



University of Stuttgart

IER Institute of Energy Economics
and Rational Energy Use

The background features a technical diagram with various symbols and equations. A central circle contains a zigzag line, possibly representing a resistor or a specific component. Below it is a circle with the number '16'. To the left, another circle contains the number '5'. Several equations are visible: $A = 113 \text{ m}^2$, $h = 320 \text{ kJ/kg}$, and $A = 384 \text{ m}^2$. Arrows indicate connections between the components.

Impact of Coordinated Infrastructure Development toward Climate Neutrality under EU Regulations from an Energy System Perspective

9th AIEE Energy Symposium

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Motivation

Motivation

Regulations – EU Level

GHG Emission Target 2030

-55% net GHG rel. to 1990 levels

GHG Emission Target 2040

-90% net GHG rel. to 1990 levels

GHG Emission Target 2050

Climate neutrality & net-negative thereafter



Emission Trading System

-62% GHG by 2030, rel. to 2005

- Energy-intensive Industry
- Power and Heat
- Aviation
- Maritime Transport

Effort Sharing Regulation

-40% GHG by 2030, rel. to 2005

- Waste
- Agriculture
- Small Industry
- Other Transport

Emission Trading System 2

-42% GHG by 2030, rel. to 2005

- Road Transport
- Buildings
- Other Sectors (Small Industry)

Motivation

Interconnection target – Electricity grid

EU electricity interconnection target



To achieve its climate and energy goals, Europe needs to improve cross-border electricity interconnections. Connecting Europe's electricity systems will allow the EU to boost its security of electricity supply and to integrate more renewables into energy markets.

[Source: Electricity interconnection targets](#)

Motivation

Interconnection target – Electricity grid

Two definitions:

- $Interconnection\ level = \frac{Nominal\ transmission\ capacity}{peak\ load\ 2030}$ (electricity demand and possible import need)
- $Interconnection\ level = \frac{Nominal\ transmission\ capacity}{Installed\ renewable\ generation\ capacity\ 2030}$ (electricity supply and the export potential)

The interconnection target is only a “suggestion”, it is not legal-binding!



Should the interconnection target be legal-binding?



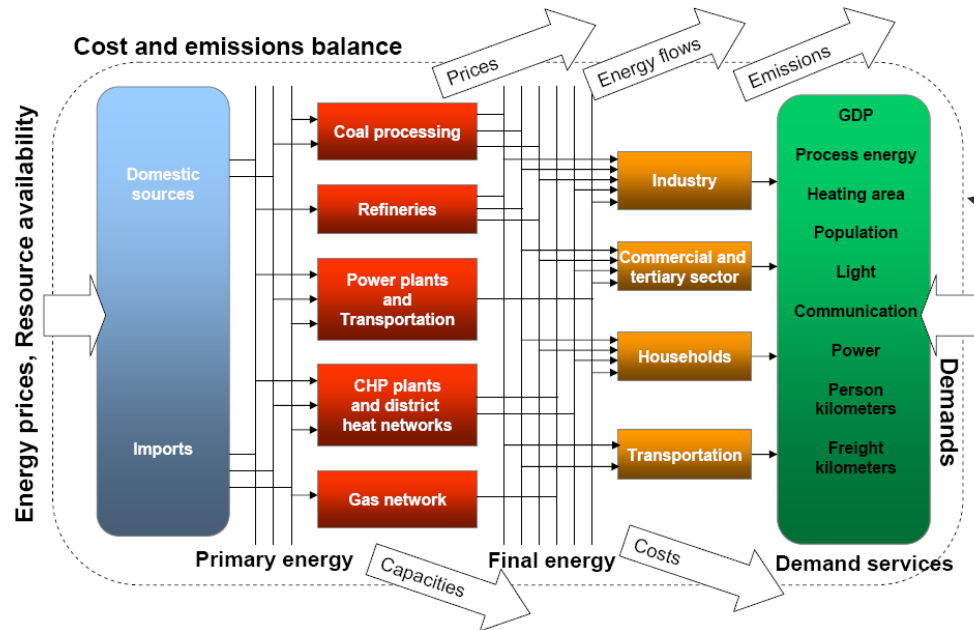
How will/can the interconnection target affect the energy system?

Source: [report of the commission expert group on electricity interconnection targets](#)

Methodology

Methodology

Model description – TIMES PanEU

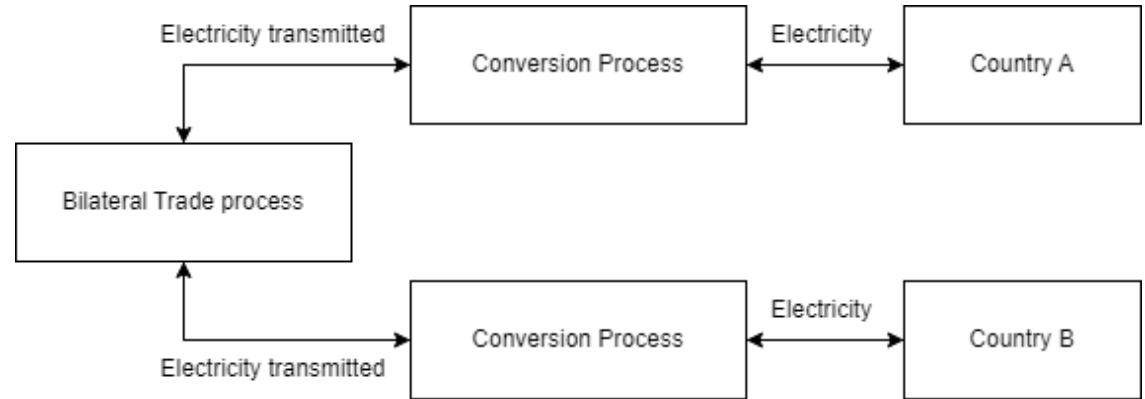


- Bottom-Up Modell, model language GAMS
- Multi-regional (EU27 + UK, CH, NO)
- Time horizon 2010-2050
- Commodity Trade between regions
- All relevant sectors and full competition between technologies and energy carriers
- Infrastructure for electricity, gas, hydrogen
- detailed energy system analysis for Germany/Europe possible

Methodology

Grid infrastructure modelling – Electricity Grid

- Countries as nodes, modelling the interconnection of both AC and DC as bilateral trade processes
- Investment costs are calculated based on the real and concept projects by TSOs in the unit of [M€/GW]
- The capacity of the bilateral trade processes is constrained in accordance with the ten-year development plan established by ENTSO-E



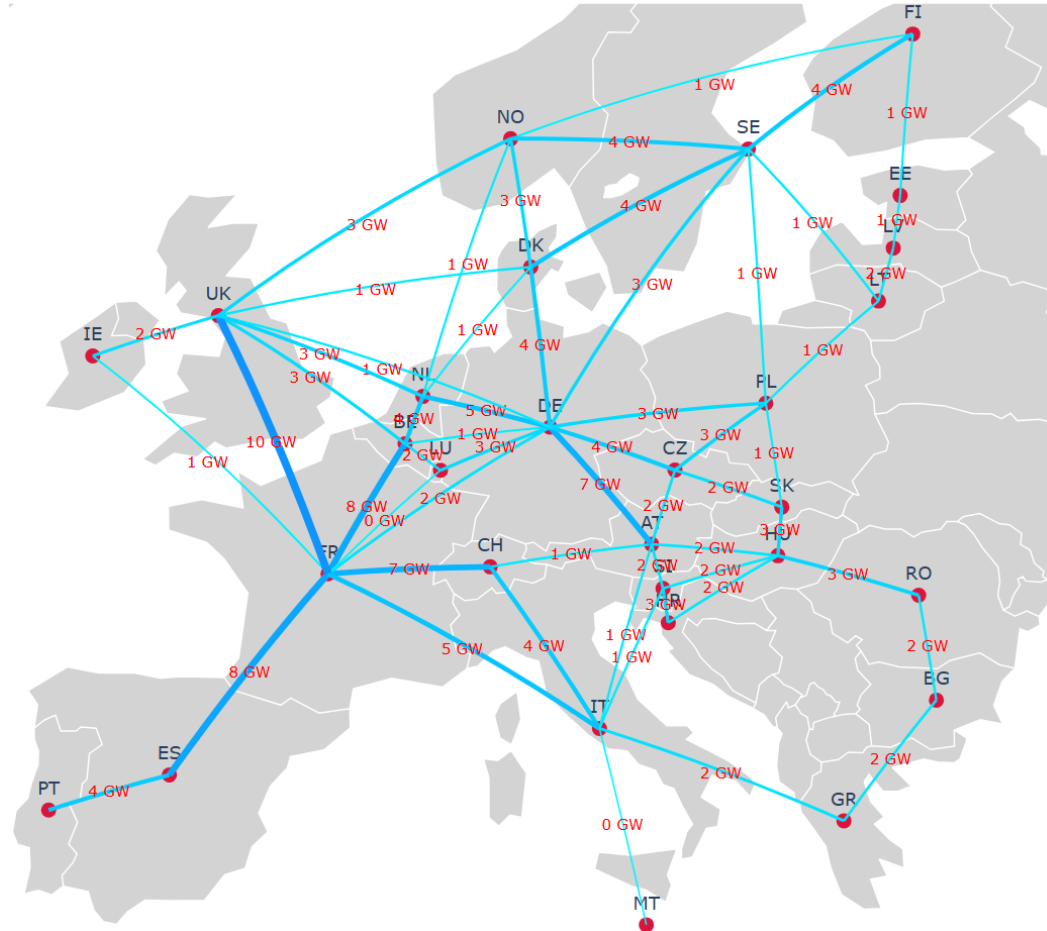
Scenarios

- **Business-as-usual (BAU):** countries build up capacities according to existing plans like TYNDP
- **High interconnection level (150%):** countries realize the importance of interconnection and start to make regulations on national levels and build up grids massively and quickly, assumed 50% more than existing plans starting from 2030

Results

Results

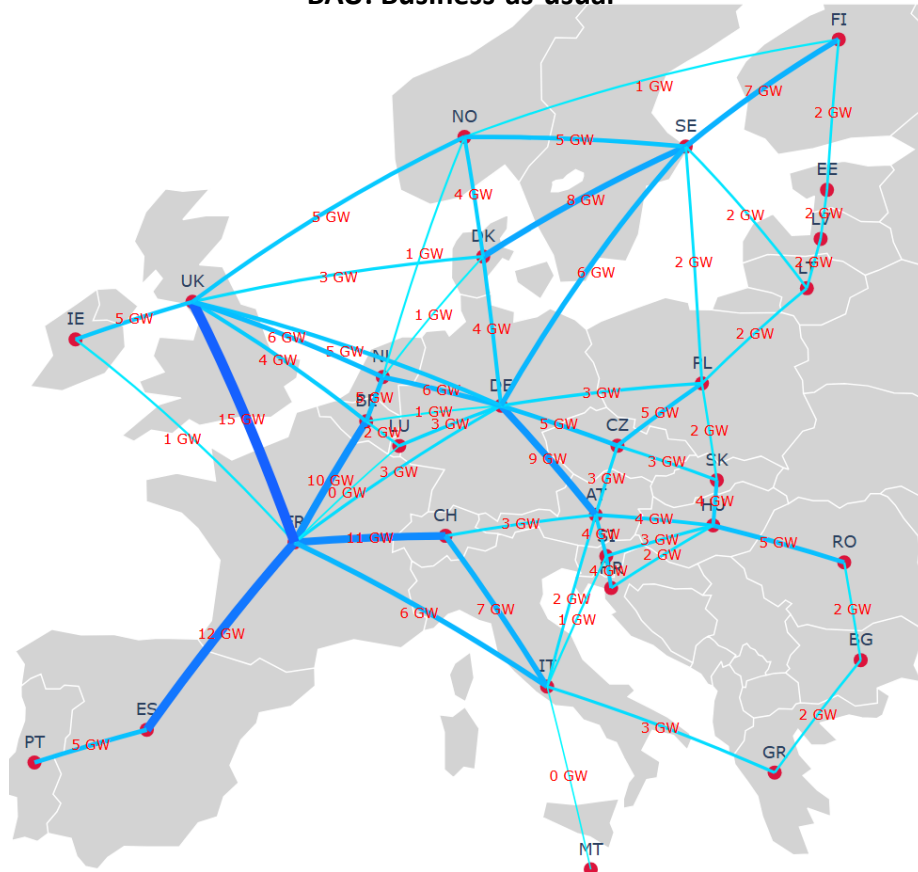
Electricity grid development – 2030 (start grid)



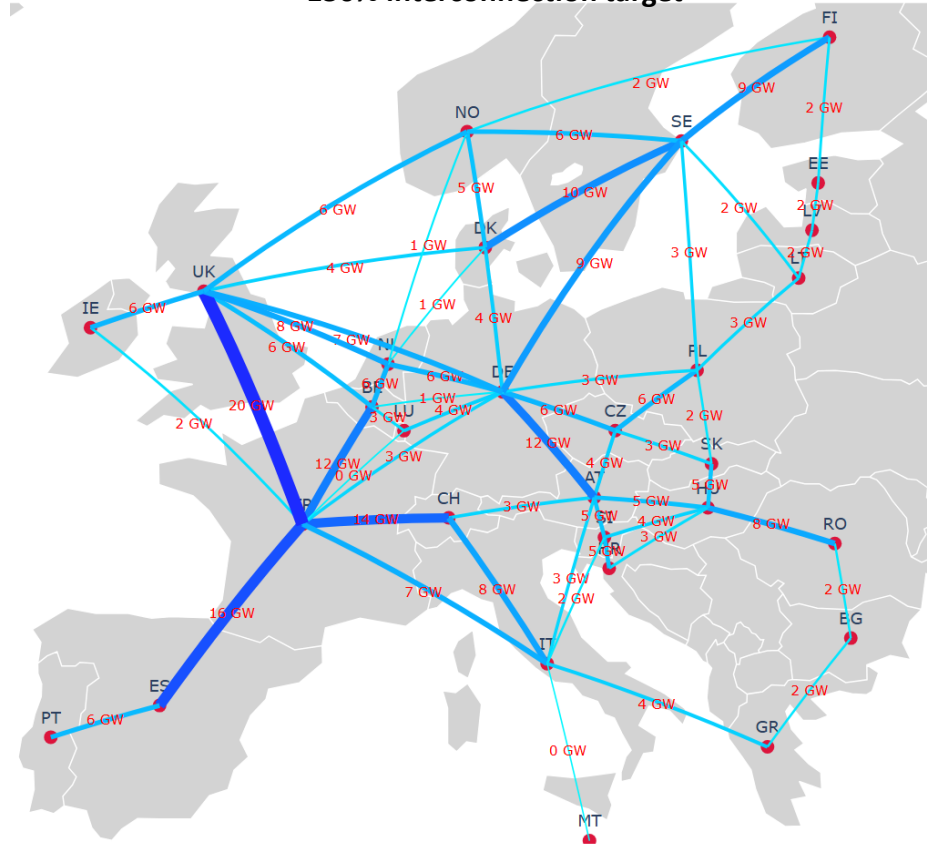
Results

Electricity grid development – 2050 (BAU and 150%)

BAU: Business-as-usual



150% interconnection target



Results

BAU: Business-as-usual
150: 150% interconnection target

Share of net electricity import to consumption [%]



Electricity marginal cost change:

- **Belgium: -1.05%** ↓
 - **Denmark: -4.63%** ↓
 - **Hungary: +5.57%** ↑
 - **Slovenia: +4.59%** ↑
- **Importers:** more “interconnected” → higher electricity import
 - **Exporters:** more “interconnected” → higher electricity export

Results

BAU: Business-as-usual
150: 150% interconnection target

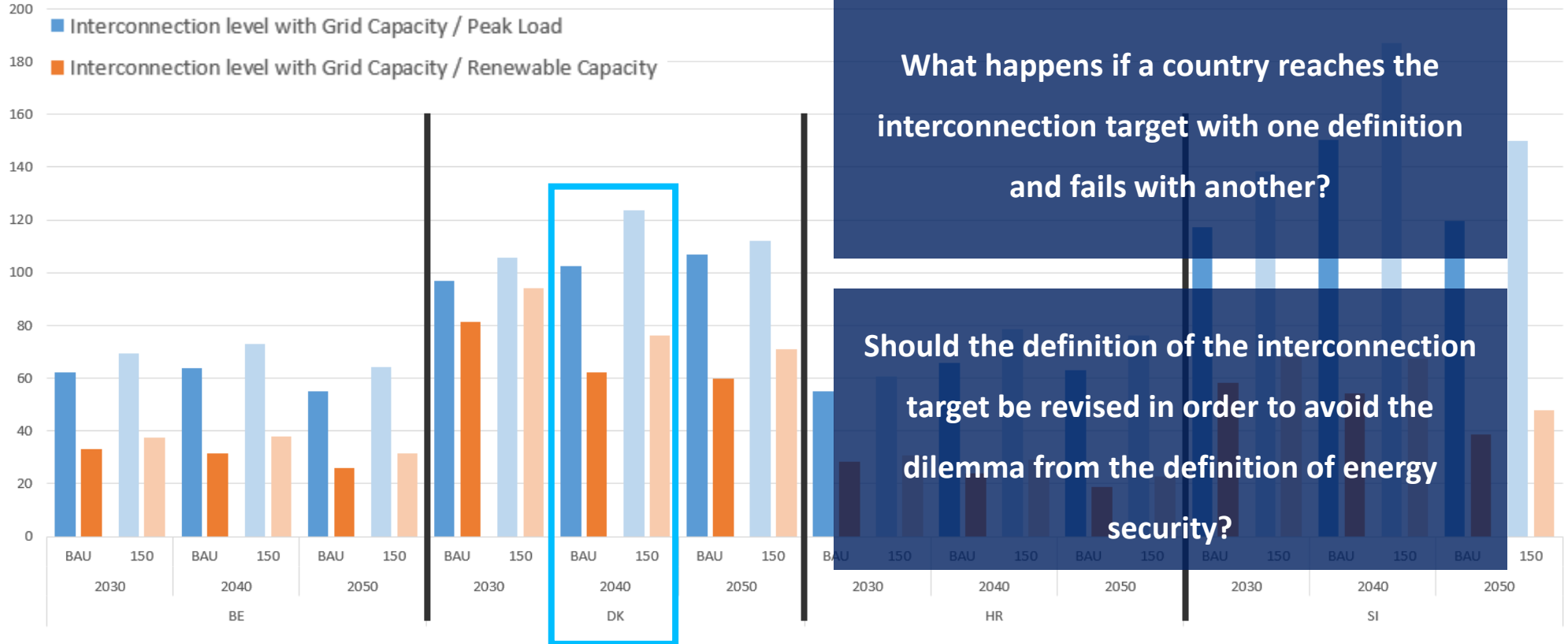
Interconnection target



Results

Interconnection target

BAU: Business-as-usual
150: 150% interconnection target



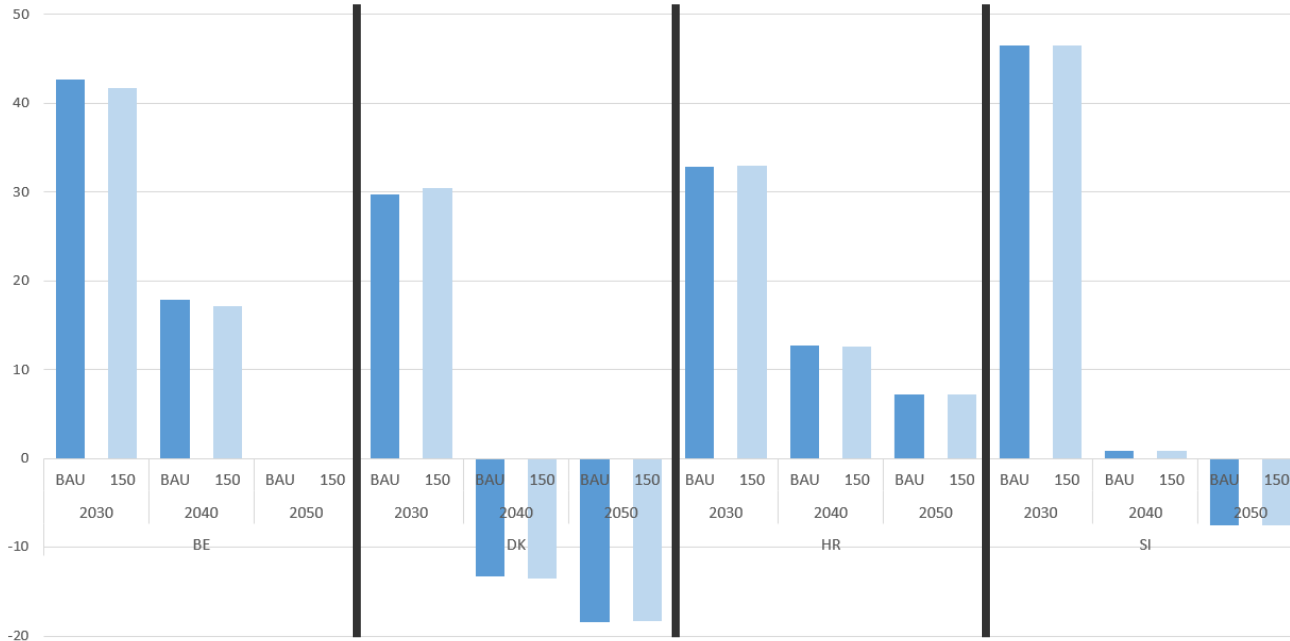
What happens if a country reaches the interconnection target with one definition and fails with another?

Should the definition of the interconnection target be revised in order to avoid the dilemma from the definition of energy security?

Results

GHG emissions compared to 1990 values [%]

BAU: Business-as-usual
150: 150% interconnection target



- EU climate neutrality at 2050
- Negative emission (CCS) in some countries offsets positive emissions (industry, agriculture...) in other countries
- Higher electricity import accelerates the transition towards climate neutrality in some countries (example: Belgium)

Conclusion

Conclusion



Increasing the capacity level of cross-border electricity grid can increase the interconnection level, but has pros and cons regarding electricity marginal cost



It requires in-depth consideration when making the interconnection target a “must-have”



The interconnection target can play a crucial role in helping the transition toward climate neutrality by 2050 at the EU level through the more efficient integration of renewable energy resources across member states



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Thank you!



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