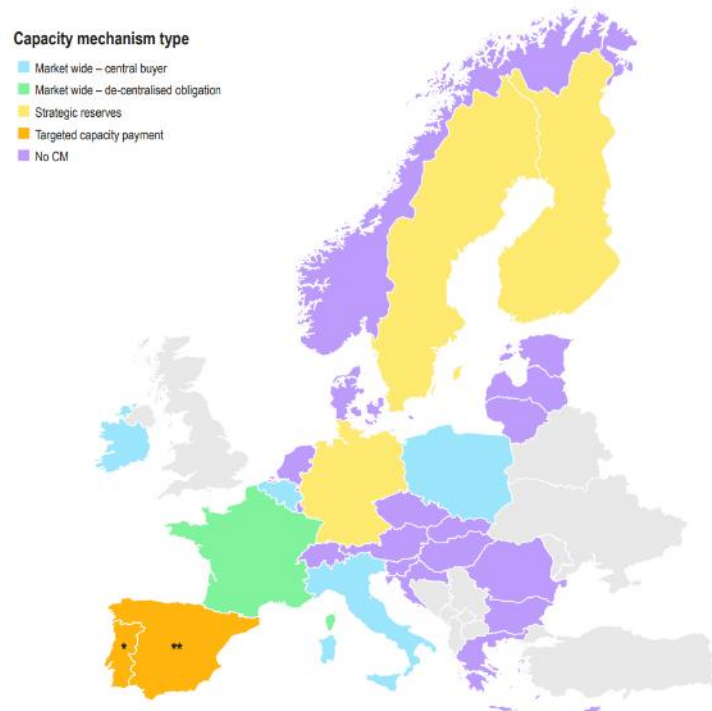
Bucksteeg, M., Spiecker, S., & Weber, C. (2019). *Impact of Coordinated Capacity Mechanisms on the European Power Market*. The Energy Journal, 40(2). <https://doi.org/10.5547/01956574.40.2.mbuc>



Relative change in LOLP in 2030

2. Strengthen coordination

- Status-quo of capacity mechanisms provides a heterogenous picture in Europe



Capacity mechanisms in Europe, Source: ACER (2022)

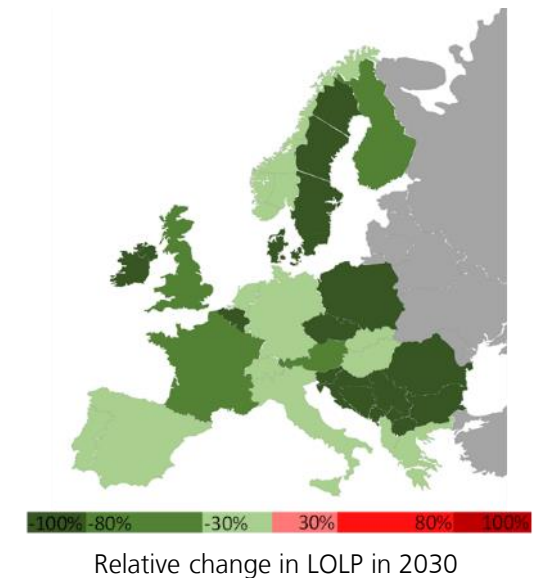
Design options: A European capacity mechanism or coordinated ones

First best: A European capacity mechanism

- Lower capacity requirements and maximisation of synergy effects
- Compatible with the single European market
- BUT: politically difficult to enforce

Second best: Coordinated capacity mechanisms

- Joint sizing of capacity requirements (based on a common adequacy level)
- Maintains sovereignty of member states by national capacity mechanisms



3. Enhance participation

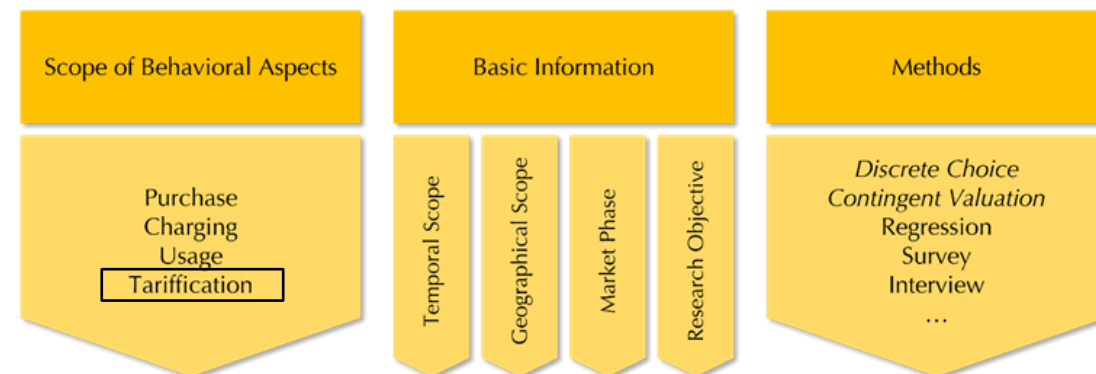
- Energy communities can **reduce the need for grid expansion**



System of systems

Example: Review of user preferences and tariff design in e-mobility

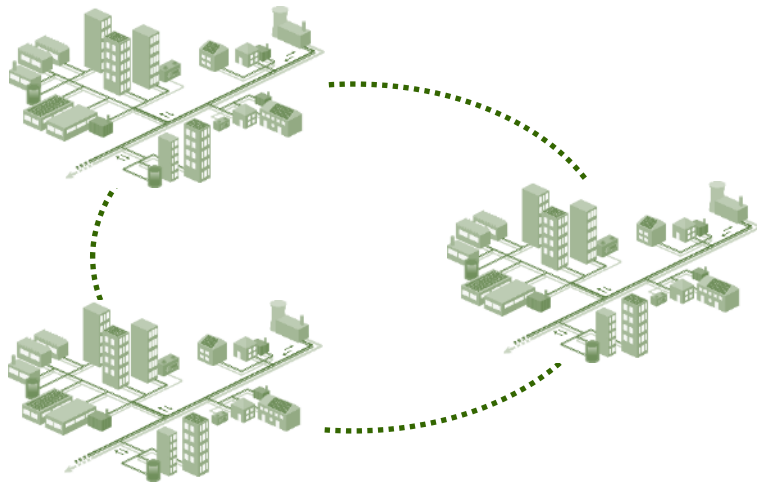
- Mainly conceptual studies, as markets are emerging
- Tariff design without consideration of user preferences shows low impacts



Breder, M. S., Hofmann, A., Bucksteeg, M., & Weber, C. (2023). *Economic analysis of behavioral aspects of electromobility with a focus on consumer behavior – A Review*. Working Paper. (unveröffentlicht)

3. Enhance participation

- Energy communities can reduce the need for grid expansion



System of systems

Design options: Actor-oriented design of products and tariffs

Energy communities and central markets

- Aggregation of decentral energy for participation in central markets

Energy communities and local markets

- Provision of flexibility (energy communities \longleftrightarrow grid operators)
 - System-friendly organisation of flexibilities to reduce grid congestion
 - Tariff design requires knowledge of the **value of flexibility** from the perspective of users and grid operators
- Energy sharing (consumers \longleftrightarrow producers)
 - Requires instruments for coping with the uncertainty and complexity of low-carbon energy systems

Three pillars

1. Create local incentives → implement more granular locational pricing
2. Strengthen coordination → avoid unilateral actions
3. Enhance participation → design consumer-oriented products and tariffs

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