Gas vs REN / EE in Germany

The need to complement renewables by decarbonised gas*

Discussion at EU Russia Gas Advisory Council, St. Petersburg, 10 July 2018

Ralf Dickel, senior visiting research fellow, Oxford Institute of Energy Studies

*Based on OIES Paper NG 129

Rationale

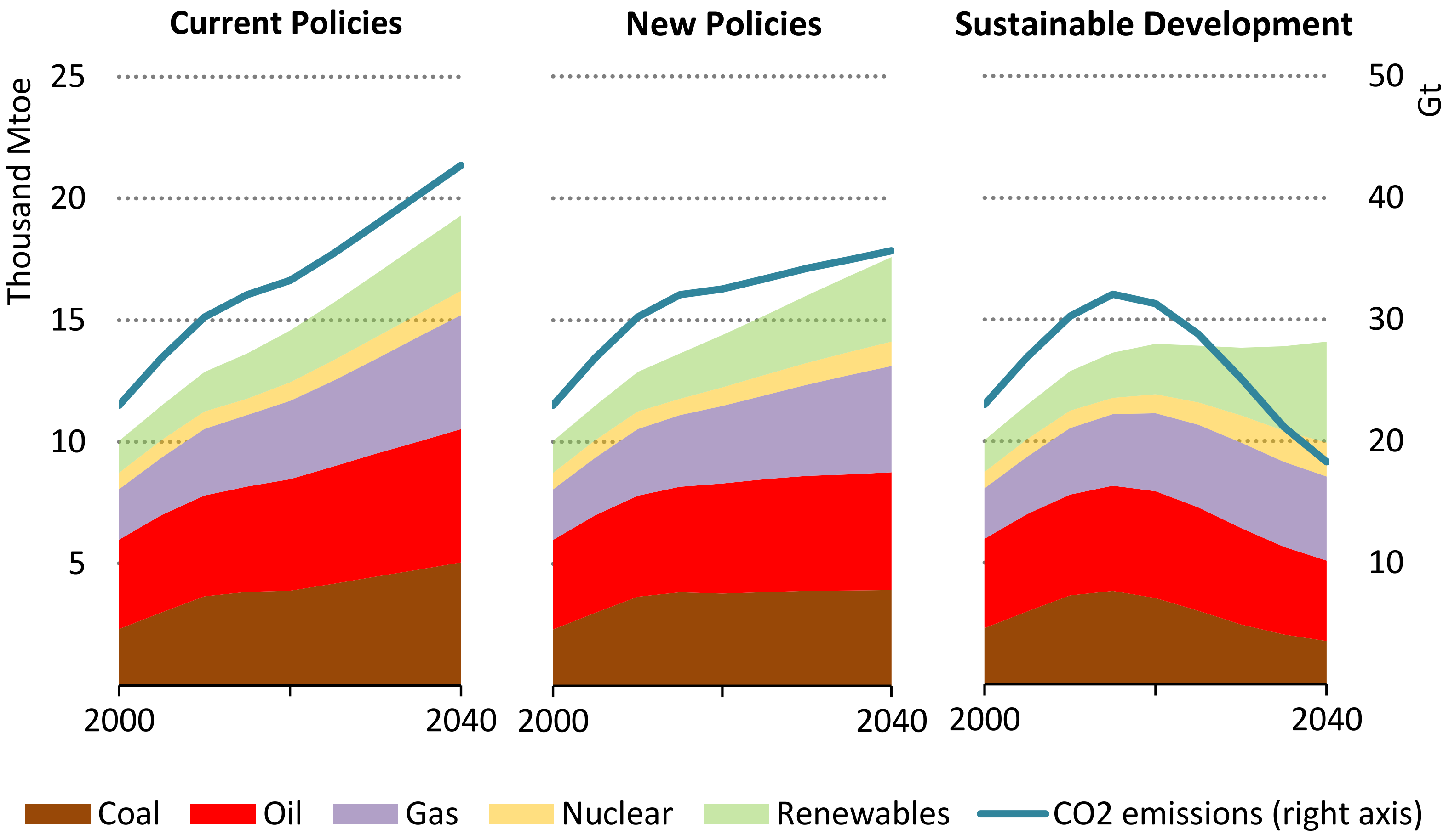
1. The Paris Agreement stipulates
   - To stay below 2 (or less) degree C : corresponding largely to staying within a carbon budget (1000 Gt CO_2 as of 2015)
   - To have a carbon neutral world in 2nd half of 21 century
2. Renewables (de facto electric renewables) will not come in time to stay within the carbon budget (example Germany)
3. De carbonized energy are not necessarily renewables (misperception), fossil fuels can be de –carbonized!

Mandatory conclusion: renewables must be complemented by de carbonized fossil fuels, for practical reasons hydrocarbons and here gas first! Disposing of CO_2 from decarbonization process in geological structures (reservoirs and aquifers) is necessary

4. An all renewable (electric) world would devalue the hydrocarbon resources and investment, shrinking the resource rent and cross border energy material trade
5. De carbonizing natural gas (and other hydrocarbons) to H_2 (or NH_3) is necessary to achieve the PA targets and avoiding devaluing gas resources /infrastructure (devices).

This requires cooperation between hydrocarbon producing and consuming countries.

World primary energy demand by fuel and energy-related CO_2 emissions by scenario (WEO 2017)

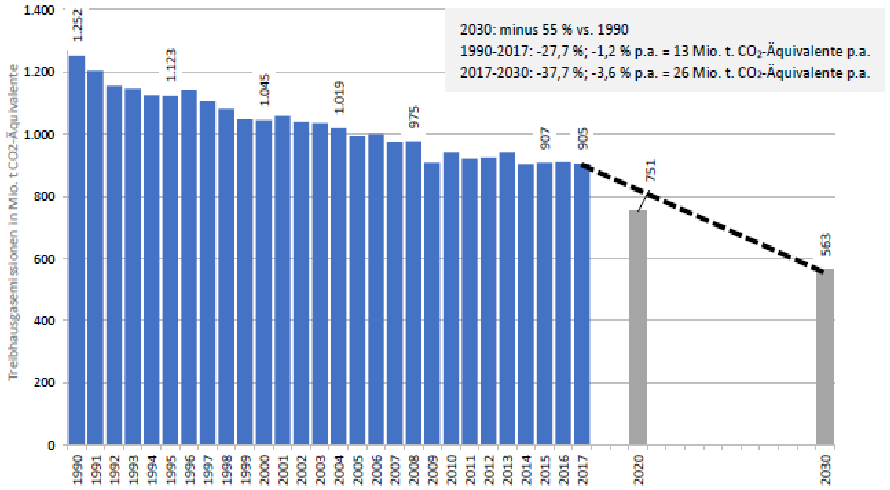


The flattening of emissions in 2014-2016 is a pause in a slower upward journey in the New Policies Scenario, but a turning point in the SDS

Germany will fall short of its decarbonisation targets

GHG Emissions Germany as of 1990 (Mio t CO2 eq)

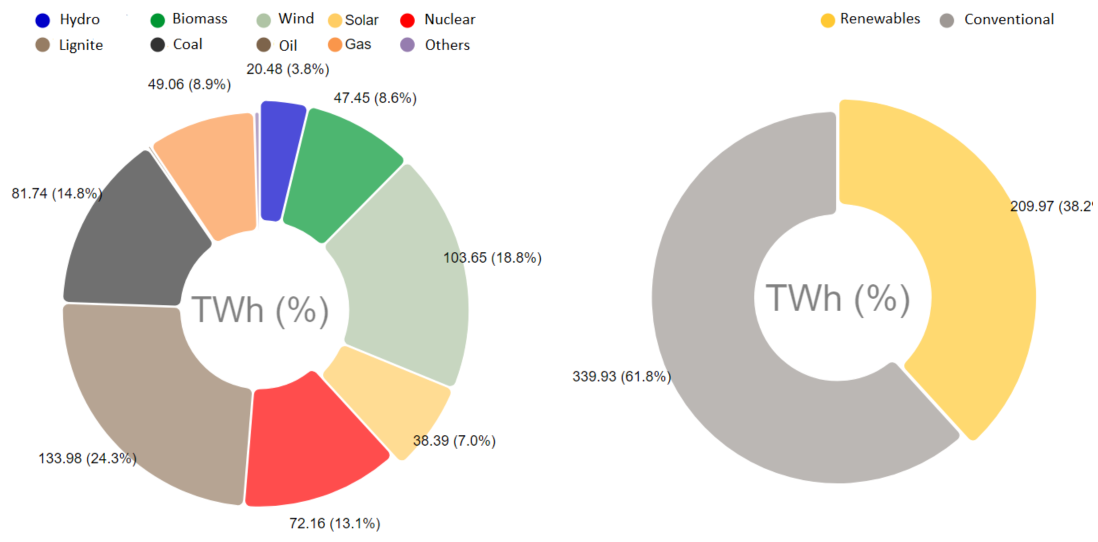
Abbildung 2: Treibhausgasemissionen in Deutschland von 1990 bis zum Reduktionsziel für 2030



Quelle: Eigene Darstellung auf Basis von UBA (2018b) und BMWi/BMU (2010)

Source: Clean Energy Wire, UBA 2018

But it will meet its electric renewables target



Nettoerzeugung von Kraftwerken zur öffentlichen Stromversorgung.
Datenquelle: 50 Hertz, Amprion, Tennet, TransnetBW, Destatis, EEX
letztes Update: 12 Mar 2018 08:58

Source: 50 Hertz, Amprion, Tennet, TransnetBW, Destatis, EEX

German decarbonisation policy

Germany was and is a pioneer

- Aiming at the targets of the 4th IPCC assessment report
- Fostering renewables internally and externally (promoting IRENA)

Flaws:

- Policy instrument flaws
  - Overlap of electric renewables policy with the ETS, leading to a reduced demand for EUAs without shortening the supply of EUAs: EUA prices stay low
  - Mistaking the instrument for the target (renewables instead of de-carbonization)
- Conceptual flaw (shared by many): decarbonising can only work with renewables
  - Equating sustainable energy supply (renewables) with GHG-free energy
    (can also be decarbonised fossil fuels, especially hydrocarbons)

=> Renewables policy will not deliver in time for Germany's decarbonisation target / for its contribution to reach the PA targets

Energy efficiency in buildings

Saving in building stock stagnates

- Energy saving in existing buildings (42 mln dwellings) is decisive
- Easy / economical measures have been implemented
- Lower gas prices make insulation unattractive
- Polystyrol on the decline (impact of the Grenfell disaster)

Sales of insulation materials in 1000 m^3

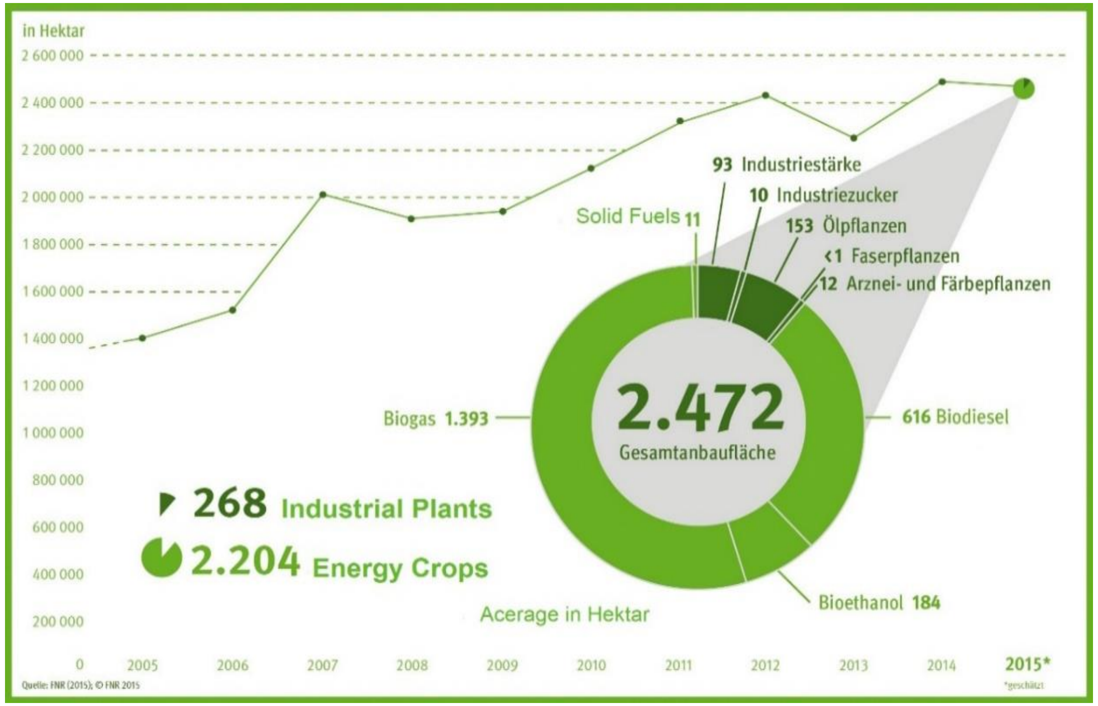
Source: Interconnection Consulting

Use of biomass for energy purposes

Limitations

- Biomethane less than 1 bcm/a compared to the 6 bcm/a target
- Use of renewables for heating, mainly wood
- Limitations by need for CO_2 absorption
- Biomass waste for small power and in industry reached its limits
- Limited acreage for energy crops

Acreage for energy crops in Germany, 2005-2015



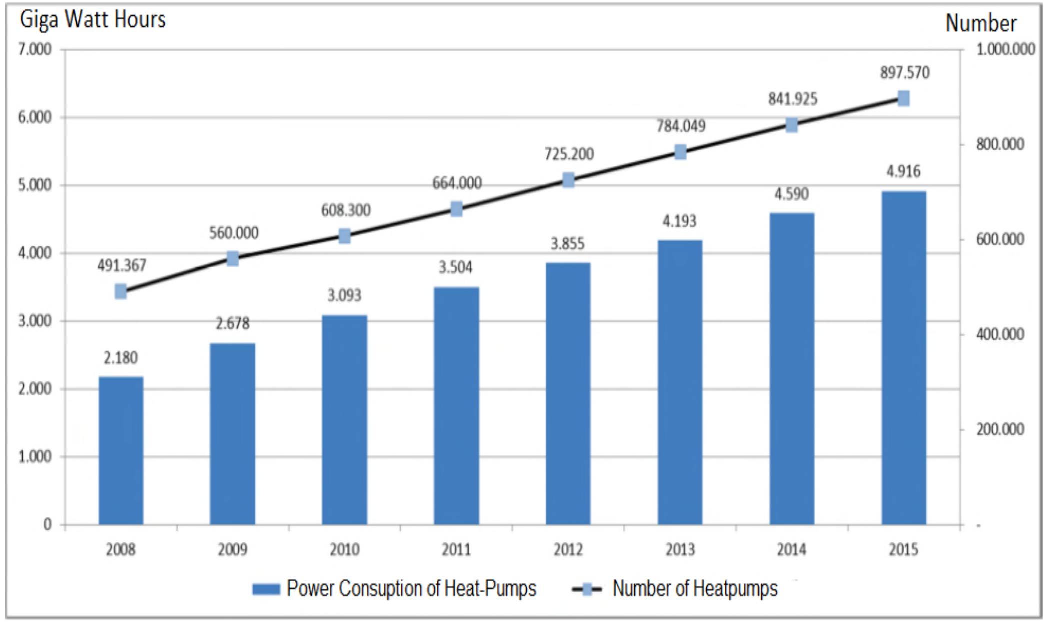
Source: FNR 2015

Heat pumps as major renewables in heating?

Obstacles to further deployment of heat pumps (6 mln by 2030)

- Major effect needs use in existing building stock (42 mln dwellings)
- Only one third installed in existing buildings
- Restrictions in urban areas
- Decreasing yields at low temperatures
- Add to the winter peak load

Number of heat pumps and power consumption of heat pumps



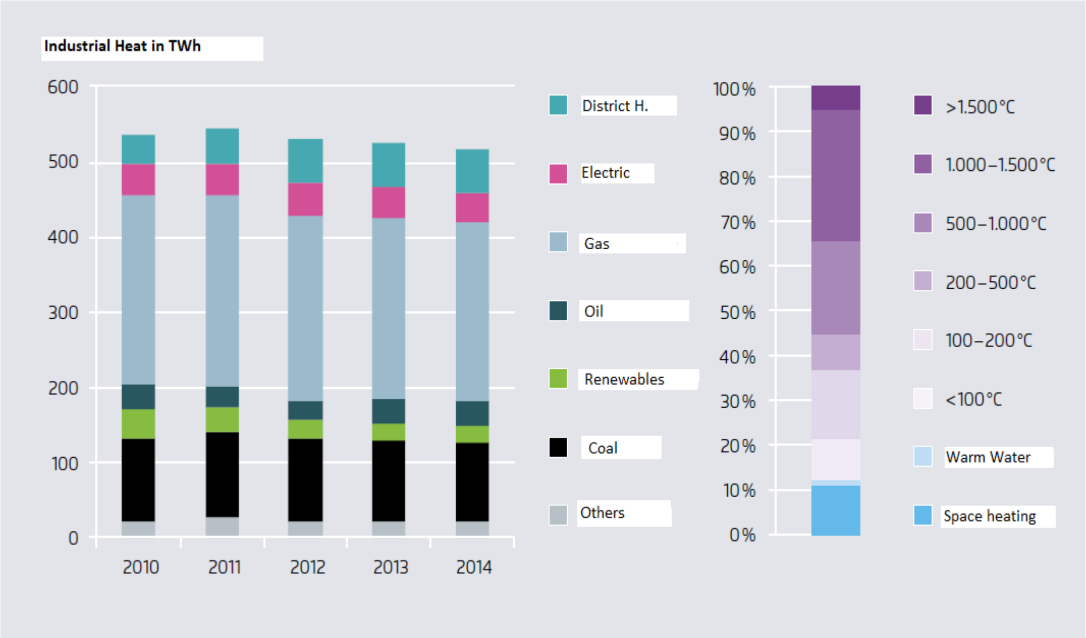
Source: Bundesumweltamt

Renewables in industry

Renewables in industry: marginal

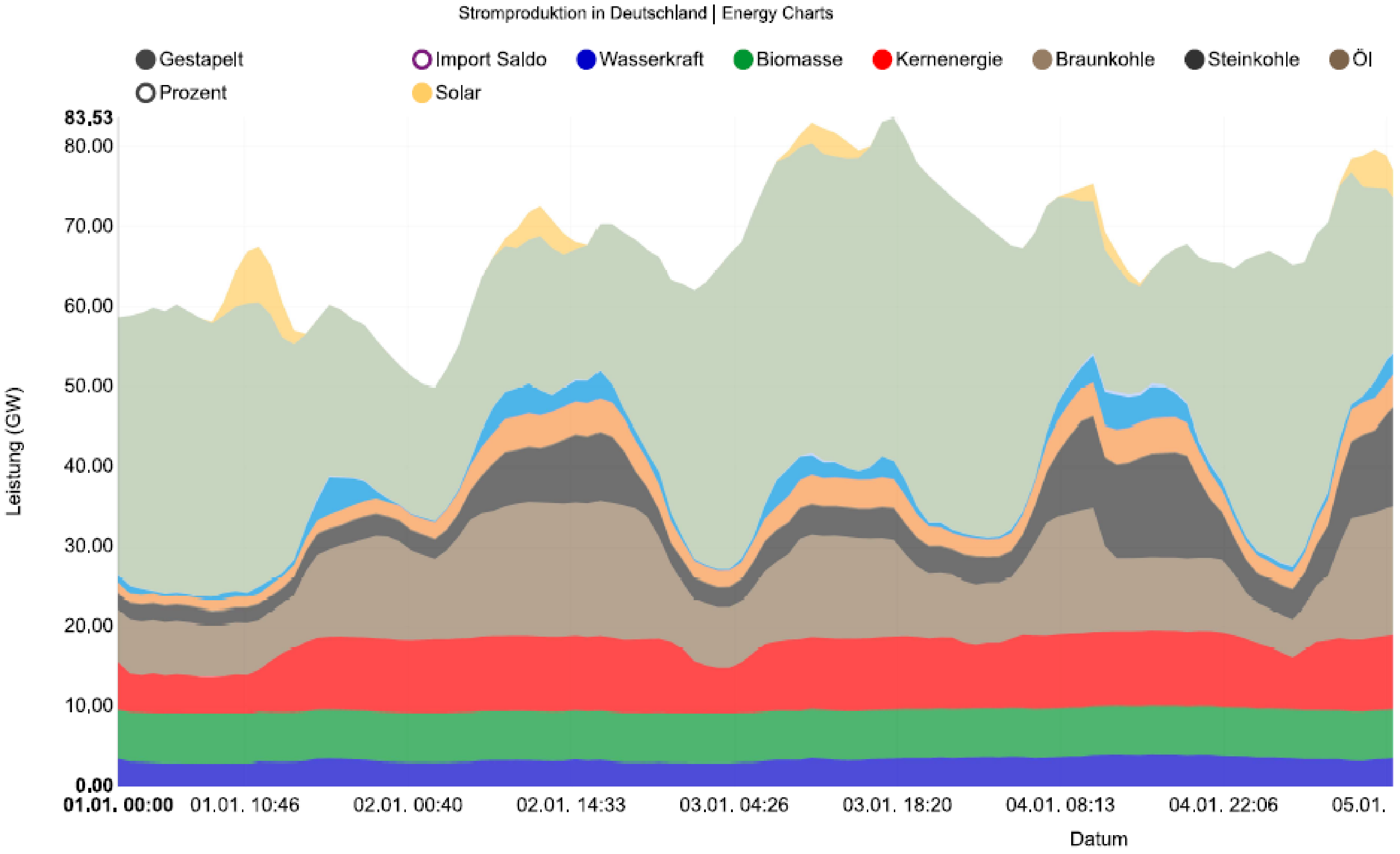
- Renewables ca 5%, constrained to waste from paper and pulp
- 50% of process heat > 500 degrees C
- Gas easy to handle at all temperatures
- Still 20% coal
- CHP potential for gas

Industrial heat consumption in TWh



Source: Agora Energiewende (Feb. 2017): Changing Heat Supply 2030

Eleanor in January 2018: testing the power system



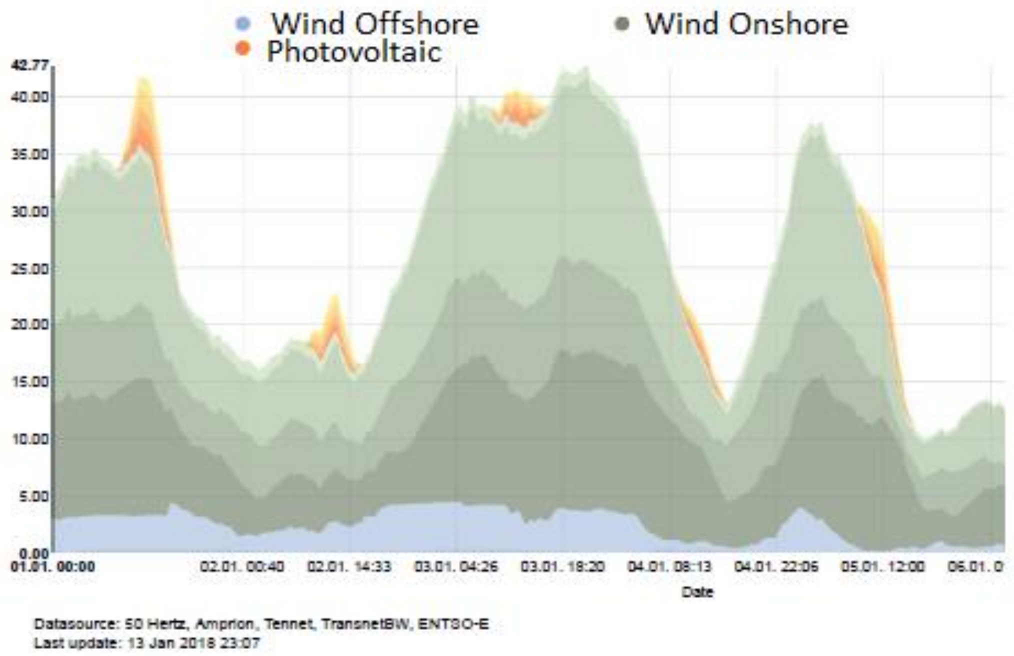
Nettoerzeugung von Kraftwerken zur öffentlichen Stromversorgung.
Datenquelle: 50 Hertz, Amprion, Tennet, TransnetBW, EEX
letztes Update: 24 Jan 2018 09:29

Challenges posed by wind and PV

Challenges of intermittence

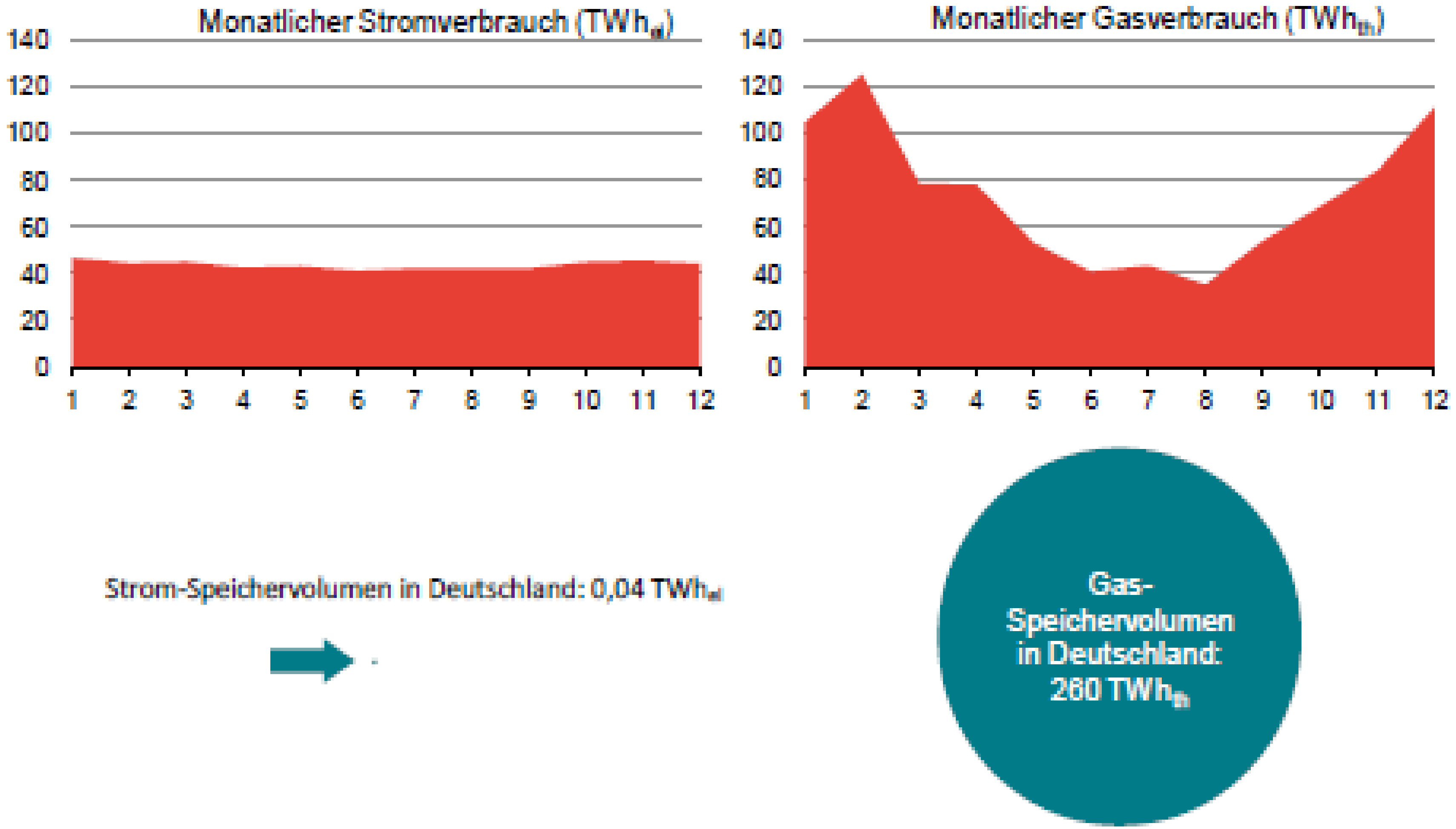
- High volatility (during storms): all thermal in load following: 2-3 GW/h
- Strong wind / PV > low demand: cut REN or export surplus + must-run thermal (1 Jan 2018)
- Low wind in dark winter: dispatchable power must cover all peak load! (2^{nd} half of Jan 2017)
- High ./. low wind: 200 h/a x 50 GW = 10 TWh (aluminium: 8 GWh/a)
- Export / import as a buffer, how long?

Wind, PV during 1-6 Jan 2018 (Eleanor)



Source: 50 Hertz, Amprion, Tennet, TransnetBW, ENTSO-E

Monthly consumption and storage volume: power vs. gas (2012,TWh)



Source: Frontier Economics on the basis of ENTSO-E, IEA and the German Bundestag (2017)

Lessons from Germany for global decarbonisation

- If renewables and energy efficiency do not reach Germany's decarbonisation targets (with € 20 bln support per year), they are unlikely to work globally to reach PA targets
- Germany's Energy Strategy – if it worked - would use up 1.5% of the carbon budget (for 2 degrees) by 2050 compared to 1% of global population
- Countries differ, but seasonal and annual variations of REN production generally apply in moderate zones, so does competition of producing energy biomass with food production
- Do not equate renewables with carbon free energy, renewables are sustainable, the point is about a carbon free energy supply first
- Only adding decarbonised hydrocarbons has the potential to reach the PA targets in time (within the carbon budget)
- Renewables alone will not reach the global decarbonisation target in time
- It is essential to complement renewables by other GHG-free energy. Known processes applied on a large scale are needed.
- Decarbonising natural gas to H_2 through a reforming process upstream is a good start

Benefits of decarbonizing natural gas upstream

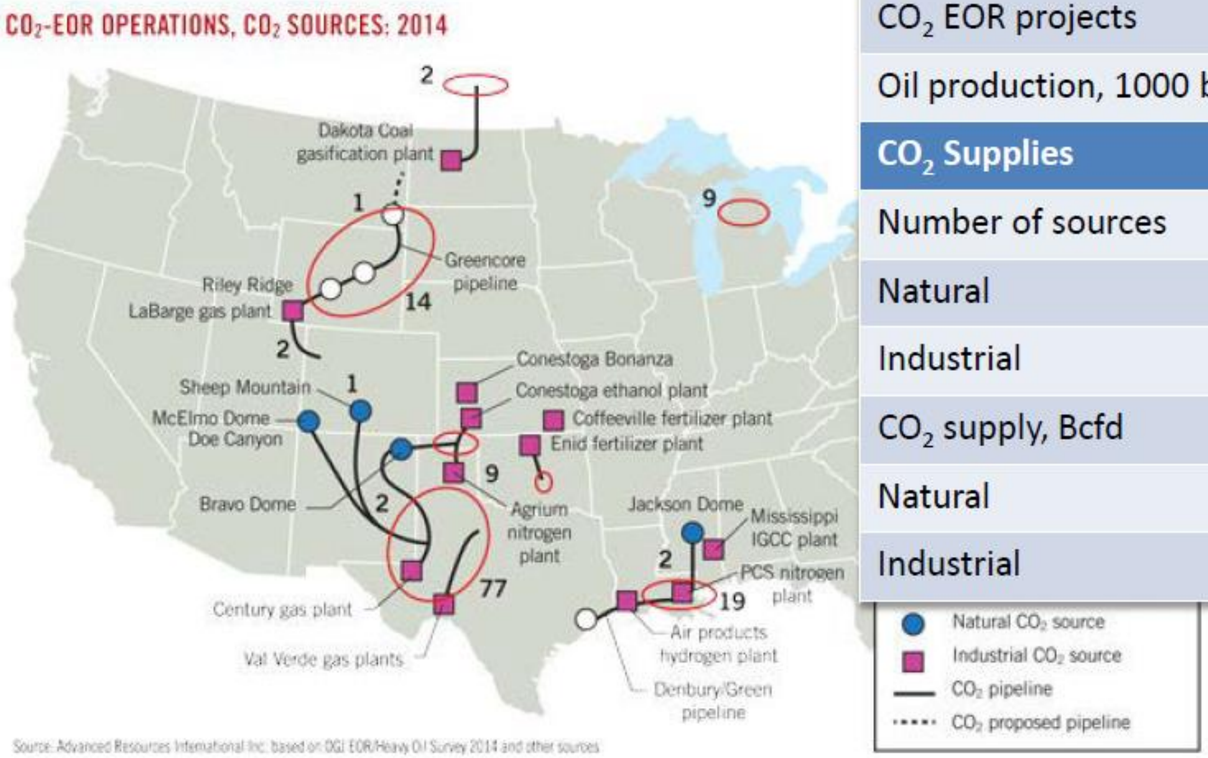
To achieve PA targets:

- Time is of the essence
- Natural gas (and other hydrocarbons) can become important part of de carbonized world (a competitive solution fuel)
- Reforming of natural gas is wide spread; NEW: reforming upstream, disposal of CO_2 in structure near production (possibly EOR); no need for long CO 2 pipelines, no discussion in populated areas

Impact on industry

- Keeps value of resources, infrastructure , adding options for new sales in traffic segment (fuel cell use cars, locomotives and ships)
- Duration: as long as gas resource can be exploited competitive with renewables
- Becomes a competitor for (electric) renewables with different pros / cons, new competitive environment for industry
- Resource owning countries sell energy contained in natural gas as H_2 (some energy losses as local heat), plus selling CO_2 storage room => carbon free H_2 as higher value product

U.S. CO_2 EOR Projects

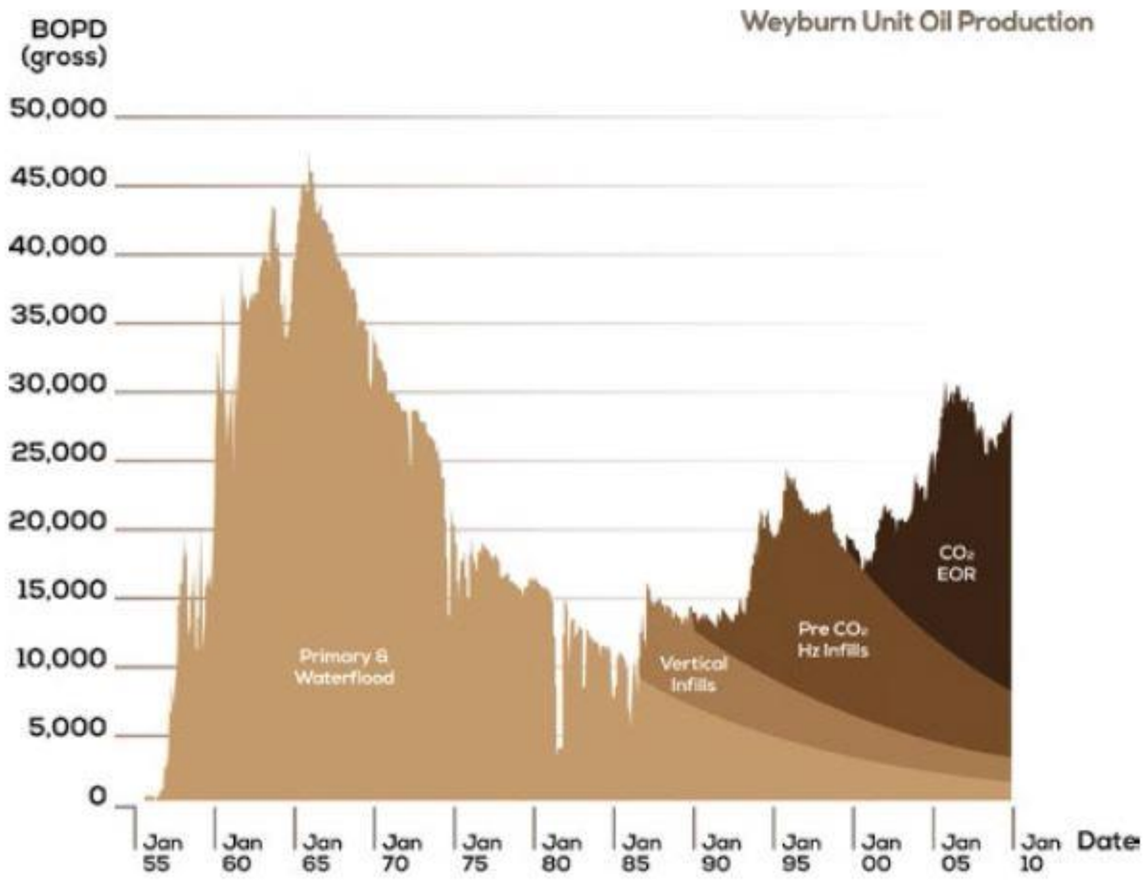


Oil Production, 2014	
CO_2 EOR projects	136
Oil production, 1000 b/d	300
CO_2 Supplies	
Number of sources	17
Natural	5
Industrial	12
CO_2 supply, Bcfd	3.5
Natural	2.8
Industrial	0.7

EERC

Source: Evolution of CO2 EOR and CCS in the United States 7th IEA International CCS Regulatory Network International Energy Agency Paris, France April 22–23, 2015 John A. Harju Associate Director for Research

EOR from CO2 injection at the Weyburn field (Canada)



Because the CO_2 is miscible with the oil a certain amount of CO_2 returns to the surface during oil production. The oil company at the Weyburn field separates this CO_2 from the oil mixture at the surface, and compresses and re-injects it along with the new CO_2 arriving from the United States.

source: What happens when CO_2 is stored underground? Q&A from the IEAGHG Weyburn-Midale CO_2 Monitoring and Storage Project

Estimates of CO_2 storage capacity in the Norwegian shelf
by the Norwegian Petroleum Directorate (CO_2 storage atlas Norwegian North Sea)

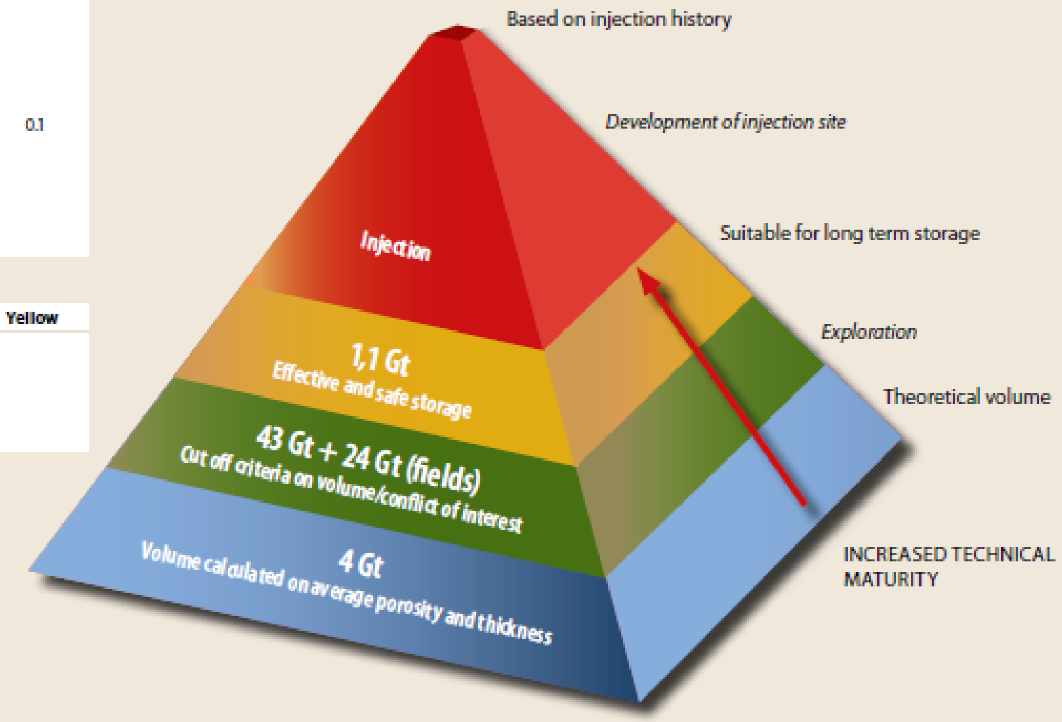
Storage capacity in Gigatons and technical maturity

Aquifers

Basin/reservoir	Storage capacity	Maturity		
	Total	Blue	Green	Yellow
Utsira and Skade	15.8		14.8	1
Bryne/Sandnes southern parts	13.6		13.6	
Sognefjord Delta east	4.1		4.1	
Statfjordfm øst	3.6		3.6	
Gassum	2.9	2.9		
Bryne/Sandnes Farsund basin	2.3		2.3	
Johansen and Cook	1.8		1.7	0.1
Fiskebank	1	1		
Hugin East	0.1		0.1	
Stord basin, Jura	0.1	0.1		
Stord basin , mounds	0.05	0.05		

Field related

		Blue	Green	Yellow
Abandoned fields	3		3	
Fields in production 2030	4		4	
2050	6		6	
Sognefjord delta including Troll	14		14	



Halland E.K., Johansen W.T., Riis F., 2012. CO2 Storage Atlas Norwegian North Sea, NPD report: http://npd.no/en/Publications/Reports/CO2-Storage-Atlas-/

Comparison / competition seen from an importing country: electric renewables vs. decarbonised gas

Electric renewables

Pros

- Wind, PV existing solution
- Sustainable in the long term
- Low variable costs
- Domestic
  - No import costs
  - No resource rent transfer
  - No import dependence

Challenges

- Volumes not high enough
- Intermittence
- No battery solution
- Not always customer-friendly

Decarbonised gas

Pros

- Additional carbon-free solution
- Easy to store, transport
- More customer-friendly
- Use of existing resources
- Use of existing infrastructure, appliances
- Continuity of the role of resource owners
- Potential use in traffic, e.g. fuel cell cars

Challenges

- Need to create a market for H_2
- Transition issues
- Resource rent transfer
- Import dependence

Potential for co-operation

Topics for joined or shared research:

- Market for energy molecules (CH_4 or H_2) vs for electric power
- Use of Hydrogen
  - Potential market development
  - Blending and separating H_2 and CH_4
  - Use of existing infrastructure / equipment
- Ways to decarbonize natural gas
- How to dispose of C, CO_2 (experience EU, Nor, US, Rus)

Conceptual discussion on trading de carbonized gas

Thank you for your attention!

GHG Emissions Germany by sector in 2016 (Mio t CO2)

Tabelle 6: Energiebedingte CO_2-Emissionen aus Verbrennungsprozessen nach Sektoren und Energieträgern in Deutschland 2016 (ohne Biomasse)

	Verbrennungsprozesse insgesamt	Energiesektor	Industrie	Verkehr	Haushalte und GHD
	Mio. t CO_2				
Flüssige Brennstoffe	252,1	18,4	17,3	163,37	47,1
Feste Brennstoffe	310,4	258,4	48,8	0,03	3,1
Gasförmige Brennstoffe	168,2	34,8	53,2	1,65	77,5
Andere fossile Brennstoffe	21,0	15,0	6,1	0,00	0,0
Insgesamt	**751,7**	**326,5**	**125,3**	**165,0**	**127,7**
	Anteile in %				
Flüssige Brennstoffe	33,5	5,6	13,8	99,0	36,9
Feste Brennstoffe	41,3	79,1	38,9	0,0	2,4
Gasförmige Brennstoffe	22,4	10,6	42,4	1,0	60,7
Andere fossile Brennstoffe	2,8	4,6	4,8	0,0	0,0
Insgesamt	100,0	100,0	100,0	100,0	100,0

Quelle: Eigene Darstellung auf Basis von UBA (2018b)

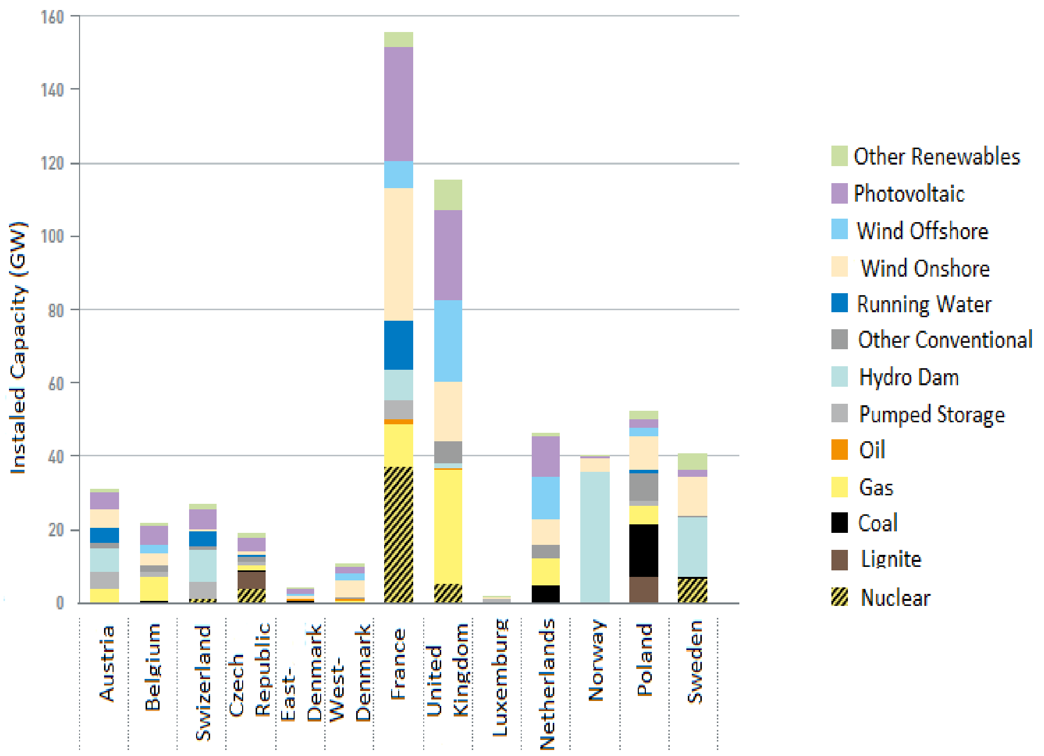
Source: Stellungnahme zum sechsten Monitoring-Bericht der Bundesregierung für das Berichtsjahr 2016

Challenges posed by wind and PV

Power exchange with neighbours?

- Export / import used to manage intermittence of wind and PV
- Most neighbours will also increase renewables (and intermittence) by 2030
- Closing nuclear by 2030 in DE, B, NL, part UK, part F
- Neighbouring grids swing to the tune of wind in Germany / NWE

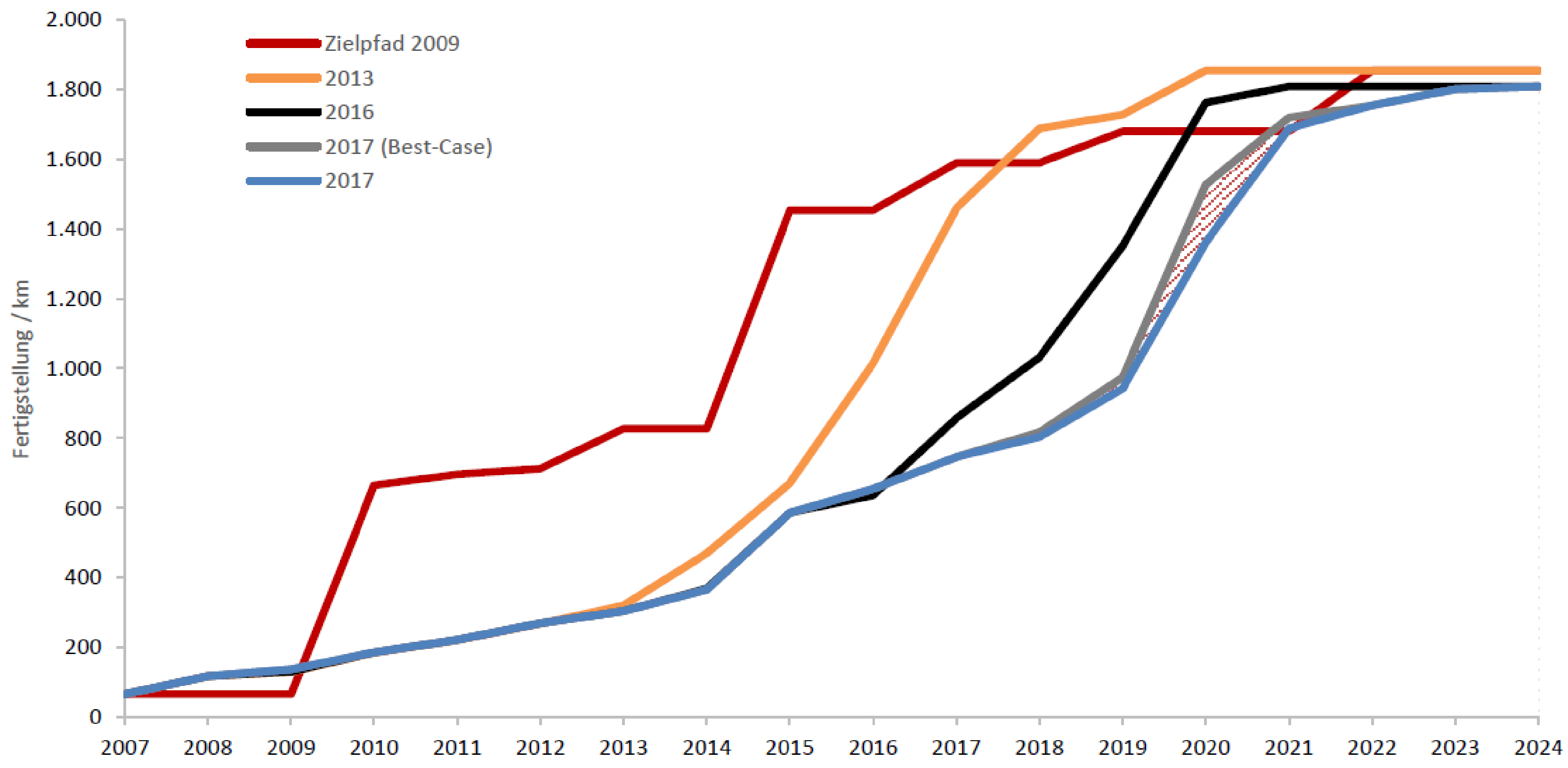
Projected capacity 2030 in other EU counties



Source: ÜNB; (Jan 2018) Scenarios for the power grid development plan (NEP) for 2030 (draft 2019 version), p. 109

Building of HV lines: Pathway 2009 and adoptions

Abbildung 5: Ursprungspfad und allmählich angepasste Zielpfade des Netzausbaus nach EnLAG



Quelle: Eigene Darstellung auf Basis von BNetzA/BKartA (2014, 2015) und BNetzA (2010, 2017c)

Source: Stellungnahme zum sechsten Monitoring-Bericht der Bundesregierung für das Berichtsjahr 2016

Decision Tree

renwables vs de-carbonization of of fossil fuels

post combustion vs. pre combustion

CCS

downstream
storage ?
depleted fields?

vs.

upstream
storage possibility
benefits

all electric sector

applying

electrolysis of surplus power

reforming proces
store CO_2

or

other processes
store C

resulting in

H_2

NH_3 or H_2

use or split

use directly

direct use of H_2 or

Sabatier process reducing CO_2 to CH_4