A 100% Renewable Electricity Supply by 2050: Climate-friendly, Reliable, and Affordable

Prof. Dr. Miranda Schreurs

German Advisory Council on the Environment, Berlin

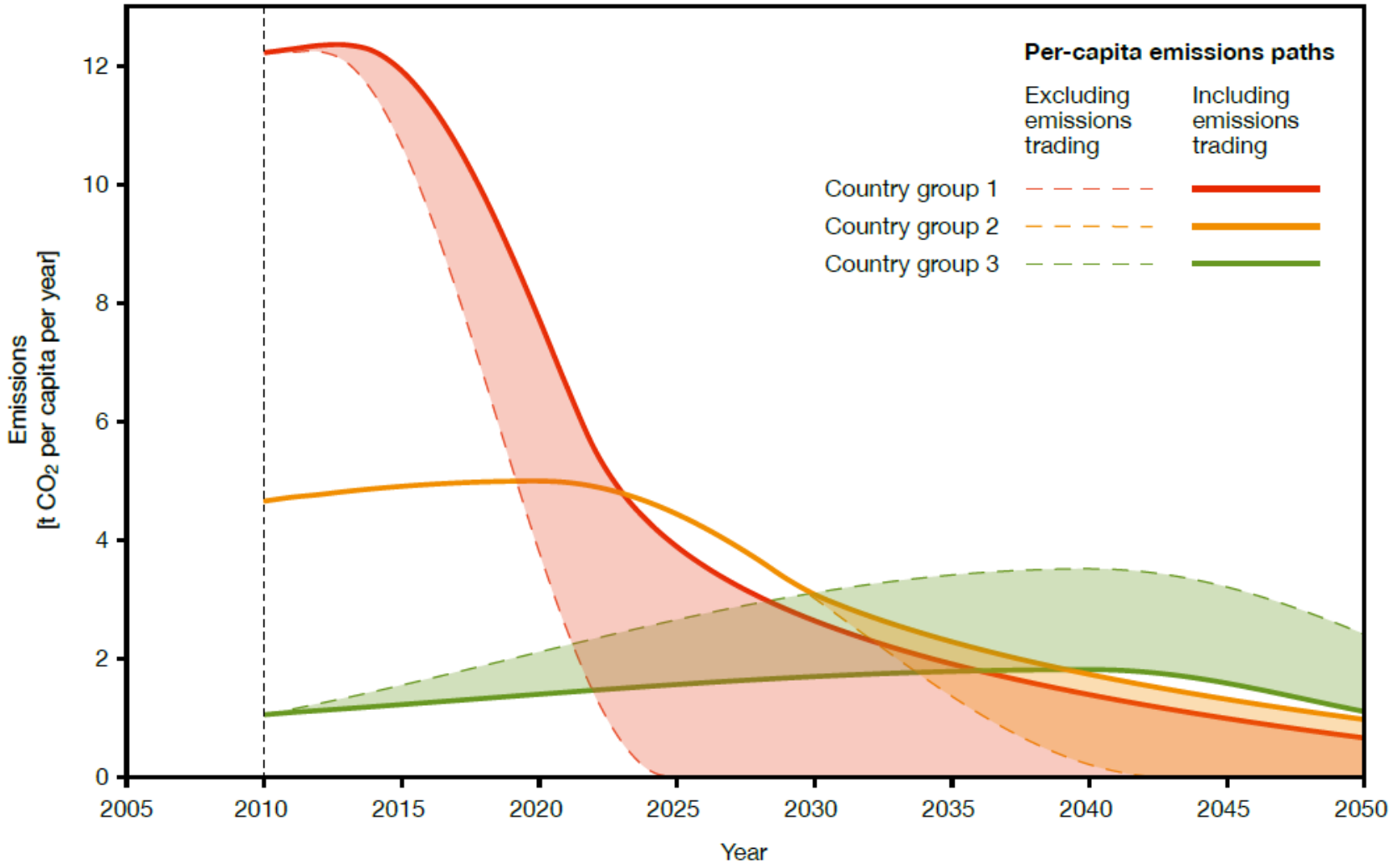
Director of the Environmental Policy Research Centre and Professor of Comparative Politics at the Freie Universität Berlin

The German Advisory Council on the Environment:

Providing scientific policy advice since 1971

- independent, inter-disciplinary scientific council nominated by the Federal Cabinet
- comprised of 7 professors (natural science, engineering, economics, law, political science)
- Broad mandate to provide early warning of negative trends and new ideas for furthering environmental policy and inform the wider public
- SRU is an active member of the European Environment Advisory Councils (EEAC)

The Challenge: Full Decarbonisation



WBGU, 2009: Solving the Climate Dilemma: the Budget Approach

Conclusions

- 100% renewable electricity is achievable by 2050
- Security of supply can be assured at a competitive cost
- Initial higher costs (compared to conventional energies) is an investment in the transition to a least cost solution
- (Offshore) wind energy will be the most important single contributor to a 100% renewable electricity system
- Pumpstorage capacity in Scandinavia will play a critical role in balancing supply and demand
- An energy transition without new coal plants or extended nuclear running times can be modelled
- Expanding supply of renewable energy from 2020 onwards requires flexible base load energy

Comparing Low Carbon Technologies

Conclusion: Renewable energy is the least controversial and most sustainable option for decarbonisation

Demand reduction

Nuclear

Fossil with CCS

Renewable Energies

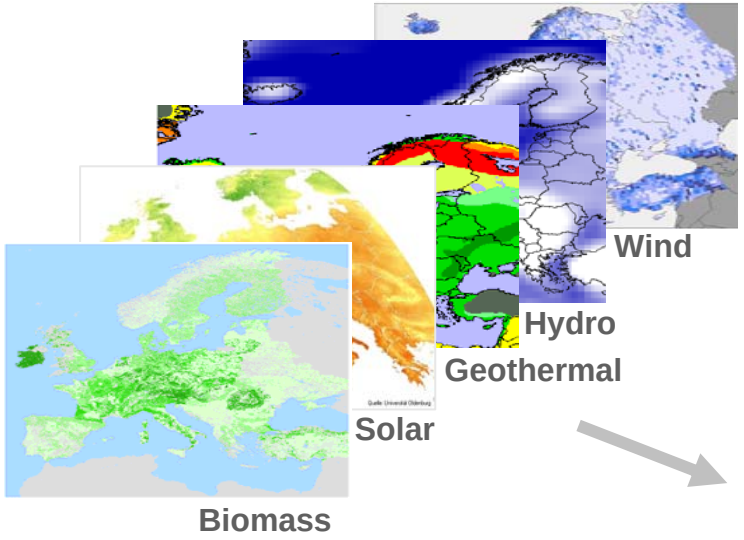
Requirement	Acceptance Resources Waste	Cost Capacity Containment	Grid Extension Storage
	?	?	

Compatibility ?

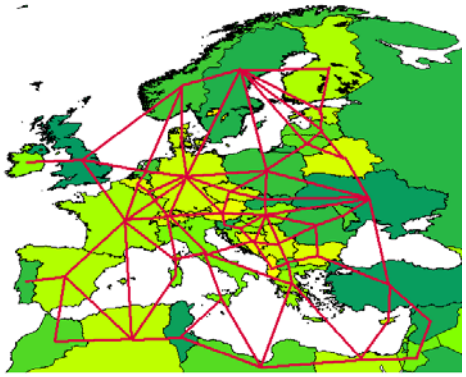
Backcasting Approach

REMix-Europe
(Renewable Energy Mix for Sustainable Electricity Supply in Europe)

Inventory of Ressources
GIS (Geographic information system), C



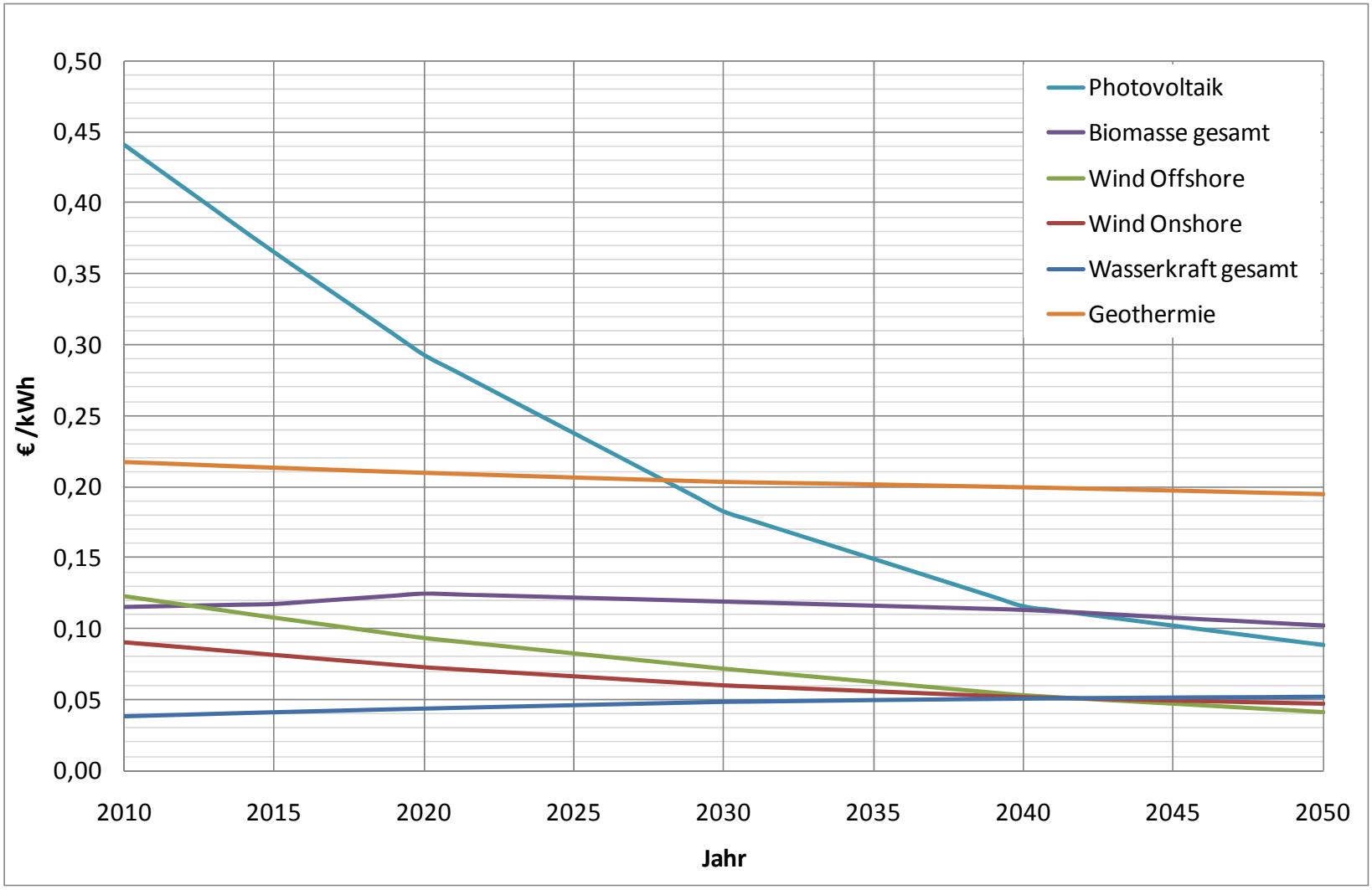
Power Needs and Load
GIS, C



Linear Optimisation
GAMS (General Algebraic Modeling System)

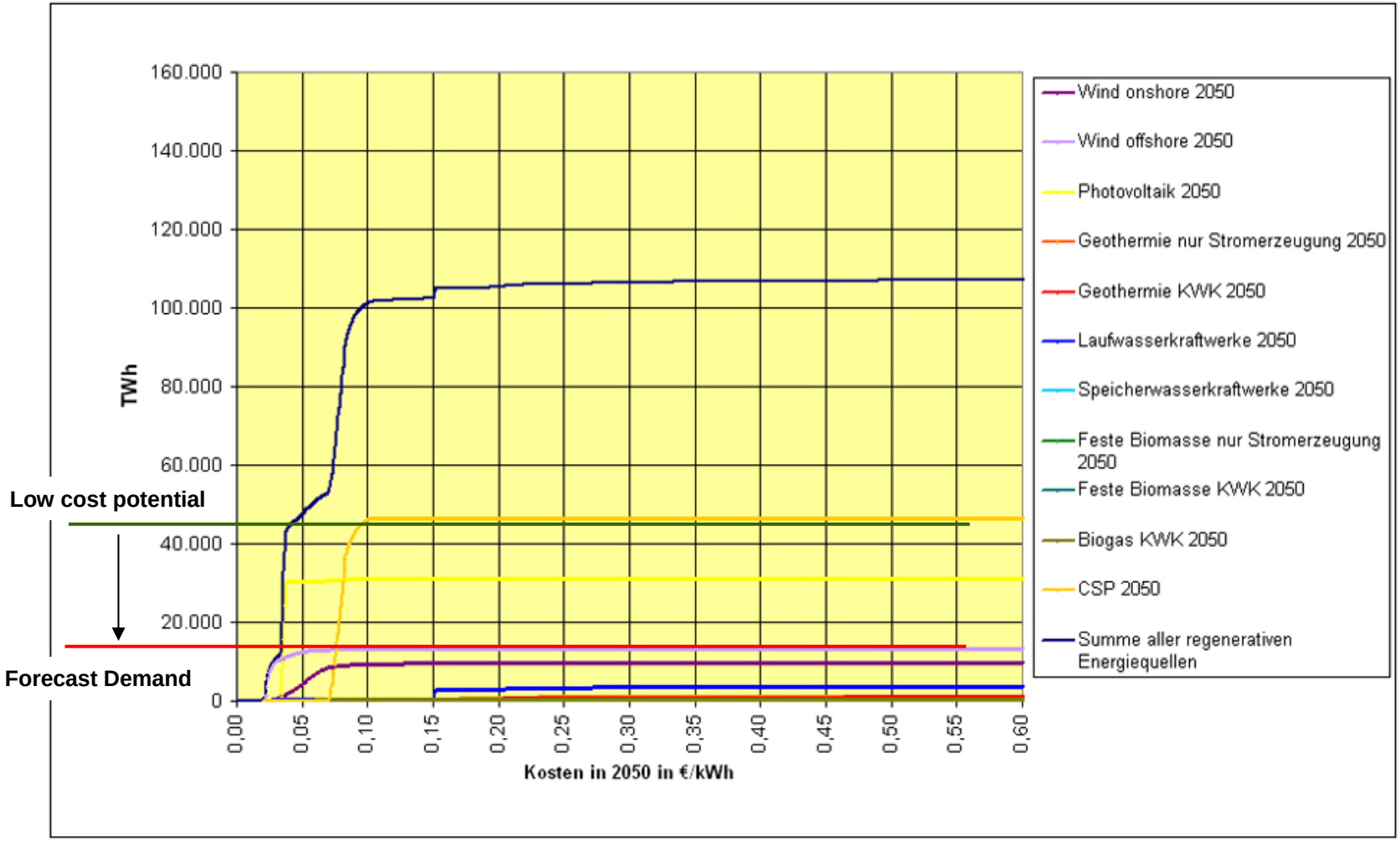
Key model assumption: Learning Cost Curves

In the middle range of literature



Low cost potential: Europe NorthAfrica (EUNA)

(ca. factor 8-10x forecasted demand)



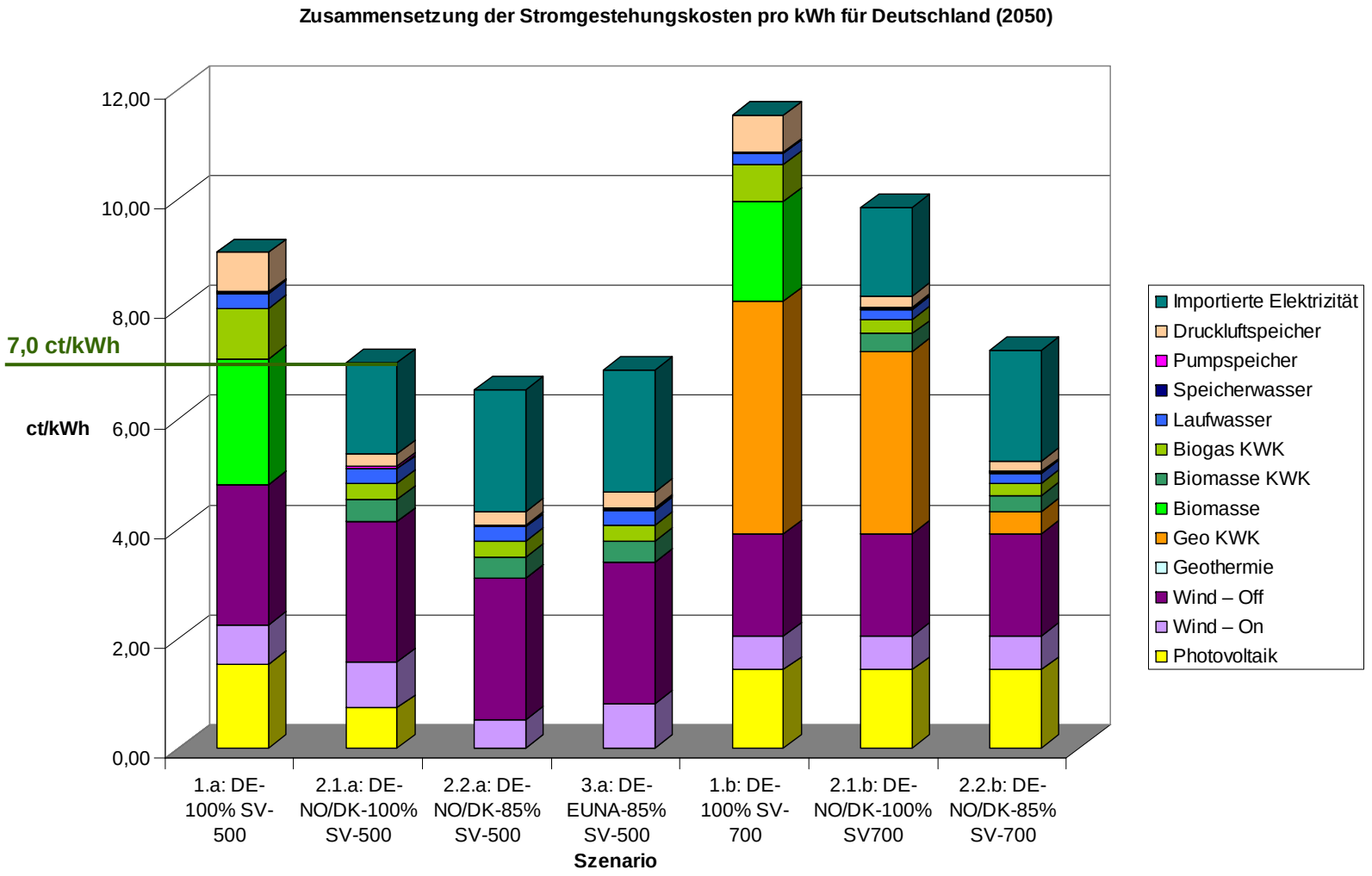
100% renewable electricity

8 scenarios

	Demand Germany 2050: 500 TWh	**Demand Germany 2050: 700 TWh**
Self-Sufficiency	Scenario 1.a DE-100 % SS-500	Scenario 1.b DE-100 % SS-700
Net self-sufficiency including trade with DK/NO	Scenario 2.1.a DE-NO/DK-100 % SS-500	Scenario 2.1.b DE-NO/DK-100 % SS-700
Max 15% Net import from DK/NO	Scenario 2.2.a DE-NO/DK-85 % SS-500	Scenario 2.2.b DE-NO/DK-85 % SS-700
Max 15% Net import from EUNA	Scenario 3.a DE-EUNA-85 % SS-500	Scenario 3.b DE-EUNA-85 % SS-700

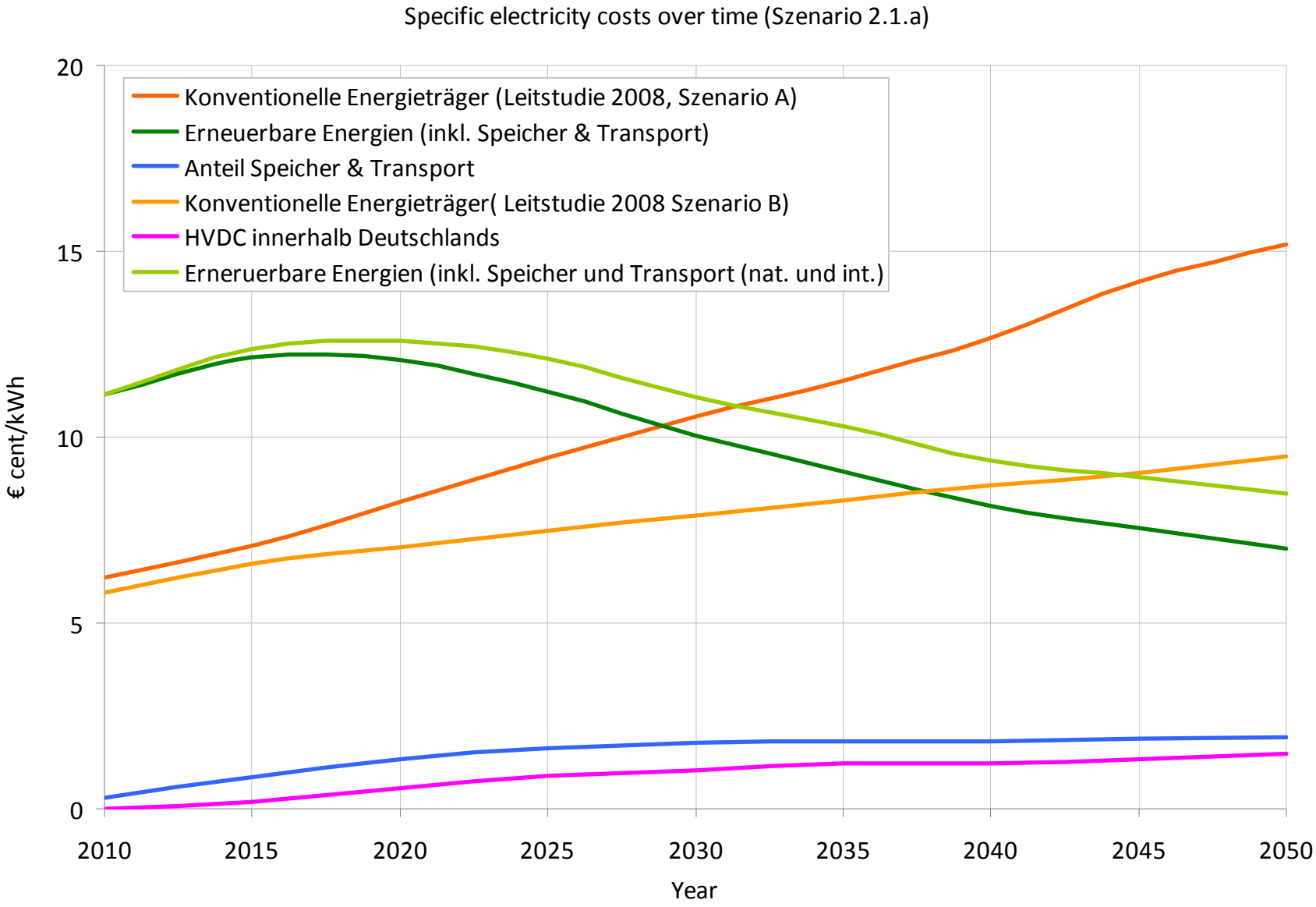
System Cost can be kept below 7ct/Kwh

assuming stabilisation of electricity consumption and trade



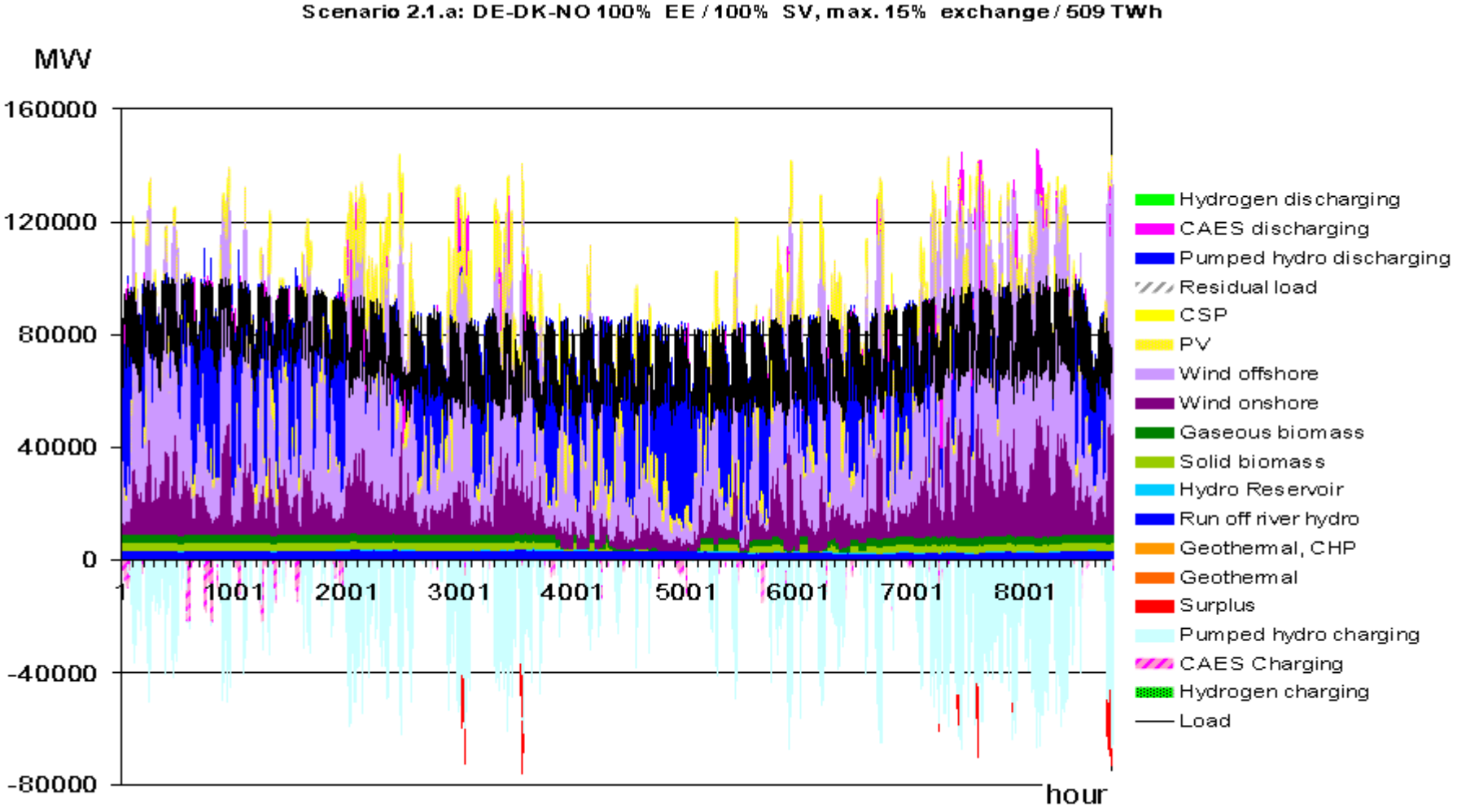
The cost development

Compared to a conventional supply scenario (Germany)



Hourly results 2050 DE-DK-N

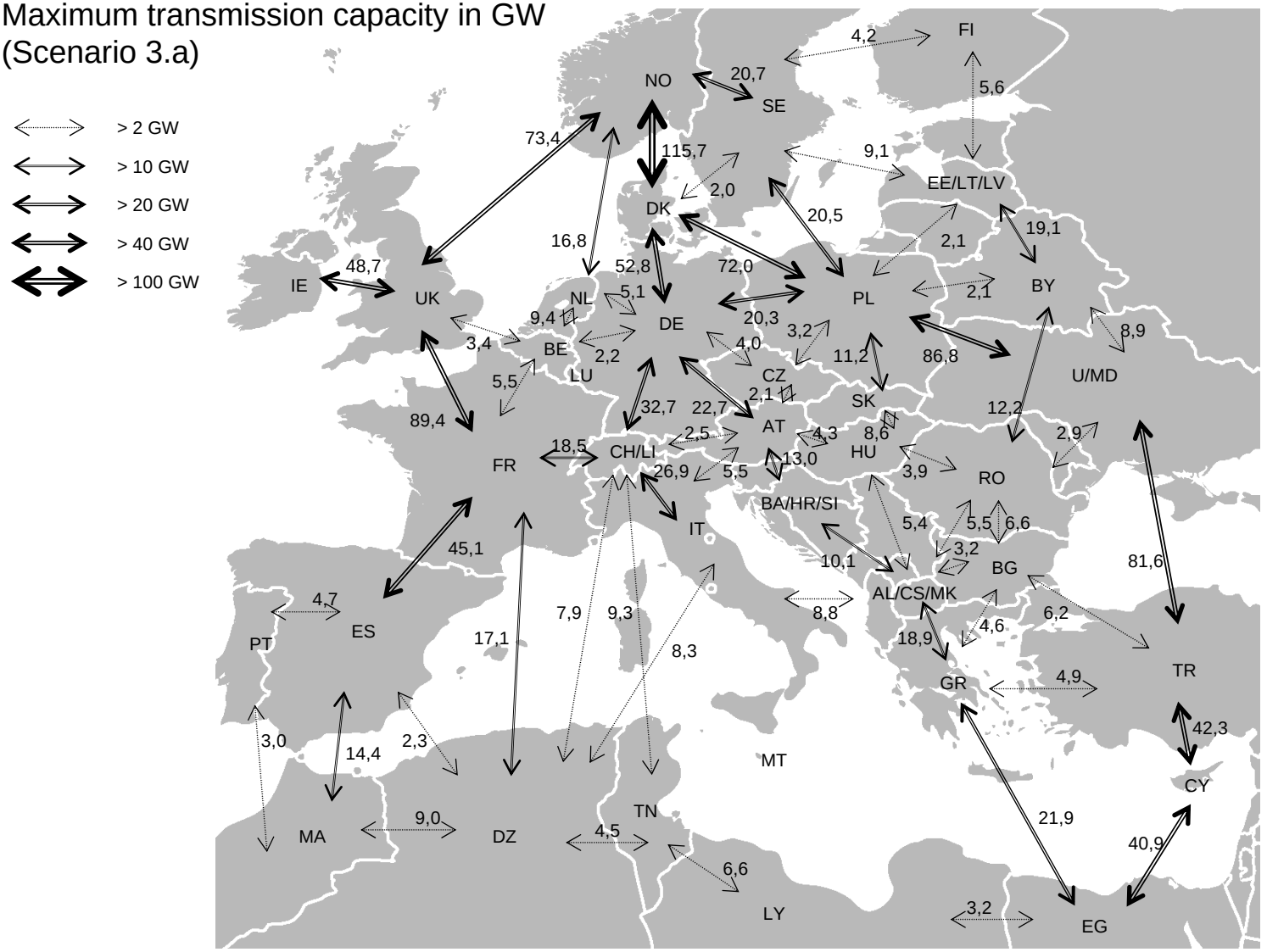
100% national production, 15% exchange



TEN-E Needs by 2050

and the key role of the nordic „power house“

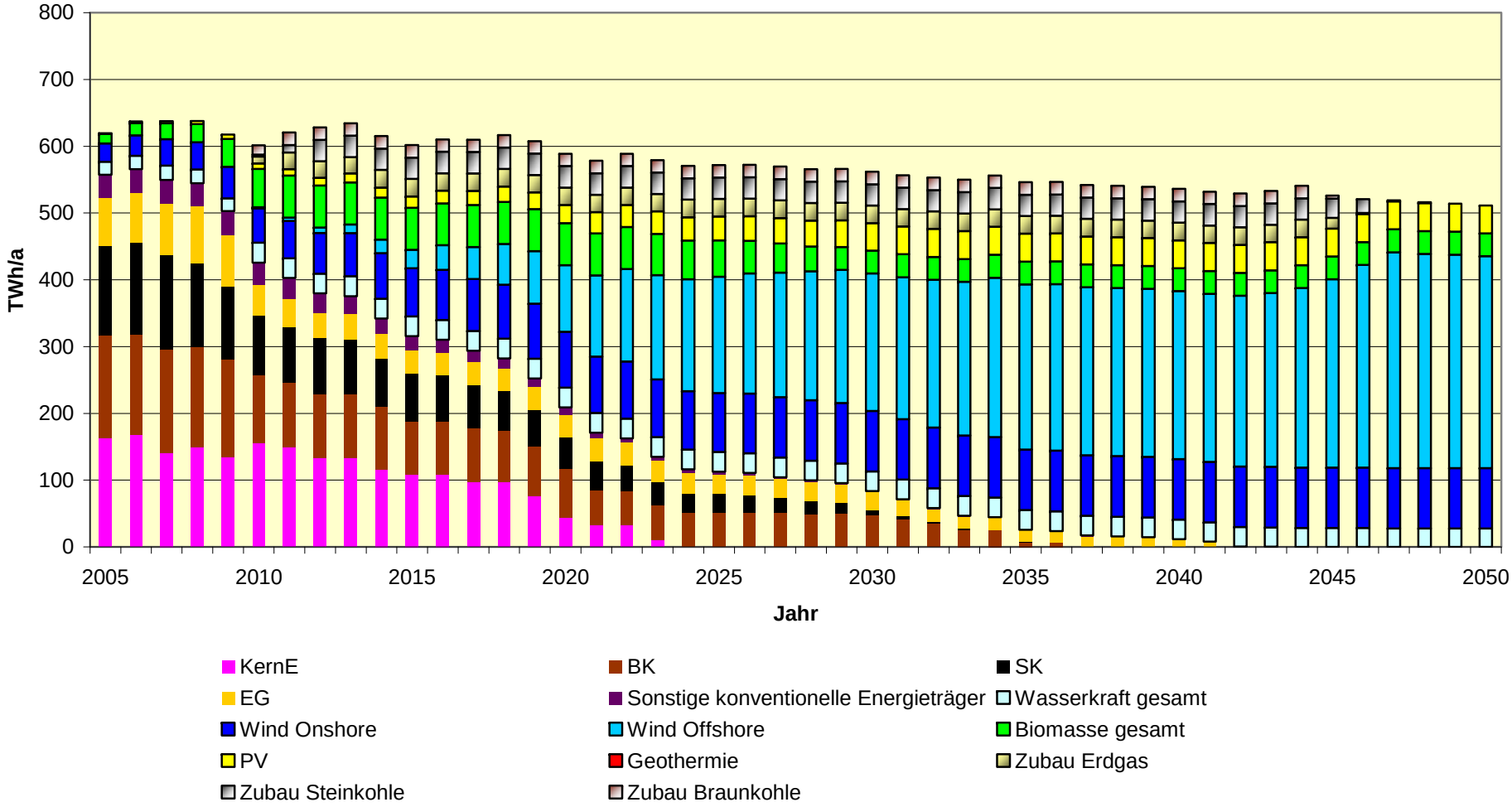
Maximum transmission capacity in GW
(Scenario 3.a)



Development of renewable energy mix

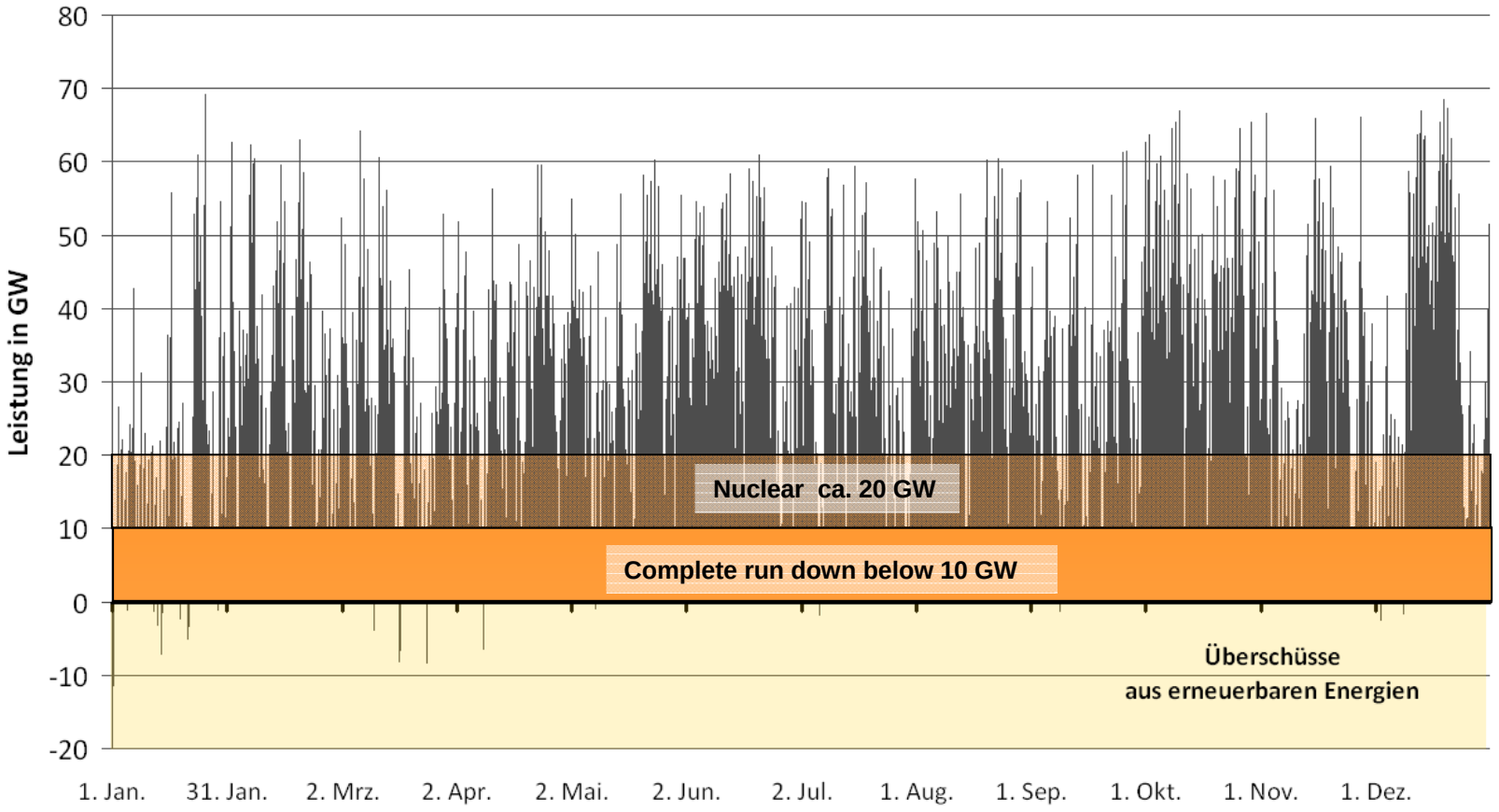
in Germany until 2050

Entwicklung der Bruttostromerzeugung 2005 bis 2050
konventionelle Erzeugung und regenerative Energiequellen (für 509 TWh/a in 2050)



Fluctuating supply

overstretches nuclear plant flexibility already in 2020



Planning for the Future

- Develop a binding climate and carbon neutral electricity target linked to emissions trading for 2050 (important for providing economic signals)
- Promote further measures for energy efficiency—the most important bridging “technology”
- Introduce measures at both the European and national levels to support the expansion of renewables, including continuation of a reformed feed-in-tariff and development of 2030 renewables targets
- Avoid the construction of new conventional power plants as they are neither consistent with a low carbon energy goal nor with the need for a flexible base load power supply
- Initiate planning for and develop incentives to foster the development of a new, expanded electricity grid
- Cooperate with Scandinavia in the development of hydro pump storage capacity

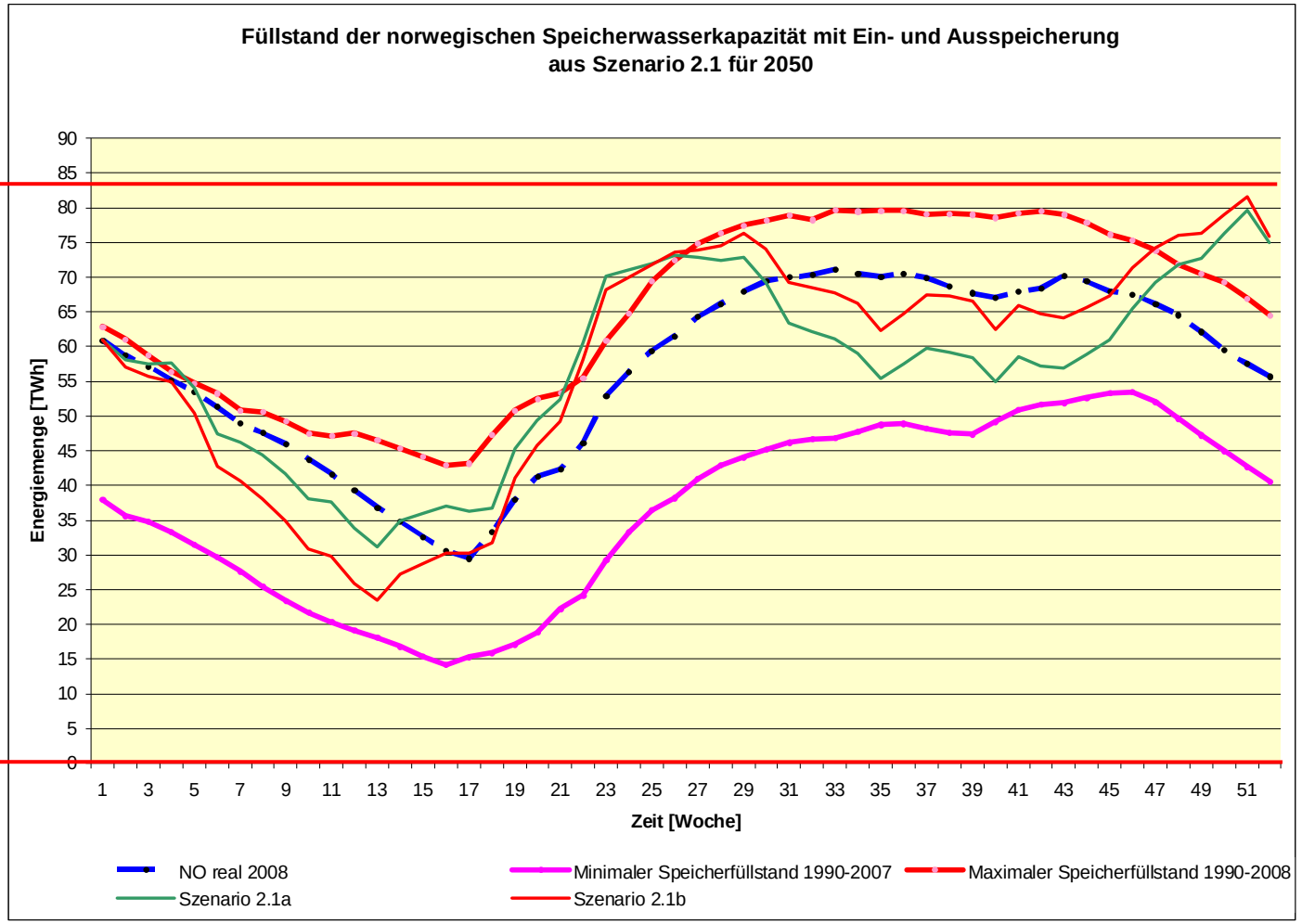
BACKUP

Pumpstorage in Norway:

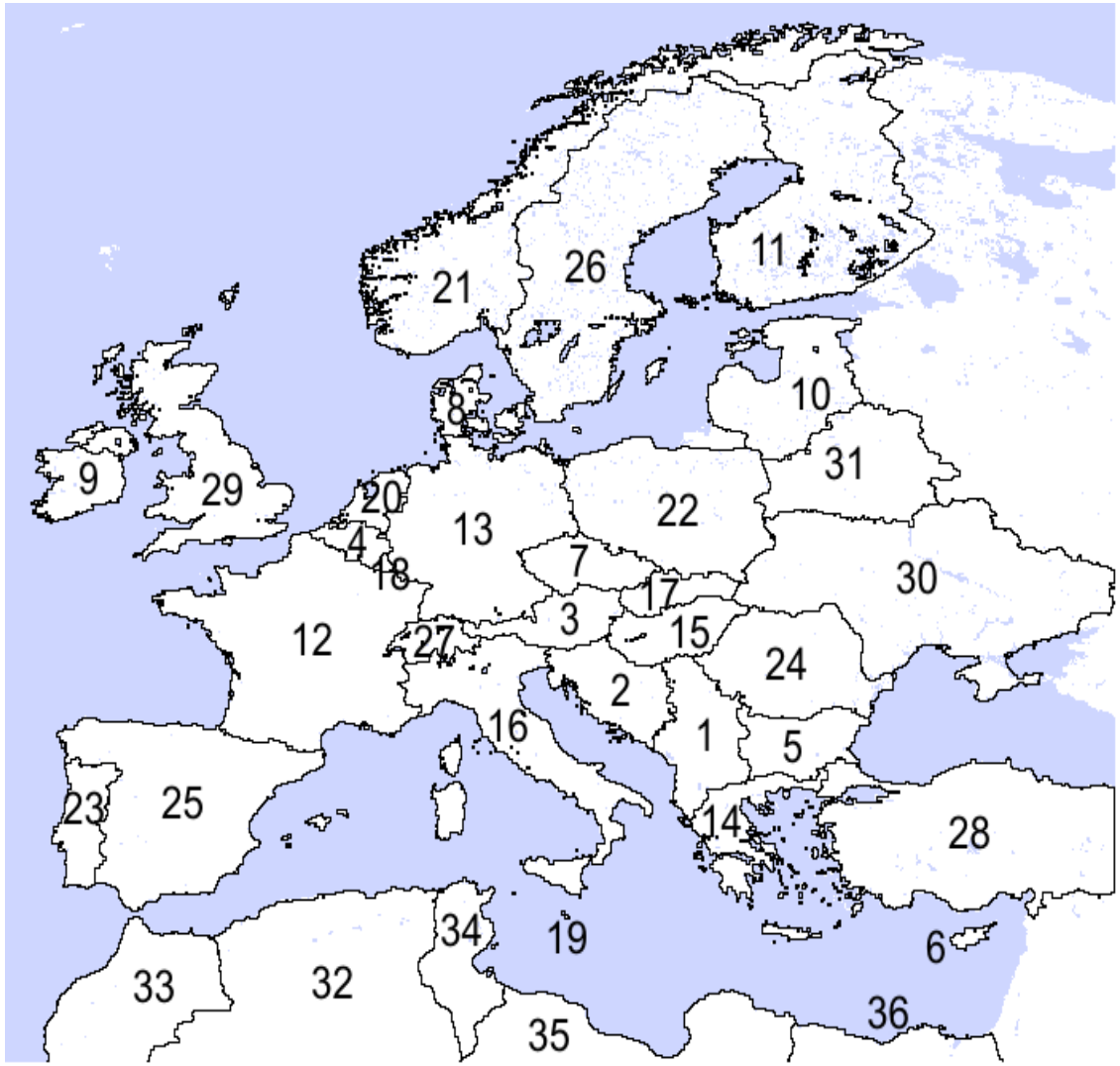
Load Management needs are anticyclical to natural fluctuation of hydropower capacity

Max. Füllstand 84 TWh

Min. Füllstand 0 TWh



DLR REMix Regions



Nr.	Land (Region)		
1	Albanien	17	Slowak. Rep.
1	Serbien	18	Luxemburg
1	Mazedonien	19	Malta
2	Bosnien	20	Niederlande
2	Kroatien	21	Norwegen
2	Slowenien	22	Polen
3	Österreich	23	Portugal
4	Belgien	24	Rumänien
5	Bulgarien	25	Spanien
6	Zypern	26	Schweden
7	Tschech. Rep.	27	Schweiz
8	Dänemark	27	Liechtenstein
9	Irland	28	Türkei[2]
10	Estland	29	Großbritannien
10	Litauen	30	Ukraine
10	Lettland	30	Moldawien
11	Finnland	31	Weißrussland
12	Frankreich	32	Algerien
13	Deutschland	33	Marokko
14	Griechenland	34	Tunesien
15	Ungarn	35	Libyen
16	Italien	36	Ägypten