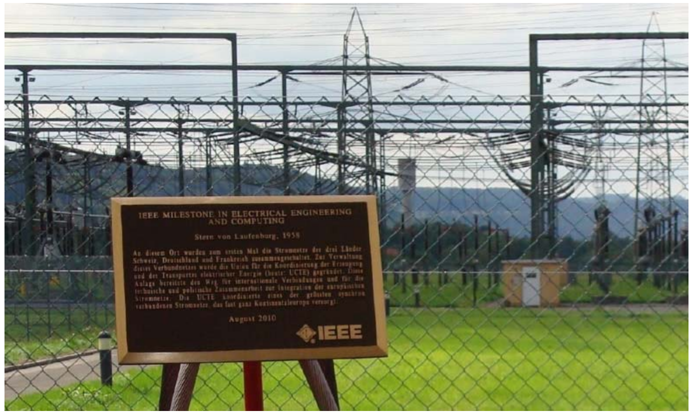
HP Conference

Bern, 12 March 2015



The Future of HP – A Central European Perspective

Christian von Hirschhausen, et al.

Berlin University of Technology, Workgroup for Infrastructure Policy (WIP)

and DIW Berlin (German Institute for Economic Research)

TU berlin WIP DIW BERLIN

Agenda

1) Switzerland, “Central Europe”, Europe

2) Focus on Austria and Germany

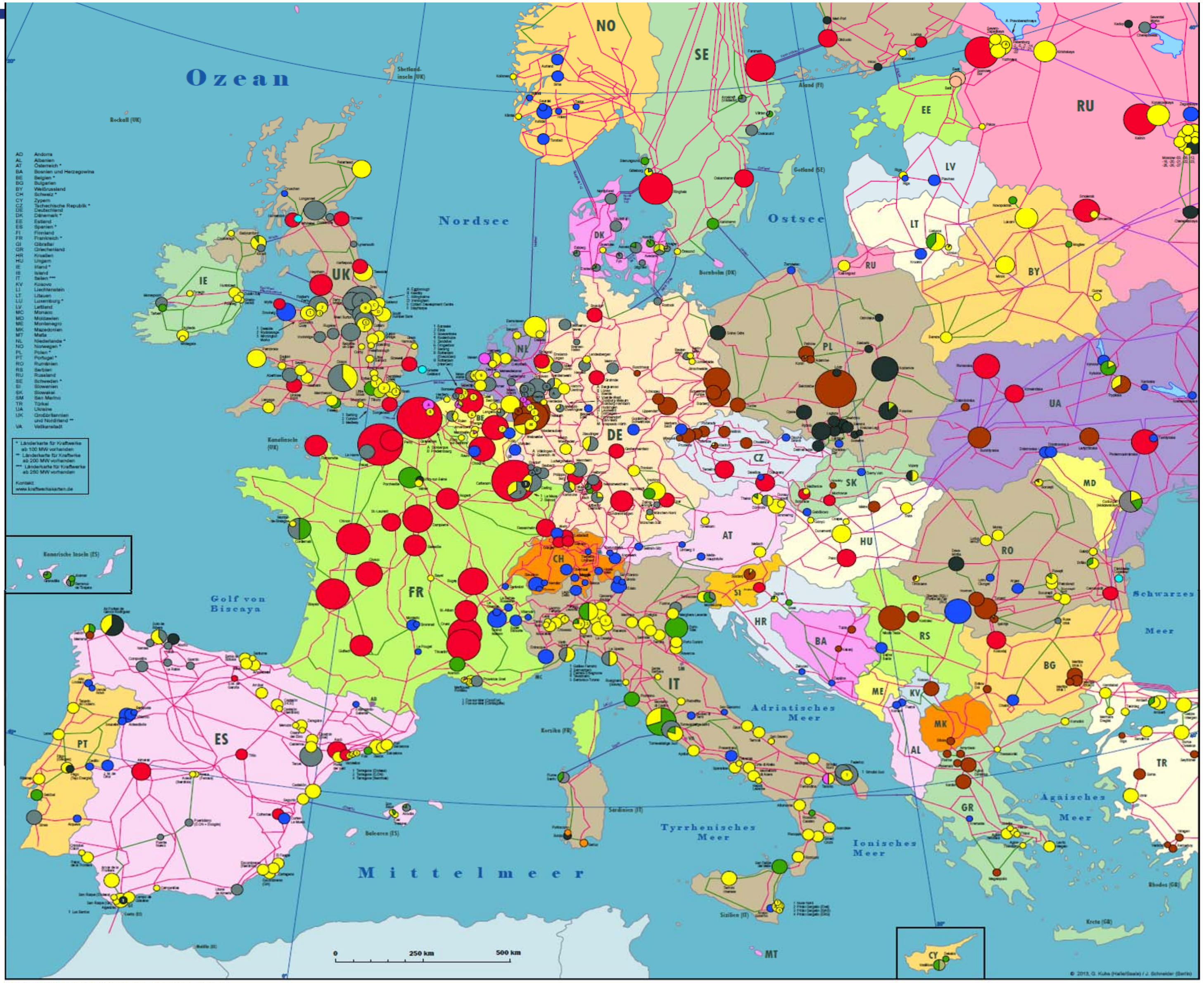
3) Currently not Economic, but …

4) Issues of Cross-Border Cooperation

5) Conclusions

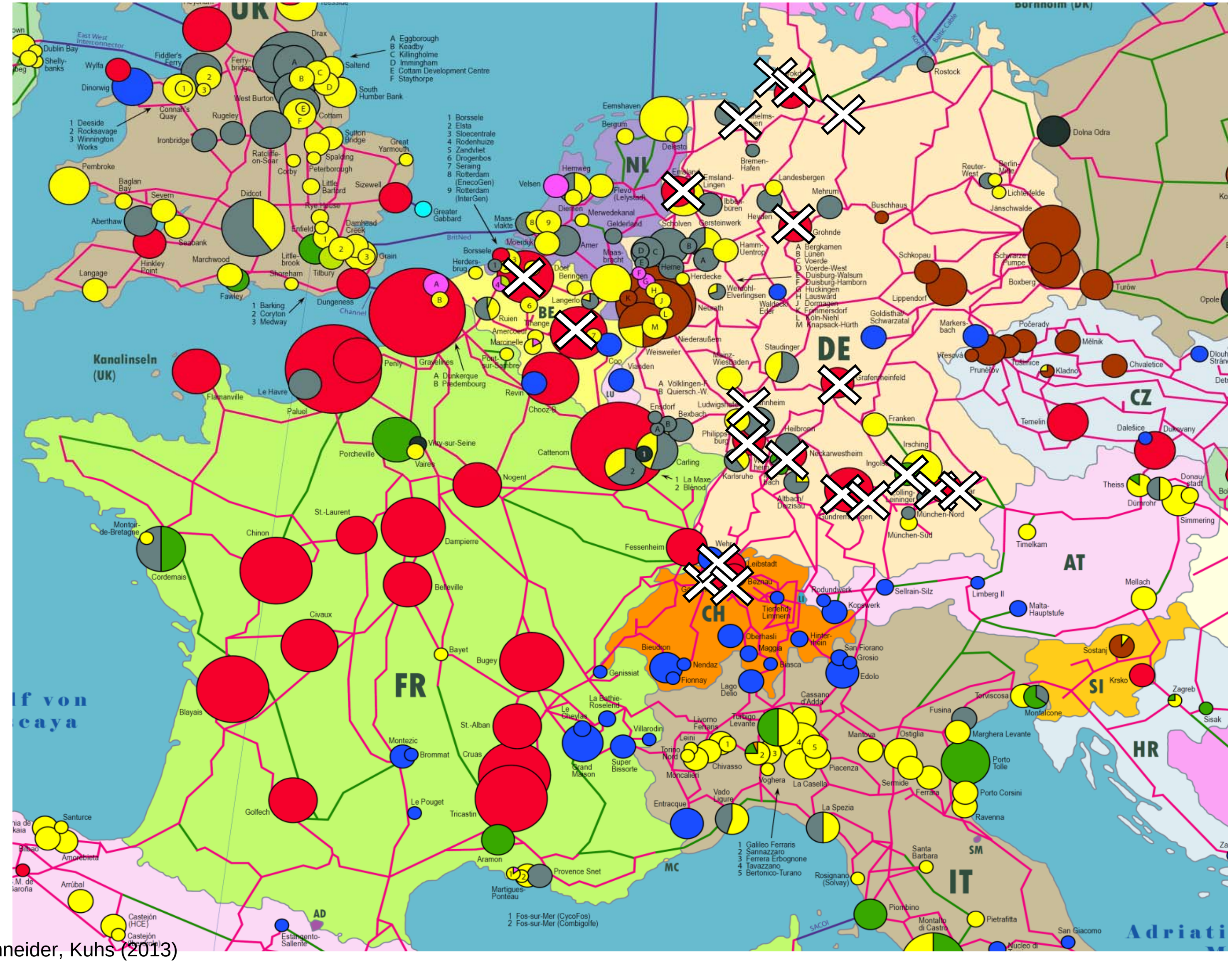
A European Internal Market? The Context
Power Plants and Networks in Europe

- Water
- Biomass
- Hard coal
- Wind
- Lignite
- Diesel
- Fuel Oil
- Gas
- Nuclear
- Furnace gas
- Oil shale
- Synthetic gas



Source: Schneider, Kuhs (2013)

Structural Changes in the Future:
1) Nuclear (2020s: D, F, to 2034: CH)

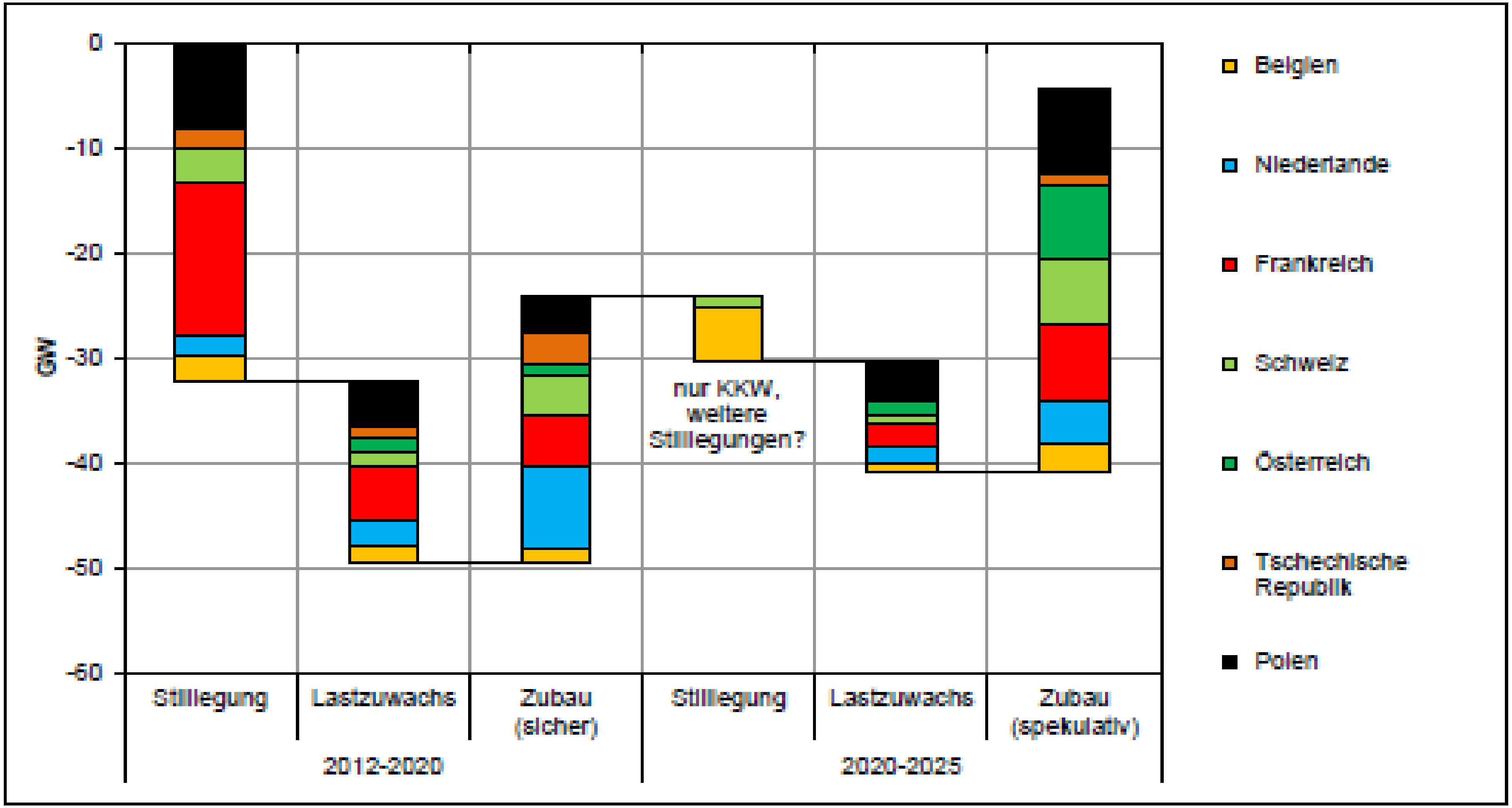


Source: Schneider, Kuhs (2013)

Deficits at the Central/Western European Level?
Contradiction between (optimistic) ENTSO-E SOAF Assessment and Oeko-Institute

(Matthes, Schlemmermeier, 2013, S. 33)

Abbildung 7 Kapazitätsentwicklungen in den Nachbarstaaten Deutschlands, 2012 bis 2025



Quelle: Entso-E (2012), Platts World Electric Power Plant Database (Stand 06/2012), Recherchen, Schätzungen und Berechnungen des Öko-Instituts

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2) Central Europe, here: Focus on Austria and Germany

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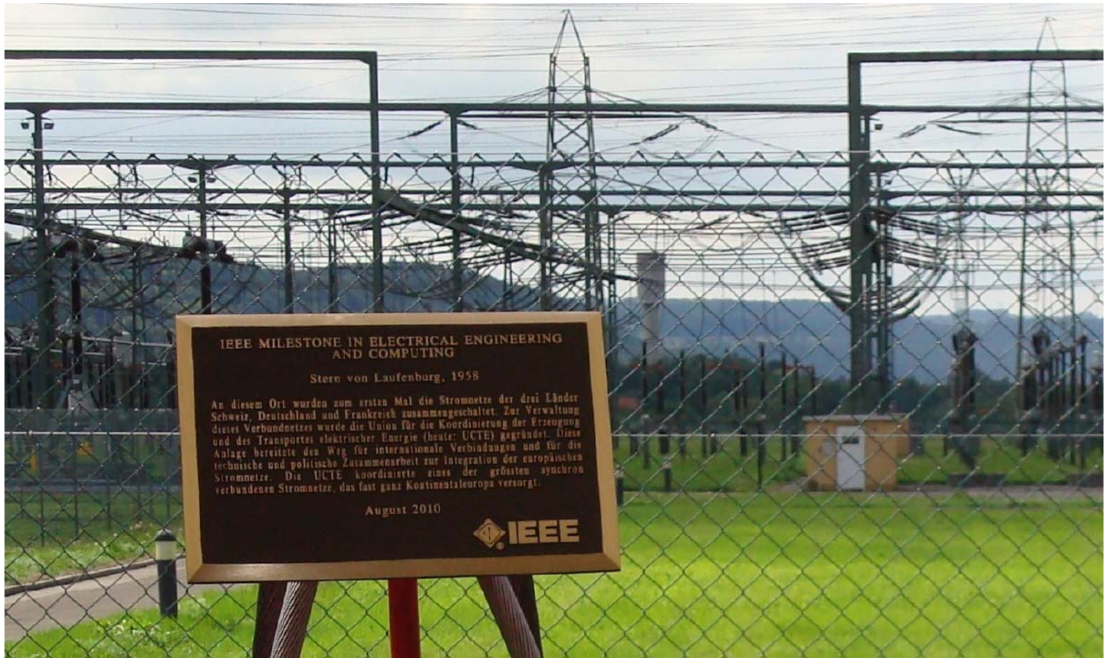
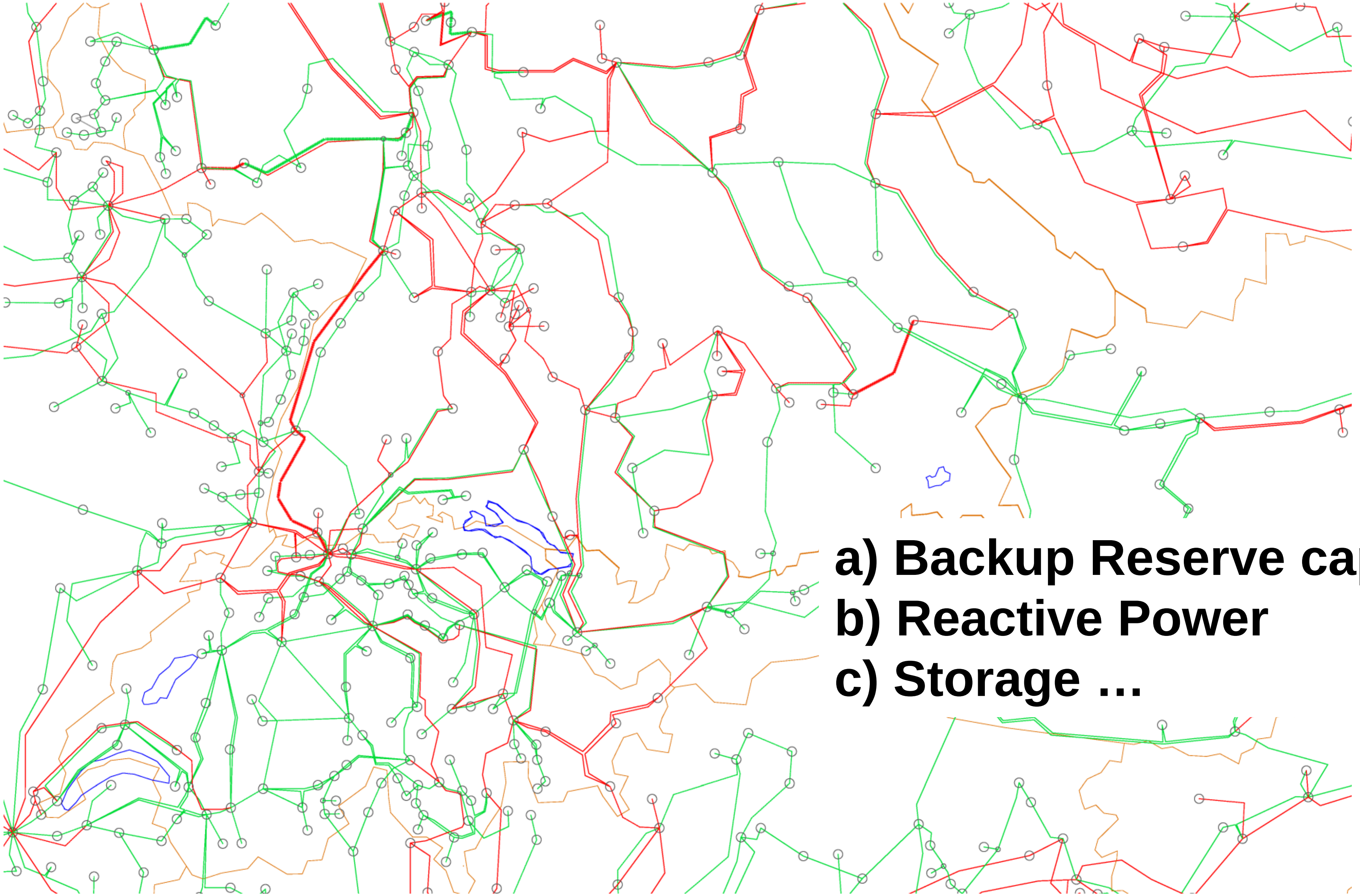
„Central Europe“: Cooperation has been „Regional“ for a Long Time

Koepchens Verbundbetrieb“ (1920s)

The „Star“ of Lauffenburg,
heart of the European electricity
transmission network (F-CH-D, 1958)



Today: „Central Europe“ Still Works, and has Significant Advantages



a) Backup Reserve capacity
b) Reactive Power
c) Storage …

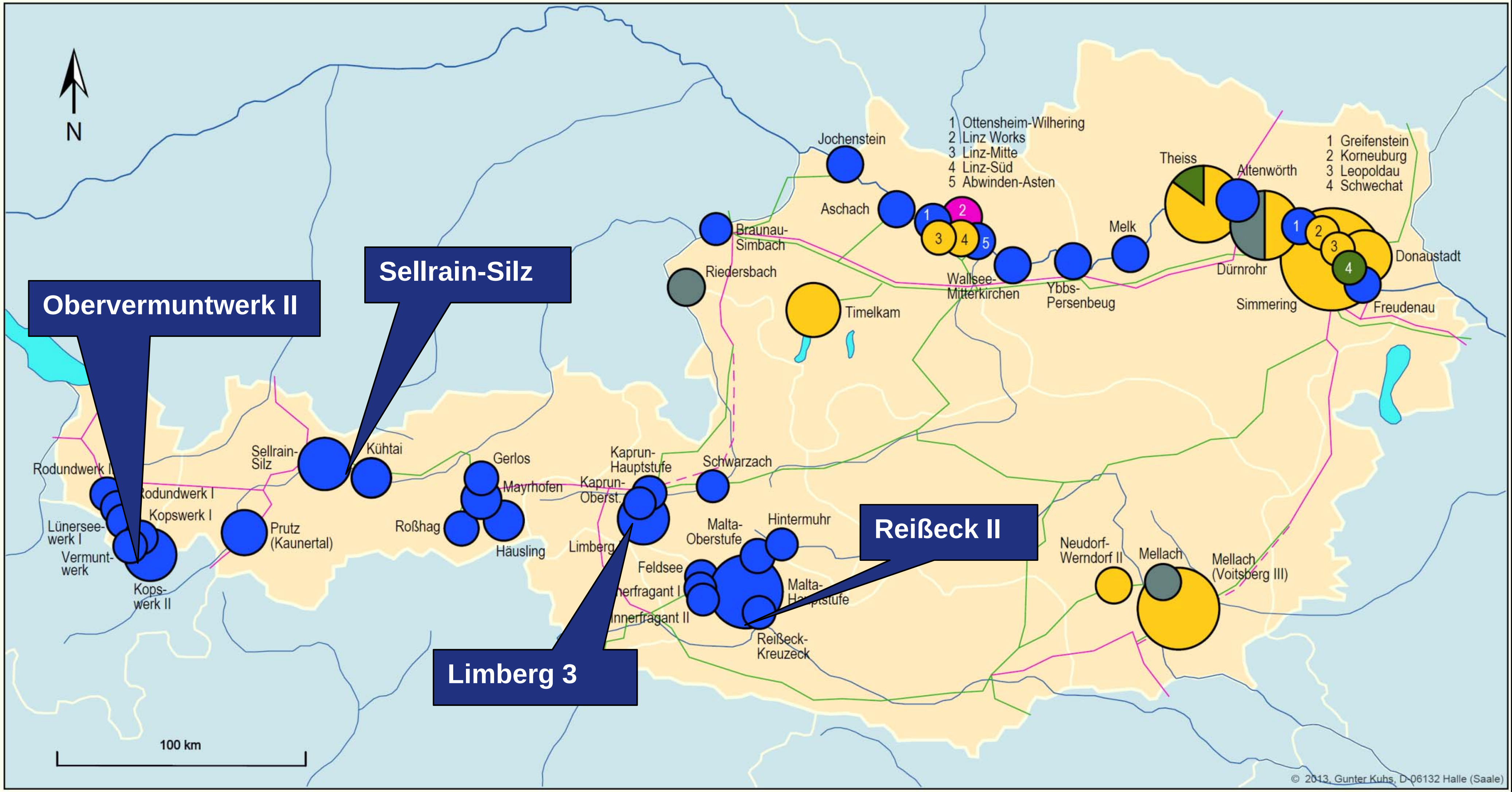
Übersicht Bewirtschaftungskosten zur Betriebs-führung sowie Steuern und Abgaben in CH, AT und DE

trilaterale PSP-Studie (Weber et al. 2014)

Kosten pro Jahr	Schweiz	Österreich	Deutschland
Materialaufwendungen Sonstiger betrieblicher Aufwand Personalaufwand	16€ / kW + 0,1€ / kWh Speicher	16€ / kW + 0,1€ / kWh Speicher	16€ / kW + 0,1€ / kWh Speicher
ÜNB Entgelte: Messung, Abrechnung, Netznutzung, System-dienstleistungen	Keine Netzentgelte für PSKW	Verbrauch: 1 € / kWa + 0,131 Ct / kWh Erzeugung: 0.1790 Cent / kWh	20 Jahre Befreiung für neue PSKW und PSKW mit Repowering. Ansonsten: Höhe abh. vom ÜNB
Pumpwerkabgaben	Je nach Kanton	/	/
Wasserzinsen, Wasserkraftsteuer, Wasserentnahmeentgelt	0,012 CHF/kWh (~ 1 ct/kWh)	Keine	Werden vernachlässigt
Weitere Steuern und Abgaben	0,008 CHF / kWh[2]	Werden vernachlässigt	Werden vernachlässigt

1 Rechtlich teilweise unklare Siituation (sind PSW Wasserkraftanlagen?).
2 Differenz aus der Gesamtbelastung von Wasserkraftanlagen durch Steuern und Abgaben (0,02 CHF / kWh) und dem durchschnittlichem Wasserzins (0,012 CHF / kWh)

Hydro power plants in Austria
2014: 13,8 GW; SOAF projection for 2025: +5000MW



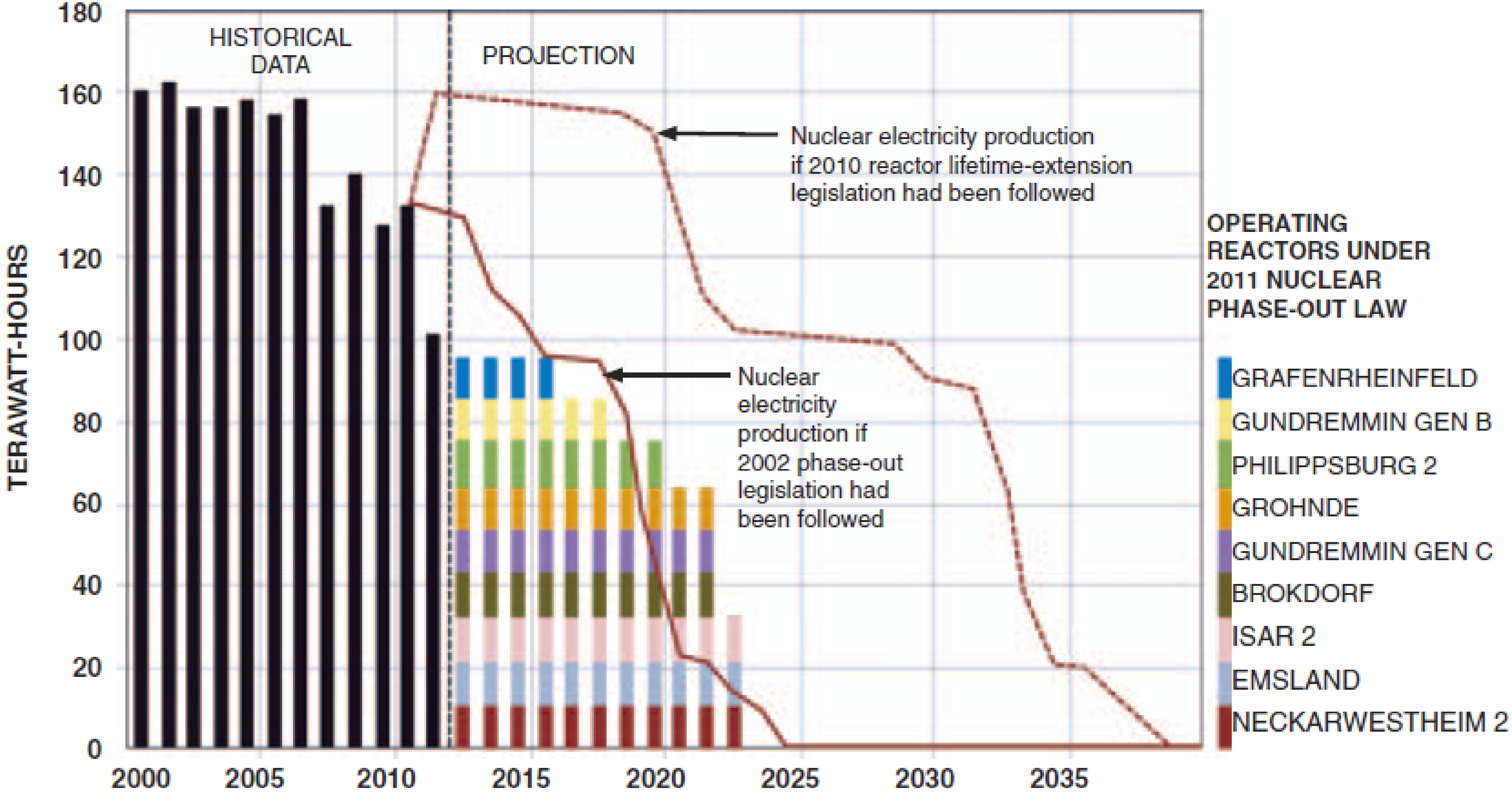
Selected projects

The energiewende in Germany

	Reduction of nuclear energy	Share of Renewable Energy		Reduction GHG-Emissions	Reduction of Energy Demand			
		Gross final energy	Electricity Production		Primary Energy	Domestic Heat	Final Energy Transport	Electricity Demand
2015 2017 2019	-47% -56% -60%							
2020		18%	35%	-40%	-20%	-20%	-10%	-10%
2021 2022 2025	-80% -100%		40-45%					
2030 2035		30%	50% 55-60%	-55%				
2040		45%	65%	-70%				
2050		60%	80%	-80% bis 95%	-50%	-80%	-40%	-25%
Basis	2010	-	-	1990	2008	2008	2005	2008

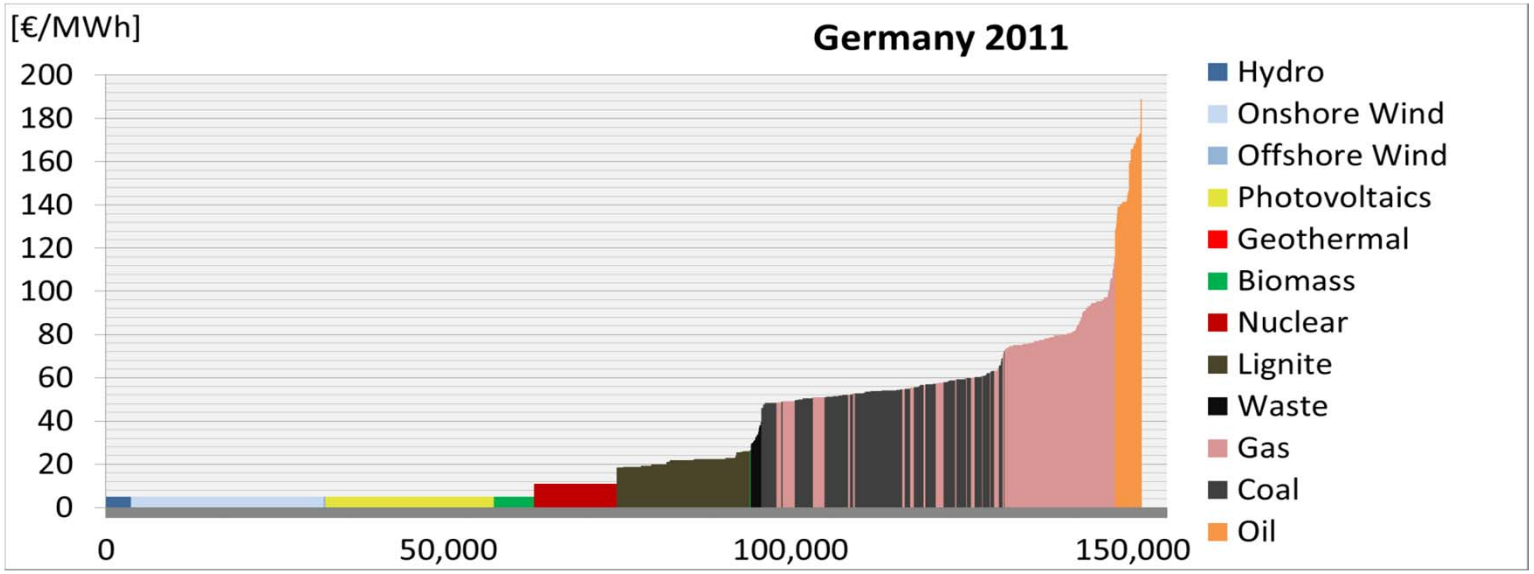
Source: Own Depiction based on BReg (2010, 2011, 2013)

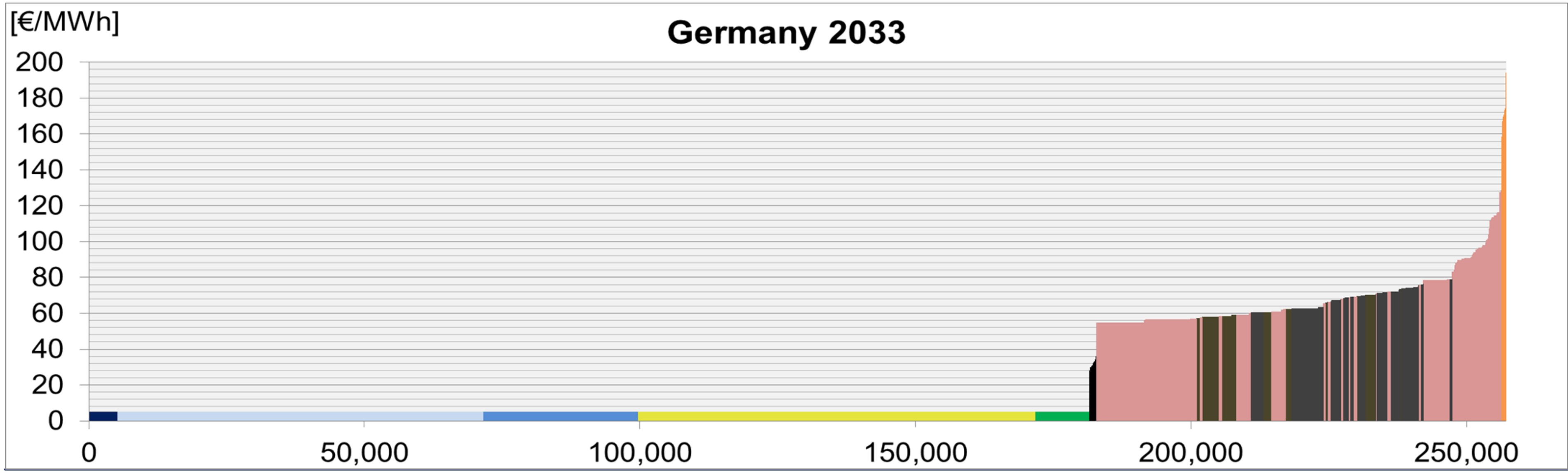
Nuclear Phasing Out "A" (the March, 2011-Moratorium)
(source: Matthes, 2012, p. 45)



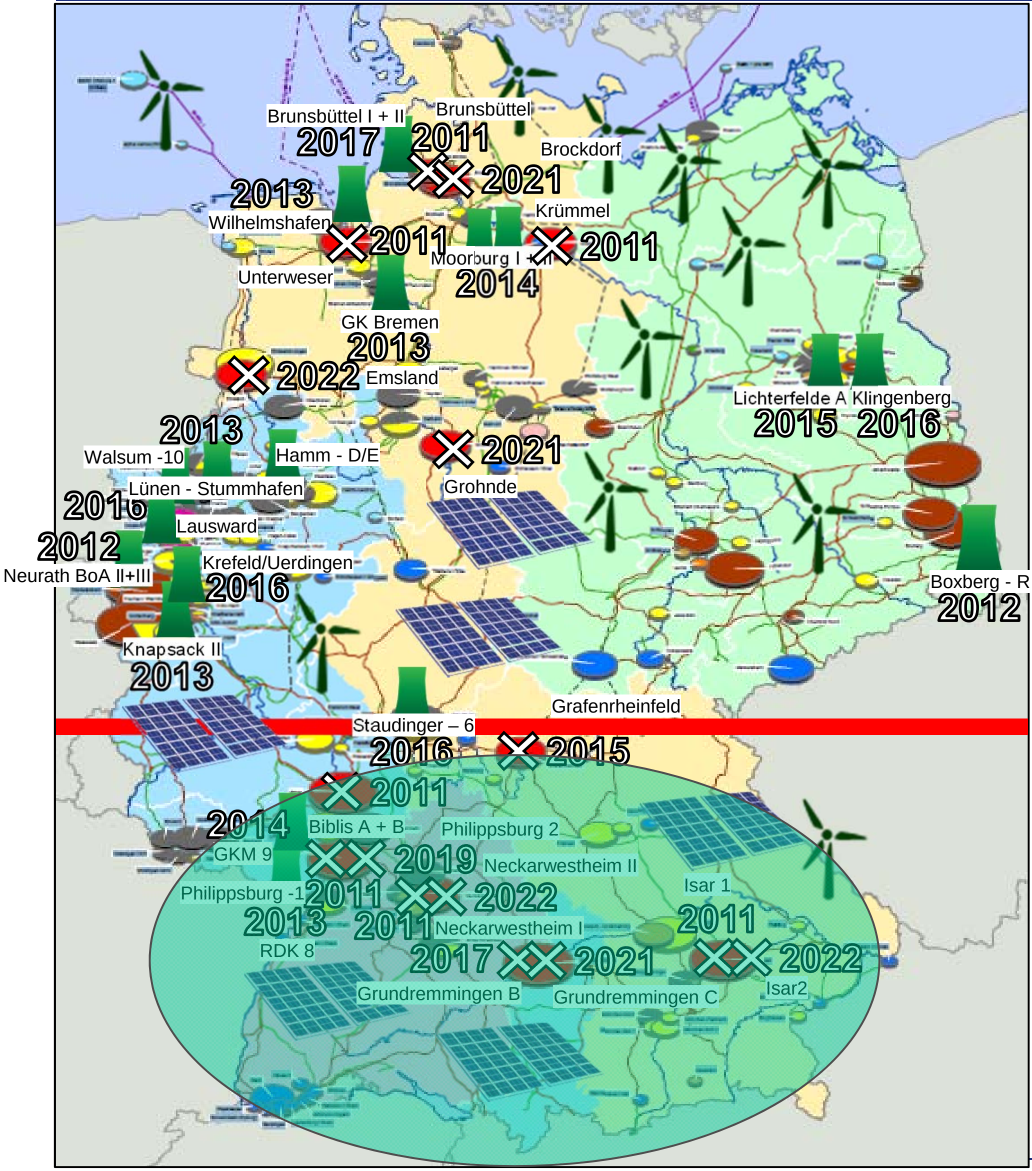
Source: Matthes (2012, p. 45)

5. Renewables Targets and Policies (Egerer and Schill, 2012)





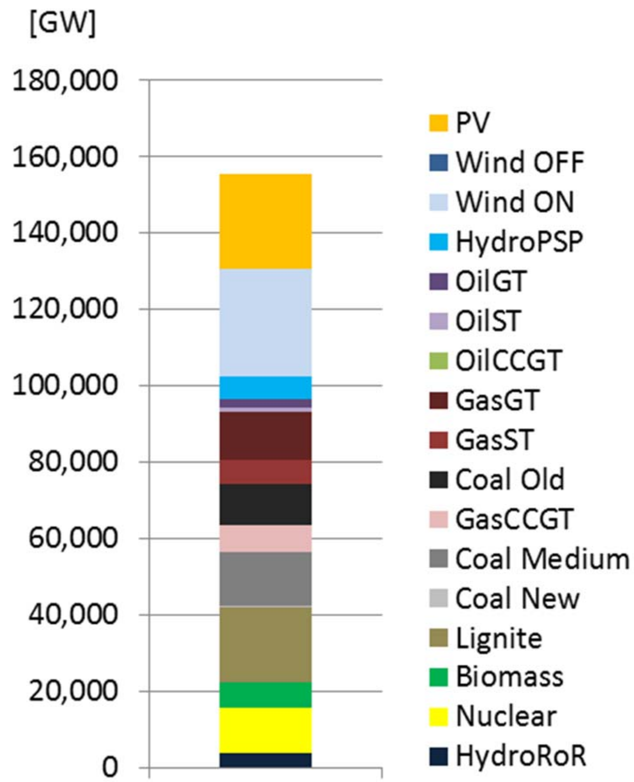
Energy Mix: Generation in Germany to 2020/2022
Focus on the South



Renewables in Germany 10/2014:

Wind: 35,6 GW

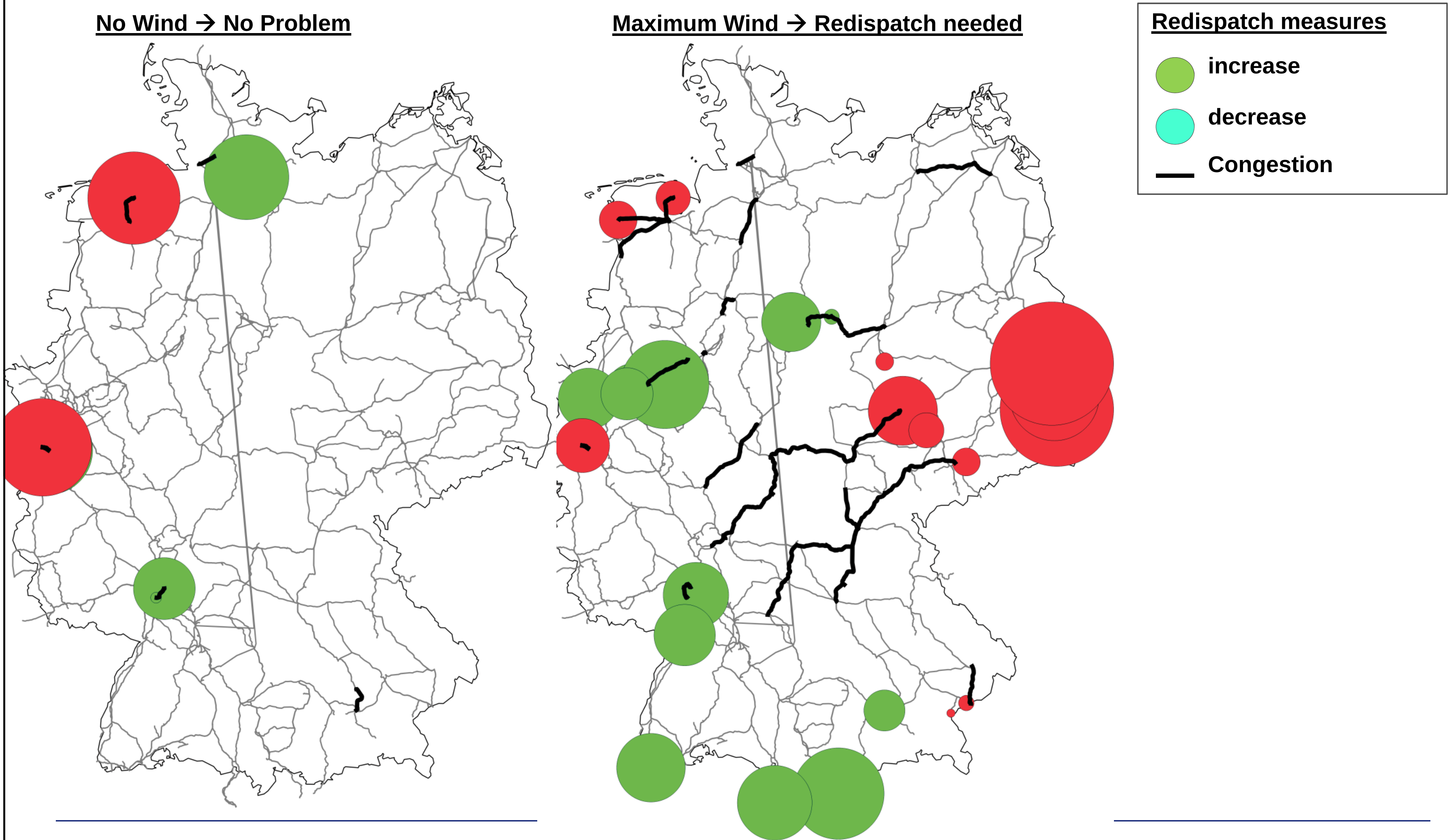
Solar: 38,1 GW



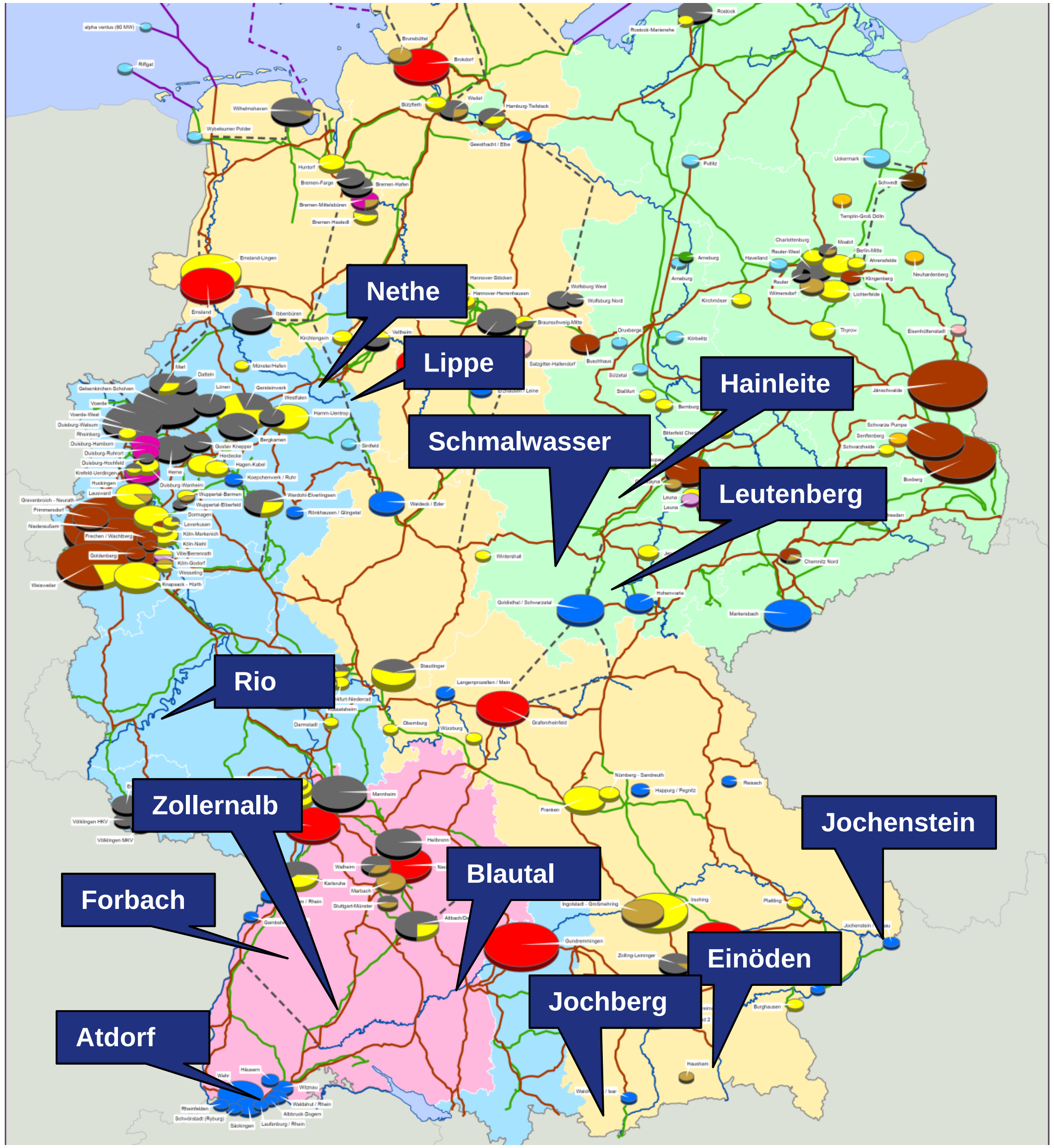
… more PSP foreseen in South Germany, but deficit remains…

Technologie	Deutschland	Region 1 (Nord Ost)	Region 2 (Nord West)	Region 3 (West)	Region 4 (Ost)	Region 5 (Süd)
Kernenergie	0	0	0	0	0	0
Braunkohle	17.6	0	0.4	7.5	9.8	0
Steinkohle	25.8	1.2	6.4	10.6	0	7.7
Erdgas	24	2.7	2.7	10.5	2.1	6.1
Mineralölprodukte	2.7	0.6	0.5	0.5	0.2	0.8
Pumpspeicher	6.3	0	0.3	0.9	2.6	2.4
Sonstige Konventionelle	1.7	0.3	0.3	0.6	0.1	0.4
Summe konv. KW	**80.2**	**4.8**	**10.6**	**32.6**	**14.8**	**17.4**
Wind Offshore	14	1.3	12.7	0	0	0
Wind Onshore	49.3	10.5	17.6	8.2	8.6	4.4
Photovoltaik	61.3	5.1	7.3	11.8	7.8	29.4
Wasserkraft	4.8	0	0.2	0.6	0.2	3.7
Biomasse	8.5	1.3	1.9	1.7	0.9	2.7
Sonstige EE	1.5	0	0	0	0	1.5
Summe EE	**139.4**	**18.2**	**39.8**	**22.2**	**17.5**	**41.7**
Summe Erzeugung	**219.7**	**23**	**50.4**	**54.9**	**32.4**	**59.1**
Netto-Einspeiseleistung	219.7	23	50.4	54.9	32.4	59.1
Nicht sicher einsetzbare Leistung	126.1	16.4	36.5	20.1	16.2	36.9
Revision, Wartungen	2	0.1	0.3	0.8	0.4	0.4
Ungeplante Ausfälle	5	0.5	0.8	1.9	0.6	1.3
Regelleistung	4.8	0.6	1.1	0.5	0.5	0.3
Nicht verfügbare Leistung	137.9	17.6	38.6	23.3	17.7	38.8
Gesichert verfügbare Leistung	81.8	5.3	11.8	31.6	14.7	20.3
Last (inklusive Netzverluste)	**88.2**	**3.5**	**13.6**	**27.7**	**9**	**34.3**
Lastmanagement	4	0.2	0.6	1.3	0.4	1.6
Verbleibende Leistung	-2.4	1.9	-1.2	5.1	6	-12.5
Leistungen im Ausland	3.9	0	0	0	0	3.9
Reservemarge	**-0.6**	**1.9**	**-1.2**	**5.1**	**+6**	**-10.7**

However, security of supply can be guaranteed in extreme scenarios for 2023, using active re-dispatch, and capacity from A and CH



Germany: +5GW Hydro capacity until 2025 in National Plan



Bnetza Number	Name	City	Year	MW
BNAP070	PSW Blautal	Markbronn	2019	60
BNAP068	Rudolf-Fettweis-Werk Oberstufe	Forbach	2019	200
BNAP069	Rudolf-Fettweis-Werk Unterstufe	Forbach	2019	50
BNAP074	PSKW Rio	Schweich	2020	307
BNAP075	Pumpspeicherwerk Einöden	Flintsbach am Inn	2020	150
BNAP098	Jochenstein	Untergriesbach	2022	150
BNAP099	PSW Leutenberg	Leutenberg	2022	201
BNAP079	PSW Lippe	Lügde	2022	80
BNAP081	PSW Hainleite	Sondershausen	2022	250
BNAP080	PSW Zollernalb	Hechingen	2022	320
BNAP082	PSW Leinetal	Freden (Leine)	2022	0
BNAP086	Trianel Wasserspeicherkraftwerk Nethe		2023	390
BNAP089	Trianel Wasserspeicherkraftwerk Schmalwasser	Tambach-Dietharz	2024	1072
BNAP090	Pumpspeicherwerk Jochberg	Jachenau	2025	700
BNAP094	Atdorf			1400

Source: Netzentwicklungsplan 2025

Little Relative Change in Storage Usage from 2013 to 2025

(2013: Calculations based on model comparison paper for the EEM conference
2025: Calculations made for Bayerischer Energiedialog)

	2013	2025 (No HVDC D)
Installed Storage (MW)	6282	7900
Storage Capacity (MWh)	39595	52077
Hours pumping	3244	3063
Hours generating	3208	3291
Energy pumping (TWh)	-9.26	-10.49
Energy generating (TWh)	6.94	7.86

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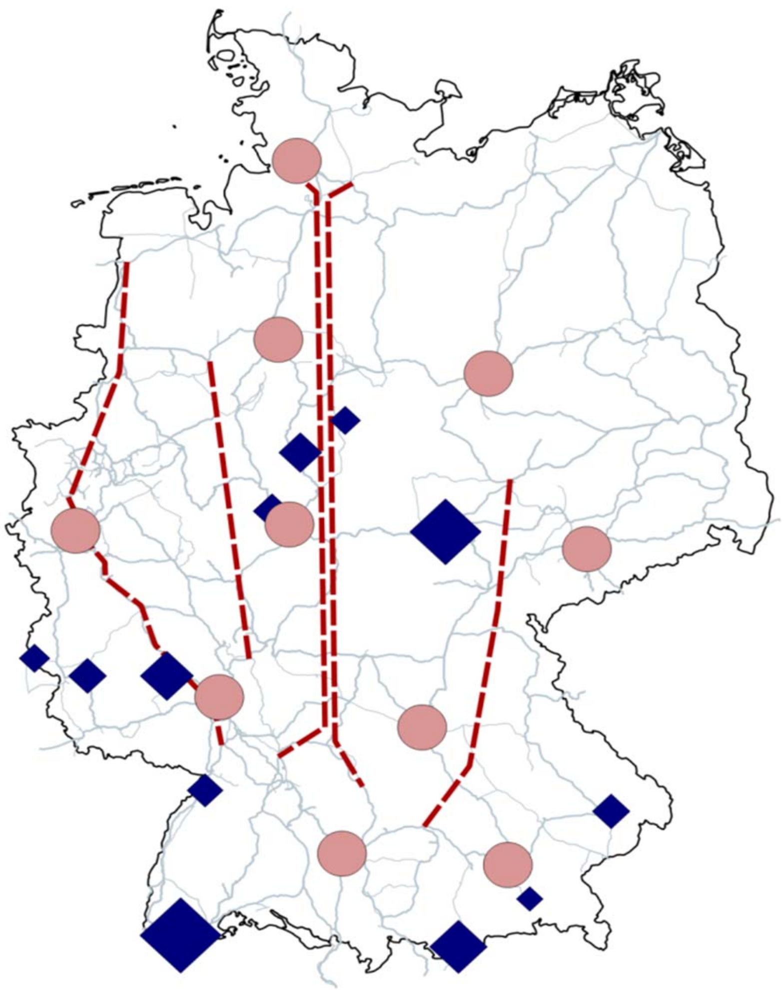
Different Options for Capacity and Flexibility in the German System (Egerer and Schill, 2014)



AC lines:

- Extensions of all existing lines possible with additional 380 kV circuits (1.7 GW)

DC point-to-point connections:

- Six connectors in steps of 1 GW

Gas-fired power plants:

- CCGT and OCGT in steps of 500 MW
- At ten important network nodes

Pumped hydro storage:

- Projects with specific capacities and locations

Generic Analysis of Incremental Returns from Balancing Markets (Weber, et al., 2014)

	Regelleistung im Pump- und Turbinenbetrieb	Regelleistung nur im Turbinenbetrieb
PSKW-Typ 1	PSKW-Typ 1 und Regelleistung im Pump- und Turbinenbetrieb	PSKW-Typ 1 und Regelleistung nur im Turbinenbetrieb
PSKW-Typ 2	PSKW-Typ 2 und Regelleistung im Pump- und Turbinenbetrieb	PSKW-Typ 2 und Regelleistung nur im Turbinenbetrieb

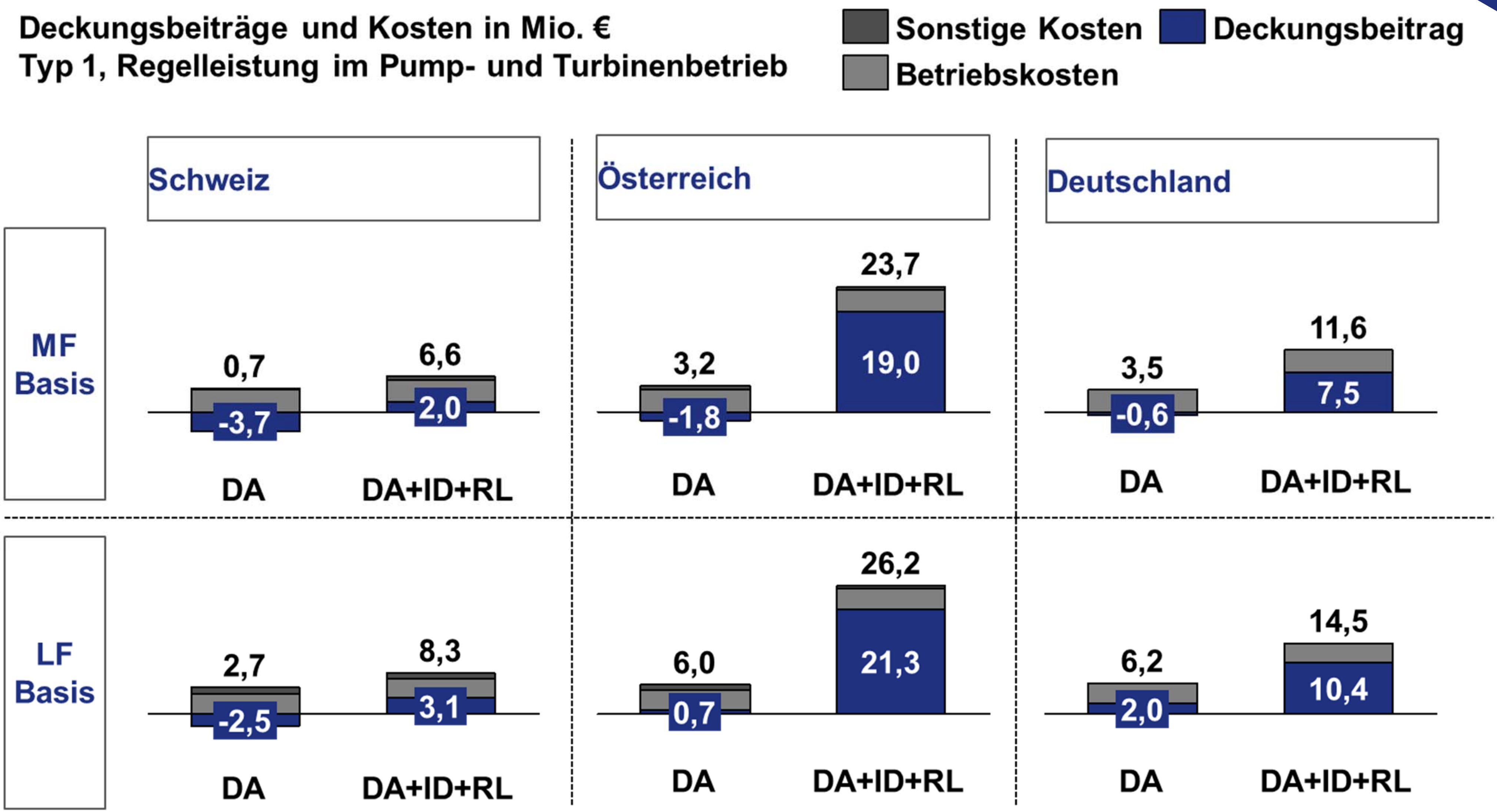
Referenz-PSKW (CH, AT, DE)

PSKW-Typen:
- Nr 1: Stundenspeicher (5 h)
- Nr 2: Tagesspeicher (55h)

Balancing Markets Yield Additional Revenues, but not Sufficient to Cover all Costs

trilaterale PSP-Studie (Weber et al. 2014)

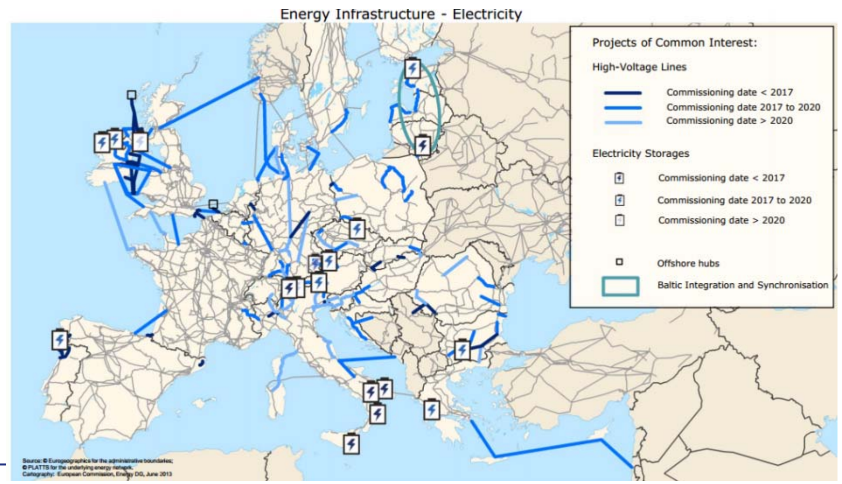
Deckungsbeiträge und Kosten in Mio. €
Typ 1, Regelleistung im Pump- und Turbinenbetrieb



Additional Financing for PSPs – European PCI/CEF Projects

- **Status Quo**
  - Derzeit keine umfangreichen Fördermaßnahmen („Kapazitätszahlungen“), jedoch beinhaltet die „Connecting Europe Facility“ Fördermittel iHv 5,85 Mrd €.
  - Voraussetzung (notwendig, aber nicht hinreichend) zum Bezug von Fördermitteln ist die Identifikation von Projekten als „Projects of Common Interest“ (PCI); Liste wird von der COM erstellt, umfasst derzeit folgende PSKW in AT-DE:
    - Kaunertal: Ausbau Kraftwerk Kaunertal, **PSKW Versetz**, 400 MW, ~73 h, TIWAG
    - Vorarlberg: **Obervermuntwerk II**, 360 MW, ~10 h, Illwerke VKW
    - Kaprun: **Limberg III**, 480 MW, ~23 h, Verbund
    - Deutschland: **Energiespeicher Riedl**, 300 MW, ~1.300 h, Donaukraftwerke Jochenstein

- **Mögliche Alternativen**
  - Nicht zentrale Finanzierung, sondern bi- bzw. multilaterale Verträge.
    - Hier jedoch ist die Einigung auf gemeinsame Ziele essentiell!



Quelle: EC

What Market Design?
Capacity instruments are, for the time being, purely national

UK-EMR:
Capacity instrument

D: Strategic reserve

www.pse-operator.pl

Polskie Sieci Elektroenergetyczne Operator S.A.

Basic Market Architecture for the future Polish market

- **Integrated Energy and Ancillary Services Markets**
  - Day-Ahead, Intra-Day and Real-Time Market
  - Energy and reserves compete for access to the transmission grid
  - Coherent incentives for the grid users
  - Consistent rules throughout all market segments
- **Hedging instruments against the risk of congestion**
  - Financial Transmission Right (FTR) Markets
  - FTR allocation and FTR auction
- **Capacity Markets ensuring long-term generation adequacy**
  - Decentralized bilateral market
  - Centralized market run by TSO

LE POINT DE VUE DE **CLAUDE CRAMPES ET THOMAS-OLIVIER LÉAUTIER**

Marché de l'électricité : quand la France donne l'exemple

La création du premier marché de capacité électrique en Europe facilitera le renouvellement du parc nucléaire à partir de 2025.

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5) Conclusions

Issues of Cross-Border Cooperation (1/3)

- **Swiss hydropower has the potential to decrease generation costs in Central Europe (and to facilitate the “Energiewende“).**

- **New investments in hydropower plants can lead to substantial (positive) spill-overs which can provide arguments for a joint cross-border financing of new projects.**

- **However, joint solutions require (inter alia) cross-border agreements on sharing of costs and benefits. These cooperation contracts come along with various challenges.**

Issues of Cross-Border Cooperation (2/3)

- The costs and benefits of new investments in hydropower plants in Switzerland can differ widely across the adjacent states and the different stakeholders. This can increase the intensity and duration of bi- or multilateral negotiations (→ high transaction costs).

- These distributional effects are difficult to predict as…
    - … they are subject to many uncertain and dynamic conditions (e.g. changes of the technical system or development of the institutional framework).
    - … hydropower plants are very durable and specific investments.

- Thus, the elaboration of cooperation contracts can be much more complex and the probability of renegotiations may increase as it will not be possible to specify every eventuality in the contract.

Issues of Cross-Border Cooperation (3/3)

- Incomplete contracts provide an opportunity to attain individual objectives to the detriment of contractual partners / adjacent states.

- Consequently, similar objectives and a relationship of trust between the cooperating states are essential in order to limit uncertainties and project risks. This can (among other conditions) decrease the transaction costs that result from the negotiation and monitoring of cross-border contracts.

- In case of cross-border cooperations, transaction costs are of major importance, as they can easily exceed the benefits from (potentially) lower generation costs and lead to the cancellation of investment projects.

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Conclusions

~ Hydropower has a certain role to play in the energiewende …

~ … but it is not yet fully economic (investor‘s perspective)

~ Time plays in favour of HP, as more intermittent renewables require more flexilibty

~ Potential for cross-border cooperation exists, but not easy to reap