

Progress towards all-renewable electricity supplies

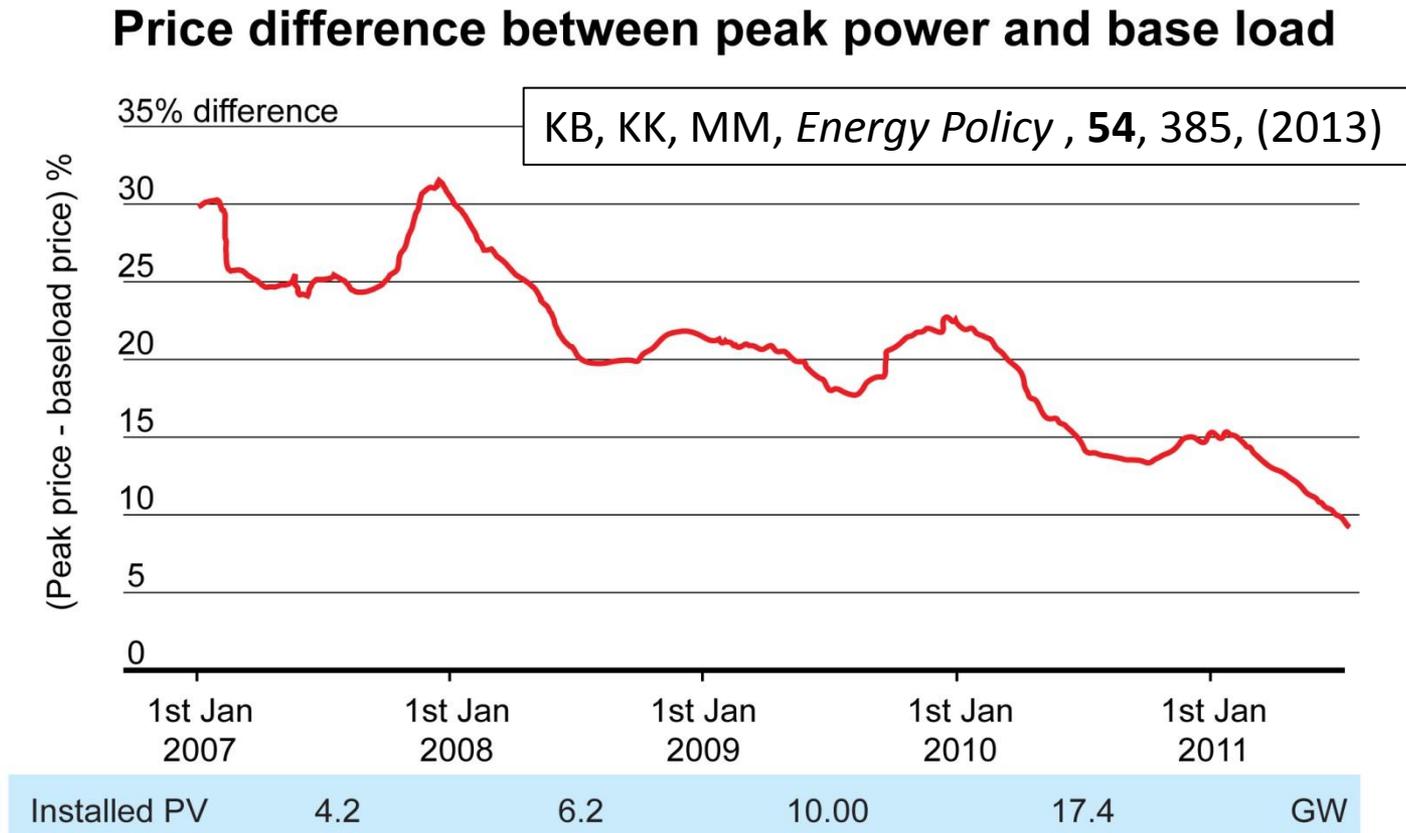
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*The Burning Answer:
a User's Guide to the Solar Revolution*
Weidenfeld and Nicholson 2014
www.burninganswers.com

K.B., Kaspar Knorr, Massimo Mazzer, *Nature Materials* (9th Nov)

The Mystery of the Falling Cost of Wholesale Electricity in Germany

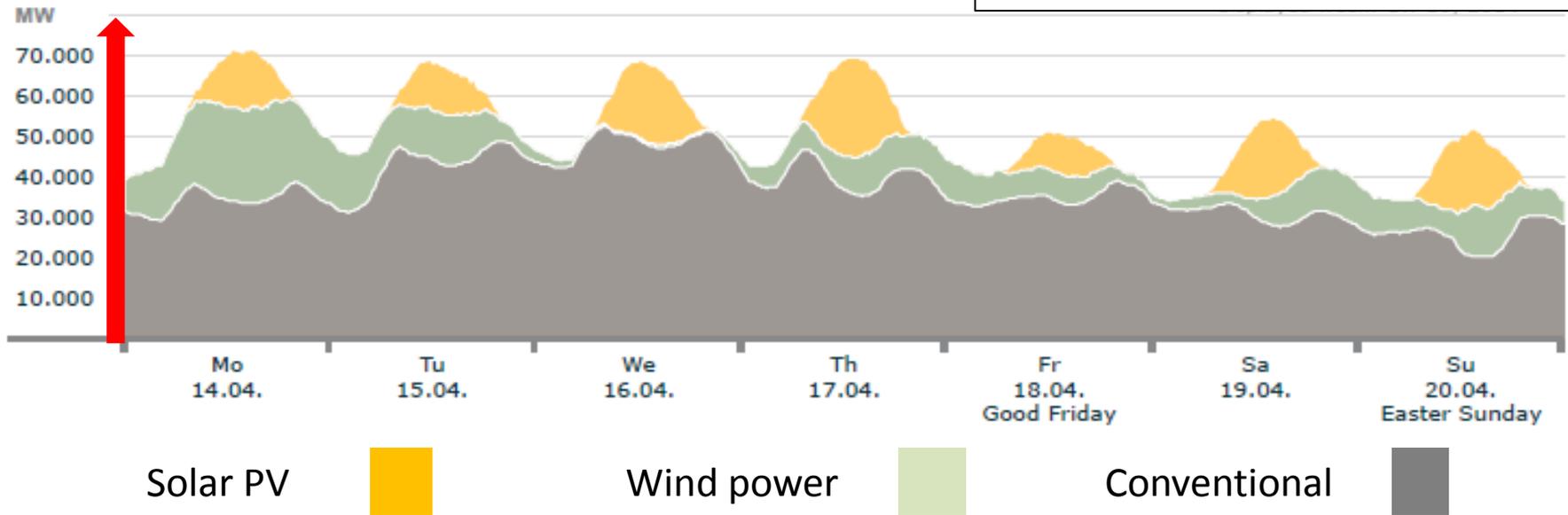


How did PV reduce wholesale electricity price 20% when only 3% of German electrical energy from PV in 2011?

Sun power was responsible for 20% wholesale price fall

Electrical Power Demand of Germany (GW)

"Electricity production from solar and wind in Germany in 2014", Fraunhofer ISE

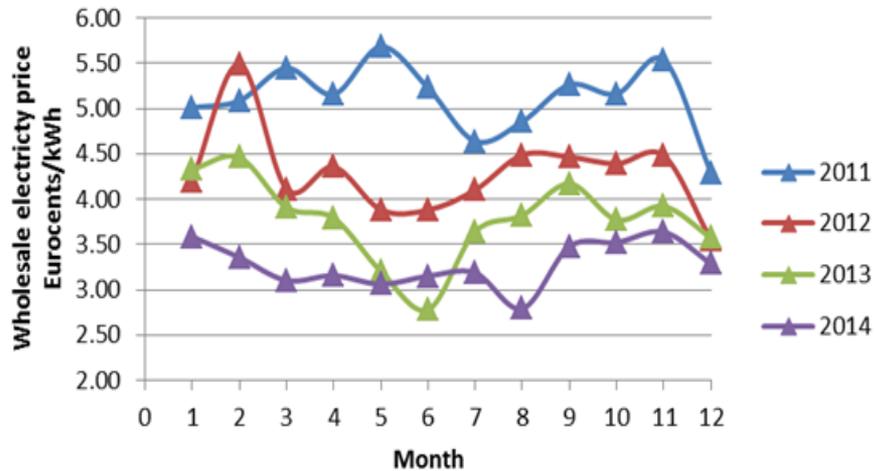


- PV power supplied 36% of demand on Thursday noon and **gold shape** of power supply matches peak demand
- PV **energy** (**gold area**) is small (only 3% in 2011)
- Local wind variability smoothed on country-wide scale
- Grid OK > 40% PV & > 30% wind power & **complementary**

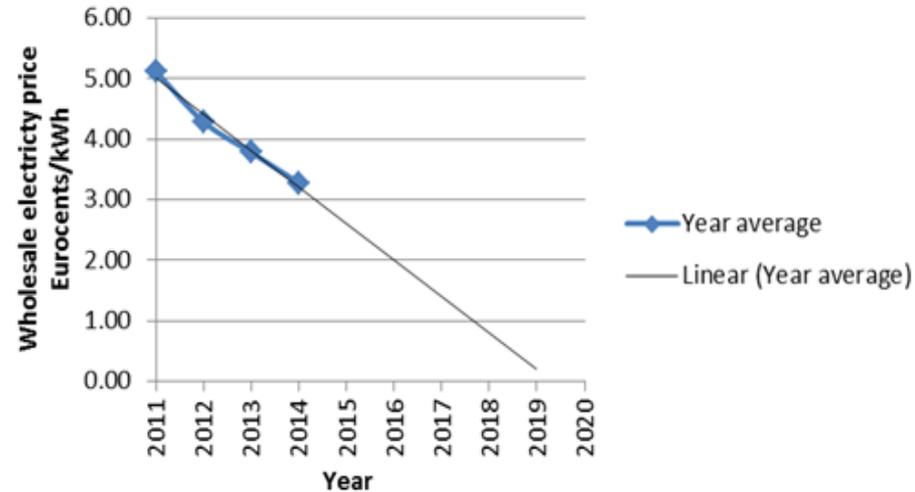
Now it's not just the peak wholesale price

Bundesministerium für Wirtschaft und Energie, 2015

German EEX spotprice



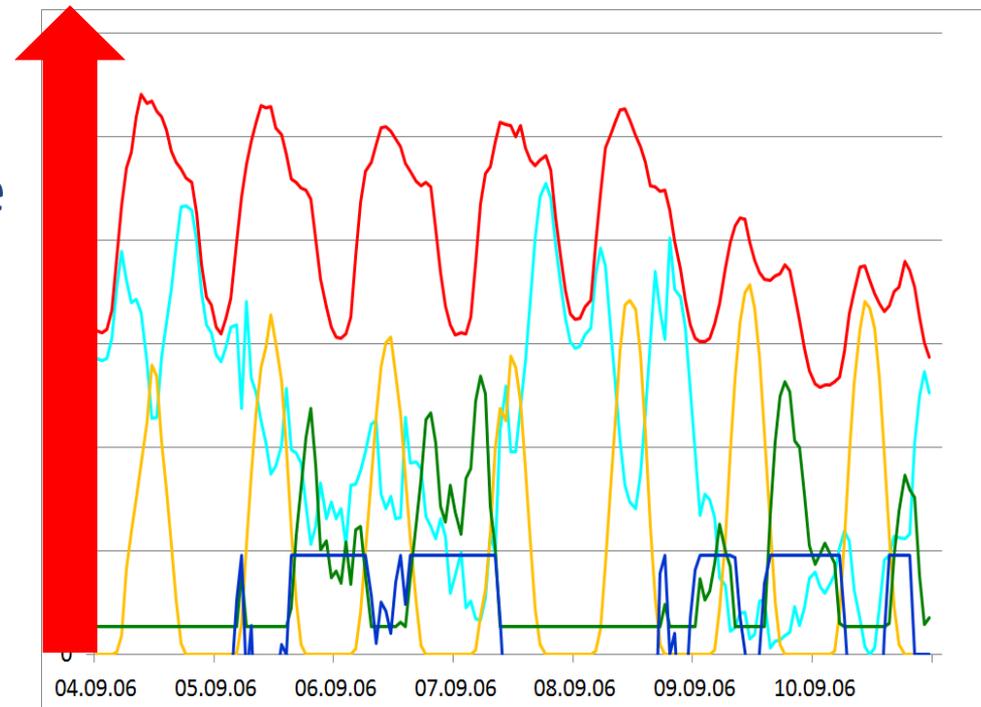
German EEX spotprice



- Since 2011 German PV & wind power have climbed further
- Now the average wholesale spot-price is falling
- UK PV 7 yrs, wind 9 yrs behind: problem for Hinkley Point C

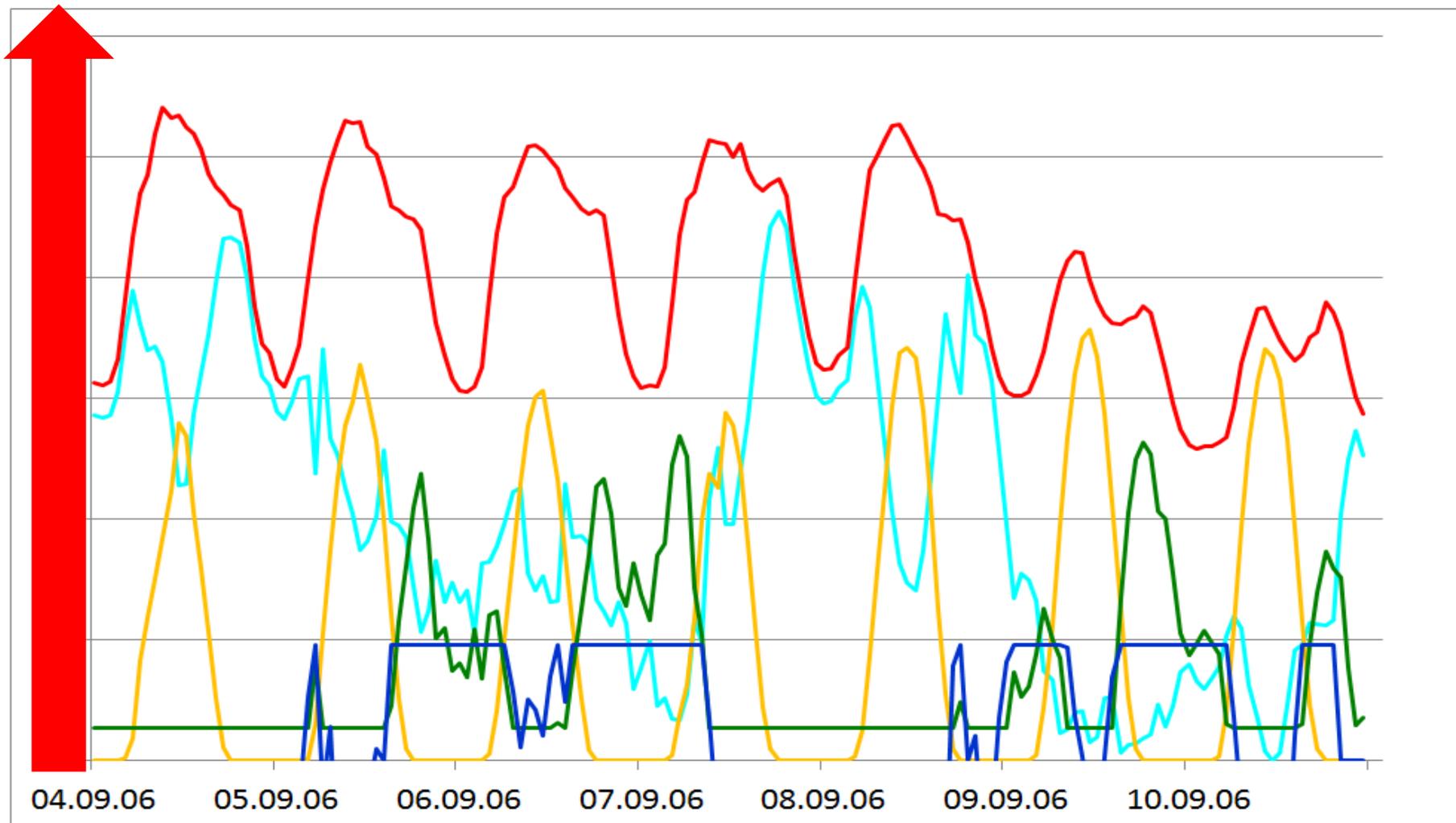
KKW: combined power plant

- Kombikraftwerk all-renewable project started in 2006
- Over 2006 it matched 1/10,000 of actual German electric power demand with real-time output of PV, wind & biogas generators
- PV and wind together can supply 78% German power demand
- Only 17% back-up power by biogas electricity required
- Only 5% back-up from storage was necessary
- Note the marked wind/biogas variation over local regions - smoothed out nationwide in 2014 demand-supply slide

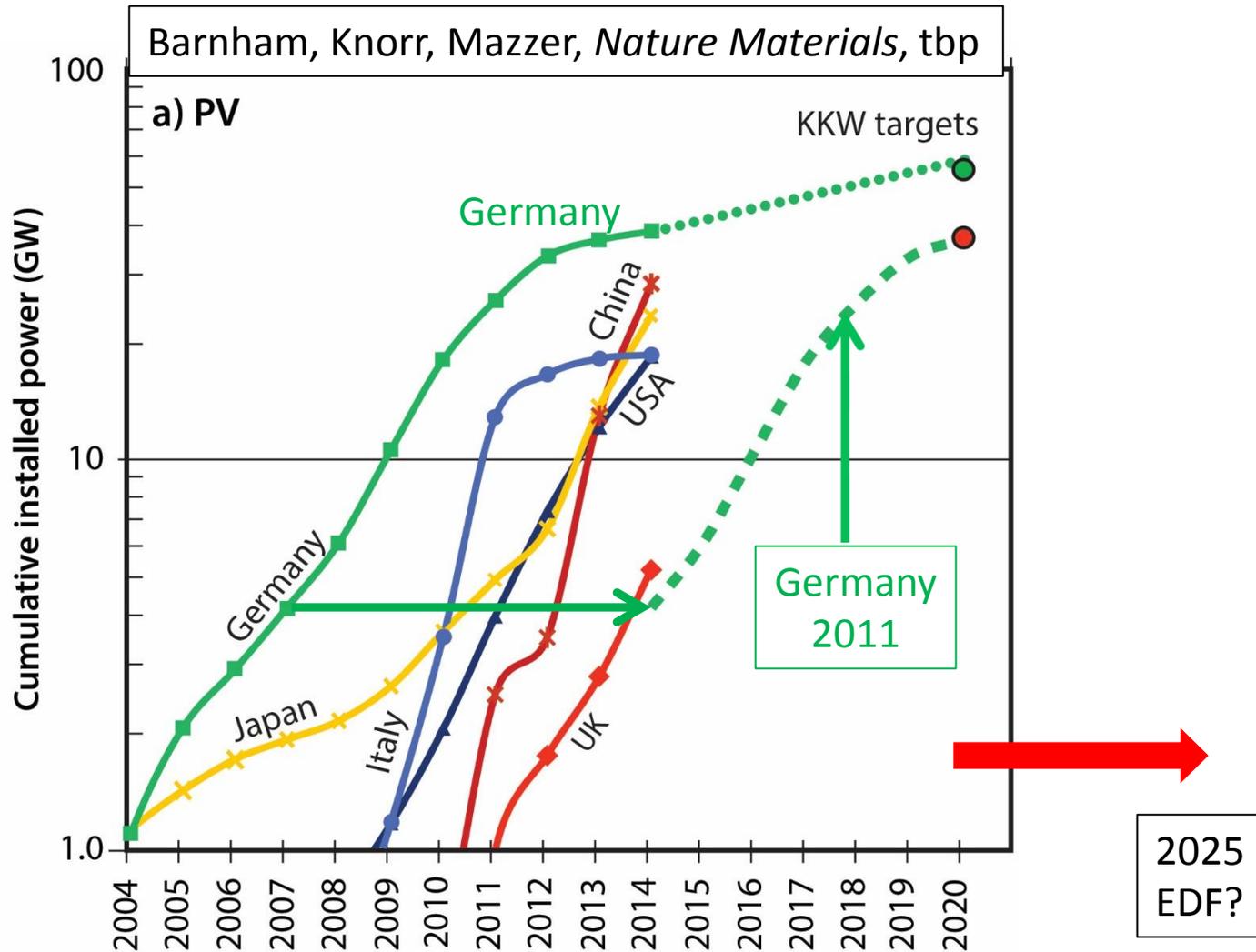


Kombikraftwerk (KKW) in Germany

Scaled German electrical power demand

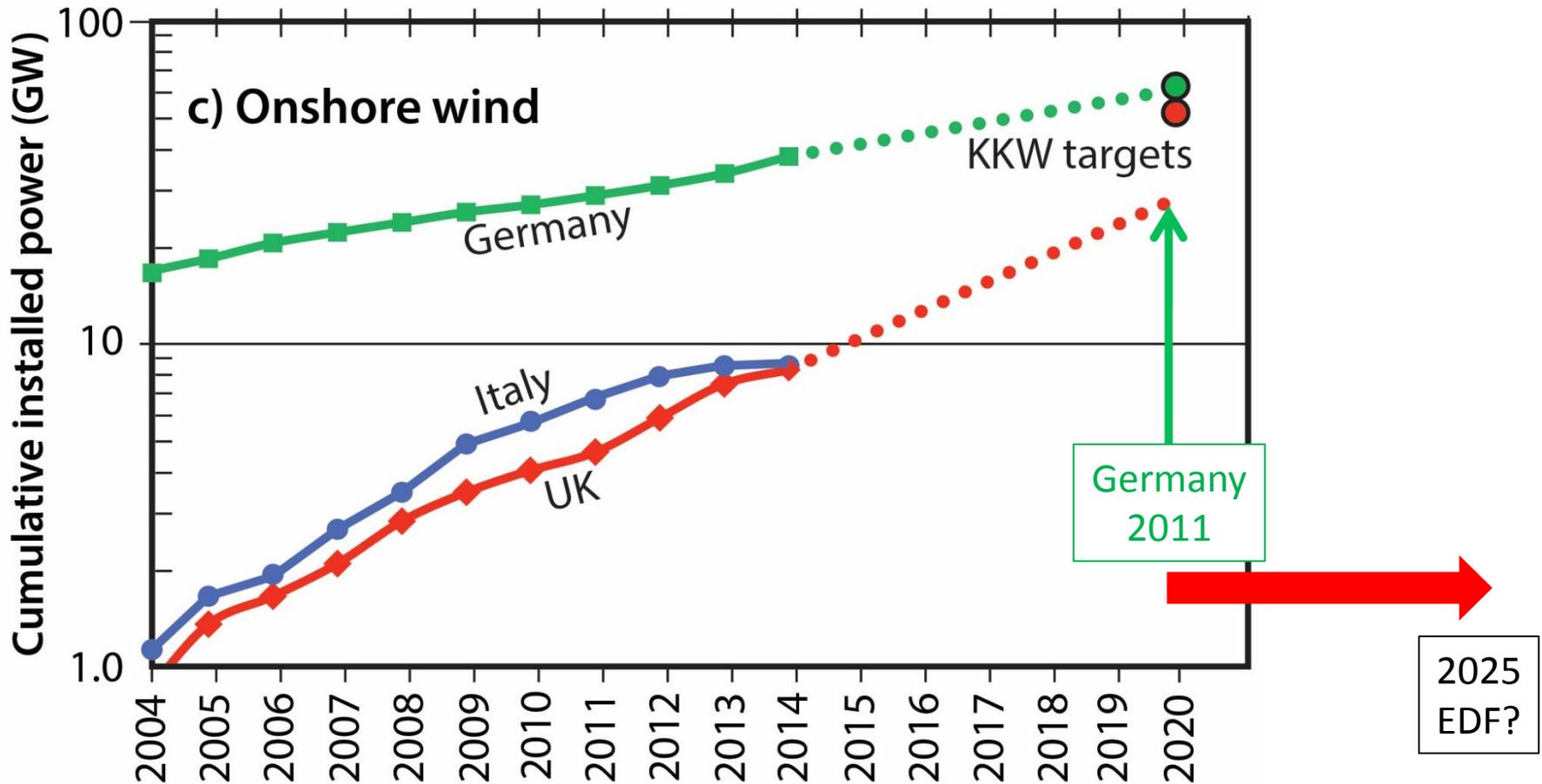


PV Power in Germany & UK



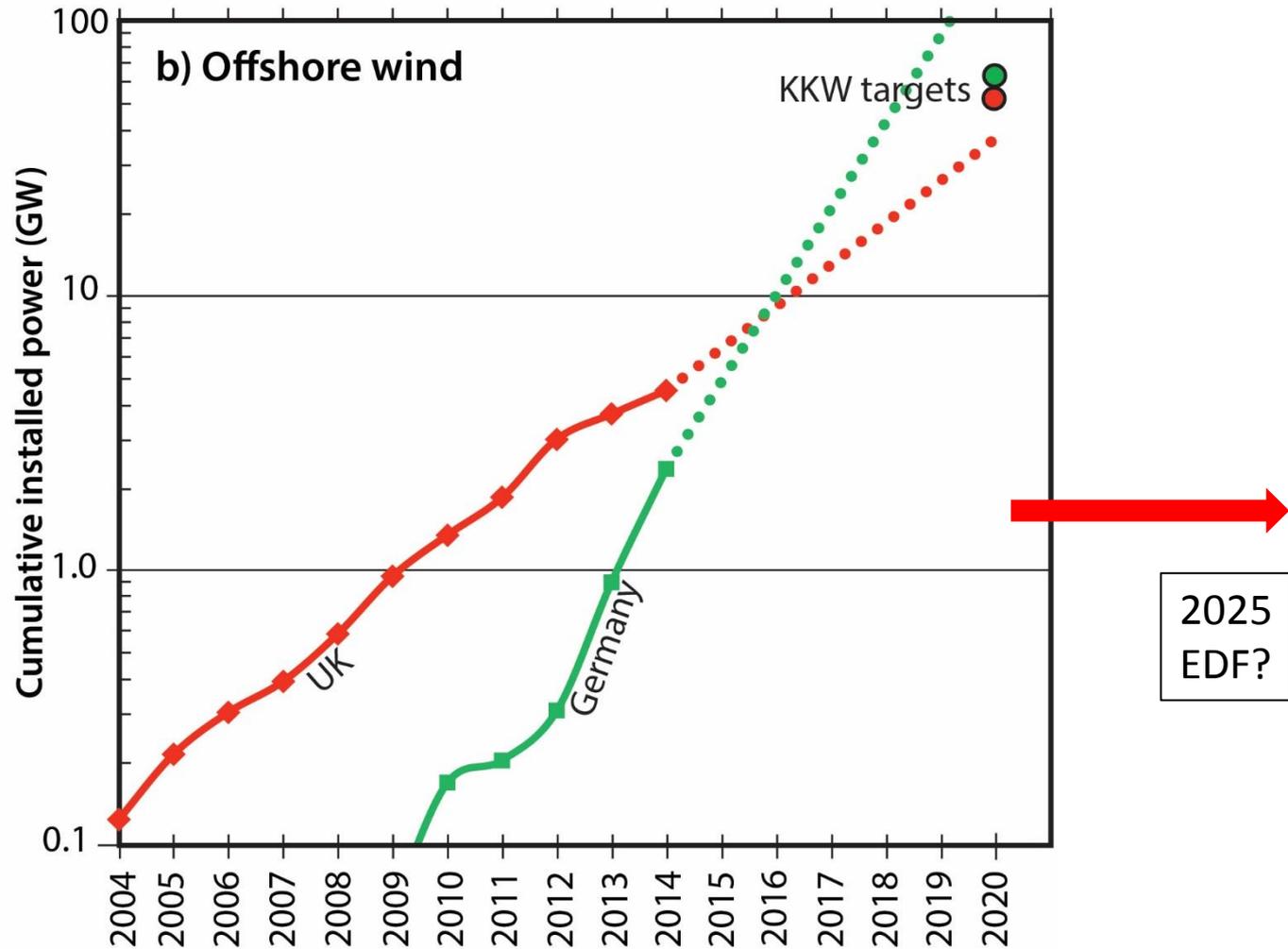
- If UK follows Germany 7 years later, hit KKW target in 2020

Onshore Wind Power Germany, Italy & UK



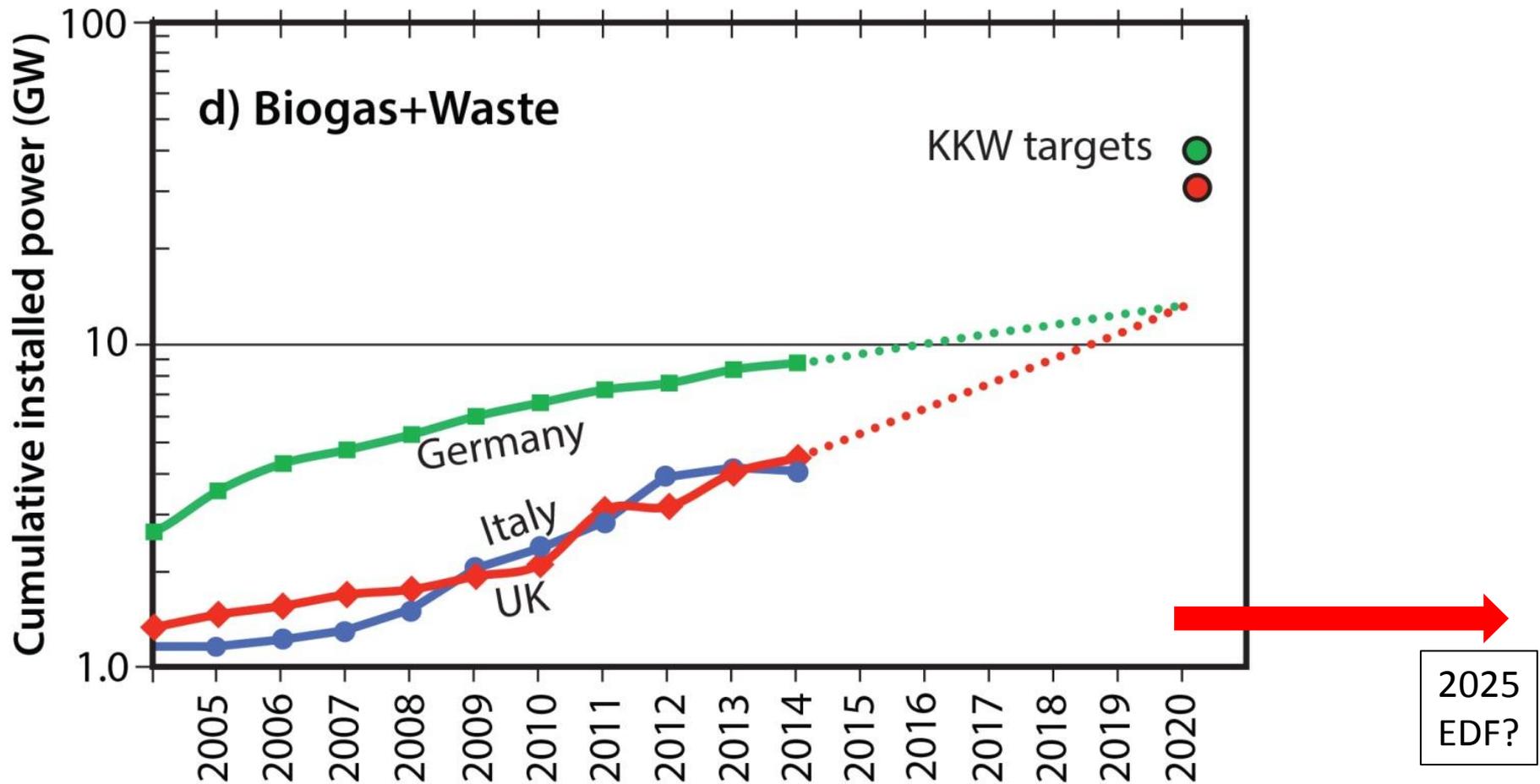
- Without latest cuts UK might have made target by 2022
- PV & onshore wind at German 2011 levels by 2020

Offshore Wind Power Germany & UK



- Impressive achievement : despite being novel, large scale, difficult environment, exponential increase heading for KKW target in 2021

Biogas electricity Germany, Italy & UK



- Bio-electricity limiting contribution in Germany too
- Use biomethane from farm, food waste (AD) in existing generators
- Higher AD subsidy reduced fuel price + CHP helps flexible capacity

Anaerobic digestion to biomethane

- Farm waste not competitive with land use for food
- Farm animal waste, crop waste and food waste decay to biomethane for electricity or gas grids
- Combined heat & power (CHP) – heat the plant
- Low carbon footprint: avoids waste rotting to CH_4
- UK has flexible capacity problem => AD + CHP



Conclusions

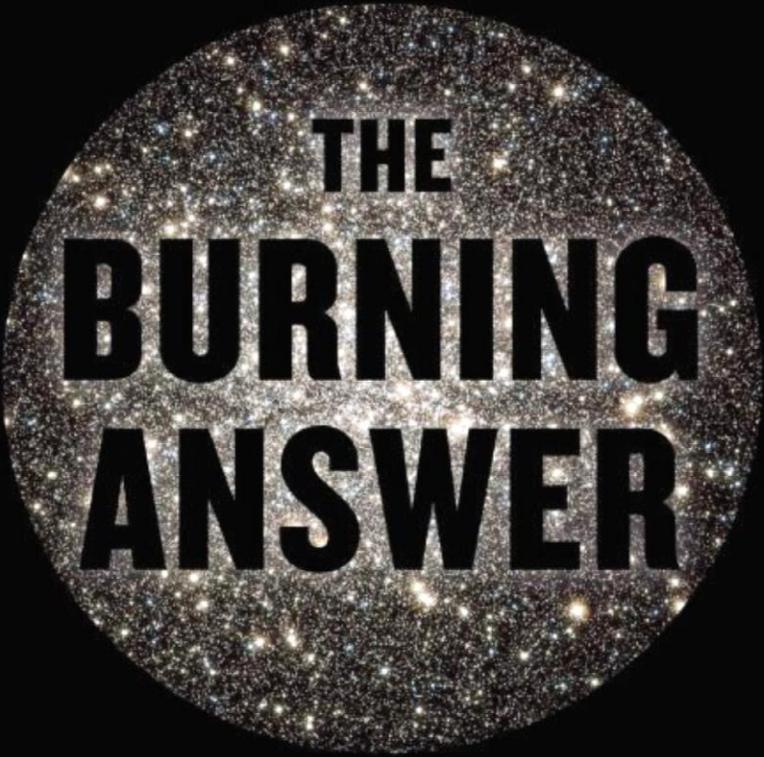
- UK all-renewable electricity supply possible by 2020 if FIT cuts reversed and speed up biogas from AD
- Biogas CHP solves UK flexible capacity problem
- Pay the FIT & AD support from taxation not levy
- Wholesale price in UK could start falling by 2020
- Problem for Hinkley C & base-load not needed
- Do you want an all-renewable electricity supply?

Recommendations for COP21

- 1) Environmental limit of 50 gCO₂/kWh on all new electricity generators
- 2) transfer fossil fuel subsidies to renewables
- 3) KKW1 tests on national electricity grids to fix appropriate indigenous resource limits

The quickest, cheapest and safest way to slow global warming

KEITH BARNHAM



THE
**BURNING
ANSWER**

**A USER'S GUIDE TO THE
SOLAR REVOLUTION**

'A bold vision' *Guardian*

More detail in:

The Burning Answer

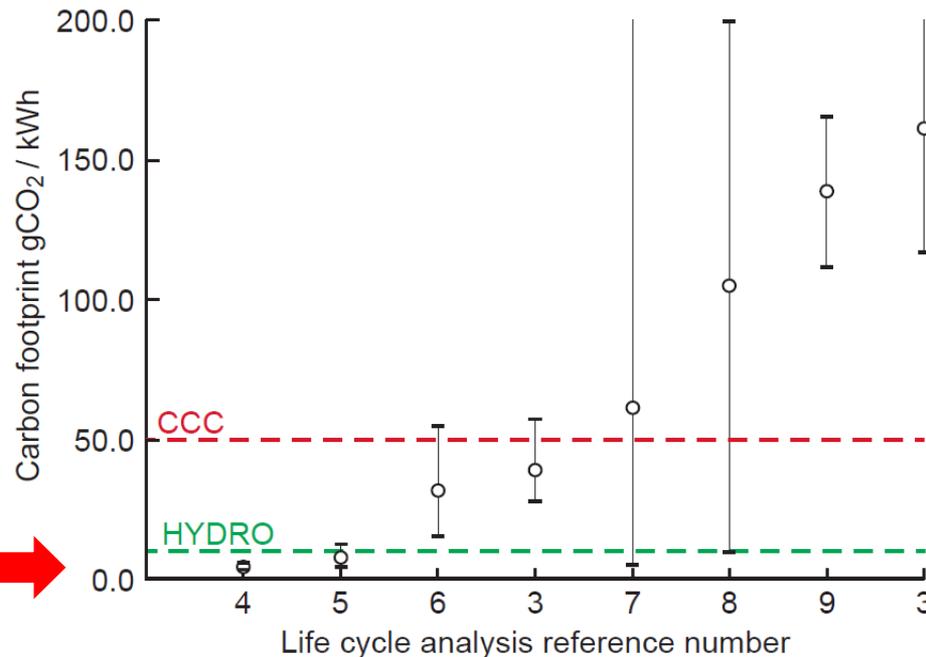
Keith Barnham

Weidenfeld and
Nicholson 2014

Is nuclear carbon footprint below CCC limit?

Keith Barnham, *The Ecologist*, <http://bit.ly/1vufGi6>

- 3 peer-reviewed surveys of 274 published life-cycle analyses (LCAs)
(Energy Policy **36**, 2940 Sovacool, **37**, 5056 Beerten, J.Ind.Ecol., 16, 2940, Warner & Heath)
- Only 6 LCAs independent & cover all 5 LCA stages



Ricardo-AEA for CCC
Cites Warner & Heath

Number of distinct assumptions 9 13