Will Nuclear Energy Fare Better in a World Where Climate Change is a Priority?

The Example of Germany

Alexander Glaser
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Game Changers for Nuclear Energy, Stanford University, August 26–27, 2010

Revision 12

Will Nuclear Energy Fare Better in a World Where Climate Change is a Priority?

Effective climate change policy would handicap fossil fuels but could at the same time also promote renewables and energy efficiency

Particularly in Western Europe, climate change is seen as an opportunity for pursuing deep changes in social and economic structures

Current climate policy often privileges renewables relative to nuclear power

A Game Changer for Nuclear Energy?

Meeting –or Failing to meet– carbon emission targets without nuclear power

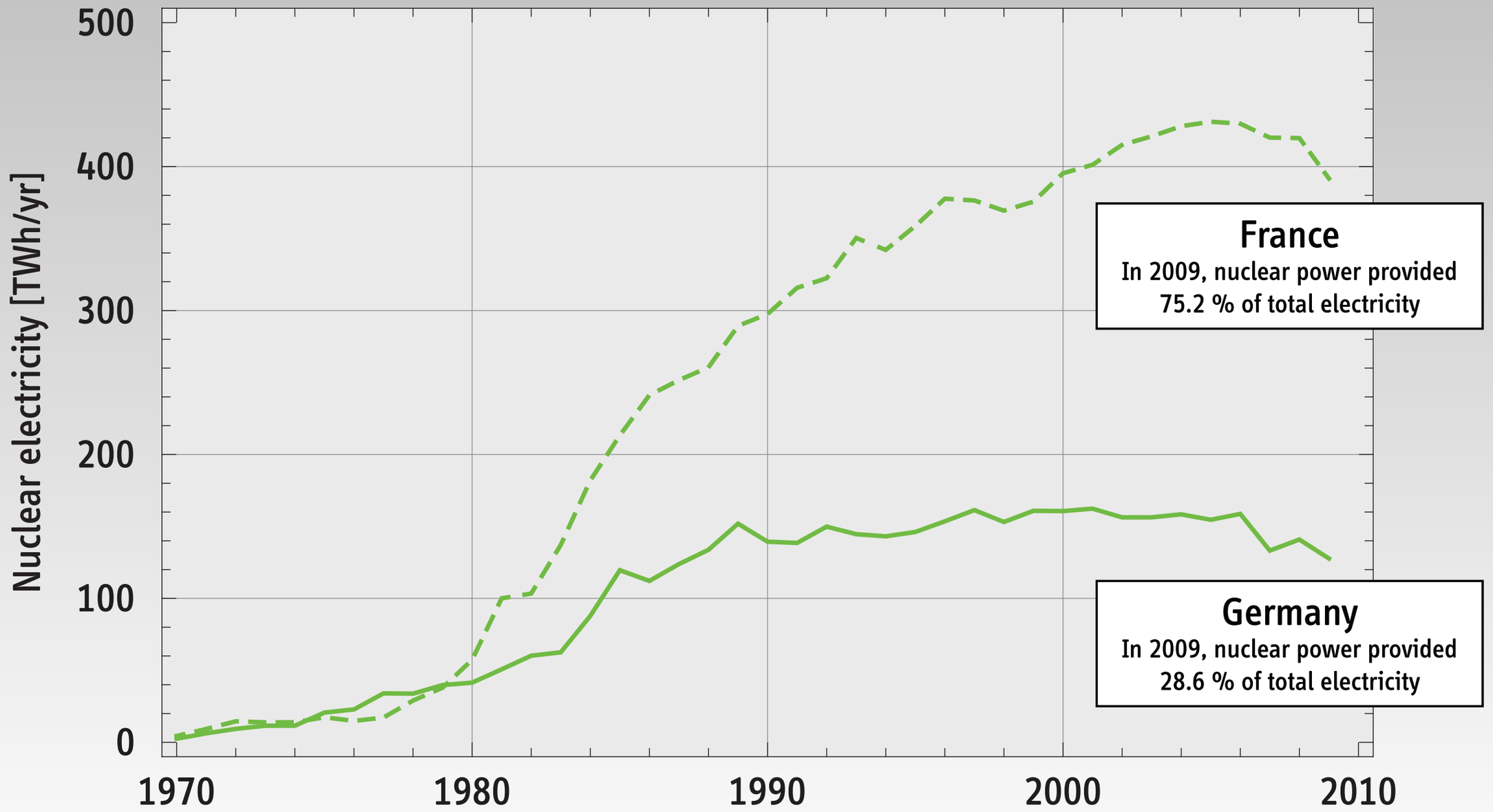
Most important implication for others: information about the hardness of the task

Most obvious candidate country today: Germany

Nuclear Power in Germany

(very briefly)

Nuclear Electricity in Germany and France



Source: Power Reactor Information System (PRIS), International Atomic Energy Agency, August 2010

Germany's Nuclear Power Program is Overshadowed by a Number of Failed Flagship Projects

Fast-Neutron Reactor Project (Kalkar, 1972–1991)

300 MWe prototype reactor nearly completed in 1985, but did not obtain operating license
Original cost estimate of plant: $150–200 million; expenditures upon cancellation: about $4 billion

Reprocessing and MOX Fabrication Plant (Wackersdorf, 1985–1989)

Strong local opposition; project cancelled when main customer signed contract with La Hague
Total expenditures upon cancellation: about $5 billion

Final Repository (Gorleben, 1977–2000)*

Ongoing debate about suitability of site; strong local opposition to project; moratorium since 2000
Spent to date: about $2 billion (compared to $6.6 billion spent on Yucca Mountain Project)

*Future of Gorleben site still unclear

Water Leakage in Asse Repository

(New Development)

Planned retrieval of about 126,000 barrels with low- and medium-level waste from repository
Expected costs: about €3.7 billion (or almost $5 billion)

Source: www.bundestag.de/presse/hib/2010_01/2010_022/01.html

Phasing Out Nuclear Energy?

"We want to achieve a secure and environment-friendly energy supply without nuclear power as soon as possible. We consider the plutonium economy a mistake."

Excerpt from the policy statement ("Berlin Program") of the Social Democratic Party
adopted in December 1989

Key Provisions of Germany's Revised Atomic Energy Law (AtG)

(in force since April 2002, after an agreement had been reached with the utilities in 2000)

- The law prohibits construction of new commercial nuclear power plants;
- It limits the remaining electricity production to 2.62 million GWh after January 1, 2000;
  This cumulative production may be reached around 2024–2025
- It prohibits sending spent fuel for reprocessing after July 1, 2005; and
- It requires construction of dry-cask storage facilities at reactor sites

Ongoing debate about removing constraints on future electricity production with existing fleet

(1.11 million GWh remained as of December 31, 2009)

Charting a Path

How is it even possible to contemplate the idea of meeting carbon emission targets without nuclear power?

Numerous Reports Released in the 2000s Explore Germany's Energy Future

Common Themes

Scope and priorities of post-2000 reports on Germany's energy future have been determined by the planned nuclear phaseout

Significant differences in findings (energy mix, energy intensity, etc.)
for developments considered most likely, but:

Strong emphasis on energy efficiency and demand reduction in all reports

As a result, both primary-energy and electricity demand
are expected drop over the next two decades (in most analyses)

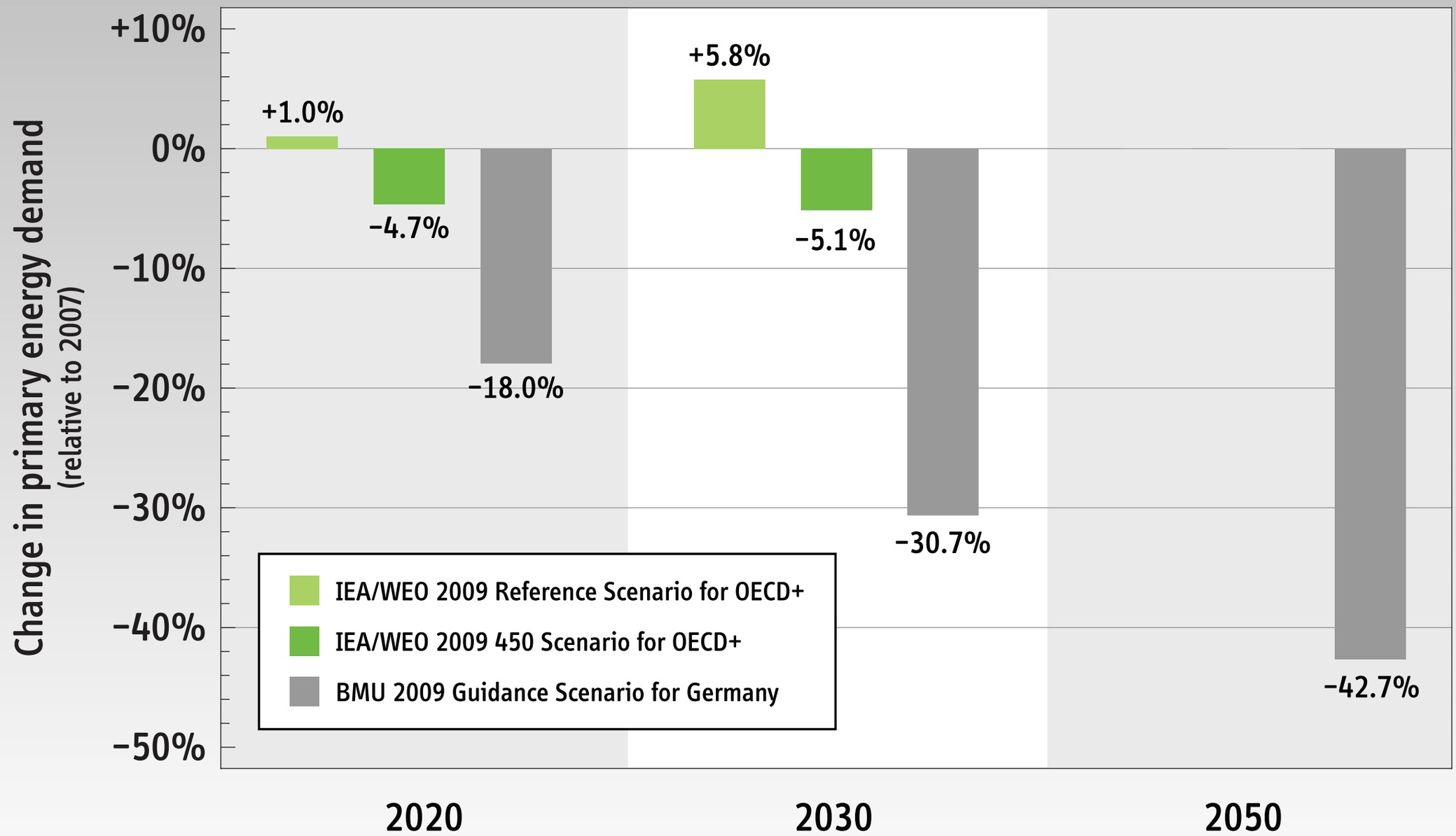
Example: 2009 BMU Guidance Scenarios

Developed by the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) in cooperation with the German Aerospace Center (DLR)

www.bmu.de/files/pdfs/allgemein/application/pdf/leitszenario2009_bf.pdf

Projected Primary Energy Demand

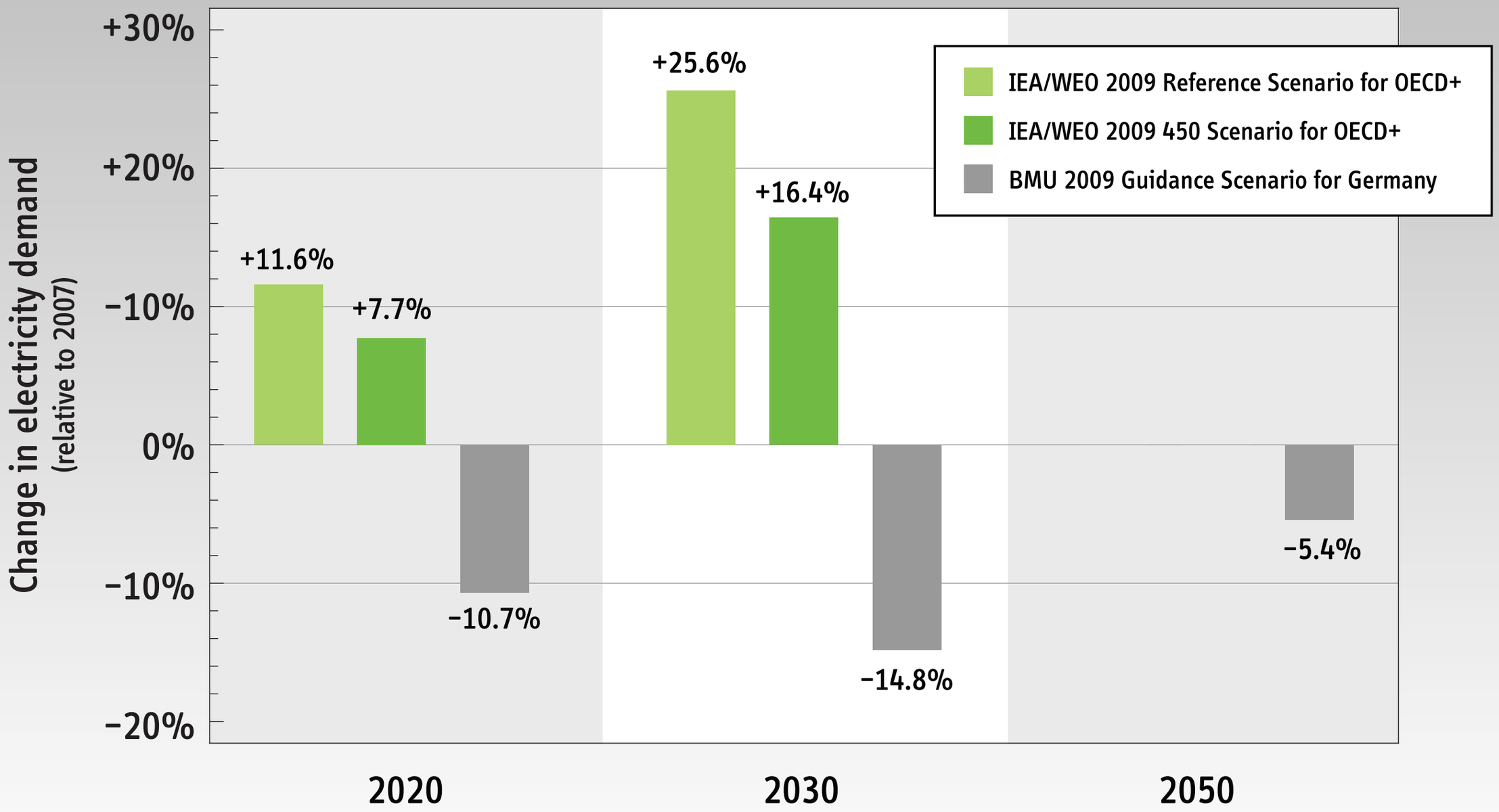
IEA/WEO Scenarios for OECD+ vs BMU Scenario for Germany, 2009



IAE/WEO data from Table 9.4, World Energy Outlook 2009

Projected Electricity Demand

IEA/WEO Scenarios for OECD+ vs BMU Scenario for Germany, 2009

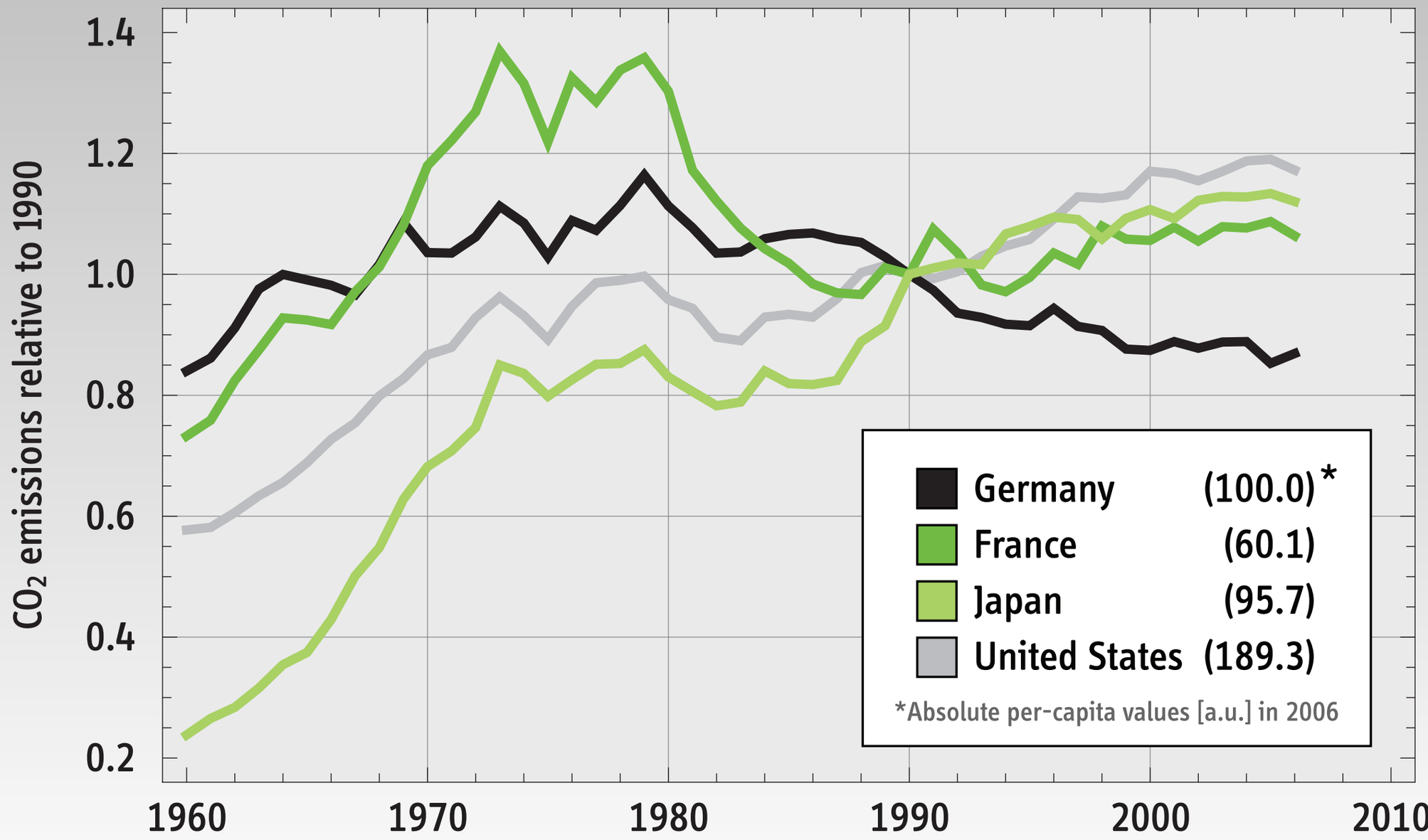


IAE/WEO data from Table 9.4, World Energy Outlook 2009

Is Germany on the Right Track?

CO_2 Emissions (vs 1990)

France's per-capita emissions are lowest but they have not decreased since 1985



Sources: Climate Analysis Indicator Tools (CAIT), World Resources Institute, cait.wri.org/cait.php; and World Bank Databank; both August 2010

Is Germany on the Right Track?

It is too early to tell ... and quite possibly it is not

Some interim goals have been met, but others not

1995: To reduce GHG-emissions by 25% in 2005* ***-- Not met***
1997: To reduce GHG-emissions by 21% in 2008–12* (averaged) ***-- Likely to be met***
2007: To reduce GHG-emissions by 40% in 2020* ***-- ???***

*All target values relative to 1990
Milestones quoted from "Modell Deutschland" Report, 2010

Example: German Energy Conservation Act (EnEV) from 2009

with certain exceptions, prohibits the use of electric storage heaters after 2019

In contrast, 70–80% of new homes built in France are equipped with electric heating

French electricity demand in Winter: +2.1 GW/|°C| in 2009 expected to increase to +2.5 GW/|°C| in 2025

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www.edfenergy.com/products-services/for-your-home/our-services/home-improvements.shtml, retrieved August 18, 2010

Will Nuclear Power Survive in Germany?

Intermittent Renewables and Nuclear Power
(and the Question of Load-Following)

Controversial debate about the "compatibility" of renewables and nuclear power on an electric grid characterized by highly volatile demand of residual load

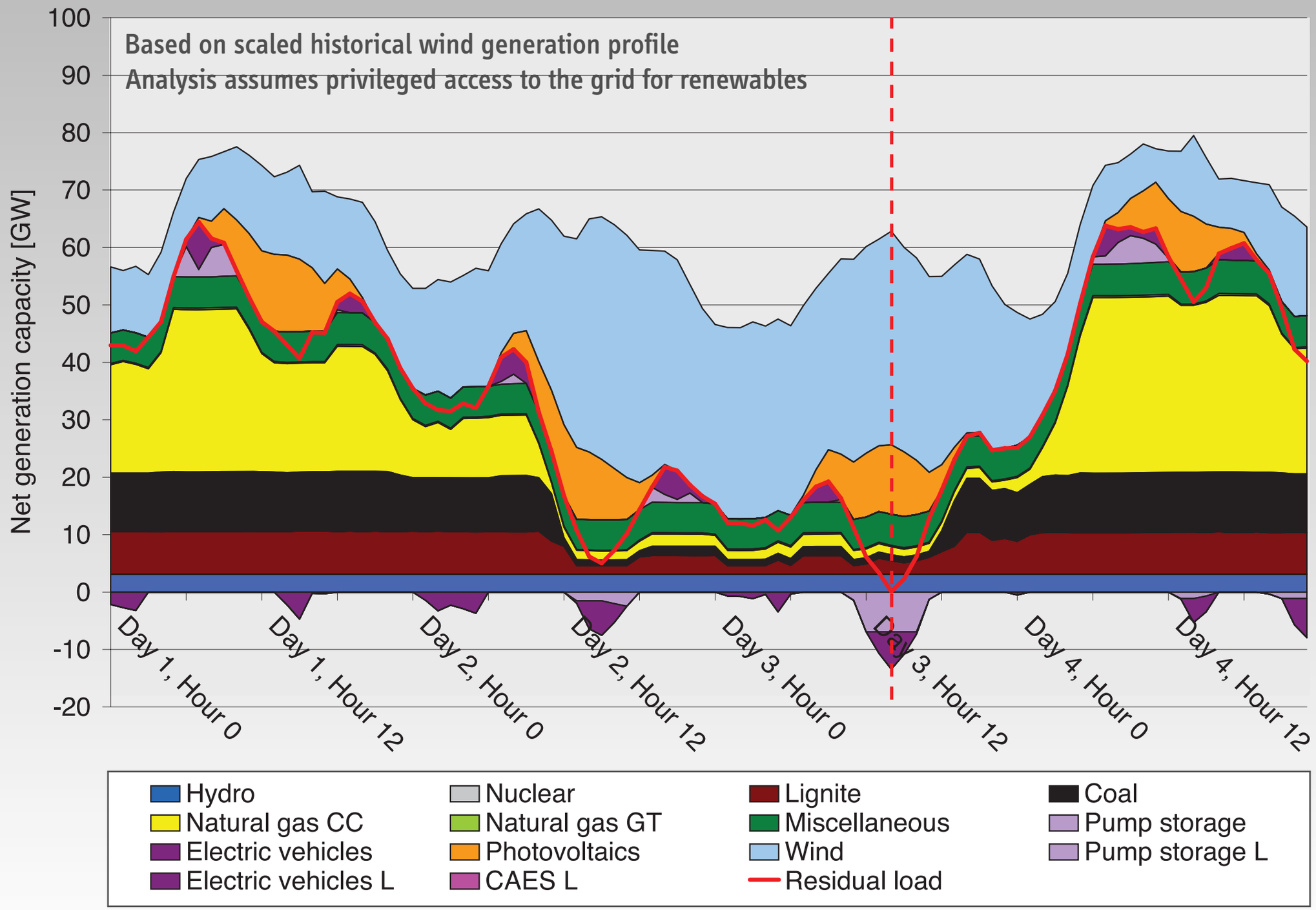
Findings from an IER report commissioned by the European utility E.ON

M. Hundt, R. Barth N. Sun, S. Wissel, and A. Voss,
Verträglichkeit von erneuerbaren Energien und Kernenergie im Erzeugungsportfolio,
Institut für Energiewirtschaft und Rationelle Energieanwendung (IER),
University of Stuttgart, October 2009

English summary of report available at:
www.ier.uni-stuttgart.de/publikationen/pb_pdf/Hundt_EEKE_Summary.pdf

Unit Commitment and Dispatch, 2030

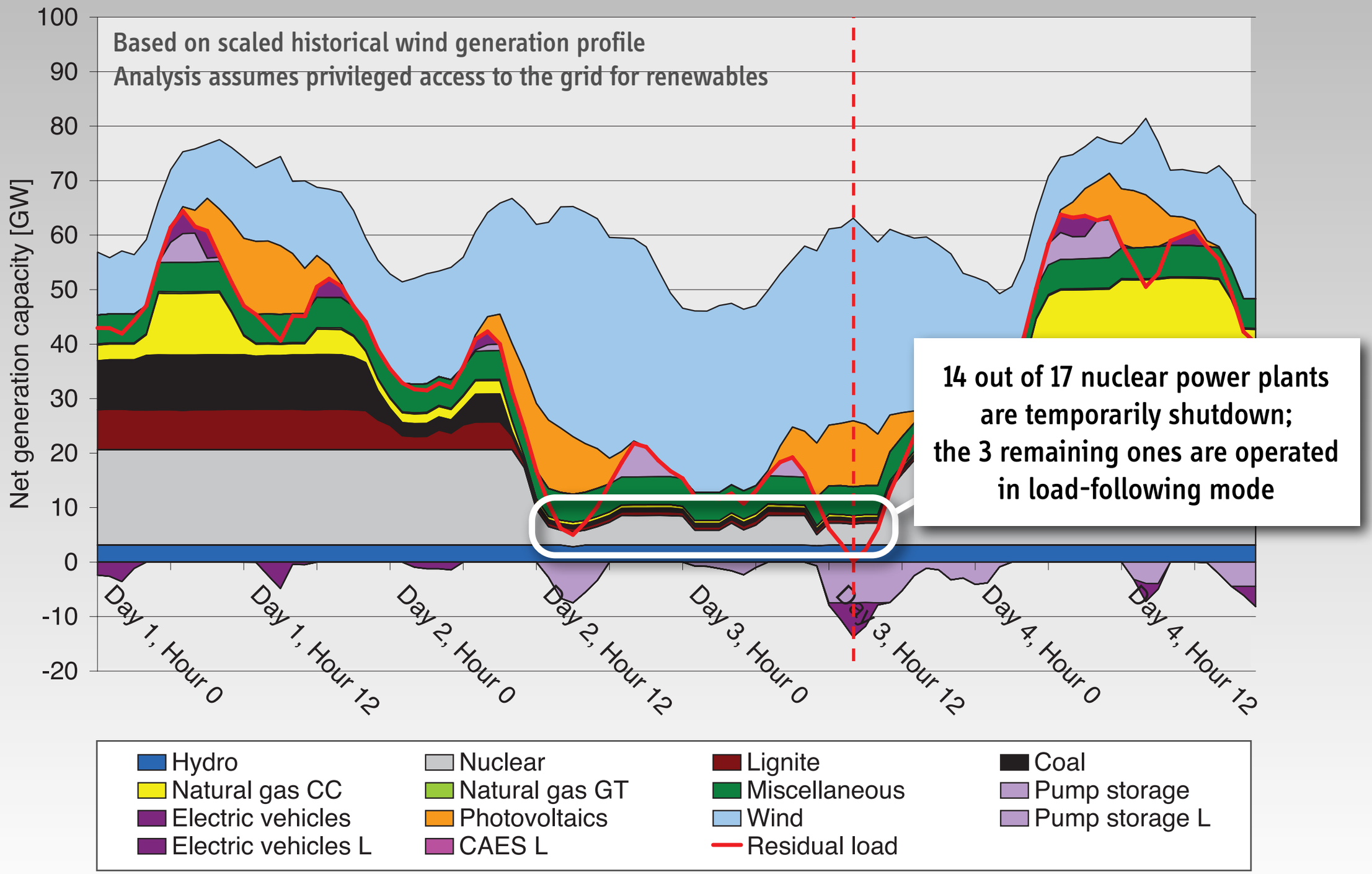
Period of lowest residual load in nuclear phaseout scenario



Source: M. Hundt et al., *Verträglichkeit von erneuerbaren Energien und Kernenergie im Erzeugungsportfolio*, IER, University of Stuttgart, 2009

Unit Commitment and Dispatch, 2030

Period of lowest residual load in nuclear life-extension scenario

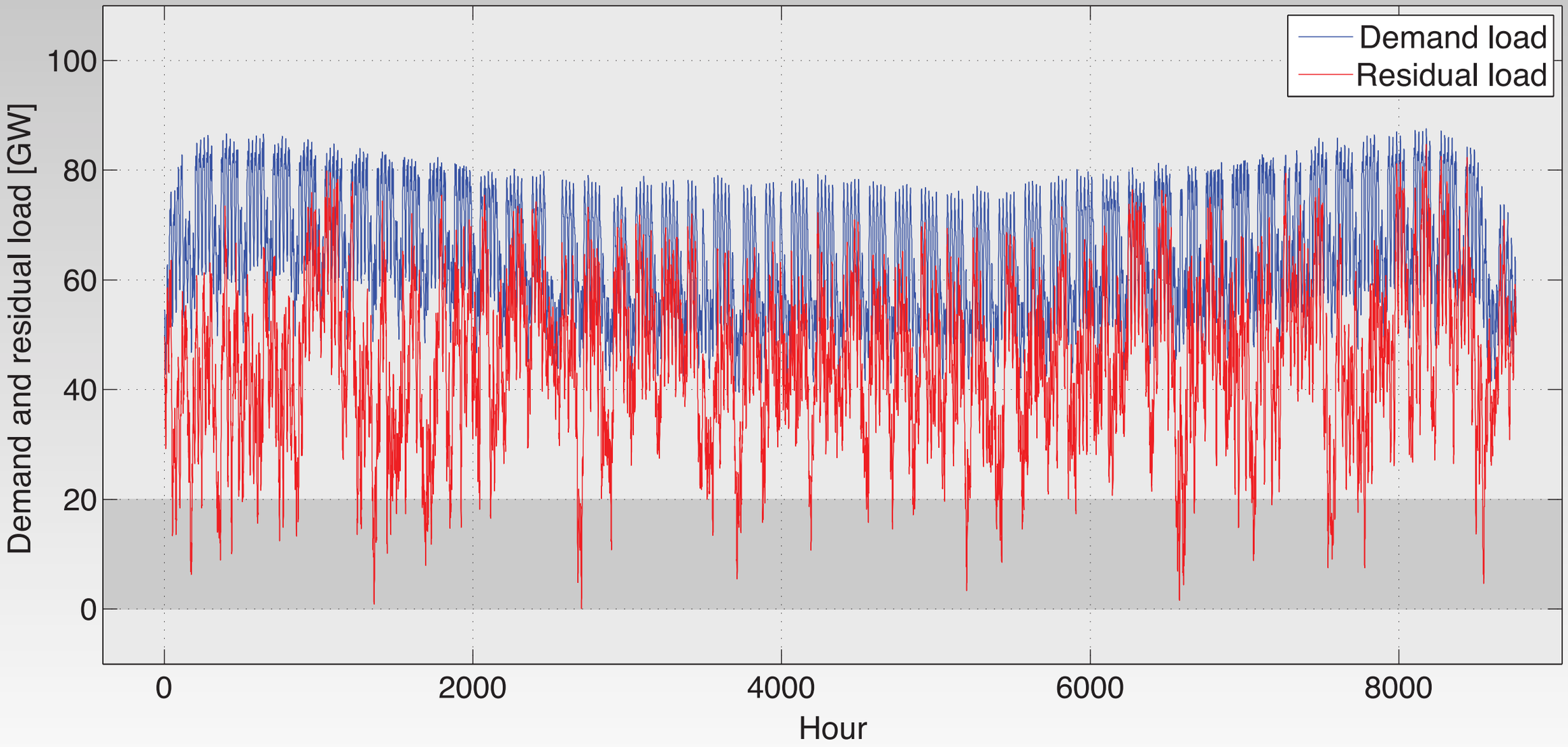


Source: M. Hundt et al., *Verträglichkeit von erneuerbaren Energien und Kernenergie im Erzeugungsportfolio*, IER, University of Stuttgart, 2009

Dynamics of Demand and Residual Load

Projection for the year 2030 based on scaled historic wind generation profile

(Residual load drops below 20 GW more than 50 times per year)



Source: M. Hundt et al., *Verträglichkeit von erneuerbaren Energien und Kernenergie im Erzeugungsportfolio*, IER, University of Stuttgart, 2009

Volatility of Residual Demand

IER report concludes that Germany's existing nuclear fleet can handle load-following even if up to 40% of electricity production is supplied by intermittent renewables

The report also finds that life-extensions would be economic and help meet carbon-emission targets

BUT

If current deployment plans for renewables are implemented, residual electricity demand drops below 20 GW in 2030 more than 50x per year

In the period of lowest demand, residual demand is expected to drop to virtually zero

Economic case for Finland's EPR (Olkiluoto) was based on capacity factor of more than 90%

Finnish EPR Olkiluoto 3: The World's First Third-Generation Reactor Now Under Construction, AREVA Press Kit, April 2007

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(Some Concluding Observations)

Triggered by the plan to remove one low-carbon energy source from the portfolio, national energy debates and policy-making have (in the case of Germany) led to:

- Strong focus on energy efficiency and demand reduction
- Privileged support and deployment of renewables

German utilities are already aware of expected low minima and high volatility of residual electricity demand in 2020–2030

Possible removal of provisions from the current Atomic Energy Act would delay phaseout, but new construction of nuclear power plants in Germany appears very unlikely today, as new plants would have to operate in load-following mode