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The role of natural gas in he future energy system – possibilities and challenges

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Workshop Natural gas, Energy Transition week 2018

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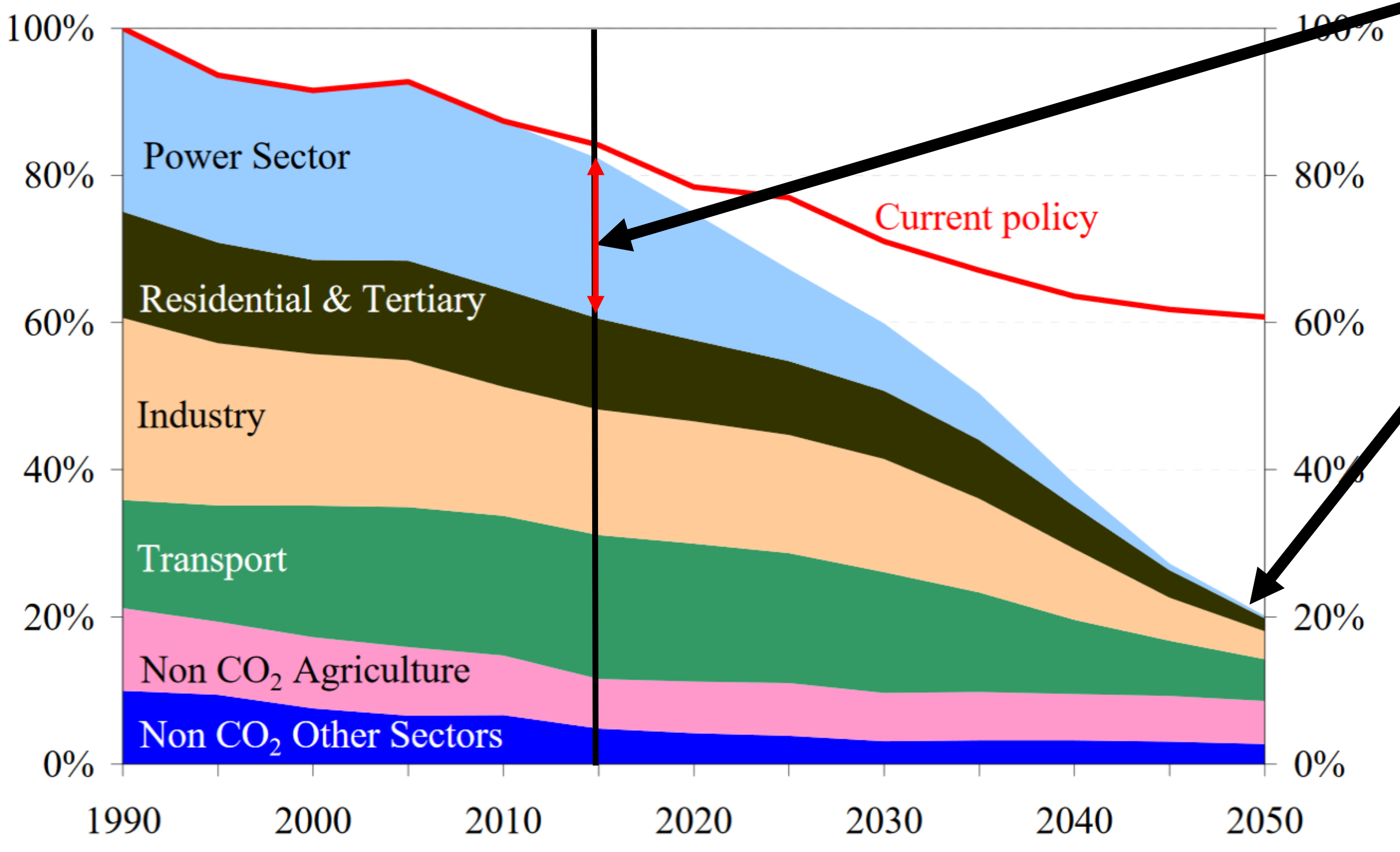
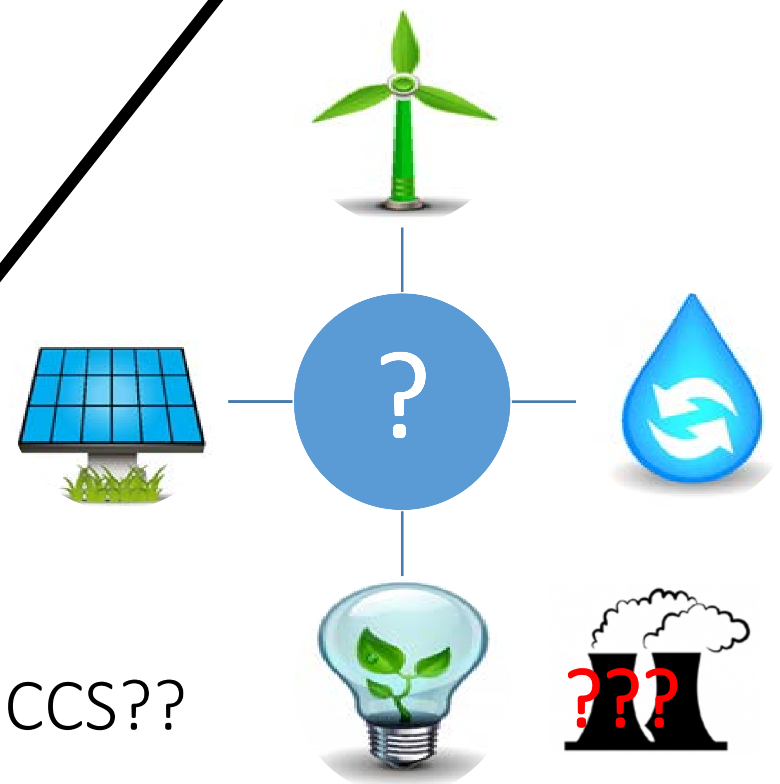
Backdrop: European Commission's view of a low-carbon Europe

Figure 1: EU GHG emissions towards an 80% domestic reduction (100% =1990)



Today: almost 25 % of total emissions from power generation



Source: European Commission. (2011). A Roadmap for moving to a competitive low carbon economy in 2050. *Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee and The Committee of The Regions, COM(2011).*

Zero Emission Power systems

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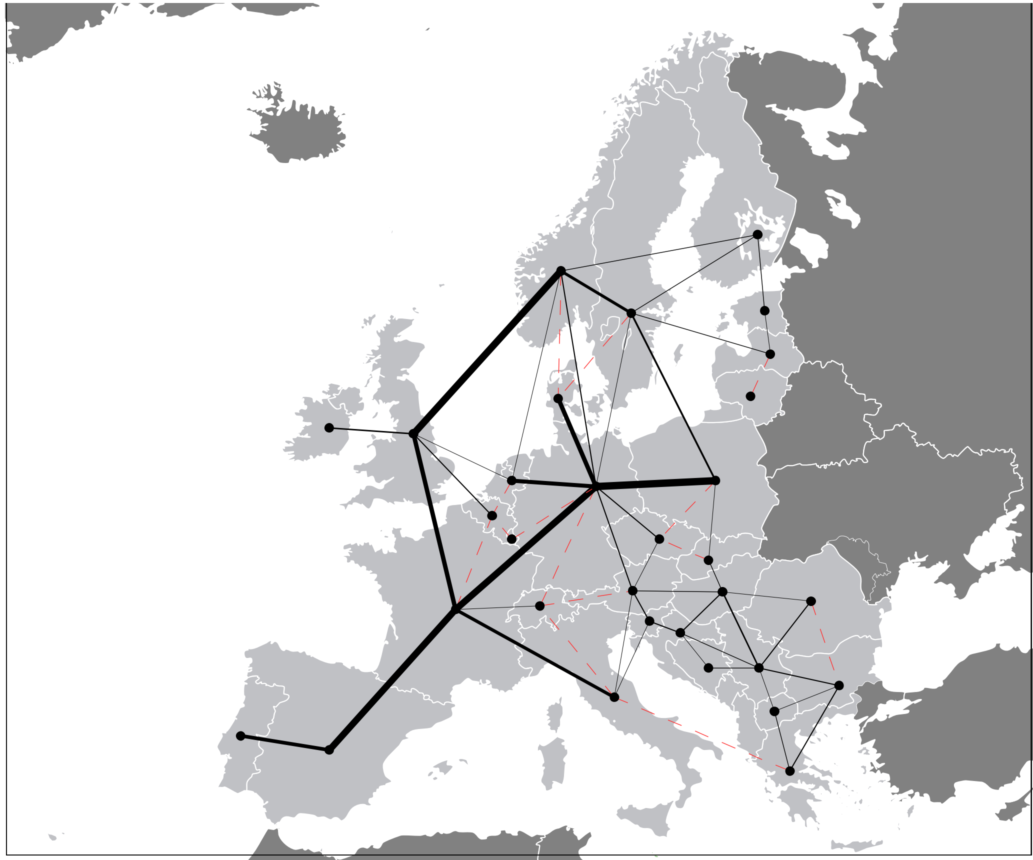
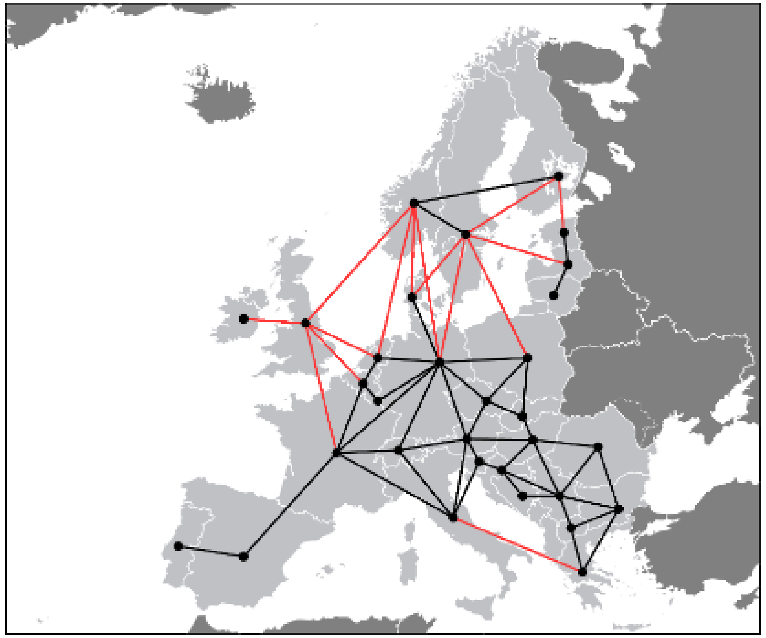
FME Forsknings-senter for miljøvennlig energi

- Challenges: intermittency and variation
- Technology choice
  - Large scale solutions/transmission/renewables
  - Distributed systems/storage/demand response
  - A combination of all

- Analyses using the EMPIRE model
- Power system design and operation
  - Time horizon until 2050 – investments in 5 year steps
  - Model operational time periods: demand, supply (stochastic wind and solar PV) and optimal dispatch.
- Provides a cost minimization capacity expansion plan for Europe, detailed for each country
- Perfect competition

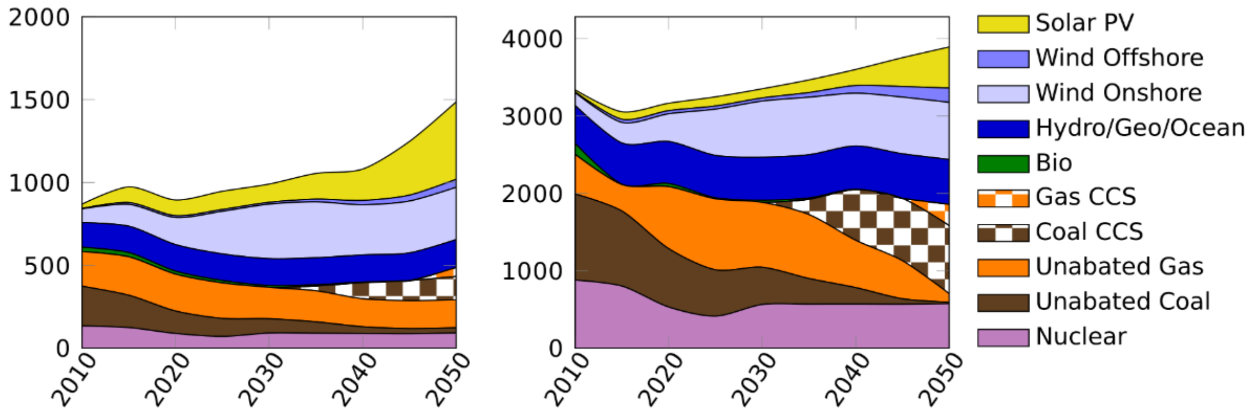


Co-optimization of strategic and operational decisions



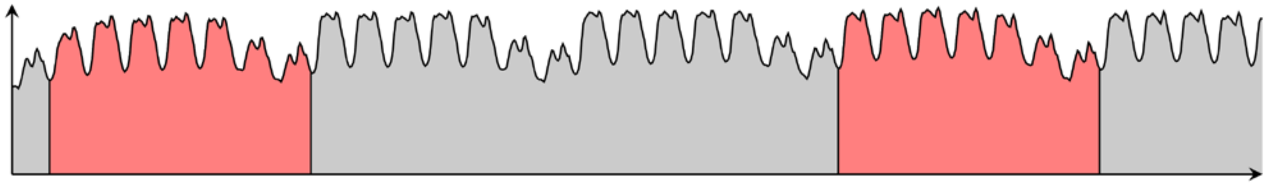
Optimal investment strategy 2010-2015

Capacity [GW] Generation [TWh]

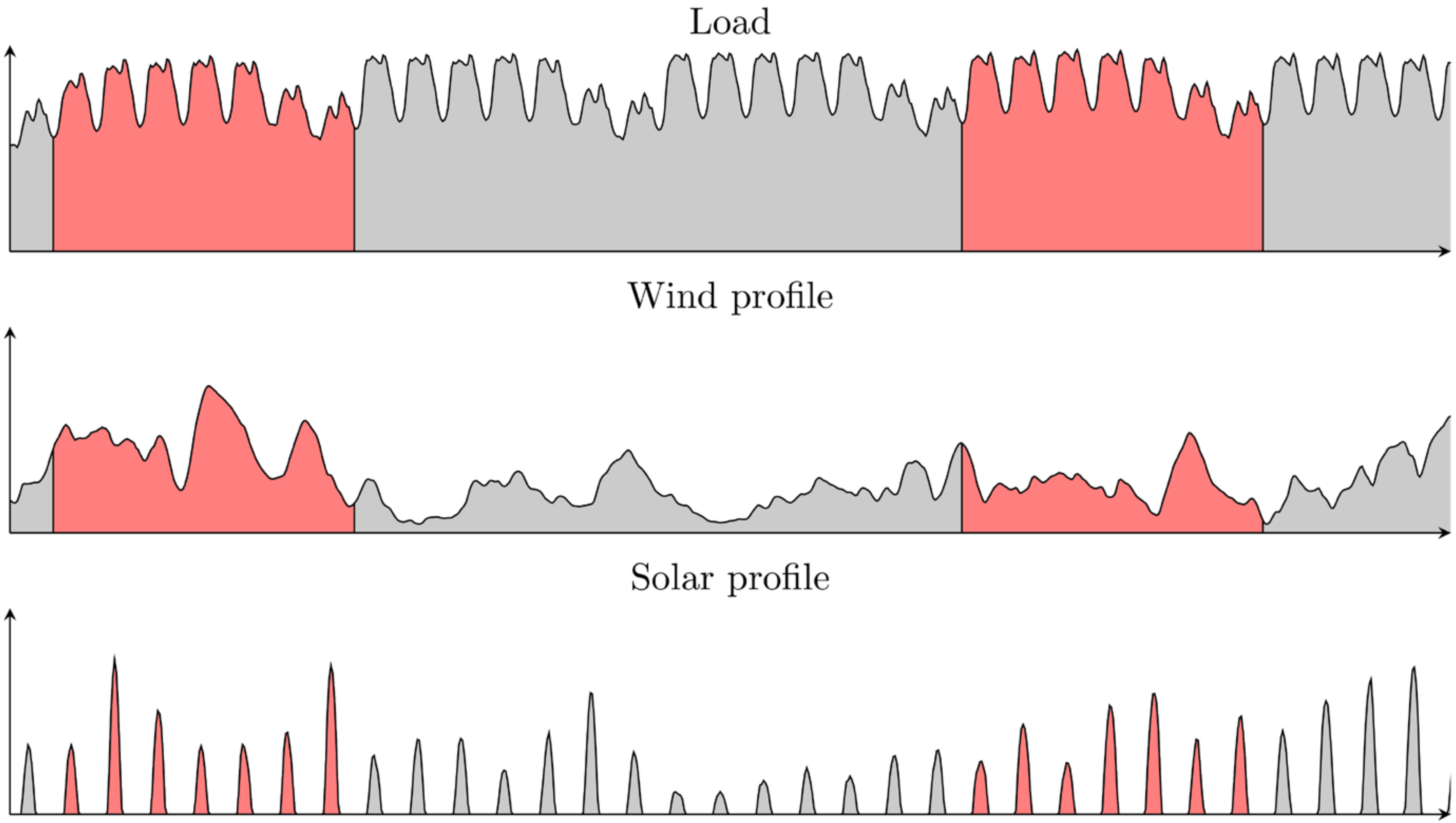


Coupled optimization problem to minimize total system costs

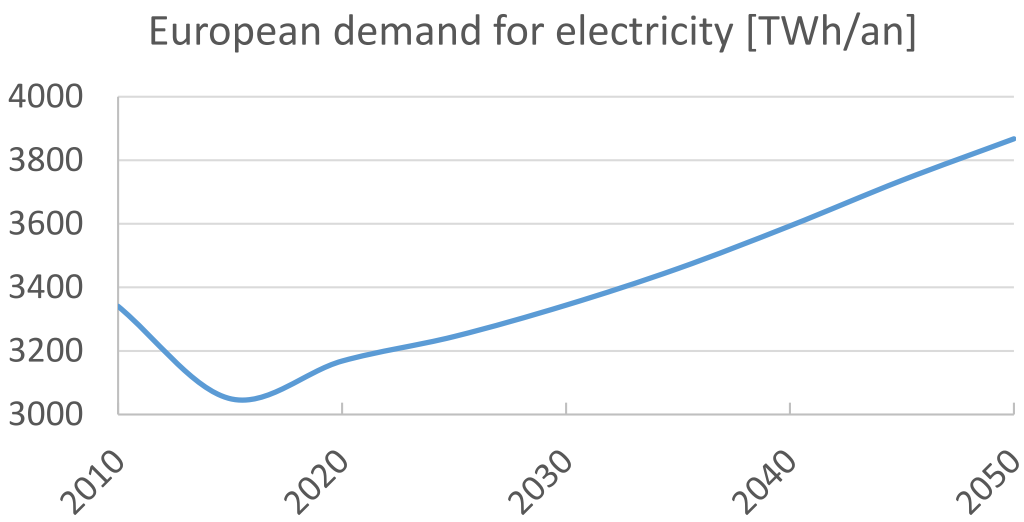
Optimal dispatch for representative 168-hour blocks

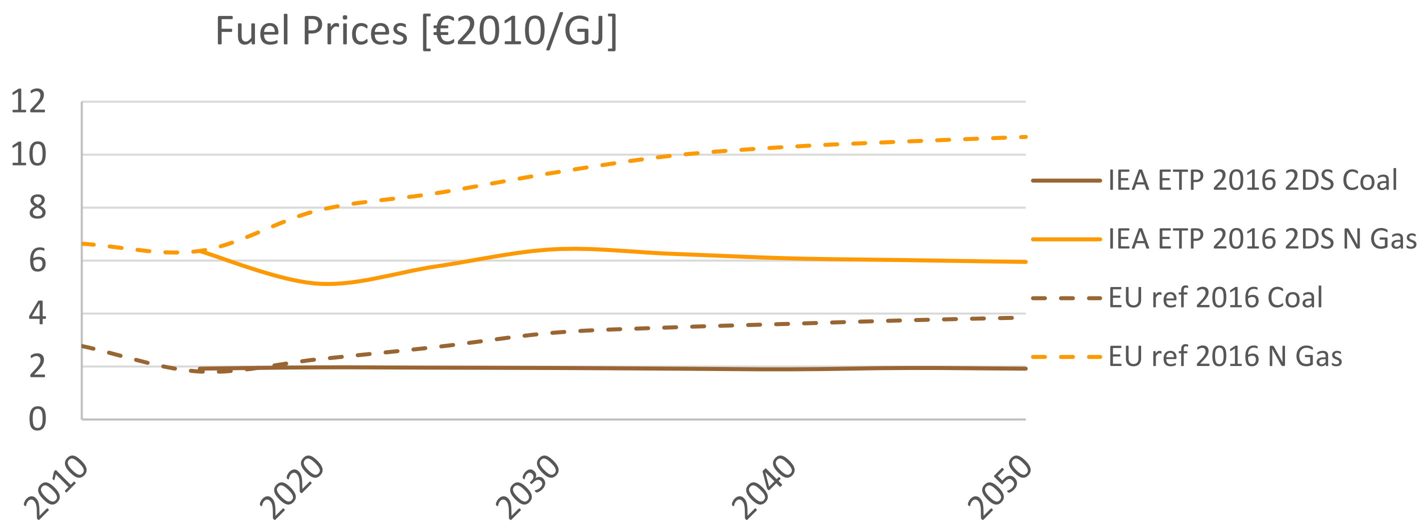


Operational data – slicing



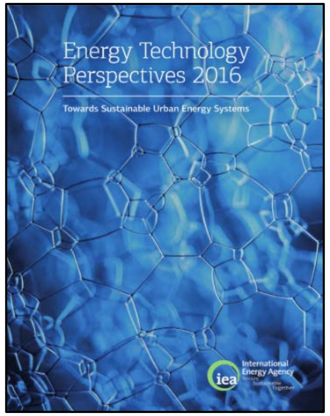
Background





EU reference scenario 2016

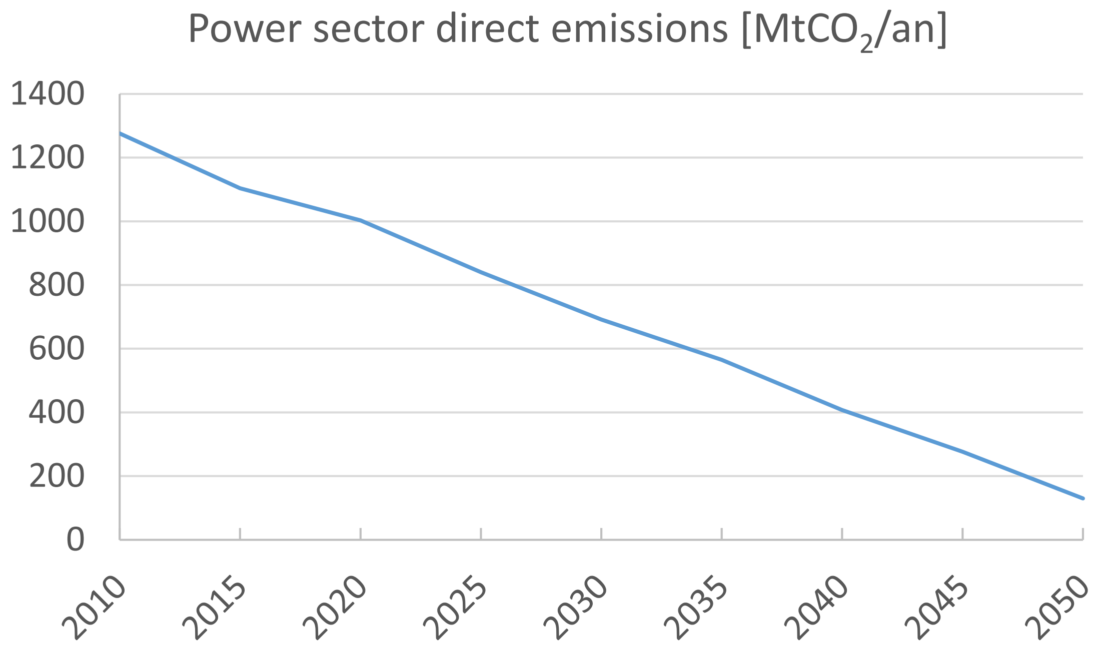
IEA Energy Technology Perspective 2016



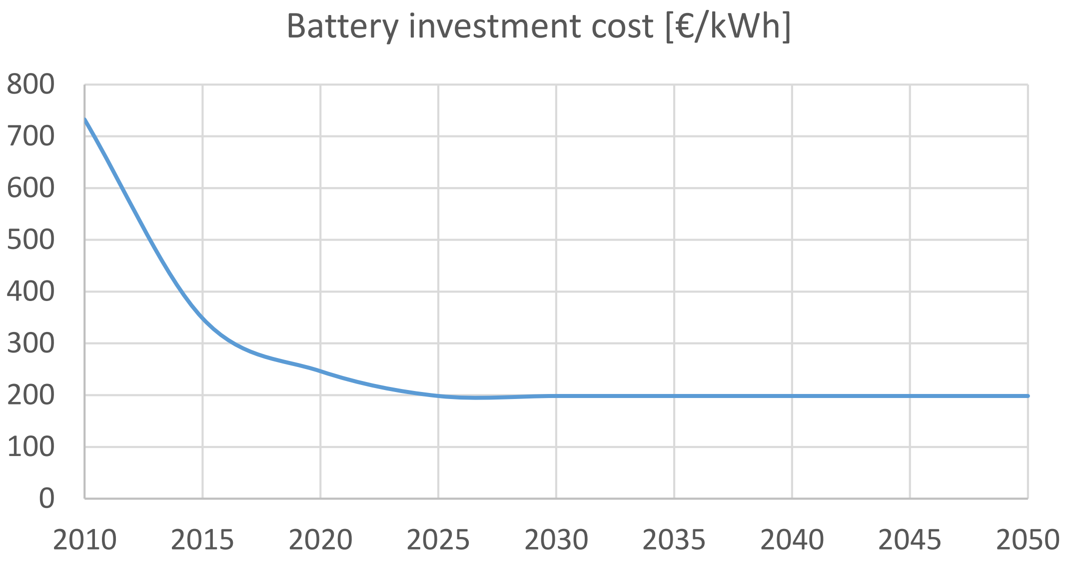
Scenario assumptions

1. Baseline decarbonization: **90 % emission reduction from 2010 to 2050**
   - i. Grid expansion towards 2020 fixed to ENTSO-E's 2016 TYDP reference capacities.
     - i. Beyond 2020: expansion limit of 4 GW for each interconnector every five year period
   - ii. Capacity limits for selected technologies
     - i. Wind onshore capacity potential from IEA's NETP 2016.
     - ii. Solar limited to cover no more than 14% of a country's area (assuming 150 W/m^2)
     - iii. Nuclear capacities limited
   - iii. RES targets defined for Germany, France, Great Britain and Spain
   - iv. Development of Norwegian hydro power predefined

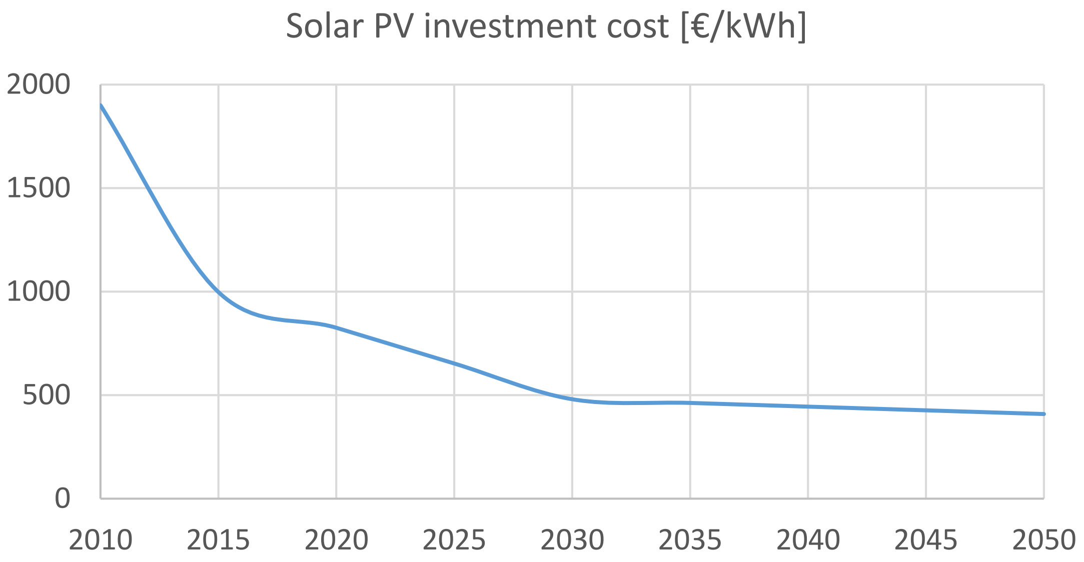
2. Alternative scenario NoCCS: same as baseline but no carbon capture and storage available



Medium optimistic assumptions for “decentral” technologies



Source: Cole, W. J., Marcy, C., Krishnan, V. K., & Margolis, R. (2016). Utility-scale lithium-ion storage cost projections for use in capacity expansion models. DOI:doi.org/10.1109/NAPS.2016.7747866



Source: PV: Fraunhofer ISE. (2015). Current and Future Cost of Photovoltaics. Long-term Scenarios for Market Development, System Prices and LCOE of Utility-Scale PV Systems. Agora Energiewende.

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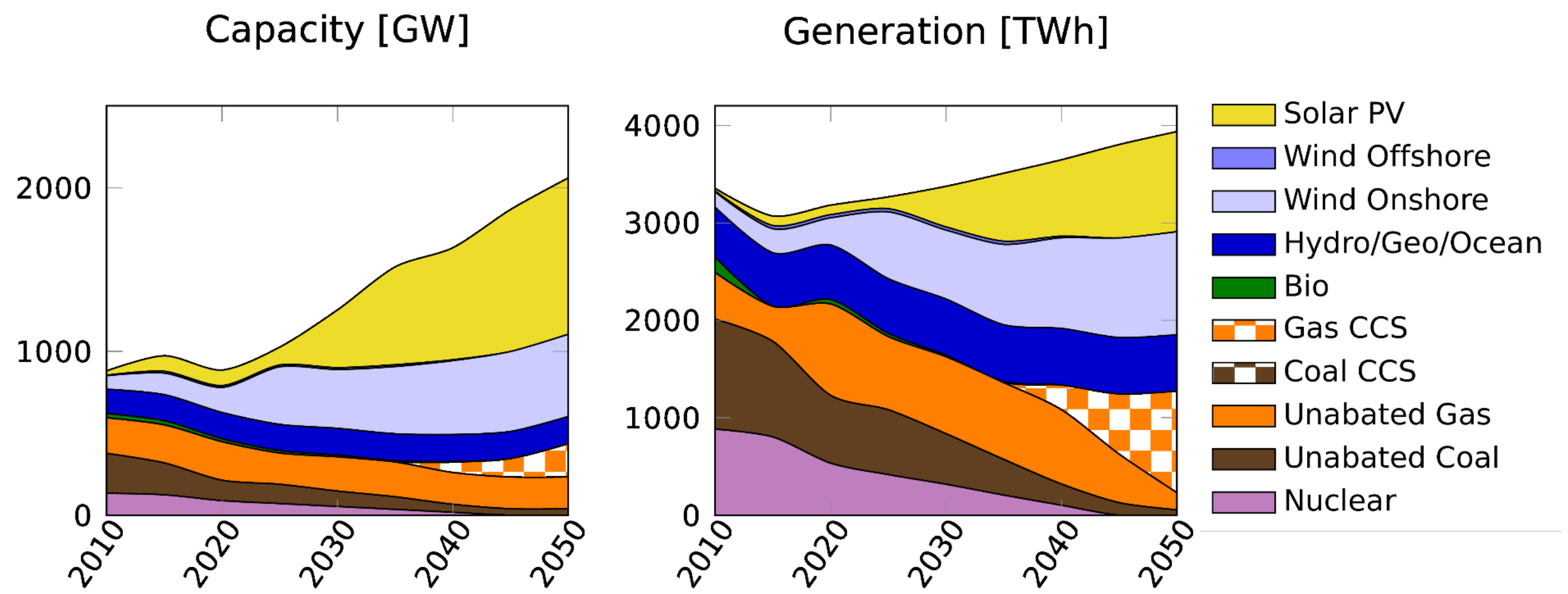
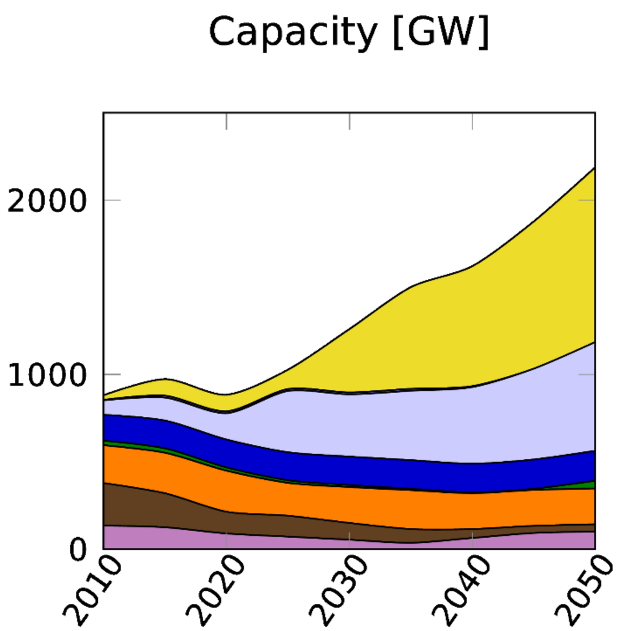
Baseline scenario: 90 % emission reduction

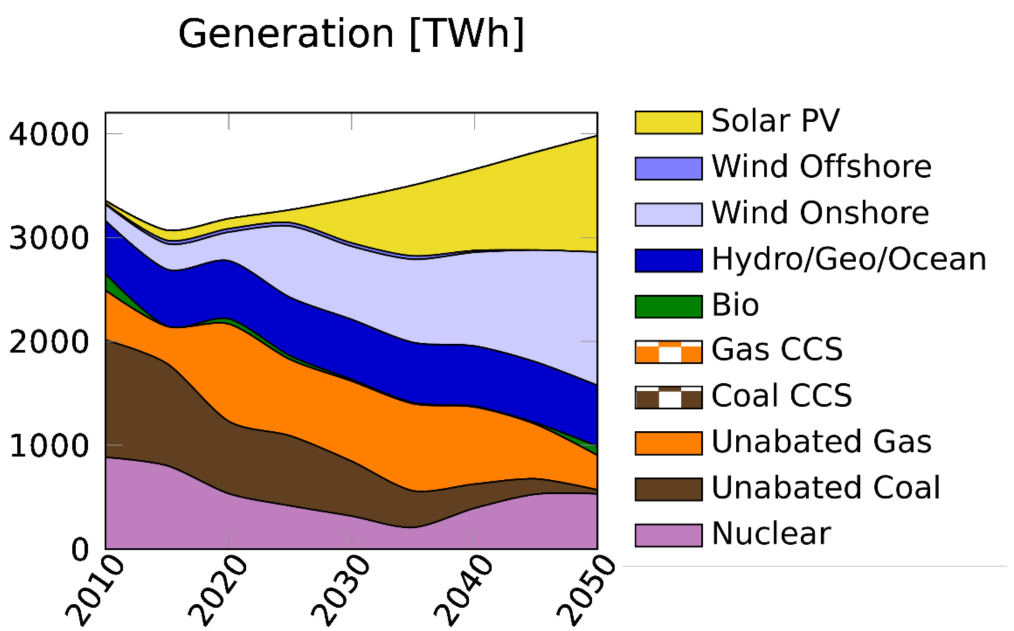


Technology/fuel (2050)	Capacity [GW]	Generation [TWh]
Solar	954 (46%)	1026 (26%)
Wind	503 (24%)	1057 (27%)
Gas CCS	204 (10%)	1043 (26%)
Coal CCS	0 (0%)	0 (0%)
Fossil unabated	233 (11%)	231 (5%)
Others	166 (8%)	578 (15%)

Battery energy storage by 2050: 99 GWh

NoCCS scenario: 90 % emission reduction





Technology/fuel (2050)	Capacity [GW]	Generation [TWh]
Solar	1001 (46%)	1120 (28%)
Wind	623 (28%)	1284 (32%)
Gas CCS	0 (0%)	0 (0%)
Coal CCS	0 (0%)	0 (0%)
Fossil unabated	247 (11%)	371 (9%)
Others	316 (15%)	1204 (30%)

Battery energy storage by 2050: 339 GWh

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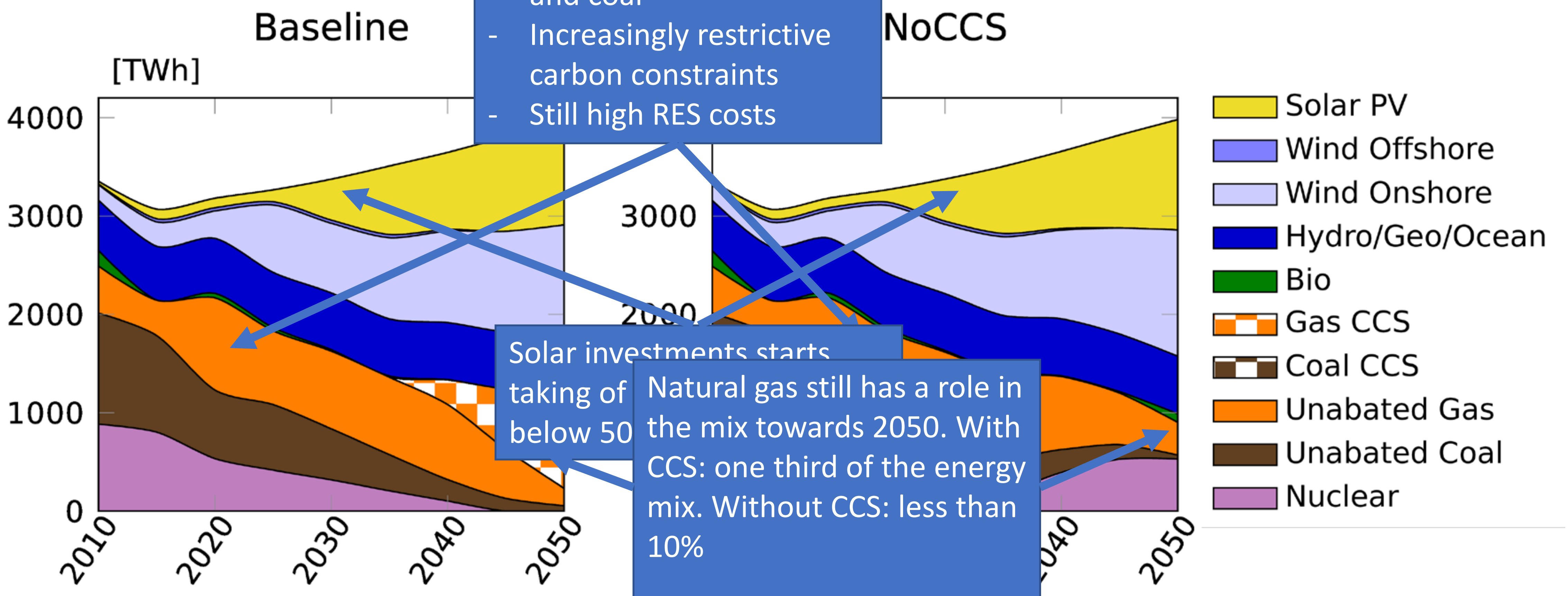
Transition to a low- n power sector

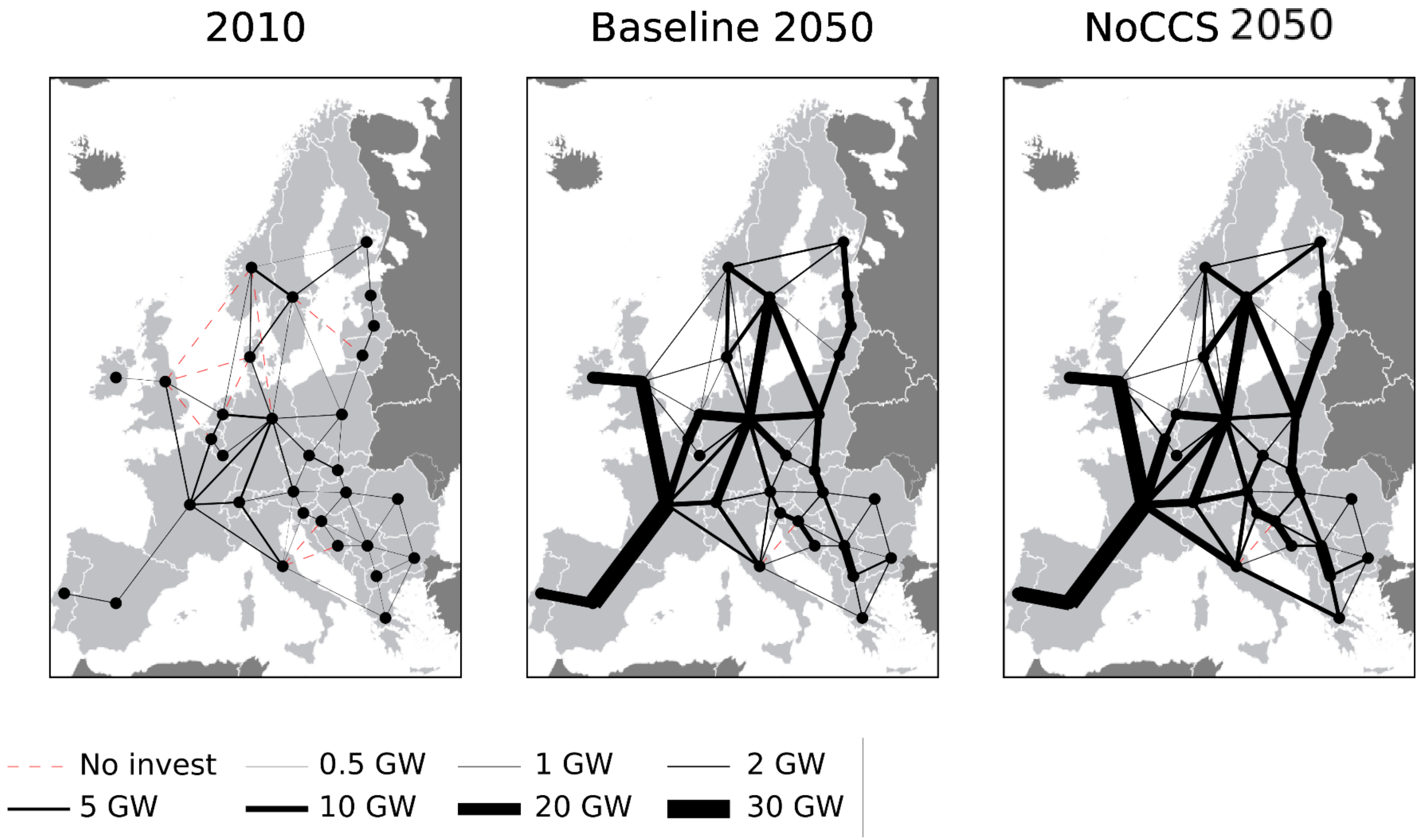
Increased shared of unabated natural gas in the medium term. Due to
- Retirement of nuclear and coal
- Increasingly restrictive carbon constraints
- Still high RES costs



Solar investments starts taking of below 50

Natural gas still has a role in the mix towards 2050. With CCS: one third of the energy mix. Without CCS: less than 10%

Transmission



Baseline
European cross-boarder interconnector expansion: capacity increases by 644 % from 2010 to 2050

NoCCS
Capacity increases by 826 % from 2010 to 2050

How will natural gas be used?

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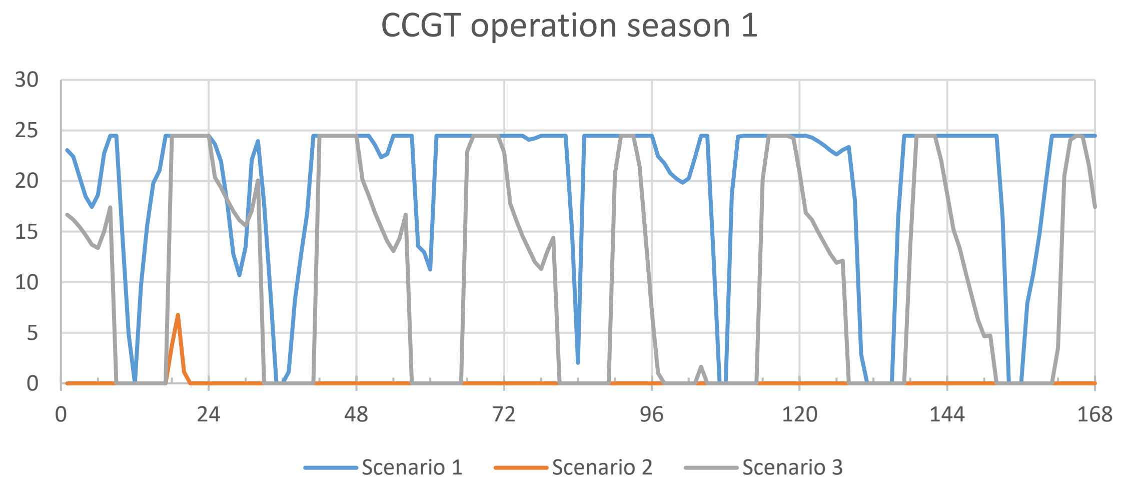
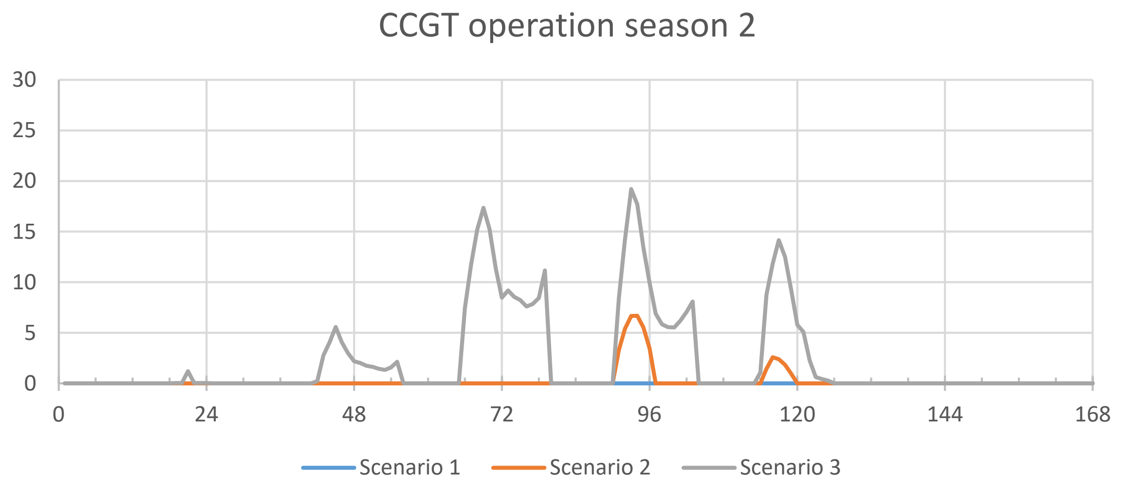
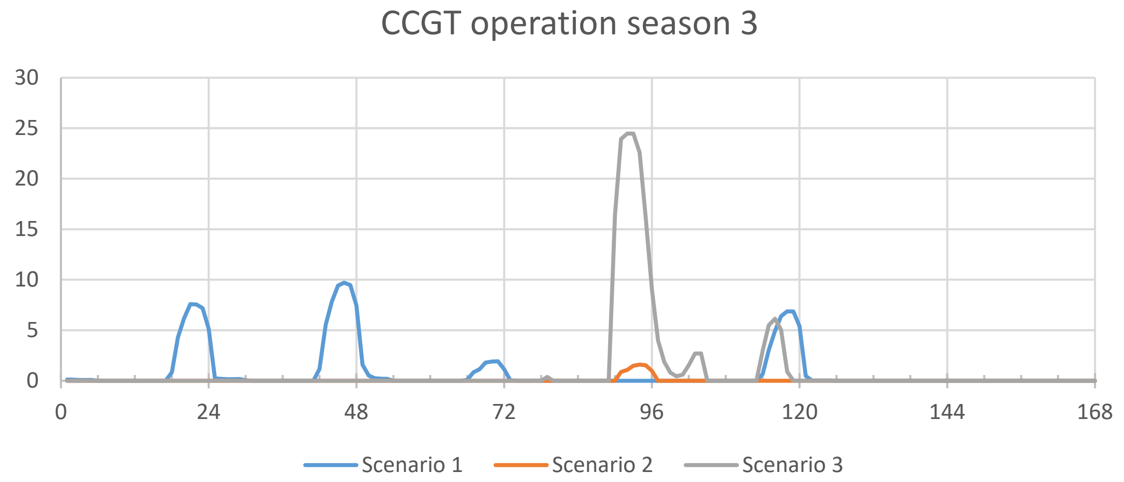
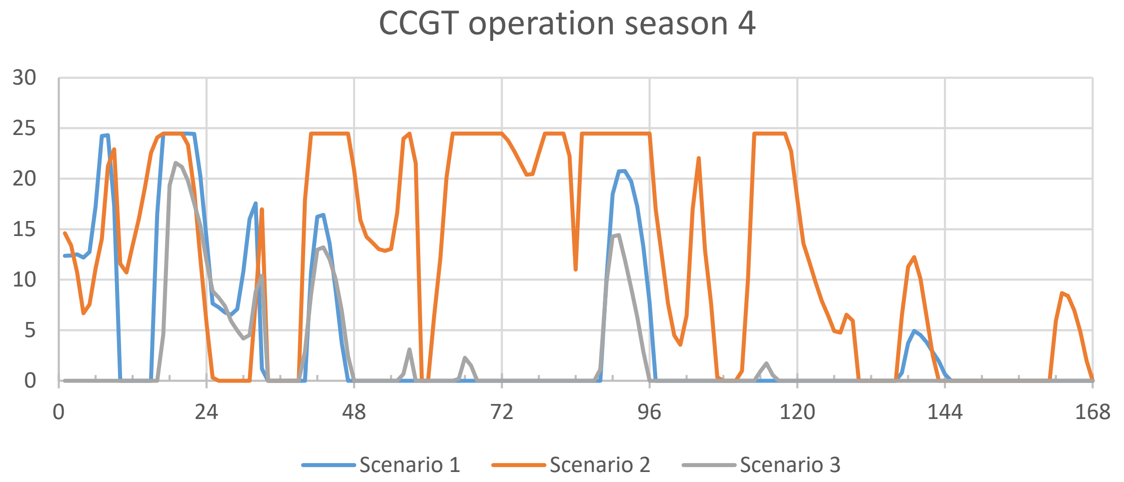
Unabated gas operation GB 2050









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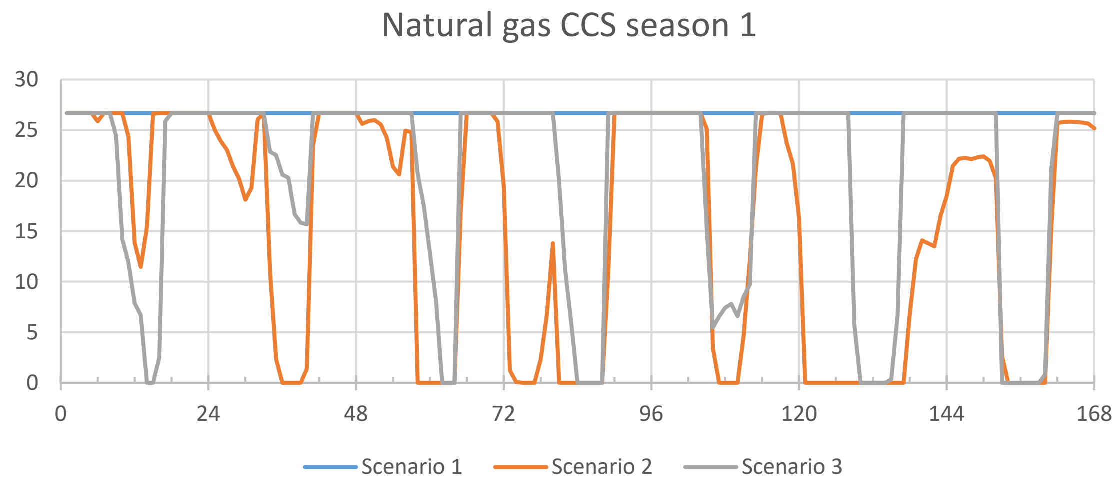
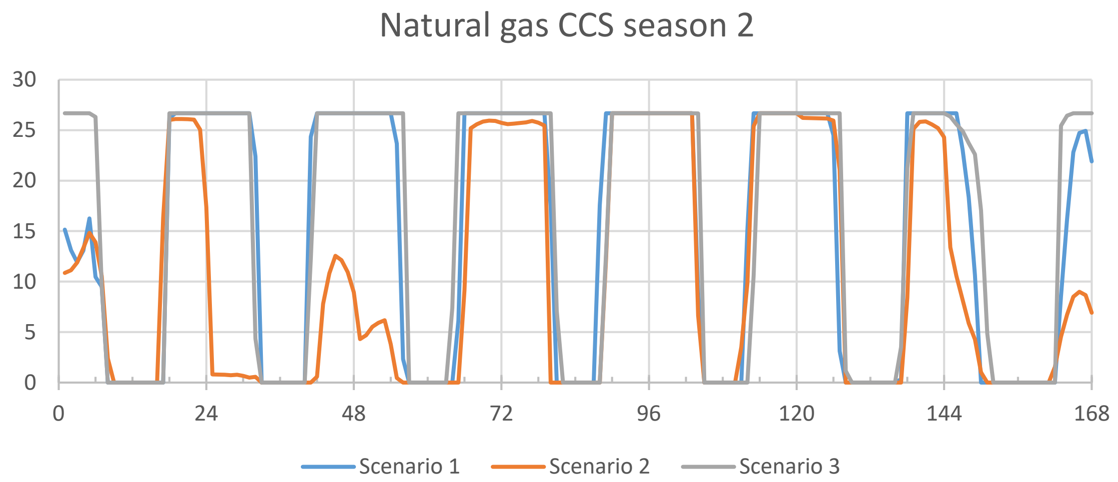
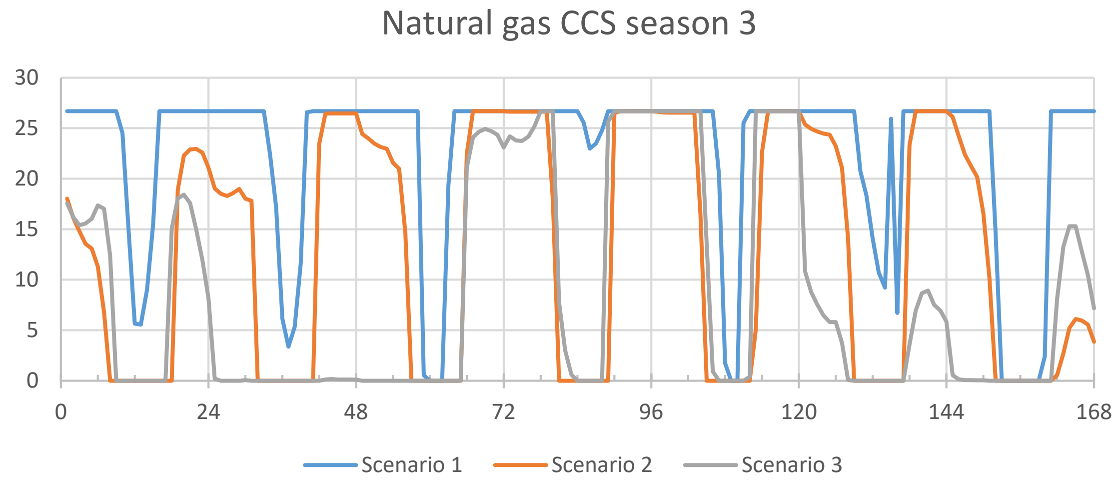
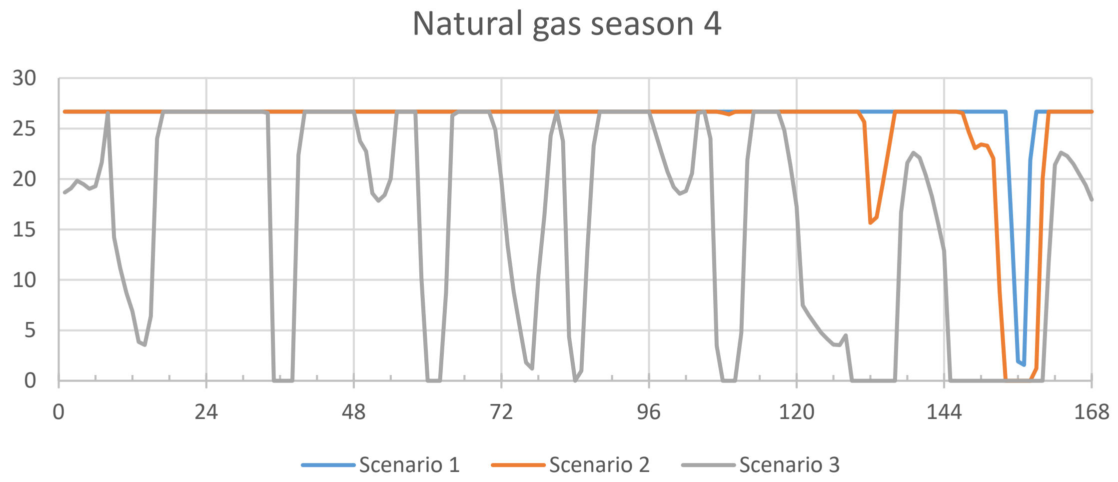
CCS gas operation GB 2050

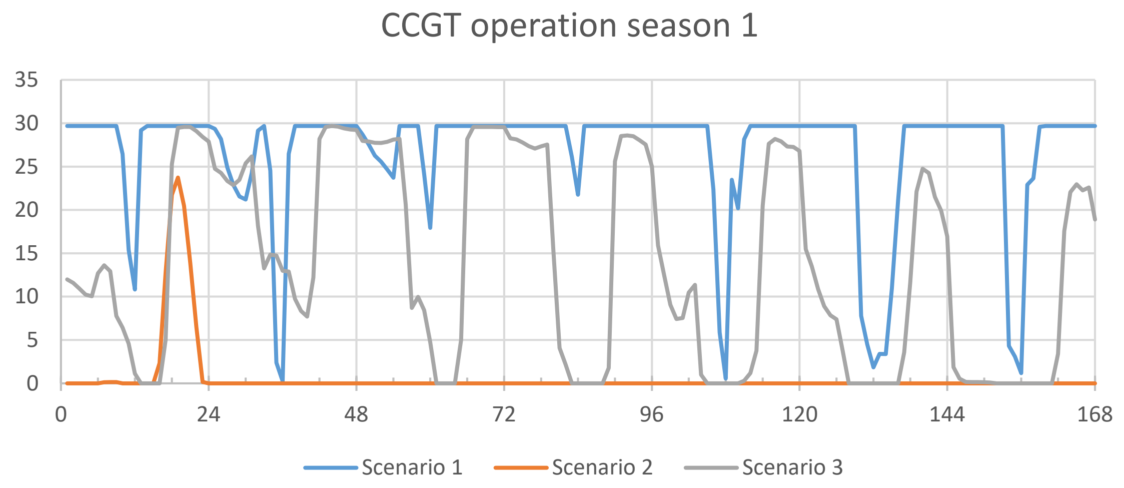


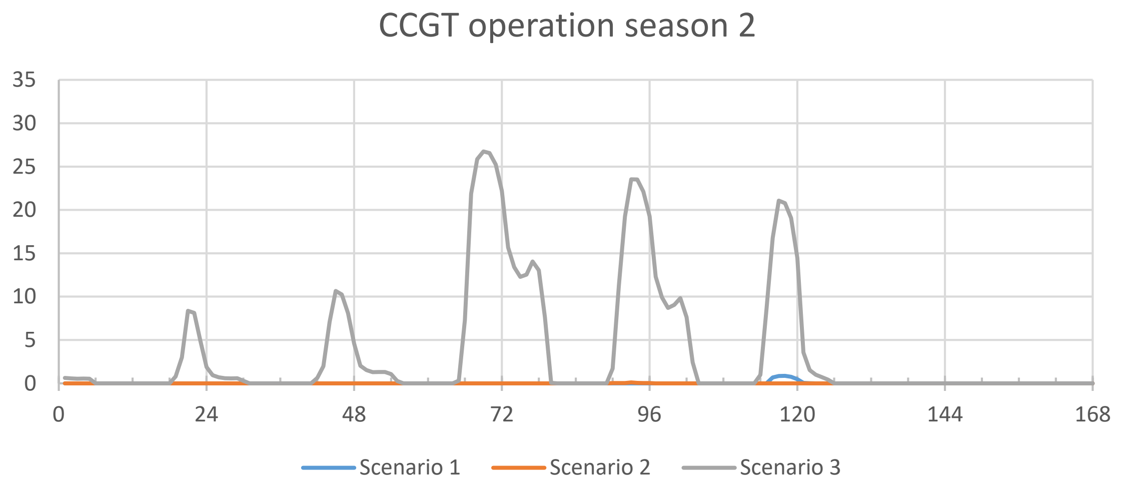


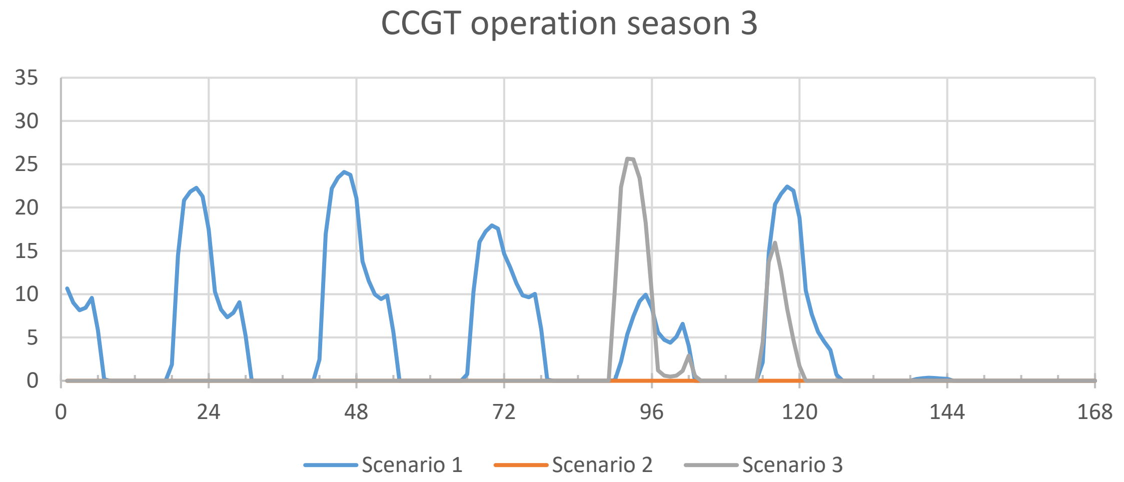


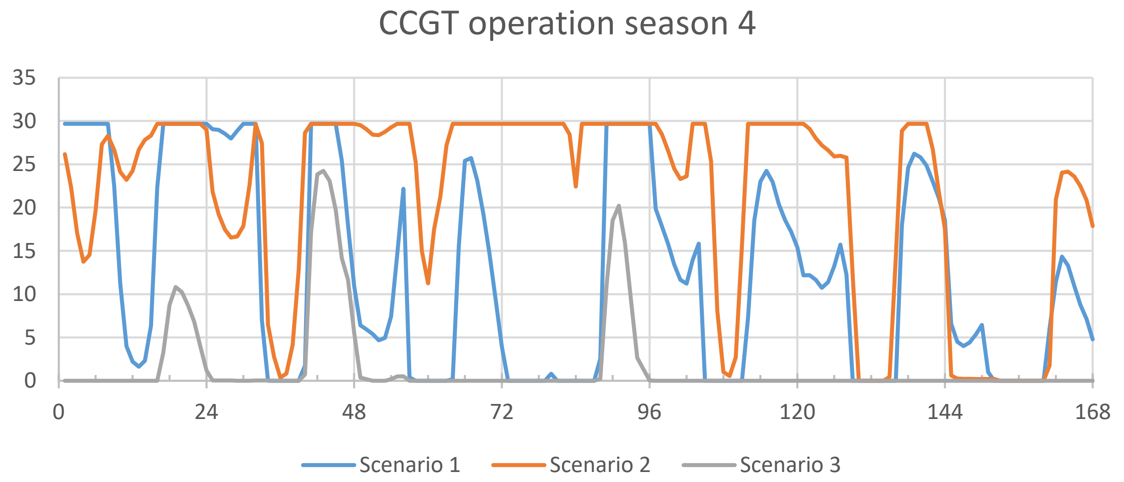


NO CCS - Unabated gas operation GB 2050

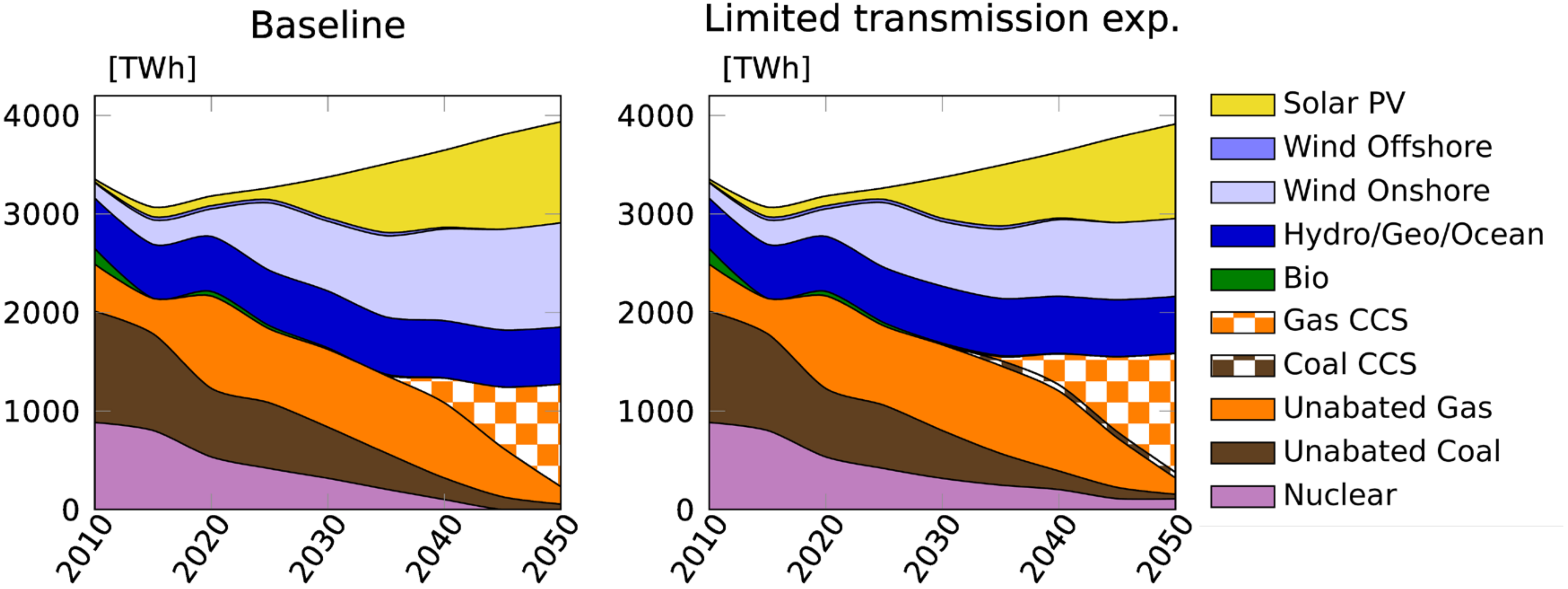




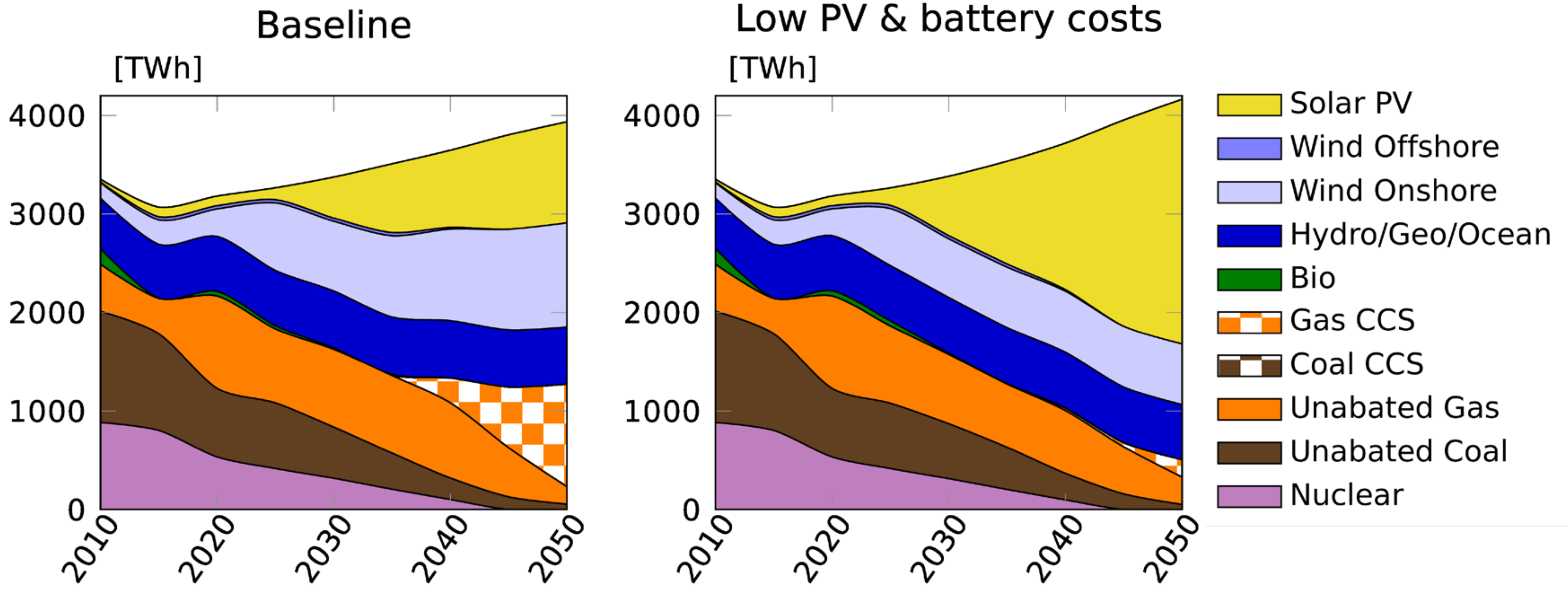




Sensitivities: Transition to a low-carbon European power sector



Sensitivities: Transition to a low-carbon European power sector



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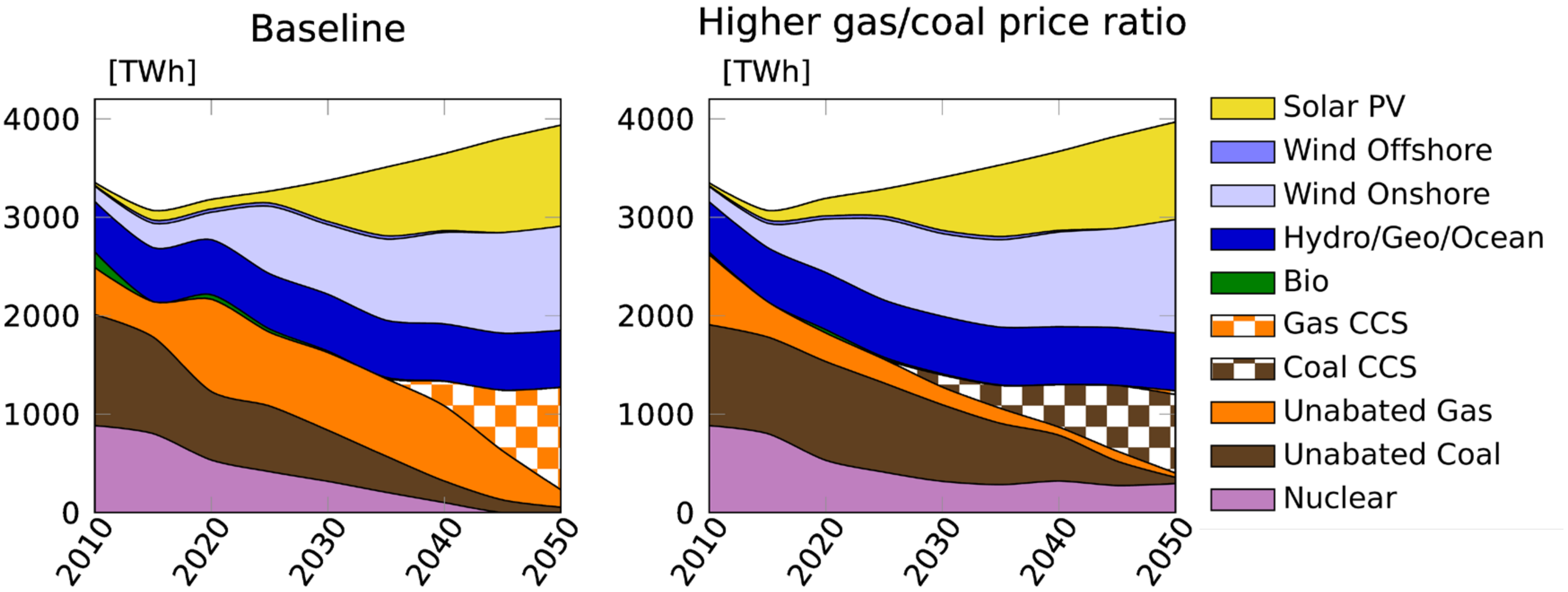
Sensitivities: Transition to a low-carbon European power sector

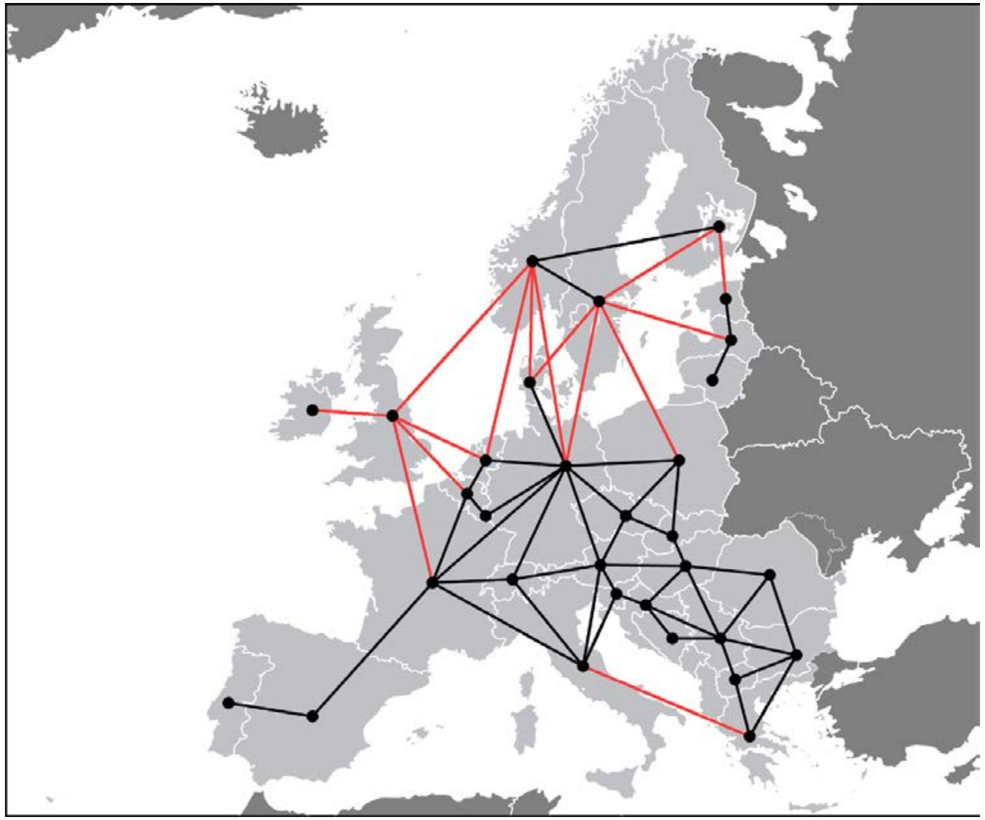


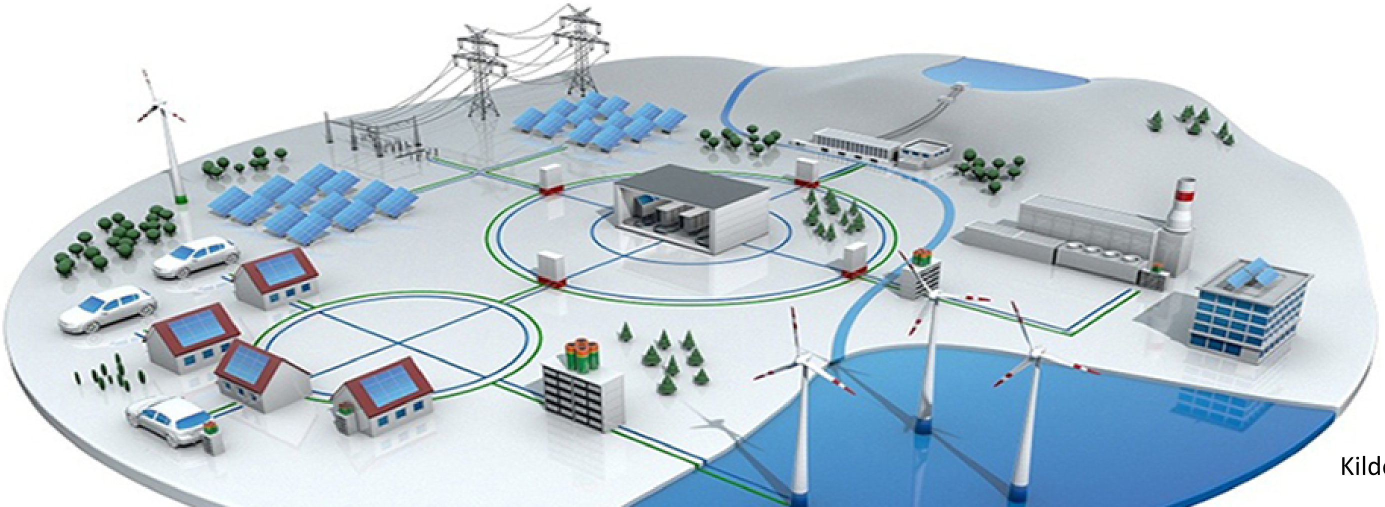
Energy systems integration and industry

Interplay between power, heating, industry: CCS is a key

- Joint transport and storage infrastructure
  - ZEP: Not only is CCS the *only* option for substantially reducing CO2 emissions in cement, steel, refinery industries, but the costs of CO2 transport and storage – 10-30% of the total CCS costs – can be significantly reduced by clustering power and industrial emitters.

- Makes it possible to use hydrogen as clean fuel in transport and heating systems





Kilde: 3M, Smart Grid: http://solutions.3m.com/wps/portal/3M/en_EU/SmartGrid/EU-Smart-Grid/

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Some challenges

- Under pressure from PV and battery costs
- Highly price sensitive, in particular to coal
- Without CCS , demand volumes down 70 %
- Independent of CCS: natural gas demand for power production will be highly volatile
  - Also the CCS part.
- Will natural gas with CCS be flexible enough
- European countries does no seem to cooperate on investments
  - How does that affect natural gas?
- Political uncertainty affects natural gas reputation

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Some opportunities

- Joint CCS infrastructure with industry and hydrogen production
  - But how will that happen?
- A clean heating system: A good alternative to electricity?
  - Maybe with CCS and hydrogen? More about that today.
- Flexibility services linked to natural gas infrastructure
  - Energy volumes far beyond what you find in hydro power systems. More about that today.

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Some insights

- Availability of CCS makes a significant difference in the cost-optimal transition to a low carbon European power system
- The role of natural gas depends on availability of CCS and on the gas/coal price ratio
  - With CCS: natural gas with CCS is used for baseload, unabated for balancing. Total share 31%.
  - Without CCS: natural gas is mostly used for balancing. Total share 8%.
- Without CCS a combination of options are used to achieve low-carbon power generation, including solar, wind and (some) bio, but also nuclear and unabated natural gas
- If solar PV and battery costs follow the most optimistic cost reduction curves available solar can become the dominant technology in the mix (share almost 60%)

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