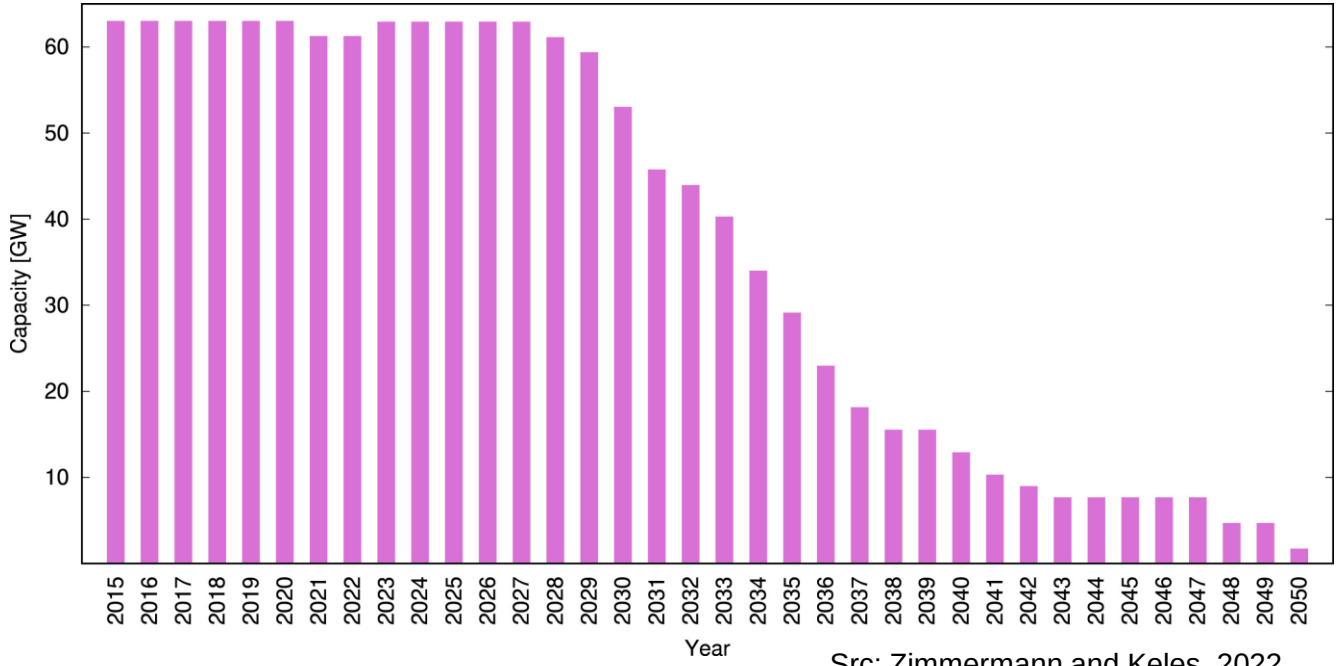
Panel debate: possible challenges in the future energy system
- missing capacities

Dogan Keles, DØRS Conference, 2023

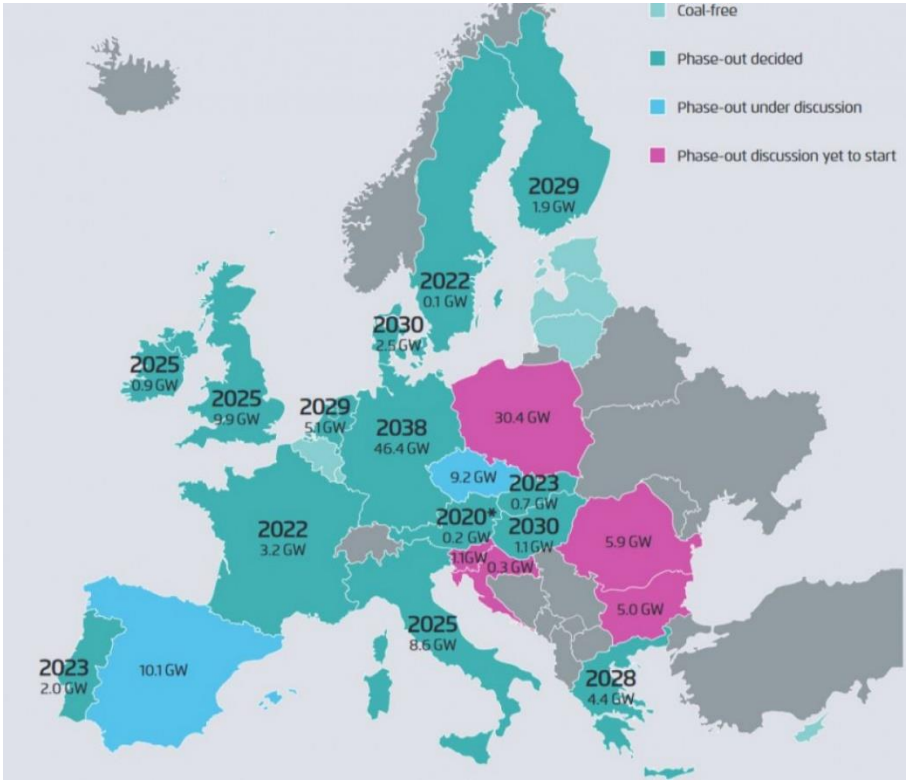
Challenges of the EU power system

Nuclear power capacity in France and shutdowns after lifespan of 50 ys.



Src: Zimmermann and Keles, 2022

Announced coal phase-out in the EU:



1. Large amount of capacities will be taken out of the EU power market
2. Increasing demand for electricity due to electrification (EU) and hydrogen for green fuels:

   from ca. 2500 TWh (in 2020) to probably 6000 TWh in 2050

→ **Missing capacities (especially flexible ones)**

Challenges of the EU power system

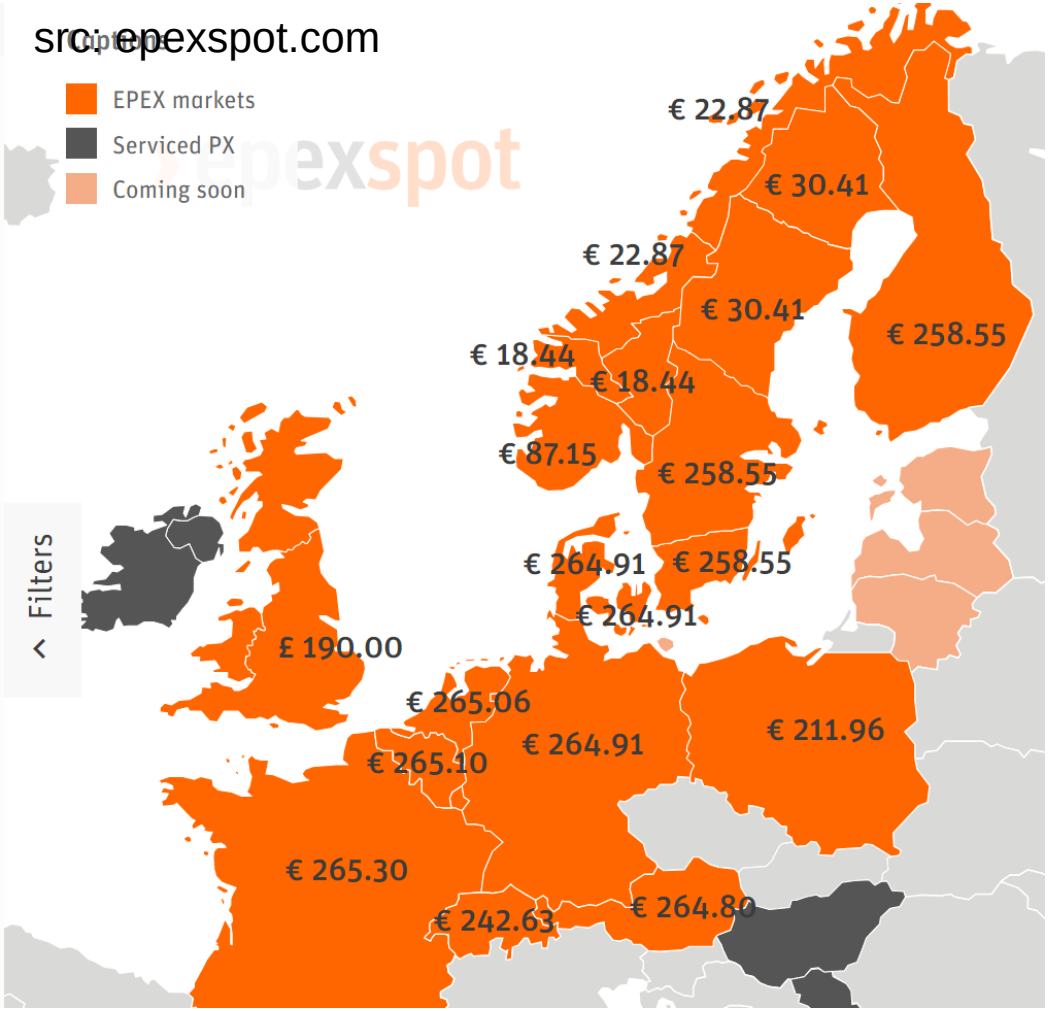
→ Missing capacities are a threat for the whole European energy system:

- Internal European Market
  Price coupling due to significant export/import flows
- High prices is most of Europe

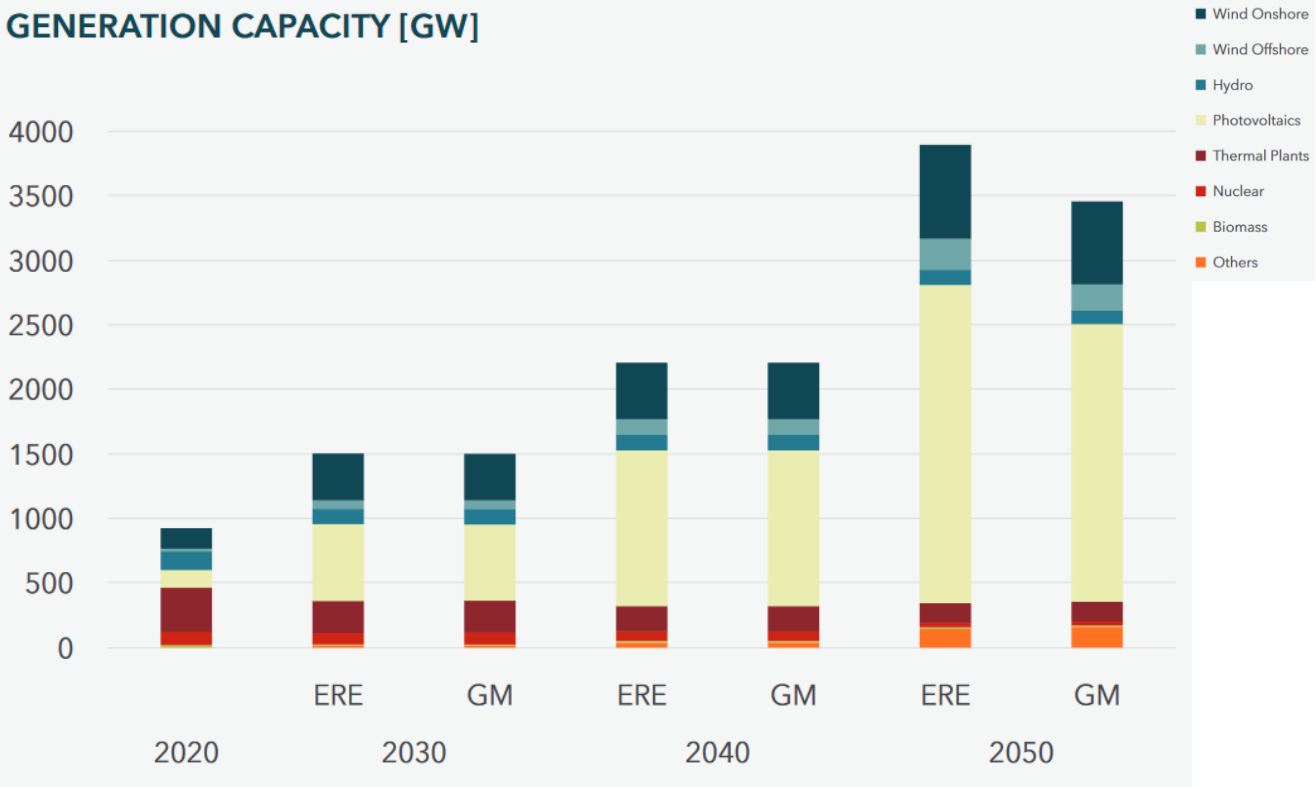
→ Large investments needed, urgently!

Prices at the EPEX for 24th August 19-20:00 in €/MWh

src: epexspot.com



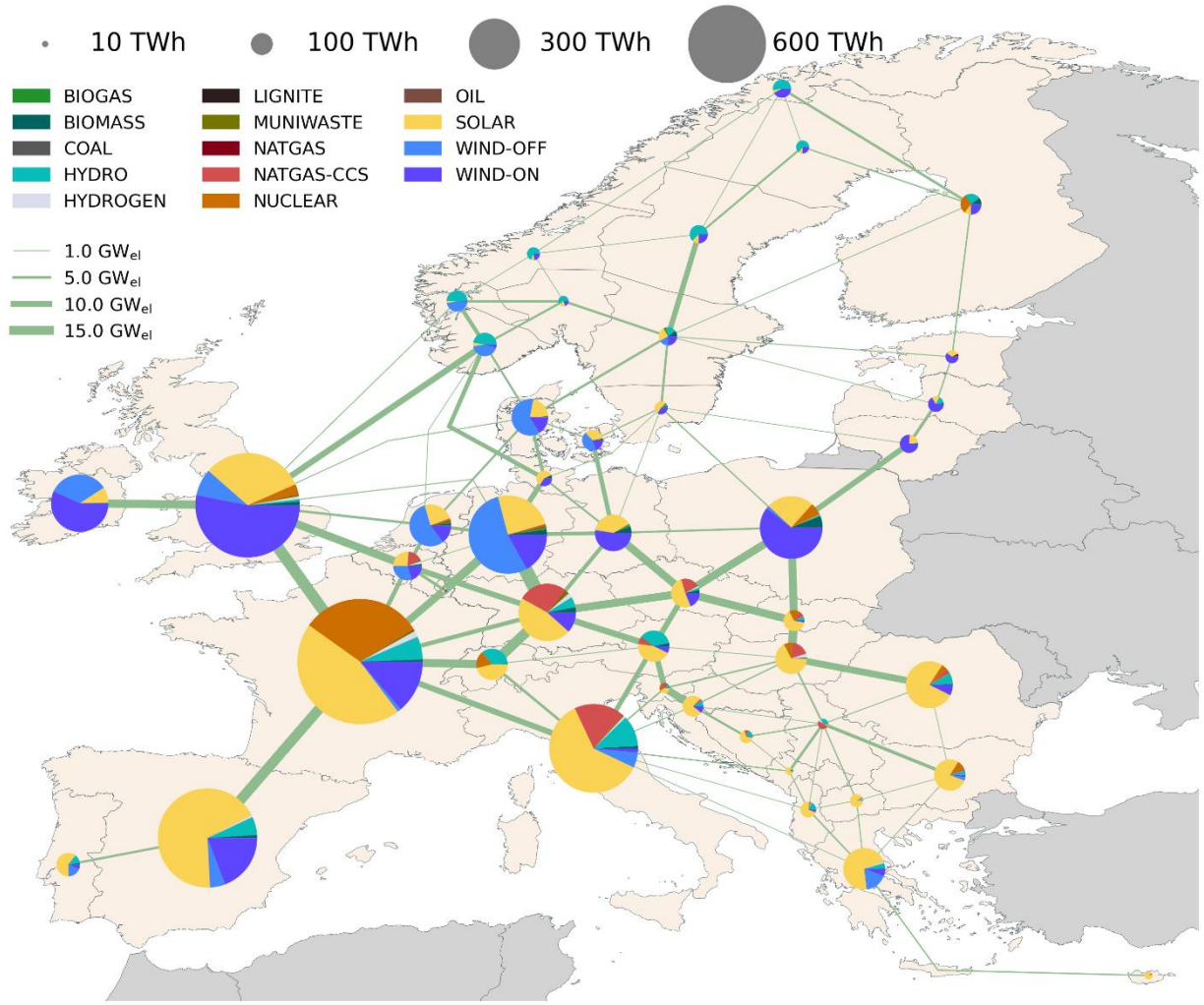
What investments are needed?



Src: Energy System 2050: Towards a decarbonised Europe, TransnetBW (2022), www.energysystem2050.net

- Electrification of transport, heat, and hydrogen increases the electricity demand.
- Needed annual growth of solar PV:
  55 GW/a by 2030 and 127 GW/a by 2050.
  (growth in 2022 was 44 GW/a)
  17 times the installed capacity by 2050
- More than 900 GW of offshore/onshore wind integrated into the energy system by 2050.
  (5 times the capacity we have today)
- Also need for ca. 300 GW flexible capacity (storage and thermal power plants)

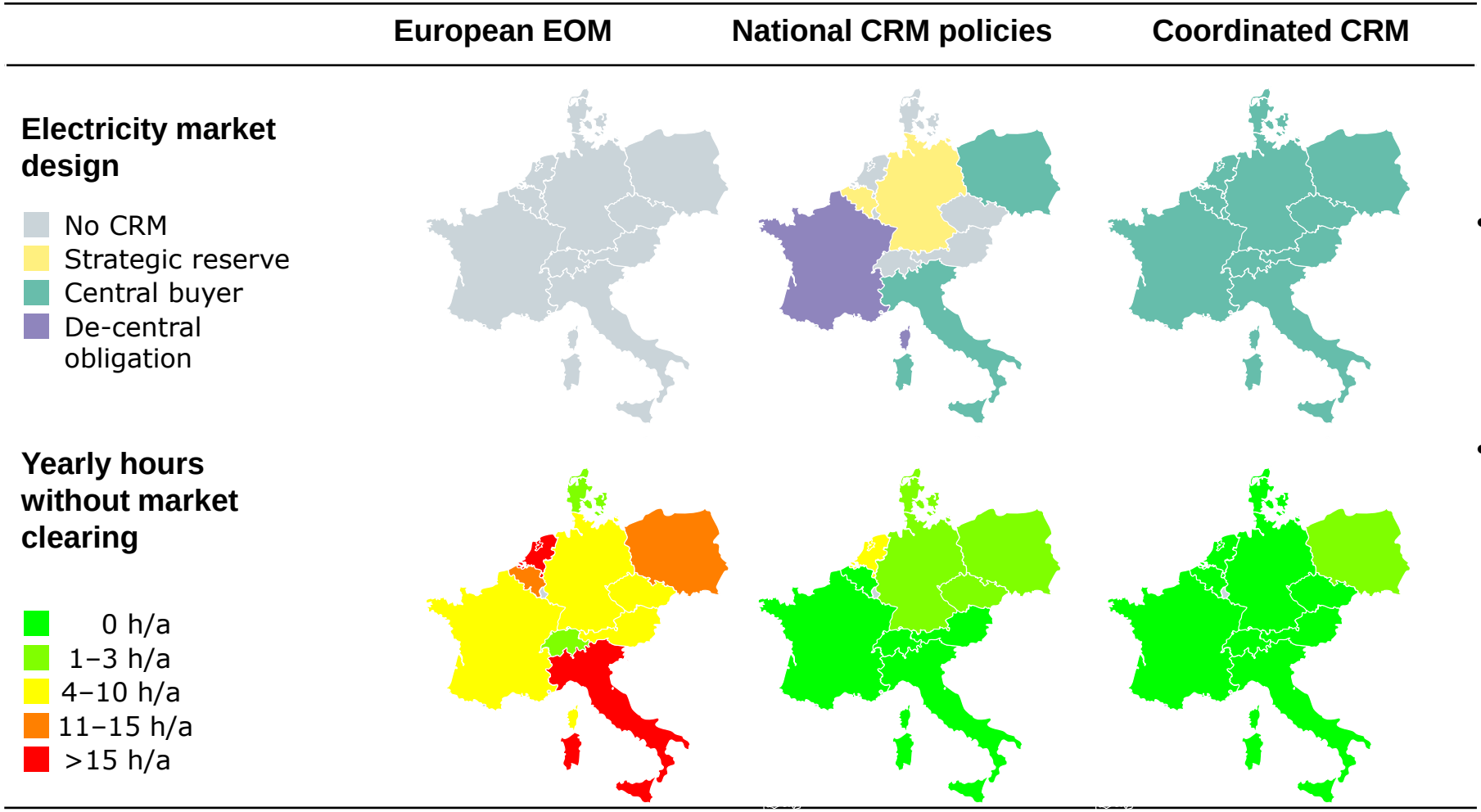
Future electricity system in 2050



- Strong increase of solar capacities in the South
- Large shares of wind power in the North-West (North and Baltic sea)
- Nuclear plays a role in France and to small shares in Poland, UK etc.
- Some areas natural gas + CCS power production are competitive (Italy and Southern Germany)
- Strong increase in interconnector capacities is needed
  (up to 3 times the line capacities of today).

Source: Kountouris, Madsen, Bramstoft, Münster, Keles (2023)

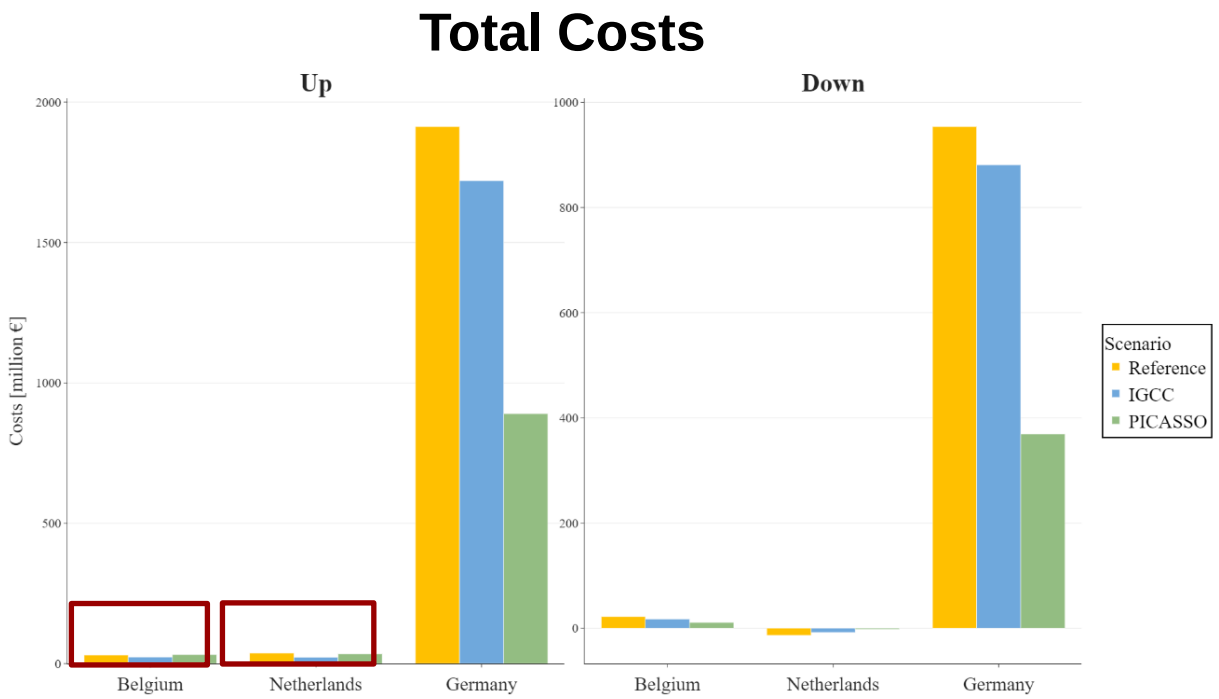
What Market Design? Security of electricity supply



- **Capacity remuneration mechanisms (CRM)** help to increase security of supply (less market failures)
- Coordinated mechanisms in the EU would be even more effective and less costly

Src.: Fraunholz, Keles, Fichtner (2020)

European market coupling – example of PICASSO collaboration



	PICASSO - reference	PICASSO - IGCC
Δ Consumer Surplus	+1,634	+1,342
Δ Producer Surplus	- 1,140	-949
Δ Congestion Rent	+53	n\a
Total Econ. Surplus	**547**	**393**

*values in million €

- Cost reductions in Germany, without large effect on activation costs in Netherlands + Belgium
- Producer rent declines in Germany, producers in Netherlands + Belgium win, consumers benefit

Src.: Backer, Keles, Kraft (2023)

References

[1] Kountouris, Madsen, Bramstoft, Münster, Keles (2023): A unified European hydrogen infrastructure planning to support the rapid scale-up of hydrogen production, working paper, Resereach square

[2] TransnetBW (2022): Energy System 2050: Towards a decarbonised Europe, www.energysystem2050.net

[3] Zimmermann and Keles (2022): State or market: Investments in new nuclear power plants in France and their domestic and cross-border effects, Energy Policy (173)

[4] Fraunholz, Keles, Fichtner (2020): Impact of electricity market designs on investments in flexibility options, in: The Future European Energy System: Renewable Energy, Flexibility Options and Technological Progress

[5] Backer, Keles, Kraft (2023): On the economic impacts of European balancing market integration: the case of the newly-installed aFRR market coupling platform PICASSO, under Review, Energy Economics.

[6] www.epexspot.com, Market Results

THANK YOU!

BACKUP

REGULATORY FRAMEWORK FOR THE PRODUCTION OF RFNBOs (REDII/REDIII)

Agora Energiewende

RED Art. 25: min. 70% GHG emissions savings from use of RFNBOs
DA Art. 28: total emissions from RFNBOs/RCFs **min. -70%** vs fossil fuel comparator **(94gCO2e/MJ)**

DA Art. 27: **input electricity** qualified as **fully renewable** (=zero emissions) for total emissions calculation (→DA Art. 28) if:

DIRECT CONNECTION

- ADDITIONALITY
- No grid connection/ smart meter

GRID CONNECTED

If >90% RES:

Max. number of FLH corresp. to grid RES % share

If <18gCO_{2e}/MJ:

- RES PPAs
- TEMPORAL CR
- GEOGRAPH. CR

General grid:

- RES PPAs
- ADDITIONALITY
- TEMPORAL CR
- GEOGRAPH. CR

Imbalance settlement

Periods with downward redispatchment of RES

Price signals

Day-ahead power price either
< €20/MWh
OR
< 0.36x ETS EUA

ADDITIONALITY:
- RES installations came into **operation <36 months before RFNBO** production; capacity additions considered part of original if added in <36 months.
- RES installations have **not received net support** (OPEX/CAPEX), excl. before repowering, repaid aid, R&D support

TRANSITION PHASE: additionality rules come **into effect in 2028**; installations coming into operation before 2028 remain exempt until **2038**

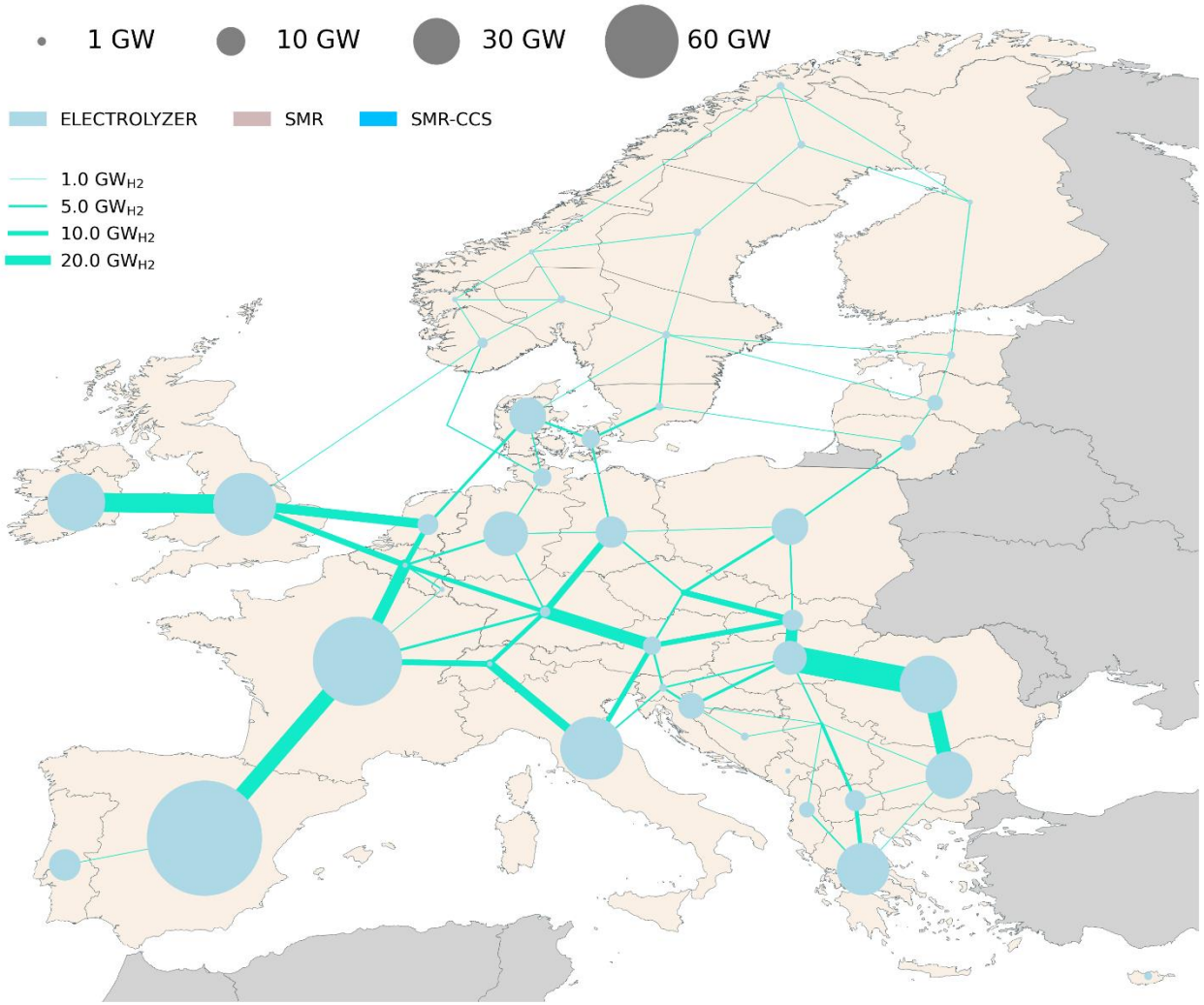
TEMPORAL CORRELATION: **monthly** matching between RES and RFNBO production **until 2030; hourly correlation from 2030**

GEOGRAPHICAL CORRELATION: RES installations for RFNBO production are located in the **same bidding zone** / an **interconnected offshore** bidding zone / **interconnected** bidding zone with **lower or equal power prices**

DA Art. 27: Methodology for production of RNFBOs / "Additionality DA"
DA Art. 28: GHG emissions savings and accounting methodology for RFNBOs and RCFs

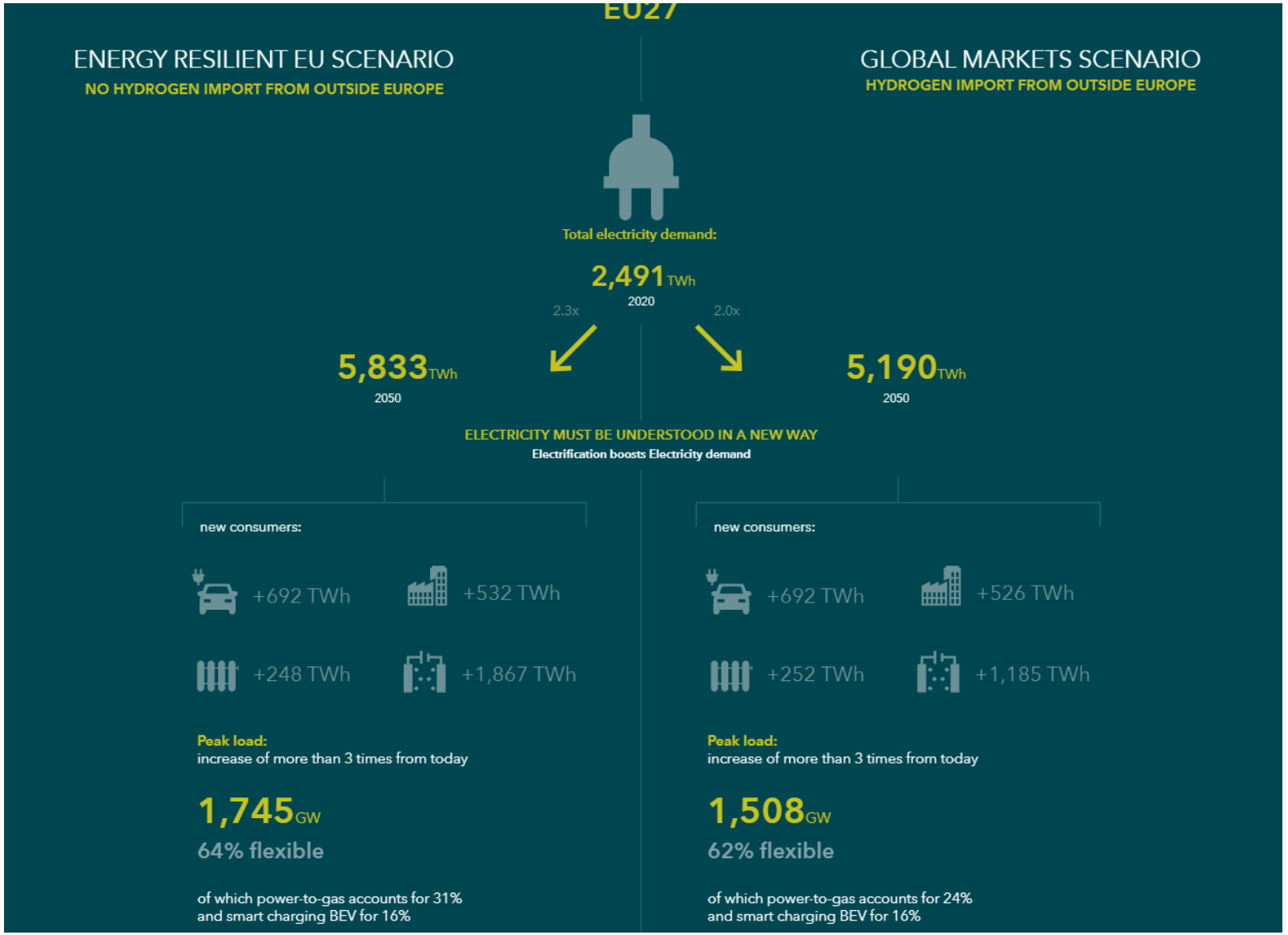
RFNBO: Renewable Fuel of Non-biological Origin; RCF: Recycled Carbon Fuel
RES: Renewable energy source; FLH: Full load hours
ETS EUA: ETS Emission allowance

How large investments: The case of hydrogen



Source: Kountouris, Langer, Bramstoft, Münster, Keles (2023)

- 500GW of electrolysis capacity needed by 2050
- Hydrogen network composed of new and repurposed nat. gas pipelines (255 TWkm),
- Large share of renewables for green hydrogen


EU27
ENERGY RESILIENT EU SCENARIO
NO HYDROGEN IMPORT FROM OUTSIDE EUROPE
GLOBAL MARKETS SCENARIO
HYDROGEN IMPORT FROM OUTSIDE EUROPE
Total electricity demand:
2,491 TWh
2020
2.3x
2.0x
5,833 TWh
2050
5,190 TWh
2050
ELECTRICITY MUST BE UNDERSTOOD IN A NEW WAY
Electrification boosts Electricity demand
new consumers:
+692 TWh
+532 TWh
+248 TWh
+1,867 TWh
Peak load:
increase of more than 3 times from today
1,745 GW
64% flexible
of which power-to-gas accounts for 31%
and smart charging BEV for 16%
new consumers:
+692 TWh
+526 TWh
+252 TWh
+1,185 TWh
Peak load:
increase of more than 3 times from today
1,508 GW
62% flexible
of which power-to-gas accounts for 24%
and smart charging BEV for 16%

Energy trading and consumption