CO_2-Strategy

Challenges and Opportunities

CO_2nnecting Europe Conference, January 16th, 2025

Prof. Dr. Georg Locher

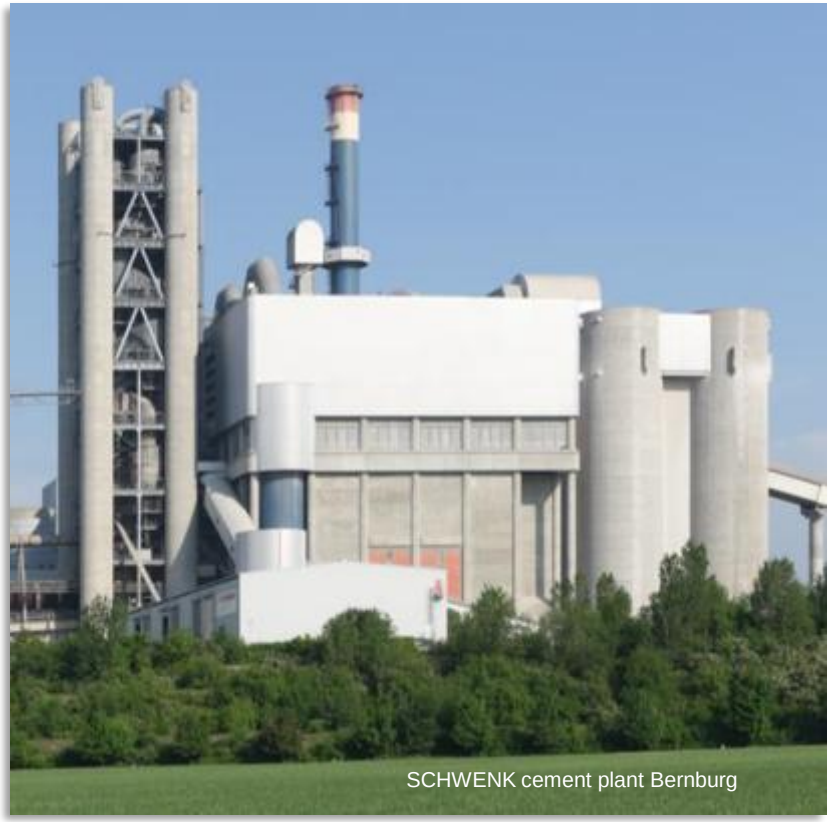
SCHWENK

Practical aspects of implementation

Infrastructure for CO_2-utilization and / or -storage

An average German cement plant requires the following for CO_2-utilization and/or -storage

- 25 wind turbines to cover the demand for electrical energy for normal operation



SCHWENK cement plant Bernburg

Source: Wikipedia

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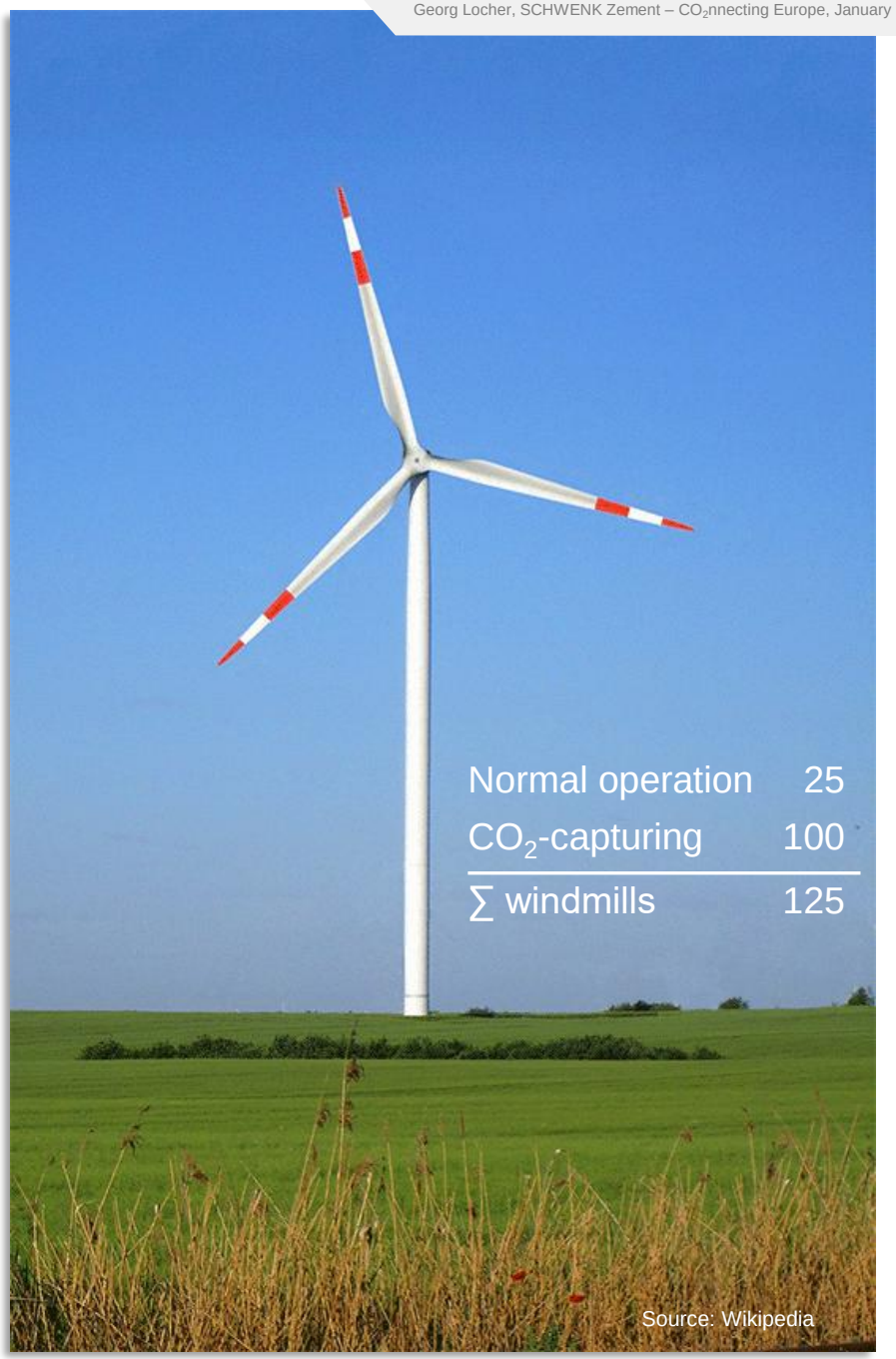
- 25 wind turbines to cover the demand for electrical energy for normal operation
- 100 additional wind turbines for CO_2-capture, -purification and -compression

Source: MAN Energy Solutions



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Source: VTG


Source: iStock

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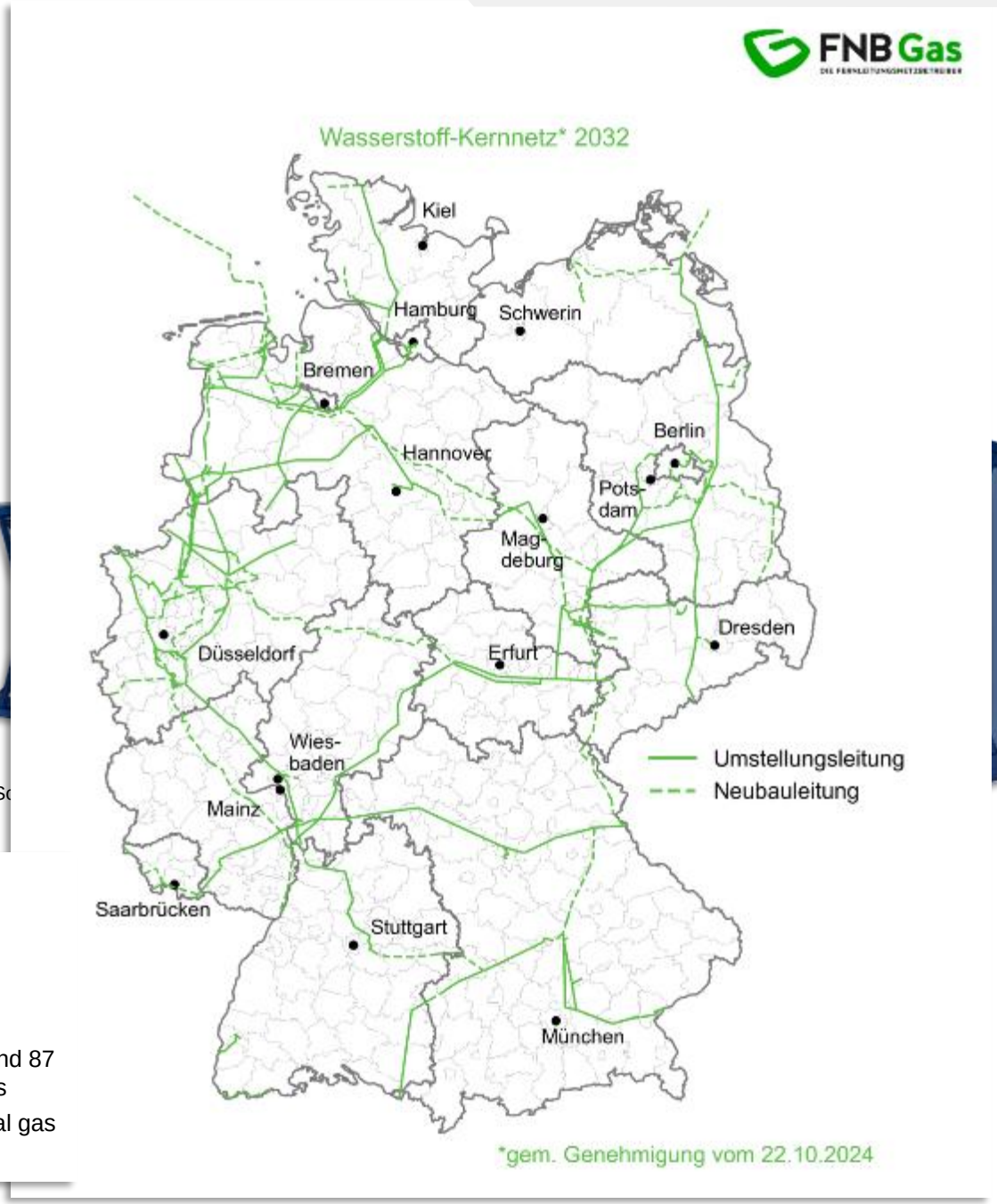
- 300 tons of H_2 per day for the conversion of CO_2 into chemical products, e. g. methanol or aviation fuel

FNB H_2-core network

- Planned commissioning in 2032
- 9,040 km length
- 18.9 bn €
- Approval on October 22nd, 2024
- 101 GW (i. e. 26.5 Mt/a) feed-in and 87 GW (i. e. 22.8 Mt/a) exit capacities
- Consists of 60 % converted natural gas pipes Invest

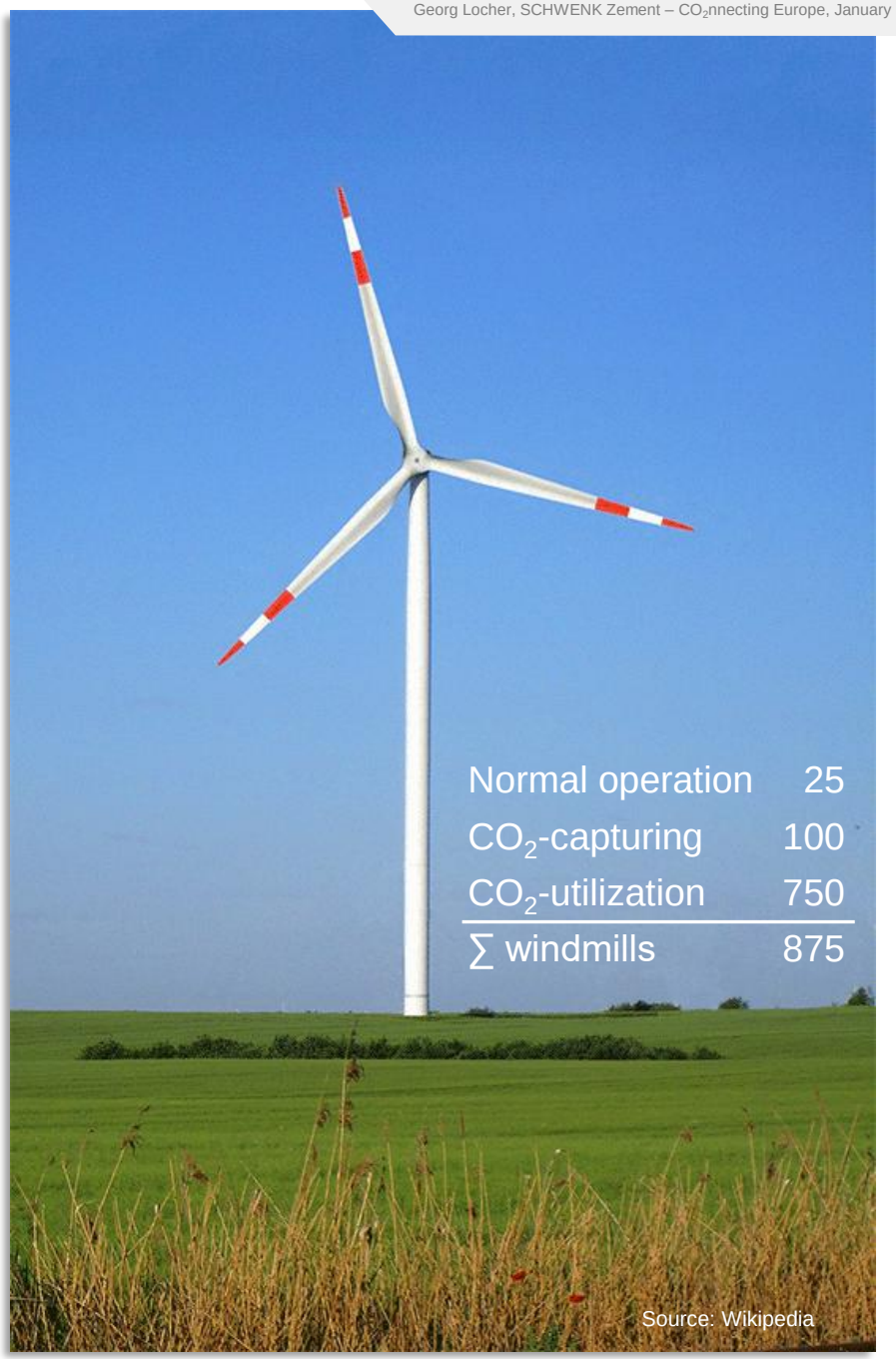


Practical aspects of implementation

Infrastructure for CO_2-utilization and / or -storage

Source: pv magazine, 9/2022

i. e. 600 electrolyzers with a capacity of 1 MW each, for which 750 wind turbines or approx. 15 % of Germany's Suedlink capacity would be required



Practical aspects of implementation

Infrastructure for CO_2-utilization and / or -storage

Options for the production of ‚green' hydrogen according to RED II DA (13.02.2023)

FfE

Direct connection

Same grid node
And smart metering system

or

No grid connection

+

Additionality
(Starting from 01.01.2028)
RE-installation no longer than 3 years before EL

Grid electricity

Share of RE in power mix > 90%
In any of the last five calendar years

PPA with RE-installation

+

Additionality
(Starting from 01.01.2028)
RE-installation no longer than 3 years before EL

or

Emission intensity grid
< 64,8g CO2eq/kWh

+

Temporal Correlation
- Until 31.12.2029: same month
- From 01.01.2030: same hour
- Always possible: day-ahead-price <= 20 €/MWh or <= 0,36 * CO2-price (t)

+

Geographical correlation
- Same bidding zone, or
- Neighboring bidding zone with higher electricity price, or
- Neighboring offshore bidding zone

Avoidance of downward regulation of renewable energy plants for redispatch measures

RE – renewable energy
EL – electrolyzer
RED – renewable energy directive
DA – delegated act
PPA – power purchase agreement

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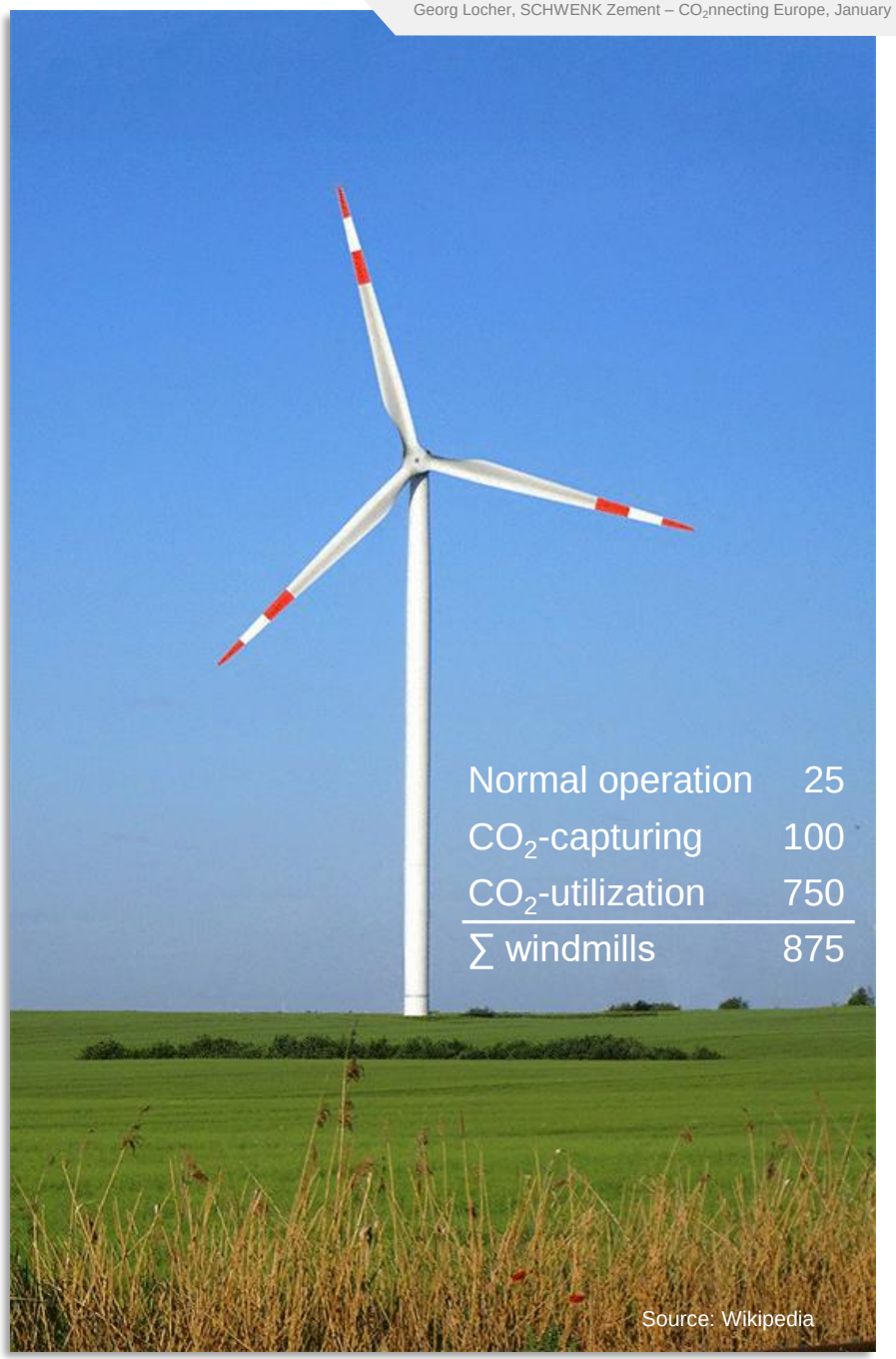


Intergovernmental Panel on Climate Change

CCS contribution to combating climate change

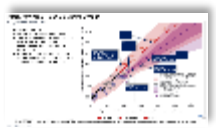
Scenarios 2050

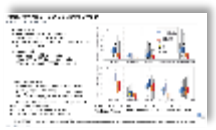
- 100-150 EJ [1)] of the CO_2 from energy supply by biomass, natural gas and coal will be stored
- the cumulative amount of CO_2 stored will be at ~100 Gt

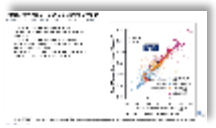
Scenarios 2100

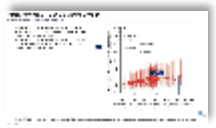
- 200-250 EJ [1)] of the CO_2 of energy supply by biomass, natural gas and coal will be stored
- the cumulative amount of CO_2 stored will be at ~600 Gt

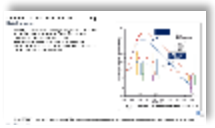

Modeling basis


CO_2-Budget


Carbon Dioxide Removal


Pathways comparison


Cumulative emissions


Radiative forcing

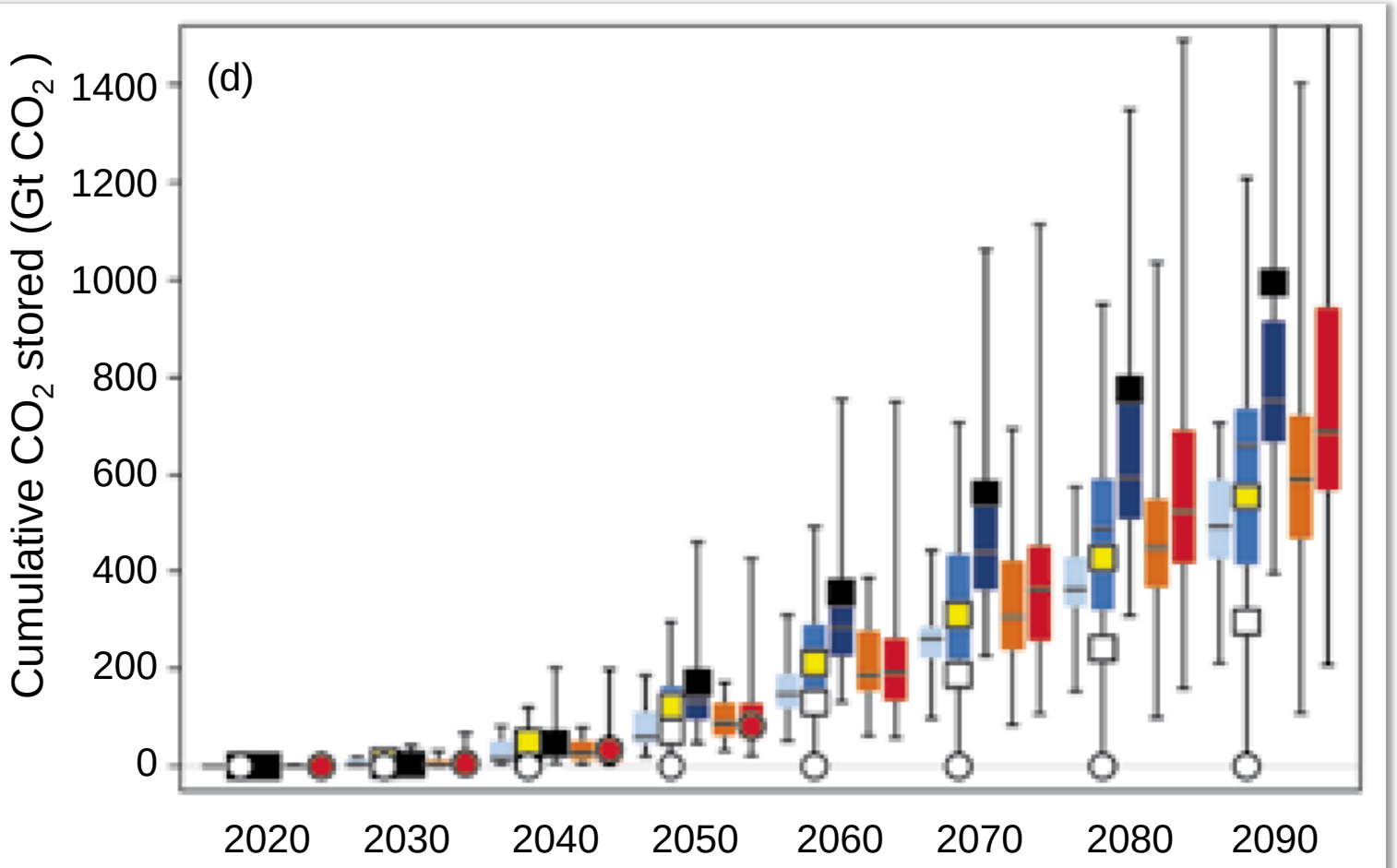


Fig. 2.17 (p 136) CCS deployment in 1.5 °C and 2 °C pathways for (a) biomass, (b) coal, (c) natural gas and (d) the cumulative quantity of fossil and biomass CO_2 stored via CCS (in Gt CO_2 stored).

biomass (a) coal (b) natural gas (c) cumulative (d)

[1)] The 2024 total energy consumption is at ~650 EJ

Source Rogelj et al. (IPCC, 2018) Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development.
In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty