Germany's electricity market

Workshop on Demand Response
October 15th, 2013

hosted by PG&E in San Francisco

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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Agenda

- Target and current state of the Energiewende
- Challenges of the Energiewende
- Germany's electricity market design

Targets for the Energiewende in Germany

		2020	2030	2040	2050
Climate	Greenhouse gases (vs. 1990)	- 40%	- 55%	- 70%	- 80 to - 95%
Renewable energies	Share of electricity	35%	50%	65%	80%
	Overall share (Gross final energy consumption)	18%	30%	45%	60%
Efficiency	Primary energy consumption	- 20%	● ● ● ● ● ● ● ● ● ● ● ● ● ▶		- 50%
	Electricity consumption	- 10%			- 25%
	Energy consumption in buildings	20% heat demand			80% primary energy

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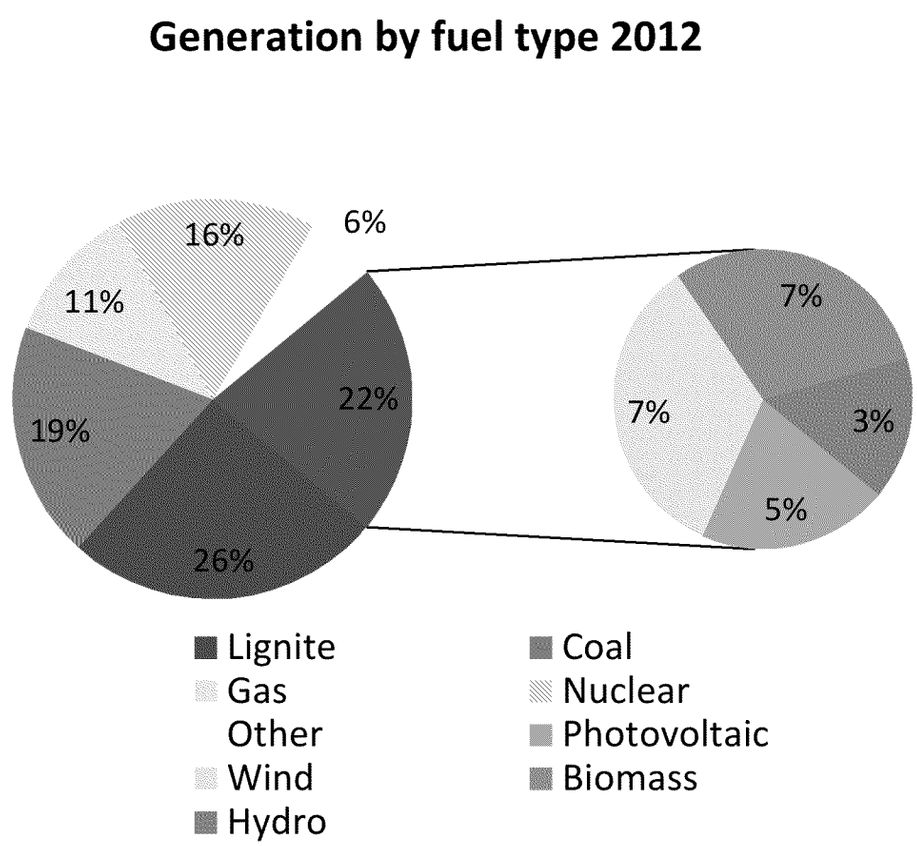
Current state of Germany's Energiewende

2012	Capacity (GW)	Energy (TWh)
Renewables		
Photovoltaic	32	28
Wind	31	46
Hydro	4	21
Biomass	6	36
Geothermal	0	0
Conventional		
Nuclear	13	100
Hard Coal	30	118
Brown Coal	25	159
Gas	24	70
Storages		
Pumped Storage Hydro	7	
TOTAL		**618**



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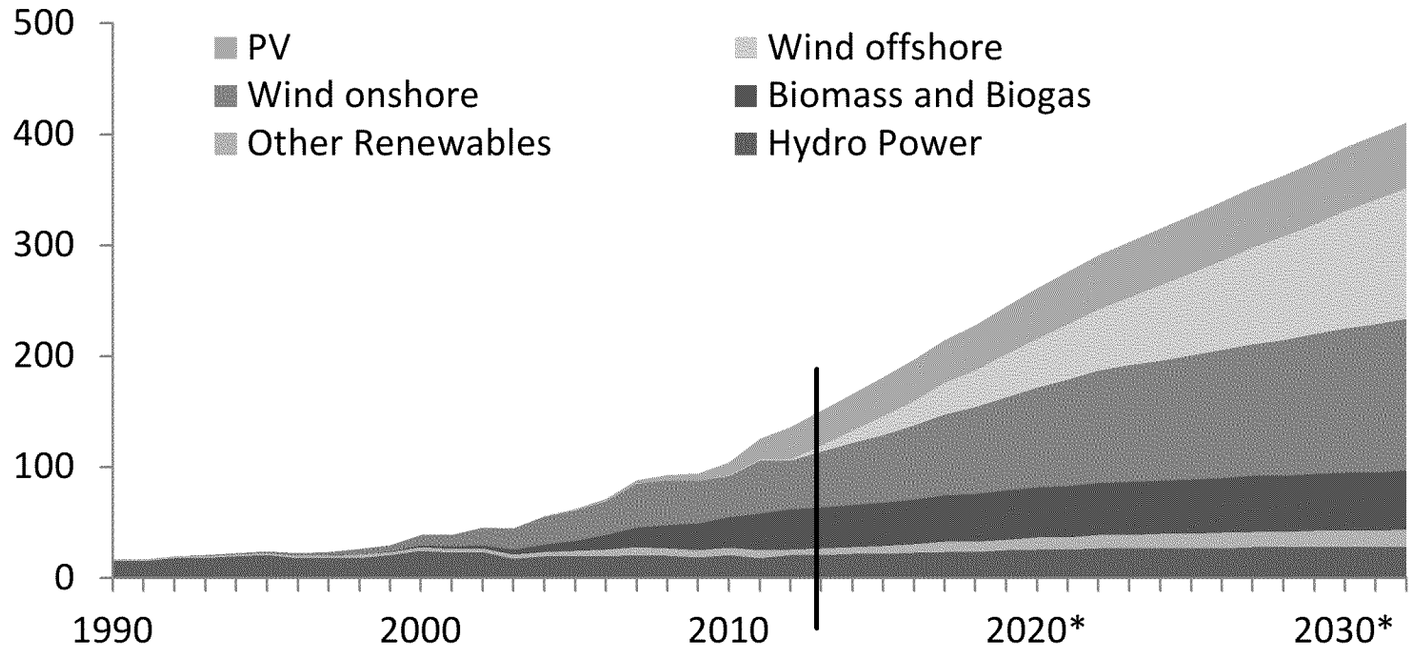
Germany's Energiewende
„it's all about wind and solar"

RES-Power Generation in Germany, TWh



	2000	2010	2020*	2030*
% Renewables	**7%**	**17%**	**43%**	**63%**
% Wind and PV			29%	48%

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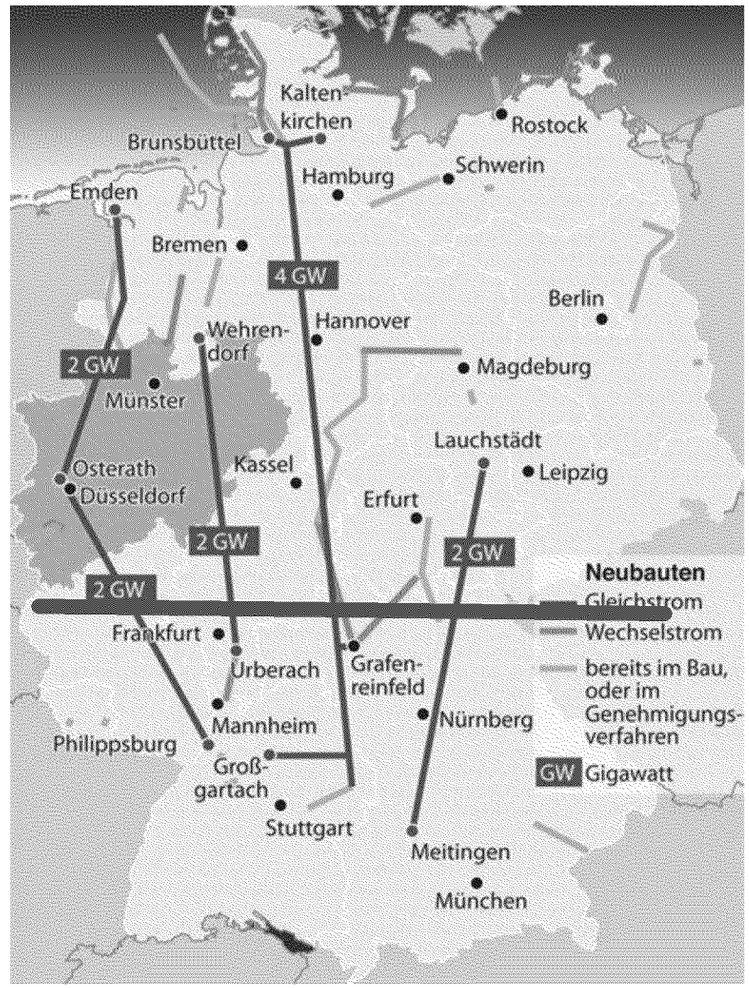
The transmission challenge

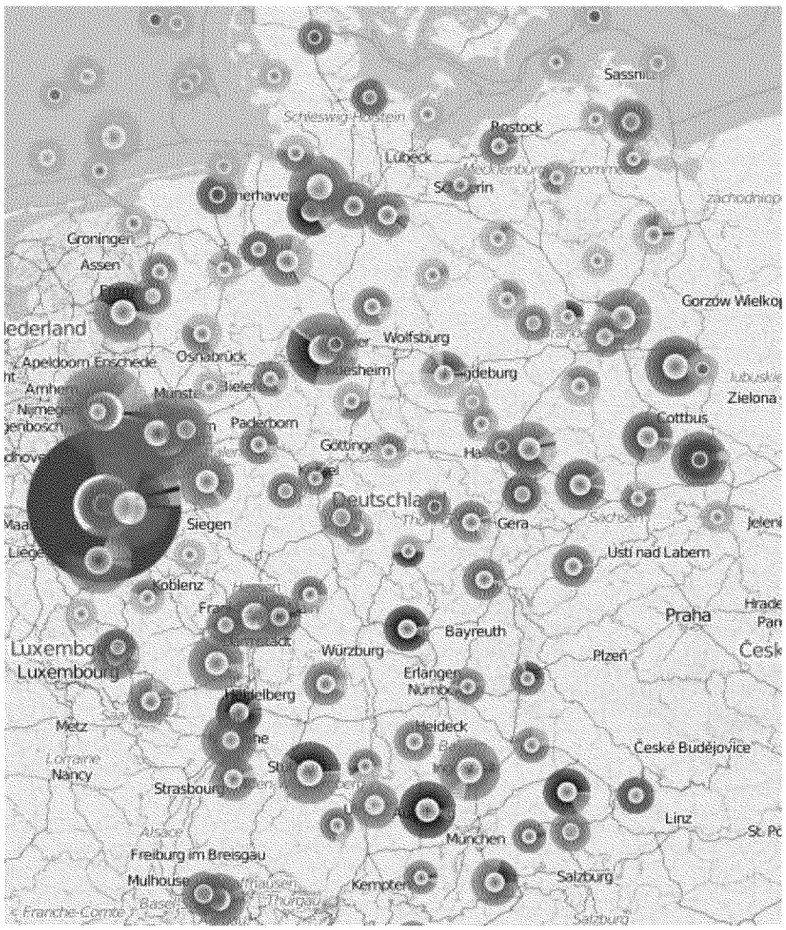
Decentralized and volatile generation sets new requirements for the **grid infrastructure**: connection of regions with strong wind generation in the North with high-demand regions in the West and South

Ten-year **grid development plans** (NEPs) by TSOs 2012: **2800 km of new transmission lines** and 2900 km of optimization and strengthening of existing lines, main focus on North-South corridors

Short term redispatch solution to address north-south congestion: “Grid Reserve” (outside the EOM)



The adequacy challenge



Conventional Capacity 2013: **104.8 GW**

Peak Demand 2012: **88.6 GW**

Firm capacity 2013: **97 GW**

Foreign supply: **2 GW**

DSM: **1.1 GW**

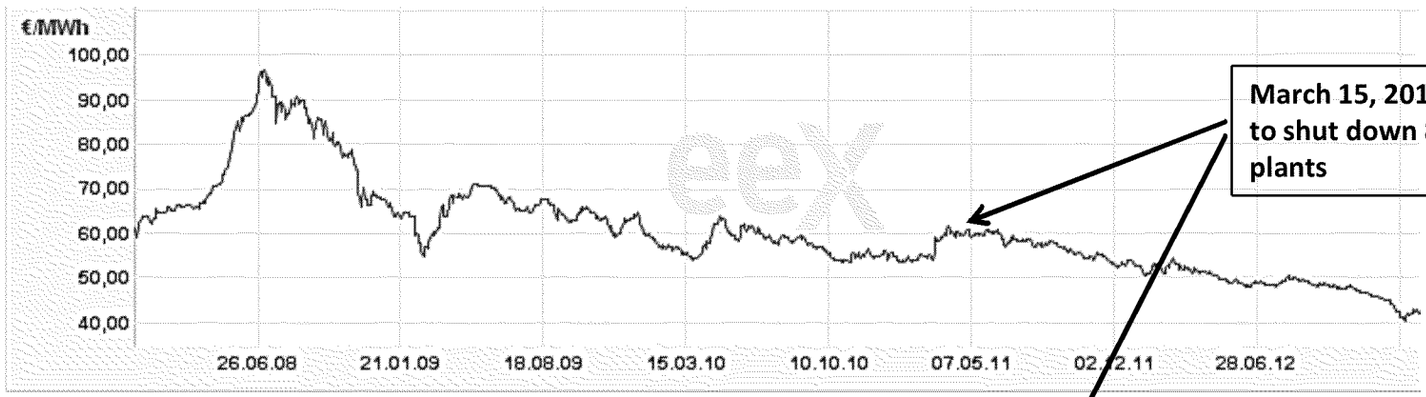
Grid reserve: **1 GW**

→ Excess capacity 2013: **12.4 GW**

→ Excess capacity 2024: **6.6 GW**

Electricity prices on the wholesale market

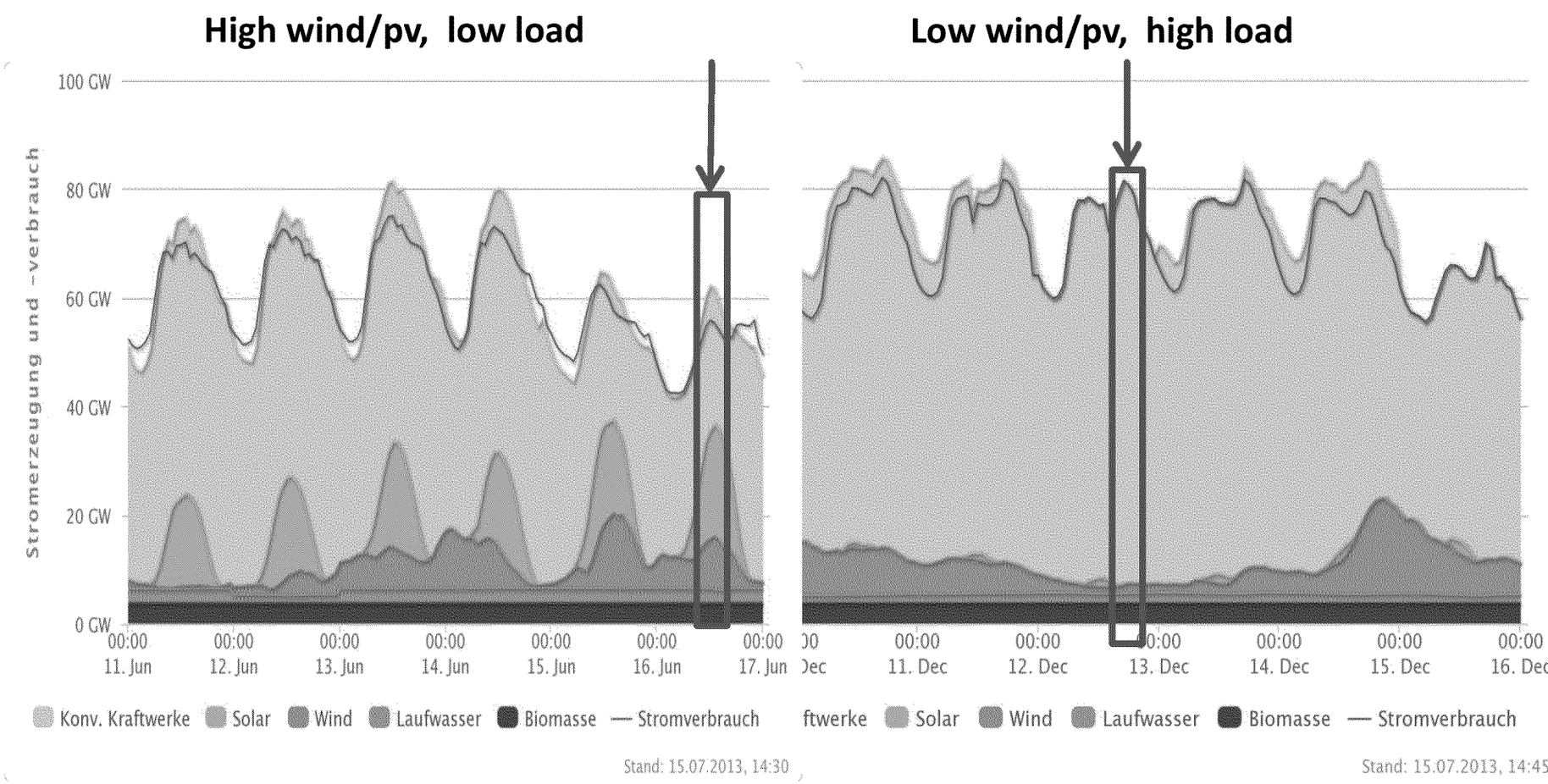
Price of a 2014 baseload future at the EEX



March 15, 2011: Decision to shut down 8 nuclear plants

Price of a 2014 Peakload future at the EEX

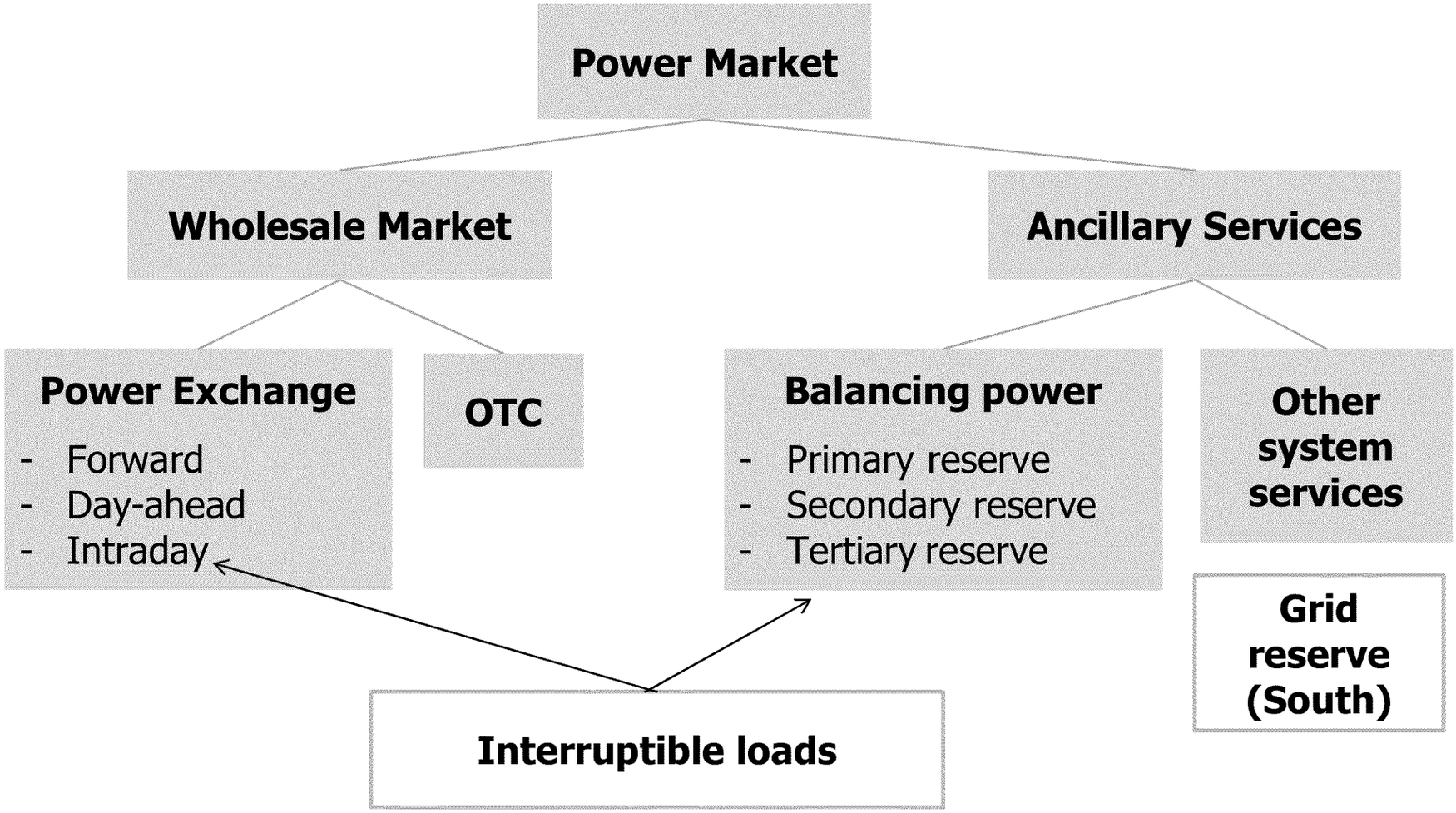
The flexibility challenge



The flexibility challenge

Flexibility options	High wind/pv, low load:	Low wind/pv, high load:
Grid	Export	Import
Flexible supply	Reduce must-run Curtail wind/pv	Flexible thermal power plants
Flexible demand	Switch on load (incl. heat)	Switch off load
Storage	Charge storage	Empty storage

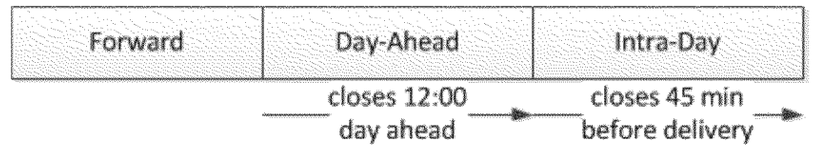
Germany's Energy-Only Market



Balancing of wind and solar energy

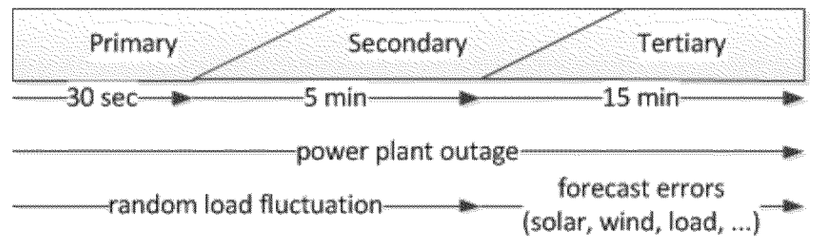
Scheduling wind & solar energy

- Wind and solar is sold by the **TSO** or **independent marketers** on the day-ahead market.
- Sellers update their **forecast intraday** and sell/buy the differences accordingly



Balancing wind & solar energy in real-time

- Random fluctuation is balanced in real-time through **primary and secondary reserve.**
- Imbalances caused by forecast errors are balanced through **tertiary reserves**.



Additional instruments

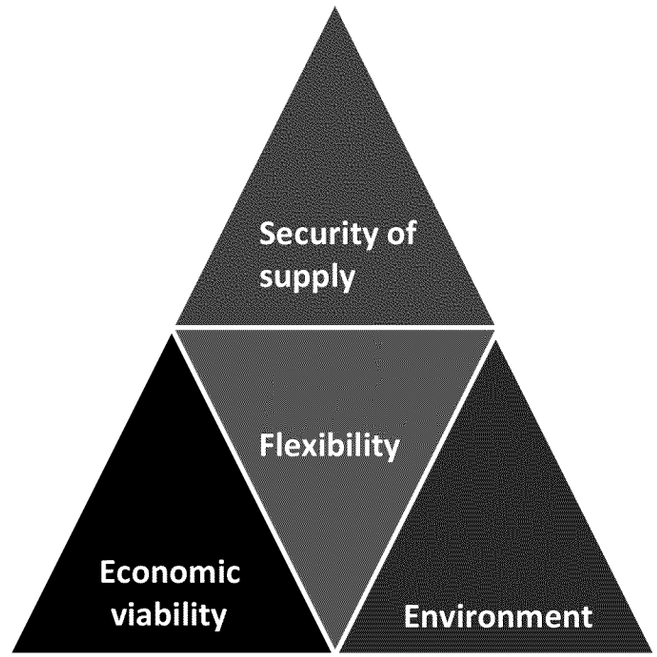
- Ordinance governing **interruptible loads**
- Ordinance governing **grid reserves** (outside EOM, in the South only)

Ordinance governing industrial loads

- Introduced in 2013, the ordinance aims to **increase the market participation of industrial loads**
- Industrial loads can be dispatched by the TSO due to high energy prices, grid congestions ("redispatch") or as an alternative to tertiary reserve

Basic characteristics	
[redacted]	
Positive / negative Power	Positive only
[redacted]	
Availability	100% except for 4 days/month
[redacted]	
Voltage Level	110kV
[redacted]	
Aggregation	Limited to 5 loads at the same high voltage connection point
[redacted]	

Optimizing the EOM



Conclusions

- Energiewende is an ambitious endeavor. Many opportunities. Many challenges.
- Supply and demand must become more flexible, also market coupling will play a major role in balancing intermittent RES-E generation.
- The electricity market provides adequate capacity through 2022, without a capacity market.
- Regional transmission congestions must be fixed.
- Optimized electricity market can be supported by CO2 price/standards, market compatible RES-E policy and a strategic reserve.

Thank you!

Backup

Energy markets and demand response

	Description	Demand Response?
Energy Market	Market is divided into Forward, Day-Ahead, Intra-Day	low DR participation due to low peak prices
Ancillary Services	Market is divided into Primary, Secondary, Tertiary reserve	low DR participation due to low prices and market barriers
Ordinance governing grid reserves („winter reserve for south Germany“)	Introduced in 2013 to increase Reliability in South Germany	not applicable for demand response
Ordinance governing interruptible loads	Introduced in 2013, partly similar to the Base-Interruptible-Program in California	high market barriers, only applicable for industrial loads with constant(!) load profile

Typically, load management is used in commercial and industrial facilities to reduce peak demand.

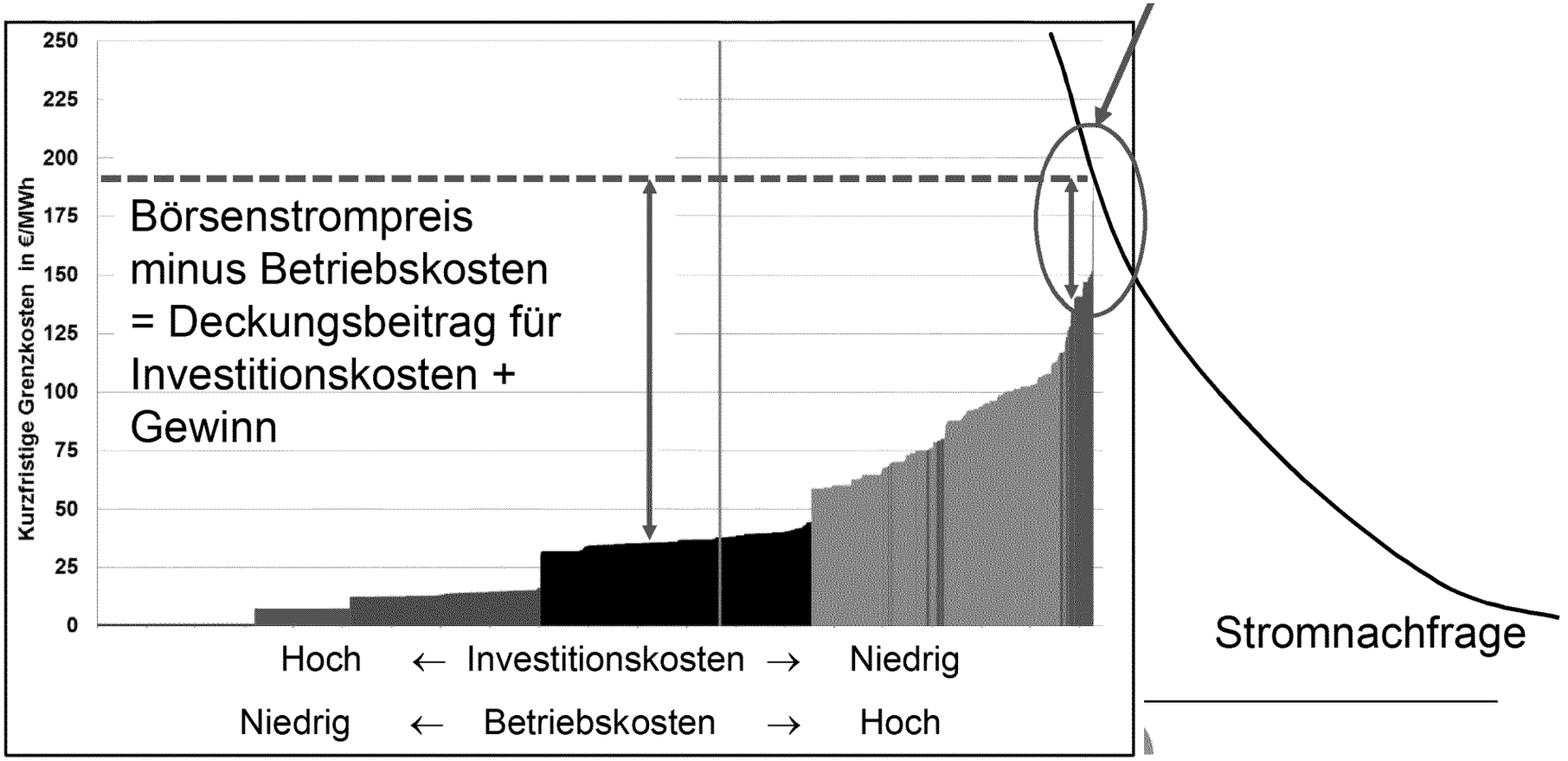
Germany has no bilateral/central capacity market. For generators the only revenue stream comes from energy market and ancillary services market.

History

- 1998: Liberalization of Germany electricity market
- 2000: Germany Renewable Energy Law
  - Introduction of Feed in Tariffs for Photovoltaic, Wind energy, Biomass, etc.
- 2010: Federal Government's energy concept
  - energy transition to 35% renewable energy by 2020 and 80% renewable energy by 2050
- 2011: Amendment to the German Atomic Energy Act
  - Immediate phase-out of 8 nuclear power plants
  - Stepwise phase-out of the remaining 9 nuclear power plants until 2022
- 2013: Ordinance governing industrial loads
  - First demand response program for industrial loads

Kraftwerke refinanzieren sich bei Preisspitzen

- Alle Kraftwerke refinanzieren Investition wenn am windstillen Winterabend abschaltbare Lasten oder Netzersatzanlagen Preisspitzen setzen



Two (of many) regulatory challenges in Germany

- Resource adequacy
  - Challenges
    - Variable renewables do not lower Germany's peak load in winter
    - Phase-out of nuclear power plants create a bottleneck in South Germany
    - Power plants are facing the "missing money"-problem
  - Regulatory status quo
    - Generators receive their revenues from energy market or ancillary services
    - Ordinance governing grid reserves (stand-by reserves for South Germany) has been implemented
  - Discussions
    - Implementation of a capacity market?
    - Role of demand response to cover peak demand?

- Ancillary services
  - Challenges
    - Variable renewable energy will increase the need for balancing power
    - Conventional power plants must run in operation mode to offer balancing power
  - Regulatory status quo
    - Design of ancillary service is still oriented on the characteristics of conventional power plants
  - Discussion
    - Further refinement of product definitions to enhance participation of demand response and variable renewables

2.b. Flexibility

Physically flexible enough ≠ economically efficient

An efficient energy system minimizes

- Production costs
- Social and environmental costs
- Costs due to must-run capacity (negative prices)

An efficient energy system consists of

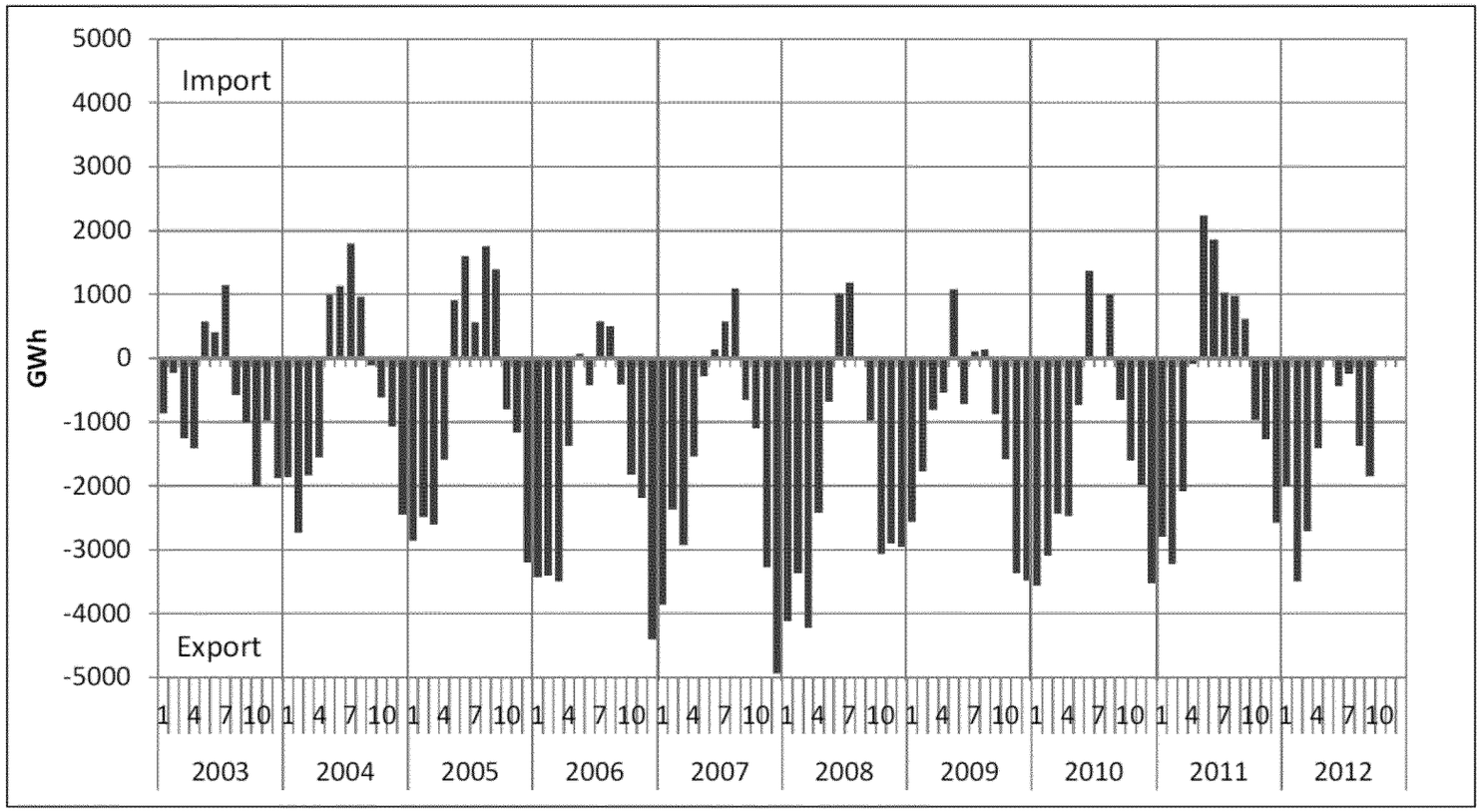
- Little must-run capacity,
- DSM, storage, interconnectors,
- Integrated renewable energies,
- Smart infrastructure,
- And is embedded in the European internal energy market.

3. Measures

How to foster an efficient system?

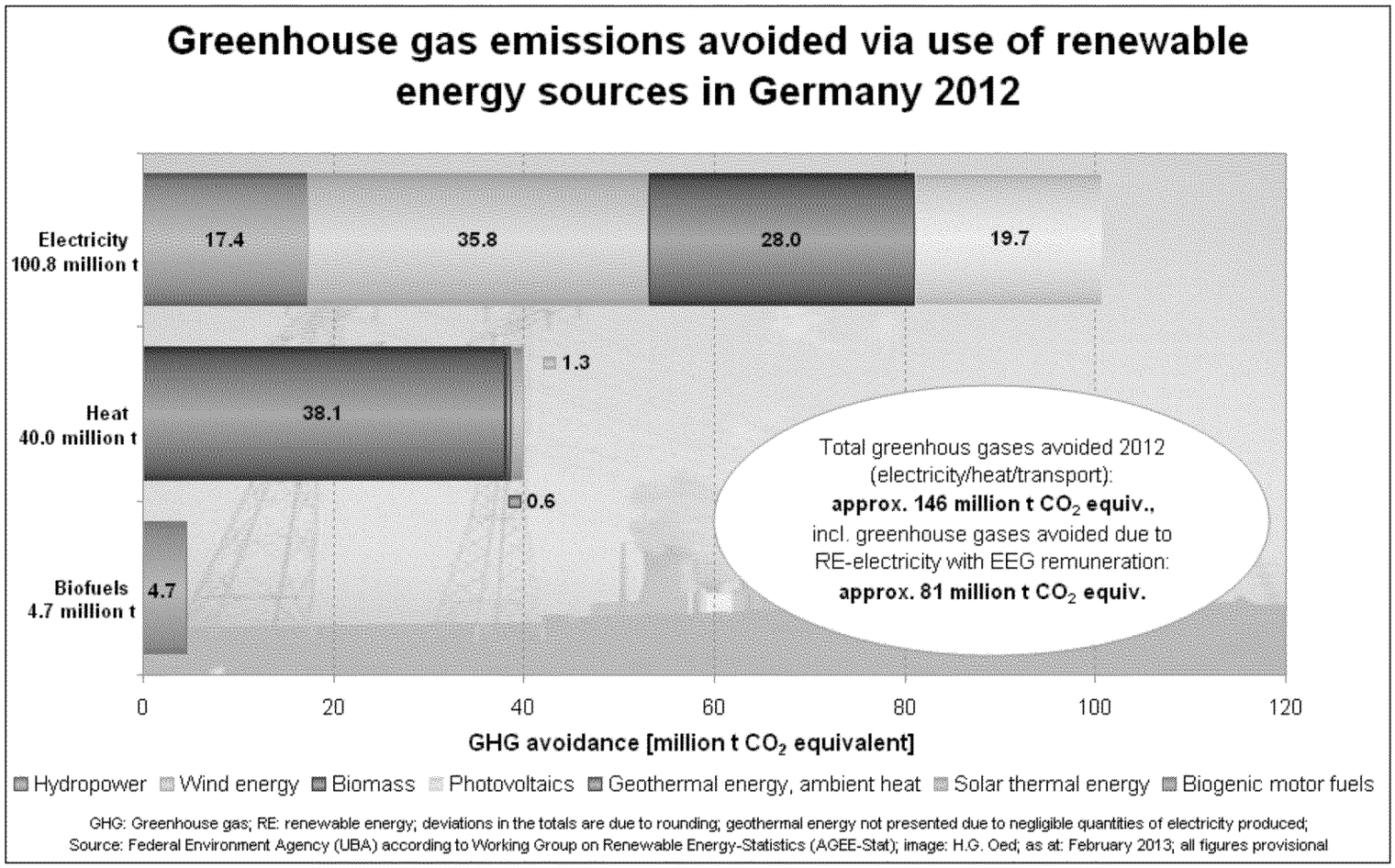
- Reduce barriers to competition, at home & across borders
- Complete the internal energy market, market coupling
- Internalize external costs to complete the price signal
- Integrate RES into the market
- Promote demand side participation, flexibility options (see 10/2012 Report of the Renewable Energies Platform WG Interaction).
- No capacity markets for must-run capacity

2) Germany is not relying on electricity imports due to the nuclear phase-out, but is exporting electricity



Quelle: *ENTSO-E, Berechnungen des Öko-Instituts*

Benefits



GHG: Greenhouse gas; RE: renewable energy; deviations in the totals are due to rounding; geothermal energy not presented due to negligible quantities of electricity produced;
Source: Federal Environment Agency (UBA) according to Working Group on Renewable Energy-Statistics (AGEE-Stat); image: H.G. Oed; as at: February 2013; all figures provisional

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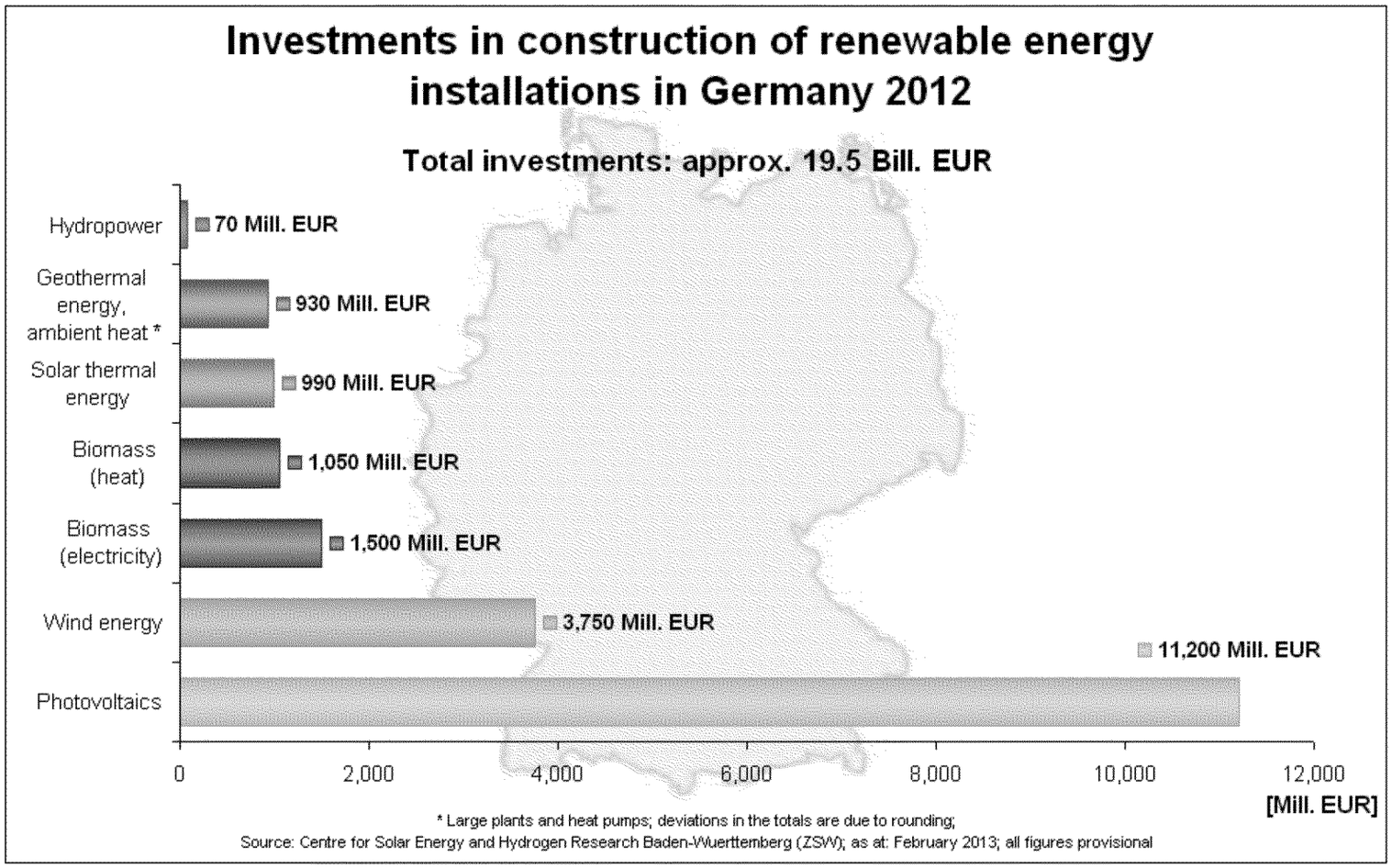
Benefits



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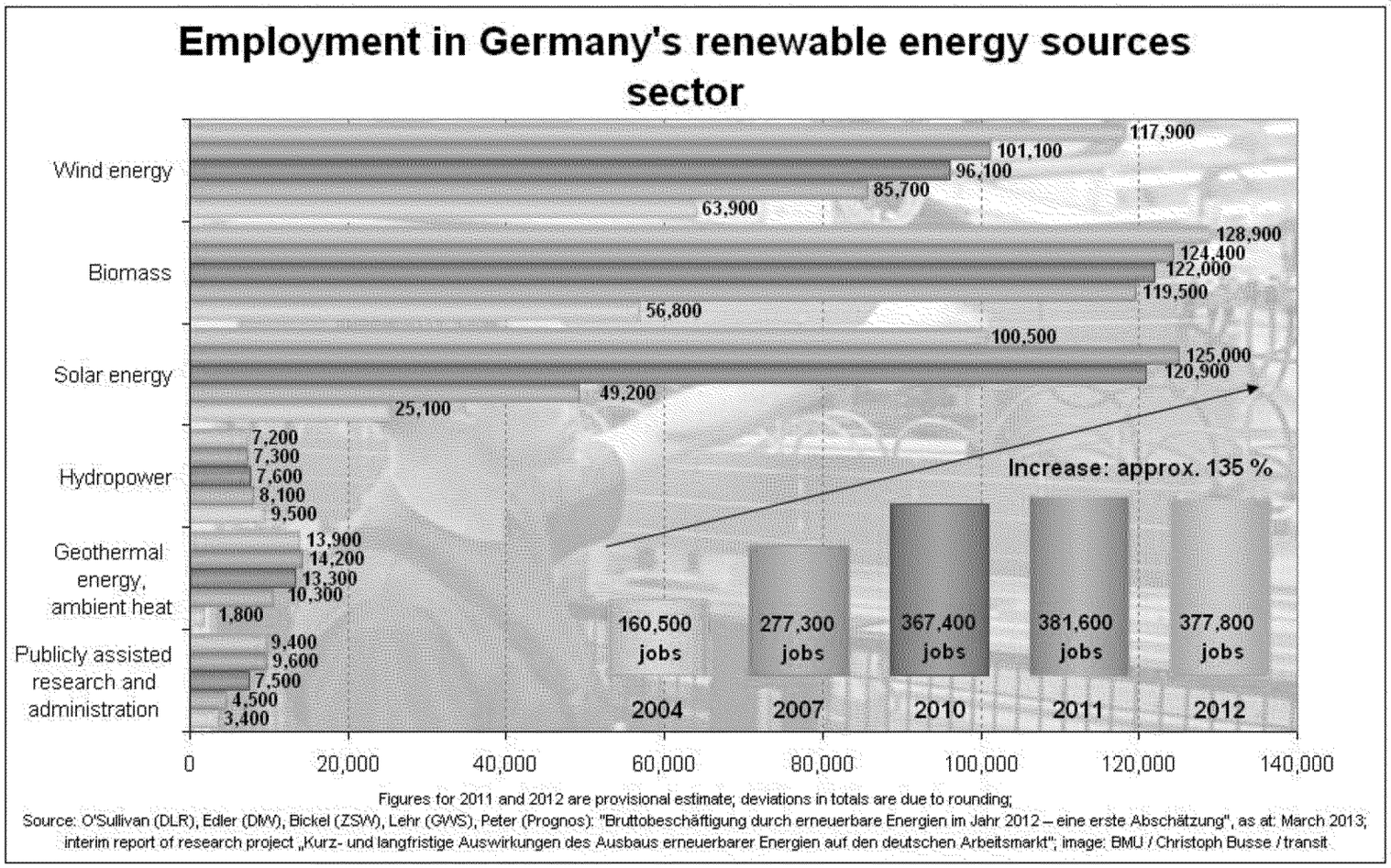
Benefits



Figures for 2011 and 2012 are provisional estimate; deviations in totals are due to rounding;
Source: O'Sullivan (DLR), Edler (DIW), Bickel (ZSW), Lehr (GWS), Peter (Prognos): "Bruttobeschäftigung durch erneuerbare Energien im Jahr 2012 – eine erste Abschätzung", as at: March 2013; interim report of research project „Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt"; image: BMU / Christoph Busse / transit

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Anpassung des Marktdesigns: Marktkopplung im Day-Ahead

Optimale Auslastung der Grenzkuppelstellen

Reduzierung der Preisvolatilität

Preiskonvergenz der Marktgebiete bei ausreichender Grenzkapazität (60% der Stunden in 2011)

Glättende Wirkung auf negative bzw. positive Preisspitzen

Übergriff extremer Wetterverhältnisse (z.B. Kältewelle, Sturmfront) auf andere Marktgebiete

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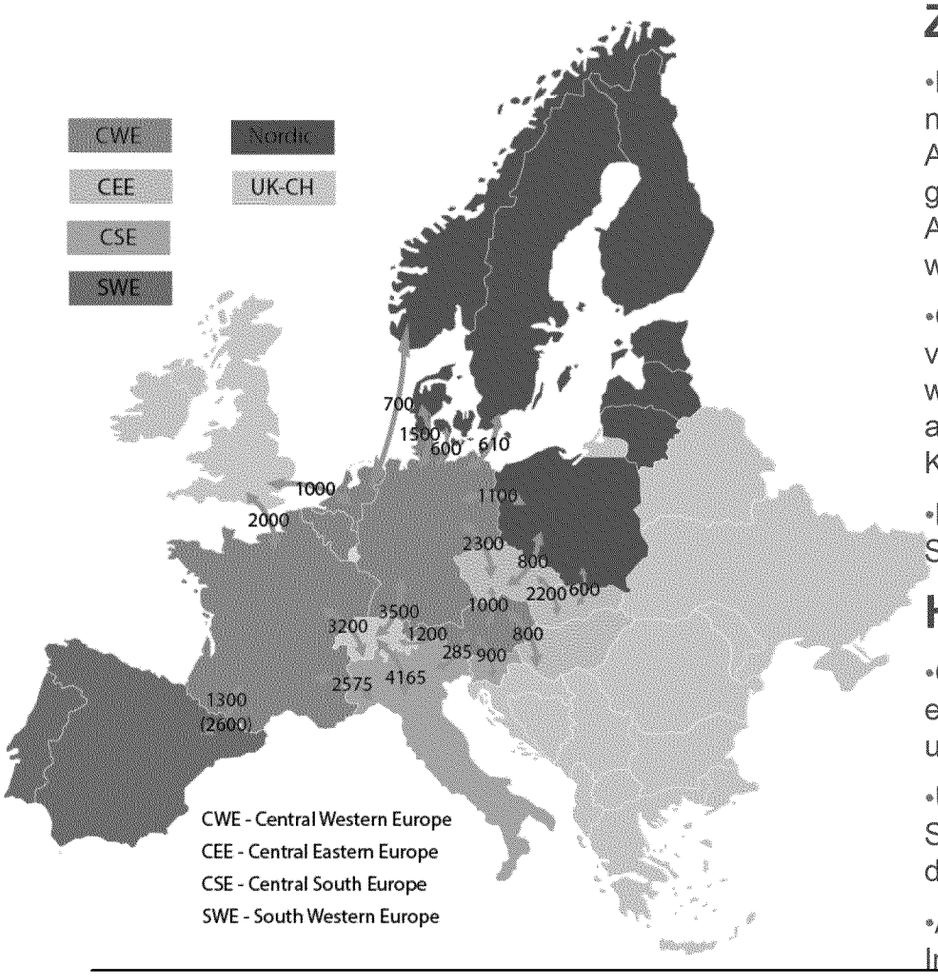
Die Integration des europäischen Strommarkts bis Ende 2014



Ziele für physische Märkte

•Eine gemeinsame einheitliche Berechnungsmethode ist notwendig, um bis 2014 das europäische Zielmodell für Day-Ahead-Märkte umzusetzen. Es sieht eine Optimierung des grenzüberschreitenden Handels basierend auf impliziten Auktionen für grenzüberschreitende Kapazitäten vor. Unterstützt wird es durch das Price Coupling of Regions-Projekt (PCR)

•Grenzüberschreitender Handel wird weiter verbessert, indem verbleibende Kapazitäten für den Intraday genutzt werden. Sie werden an eine integrierte Intraday-Plattform weitergereicht, die aus einem Gemeinsamen Orderbuch und einem Modul zum Kapazitätsmanagement besteht (SOB / CMM)

•Die finale Optimierung erfolgt durch ein europaübergreifendes System für Regelenergie

Herausforderungen

•Gemeinsame, harmonisierte und verbindliche Regeln auf europäischer Ebene: Rahmenleitlinien zur Kapazitäts-zuweisung und zum Engpassmanagement (FG CACM)

•Umsetzung von PCR in Nordwesteuropa (NWE) und Südwesteuropa (SWE) in 2013, gefolgt von CSE und CEE im darauffolgenden Jahr

•Auswahl im Jahr 2013 und Umsetzung erster Schritte des Intraday "SOB/CMM" im Jahr 2014

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Technologie	ENTSO-E, Januar 2013	Weiterentwickelte Methode, Winter 2013
Kernenergie	12,1	12,1
Braunkohle	21,3	21,0
Steinkohle	31,1	29,2
Erdgas[12]	28,0	28,8
Mineralölprodukte	3,8	3,8
Pumpspeicher	6,4	6,5
Sonstige Konventionelle	0	4,1
Summe konv. KW	**102,7**	**105,2**
Wind (offshore)	0,4	0,8
Wind (onshore)	31,2	32,8
Photovoltaik	33,0	39,4
Wasserkraft	4,8	4,8
Biomasse	5,7	6,0
Sonstige EE	4,4	0,6
Summe EE	**79,5**	**84,0**
Summe Erzeugung	**182,2**	**189,2**
Netto-Einspeiseleistung	182,2	189,2
Nicht sicher einsetzbare Leistung	73,8	75,0
Revisionen, Wartungen	3,4	2,0
Ungeplante Ausfälle	7,2	10,5
Regelleistung	4,8	4,8
Nicht verfügbare Leistung	89,1	92,3
Gesichert verfügbare Leistung	93,0	97,0
Last	91,8	88,6
Lastmanagement	0	1,1
Verbleibende Leistung	1,3	9,4
Reserveleistung	4,8	0
Unterschied zur Höchstlast	0	0
Adequacy Reference Margin (ARM)	4,8	0
Leistung im Ausland	0	2,0
Netzreserve in AT	0	1,0
RC - ARM	**-3,5**	**12,4**