From champion to 'fossil of the day'

A critical view of the German Energiewende

Axpo Nordic Forum

Malmö, 24 October 2017

Dr. Wolfgang Peters, MBA

Managing Director, The Gas Value Chain Company GmbH, Germany

Former CEO, RWE Supply & Trading CZ, a.s., Czech Republic

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

Two amazingly divergent views

Fatih Birol, Berlin Nov. 2016: source of inspiration”

“(

Two amazingly divergent views

COP22 Marrakech November 2016:
Germany declared “Fossil of the Day”

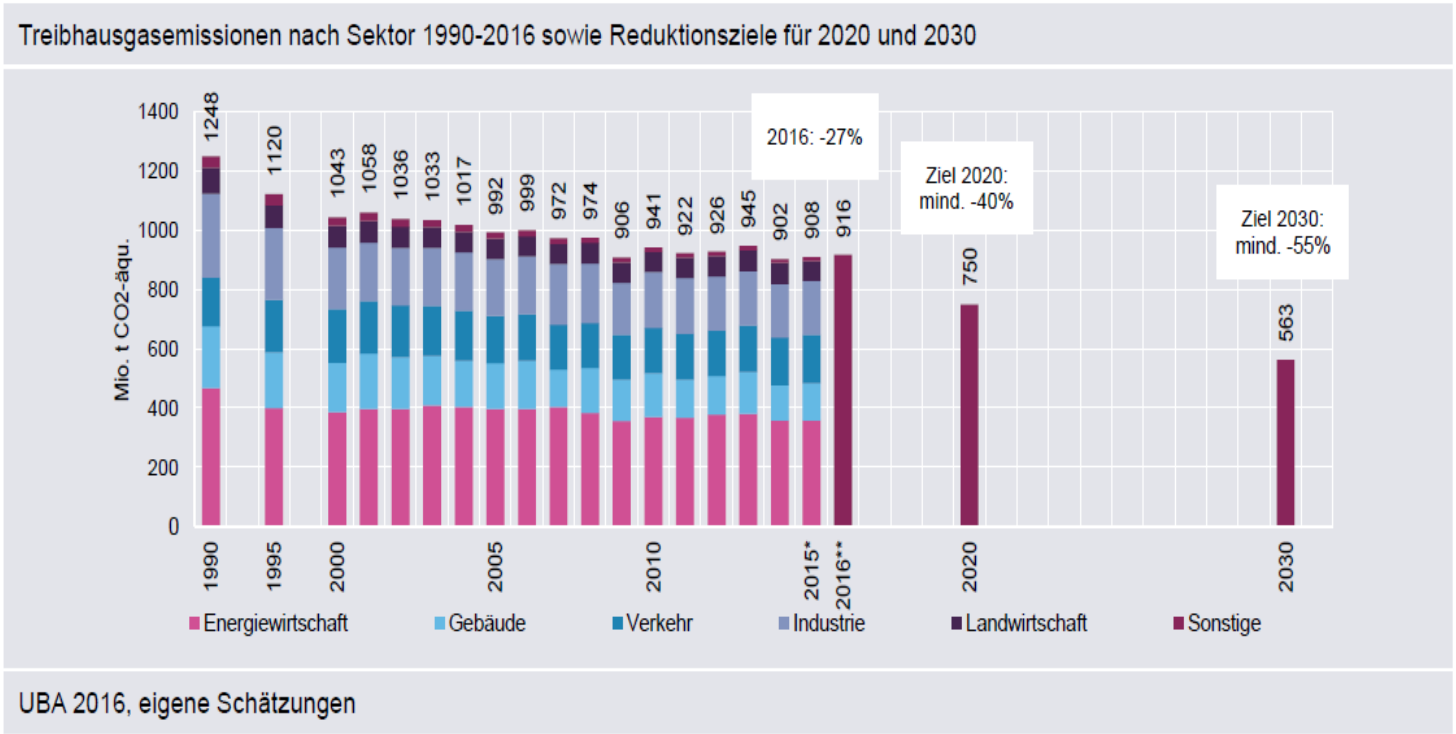
Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

Achievement & failure:
RES instead of CO2 reductions

CO2 emissions 2016 up by 8 million tons
2020 reduction target impossible to meet



Source: Agora Energiewende 2016

Achievement & failure:
RES instead of CO2 reductions

EEG 2000: 20 years must-run priority & guaranteed feed-in tariffs

EEG fallacy: stifling efficiency & innovation

EEG-Umlage 2000: 'cost of an ice cone' ? 2016: € 25 billion

ABBILDUNG 4: EEG-KONTO – KOSTEN UND ERLÖSE

EEG-Konto	
Ausgaben	**Einnahmen**
• Zahlung der EEG-Einspeisevergütung an EEG-Anlagenbetreiber	• Einnahmen aus der Vermarktung des Stroms aus EEG-Anlagen an der Strombörse durch die Übertragungsnetzbetreiber
• Zahlung der Markt- und Managementprämie an EEG-Anlagenbetreiber	• Differenz: EEG-Umlage
	Saldo: 0

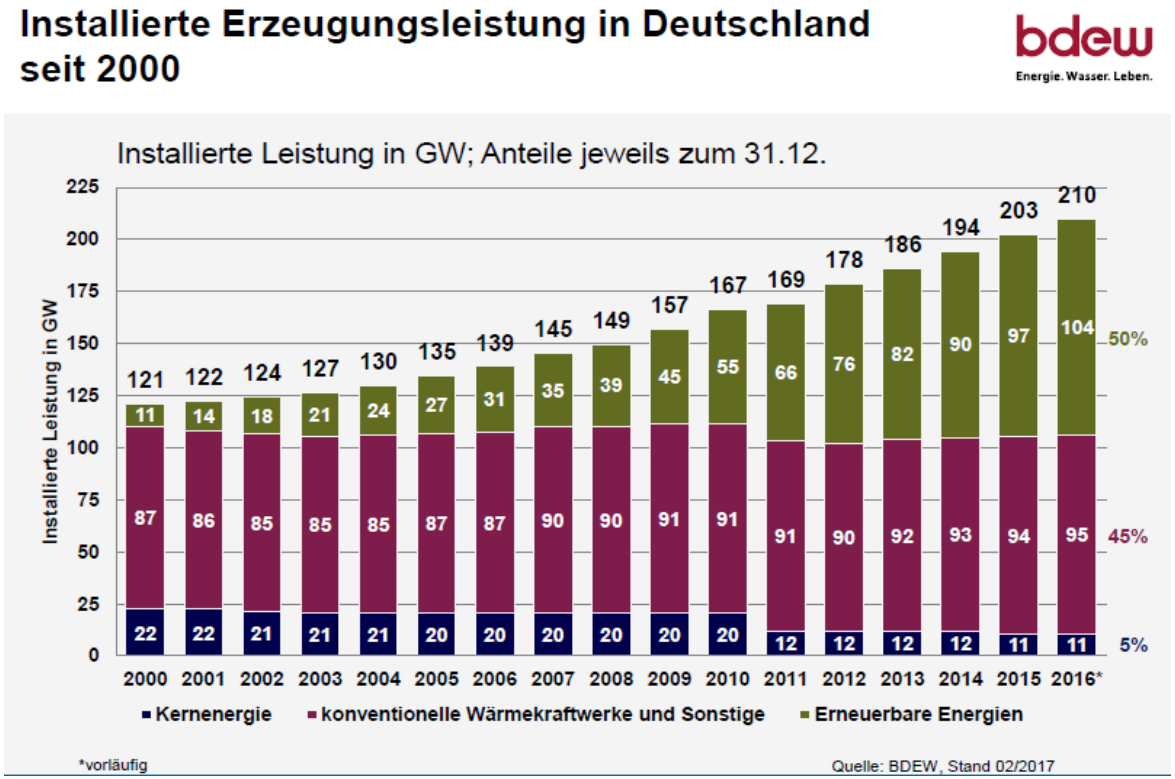
Quelle: IWR, 2015[20].

Source: DICE

Achievement & failure:
RES instead of CO2 reductions

EEG ‘subsidy’ system caused enormous build-up of RES

Generation capacity conventional/RES at par: 106 vs 104 GW

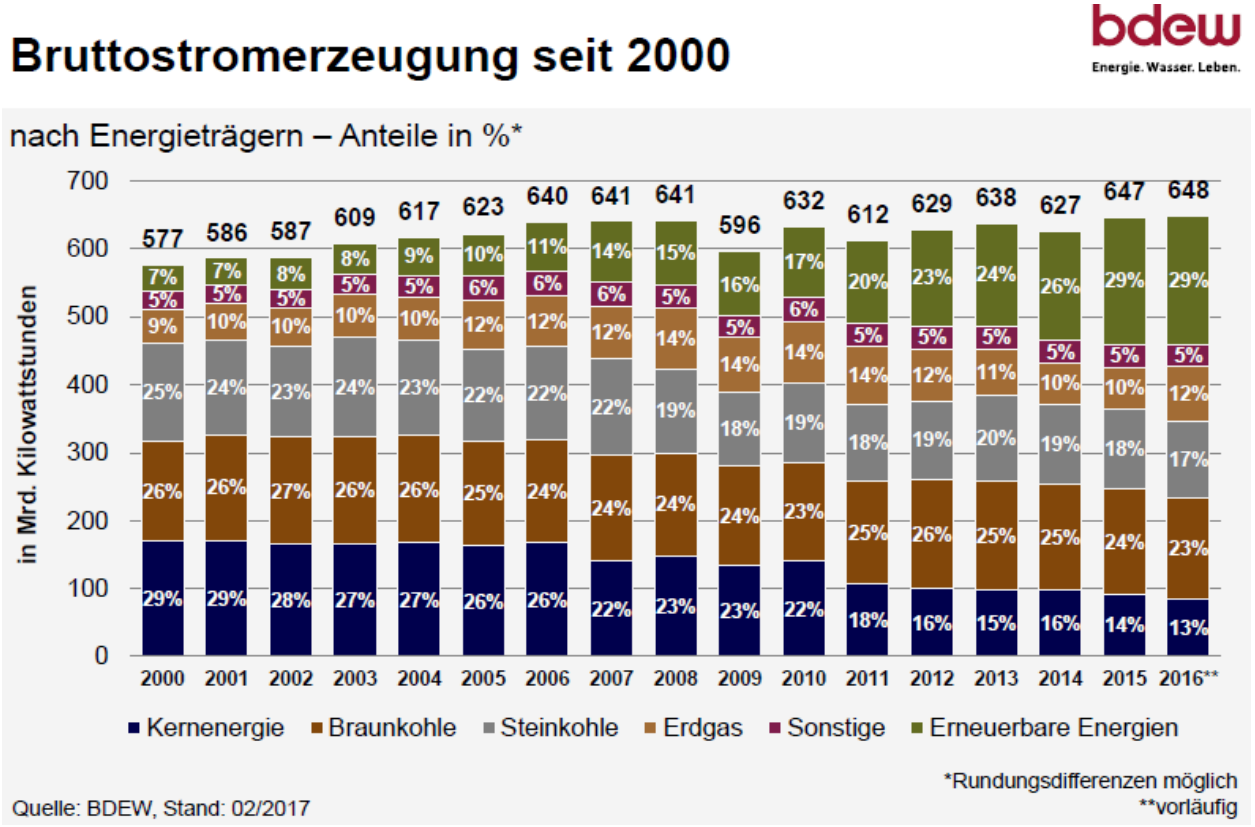


Source: BDEW Report 2017, page 9

Achievement & failure:
RES instead of CO2 reductions

RES share gross power output 29%: ~188 of total 645 TWh

RES average load factor ~20% = ~1,752 load hours



Source: BDEW Report 2017, page 9

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

RES ‘tunnel vision’: blind eye on systemic imperfections

Too much:
‘High noon’

Too little:
‘Kalte Dunkelflaute’

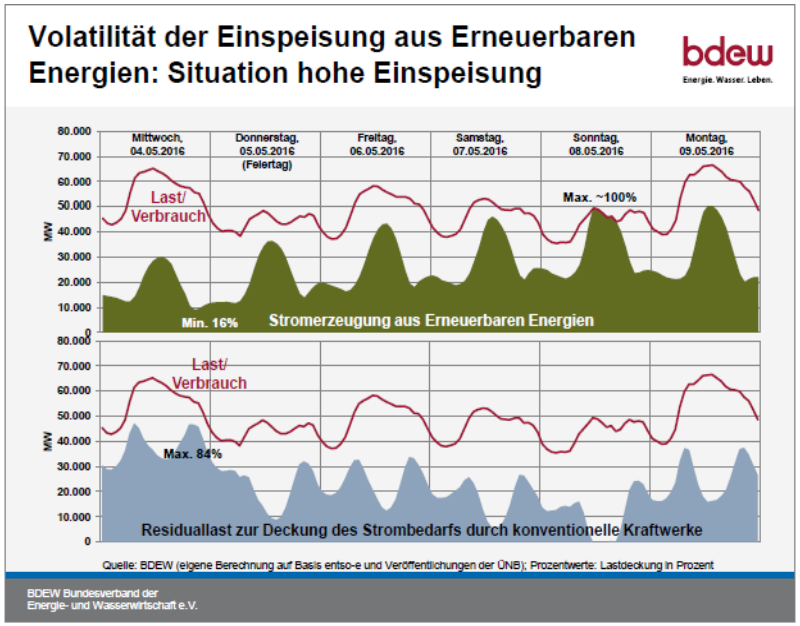


Abb. 13: Deckung des Strombedarfs 04.Mai bis 09. Mai 2016

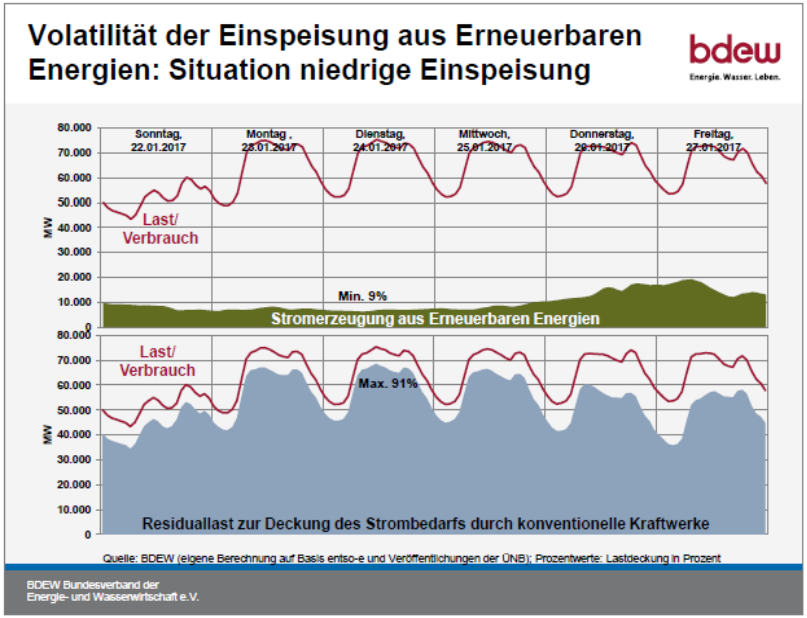


Abb. 14: Deckung des Strombedarfs 22. Januar bis 27. Januar 2017

Curtailment and/or
export at negative prices

RESIDUAL LOAD:
100% conventional capacity

Source: BDEW Report 2017, page 14/15

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

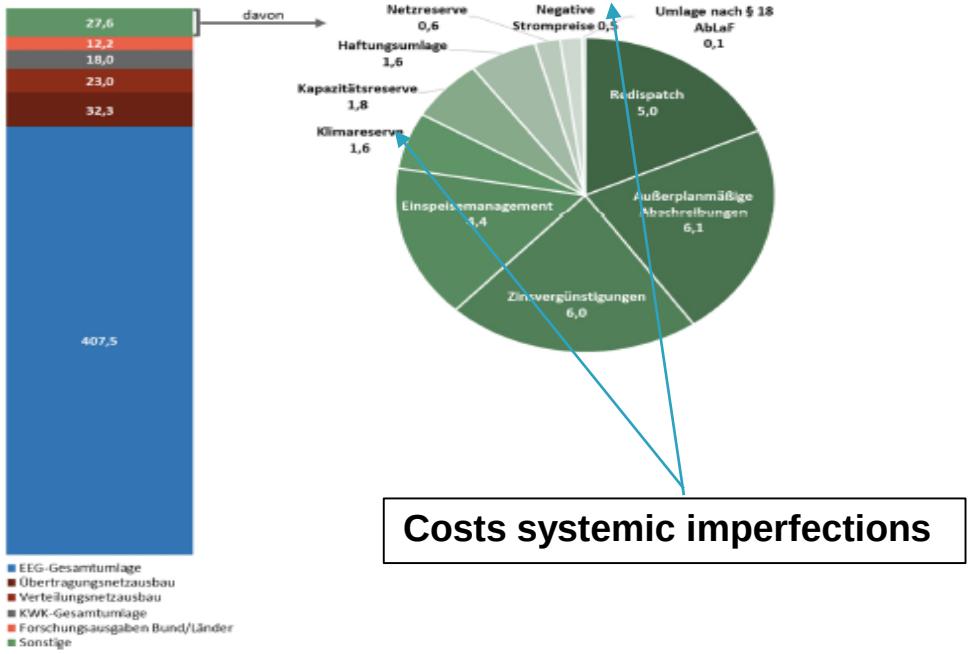
Centrally planned economy style regime at excessive costs

Total costs Energiewende*) 2000 to 2025: ~€ 520 billion

Costs from systemic imperfections revealing

***) power only**

ABBILDUNG 16: PROGNOSE DER GESAMTKOSTEN DER ENERGIEWENDE (BIS 2025) IN MILLIARDEN EURO



Quelle: Eigene Berechnungen.

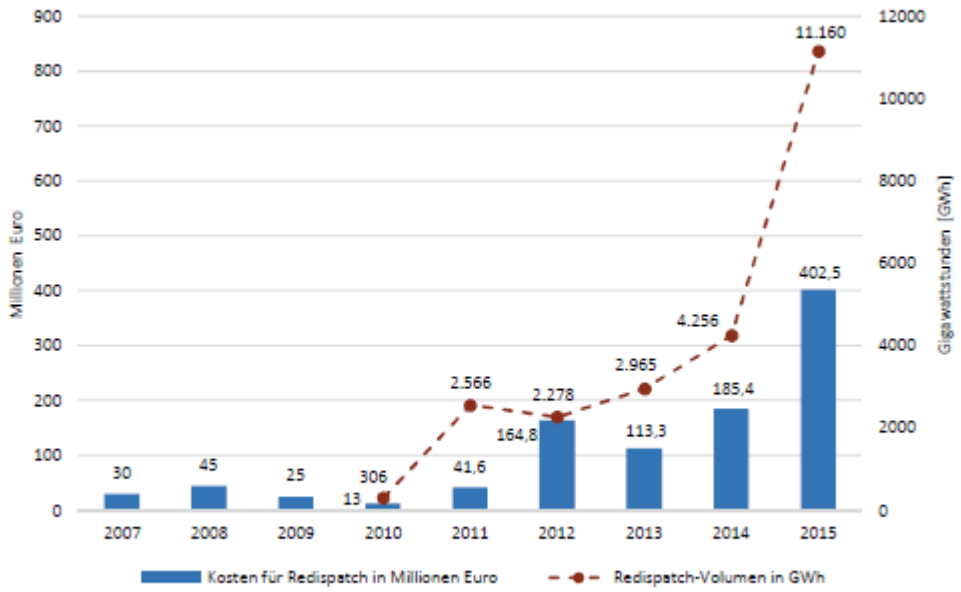
Source: DICE

Centrally planned economy style regime at excessive costs

Redispatch: TSO 'orders' conventional operators up or down

BNetzA 2016: interventions 329 days/13,339 hours

ABBILDUNG 11: ENTWICKLUNG DES REDISPATCH-VOLUMENS UND DER REDISPATCH-KOSTEN



Quelle: BDEW (2016b), 6 und 9.

Source: DICE

Centrally planned economy style regime at excessive costs

Surplus export at negative prices (gross export 2016 ~80 TWh)

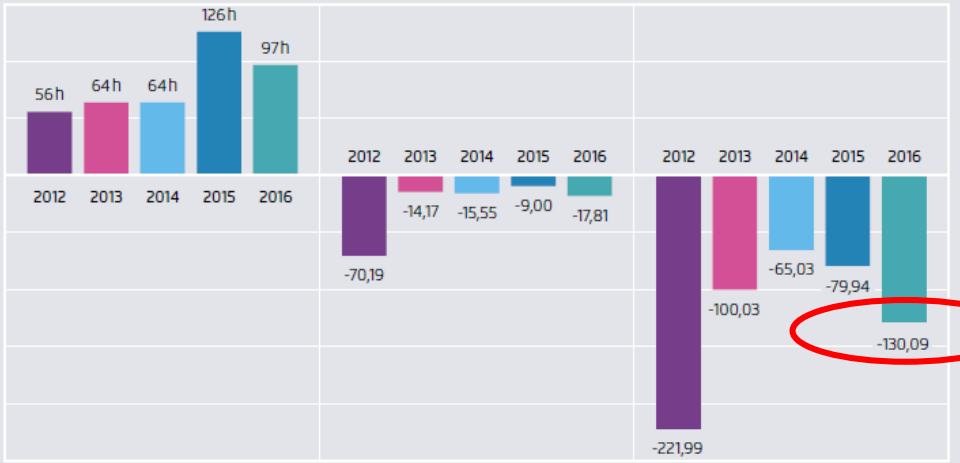
TABELLE 9: ANZAHL DER STUNDEN MIT NEGATIVEN STROMPREISEN SEIT 2008

2008	2009	2010	2011	2012	2013	2014	2015
15	71	12	15	56	64	64	126

Quelle: Eigene Berechnungen basierend auf Daten von EPEX Spot.

Source: DICE

Stunden mit negativen Preisen sind seltener geworden, doch das Preisniveau sinkt: Stunden mit negativen Strompreisen, mittlerem negativer Preis sowie geringster Preis 2012–2016 Abbildung 27



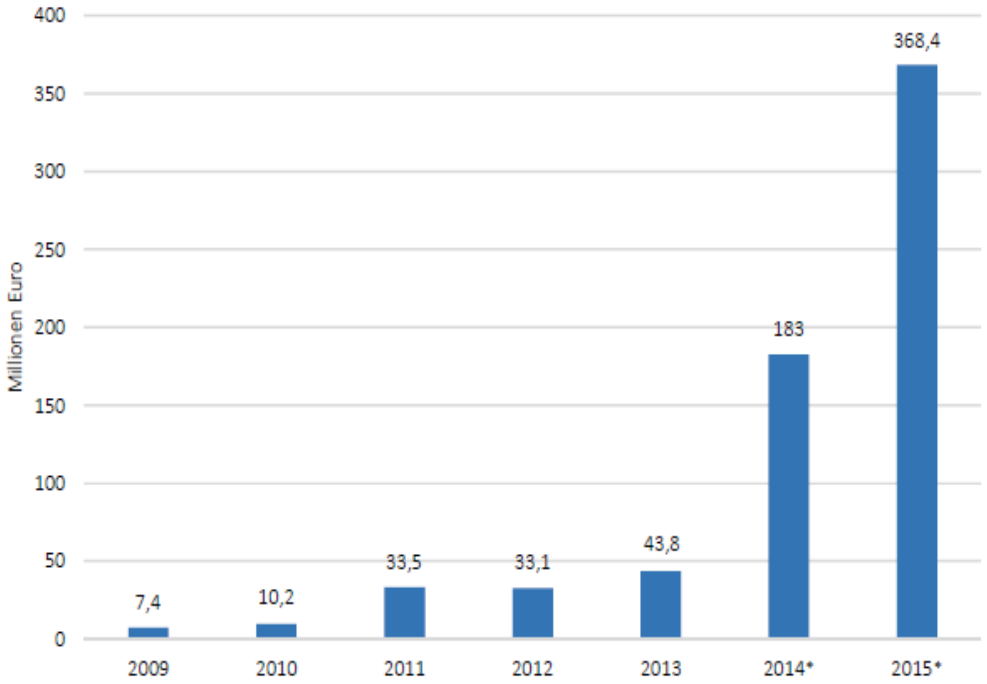
EPEX 2016

Source: Agora Energiewende 2017

Centrally planned economy style regime at excessive costs

‘Einspeisemanagement’ (feed-in management):
TSO ‘orders’ curtailment of RES production (‘lost volumes’)

ABBILDUNG 12: KOSTEN DES EINSPEISEMANAGEMENTS



Quelle: Bundesnetzagentur, 2016, 15f.

Source: DICE

Centrally planned economy style regime at excessive costs

Grid reserve: retired German and active foreign power plants 2016: Capacity 8.4 GW; Molecules 1.2 TWh; Costs € 256 million

Netz- und Systemsicherheitsmaßnahmen der Jahre 2015 bis 2017 (einschl. Reservekraftwerke)

	Redispatch		Reservekraftwerke				EinsMan		Menge Anpassungen von Strom-einspeisung/ -abnahme in GWh
	Gesamtmenge (Erhöhungen + Reduzierungen) in GWh	Kosten[1] in Mio. Euro	Menge (Erhöhungen) in GWh	Kosten[2] Abruf in Mio. Euro	Leistung[3] in MW	Vorhalte-kosten[4] in Mio. Euro	Menge (Reduzie-rungen) in GWh	Geschätzte Entschädigungs-ansprüche[5] in Mio. Euro	
2015	15.436	411,9	551	65,5	7.660	162,3	4.722	478	26,5
Quartal 1	3.329		95				1.135	116,9	8,7
Quartal 2	1.811		53				737	76,6	4,7
Quartal 3	3.336		0				815	82,8	6,2
Quartal 4	6.961		403				2.036	201,8	6,6
2016	11.475	218,8	1.209	78,3	8.383	177,4	3.743	373	14,4
Quartal 1	3.895	51,8	695	55,7			1.524	149,1	6,6
Quartal 2	1.939	22,3	146	11,7			534	54,4	2,2
Quartal 3	1.452	27	2	2,1			551	56	0,6
Quartal 4	4.189	117,6	365	[9,4]			1.134	113,2	5
2017					[11.290]	[106]			

Source: : BundesNetzA Report 2016, page 10

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

Energiewende Part 2: ‘all-electric sector-coupling’

Massive increase in power & peak capacity demand

Quaschning study: from ~600 to 1,300 TWh

Provided all efficiency measures are implemented

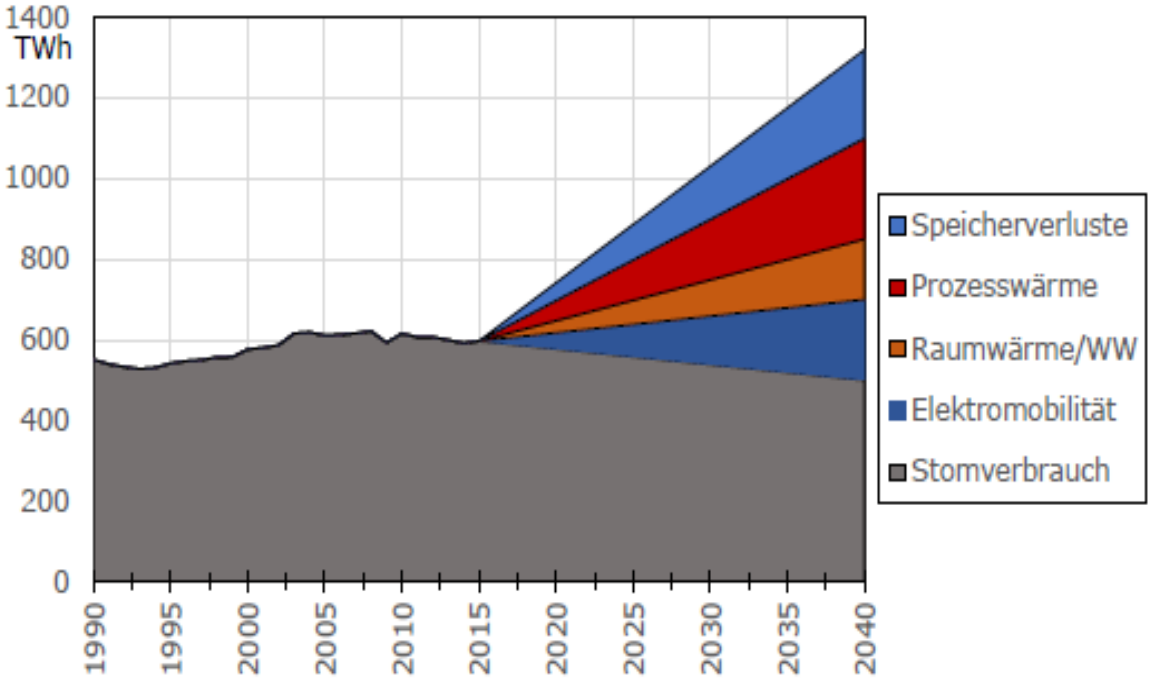


Bild 14 Entwicklung des Strombedarfs für eine klimaneutrale Energieversorgung mit Effizienzmaßnahmen

Source: : Quaschning, Sektorkopplung, page 29

Energiewende Part 2: ‘all-electric sector-coupling’

Demand increase by example 1/3rd German passenger cars

Average driving distance: 20,913 Pkm

Consumption BEV 150/300: 0.625 MJ/km = 174 Wh/km

15 million e-cars (1/3rd of total): 54.45 TWh

Tabelle II-7: Eigenschaften neu zugelassener Pkw-mittel – Entwicklung von 2010 bis 2050

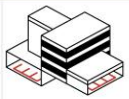
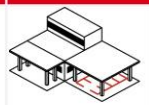
	2010	2020	2030	2040	2050
Energieverbrauch in MJ/km					
ICEV-B	2,57	1,84	1,50	1,13	1,08
ICEV-D	2,35	1,80	1,48	1,17	1,08
PHEV	2,37 / 0,80	1,71 / 0,68	1,59 / 0,64	1,13 / 0,56	1,07 / 0,52
REEV	2,78 / 0,80	2,00 / 0,67	1,90 / 0,63	1,41 / 0,55	1,33 / 0,51
BEV 150	0,80	0,67	0,62	0,54	0,50
BEV 300	0,89	0,73	0,63	0,55	0,51
ICEV-CH_4	2,57	1,84	1,50	1,13	1,08
ICEV-H_2	1,43	1,19	1,13	0,92	0,80

Source: : UBA/Öko Institut Verkehr 2016, page 94

Energiewende Part 2: ‘all-electric sector-coupling’:

Massive increase in peak capacity demand

From 3.7 KW ‘wallbox’ to 350 KW fast-charging loading stations

Anteile der Ladevorgänge	Privater Aufstellort: aktuell 85 %			Öffentlich zugänglicher Aufstellort: aktuell 15 %		
Typische Standorte für Lade-infrastruktur	 Einzel- / Doppel-garage bzw. Stellplatz beim Eigenheim	 Parkplätze bzw. Tiefgarage von Wohnanlagen, Mehrfamilien-häusern, Wohn-blocks	 Firmenpark-plätze auf eigenem Gelände	 Autohof, Autobahn-Raststätte	 Einkaufs-zentren, Parkhäuser, Kundenpark-plätze	 Straßenrand / öffentliche Parkplätze
Vorgaben zur Lade-technologie	Combined Charging System vorschreiben			Combined Charging System als Mindeststandard in Ladesäulenverordnung vorgeschrieben		
Ladedauer für 20 kWh (Verbrauch für 100 km)	**6 Stunden** (AC 3,7 kW)	**6 Stunden** (AC 3,7 kW) **1-2 Stunden** (AC/DC 11-22 kW)	**6 Stunden** (AC 3,7 kW)	**30 Minuten** (DC 50 kW) **10 Minuten** (DC 150 kW)	**6 Stunden** (AC 3,7 kW)	**1-2 Stunden** (AC/DC 11-22 kW)
Ladedauer perspektivisch				**wenige Minuten** (DC 350 kW)		
Strom-versorgung	Über vorhandenen Hausanschluss	Über vorhandenen Anschluss der Anlage oder separaten Anschluss an das Niederspannungs- bzw. Mittelspannungsnetz				Über vorhandene Infrastruktur (z.B. Straßenbeleuch-tung) oder neuen Anschluss an das Niederspannungs- bzw. Mittel-spannungsnetz
Abrechnung	Abrechnung möglich je nach gewünschtem Geschäftsmodell, z.B.: - kostenlos - pauschal - nach Ladeleistung - nach bezogener Energiemenge					

Source: www.nationale-plattform-elektromobilitaet.de

Energiewende Part 2: ‘all-electric sector-coupling’

Massive increase in peak capacity demand

Baseload capacity (8,760 hours) for 54.45 TWh
Peak capacity for 7,100 fast-charging loading stations at 350 KW

Baseload capacity e-mobility			
Demand TWh	Loadhours		Capacity GW
54.45	8760		6.22
Additional peak load ski holiday driving season			
	unit capacity	loading points	Capacity GW
highway fast charging	350.00	7,000.00	2.45
Assumed total capacity:			8.67

Source: UBA, Own calculations

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

Increased demand: substantial short position RES

Recall: demand from ~600 to 1,300 TWh

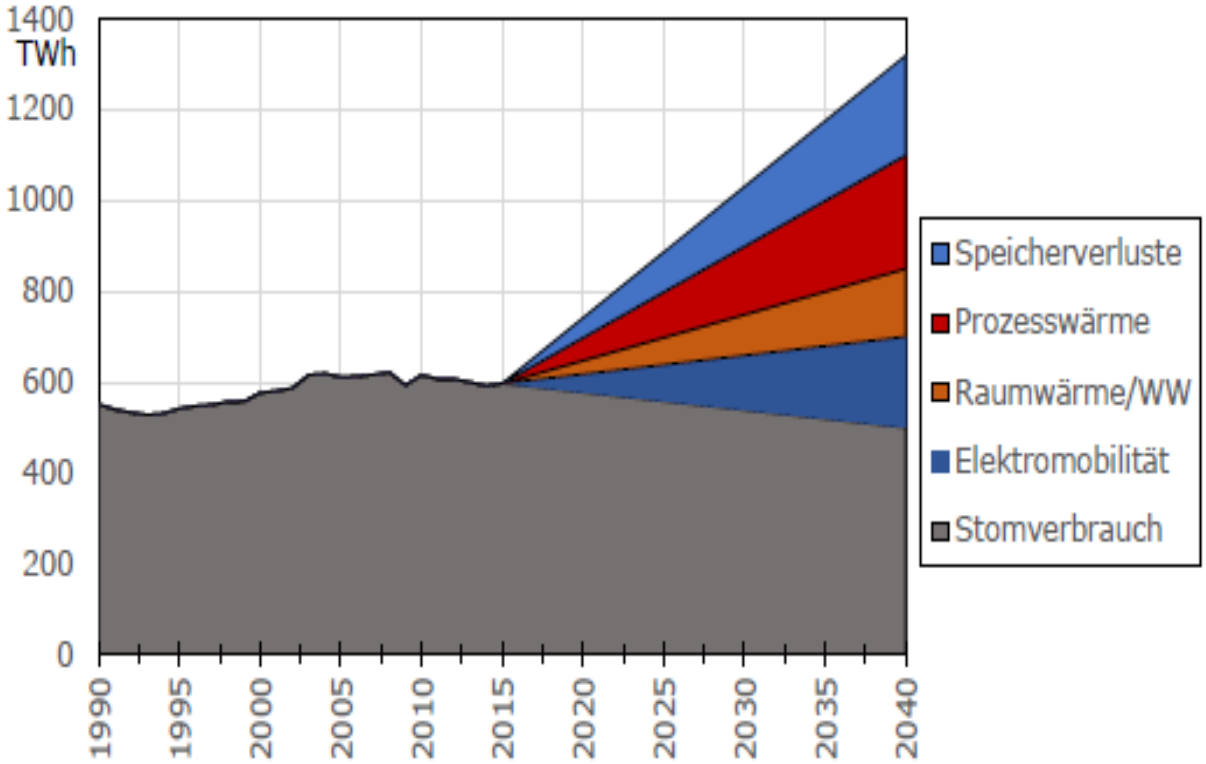


Bild 14 Entwicklung des Strombedarfs für eine klimaneutrale Energieversorgung mit Effizienzmaßnahmen

Source: : Quaschning, Sektorkopplung, page 29

Increased demand: substantial short position RES

RES capacity in 2040 ~doubled from 104 to 187 GW
RES output 2040: 460 of 1,300 TWh (optimistic load factor ~28%)

Short position: 840 TWh

Tabelle 12 Entwicklung der regenerativen Stromerzeugung bis 2040 bei dauerhaftem Einhalten der EEG-Zielkorridore aus dem EEG 2014 [EEG14]

Erzeugung	Jährlicher Ausbau in GW	Installierte Leistung 2040 in GW	Volllaststunden in h/a	Strom-erzeugung 2040 in TWh [2]
Photovoltaik	2,5 (brutto)	50	950	48
Windkraft onshore	2,5 (netto)	104	2500	260
Windkraft offshore [1]	0,85 (netto)	24	4500	108
Biomasse	0,1 (brutto)	3	5500	17
Wasserkraft [1]	0,05 (netto)	7	3800	27
Summe	6	187		460 (35 %)

[1] Ausbauziele für Wind-Offshore: 6,5 GW bis 2020 und 15 GW bis 2030, keine Ziele für die Wasserkraft
[2] durchschnittliche Anlagenlebensdauer 20 Jahre

Source: : Quaschning, Sektorkopplung, page 29

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

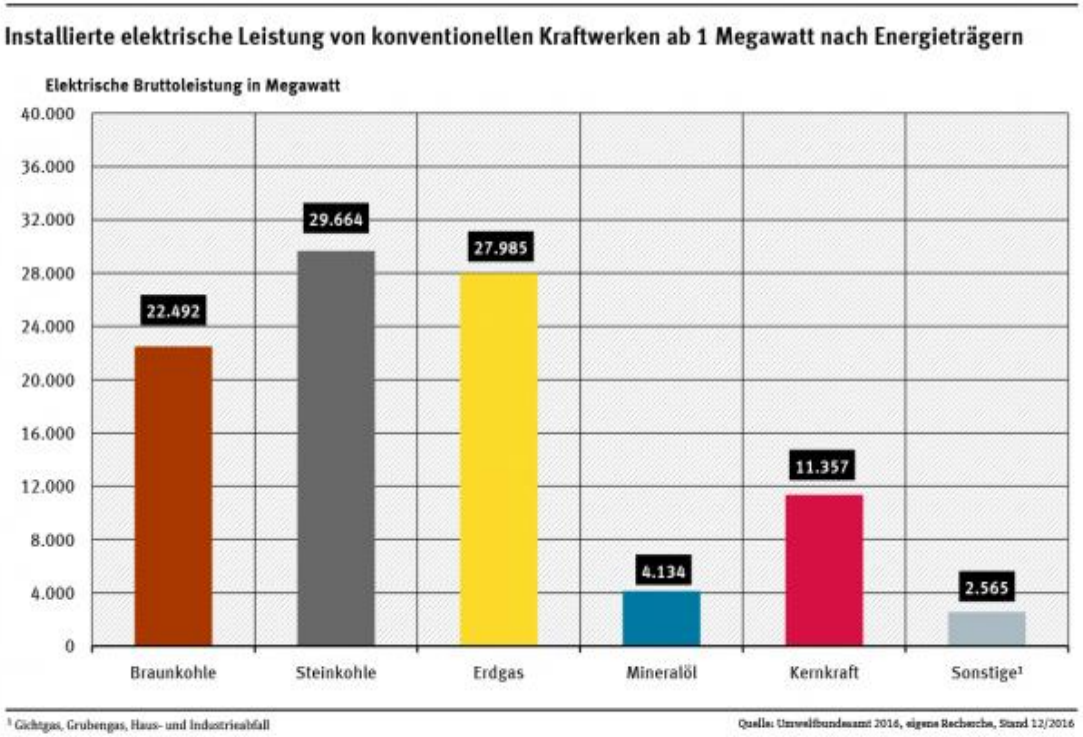
Avoid rising CO2: cover short position with GAS

GAS required to 'save the day'!

~10 GW nuclear gone in 2020/21

Higher load factors lignite/coal?

~100 GW additional gas capacity: 840 TWh (at 8,400 Lhrs)



Source: https://www.umweltbundesamt.de/daten/energiebereitstellung-verbrauch/konventionelle-**kraftwerke-erneuerbare-energien#textpart-1**

Avoid rising CO2: cover short position with GAS

GAS required to 'save the day'!

Increase coal: massive <u>increase</u> CO2; Gas: massive <u>reduction</u> CO2

Gas supremacy prevails by far also by 'well-to-grid' standards

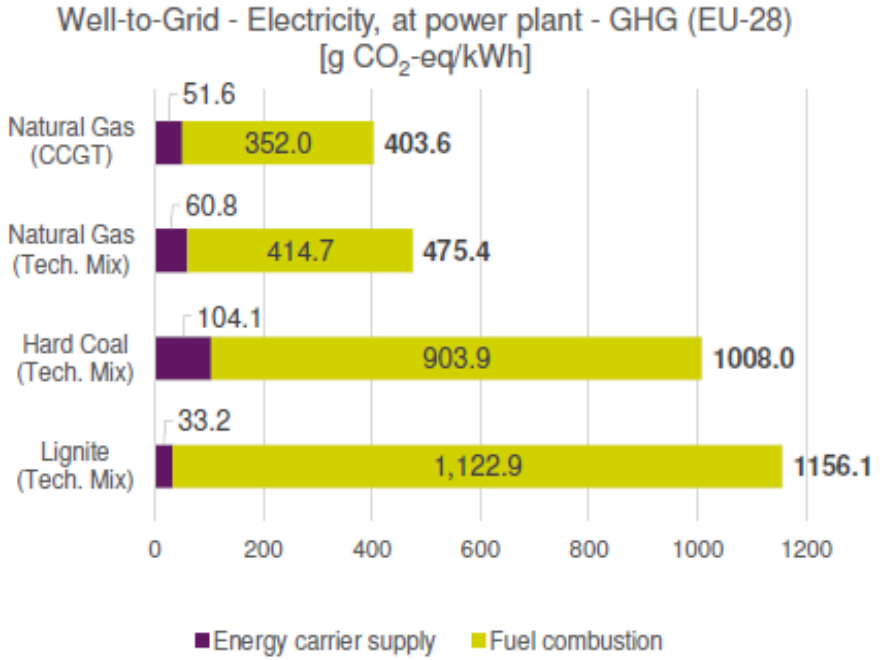


Figure 7-8: Well-to-Electricity – GHG Emissions: Electricity Production Comparison for different Energy Carriers [33]

Source: Thinkstep Natural Gas GHG Intensity Report, page 91

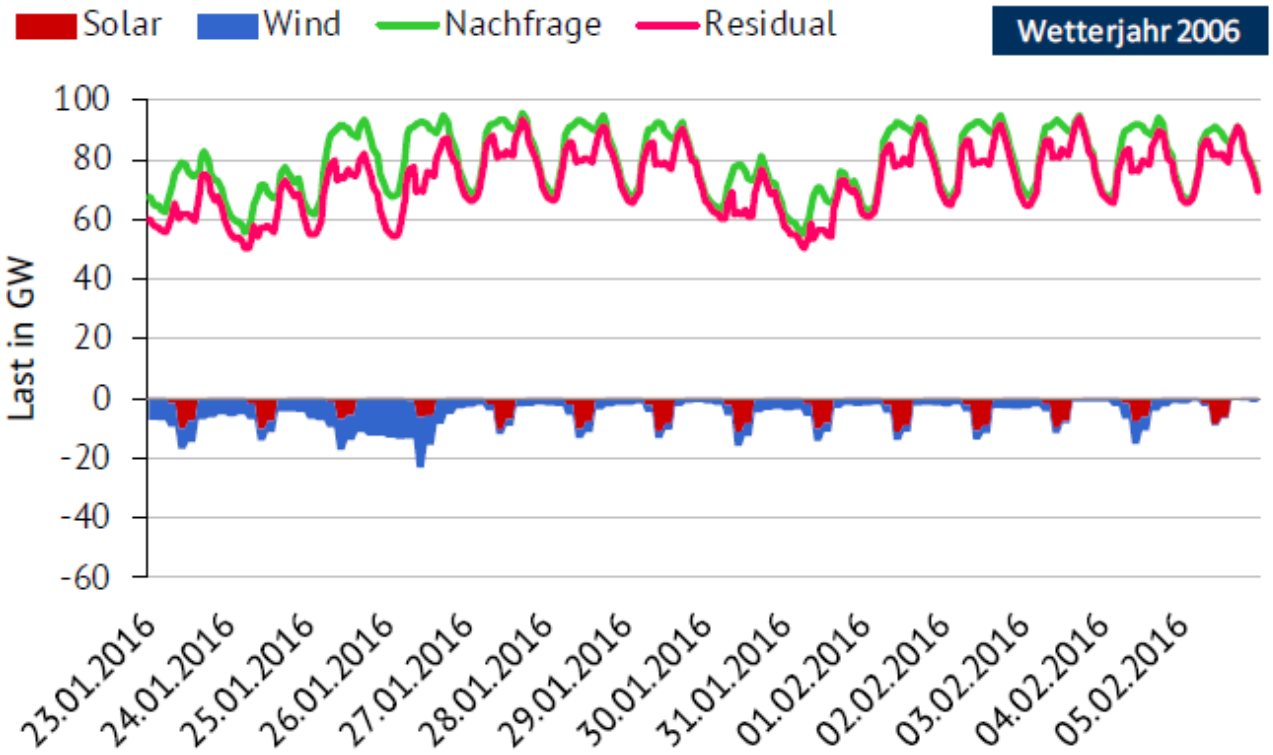
Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

‘Kalte Dunkelflaute’: increased residual load requirement

‘Residual Load’ needed for complete wind & solar capacities
Weather year 2006 (recurrent) projected on to 2016



Source: Greenpeace/Energy Brainpool, ‘Kalte Dunkelflaute’, page 5

‘Kalte Dunkelflaute’: increased residual load requirement

Solar + wind capacity 2040: 178 GW

Residual load requirement: 178 GW

Retired coal plants in ‘grid reserve’? New GAS capacity!

Tabelle 12 Entwicklung der regenerativen Stromerzeugung bis 2040 bei dauerhaftem Einhalten der EEG-Zielkorridore aus dem EEG 2014 [EEG14]

Erzeugung	Jährlicher Ausbau in GW	Installierte Leistung 2040 in GW	Volllaststunden in h/a	Strom-erzeugung 2040 in TWh [2)]
Photovoltaik	2,5 (brutto)	50	950	48
Windkraft onshore	2,5 (netto)	104	2500	260
Windkraft offshore [1)]	0,85 (netto)	24	4500	108
Biomasse	0,1 (brutto)	3	5500	17
Wasserkraft [1)]	0,05 (netto)	7	3800	27
Summe	6	187		460 (35 %)

[1)] Ausbauziele für Wind-Offshore: 6,5 GW bis 2020 und 15 GW bis 2030, keine Ziele für die Wasserkraft
[2)] durchschnittliche Anlagenlebensdauer 20 Jahre

Source: : Quaschning, Sektorkopplung, page 29

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

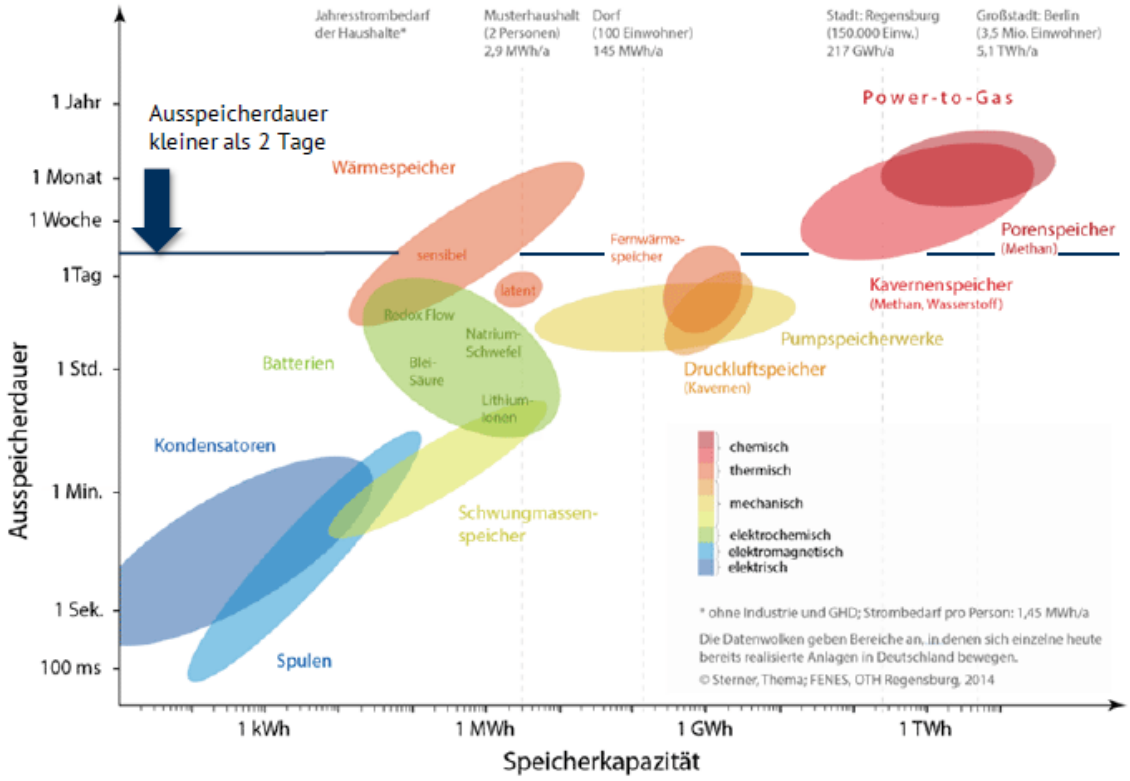
Long-term storage RES production: by PtG

Improve RES 'harvest': GAS GRIDS & Storage to save the day

Instead of curtailment / export at negative prices: RES 'storage'!

PtG only technology for long-term storage of renewable power

'Gas can green'! Increasing share of hydrogen & synthetic gas.



Source: Greenpeace/Energy Brainpool: Minimum Power Flexibility, page 2

Agenda:

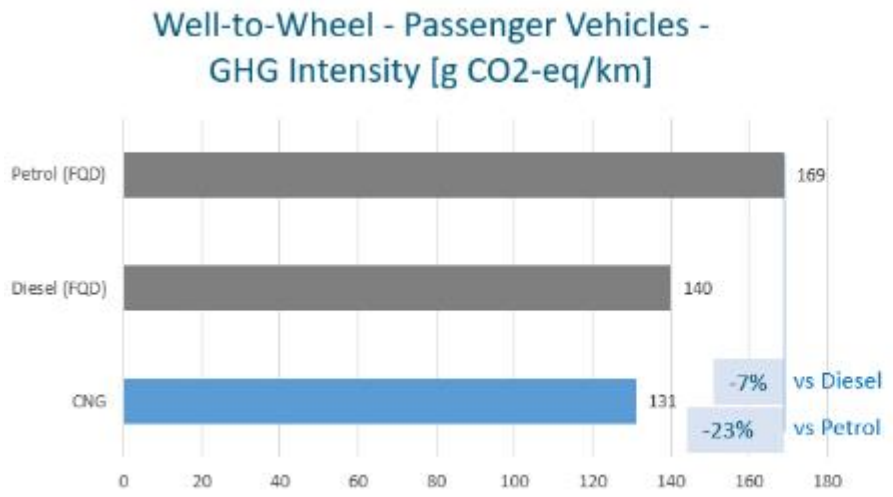
- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

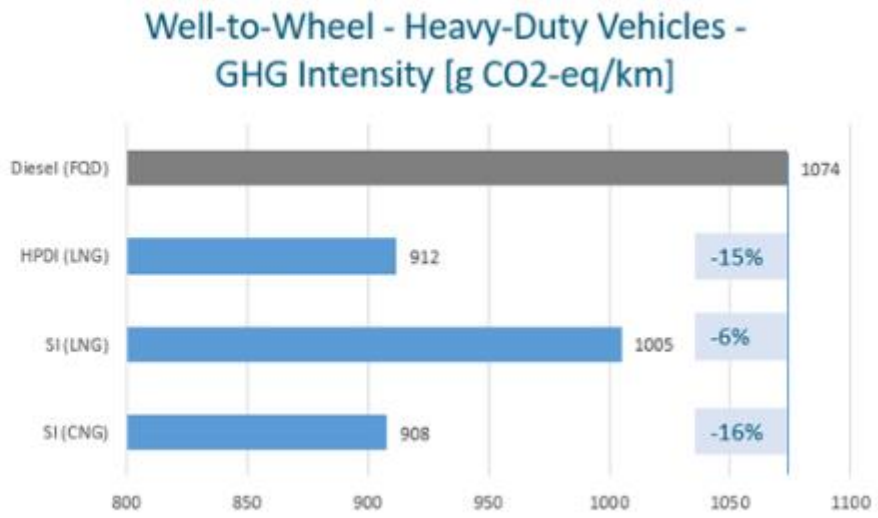
- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!

Direct use of gas for transport achieves more than electrification

CNG passenger cars: - 23% CO2
LNG heavy duty vehicles: - 15%
LNG maritime: -21%
Further: high benefits clean air



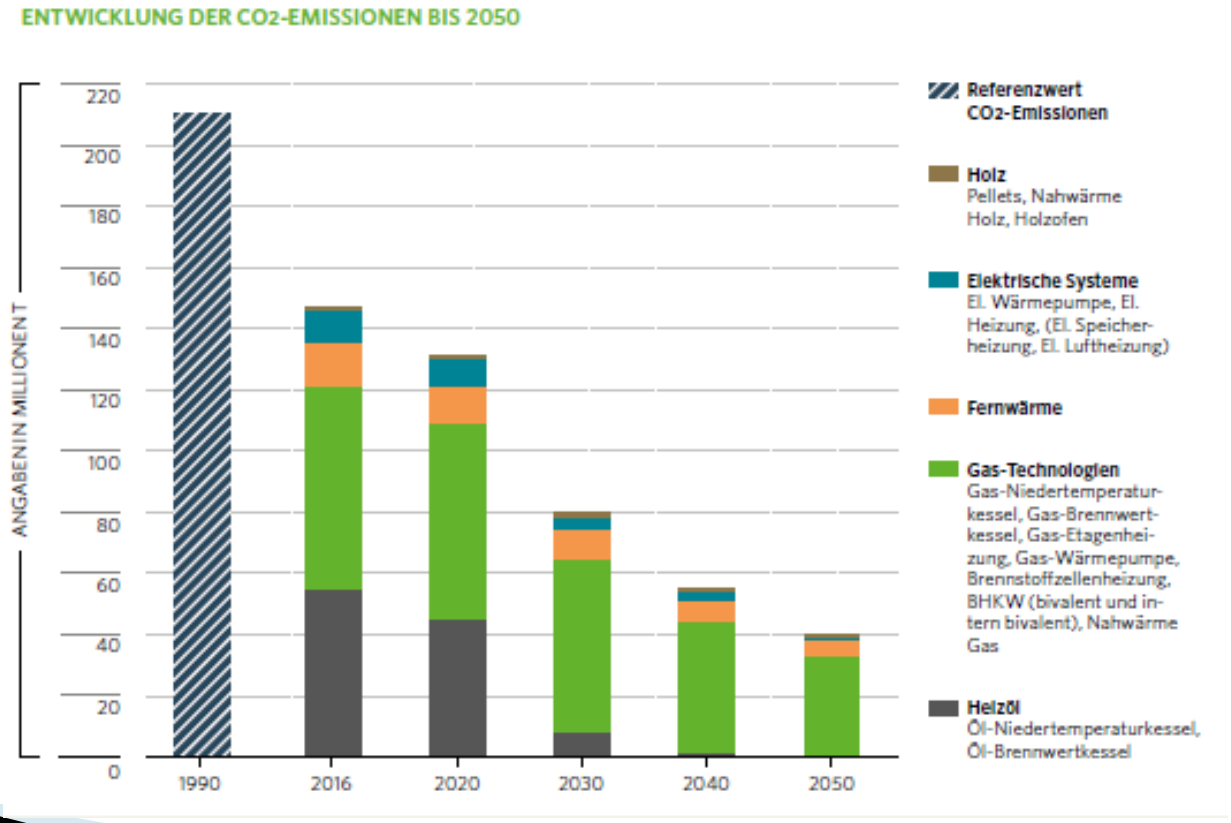


Source: http://ngvemissionsstudy.eu/

‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!

Heat sector: Replace oil by gas, the latter increasingly ‘green’

CO2 reduction 2050 ~81%



Source: Zukunft ERDGAS, Wärememarktstudie

Agenda:

- Two amazingly divergent views
- Achievement & failure: RES instead of CO2 reductions
- RES ‘tunnel vision’: blind eye on systemic imperfections
- Centrally planned economy style regime at excessive costs
- ‘Energiewende Part 2’: ‘all-electric sector-coupling’
- Increased demand: substantial short position RES
- Avoid rising CO2: cover short position with GAS
- ‘Kalte Dunkelflaute’: increased residual load requirement
- Long-term storage RES production: by PtG

- ‘Energiewende Part 2’ reloaded: technology open and direct deployment of gas!
- Gas Advocacy in ‘last man standing’ fashion: the next level

Gas advocacy in ‘last man standing’ fashion

The next level: besides rational arguments, use popularity concerns

Source: Zukunft ERDGAS, Jahresbericht 2016, page 18

For further reading soon to come:

‘Energiewende: From Champion to ‘Fossil of the Day’

Without natural gas to save the day, ‘all-electric sector-coupling’ will ensure further fossil of the day awards

(www.gasvaluechain.com)

Thank you very much for your attention!