The role of technologies and structural changes in the energy system of the EU 27 to achieve the long term greenhouse gas reduction target of 80 %

Markus Blesl

Institute of Energy Economics and the Rational Use of Energy
University of Stuttgart

16. March 2012, Sophia Antipolis, France

Outline

- Electricity Generation Cost of the future
- Energy Policy in Germany

- Model description
- Scenario Definition

- Focus: CO_2 Emissions
- Focus: Primary energy
- Focus: Electricity generation
- Focus: Renewables
- Focus: Cost

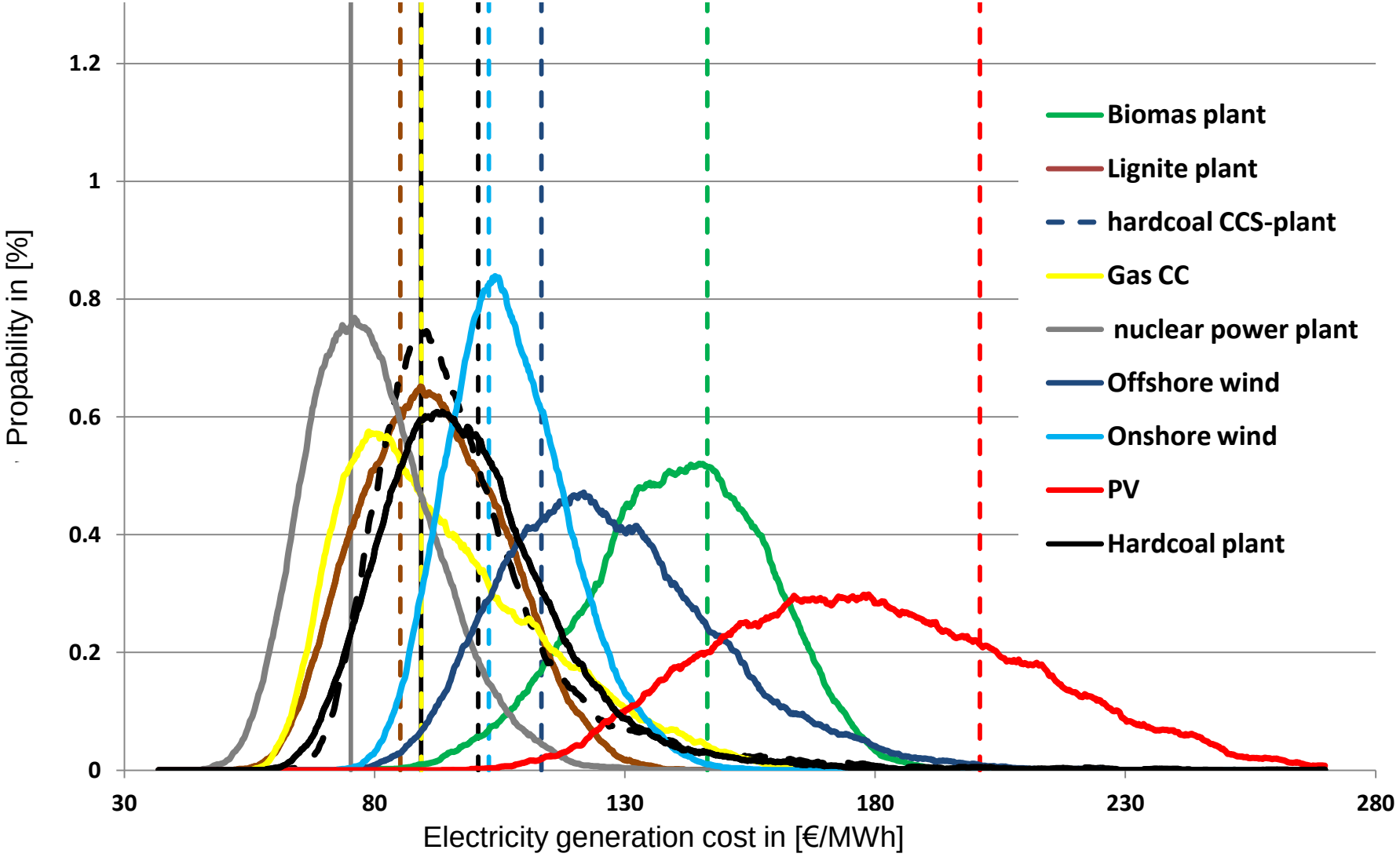
Assumptions for future electricity generation technologies

	Unit	Coal	Coal CCS	lignite	Gas CC	EPR
Net Capacity	[MW_{el}]	800	740	1050	800	1600
Elec. Efficiency	[%]	50	38	47	60	36
	range[1)]	45 – 54	34 – 44	44 – 52	54 – 63	33 - 38
Spec. Investment cost	[€/kW_{el}]	1500	2400	1500	700	3000
	range[1)]	1250 – 1800	1750 – 2450	1350 – 1850	680 – 900	2400 - 3800
Operation time	[%/a]	68,5	68,5	68,5	68,5	68,5
	range[2)]	50 – 86	50 – 86	50 – 92	50 – 86	50 – 93
Technical lifetime	[Jahre]	40	40	40	30	40
	range[3)]	20 – 50	20 – 50	20 – 50	20 – 40	30 - 60
Building time	[Jahre]	4,0	4,0	4,5	3,0	6,0
	range[4),1)]	2,0 – 8,0[4)]	3,5 – 8,0[4)]	3,5 – 8,0[4)]	1,5 – 6,0[4)]	4,0 – 12,0[1)]
Spec. demolitation cost	[%-Inv.]	5,0				15,0
	range[1)]	-	-	-	-	10,0 – 50,0
Operation and maintainance						
- fix	[€/kW_{el}/a]	35,0	65,0	39,0	19,0	55,0
- variable	[€/MWh_{el}]	4,0	5,0	4,4	2,0	0,5
Distribution	[1)] BetaPERT, [2)] triangle, [3)] Minimum-Extrem, [4)] Normal					

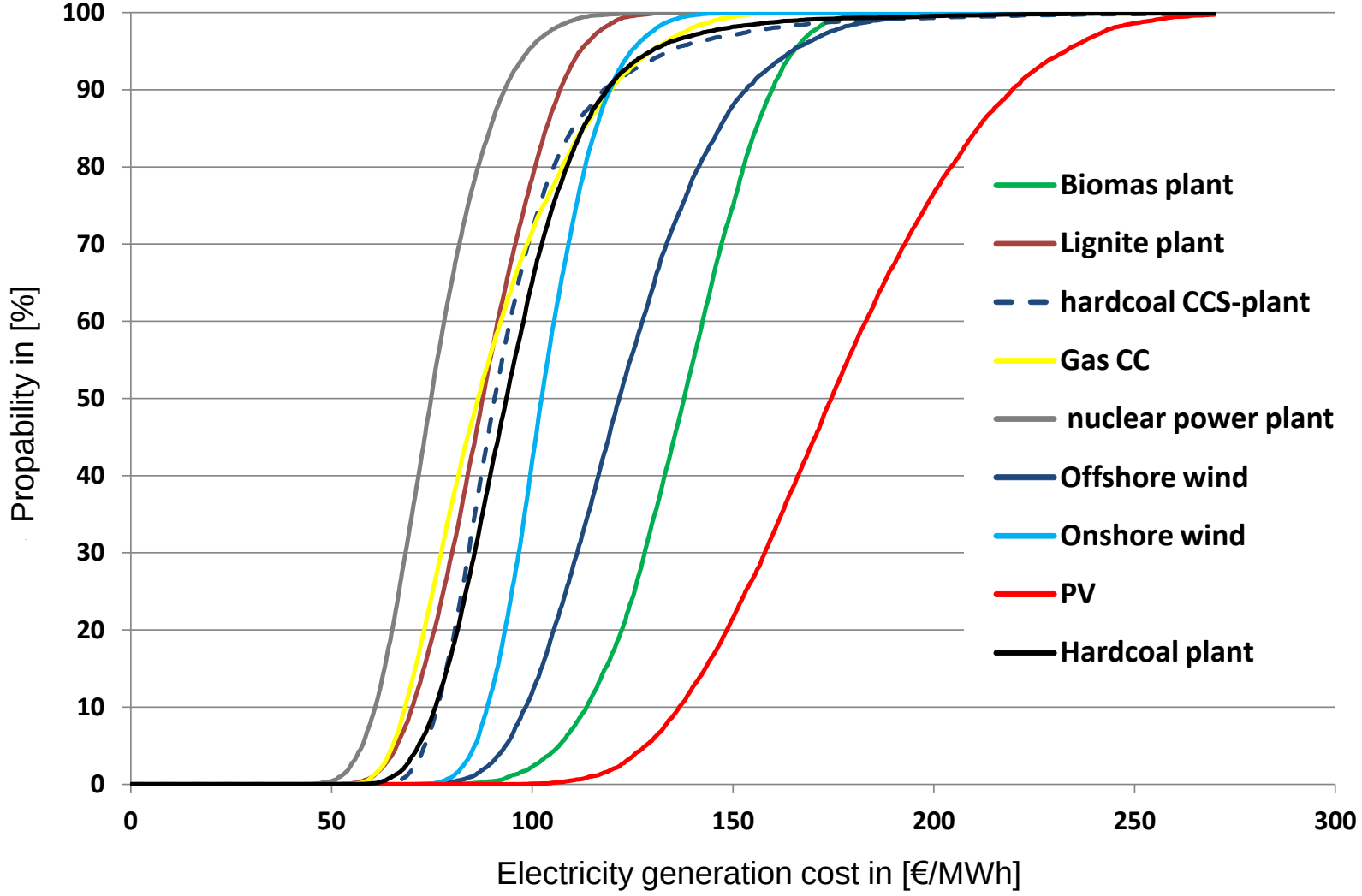
Assumptions for future electricity generation technologies (II)

	Unit	Biomas	Onshore	Offshore	PV
Net Capacity	[MW_{el}]	20	3	5 x 40	>1
Elec. Efficiency	[%]	31	-	-	-
	range[1)]	26 – 40	-	-	-
Spec. Investment cost	[€/kW_{el}]	2850	1050	2050	1450
	range[1)]	2100 – 3350	950 – 1300	1100 – 3500	1000 – 2000
Operation time	[%/a]	68,5	21,1	41,0	10,6
	range[2)]	50,0 – 86,0	15,5 – 27,0	25,1 – 47,9	9,1 – 18,3
Technical lifetime	[Jahre]	30	20	20	25
	range[3)]	20 – 40	12 – 30	12 – 30	15 – 30
Building time	[Jahre]	1,5	0,5	1,0	0,5
	range[4),1)]	0,7 – 3,0	0,2 – 1,0	0,5 – 2	0,2 – 1,0
Capacity credit	[%][4)]	-	8,0	8,0	2,0
Operation and maintainance					
- fix	[€/kW_{el}/a]	152,0	50,0	120,0	33,0
- variable	[€/MWh_{el}]	2,8	-	-	-
Distribution	[1)] BetaPERT, [2)] triangle, [3)] Minimum-Extrem, [4)] Normal				

Electricity generation costs



Cumulativ propability of electricity generation costs



German energy policy

- 2002: Phase out of nuclear till 2023
- 2010: Energy concept
  i. Prolongation of the life time of nuclear power operation to 44 years
  ii. Share of renewable energies of gross electricity consumption of 35% in 2020 and 80 % in 2050
  iii. Greenhousgas reduction target for Germany 40 % in 2020 and 80 % in 2050
  iv. Minimum share of biofuels in transport
  v. Minimum use of electromobility (1 Mio. Cars in 2020, more then 5 Mio. Cars in 2030)
- 2011: Energy change
  i. Phase out till 2022, immediately shout down 9 old nuclear power plants
  ii. Higher share of renewable electricity generation in 2020 (40%)

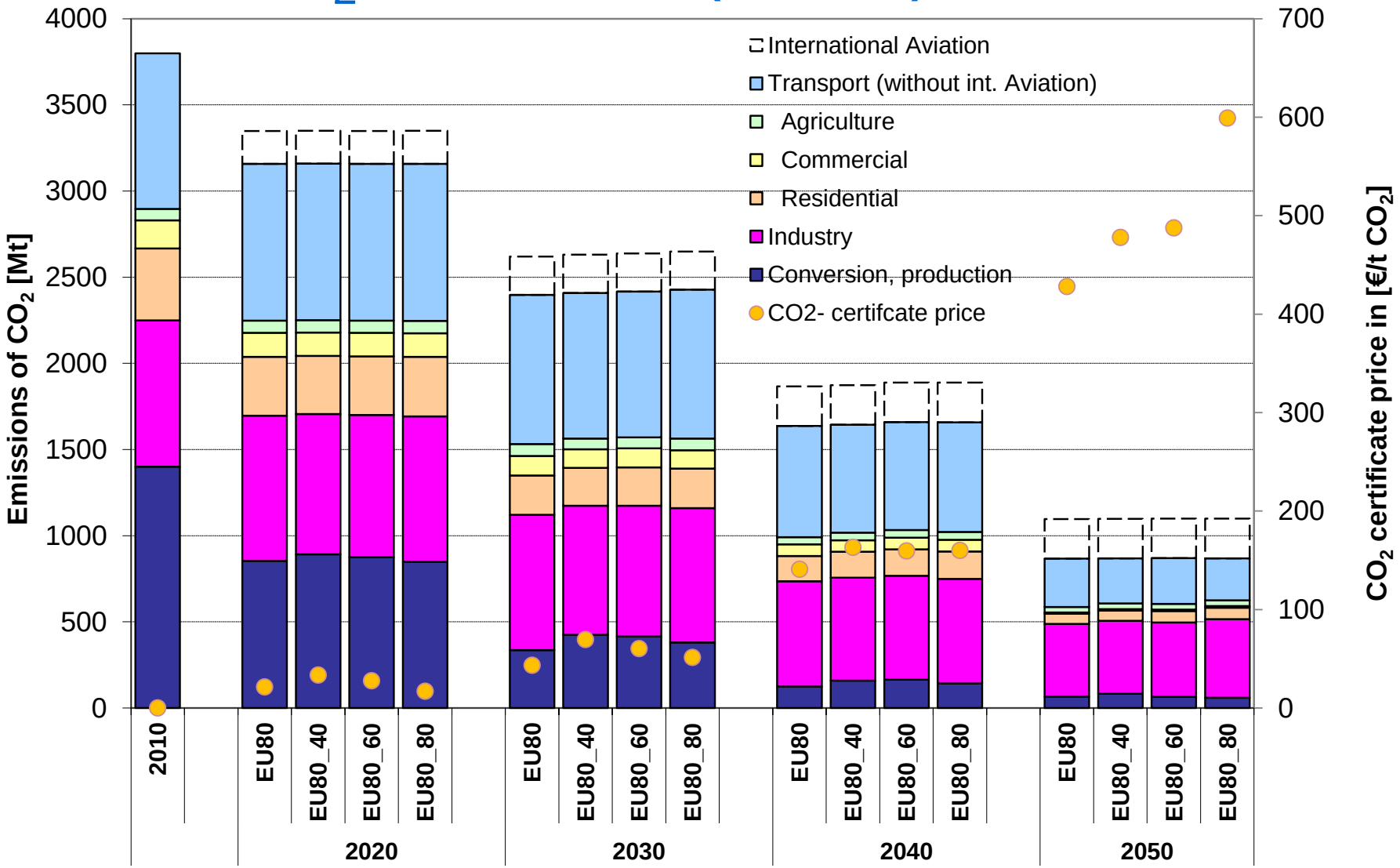
TIMES PanEU model characterisation

- **Modelling horizon 2000 – 2050**
- **12 time slices (4 seasonal, 3 day level)**
- **30 region model (EU 27 + IS, NO, CH)**
- **Country specific particularities (characterisation of new power plants, load curves, availability factors for renewable energy sources, ...)**
- **Detailed electricity exchange balances**
- **Emissions: Greenhouse gas emissions and Pollutants**
- **Sectors: Public and industrial electricity and heat supply, conversion, industry, residential, commercial, transport and agriculture**

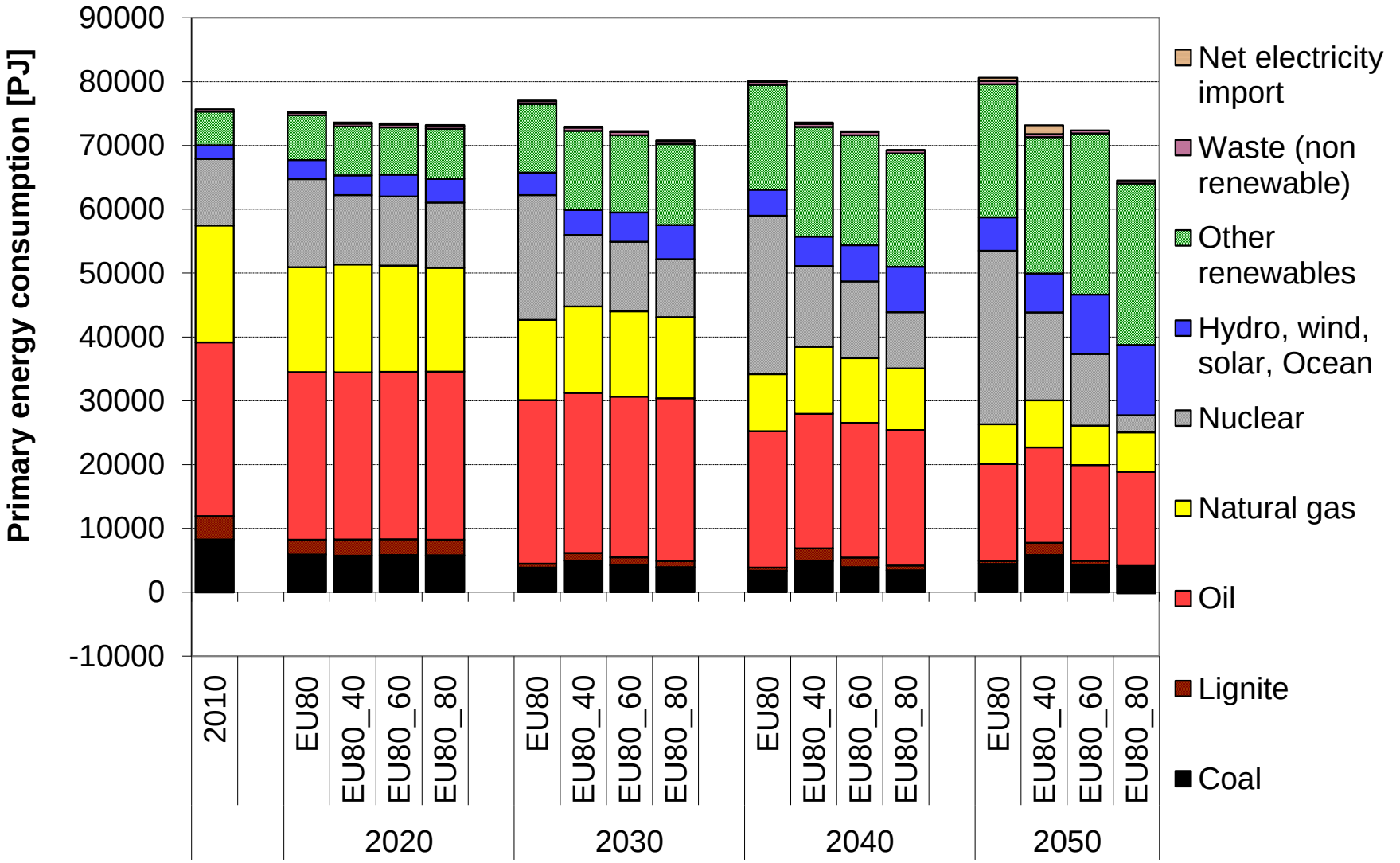
Scenario definition

Scenario name	Scenario characteristics
EU80	▪ 80 % GHG reduction target for EU-27 (1990 to 2050) ▪ No additional renewable targets ▪ Nuclear: Lifetime extension to 60a and capacity extensions in Germany and other EU-member states
EU80_40	▪ 80 % GHG reduction target for EU-27 (1990 to 2050) ▪ 40 % electricity generation based on renewable energy ▪ Nuclear: Phase-out according to decisions; others: current level of use / slight capacity extension
EU80_60	▪ 80 % GHG reduction target for EU-27 (1990 to 2050) ▪ 60 % electricity generation based on renewable energy ▪ Nuclear: Phase-out according to decisions; others: current level of use / slight capacity extension
EU80_80	▪ 80 % GHG reduction target for EU-27 (1990 to 2050) ▪ 80 % electricity generation based on renewable energy ▪ Nuclear: Phase-out according to decisions; others: current level of use / slight capacity extension

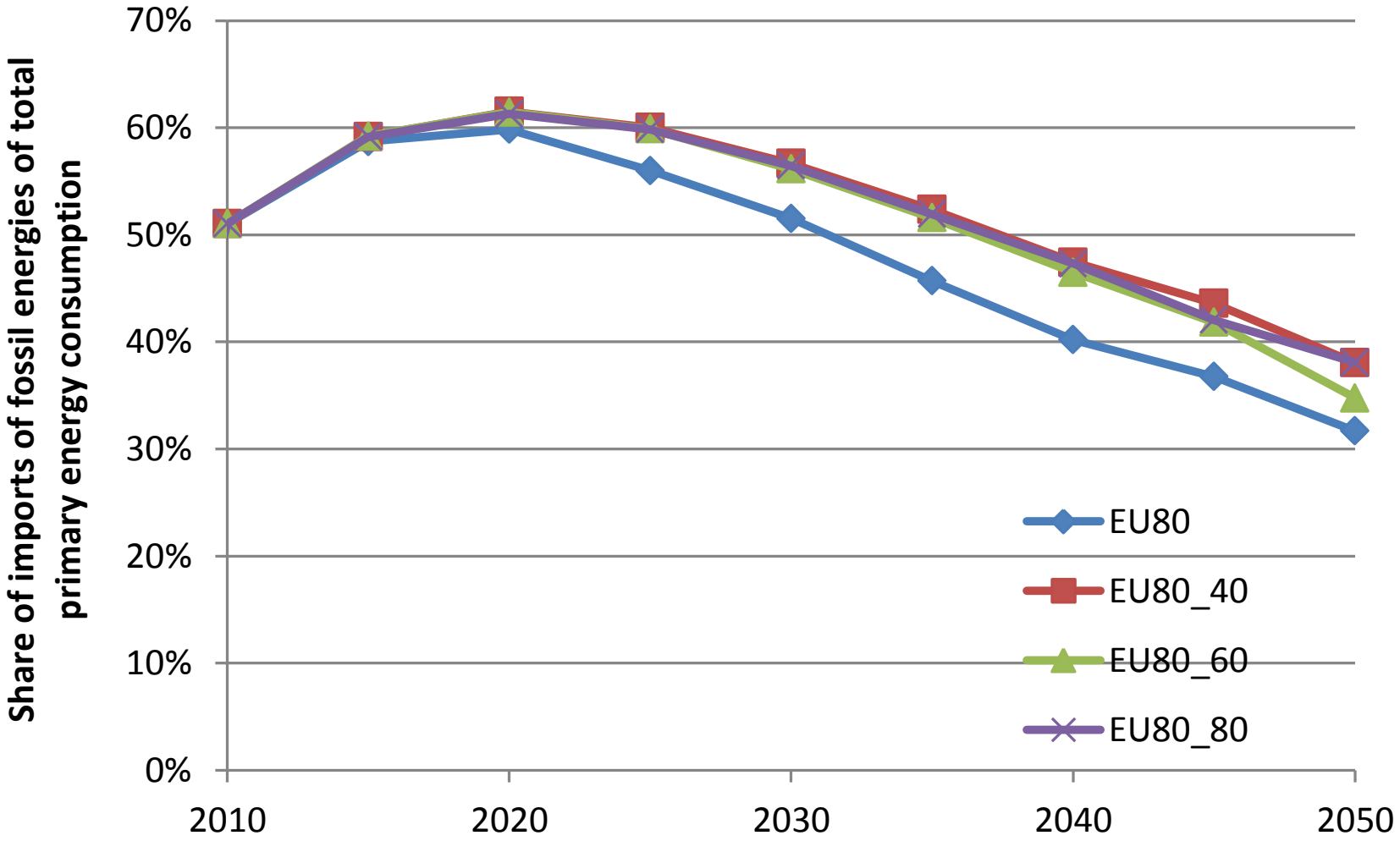
Focus: CO_2 Emissions (EU-27)



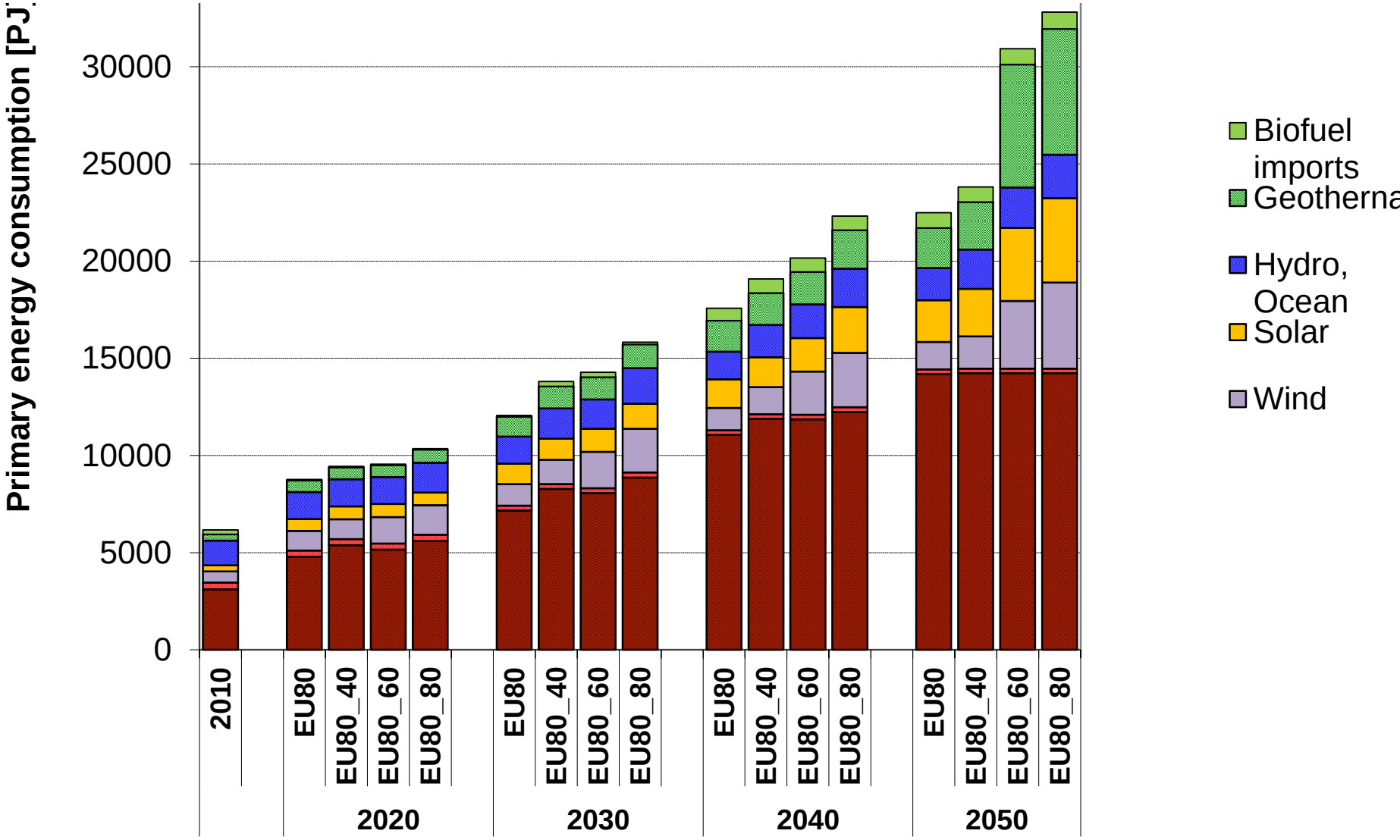
Primary Energy Consumption (EU-27)



Share of imports of fossil energies of total primary energy consumption in EU-27

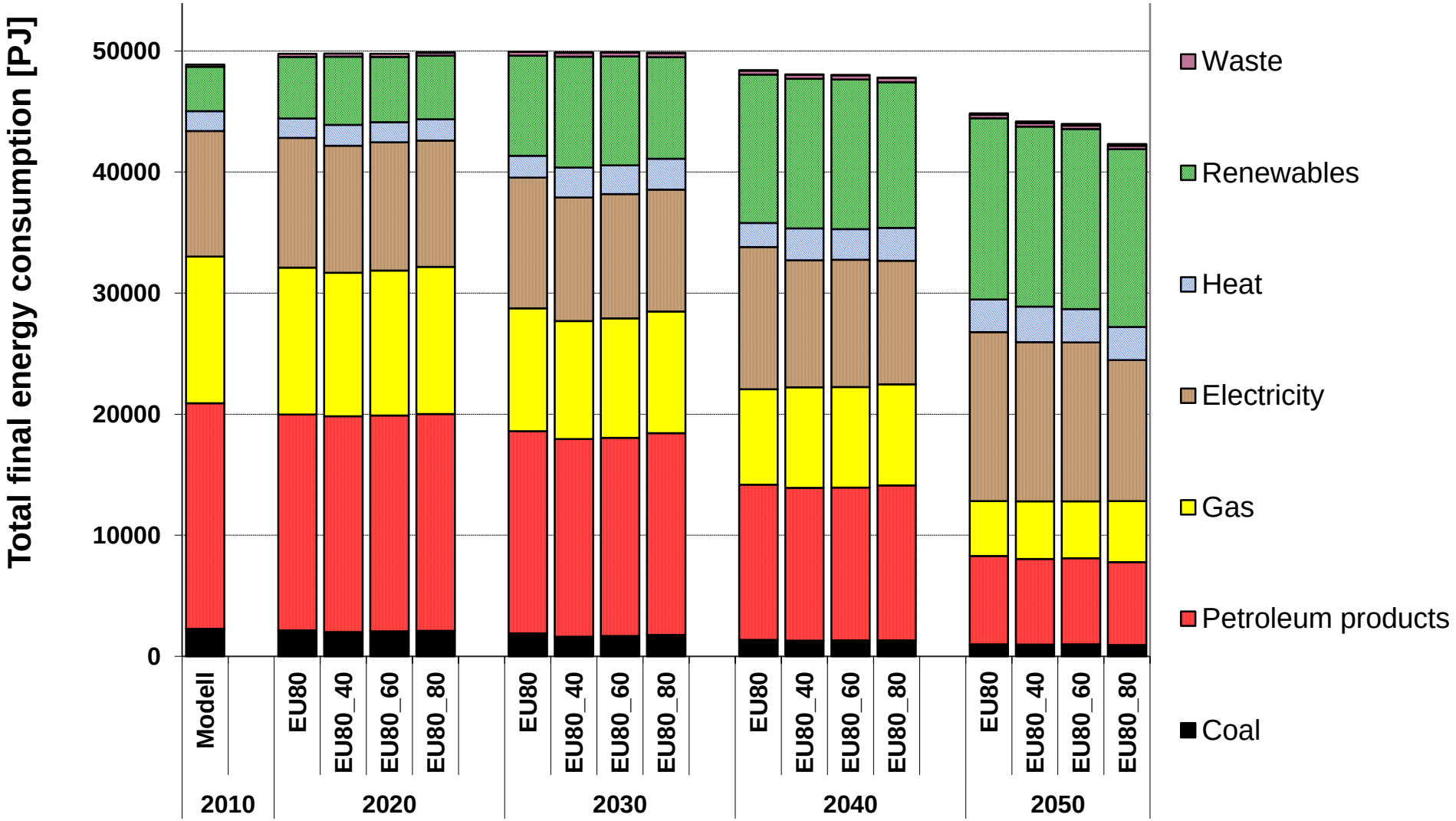


Primary Energy Consumption Renewable (EU-27)

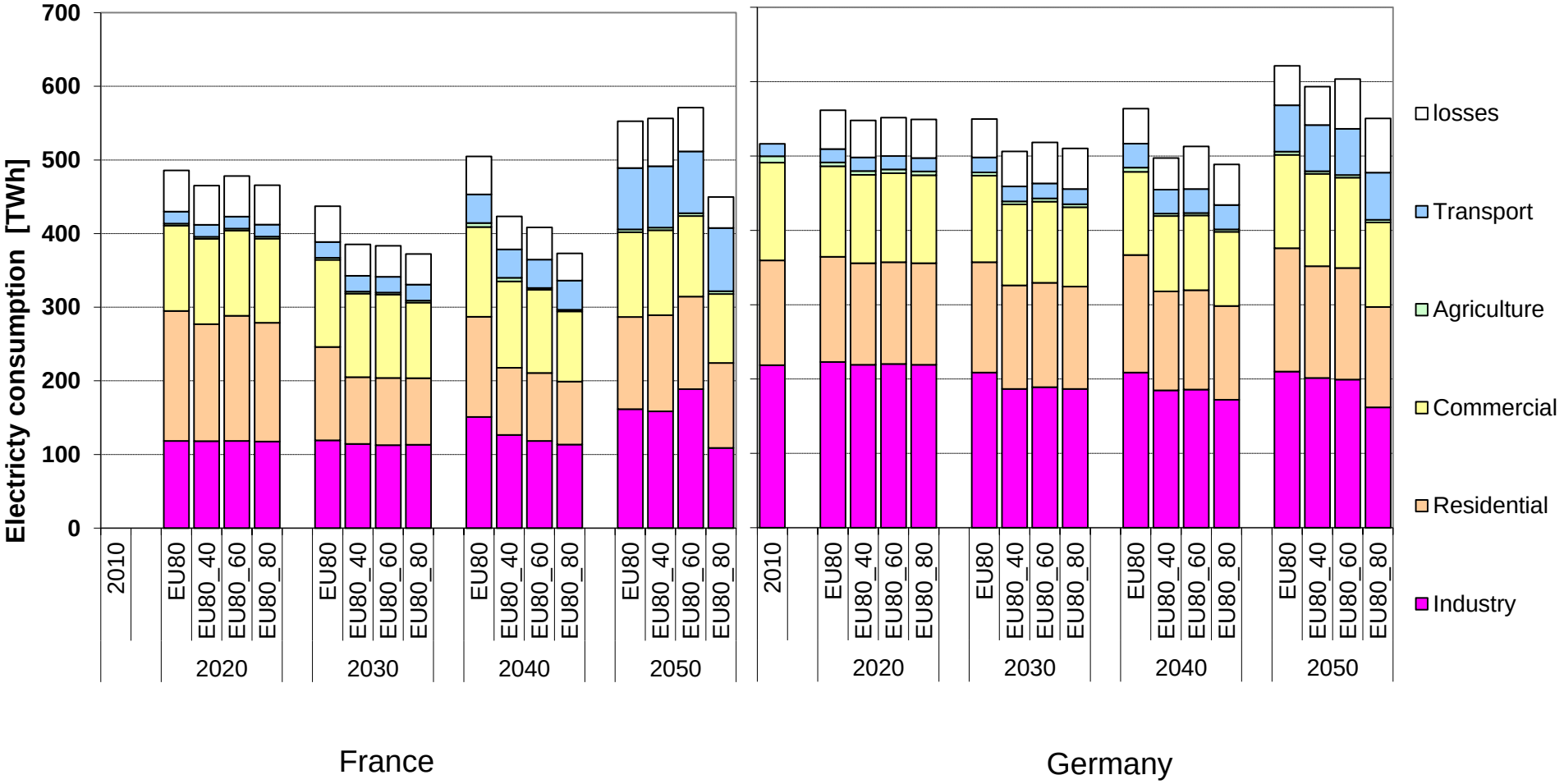


Final Energy Consumption (EU-27)

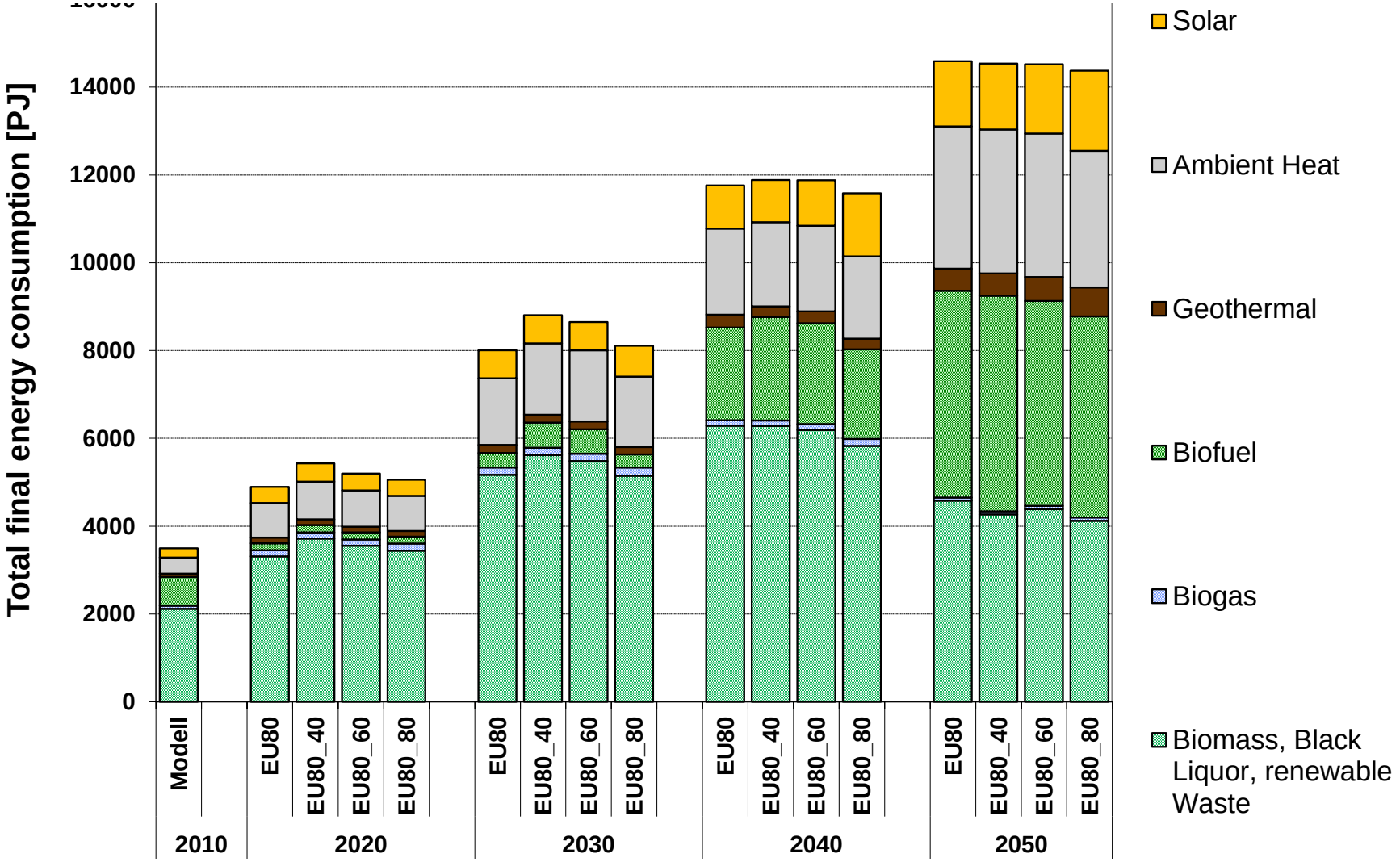
ınol,



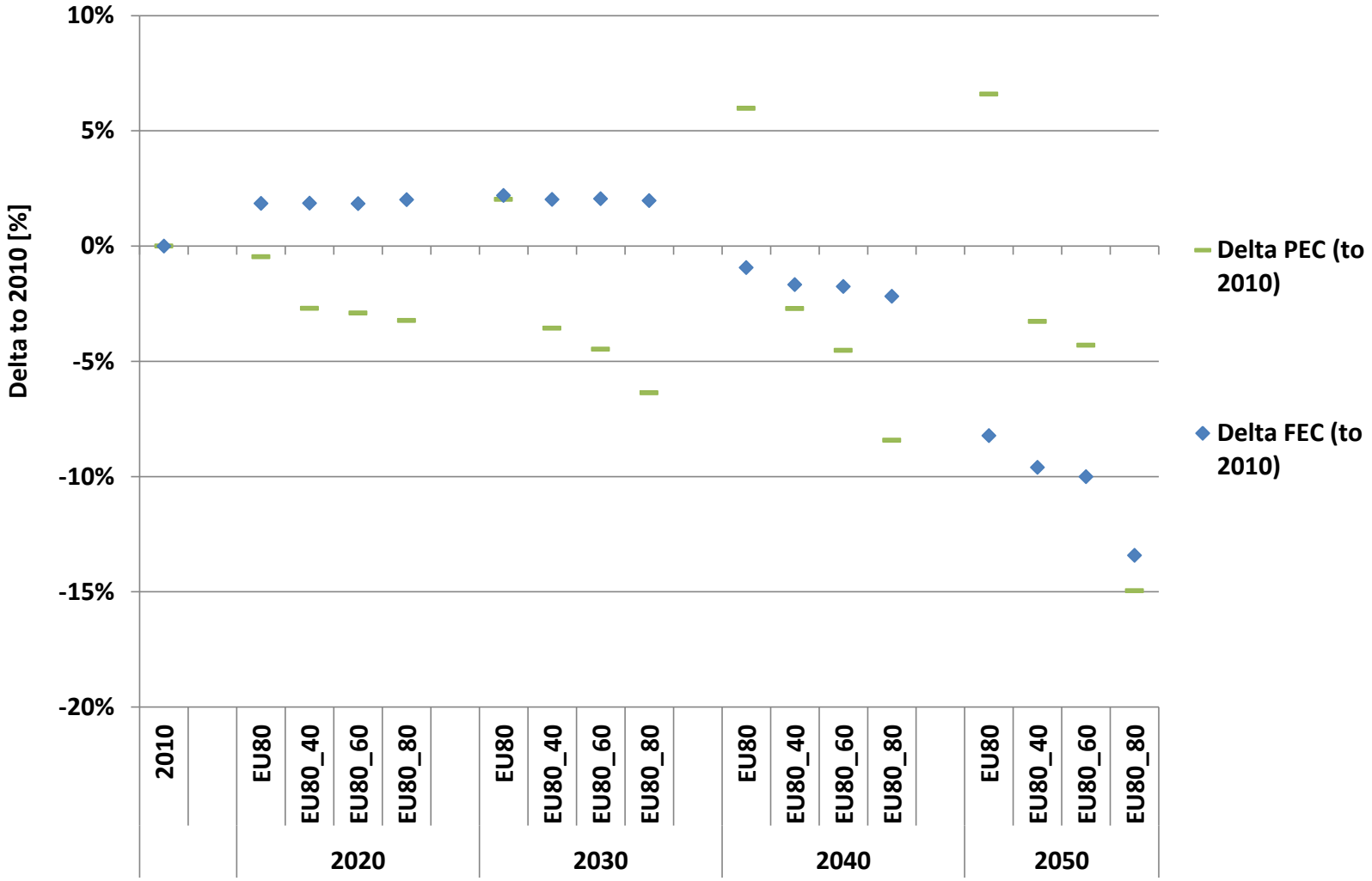
Electricity consumption France and Germany



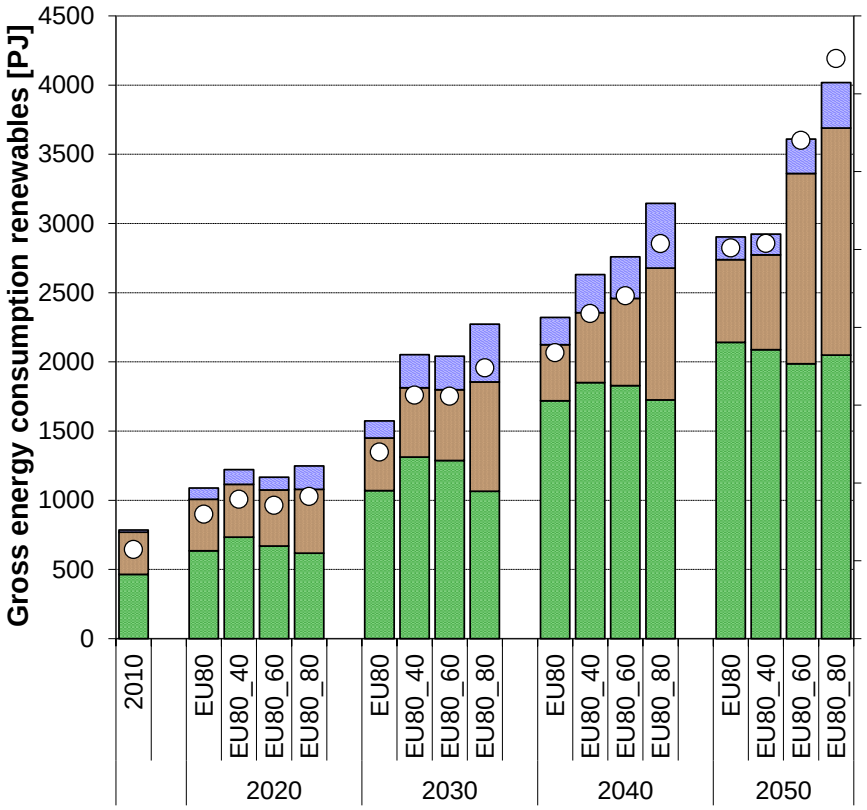
Final Energy Consumption Renewable (EU-27)



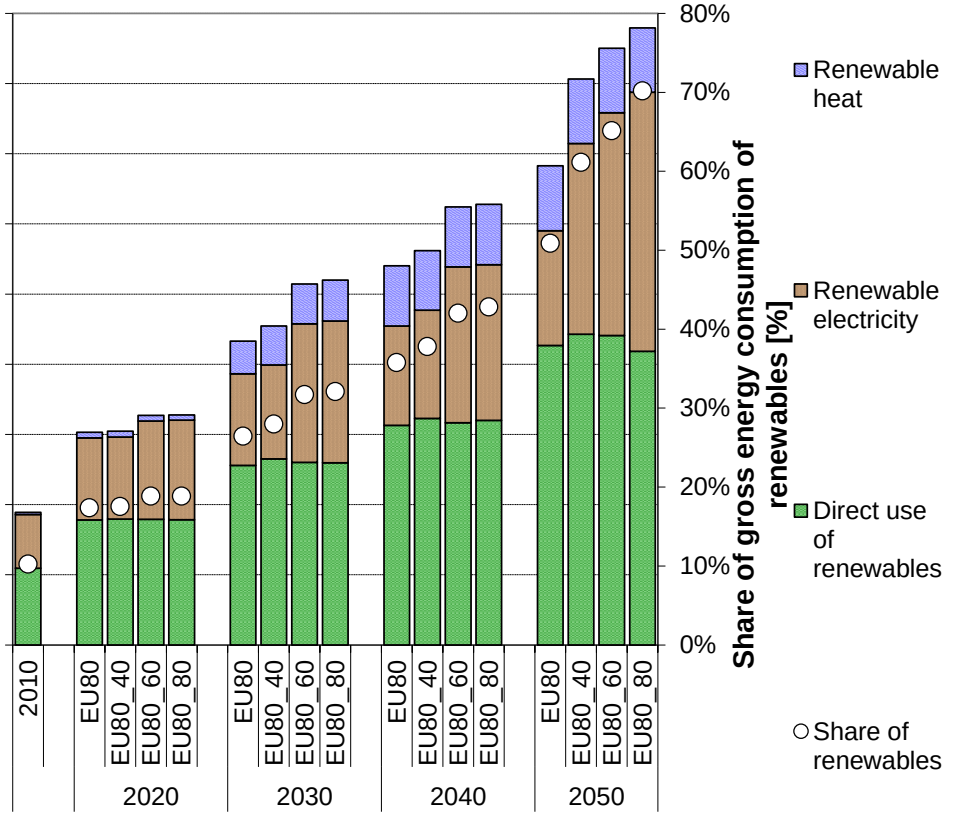
Focus: Energy Efficiency (EU-27)



Gross energy consumption renewables Germany and France

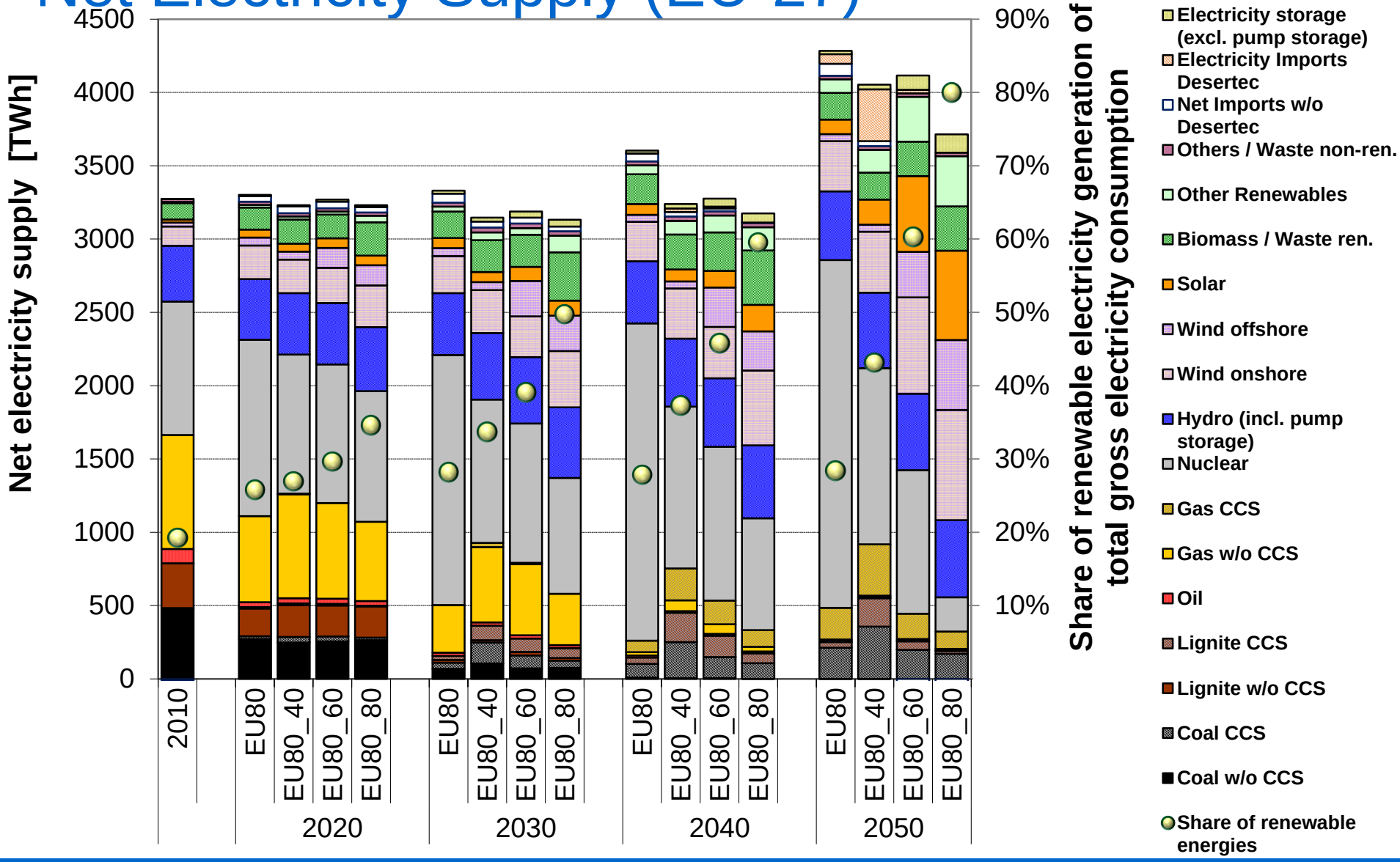


France

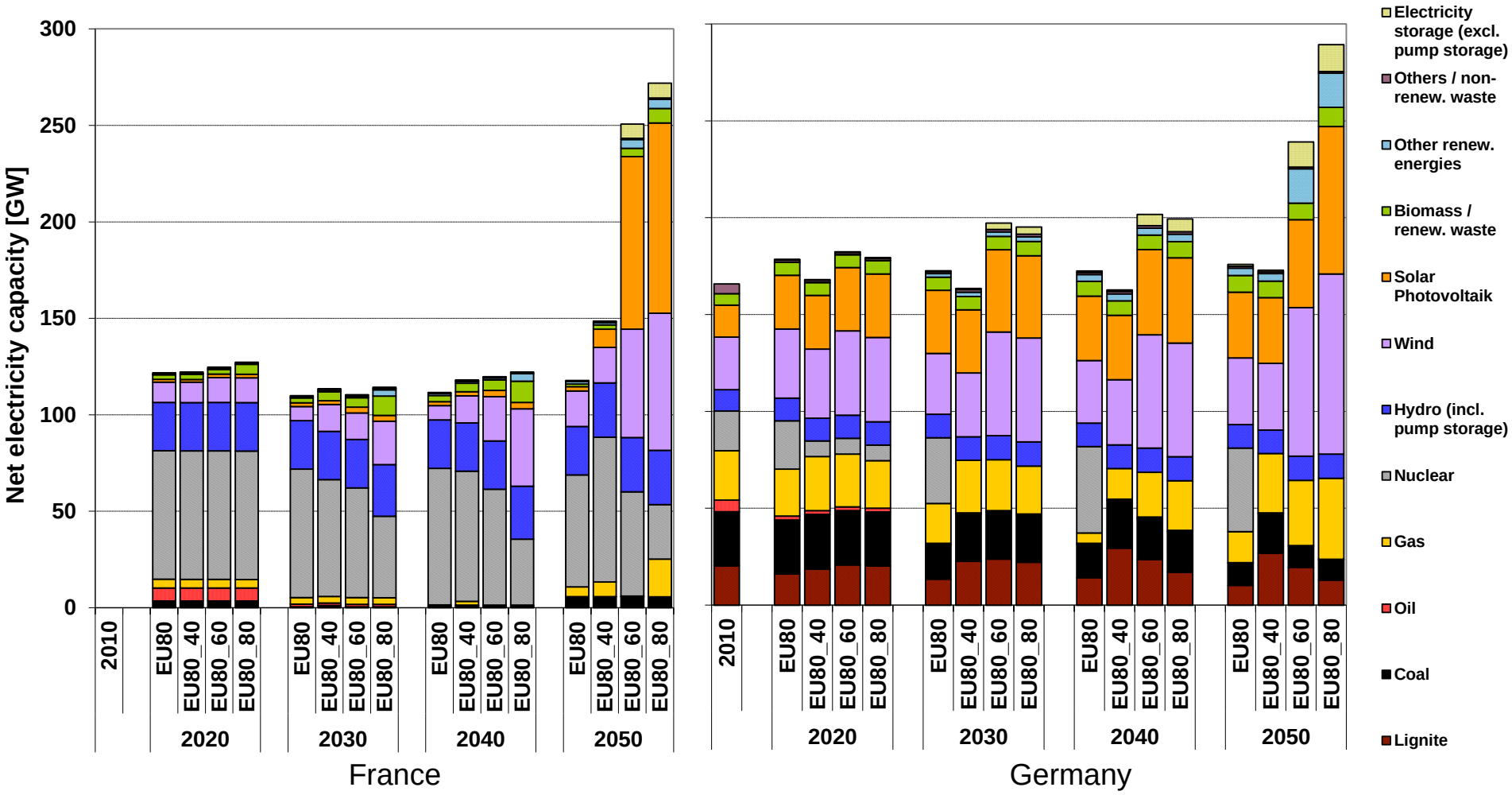


Germany

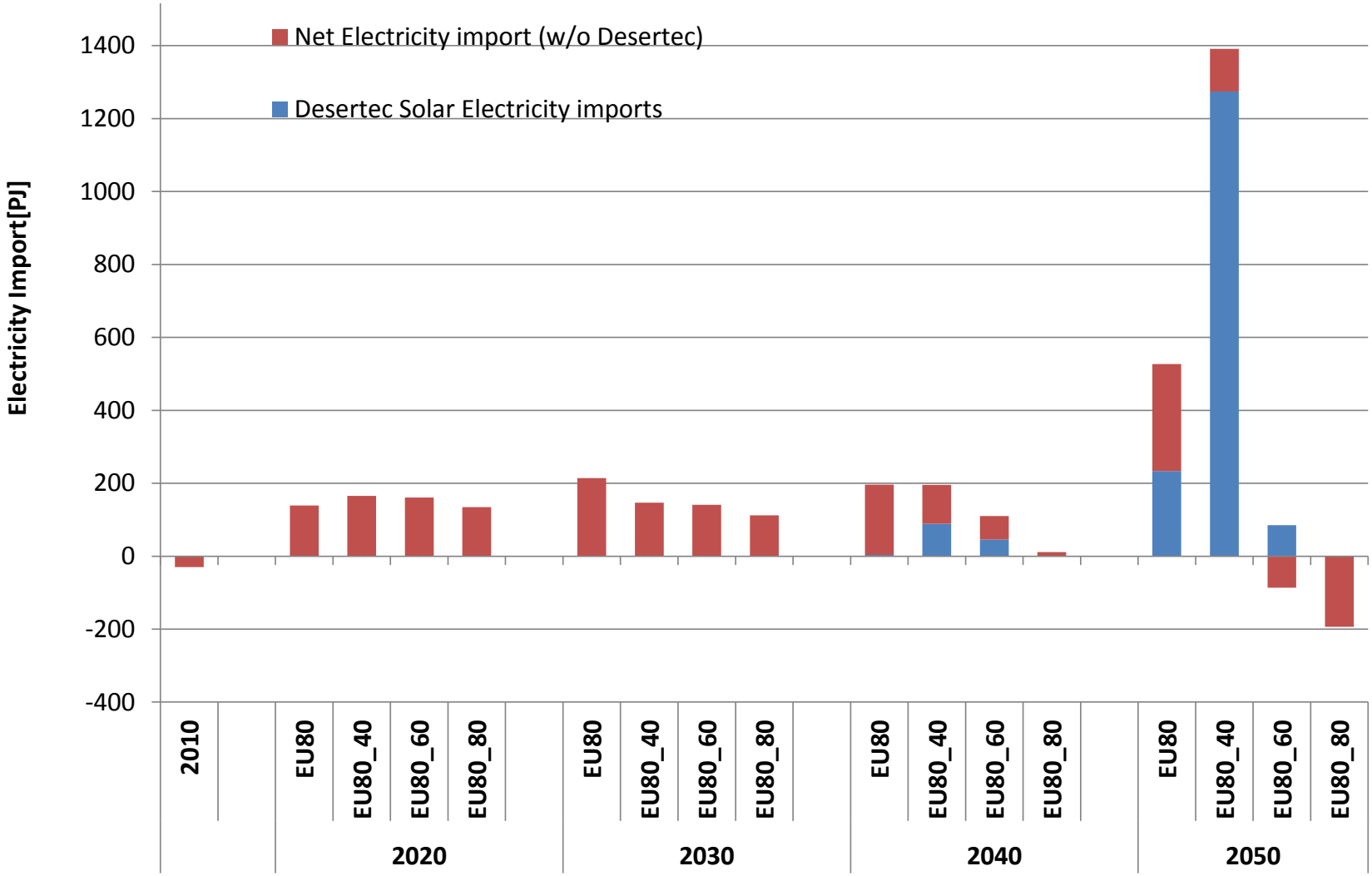
Net Electricity Supply (EU-27)



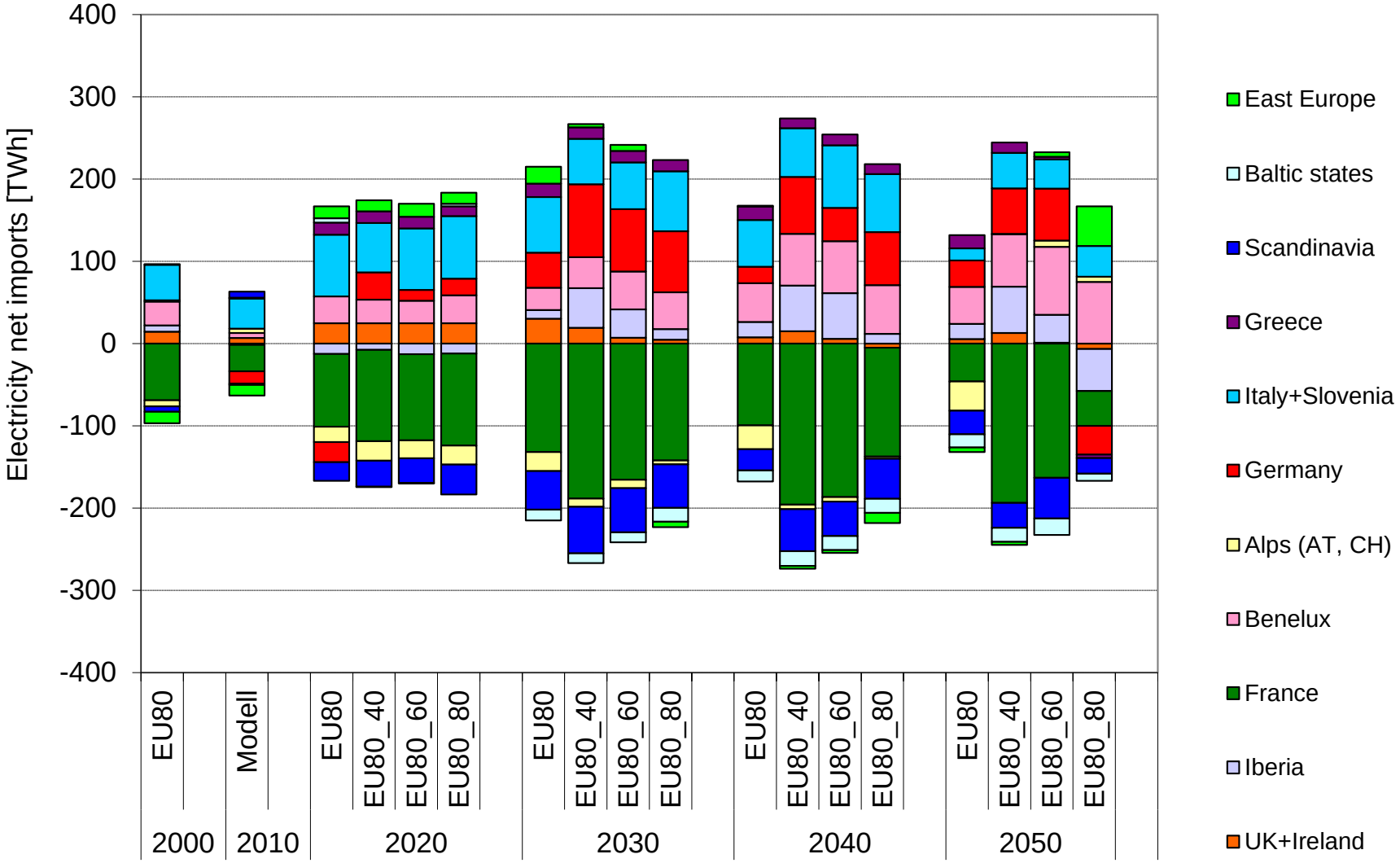
Installed net electricity capacity France and Germany



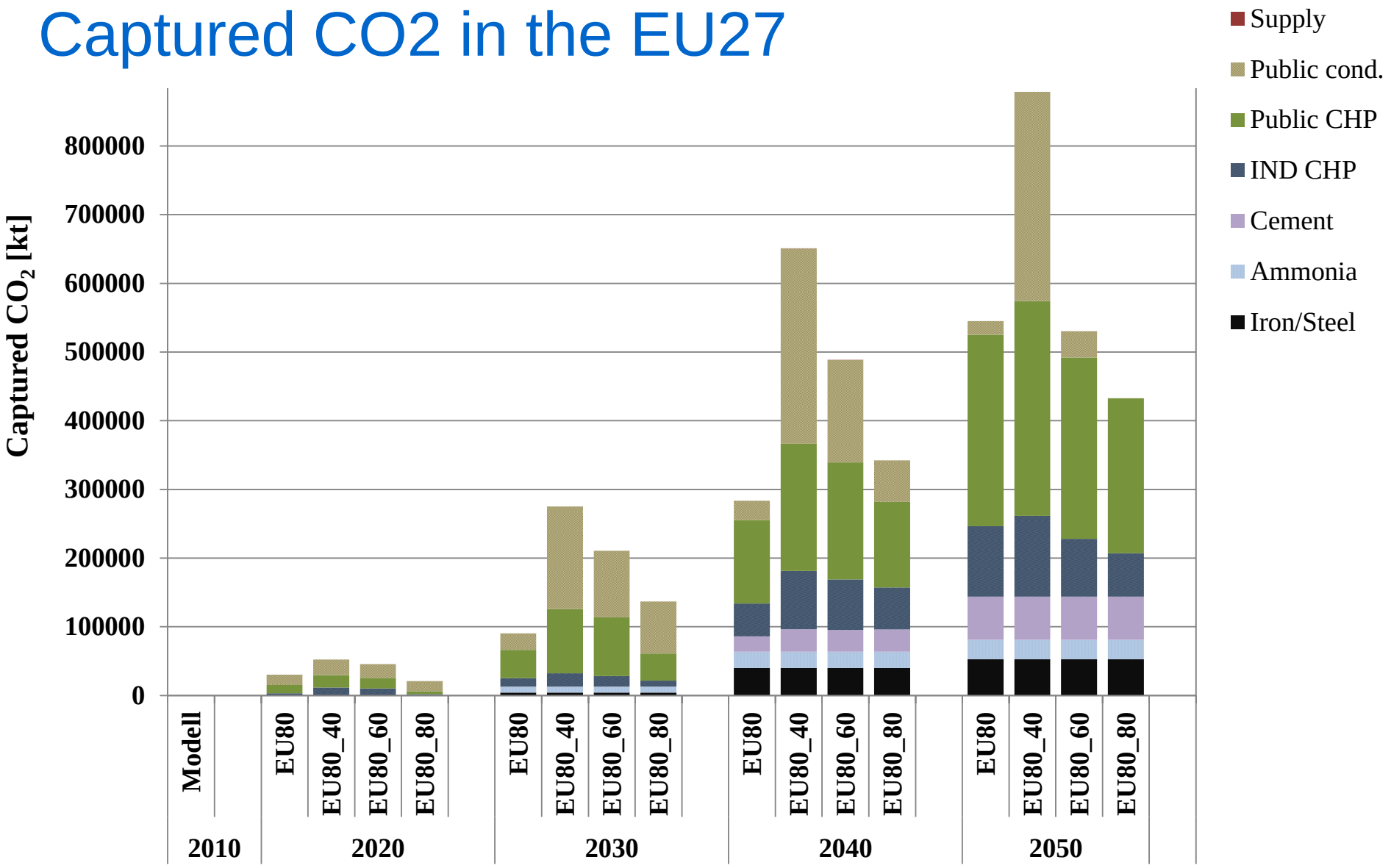
Electricity Import into the EU-27



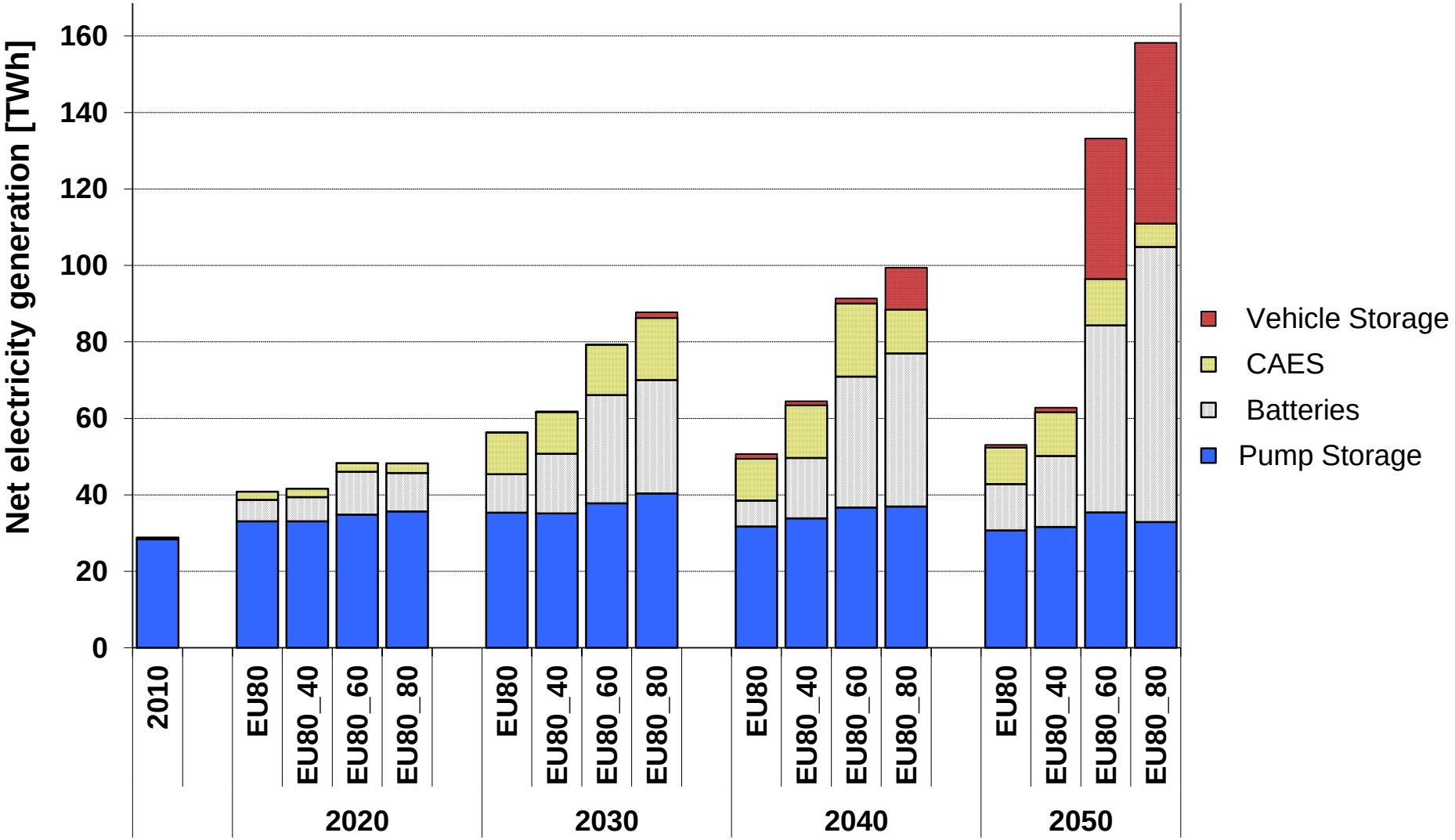
Electricity trade in the EU27



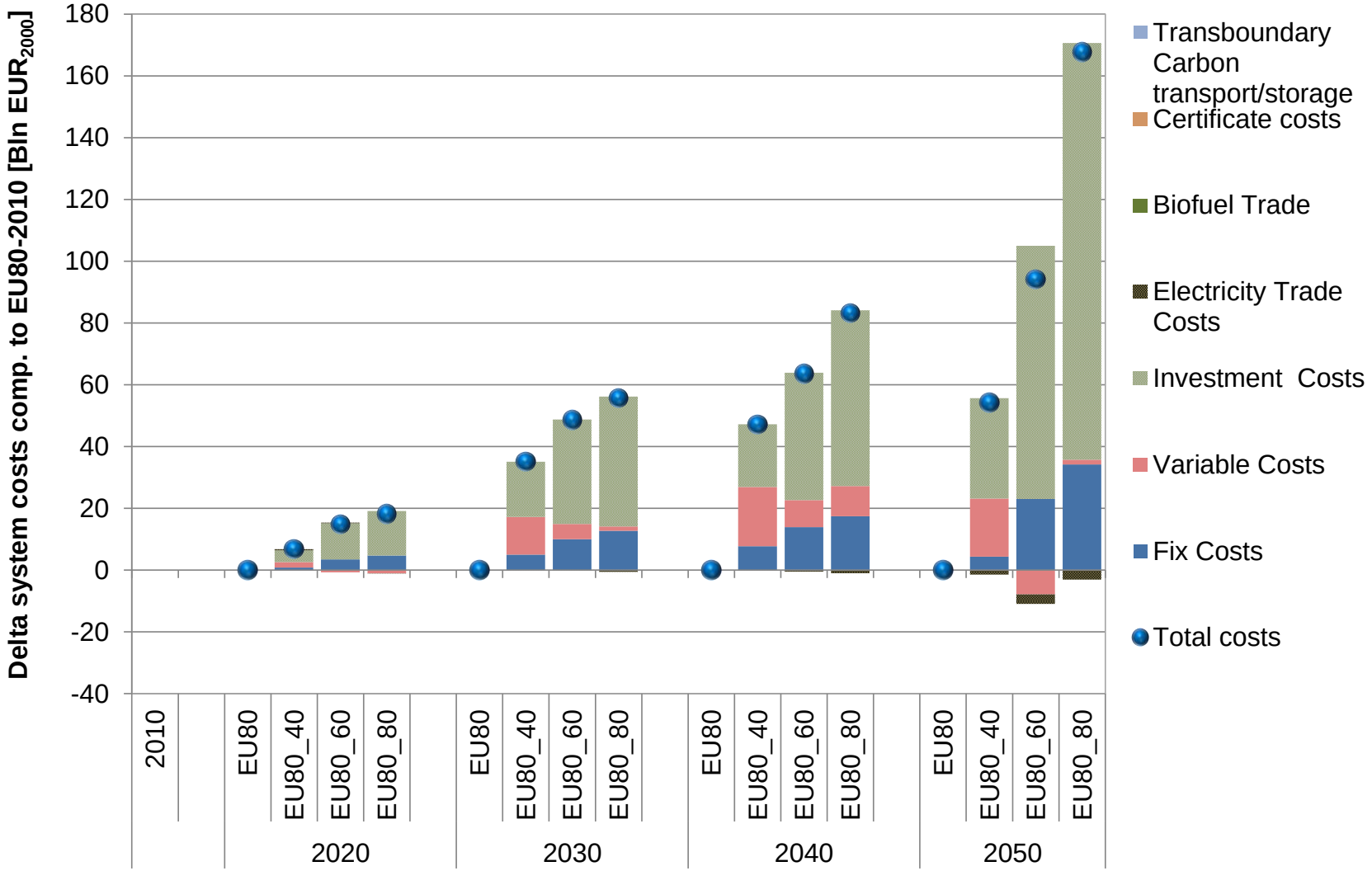
Captured CO2 in the EU27



Stored electricity in the EU27



Annual energy system costs compared to EU80-2010 in the EU27



Cumulated energy system costs Germany, France and in the EU-27

Cumulated system costs compared to EU80 [Bln €$_{2000}$]	2010 - 2030			2010 – 2050		
EU80_40	39	17	148	60	38	257
EU80_60	64	23	211	99	75	419
EU80_80	64	27	239	141	108	698

Thank you for your attention !

IER *Institut für Energiewirtschaft Rationelle Energieanwendung*

Heßbrühlstr. 49a, 70565 Stuttgart
Tel.: +49 711 / 685 878 65
E-mail: Markus.Blesl@ier.uni-stuttgart.de