Power in Germany: The turning point of 2011
Dauphine Université Paris

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Challenges in Generation –

The new landscape of the German power sector

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Agenda

1 German energy system: targets, status quo and recent developments

2 Current issues

3 Future perspective – different energy scenarios

4 Policy regulations

Germany with ambitious targets and far-reaching legislation as part of the “Energiewende”

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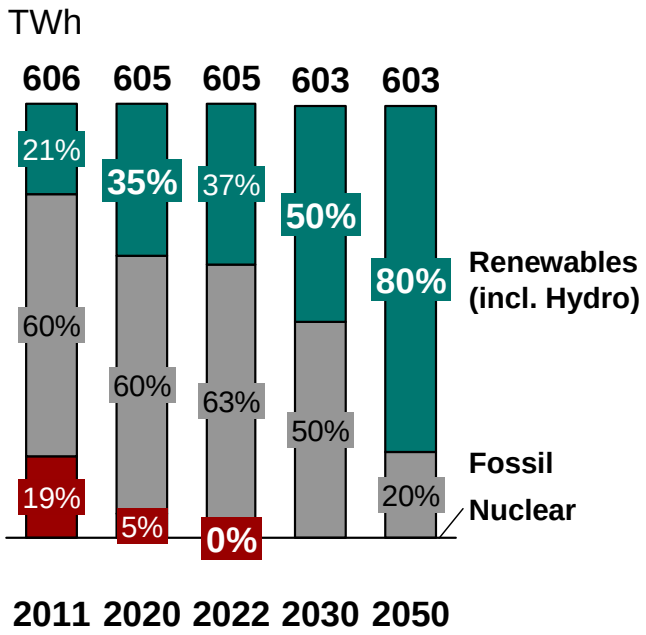
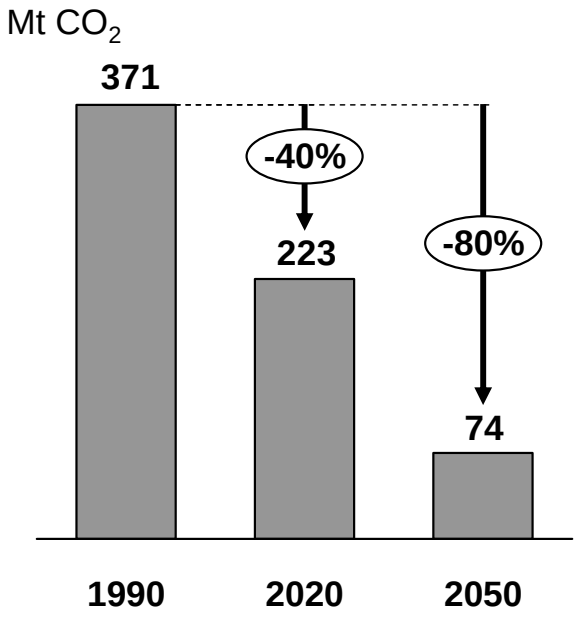
Targets of German “Energiewende”

Power Generation



- Increase **share of RES in power generation** to:
  35% (2020), 50% (2030), **80% (2050)**
- Increase RES share of primary energy cons. to >50% (2050)
- **Nuclear phase-out by 2022**

CO_2 Emissions

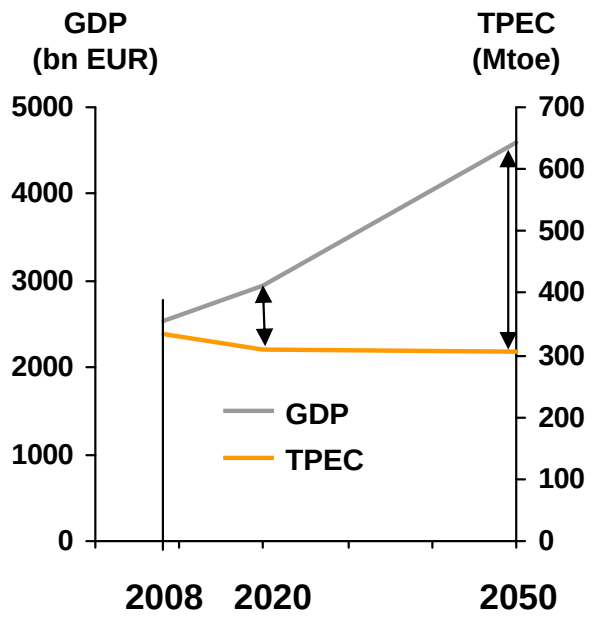


Reduction of **CO_2 emissions** compared to baseline 1990:

-40% by 2020

-80% by 2050

Energy Efficiency



TPEC: Total primary energy consumption

Increase of **energy efficiency** in primary energy use compared to baseline 2008:

20% by 2020

50% by 2050

Today, Germany has a Renewable share of 21% of generated power and 42% of installed capacity

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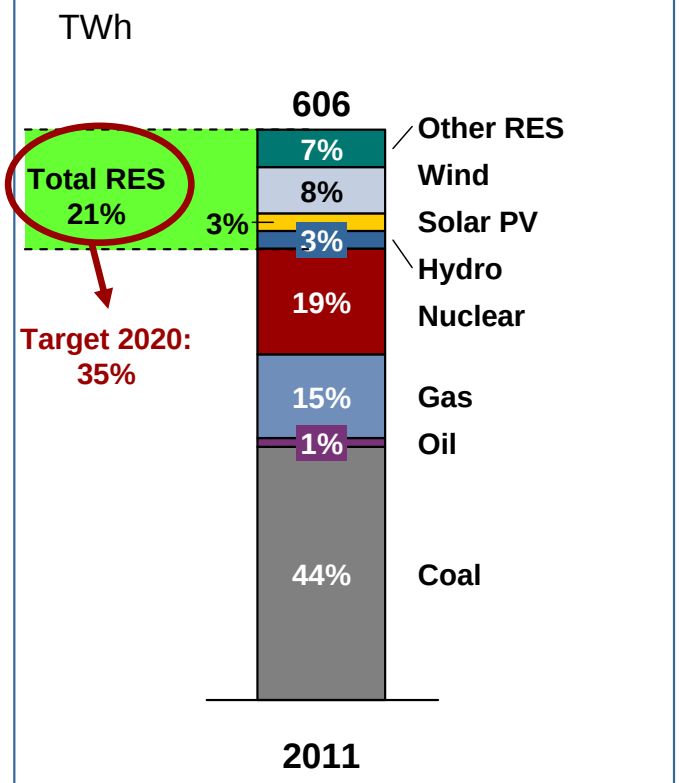
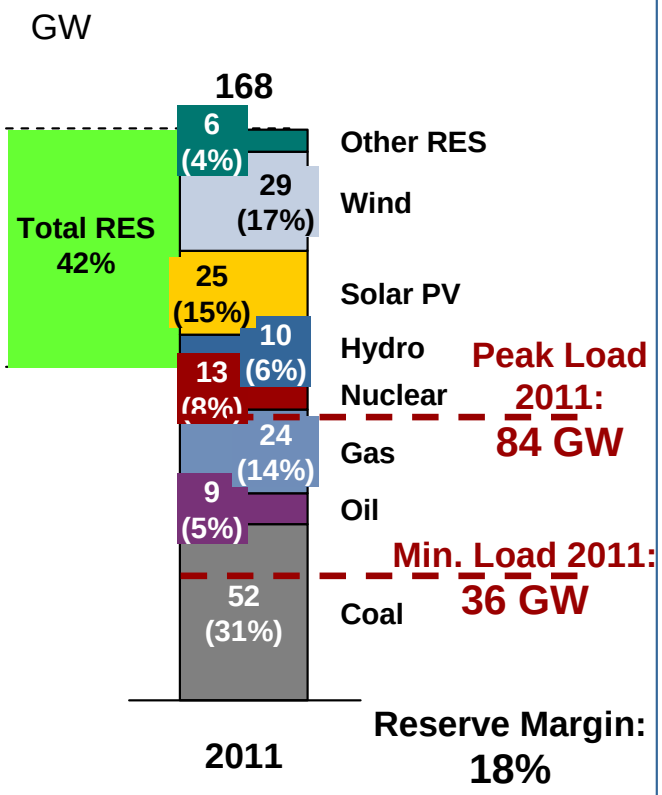
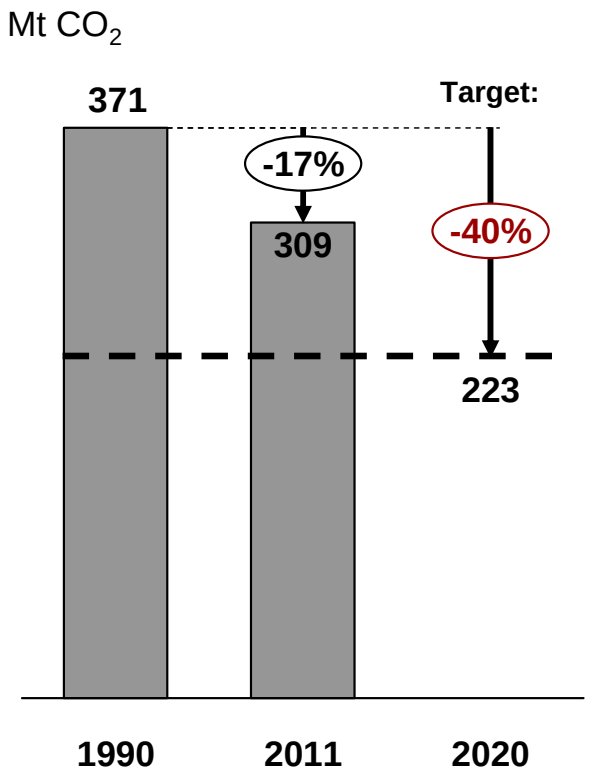
Power Generation 2011



Installed Capacity 2011



CO_2 Emissions



To reach German targets (35% in 2020), RE share to be increased by another 14% within the next 9 years

Further renewable growth potential mainly in Solar PV and Wind; Wind Offshore still in starting phase

-17% reduction during the last 21 years; target of -40% in 2020 challenging (-23% within the next 9 years)

Renewable generation within load range of Germany
→ requires a flexible fossil fleet and adaptive grid

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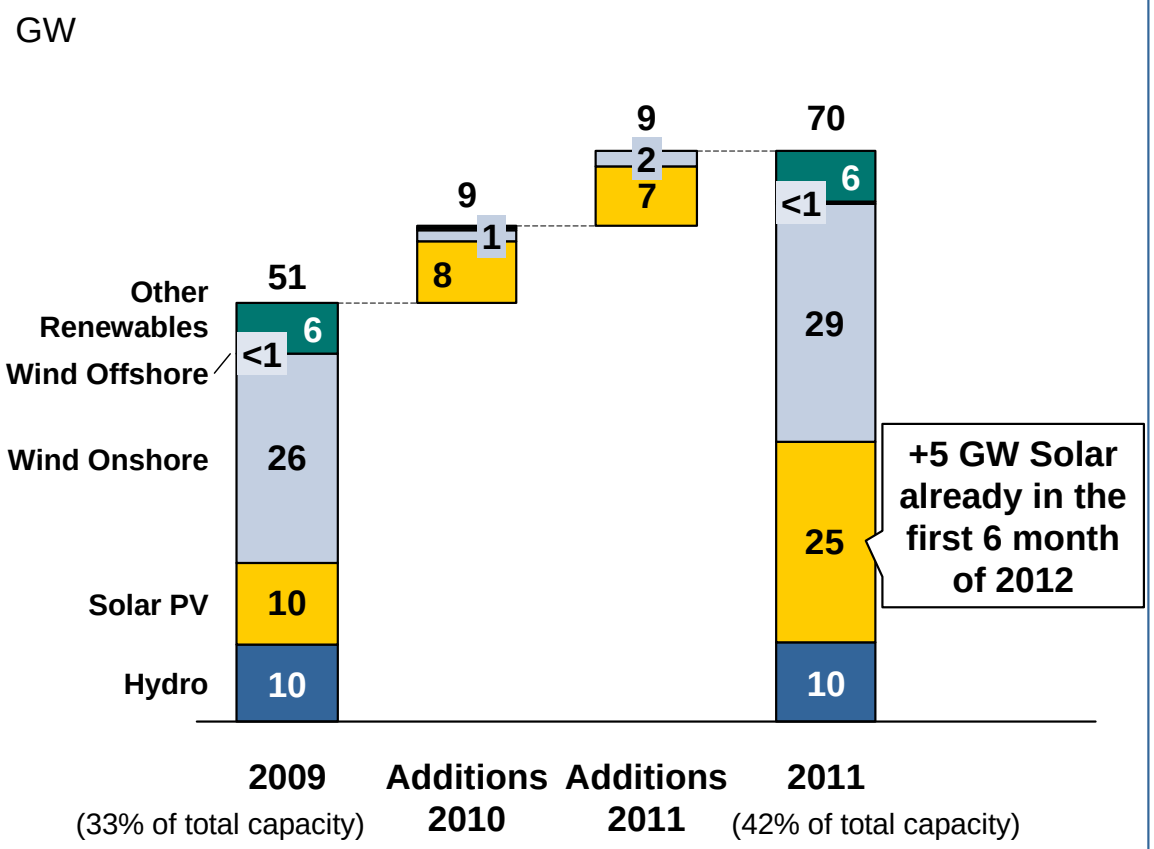
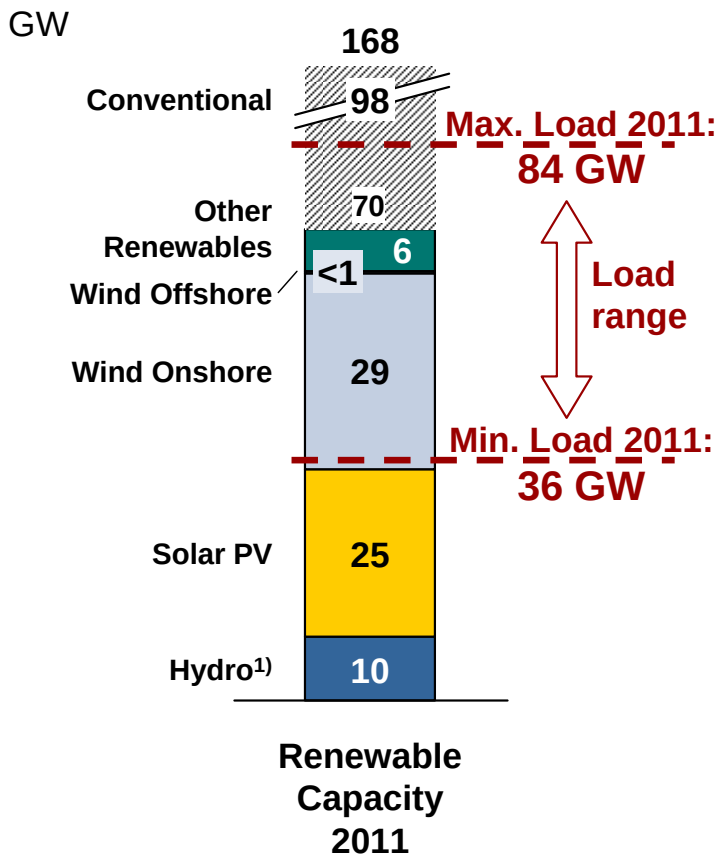
Installed RES Capacity 2009-2011



Installed Capacity vs. Load



Evidence positive, that Renewable boom in Germany continues

➔ Grid must be able to deal with more and more fluctuating renewable generation

➔ Flexible fossil fleet necessary to balance fluctuating renewable generation

1) Hydro including 6 GW of hydro pumped storage

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Grid Capacity, energy storage and flexible fossil fleet is key to integrate more renewables

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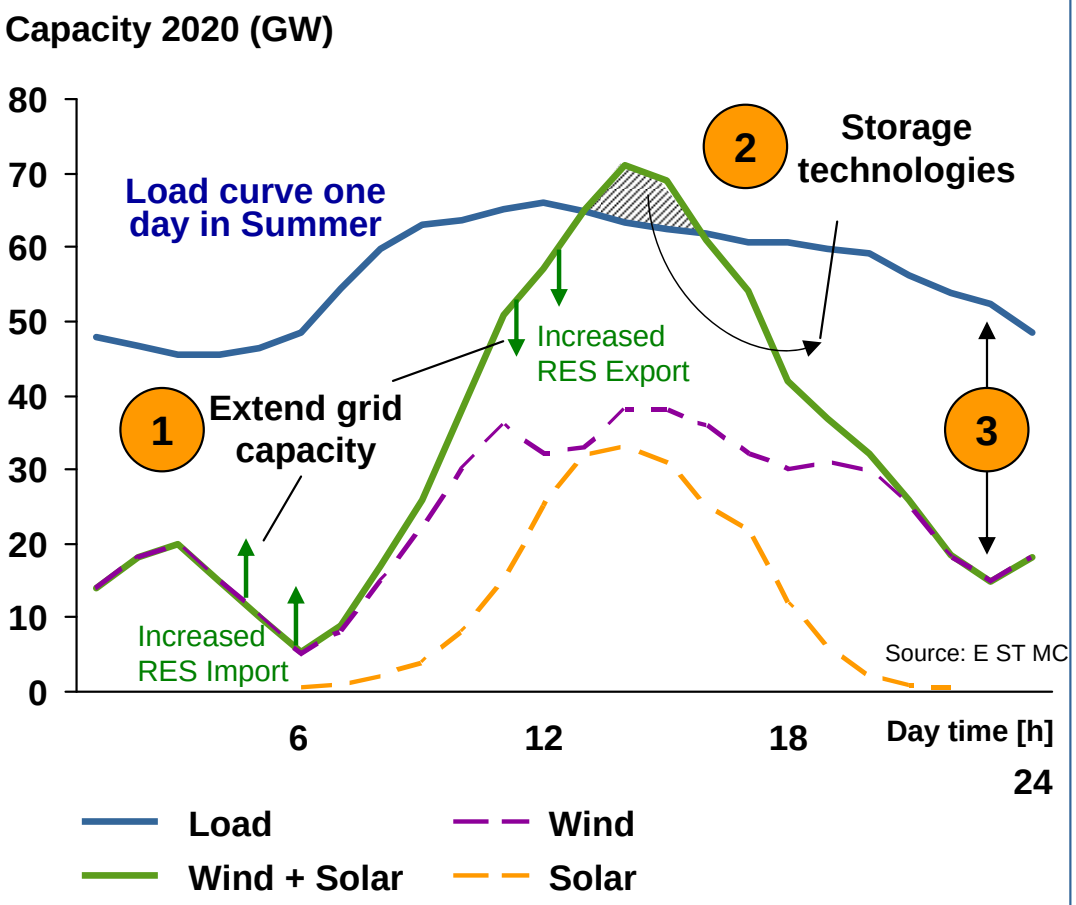
Load curve vs. renewable capacity, Germany 2020



Solutions

Tree levers to integrate more renewables:

1. Extension of **grid capacity** to utilize geographically different potentials of wind and solar generation
2. Increase of the **energy storage** capacity to balance temporary overcapacities of wind and solar generation
3. Transition to more **flexible fossil fleet** with ability to follow the highly fluctuant renewable current entry

1 TSOs‘ grid development plan with major HV-grid extensions and four North-South „highways“

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High-voltage lines (AC):

1,700 kms in new routes

2,800 kms in existing routes

High-voltage lines (DC):

2,100 kms in new routes

Total (AC+DC): 6,600 kms

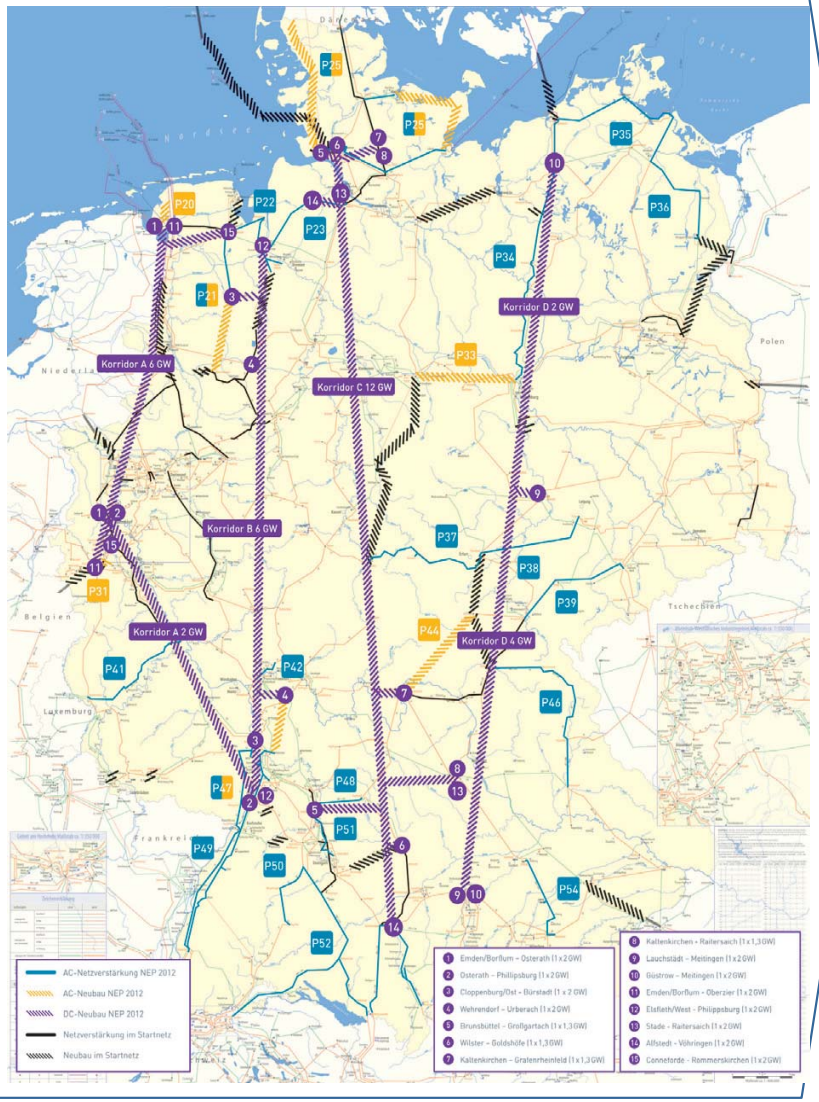
Extension (Aufseilung) of existing lines:

1,300 kms

Expected costs: € 20‘‘

Challenges:

- Potential over-estimation of required extension
- Distributed generation reduces need for HV grids
- Plan is mainly driven by new on-/off-shore wind in northern Germany and high load factor for coal
- Implementation:
  Lacking coordination between federation and states
  Slow and tedious permitting processes



Key Questions:

- **Who will finance the grid development?**
- **How will general public resistance affect the grid development plan?**

Source: Netzentwicklungsplan

2 On the long run, storage technologies will be required to fully decarbonize the European Power Sector

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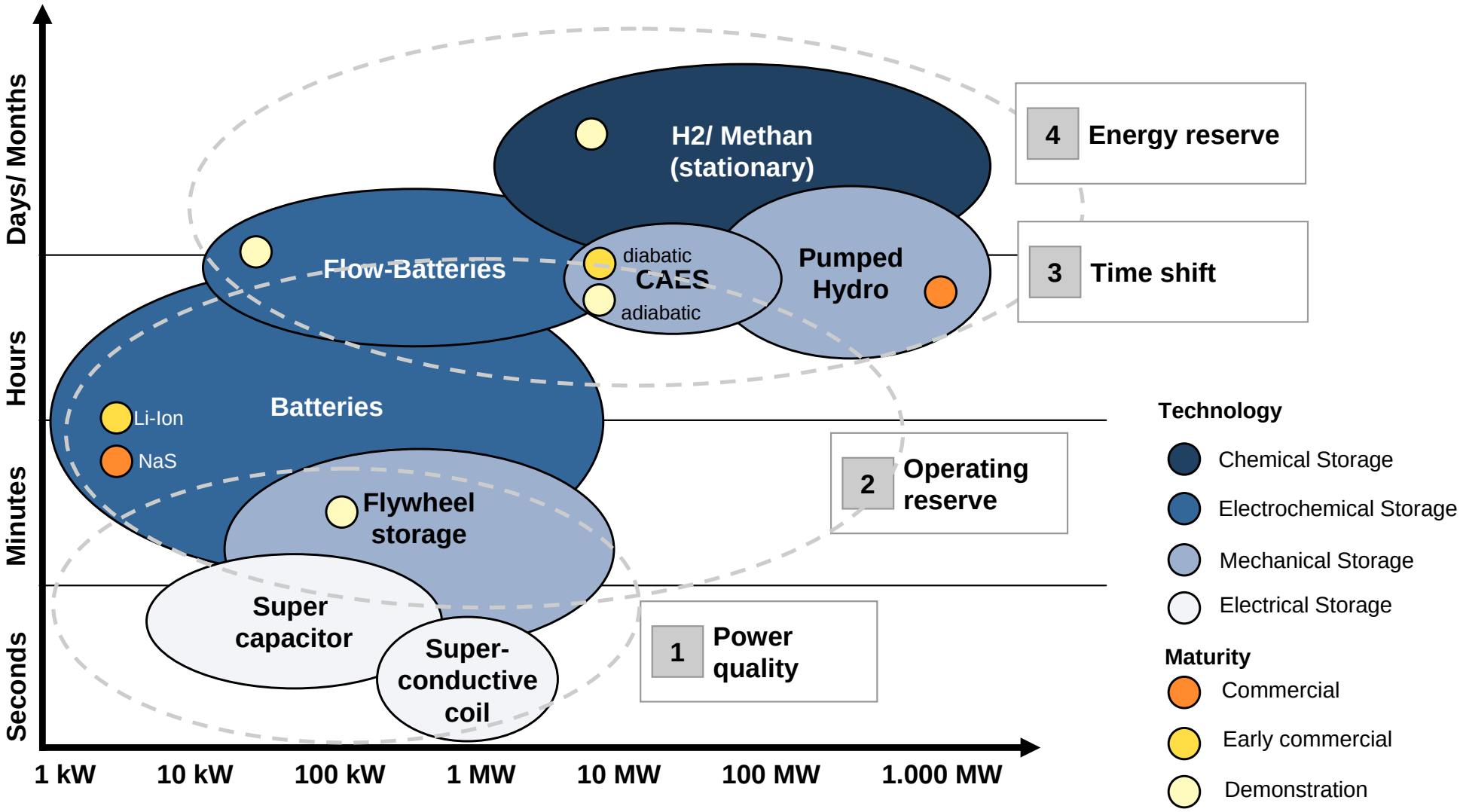

Source: Study of DNK/WEC "Energie für Deutschland 2011", Bloomberg – Energy Storage technologies Q2 2011

CAES – Compressed Air Energy Storage

3 Before Energy Storage becomes reality: 12-17 GW of dispatchable capacity required by 2022

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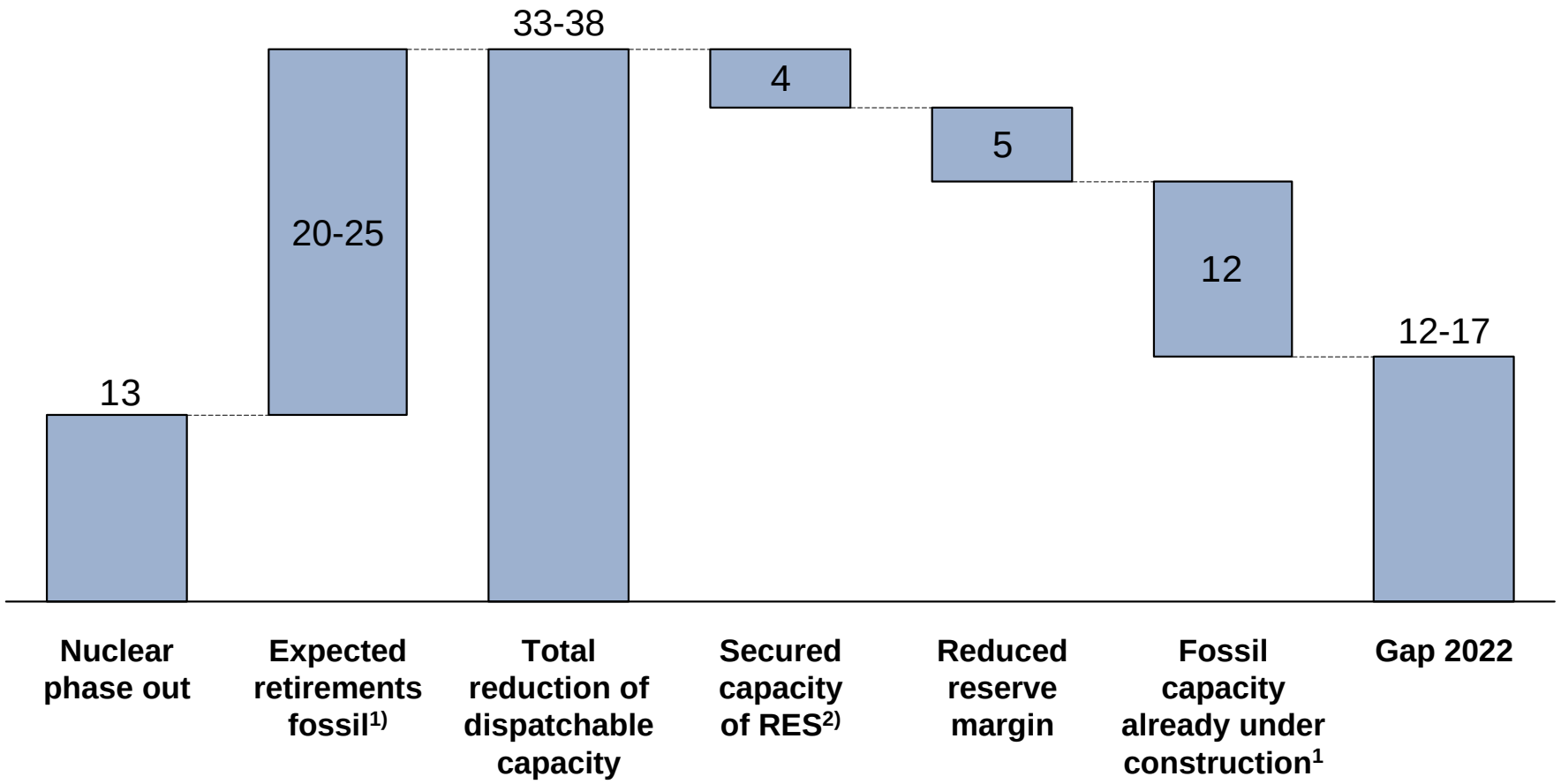
Dispatchable capacity to be replaced in Germany 2011-2022



1) Mainly coal power plants 2) Secured capacity from New Build only

Source: Siemens calculations

3 Backbone gas: World record in efficiency with flexible SGT5-8000H series

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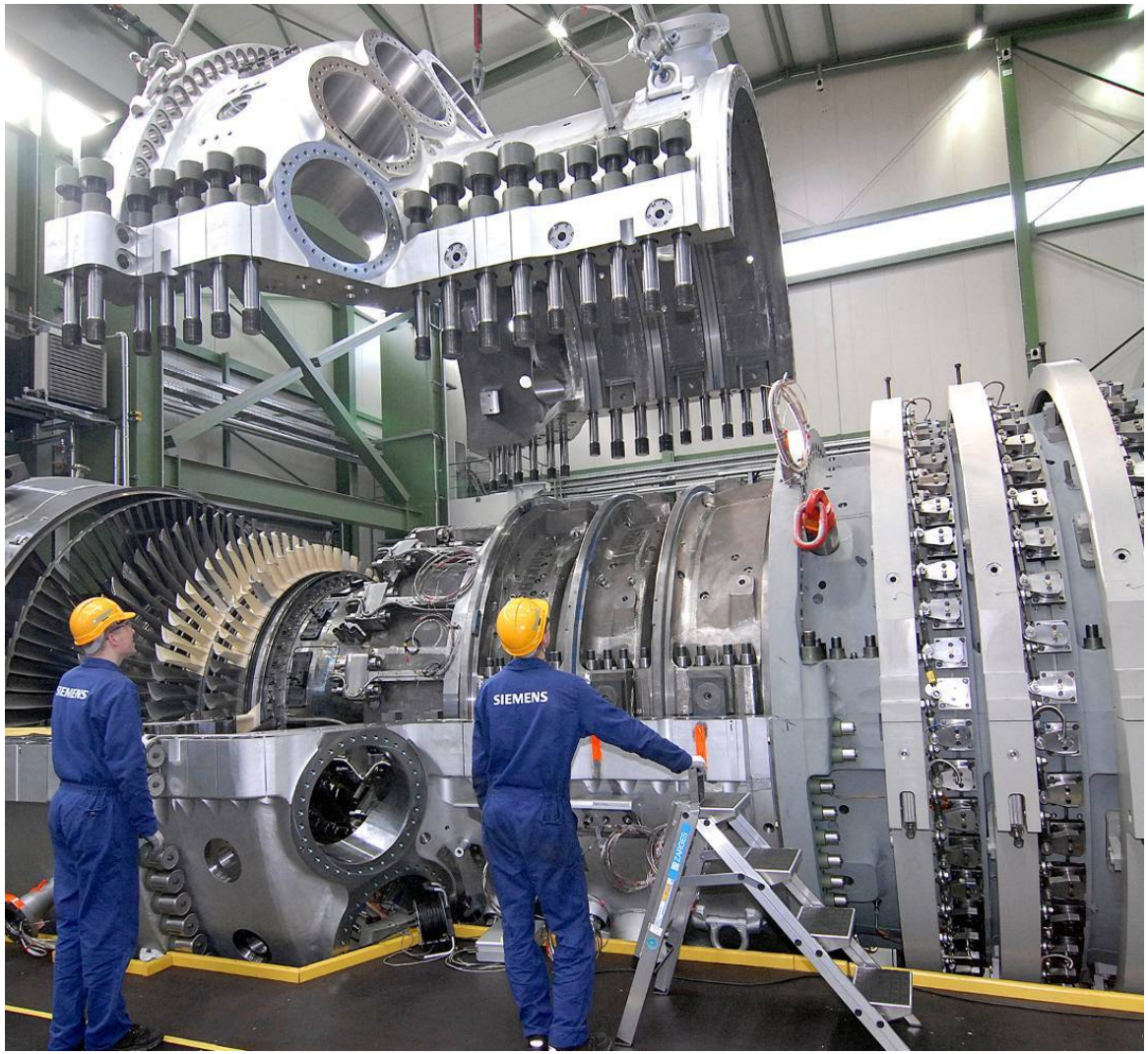

- 60,75% efficiency in combined cycle power plant
- 375 MW* output in simple cycle power plant (50Hz)
- > 570 MW* output in combined cycle power plant (50Hz)
- Reduced emissions – 43.000 t CO2 savings per year compared to state-of-the-art-technology
- Fast start-up capability and operational flexibility also in part-load operation

* ISO conditions

3 Increase of renewables increasingly pushes gas power plants out of the merit order

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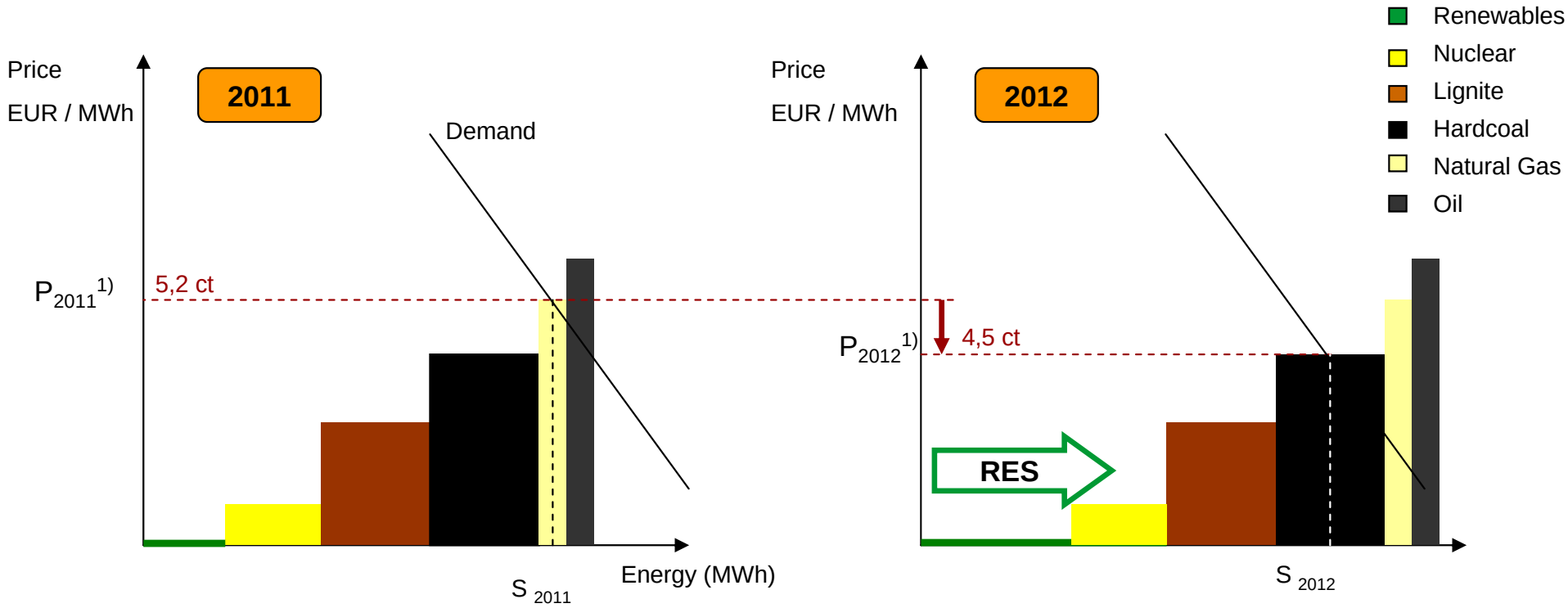
Merit order curve and impact of increasing share of renewables



- Pricing in liberalized power markets according to marginal costs (mainly fuel costs), leading to „**merit order“ curve**
- Increasing share of RE and privileged feed-in reduces load hours of conventional fleet: Power prices drop (zero marginal costs of renewables), **no market signals for new investments**

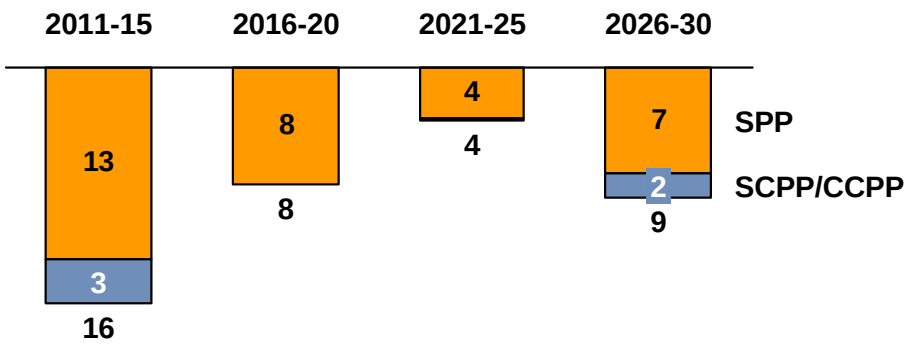
1) Base Load price Q1 2011 vs. Q1 2012 from EEX

3 Solution for future deficit in power generation capacity: Deactivation of power plants rather than retiring; BUT: CO_2 targets will be missed

Germany: Fossil retirement[1)] simulation

GW

Source: Market model E ST MC



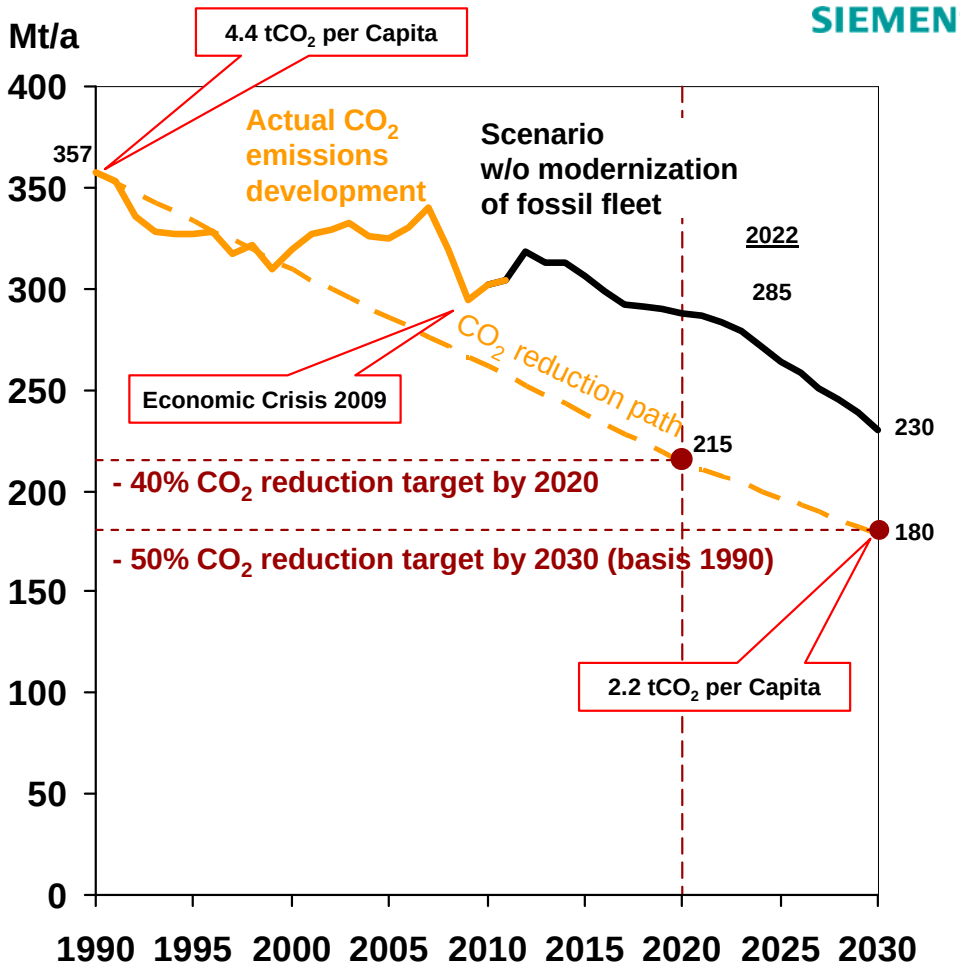
Retirements

Deconstruction and Replacement

Deactivation and Cold Reserve

~37 GW to be retired according to age structure
→ this could become a huge cold reserve!

CO_2-Emission development 1990-2030



1) Large power plants only (SPP >250 MW; SCPP, CCPP >60 MW)

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Energy transition in Germany – Three scenarios for capacity development

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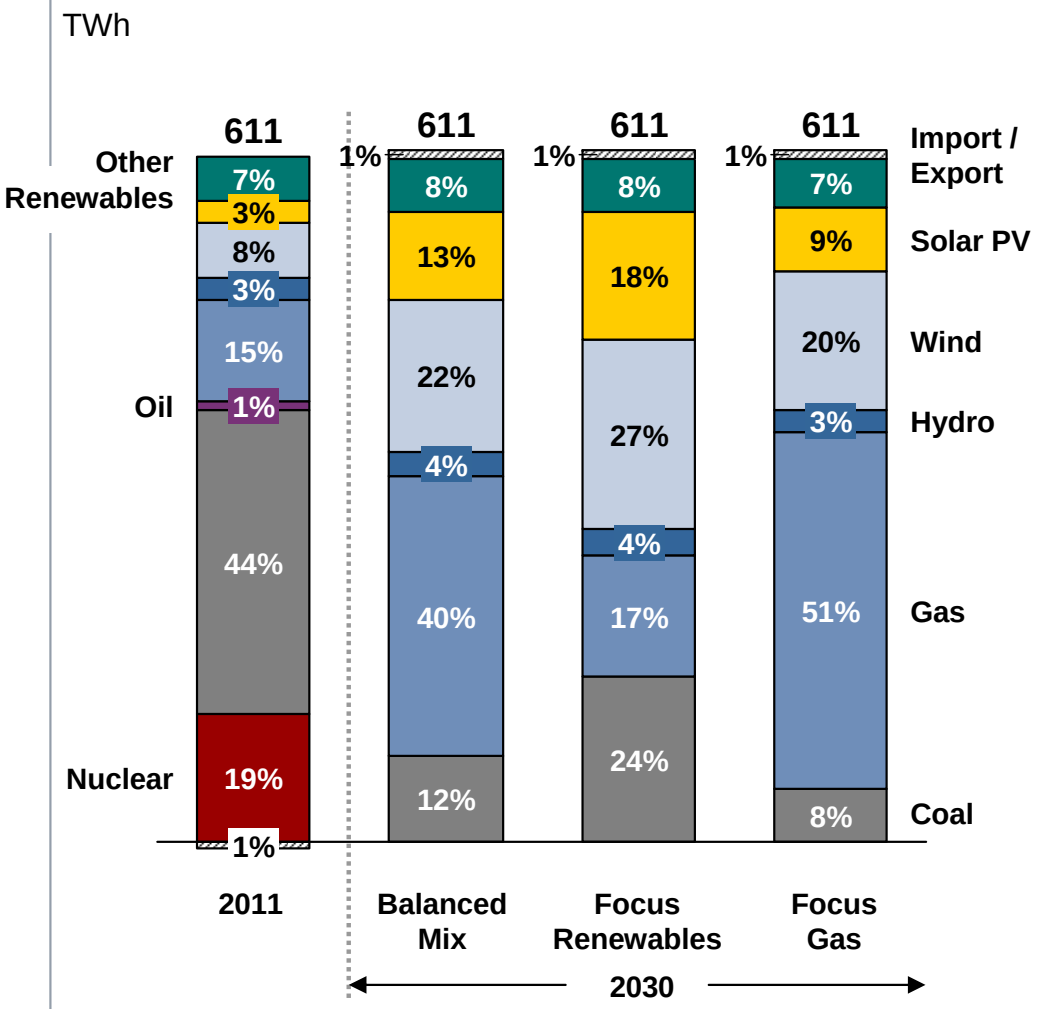
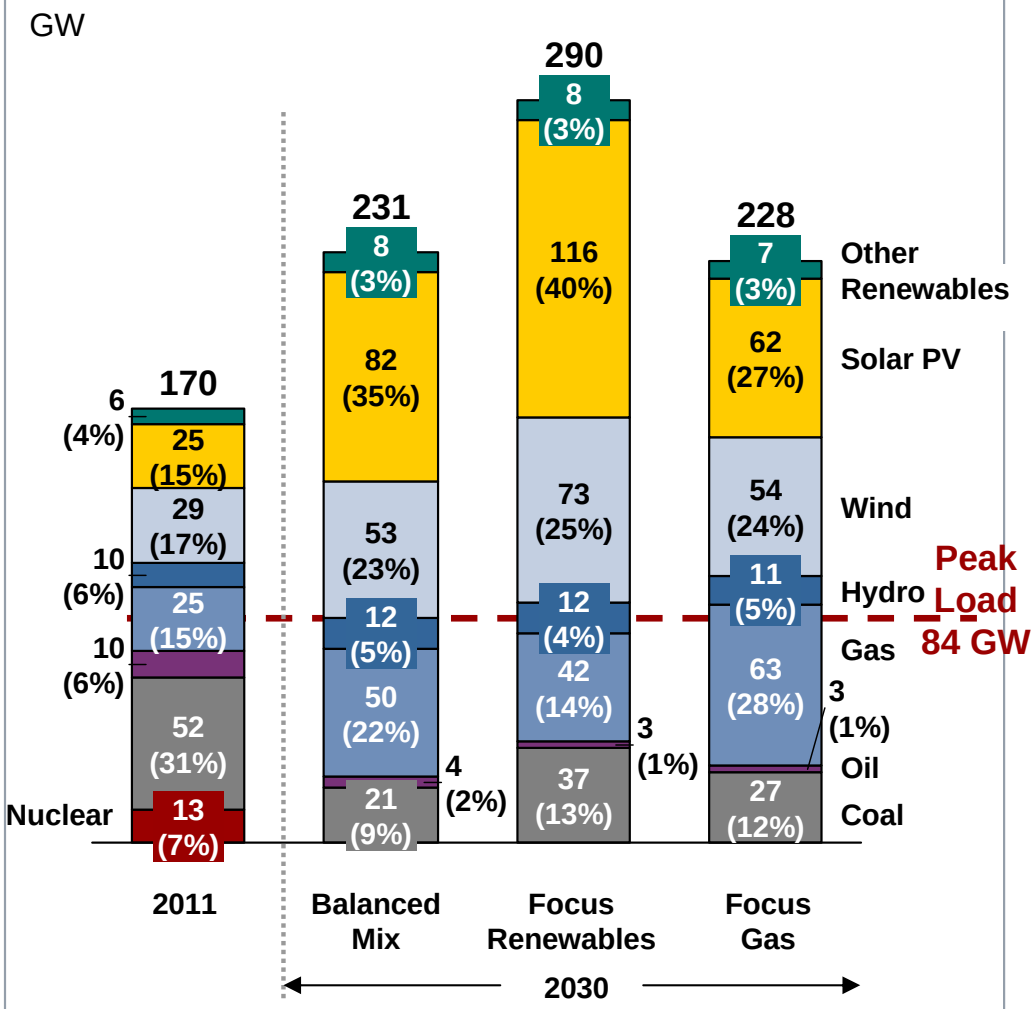
Energy Consumption



Installed Capacity



Source: Siemens

Three scenarios – comparable CO_2-reduction but different costs

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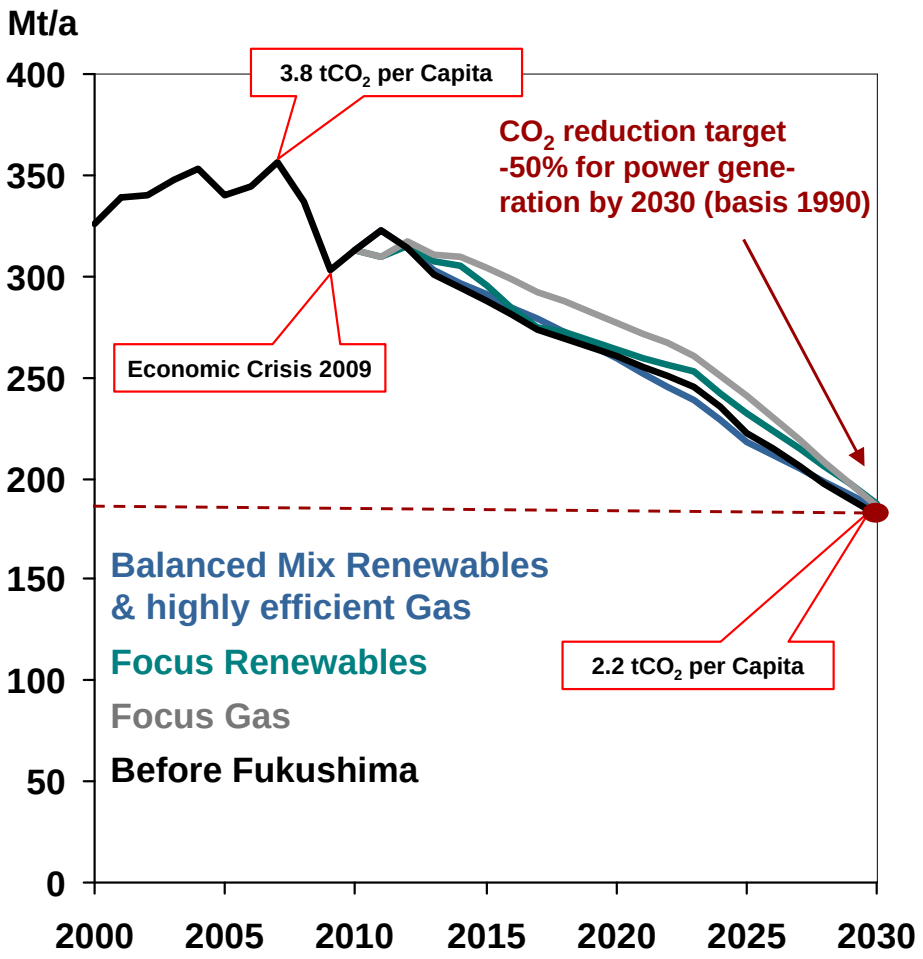
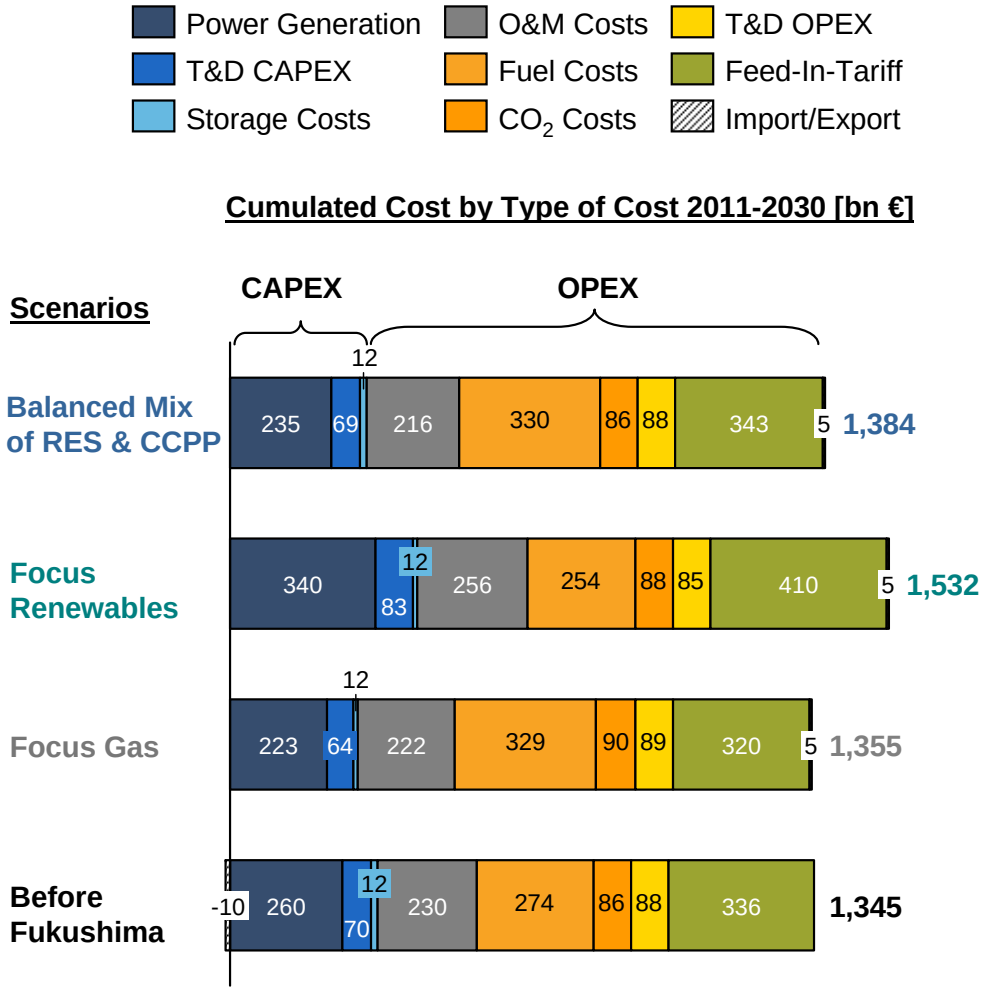
3 scenarios to reach CO_2 target in 2030



Cumulated Costs



Source: Siemens

Electricity prices 2000-2012 mainly driven by fuel price increase – from 2012 onwards driven by transition of energy system.

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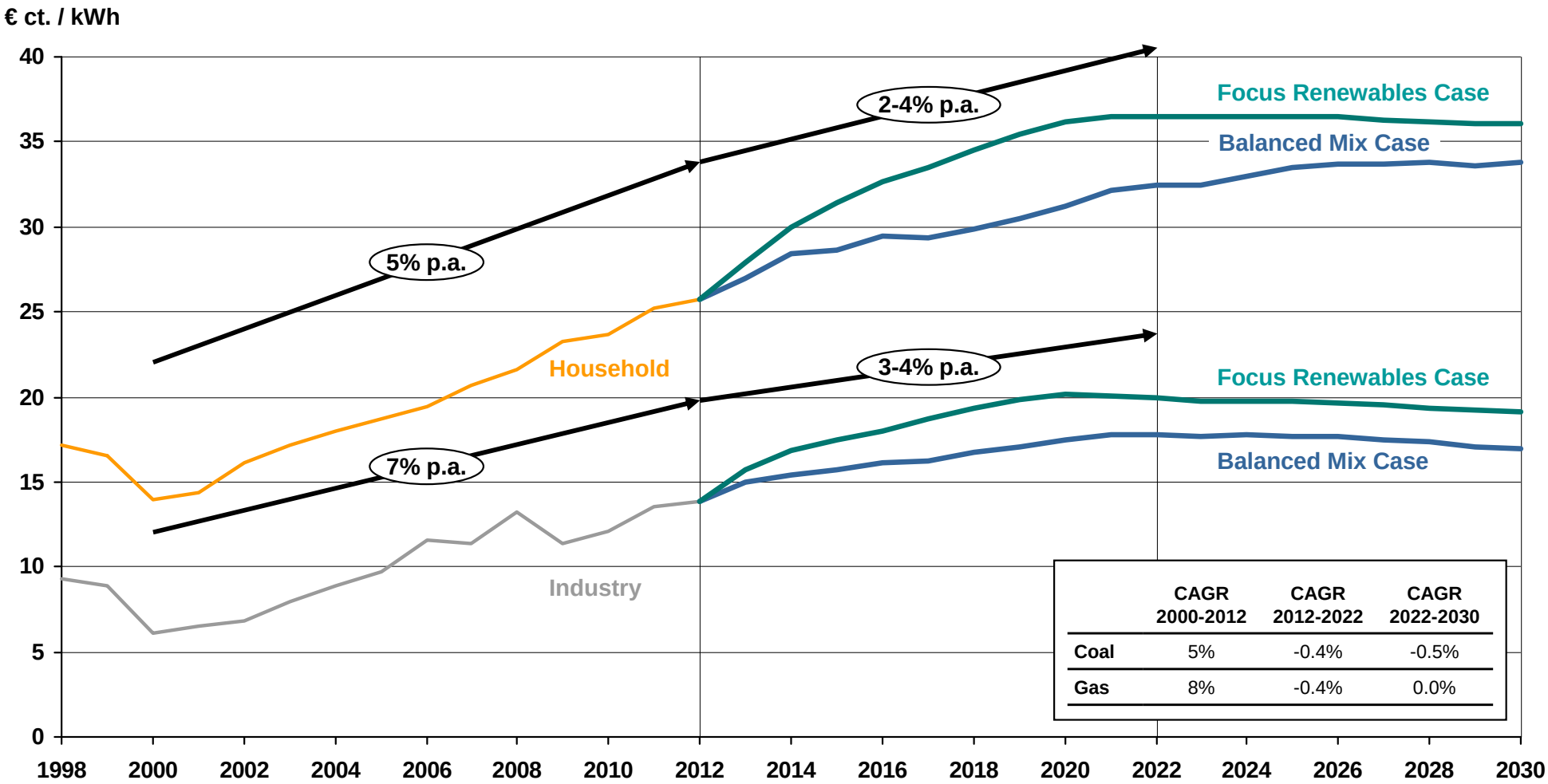
Development of electricity prices in Germany, 2000-2030



	CAGR 2000-2012	CAGR 2012-2022	CAGR 2022-2030
Coal	5%	-0.4%	-0.5%
Gas	8%	-0.4%	0.0%

Source: Siemens AG, own calculations
Historical data BDEW (As of: May 4, 2012)

Electricity Bill Household (per year)
(Focus Renewables Case)

2011 **925 €** → **+400 € (+43%)** → **1,325 €** 2022

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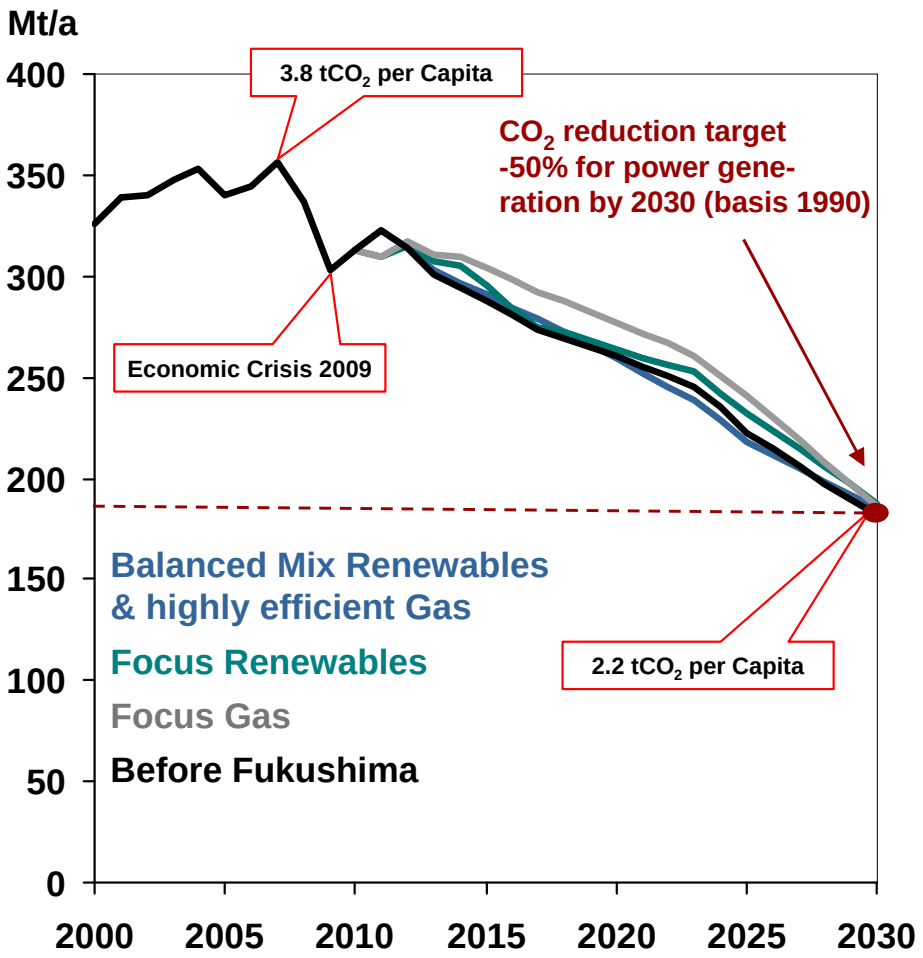
Policy framework should address three major topics

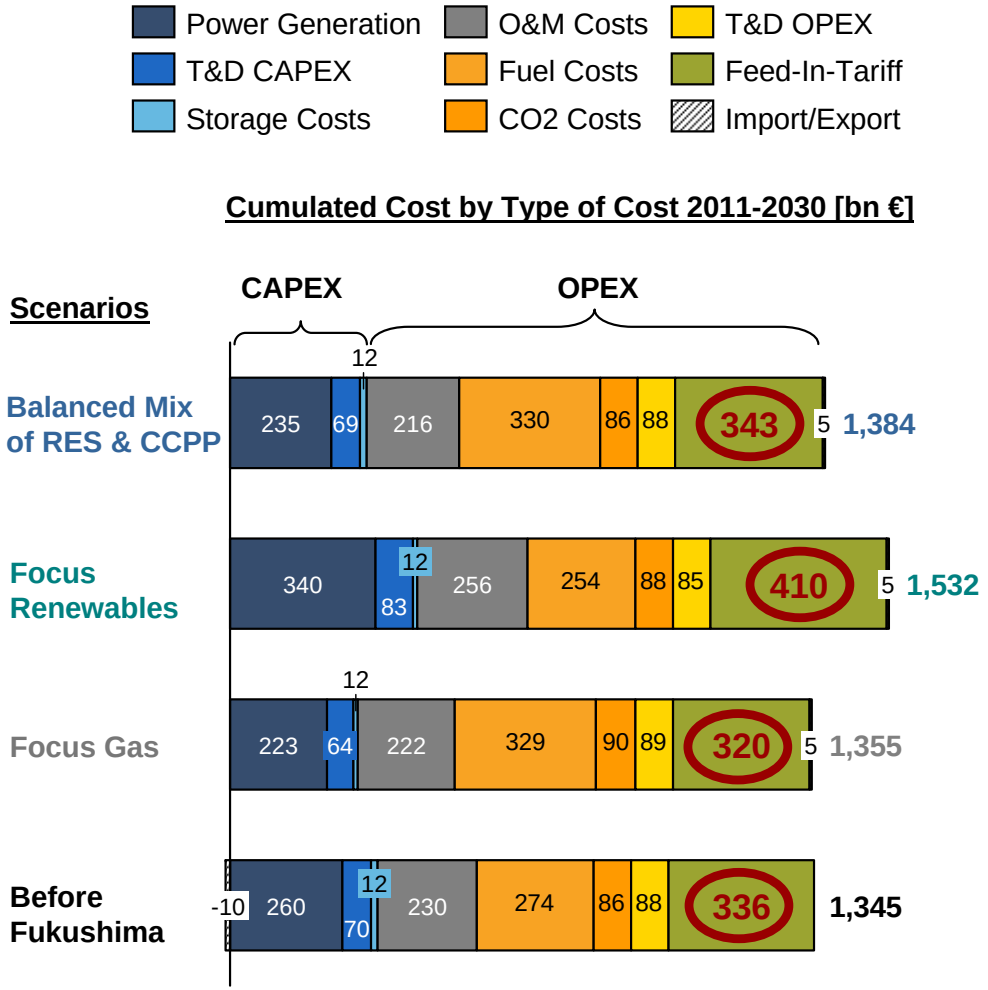
1. **Feed-In-Tariffs**
2. **CO_2 certificate pricing**
3. **Capacity Markets**

Feed-In Tariffs are a major part of the total costs for all scenarios

3 scenarios to reach CO_2 target in 2030



Cumulated Costs



Source: Siemens

Only with a CO_2 price > € ~30, replacement of inefficient old coal-fired plants with gas-fired CCPPs will be triggered

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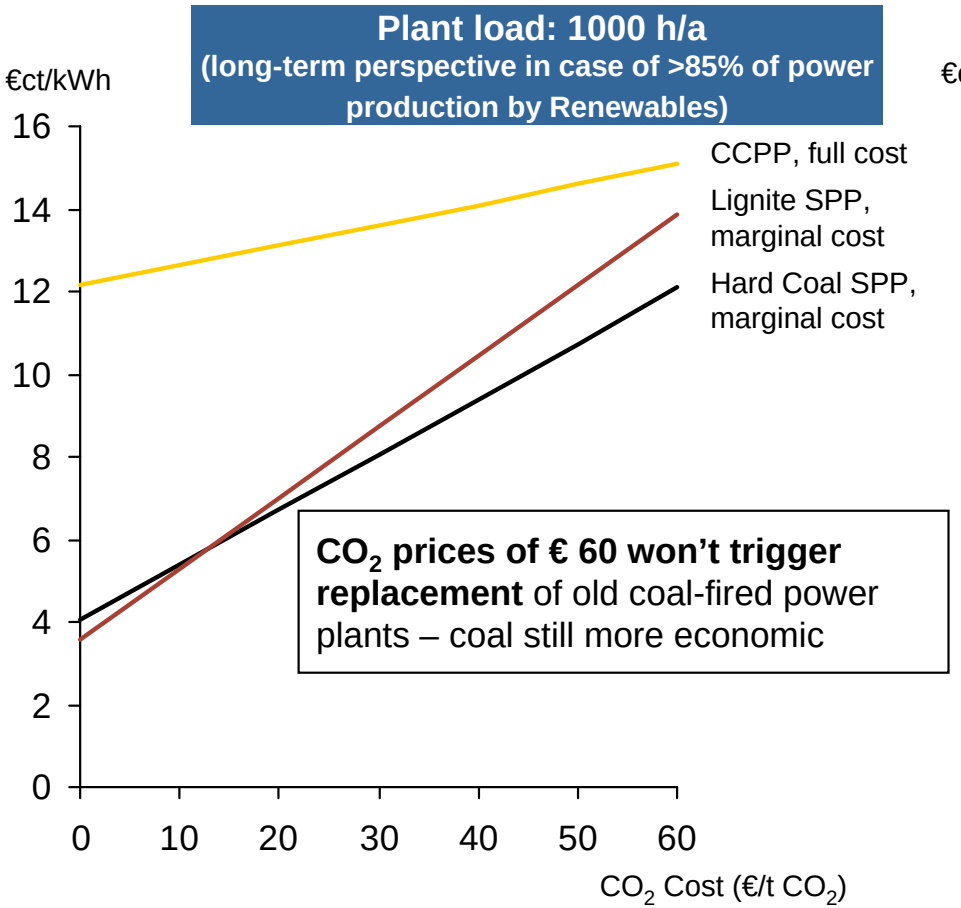
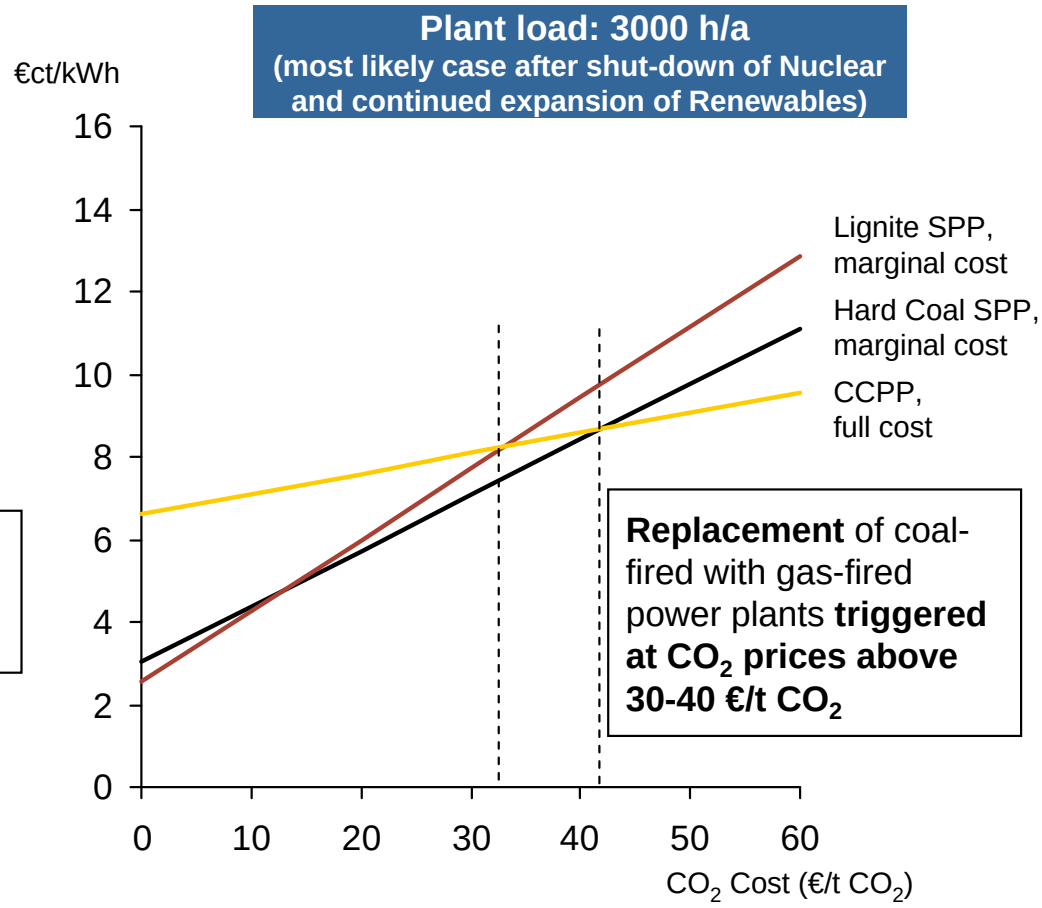
2 CO_2 certificate pricing

Cost of electricity (in €ct/kWh)





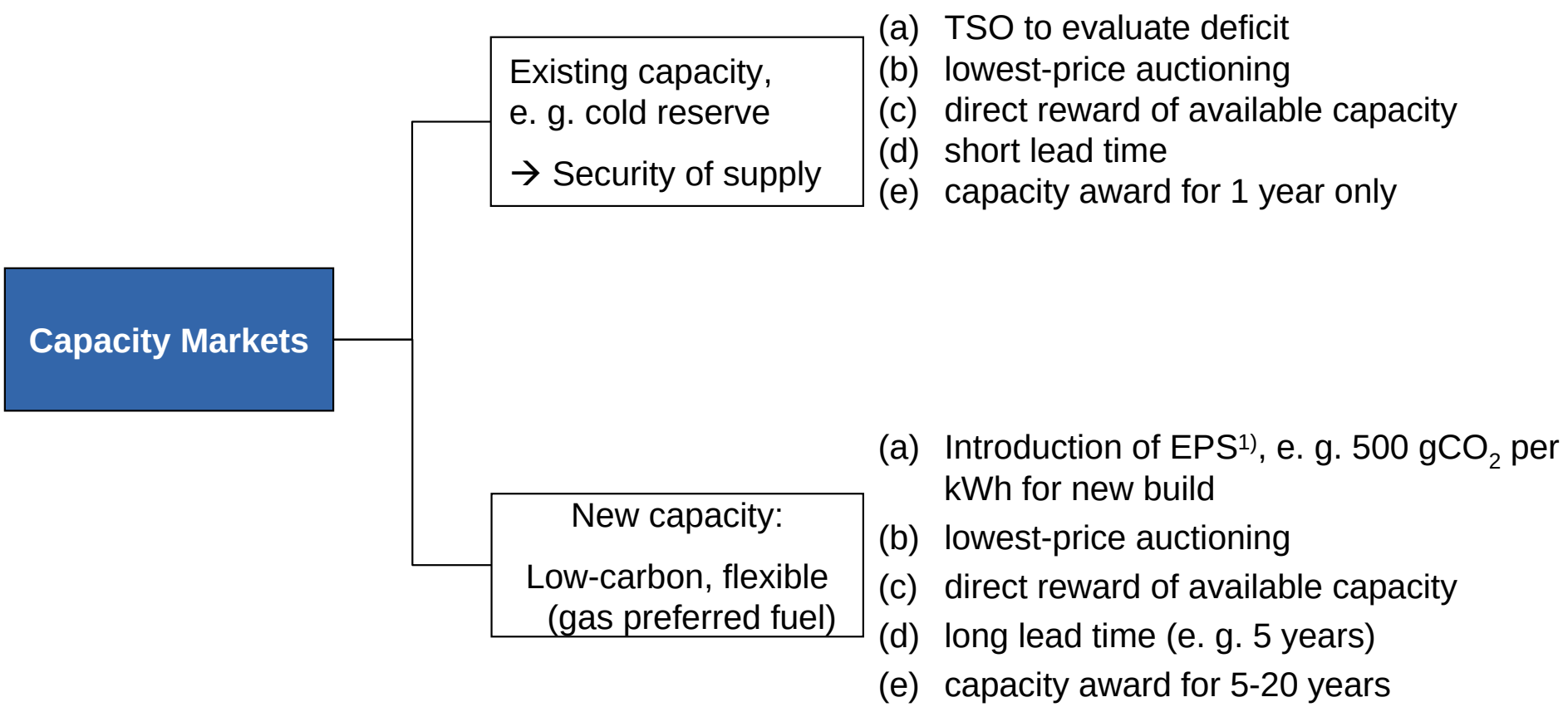
CCPP: full cost scope (incl. CAPEX for new build)

SPP: marginal cost scope w/o capital cost (existing, fully depreciated plants)

Source: E ST

Capacity markets may help to shift the energy system towards low-carbon infrastructure

Capacity Markets



1) Environmental Performance Standard

Source: Siemens

A “European Energy Framework” is required to support further growth of renewables

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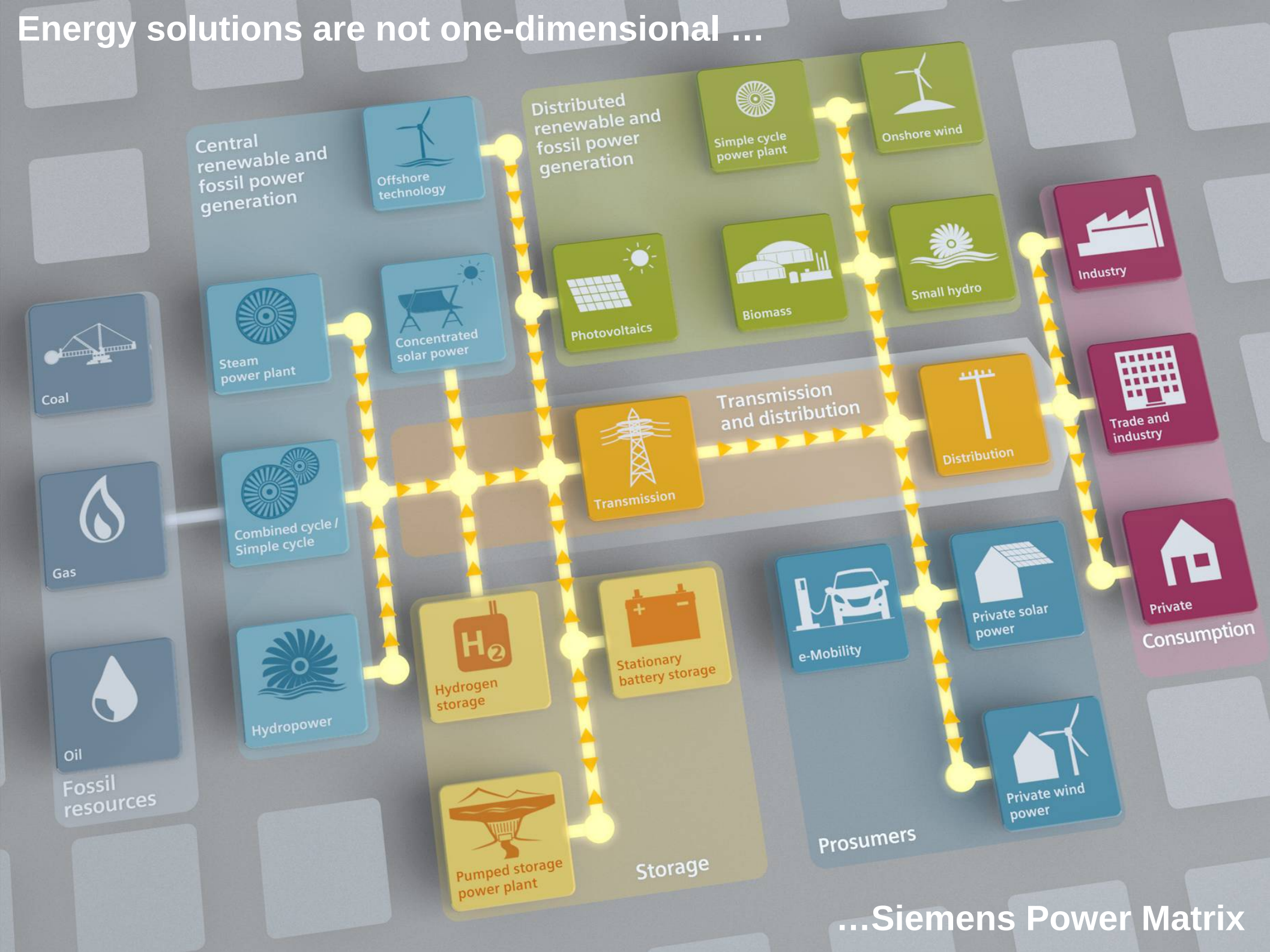
Proposed content of a “European Energy Framework”

- European **renewable targets for 2030** (similar to 2020, e. g. 30%)
- **Emission Trading System (ETS)** as core element of a **market-driven RES growths**
- **Harmonized market integration mechanisms** which allow **real competition between renewables and fossil energy** sources (rather than unified subsidy schemes)
- **European grid expansion** to improve electricity flow between member states (European Supergrid)
- Europe-wide **rules for grid integration of renewables**, i. e. grid access, standardization of grid code etc.
- **Innovation program** (e.g. SET plan) to further develop renewable technologies (efficiency, cost reduction, improved compatibility with dispatchable power):
  →Reach **market maturity of technologies** such as ocean power.
  →R&D program and **large-scale pilots for Energy Storage technology**

Energy solutions are not one-dimensional …



…Siemens Power Matrix