

Is CCS competitive with alternative solutions?

The economics of CCS

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Institute for Energy Economics
and Financial Analysis

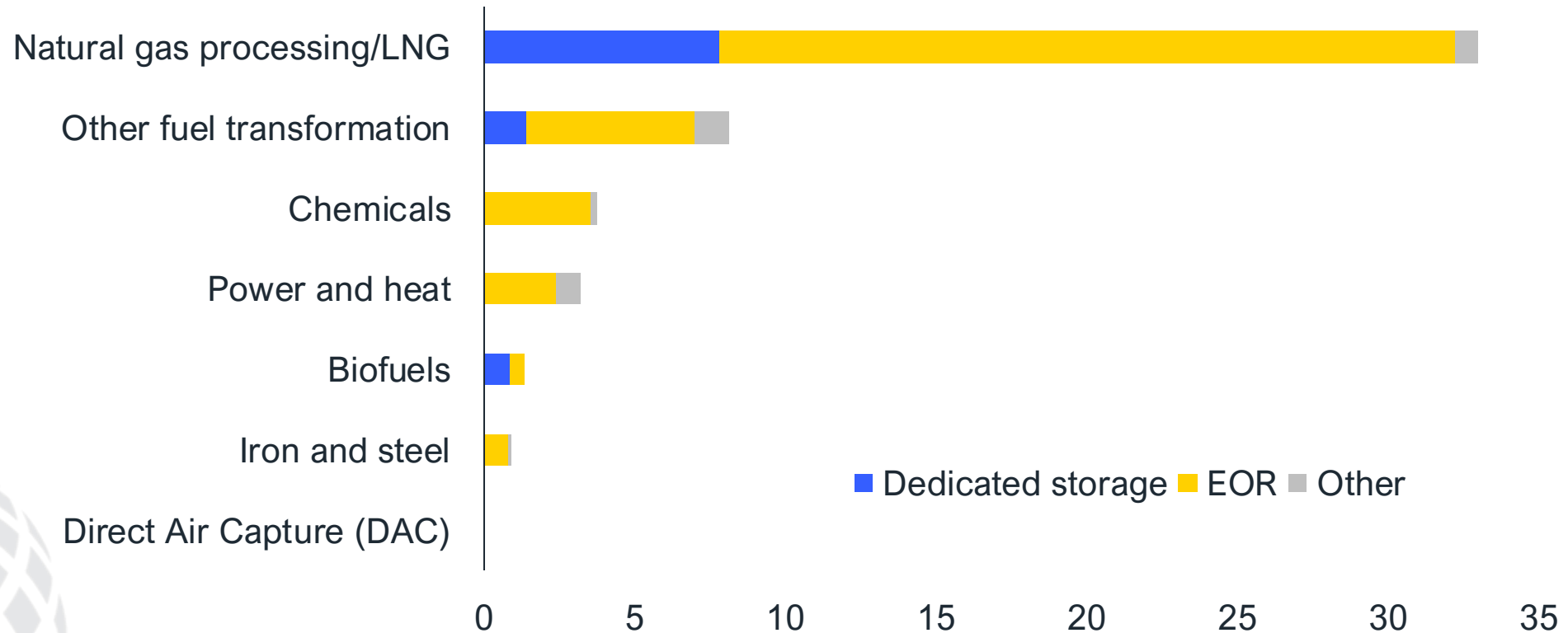
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Accelerating the Energy Transition in Asia

Overview

Today, CCUS projects are mostly in gas sector & for EOR

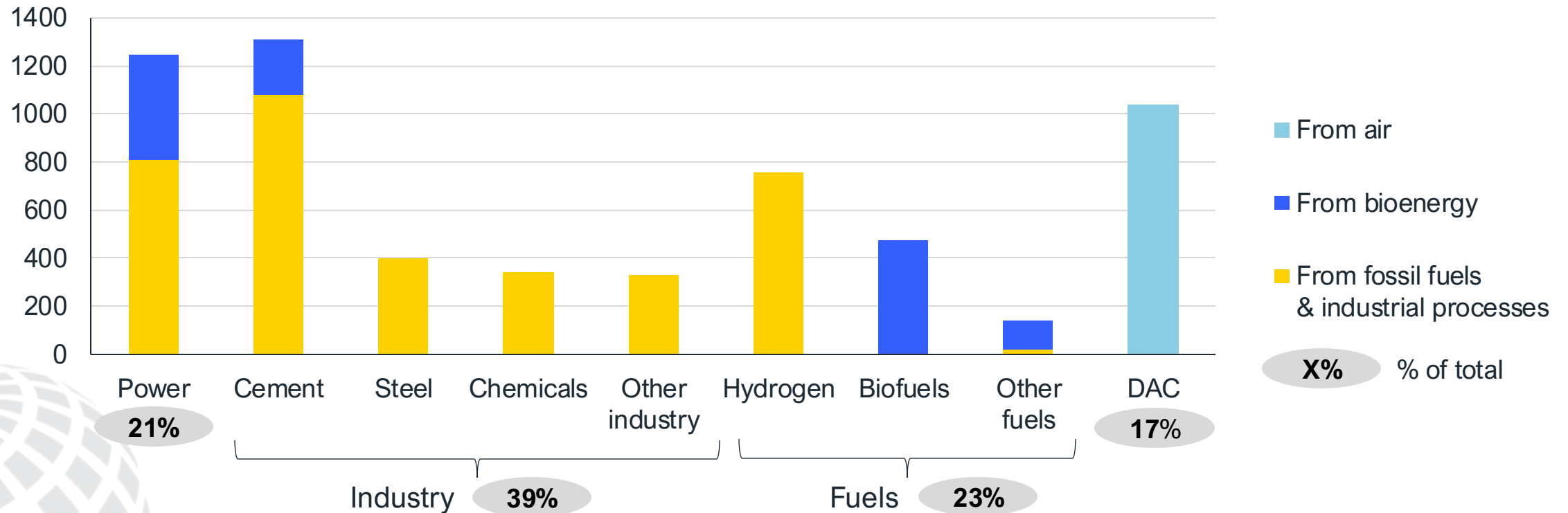
Operational CCUS projects, MtCO₂/yr captured



Source: IEA, [CCUS projects database 2024](#)

CCS is forecast to be used across a range of applications

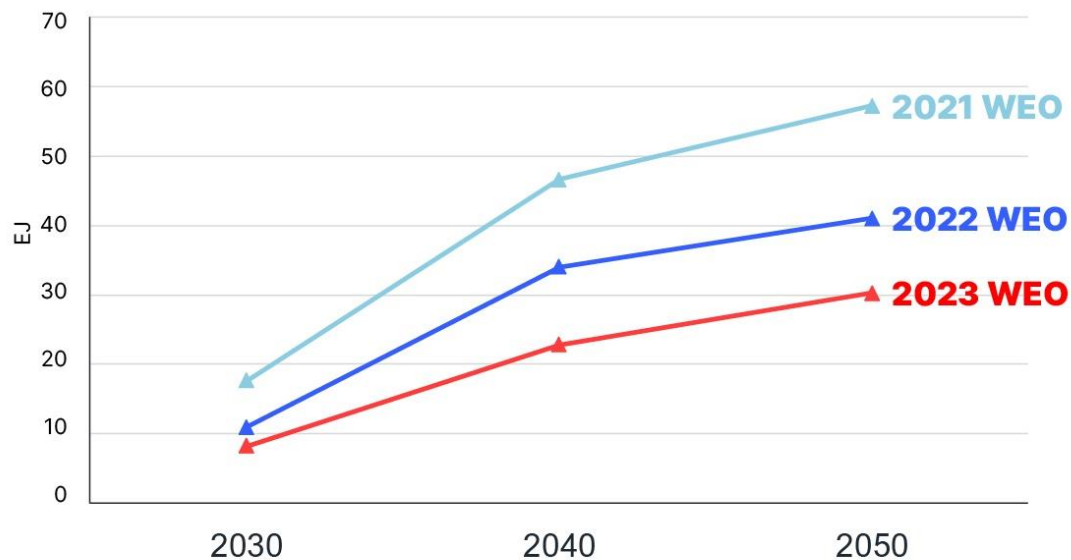
Total CO₂ captured in 2050 in IEA NZE scenario, MtCO₂



Source: IEA, [Net Zero Roadmap – 2023 Update](#)

However, expectations are decreasing for fossil fuels + CCS

Contribution of fossil fuels with CCS to global energy supply in the IEA NZE

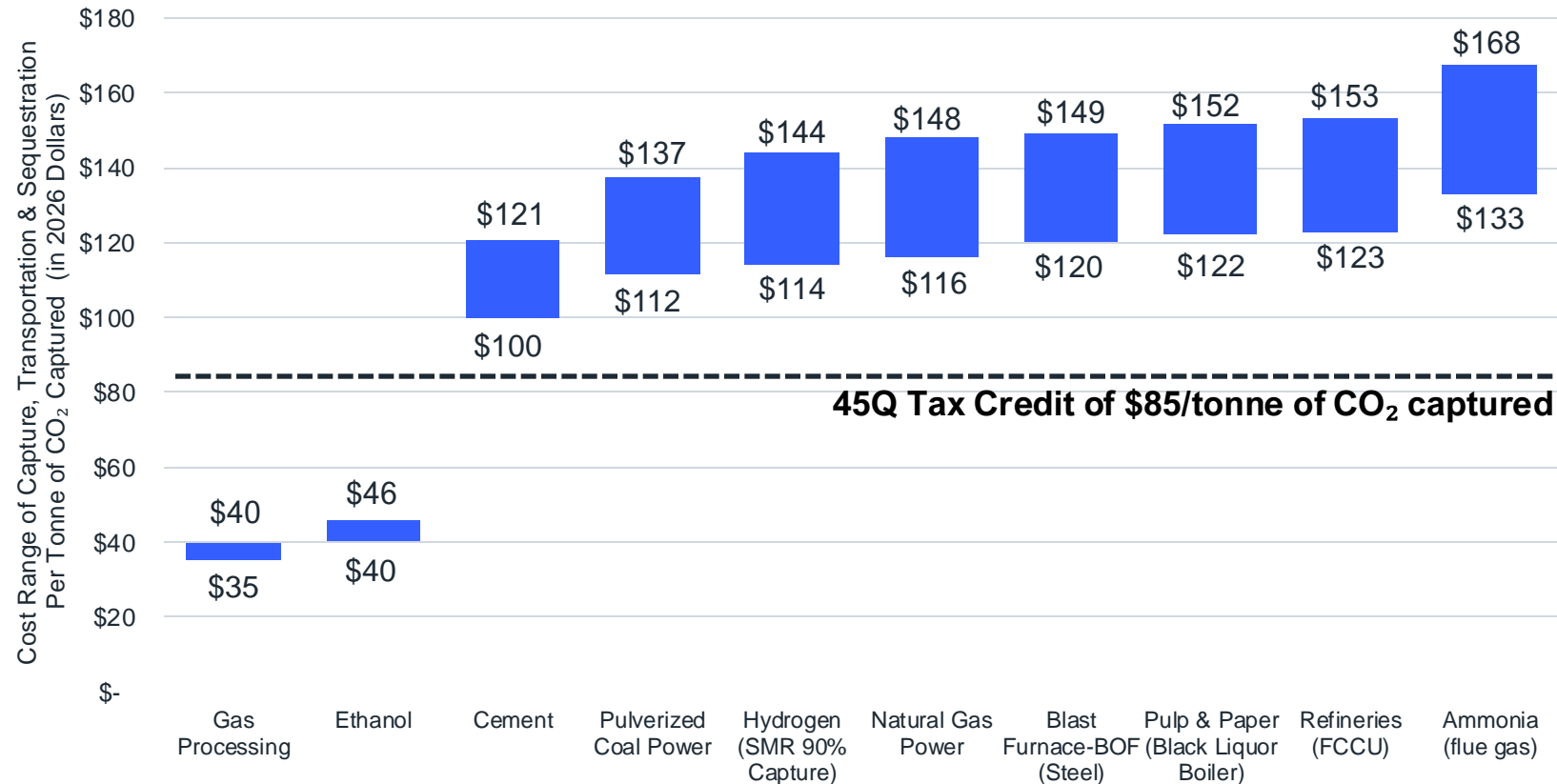


Major reductions (2050):

- -60% of **gas** use with CCS
- Near elimination of **fuel** transformation
- -50% of **hydrogen** from fossil fuels
- -50% decrease in **gas power** + CCS
- -30% in CCUS use for **steel** production

Source: IEA, [World Energy Outlook 2023](#), [2022](#) and [2021](#), [Net Zero Roadmap](#), [Net Zero Roadmap – 2023 Update](#)

Recent cost estimates remain high...



EPA estimate of cost of new CCS rule to power industry by 2047:

\$7.5-19b

East Kentucky Power Cooperative estimate of cost at its Spurlock coal plant:

\$10.7b

Source: Energy Futures Initiative (EFI), [Turning CCS projects in heavy industry & power into blue chip financial investments](#); NRECA, [‘Too Far, Too Fast’: Co-ops Warn of Surging Costs, Reliability Crunch in Bid to Halt EPA Rule](#); S&P Global, [US EPA defends carbon capture tech underpinning new power plant rule](#).



Carbon Capture and Storage (CCS) projects' poor report card

... and are worsened by poor performance

Cost **USD2.1bn**

Injected 8.5 MtCO₂ in first 7 years

~**USD138/tCO₂** in last 2 years



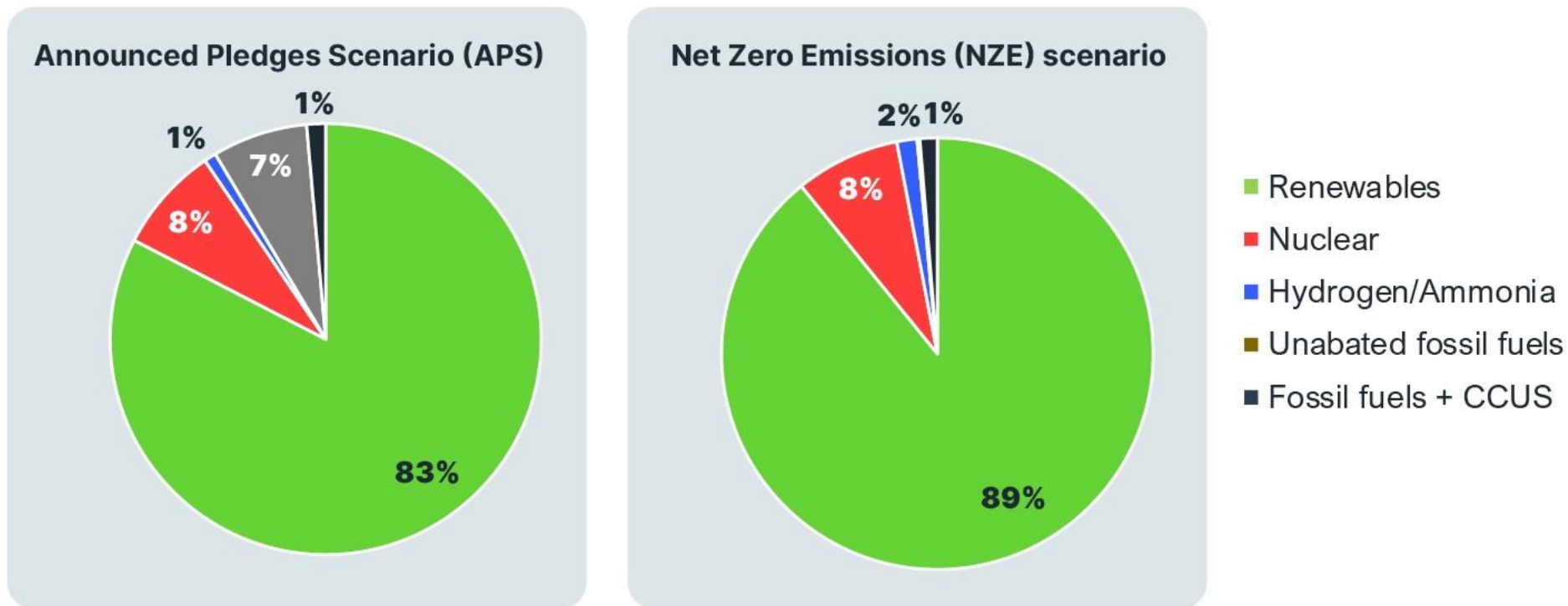
Project		Capacity (MtCO ₂ p.a.)	Performance
Natural Gas processing			
	1986 Shute Creek	7	Lifetime under-performance of 36%
	1996 Sleipner	0.9	Performing close to the capture capacity
	2004 In Salah	1.1	Failed after 7 years of operation
	2007 Snøhvit	0.7	Performing close to the capture capacity
	2019 Gorgon	4	Lifetime under-performance of ~50%
Industrial sector			
	2000 Great Plains	3	Lifetime under-performance of 20–30%
	2013 Coffeyville	0.9	No public data was found on the lifetime performance.
	2015 Quest	1.1	Performing close to the capture capacity
	2016 Abu Dhabi	0.8	No public data was found on the lifetime performance.
	2017 Illinois Industrial (IL-CCS)	1	Lifetime under-performance of 45–50%
Power sector			
	2014 Kemper	3	Failed to be started
	2014 Boundary Dam	1	Lifetime under-performance of ~50%
	2017 Petra Nova	1.4	Suspended after 4 years of operation

Source: IEEFA. The Carbon Capture Crux: Lessons learned. September 2022.

Sectoral view

Power: CCS is unlikely to be cost competitive

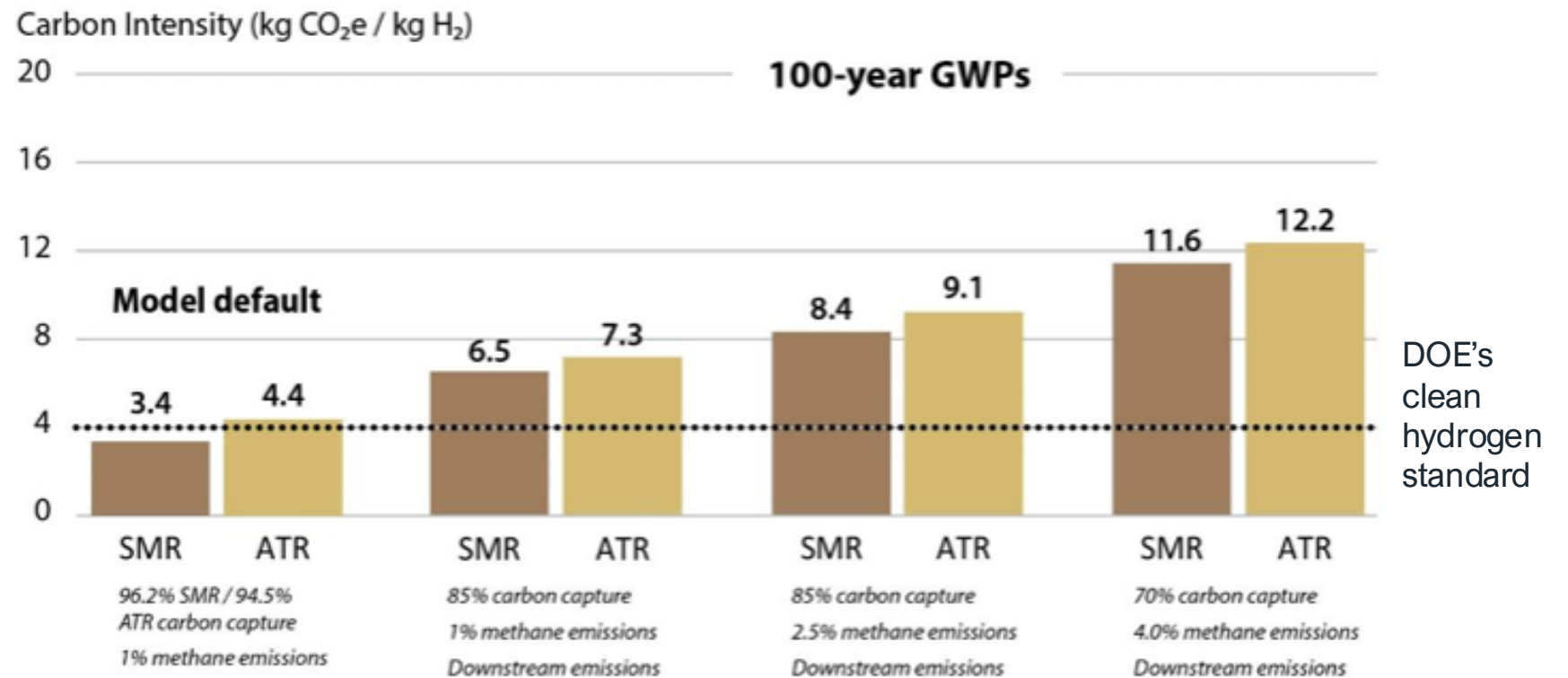
Electricity generation by 2050, IEA scenarios, %



Source: IEA, [World Energy Outlook 2023](#)

Hydrogen: Blue hydrogen is unlikely to meet clean hydrogen standards

Figure 8: Range of Carbon Intensities Reflecting 100-year GWPs but More Realistic Real-world Assumptions About Methane Emissions, CO₂ Capture Rates and Downstream Emissions



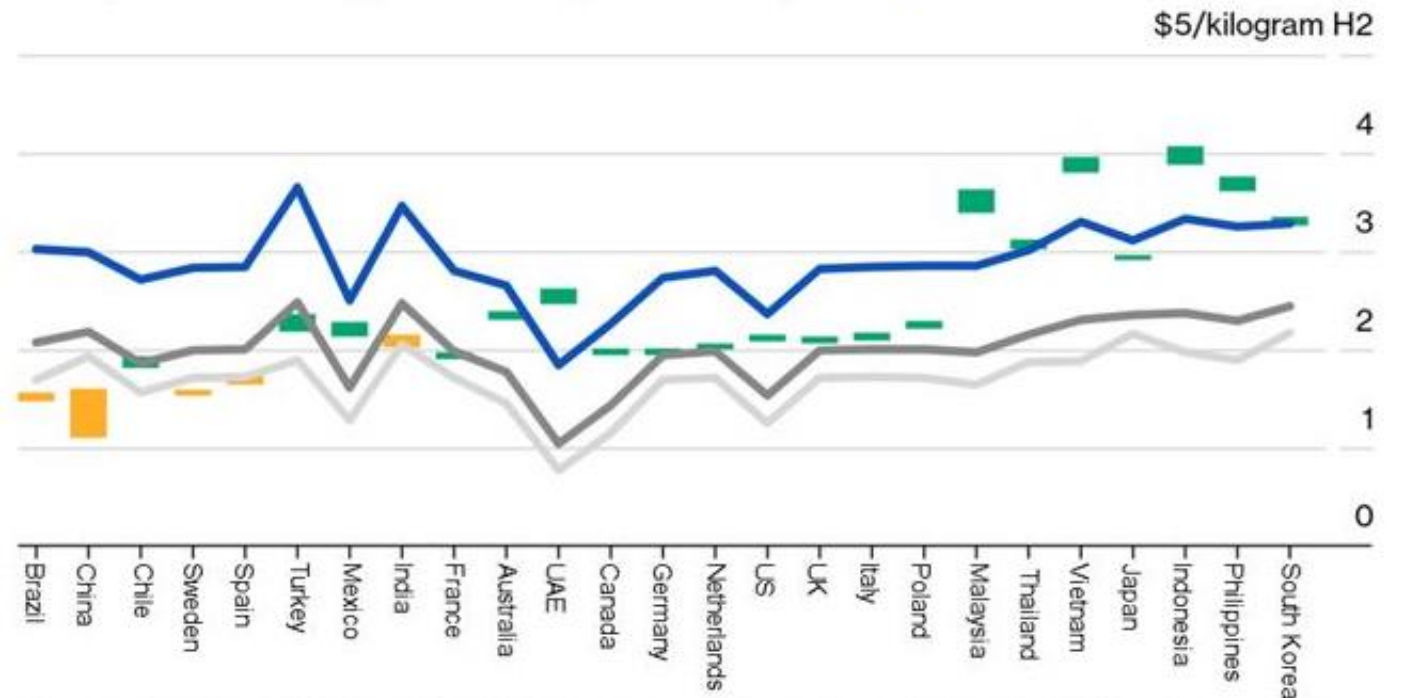
Source: IEEFA, [Blue hydrogen: Not clean, not low carbon, not a solution](#) (IEEFA runs with DOE's GREET model)

Hydrogen: Blue Hydrogen's cost advantage is expected to be short-lived

Green Hydrogen Is Cheaper Than Gray in Five Markets in 2030

Levelized cost of hydrogen, 2030

■ Green H2 ■ Markets where green H2 will undercut gray H2 from existing plants
 ■ Gray H2 from existing plants / Gray H2 from new plants / Blue H2



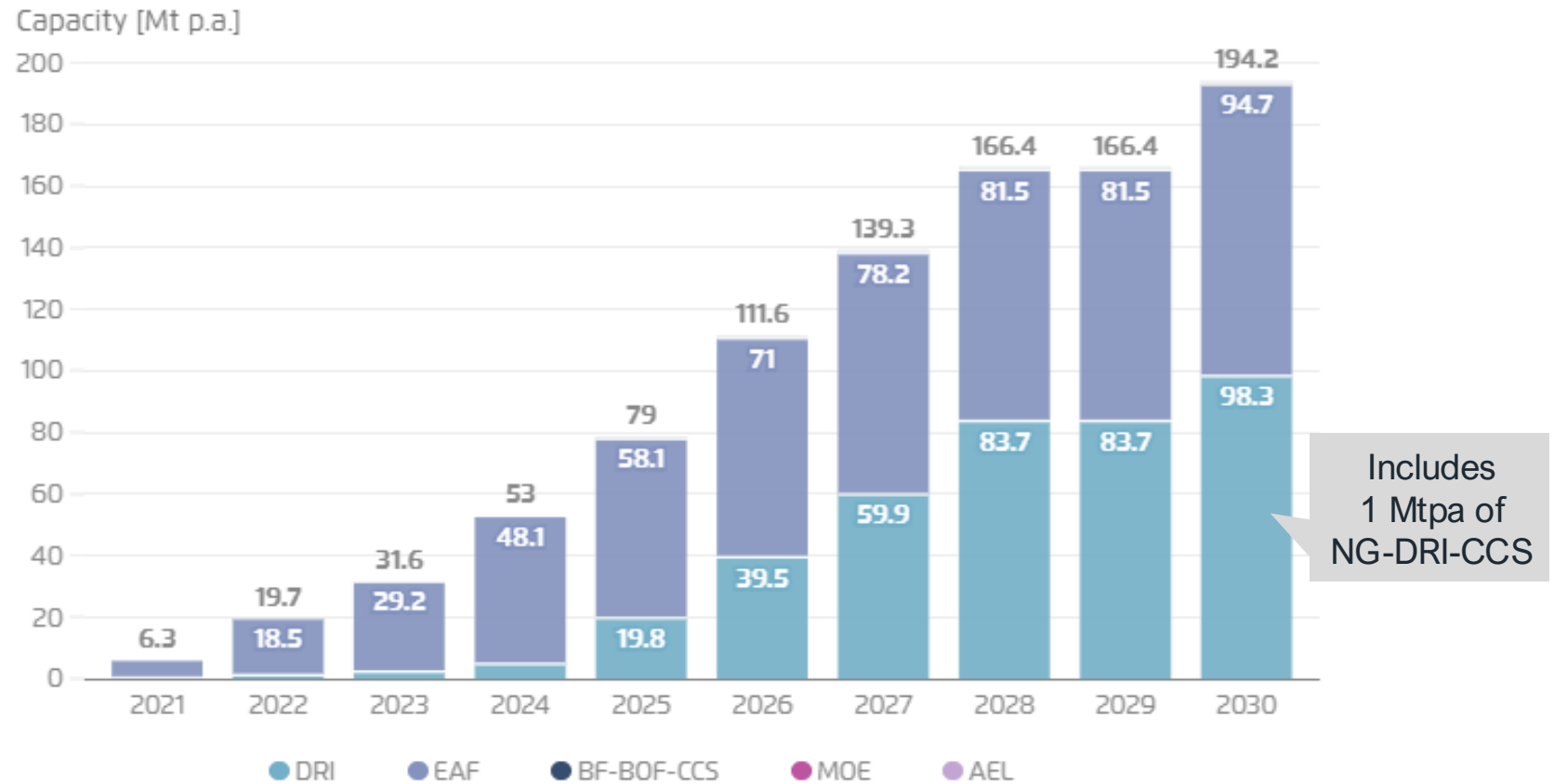
Source: BloombergNEF. Note: Blue H2 is the average of auto-thermal reforming (ATR) and steam methane reforming (SMR) production. Green H2 includes Western-made proton-exchange membrane electrolyzers (top of range) and alkaline electrolyzers (bottom of range), except in China, which includes Chinese-made alkaline electrolyzers (bottom of range).

BloombergNEF

Source: BloombergNEF, [Green Hydrogen to Undercut Gray Sibling by End of Decade](#) (August 2023)

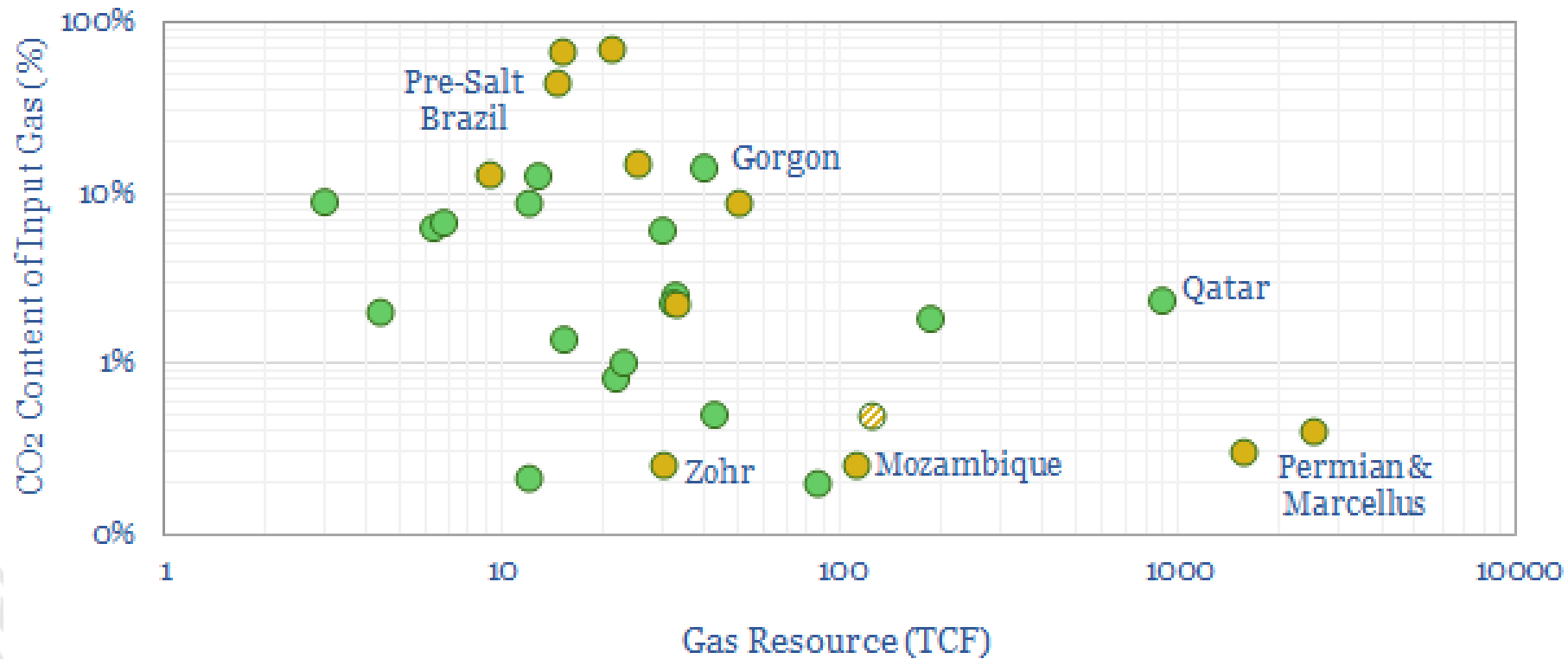
Steel: CCS is left behind by EAF and DRI technologies

Low-carbon steelmaking announcements by technology and by deployment year, cumulative capacity in Mtpa



Source: Agora Industry, [Global Steel Transformation Tracker](#)

Gas/LNG: There is more than enough resource at low CO₂ content to meet global needs



Source: Thunder said energy, [The World's Great Gas Fields and Their CO₂](#)

Conclusion: CCS will likely play a niche role

- CCS + fossil fuels unlikely to be cost & emissions competitive
- Costs are underestimated & performance overestimated
- Renewables based solutions are progressing faster
- Likely role limited to cases where no alternatives exist

Contact

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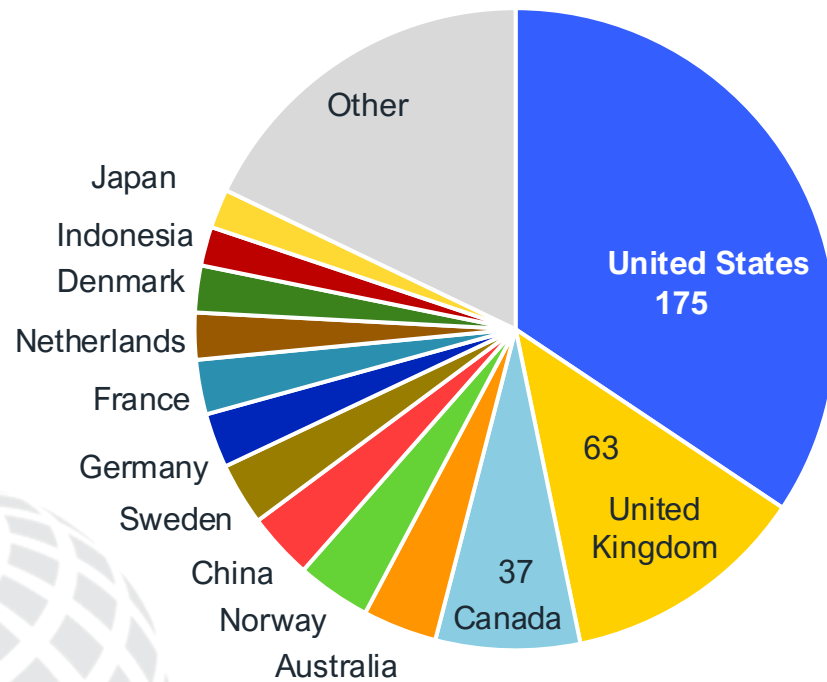
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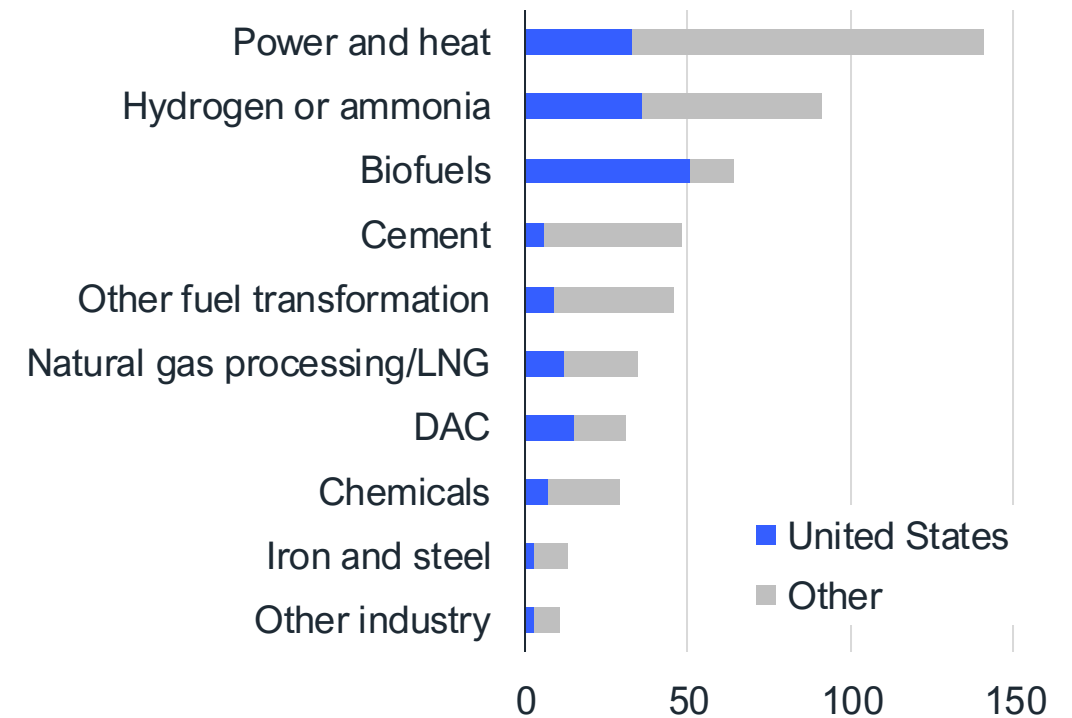
Generous IRA subsidies are driving new projects

Under construction & planned CCS projects

Number of projects by country



Number of projects by sector



Source: IEA, [CCUS projects database 2024](#)