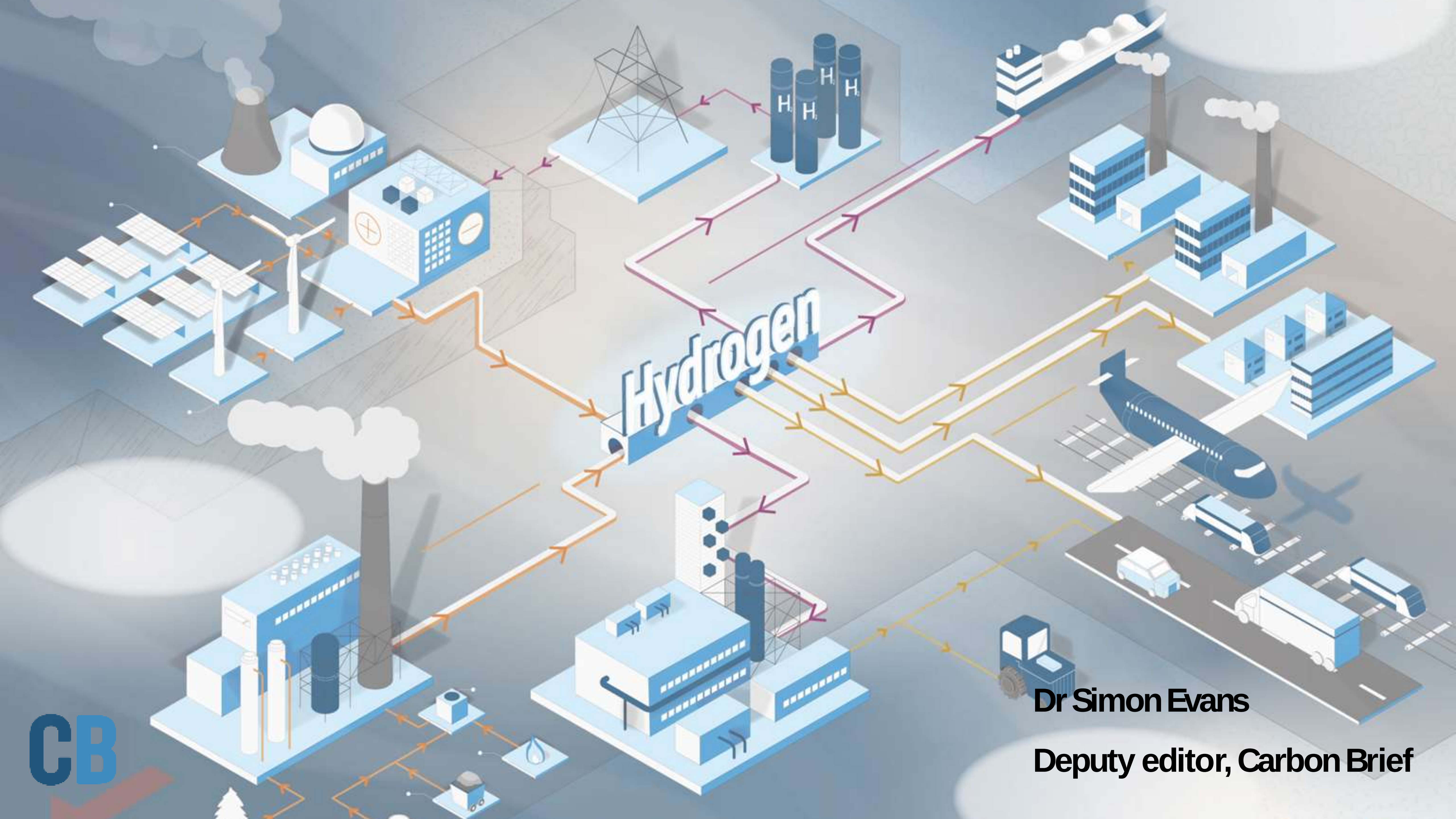

Dr Simon Evans

Deputy editor, Carbon Brief

21 June 2021 16:00

Guest post: Why CO2 removal is not equal and opposite to reducing emissions

In recent years, countries, companies and institutions around the world have set "net-zero" emissions targets... Read More

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Guest post: Why CO2 removal is not equal and opposite to reducing emissions
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CCC: Adaptation to climate risks 'underfunded and ignored' by UK government
UK POLICY | 16.06.21

Sustainable production of soy and maize could 'boost yields and cut emissions' in China

FOOD AND FARMING | 14.06.21

Guest post: Hundreds of planned coal mines 'incompatible with 1.5C target'

GUEST POSTS | 10.06.21

Guest post: G7 climate laws 'cut emissions by 1.3bn tonnes in 2019'

GUEST POSTS | 08.06.21

POPULAR ARTICLES

Vacancy: Journalist at Carbon Brief

IN FOCUS | 27.05.21

Satellite data reveals

Assumptions

1. Net-zero (by 2050?)
2. Emissions-free electricity (by 2035?)
3. Largely renewable electricity system

Problem statement

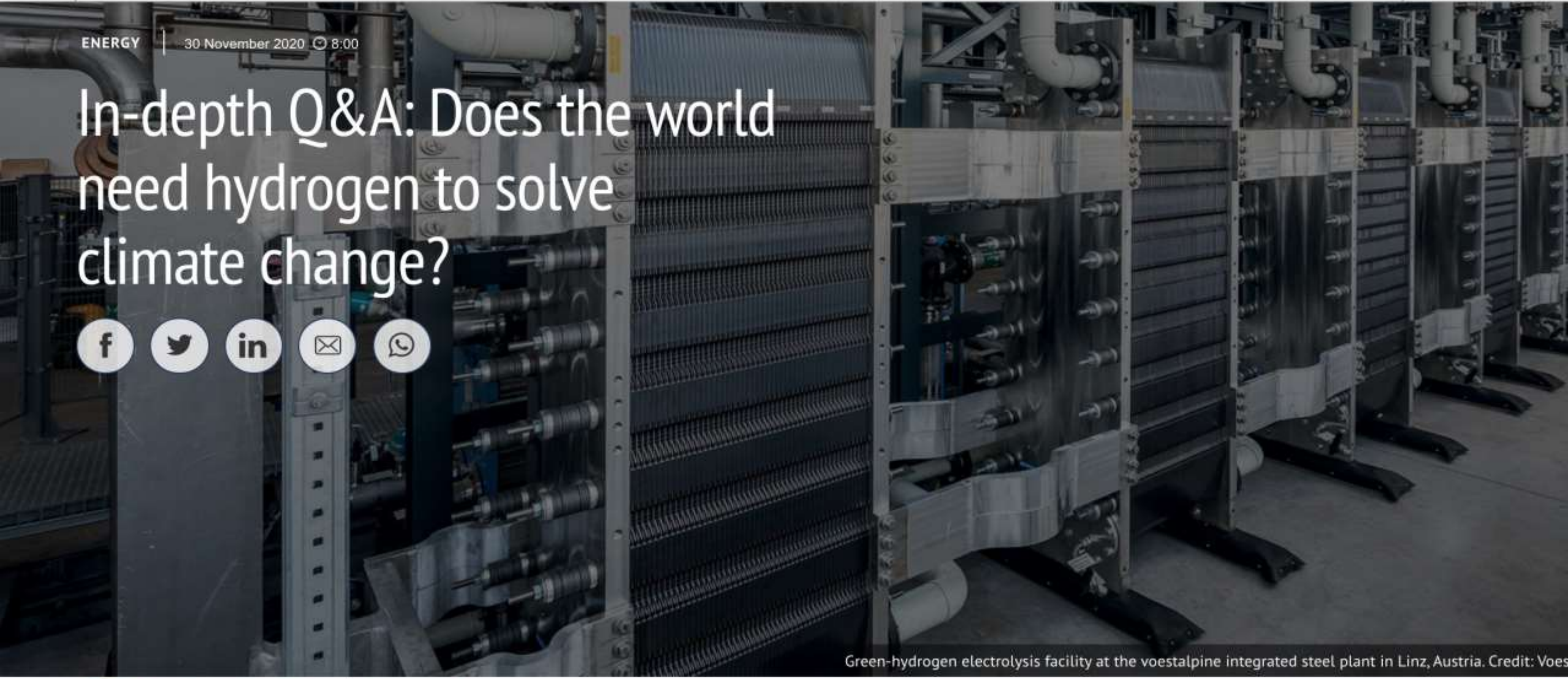
1. Wind and solar are cheap but variable
2. Society needs a reliable/stable power system
3. Need for storage on various timescales

Technologies to help balance power system at different durations

BP Energy Outlook 2020

ENERGY | 30 November 2020 8:00

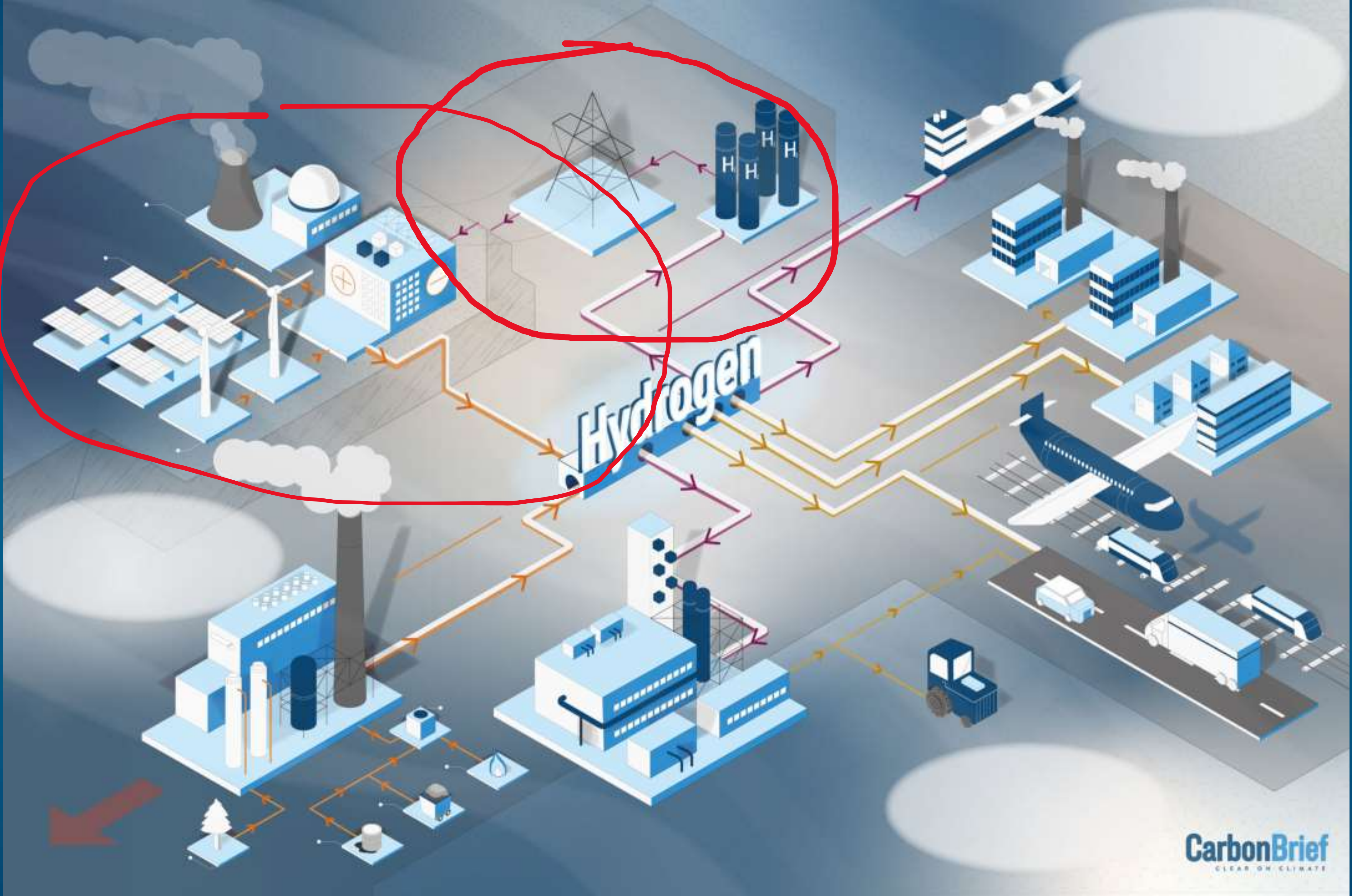
In-depth Q&A: Does the world need hydrogen to solve climate change?



Green-hydrogen electrolysis facility at the voestalpine integrated steel plant in Linz, Austria. Credit: Voes

MULTIPLE AUTHORS
30.11.2020 | 8:00am

ENERGY In-depth Q&A: Does the world need hydrogen to solve climate change?


Hydrogen
H
H
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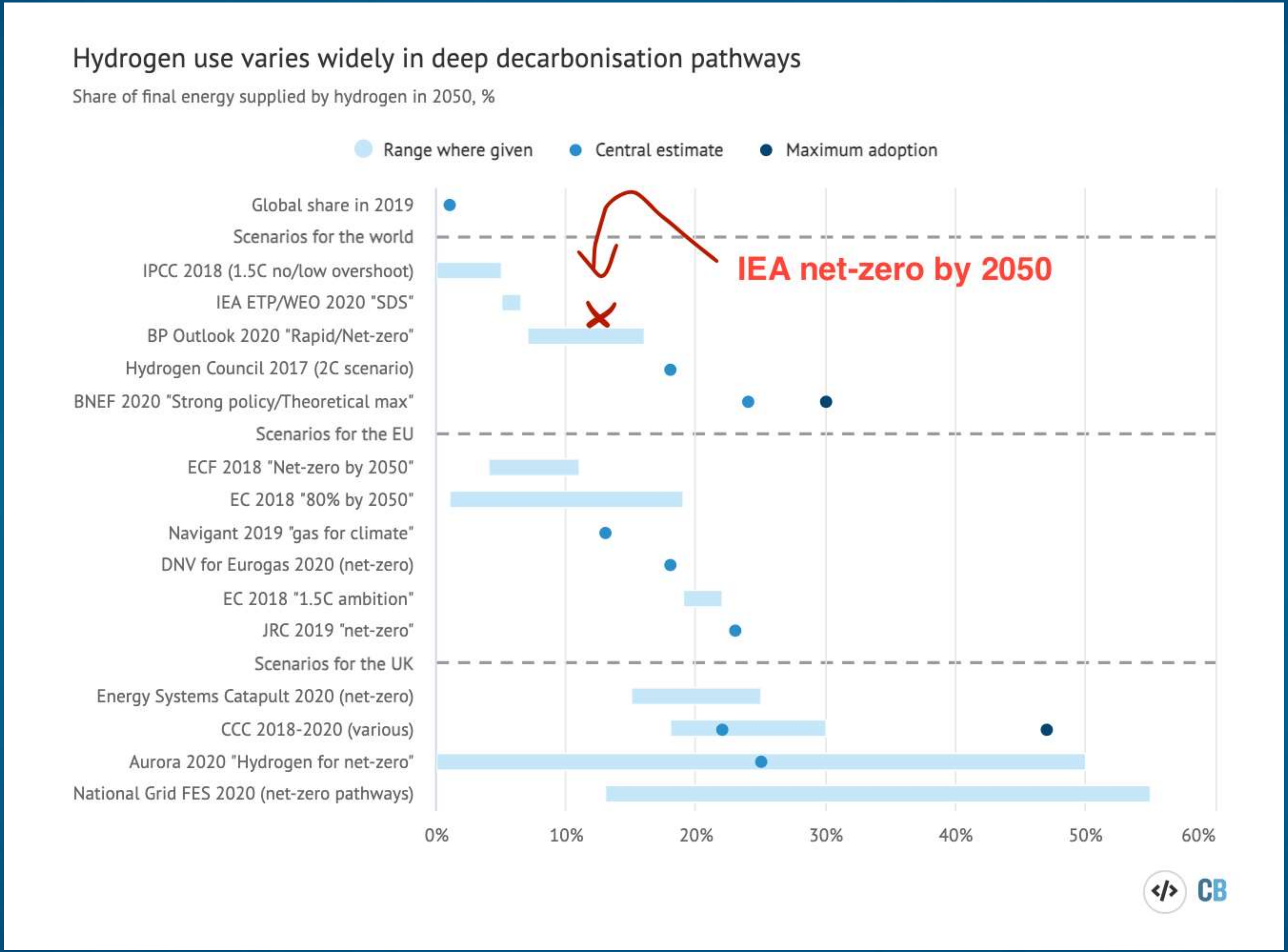
CarbonBrief
CLEAR ON CLIMATE



Hydrogen use varies widely in deep decarbonisation pathways
Share of final energy supplied by hydrogen in 2050, %
Range where given
Central estimate
Maximum adoption
Global share in 2019
Scenarios for the world
IPCC 2018 (1.5C no/low overshoot)
IEA ETP/WEO 2020 "SDS"
BP Outlook 2020 "Rapid/Net-zero"
Hydrogen Council 2017 (2C scenario)
BNEF 2020 "Strong policy/Theoretical max"
Scenarios for the EU
ECF 2018 "Net-zero by 2050"
EC 2018 "80% by 2050"
Navigant 2019 "gas for climate"
DNV for Eurogas 2020 (net-zero)
EC 2018 "1.5C ambition"
JRC 2019 "net-zero"
Scenarios for the UK
Energy Systems Catapult 2020 (net-zero)
CCC 2018-2020 (various)
Aurora 2020 "Hydrogen for net-zero"
National Grid FES 2020 (net-zero pathways)
0%
10%
20%
30%
40%
50%
60%
IEA net-zero by 2050
CB

Figure 2.19 ▷ **Global hydrogen and hydrogen-based fuel use in the NZE**

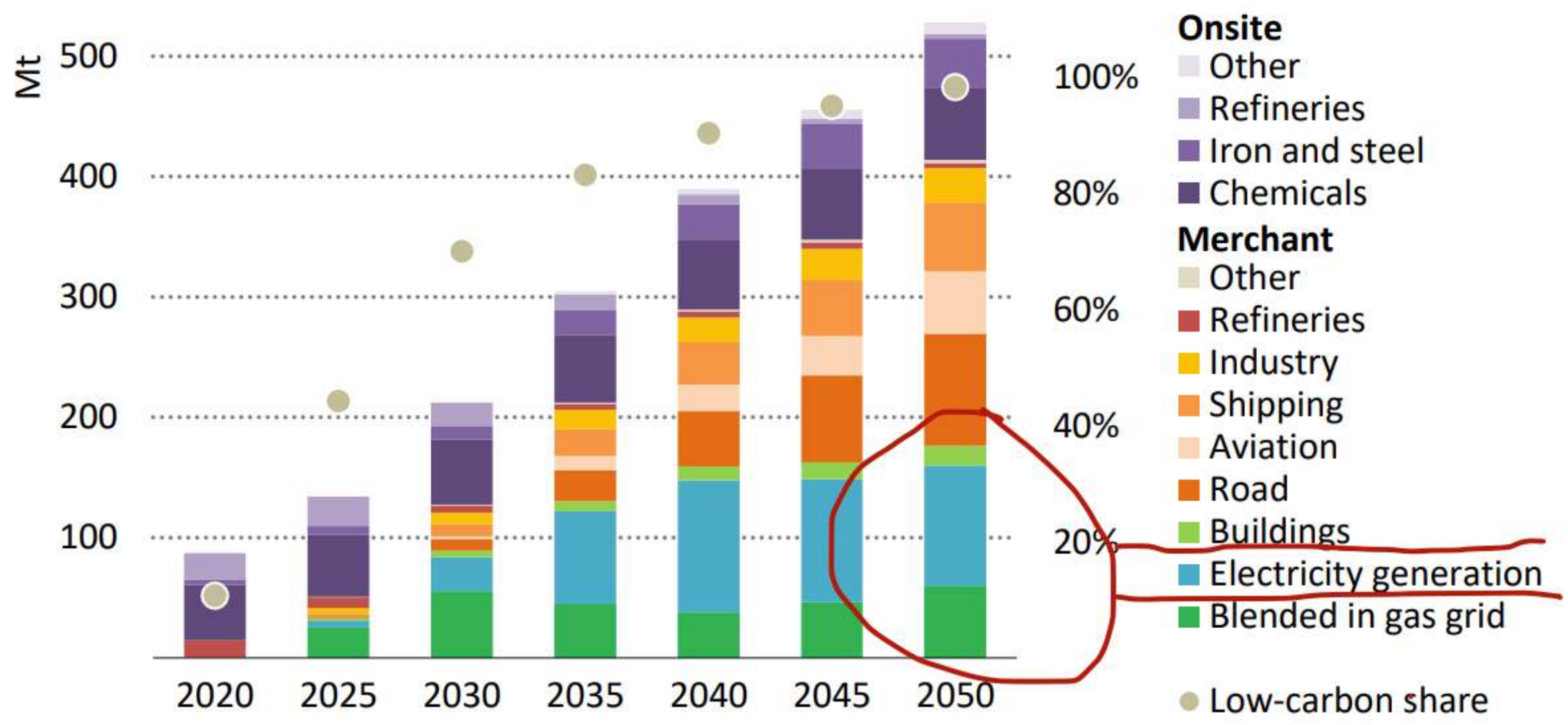
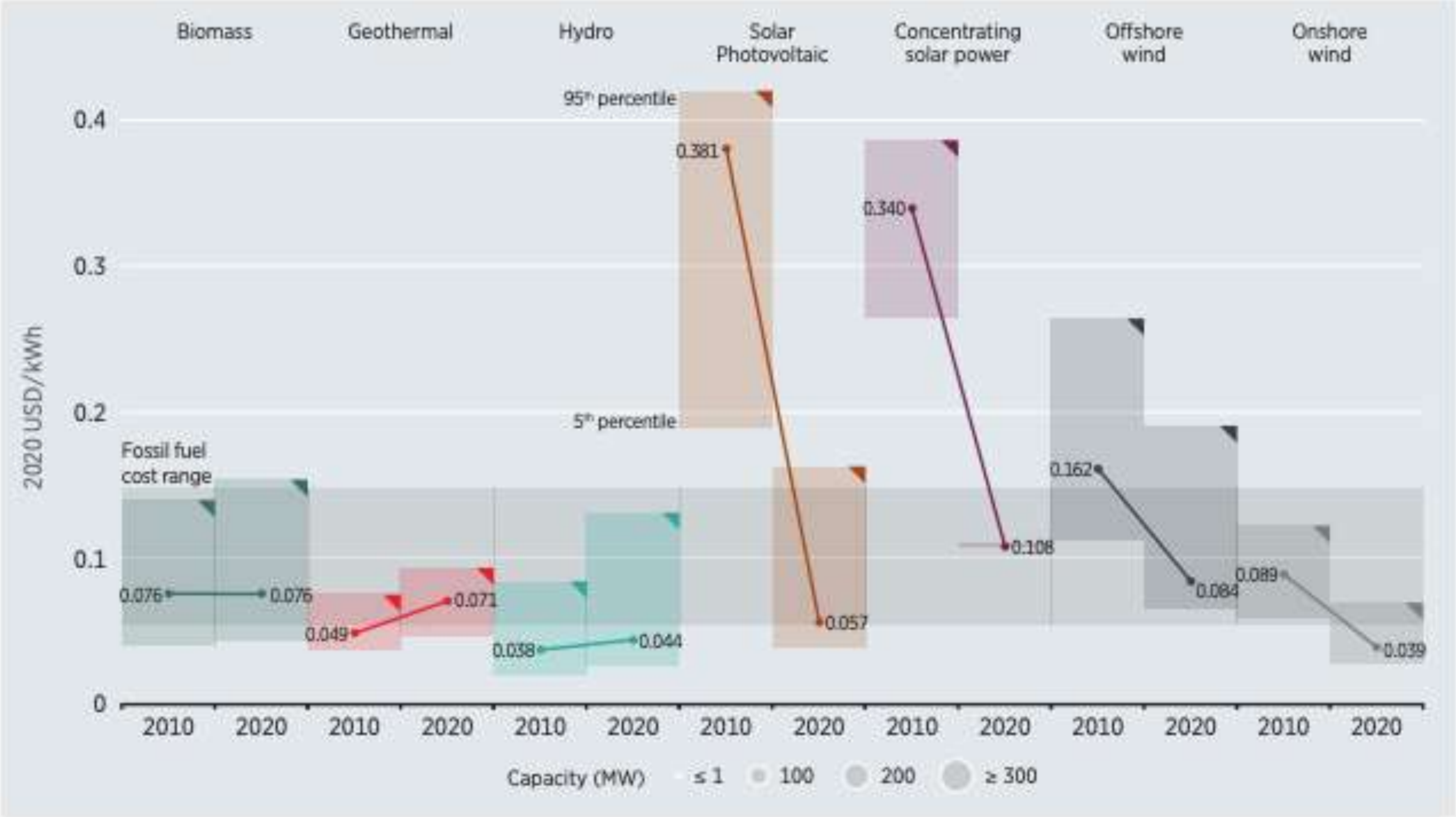


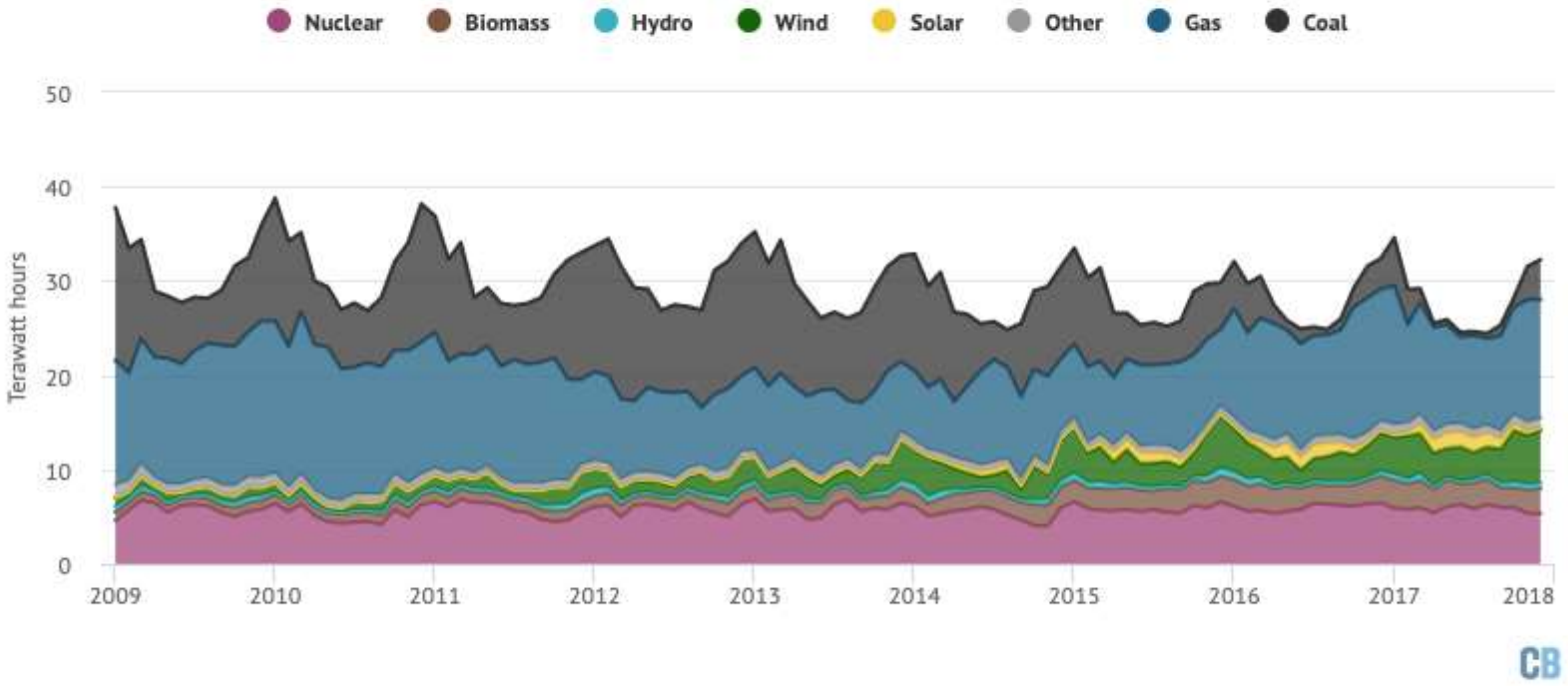
Figure ES.2 Global LCOEs from newly commissioned, utility-scale renewable power generation technologies, 2010-2020

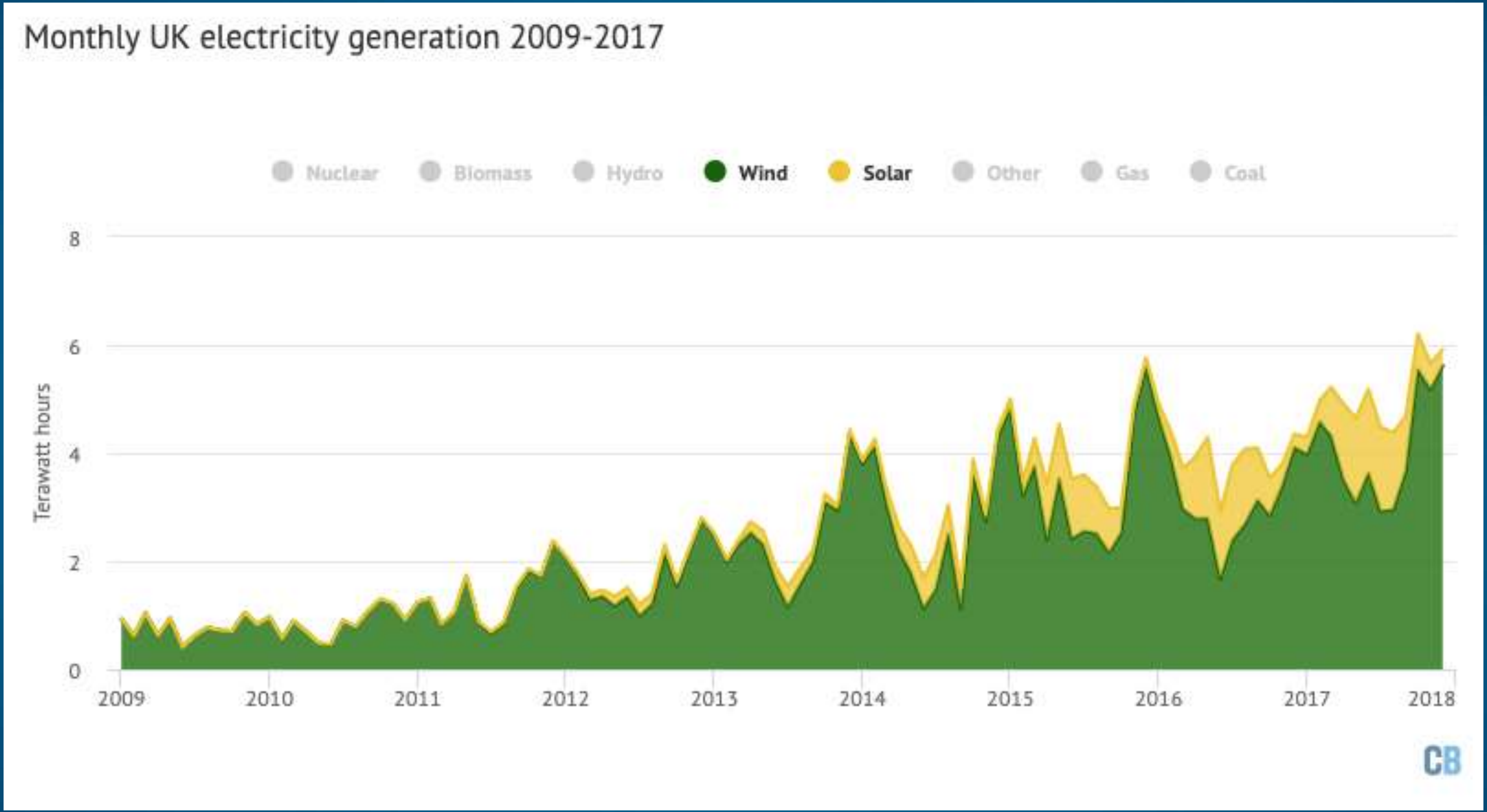


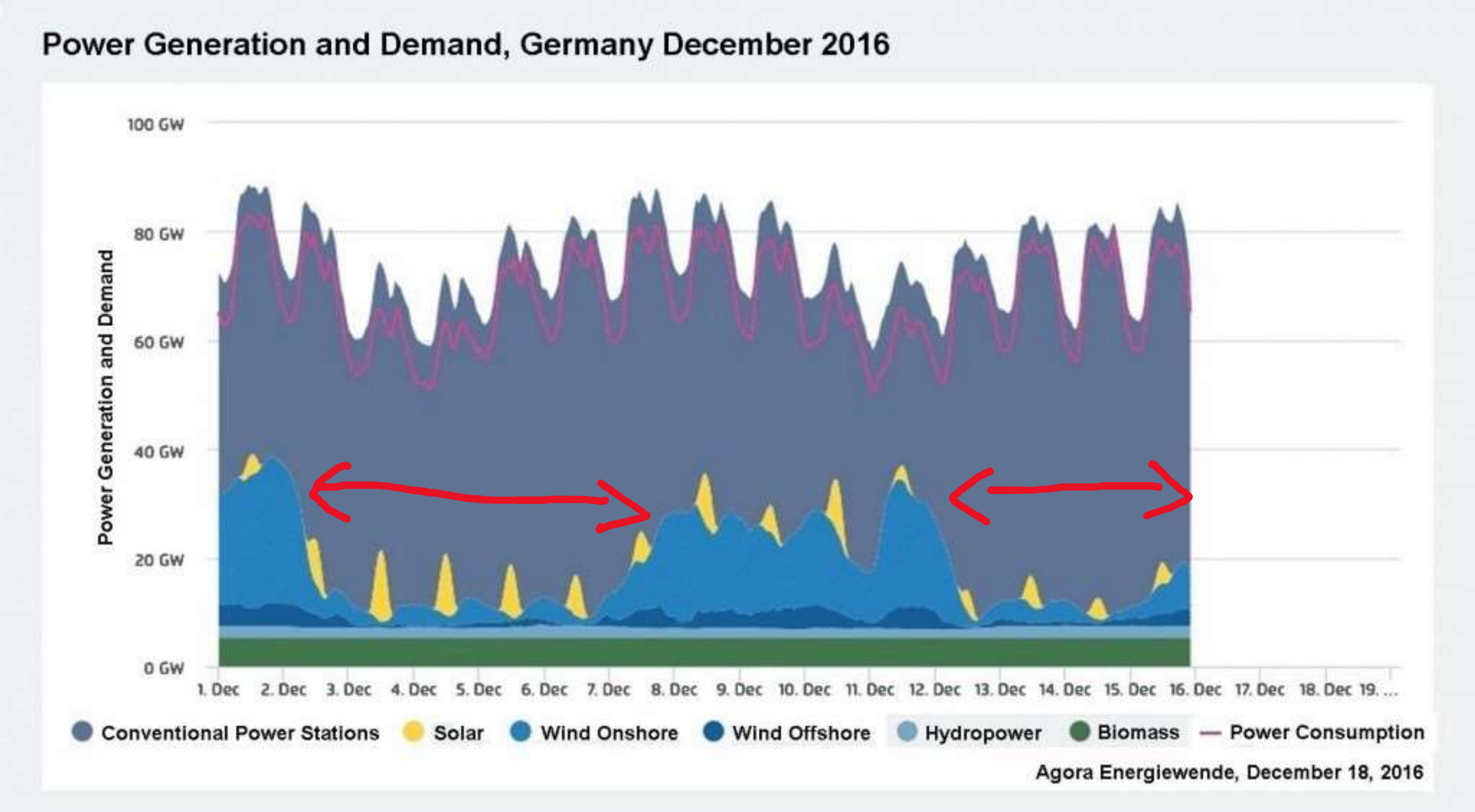
Source: IRENA Renewable Cost Database

Note: This data is for the year of commissioning. The thick lines are the global weighted-average LCOE value derived from the individual plants commissioned in each year. The project-level LCOE is calculated with a real weighted average cost of capital (WACC) of 7.5% for OECD countries and China in 2010, declining to 5% in 2020; and 10% in 2010 for the rest of the world, declining to 7.5% in 2020. The single band represents the fossil fuel-fired power generation cost range, while the bands for each technology and year represent the 5th and 95th percentile bands for renewable projects.

Monthly UK electricity generation 2009-2017




Monthly UK electricity generation 2009-2017
Nuclear
Biomass
Hydro
Wind
Solar
Other
Gas
Coal
Terawatt hours
8
6
4
2
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
CB


Power Generation and Demand, Germany December 2016
100 GW
80 GW
60 GW
40 GW
20 GW
0 GW
Power Generation and Demand
1. Dec 2. Dec 3. Dec 4. Dec 5. Dec 6. Dec 7. Dec 8. Dec 9. Dec 10. Dec 11. Dec 12. Dec 13. Dec 14. Dec 15. Dec 16. Dec 17. Dec 18. Dec 19. ...
Conventional Power Stations
Solar
Wind Onshore
Wind Offshore
Hydropower
Biomass
Power Consumption
Agora Energiewende, December 18, 2016

Comparison with backup CCGT fitted with CCS

Much of the existing backup generation capacity in the UK system currently comprises 35 GW of unabated CCGT plant. However, in order to meet the net zero carbon targets, this entire CCGT fleet would need to be replaced by 2050 with new CCGT plants fitted with carbon capture and storage.

The FES report and the CCC Net Zero Technical report of May 2019 both propose that the most appropriate carbon capture technology for the power sector would be pre-combustion CCS using steam reformed methane to produce hydrogen to fuel the CCGT (or OCGT) plants. The recent BEIS Carbon Capture Technology report (2018) gives the levelized cost CCGT with pre-combustion carbon capture and storage as £100/MWh at 100% load-factor.

However, our analyses have shown that for the FES Net Zero scenario in 2050, with 90 GW of wind generation capacity installed, the predicted load-factor for CCGT plants used as backup generation for intermittent renewables would likely be in the region of between 20% and 25%. Thus, by applying these load factors to the cost model supplied with the BEIS report gives a levelized cost for CCGT with CCS nearer £250/MWh, when used in this application. This indicates that long-term energy storage would likely be a lower cost alternative to CCGT with carbon capture and storage, as well as being a fully renewable solution.

CCC advice 2020

Box M5.2

New evidence informing our analysis

A number of new publications have supplemented the evidence base used for this report:

- A report published by AECOM[14] explored potential solutions to improve capture rates of gas CCS plants at start-up and shut-down periods. This analysis suggests gas CCS could run more flexibly to accommodate more renewables without increasing residual emissions. However, this would lead to additional costs that could make gas CCS less competitive than generation technologies with flexible outputs such as hydrogen plants.
- A study by Jacobs investigated the costs of long-term storage technologies.[15] The analysis shows that pumped hydro could provide the cheapest form of one-week duration storage at £70/MWh. Other forms of storage such as Compressed Air Energy Storage (CAES) could have higher costs at £160/MWh for the same storage duration. In comparison, hydrogen storage could cost £100/MWh. Nevertheless, this analysis does not consider seasonal storage that could offer months of storage. Our analysis relies more heavily on this form of hydrogen storage, given that medium-term storage technologies could not be modelled directly within our analysis using the Dynamic Dispatch Model (see section 3). However, a combination of these technologies might be required to meet storage requirements in a renewable-driven generation mix.

CCC advice 2020

Duration (hrs)	Short-Term Storage		Long-Term Storage			
	LI Batteries (£/MWh)	LAES (£/MWh)	Pumped Hydro (£/MWh)	Hydrogen CCGT (£/MWh)	Hydrogen OCGT (£/MWh)	CAES (£/MWh)
144	£1,530.6	£339.7	£70.3	£101.4	£122.1	£159.3
96	£1,065.5	£258.3	£64.1	£103.0	£125.5	£144.2
72	£871.9	£217.3	£63.9	£104.6	£127.4	£137.3
48	£675.9	£176.2	£67.5	£109.7	£129.3	£134.3
24	£454.1	£151.6	£82.0	£128.0	£137.3	£145.4
12	£317.6	£158.0	£105.6	£169.5	£163.5	£184.9
8	£266.0	£171.3	£125.4	£204.0	£191.8	£219.4
4	£217.5	£216.5	£178.9	£286.7	£265.7	£304.2
2	£217.9	£320.5	£294.6	£434.8	£387.2	£458.0
1	£259.7	£540.7	£522.8	£749.1	£627.0	£786.2
0.5	£365.2	£989.3	£991.1	£1,367.7	£1,111.7	£1,432.9

Jacobs