Scenarios in the EU Roadmaps

Insights for power sector roadmaps

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Agora Energiewende – who are we?

Think-tank with 20 experts

Independent and non-partisan

Project duration 2012-2021

Financed by the Mercator Foundation and the European Climate Foundation

Mission: How do we make the *Energiewende* in Germany a success story?

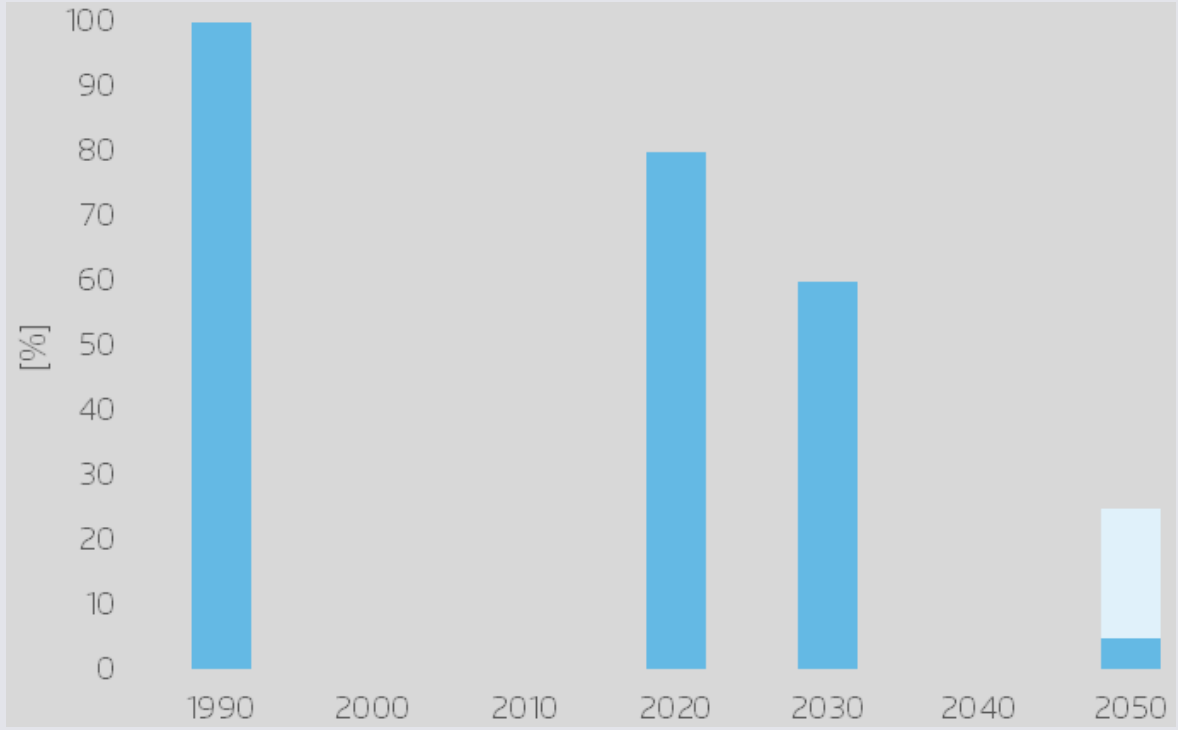
Scientific assessments

Dialogue

Putting forward proposals

Long-term energy & climate targets of the European Union

Greenhouse gas emissions in the EU (1990=100%)



European Commission (2014)

Reducing domestic EU GHG emissions by

→ 20% by 2020 (binding on national level; ETS and national effort sharing for non-ETS)

→ 40% by 2030 (binding on EU & national level; ETS & effort sharing for non-ETS)

→ 80-95% by 2050 (EU Heads of State; Oct. 2009, Feb. 2011)

Options for transforming power systems

→ Energy efficiency (EE)

→ Nuclear power

→ CCS

→ Renewables (RES)

EE and RES for cost-efficient decarbonisation

Power sector scenarios of the EU's energy & climate strategy

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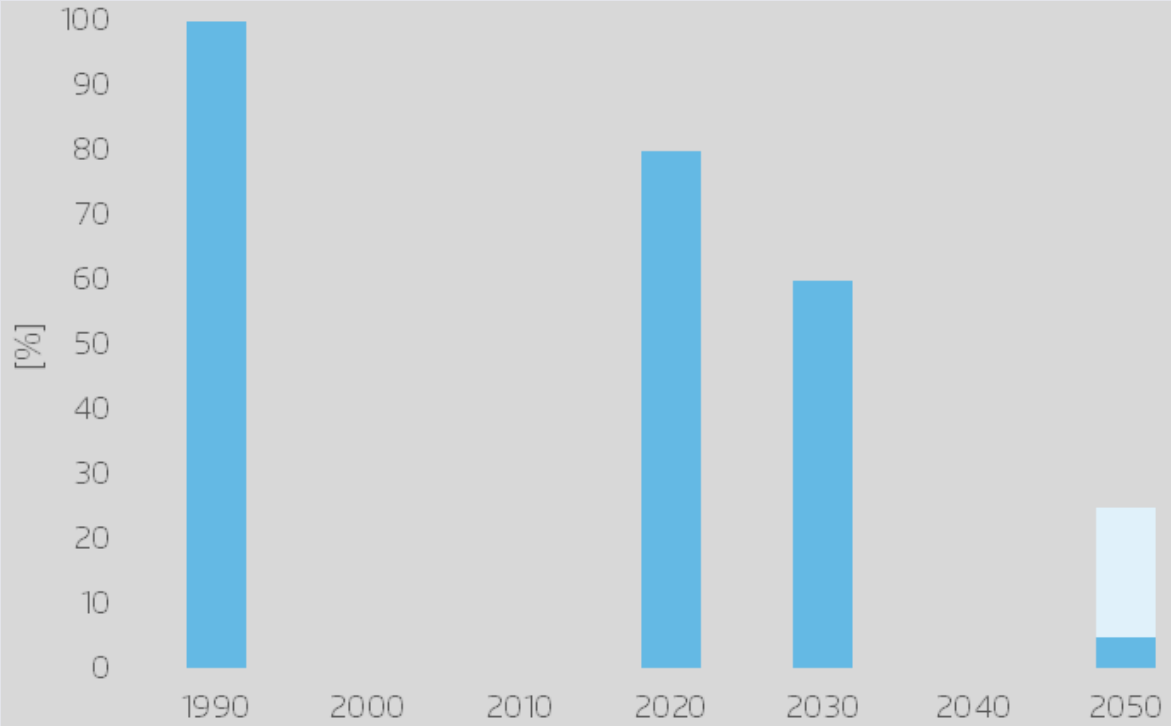


European Commission (2011)

Energy Roadmap 2050

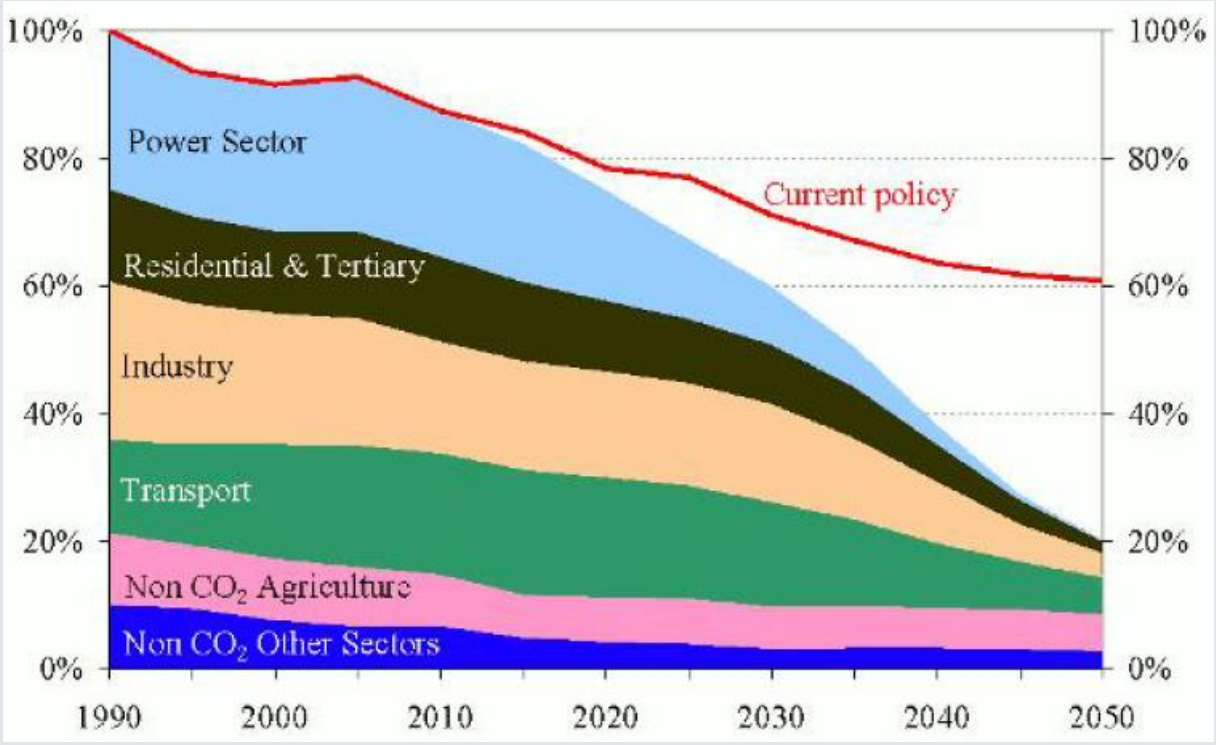
→ Reference scenario

→ Current policy initiatives

→ 5 Decarbonisation scenarios (with differing assumptions on energy efficiency, technology costs (RES, nuclear, CCS)) with a 80% reduction in domestic GHG emissions

Power sector scenarios of the EU's energy & climate strategy

Sectoral emissions paths to reach a 80% GHG reduction in the EU by 2050



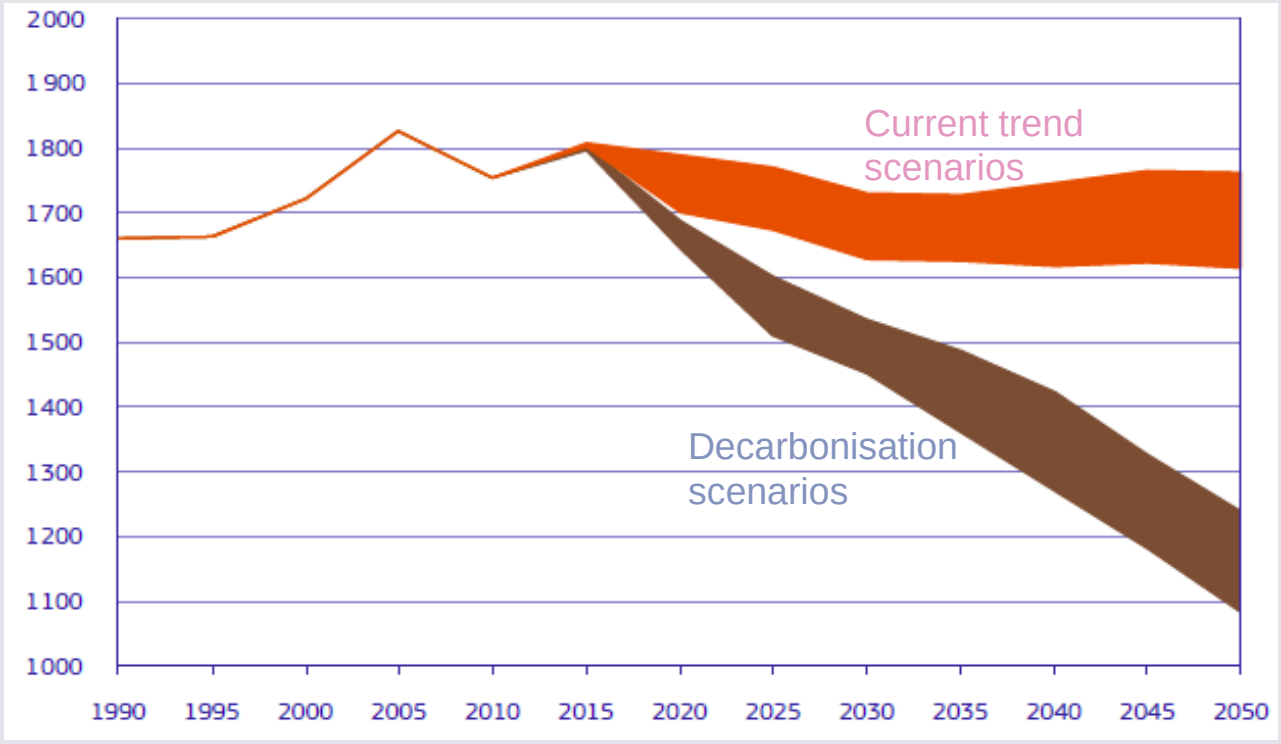
European Commission (2011)

Main results decarbonisation scenarios in the EU Energy Roadmap 2050

→ (Almost) full decarbonisation of the power sector (emissions decrease by 96 to 99%)

Power sector scenarios of the EU's energy & climate strategy

Gross energy consumption — range in current trend (REF/CPI) and decarbonisation scenarios (million toe)



European Commission (2011)

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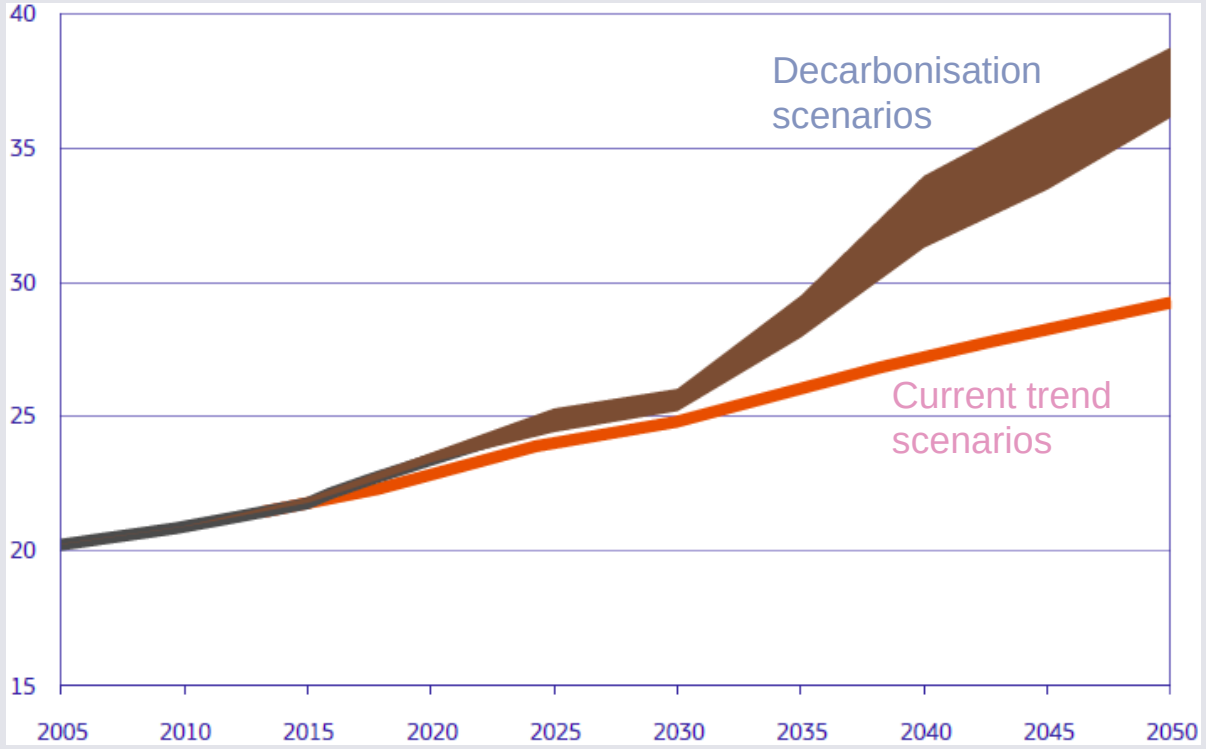
→ Energy savings through increased energy efficiency lowering costs and increasing security of supply

Power sector scenarios of the EU's energy & climate strategy

Share of electricity in current trend and decarbonisation scenarios (% of final energy demand)



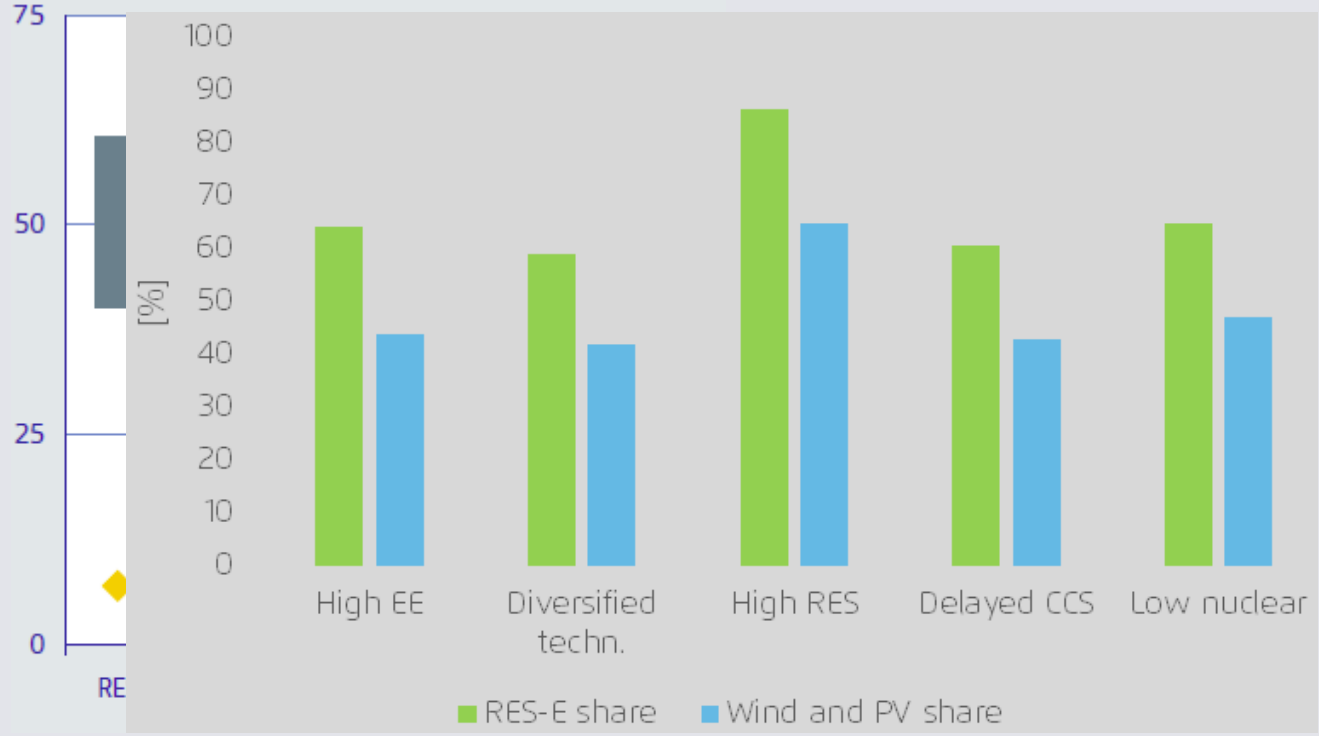
European Commission (2011)

Main results decarbonisation scenarios in the EU Energy Roadmap 2050

- → (Almost) full decarbonisation of the power sector (emissions decrease by 96 to 99%)
- → Energy savings through increased energy efficiency lowering costs and increasing security of supply
- → Electrification of final energy demand (decarbonisation of transport and heating through RES-E)

Power sector scenarios of the EU's energy & climate strategy

2050 range of fuel shares in primary energy consumption compared with 2005 (%); RES-E share in the power mix and Wind &PV share in the power mix



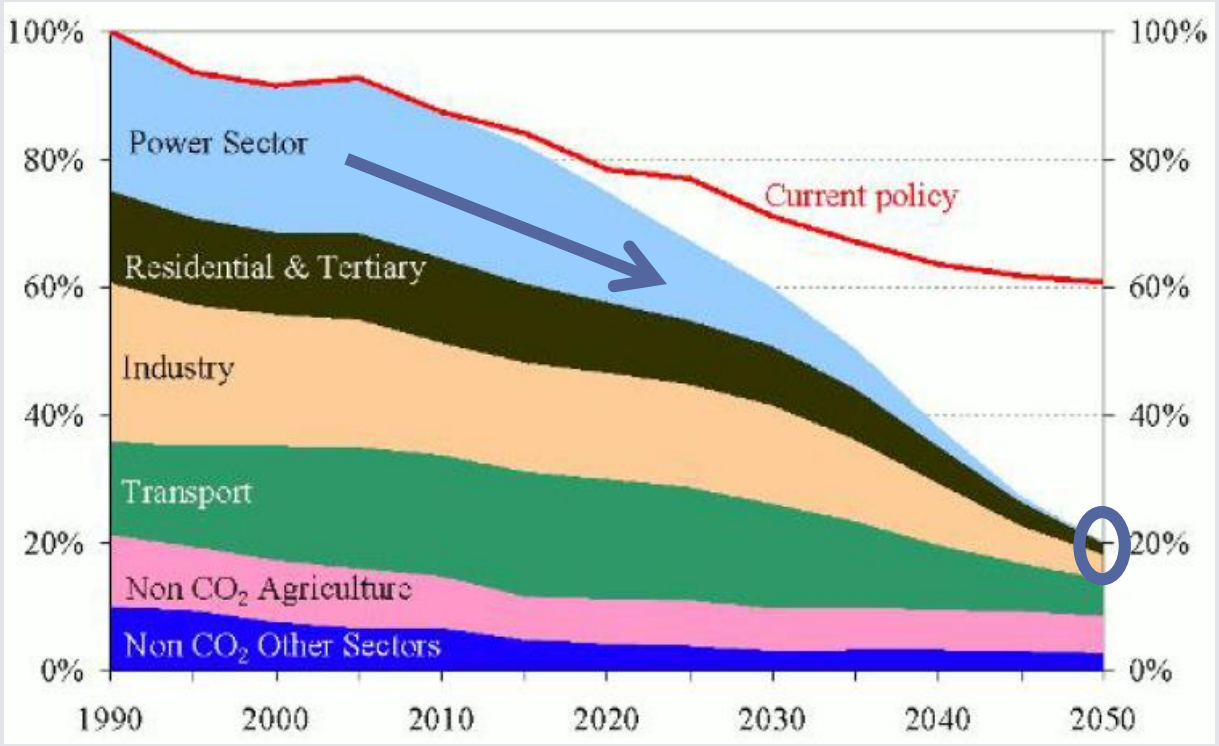
European Commission (2011)

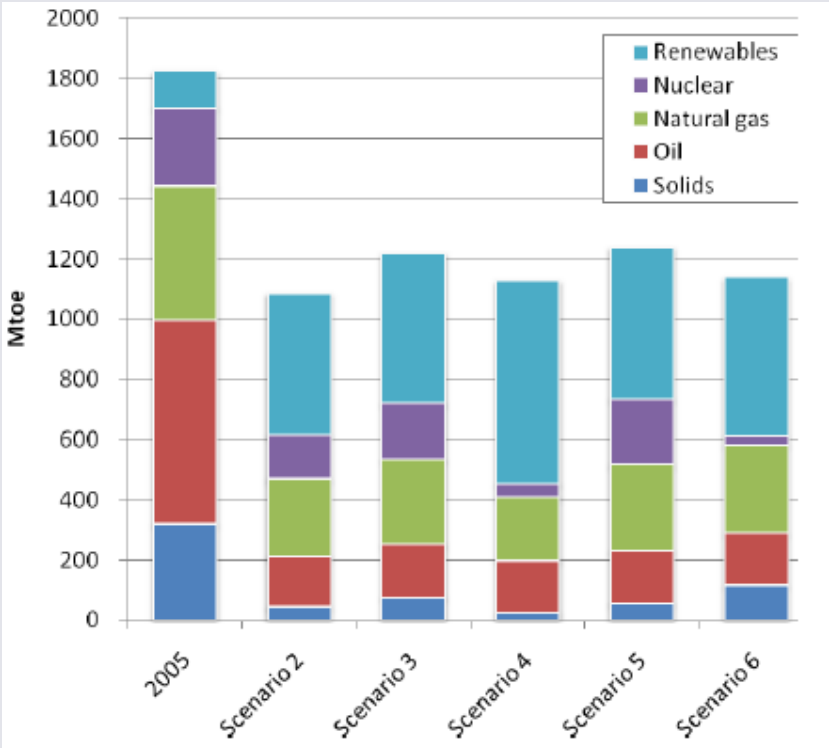
Main results decarbonisation scenarios in the EU Energy Roadmap 2050

- → (Almost) full decarbonisation of the power sector (emissions down by 96 to 99%)
- → Energy savings through increased energy efficiency lowering costs and increasing security of supply
- → Electrification of final energy demand (decarbonisation of transport and heating through RES-E)
- → RES main fuel; all other fuels show lower share in 2050 than in 2005;
  RES-E share: 60 to 86%; Wind & PV contribute some 2/3 of entire RES-E

EU energy & climate targets imply significant reduction of the use of fossil fuels and decarbonisation of the power sector

EU sectoral GHG emissions (1990 = 100%) (left) and primary energy consumption in the EU 2050 energy roadmap (right)





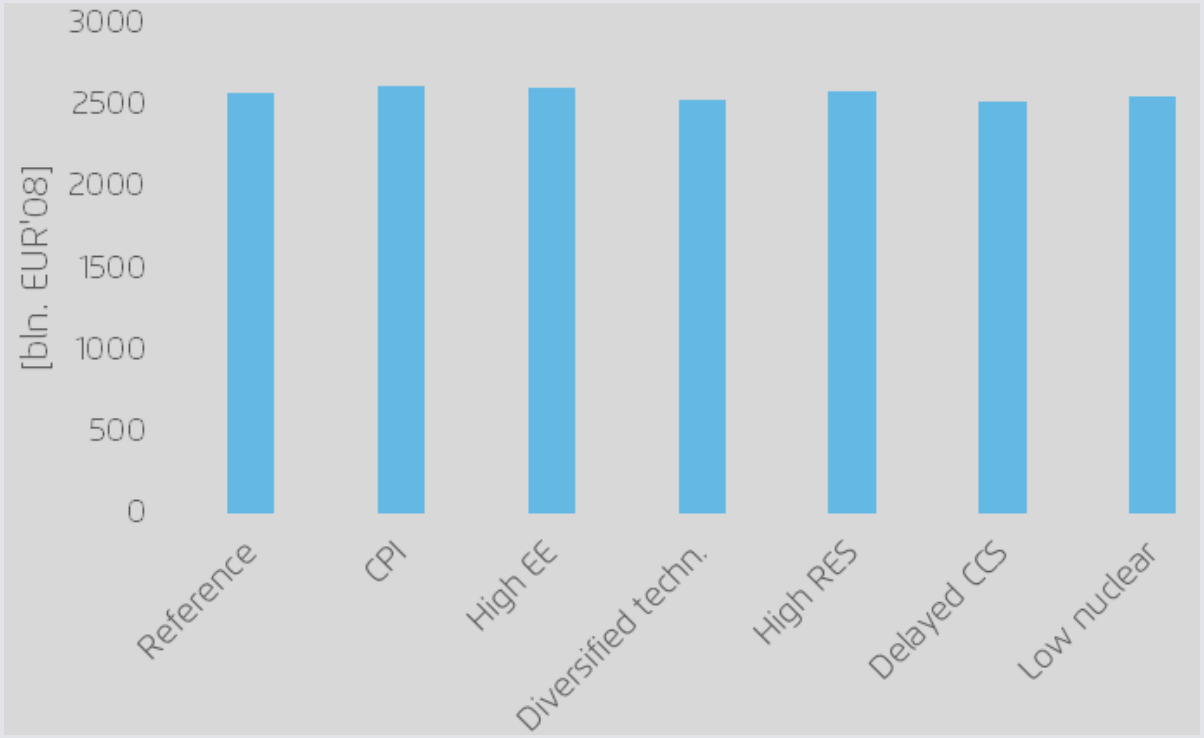
Gas: -30 to -50%

Coal: -70 to -90%

EC (2011)

Energy system decarbonisation leaves total system costs unchanged

Average annual total energy system costs 2011-2050



European Commission (2011)

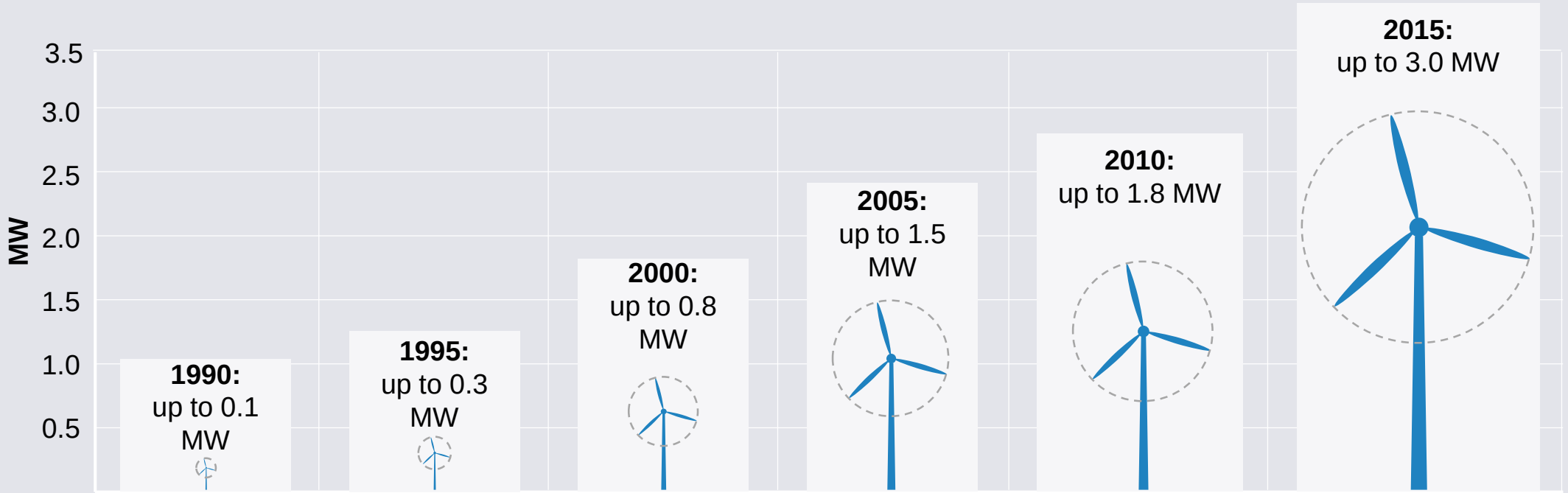
Main results decarbonisation scenarios in the EU Energy Roadmap 2050

- → Shift in cost structure occurs
- → Increase in capital costs
- → Decrease in variable costs (fuel costs and imports)
- → Outdated RES cost assumptions in the EC's Roadmap modelling: 2050 cost assumptions for solar PV where in reality already reached in 2015

A key insight: It’s about Wind and Solar

Wind energy has become a mature technology, with windmills of 2 - 3 MW being standard

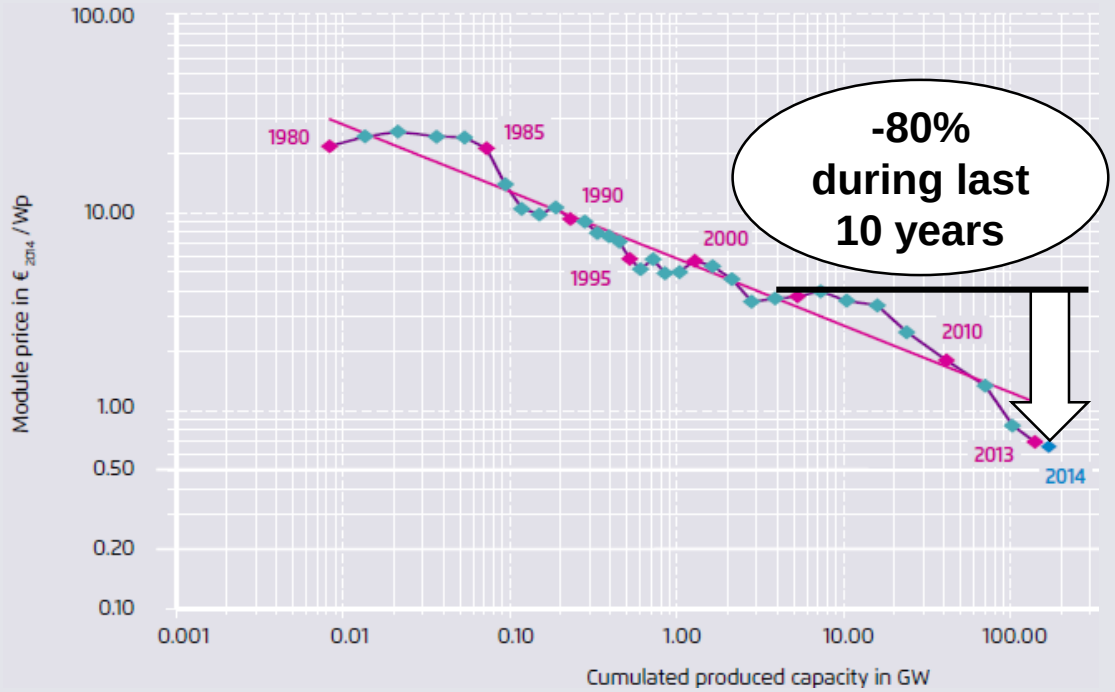
Size development of wind turbines 1990 - 2015



IEA (2013)

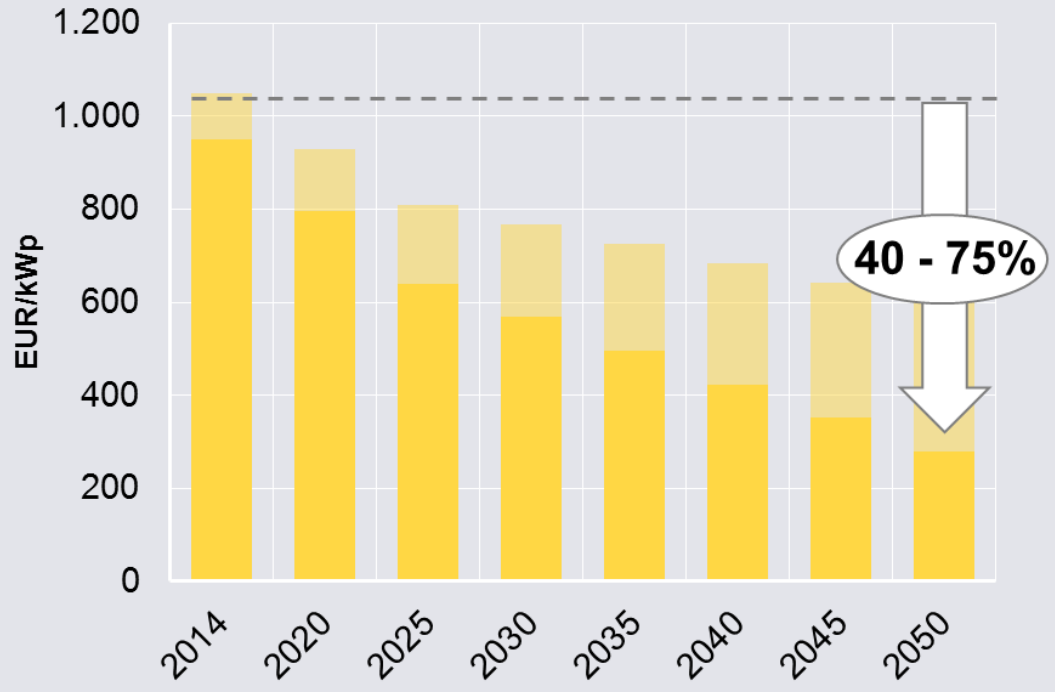
Due to falling module prices, costs for Solar PV dropped massively in the last 10 years. The end of the cost digression is not yet reached

Historical price curve for PV modules since 1980



Fraunhofer ISE (2015)

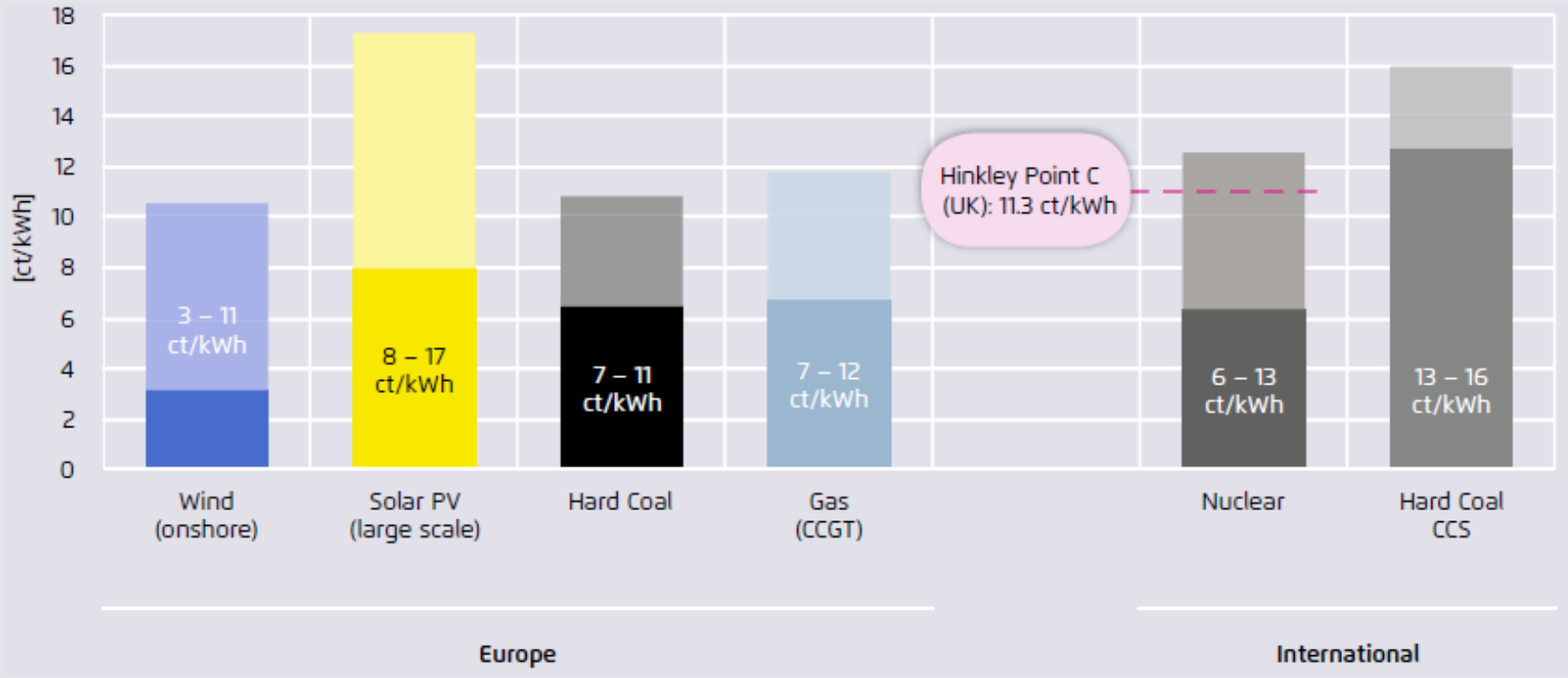
Expected cost digression for large-scale PV systems 2014 - 2050



Fraunhofer ISE (2015)

Today, wind and solar are cost competitive to other decarbonisation options and new fossil fuel plants

Range* of levelised cost of electricity (LCOE) in Europe in 2015

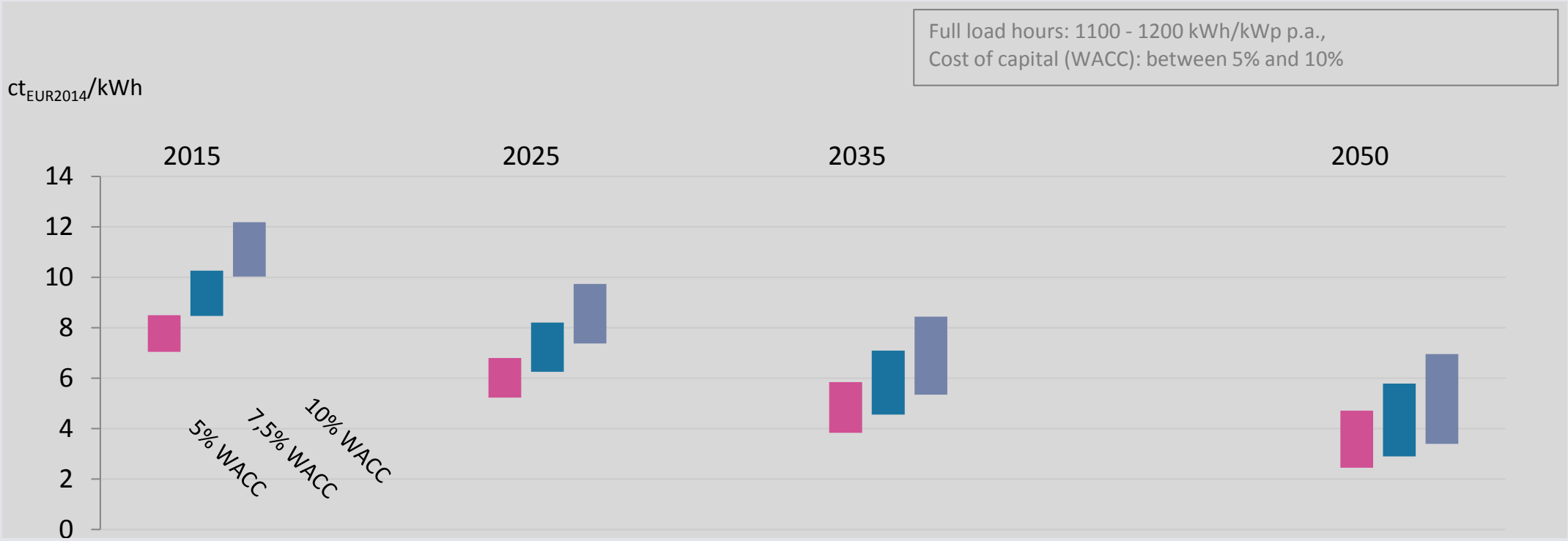


Agora Energiewende (2016), IRENA (2015), BNetzA (2016)

* based on varying utilization, CO_2-price and investment cost

Serbia: Current and future cost of solar energy

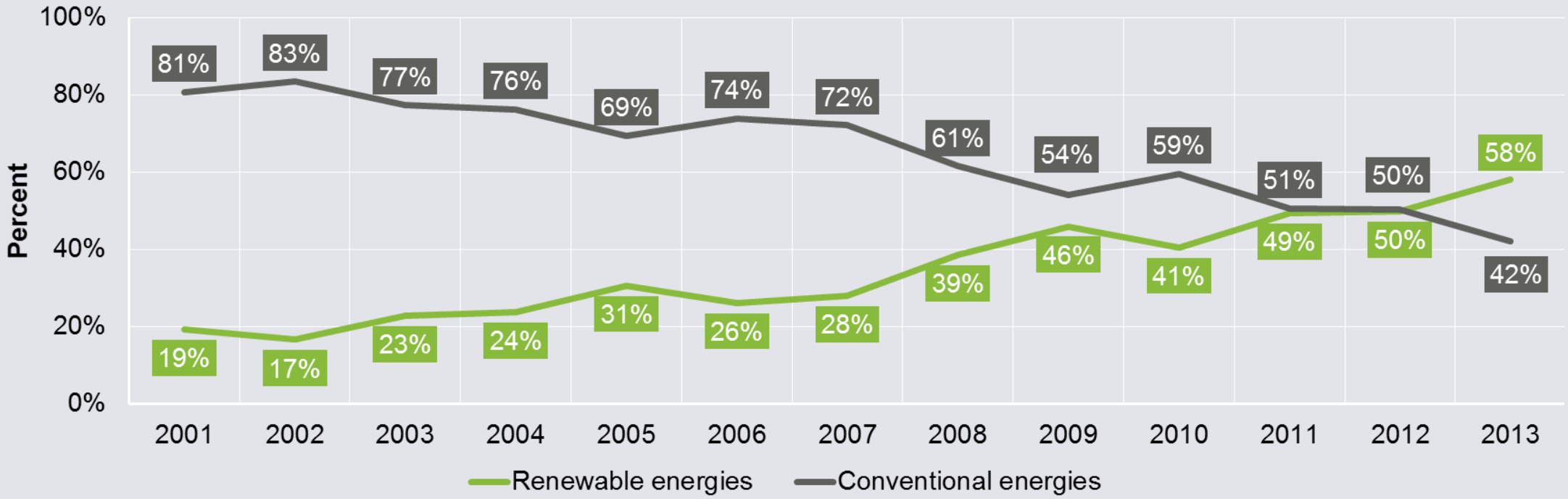
Levelised cost of electricity (LCOE) from large-scale solar PV in Serbia



Calculation based on Fraunhofer ISE (2015); Ranges include differences in irradiation within the country and scenarios of technology and global market development; global market for modules, inverters and other cost components is assumed, short-term effects of higher cost in new markets (e.g. 1st GW in a specific country) not considered

Global capacity additions in renewables have overtaken those of conventional sources (coal, gas, nuclear)

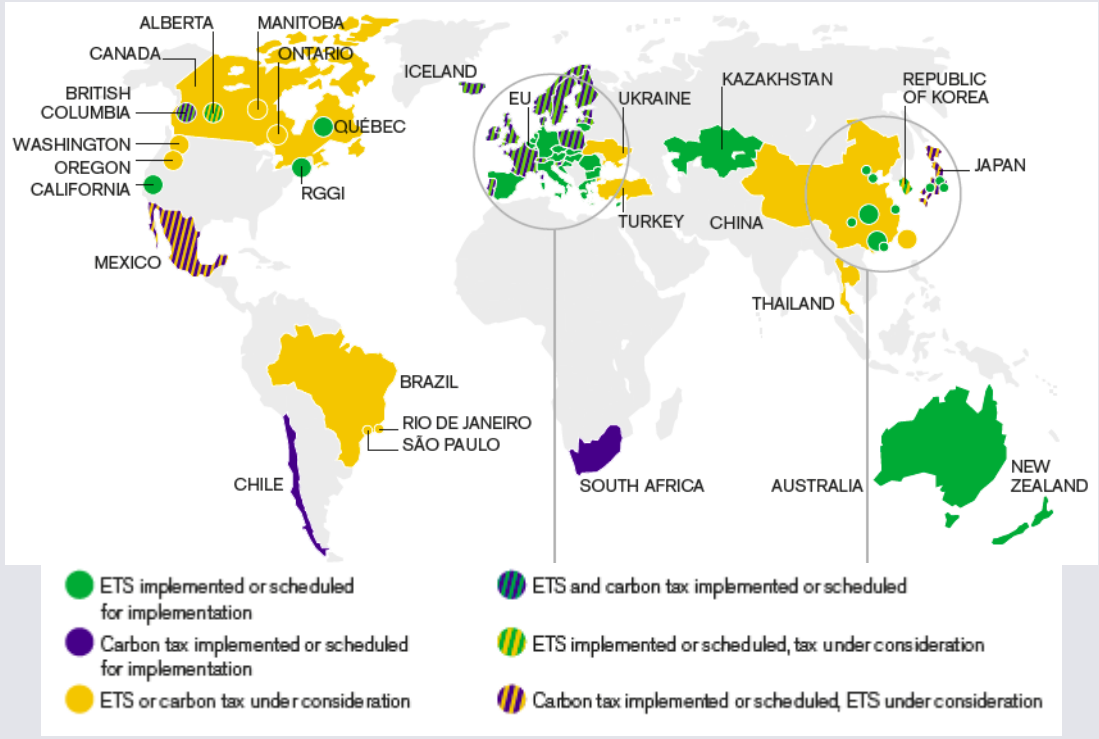
Share in global capacity additions 2001- 2013



IRENA (2014)

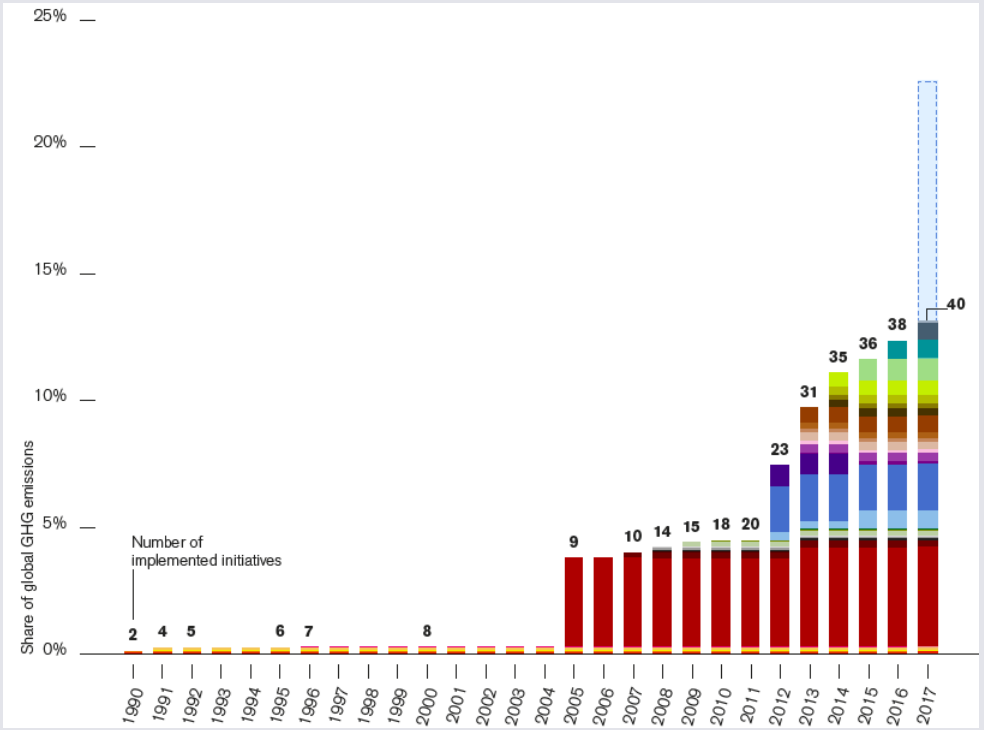
Carbon pricing schemes emerge across the globe and will soon cover 25% of global emissions

Existing & emerging carbon pricing schemes



World Bank (2016)

Share of global emissions covered in carbon pricing schemes



World Bank (2016)

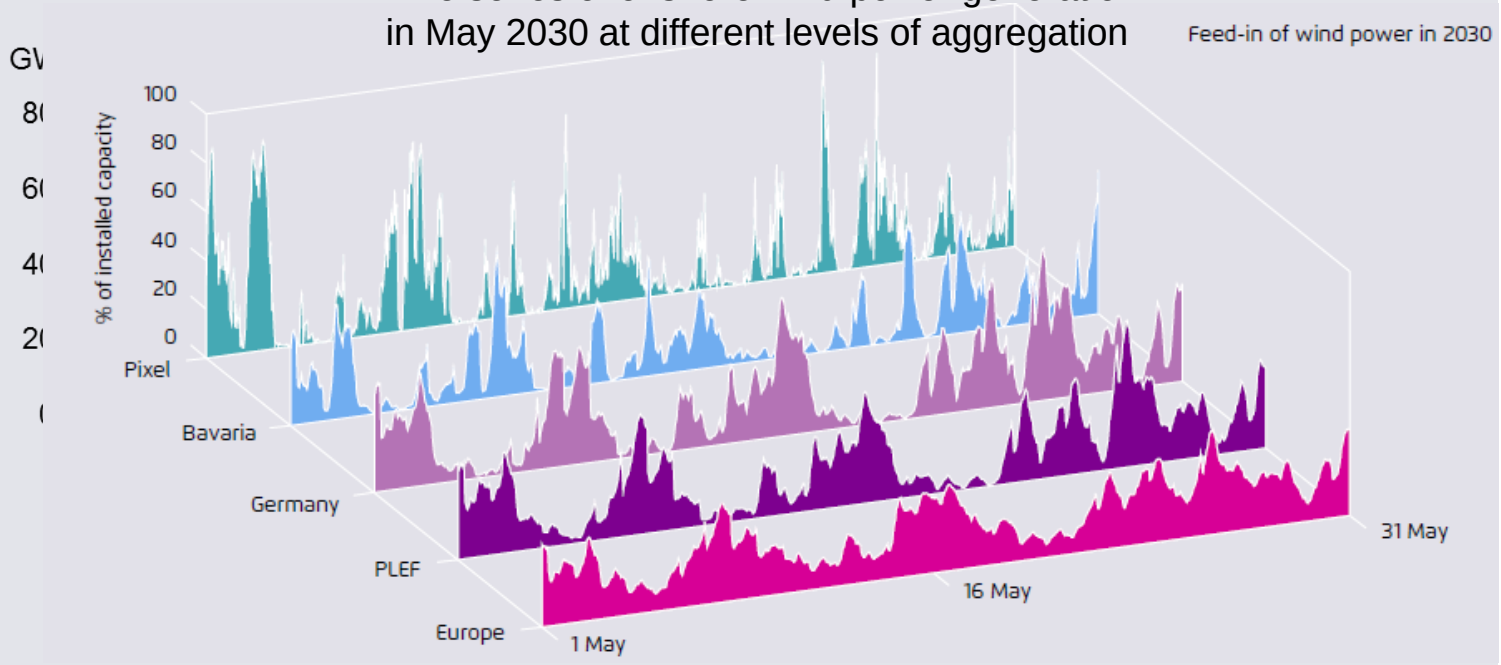
The 2030 European power system

Flexibility and integration at its core

Flexibility and *integration* are the paradigms of the new power system

Electricity generation and consumption in a sample week with 50% RES share

Time series of onshore wind power generation in May 2030 at different levels of aggregation



Insights long-term EU energy scenarios

- Energy efficiency and RES (mainly wind and PV) main enabler of power sector decarbonisation
- Flexibilising power systems key for managing variability from wind & PV
- Flexible fossil & biomass plants, demand response, storage, sector coupling important flexibility options
- Cross border system integration (grids, system operations) key for minimizing flexibility challenge
- Wind and PV are about to become the cheapest options for power generation; Integration costs are moderate

Agora Energiewende (2015), Fraunhofer IWES (2015)

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Thank you for your attention!

Questions or Comments? Feel free to contact me:

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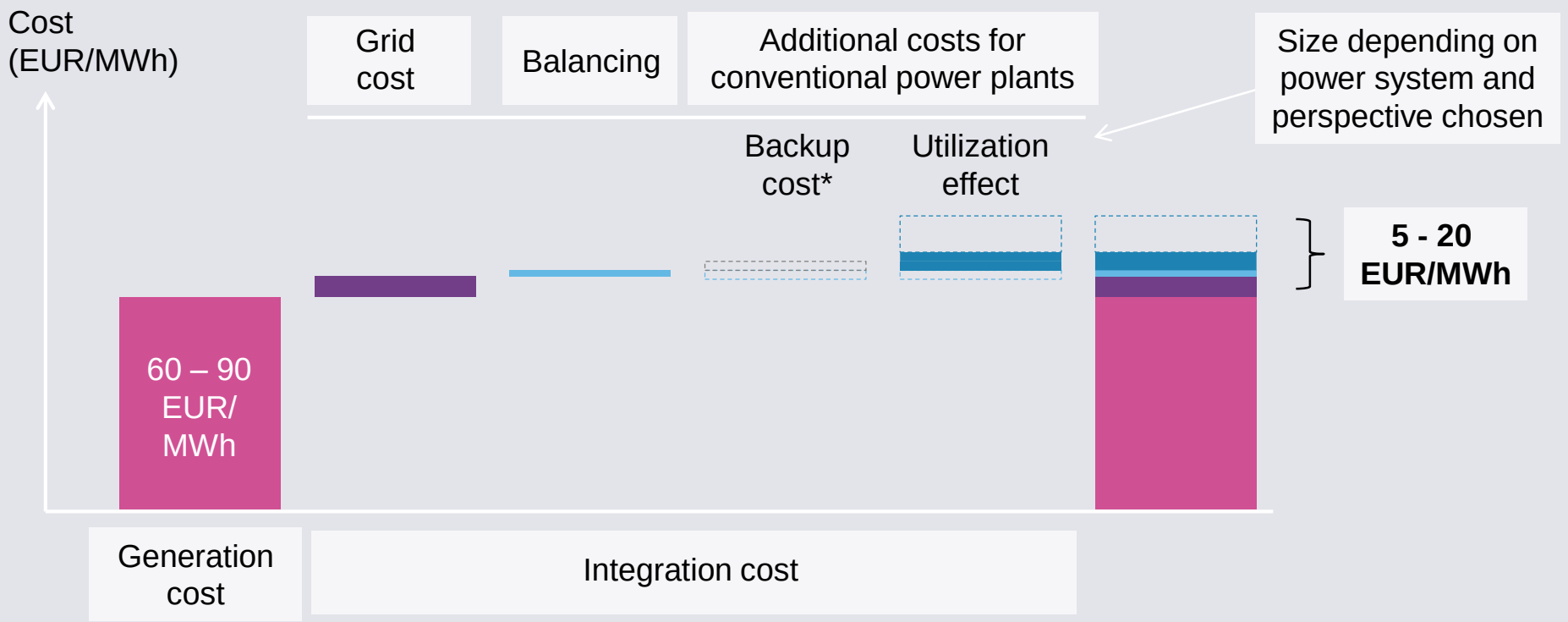
Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.

The integration cost of wind and solar (5 to 20 EUR/MWh) are moderate

Components of integration costs



Agora Energiewende (2015)

* part of utilization effect

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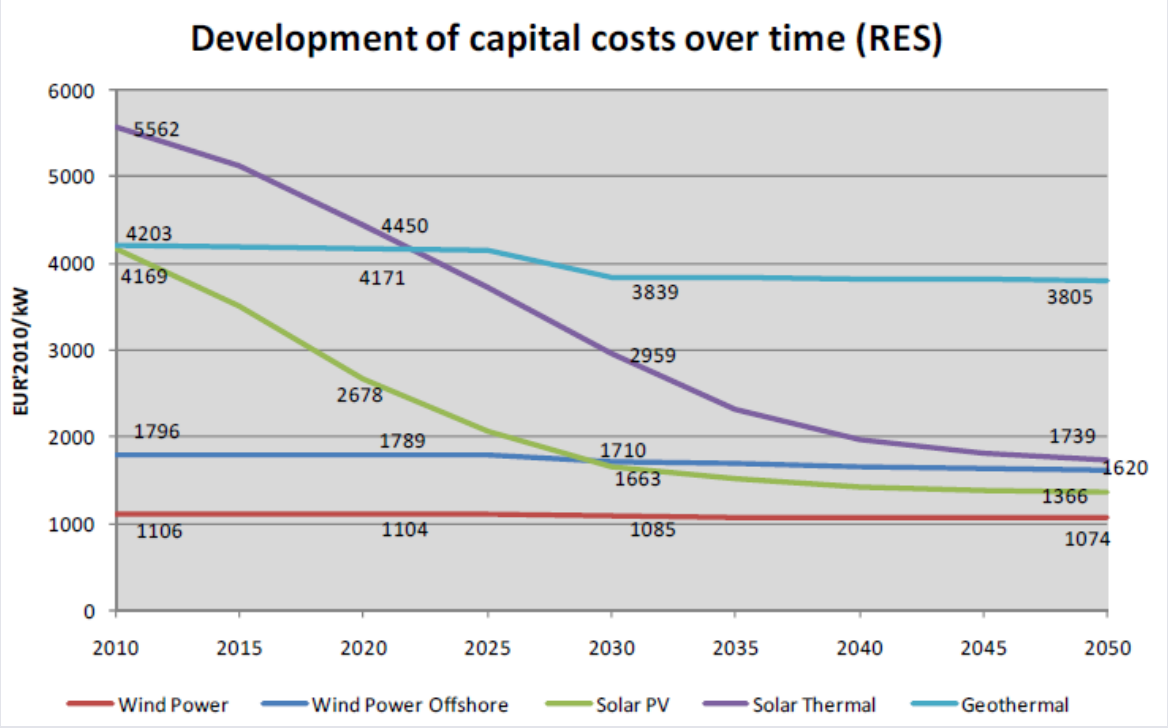
Average annual total energy system costs 2011-2050



European Commission (2011)

Main results decarbonisation scenarios in the EU Energy Roadmap 2050

→ Conservative cost assumptions in the modelling: 2050 cost assumptions for PV where in reality already reached in 2015