

BNEF Hydrogen Outlook

PV Magazine Roundtable

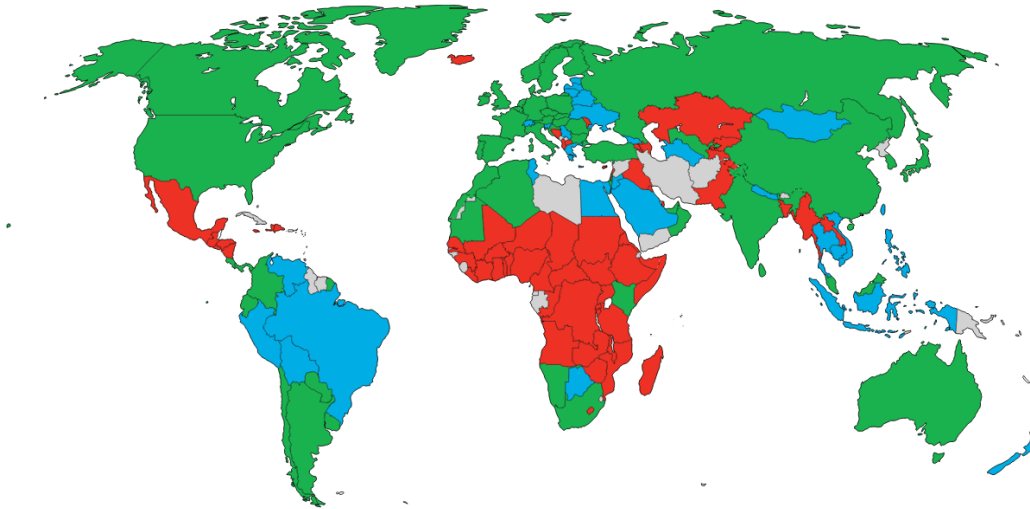
Adithya Bhashyam

December 6, 2023

Some 52 markets have announced a hydrogen strategy

Hydrogen strategies as of October 6, 2023

■ Available (52) ■ In preparation (29) ■ No activity (60)
■ Not assessed (31)



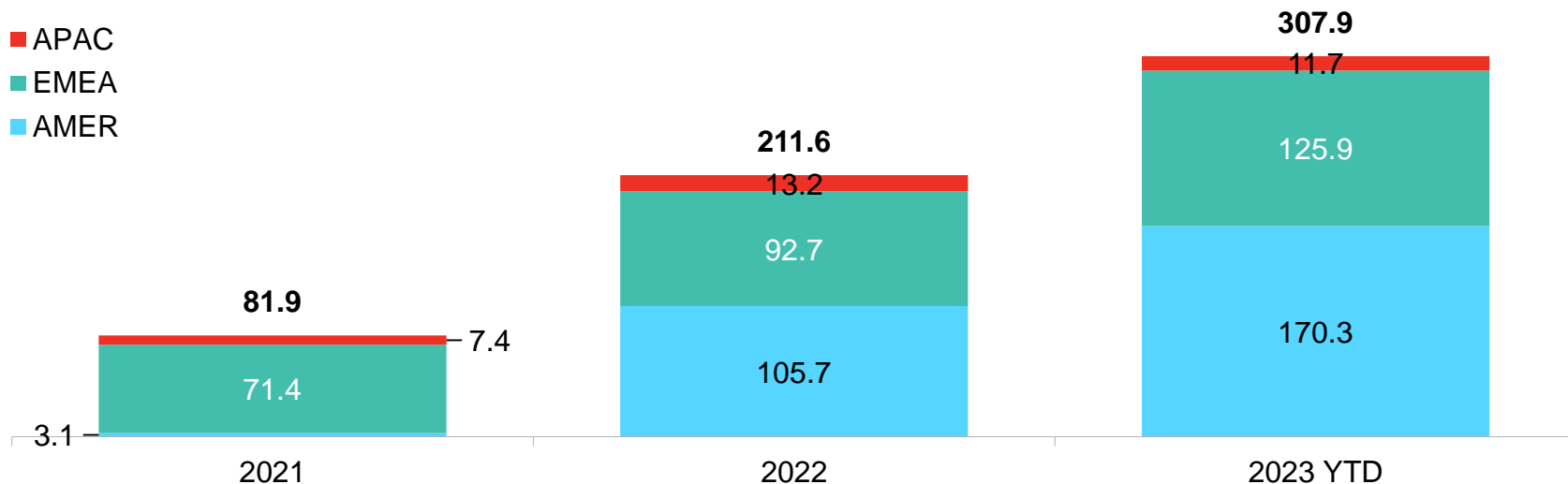
Source: BloombergNEF. Note: Mapped data show strategies for distinct economies. A full list of strategies can be found in BNEF's Global Hydrogen Strategy Tracker ([web](#) | [terminal](#)).

Government subsidies for hydrogen have almost quadrupled since 2021

Growth in announced hydrogen funding as of September 25, 2023

\$ billion (2022 real)

- APAC
- EMEA
- AMER

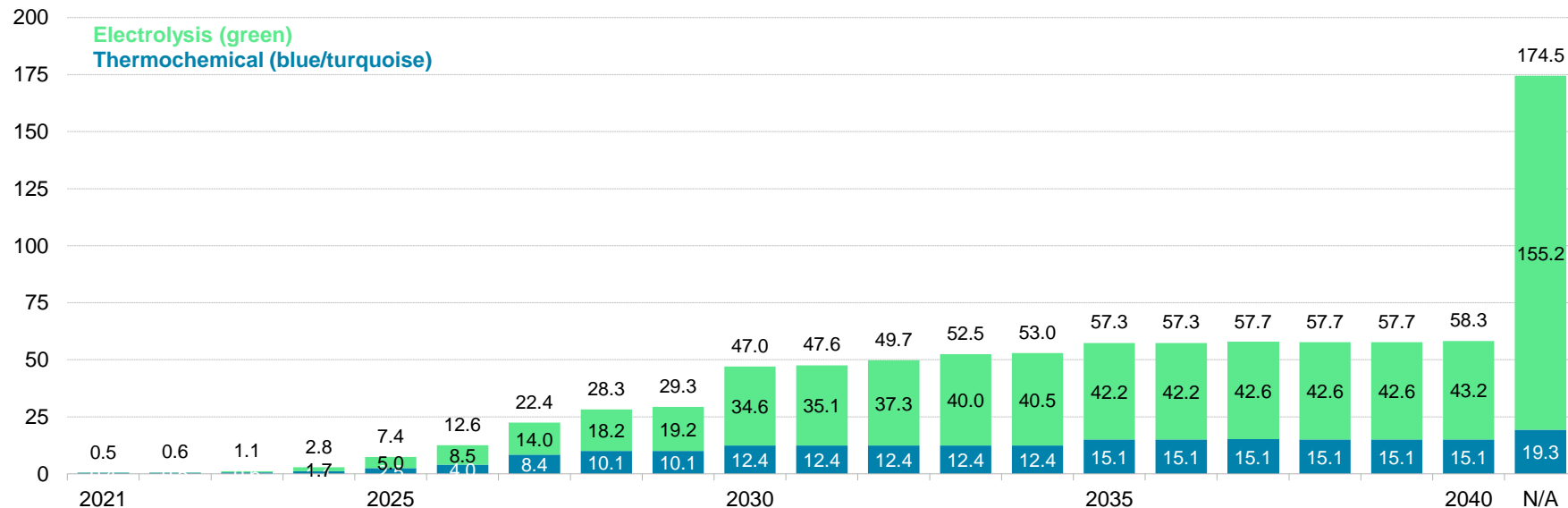


Source: BloombergNEF. Note: Includes funding schemes that are announced and in force. Includes tax credits, grants, R&D funding, contracts for difference and fixed premium subsidy mechanisms. Excludes loans and loan guarantees. Funding from US Inflation Reduction Act tax credits for hydrogen and carbon capture estimated based on the announced clean hydrogen project pipeline as of September 25, 2023 for '2023' and September 1, 2022, for '2022' ([web](#) | [terminal](#)).

Announced supply could displace more than current demand, with green dominating

Cumulative clean hydrogen supply pipeline proposed by developers

Million tons of H₂ per year



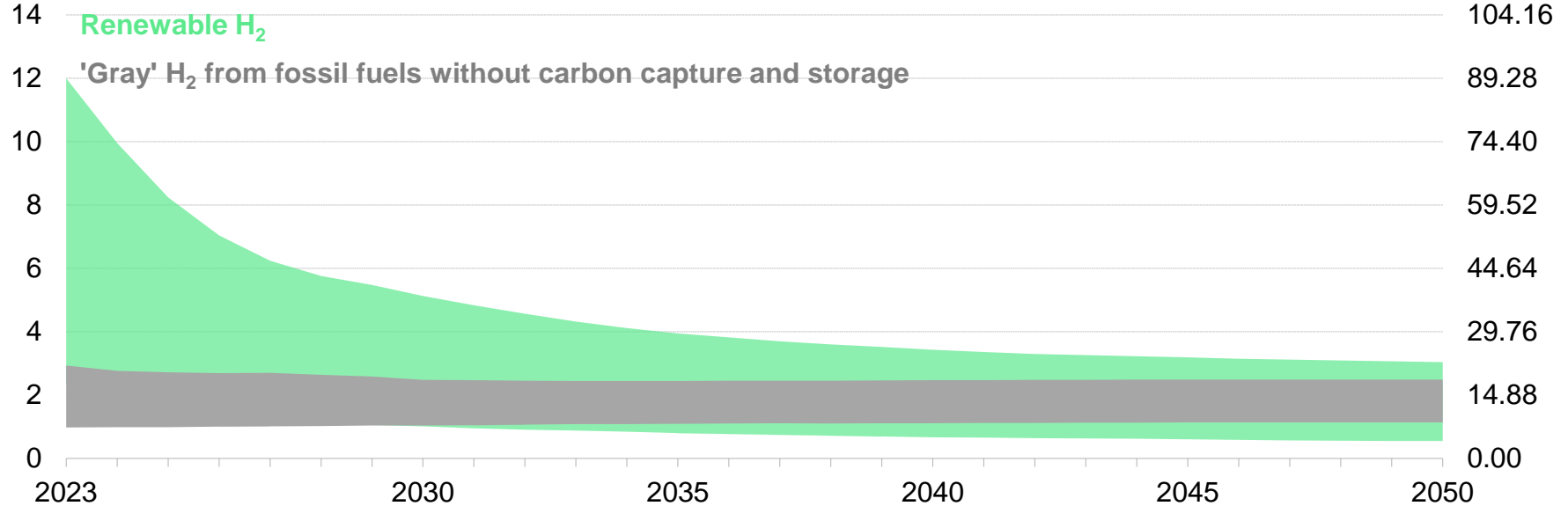
Source: BloombergNEF Hydrogen Project Database ([web](#)). Note: This is not a forecast but a pipeline of proposed projects. N/A refers to projects without a announced commissioning year.

The cost of green hydrogen production could undercut gray hydrogen in the 2030s

Levelized cost of H₂ from cheapest available renewable power in 28 markets

\$/kilogram (real 2022)

\$/MMBtu



Source: BloombergNEF. Note: Based on project financing year. Values at the bottom show cheapest hydrogen available from a Chinese alkaline electrolyzer in the cheapest modeled market; values atop the range show cheapest values available using a proton exchange membrane electrolyzer in the most expensive modeled market. Electricity costs derived from BNEF's 1H 2023 LCOE Update ([web](#) | [terminal](#)), mid scenario. MMBtu is million British thermal units.

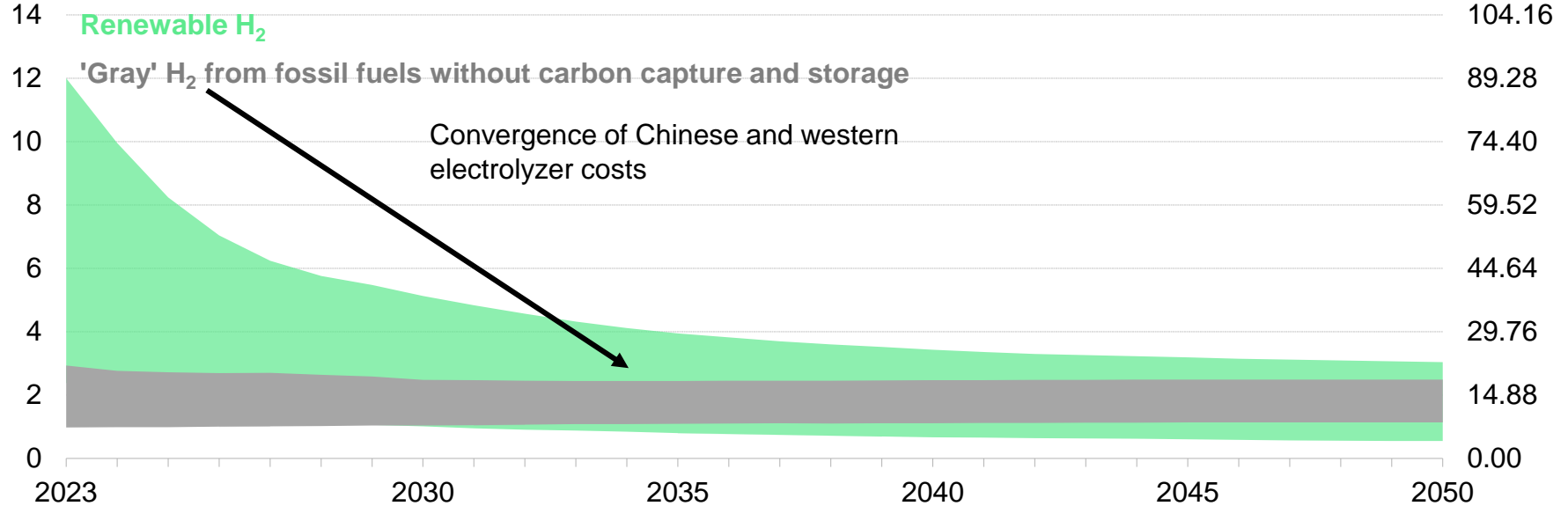


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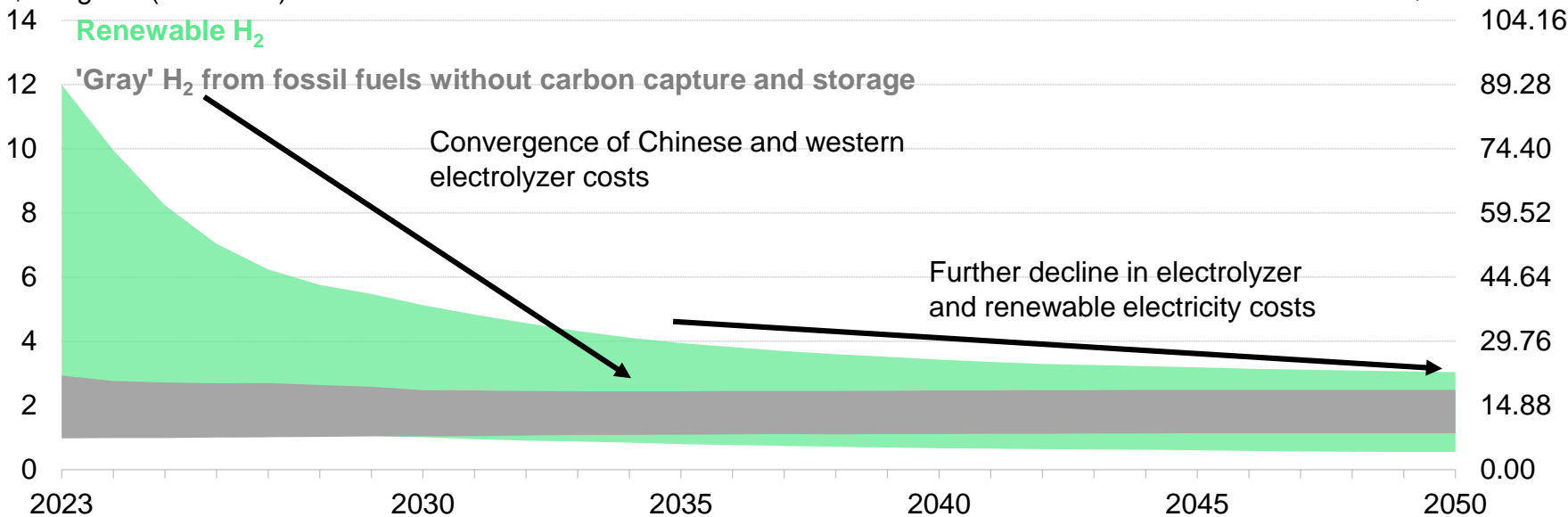


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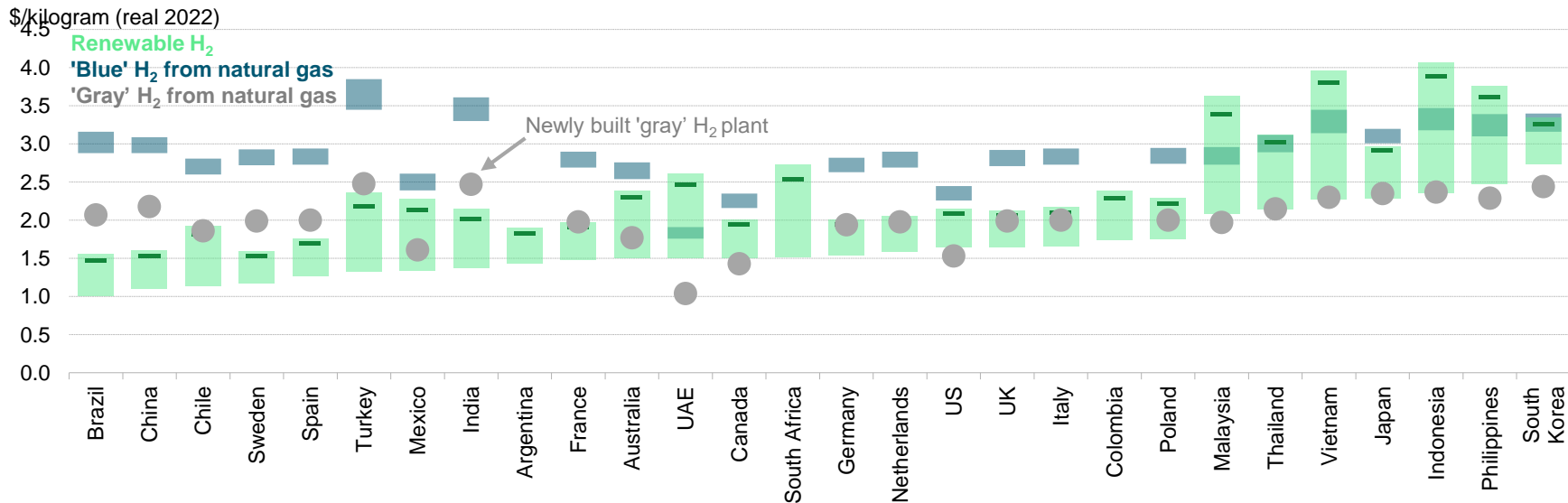


Source: BloombergNEF. Note: Based on project financing year. Values at the bottom show cheapest hydrogen available from a Chinese alkaline electrolyzer in the cheapest modeled market; values atop the range show cheapest values available using a proton exchange membrane electrolyzer in the most expensive modeled market. Electricity costs derived from BNEF's 1H 2023 LCOE Update ([web](#) | [terminal](#)), mid scenario. MMBtu is million British thermal units.



Green H₂ should outcompete new blue – and even gray in some markets – by 2030

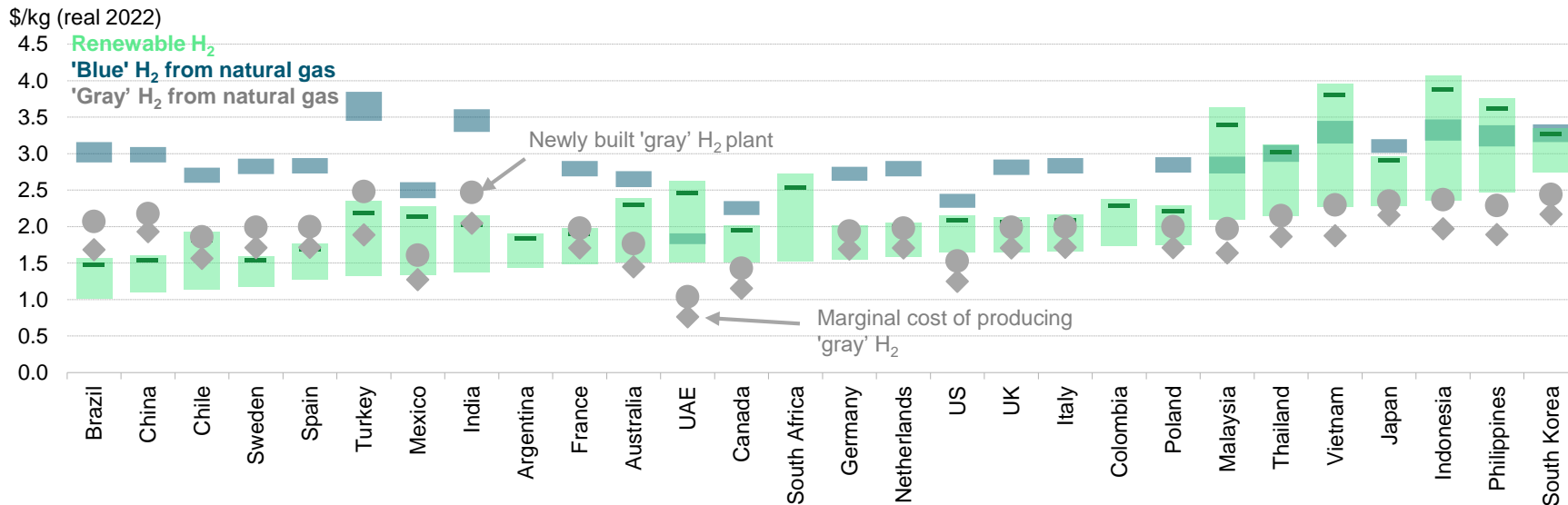
Levelized cost of H₂ in 28 markets, 2030



Source: BloombergNEF, NETL. Note: Based on project financing year. Assumes our optimistic electrolyzer cost scenario. Renewable levelized cost of hydrogen (LCOH₂) range reflects a diversity of electrolyzer type, Chinese alkaline (low) to PEM (high). The electrolyzer's electricity is sourced from the cheaper renewable resource. Capital and operational costs for blue hydrogen are sourced from the [National Energy Technology Laboratory \(NETL\)](#). Gas prices derived from BNEF's 1H 2023 LCOE Update ([web](#) | [terminal](#)). Grid electricity prices assumed at \$75 (real 2022) for all modeled markets.

A new green H₂ plant could also outcompete existing gray H₂ running at marginal cost in some markets

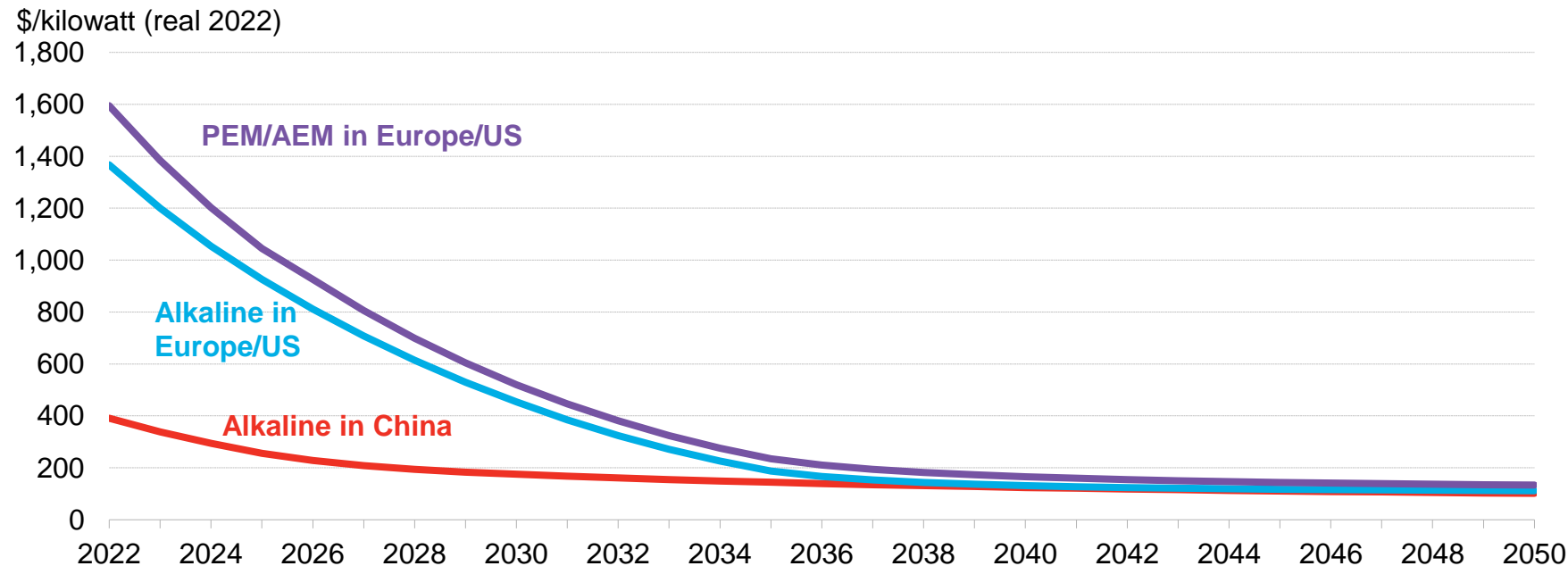
Levelized cost of hydrogen in 28 markets, 2030



Source: BloombergNEF, NETL. Note: Based on project financing year. Assumes our optimistic electrolyzer cost scenario. Renewable LCOH₂ range reflects a diversity of electrolyzer type, Chinese alkaline (low) to PEM (high). The electrolyzer's electricity is sourced from the cheaper renewable resource. Capital and operational costs for blue hydrogen are sourced from the [National Energy Technology Laboratory](#). Gas prices derived from BNEF's 1H 2023 LCOE Update ([web](#) | [terminal](#)). Grid electricity prices assumed at \$75 (real 2022) for all modeled markets.

Electrolyzer system costs need to come down further

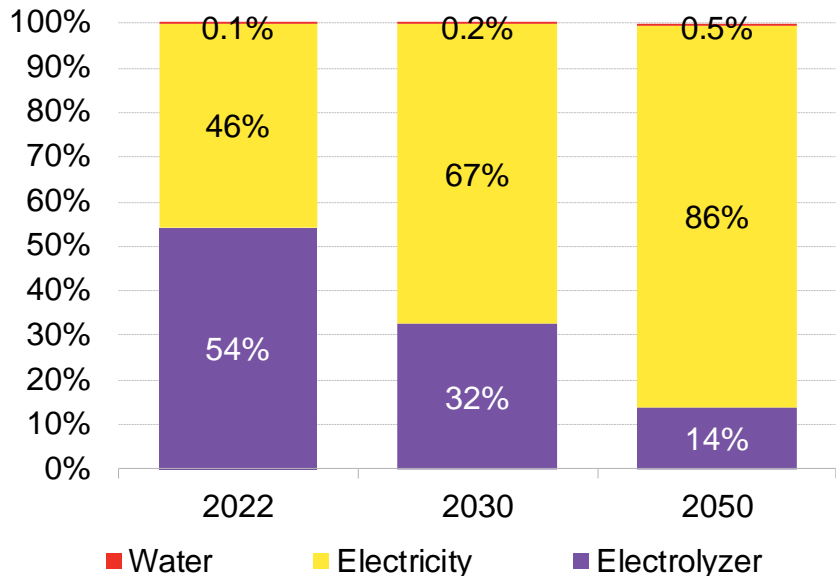
Benchmark electrolysis system capex at the EPC¹ level



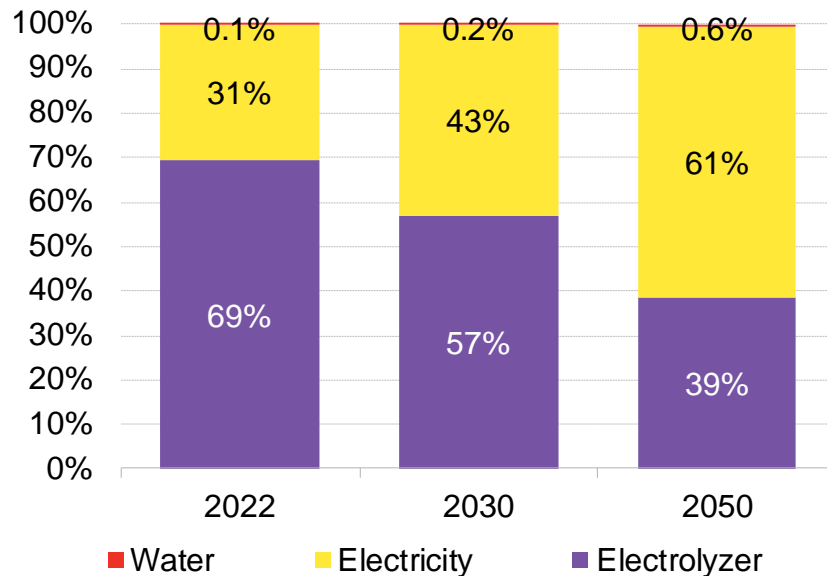
Source: BloombergNEF. Note: EPC = Engineering, procurement and construction. Assumes a single sale in 2022 of several tens of megawatts and several hundreds of megawatts in 2025. PEM stands for proton exchange membrane. AEM stands for anion exchange membrane.

Electrolyzer costs make up most of green hydrogen cost today, but that will change

LCOH₂ breakdown between key components, US onshore wind



LCOH₂ breakdown between key components, US solar (tracking PV)

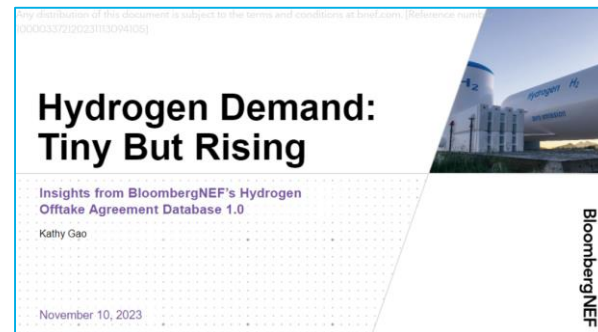
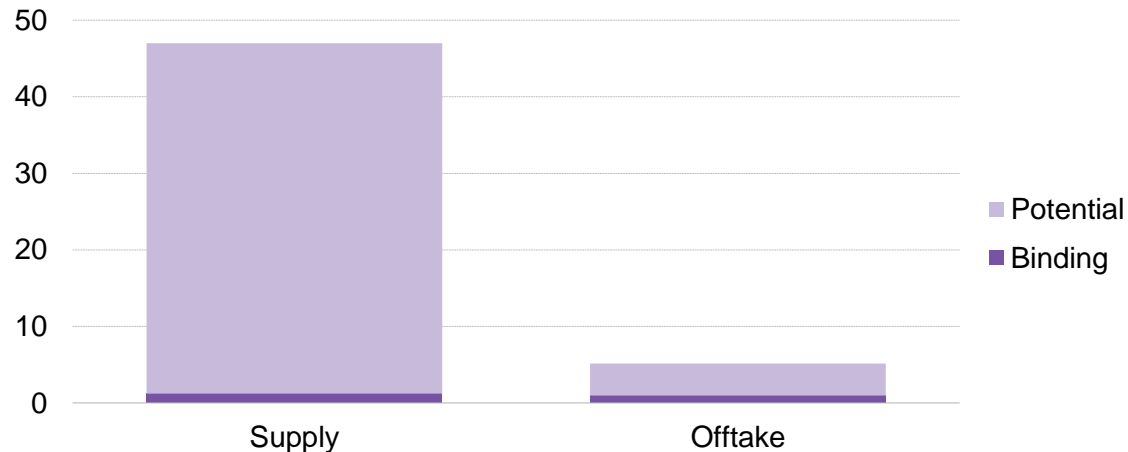


Source: BloombergNEF. Note: Assumes a 1:1 capacity ratio of electrolyzer and power source. 'Electrolyzer' includes all capital and operational expenses related to the electrolyzer facility, as well as project financing costs. See Appendix for a full set of assumptions. LCOH₂ is levelized cost of hydrogen.

Only 1.3% of clean hydrogen capacity by 2030 has signed a binding offtake agreement

Low-carbon hydrogen supply and offtake by 2030

Million metric tons per year

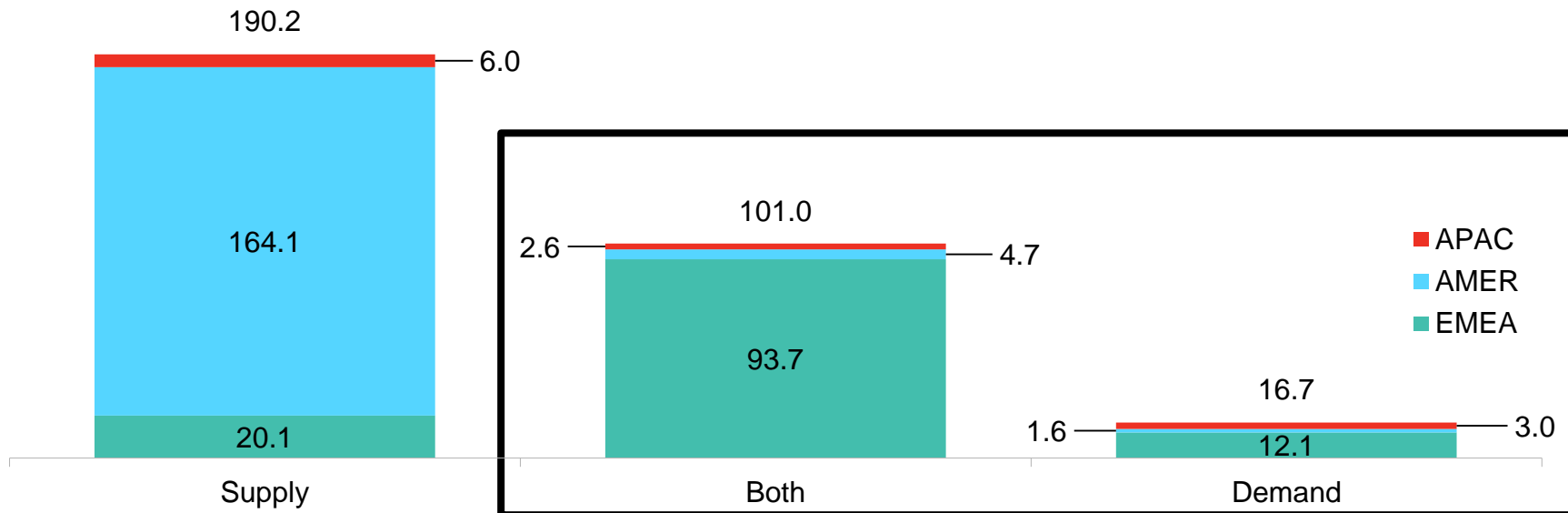


Source: BloombergNEF. Note: Data as of September 29, 2023. The database only includes projects of over 20 megawatts or 2,800 metric tons/year of capacity. Potential offtake includes letters of intent, heads of terms agreements, memoranda of understanding, and unspecified offtake agreements disclosed in news.

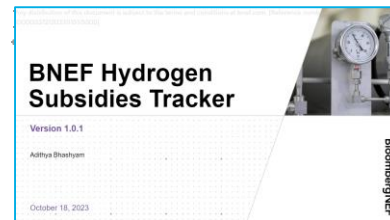
Globally, more support for hydrogen demand is needed

Hydrogen funding by category (supply vs demand) as of October 16, 2023

\$ billion (2022 real)



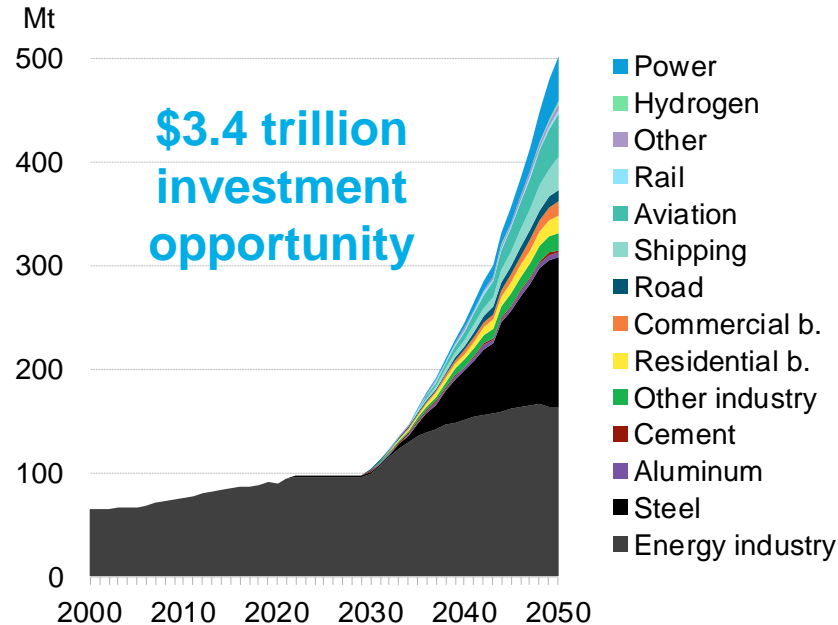
Source: BloombergNEF Hydrogen Subsidies Tracker



Clean hydrogen requires \$3.4 trillion in investments until 2050 under a net-zero scenario

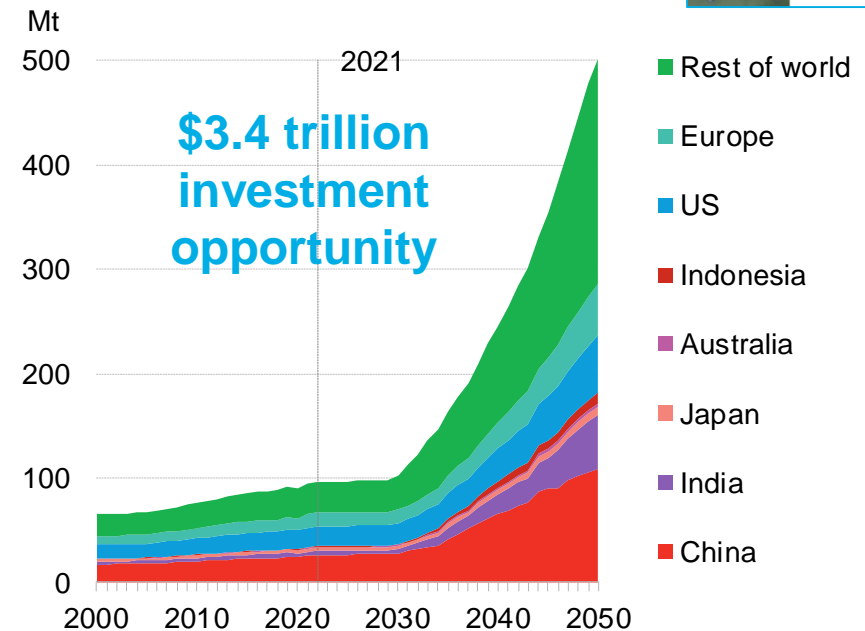


By sector



Source: BloombergNEF. Note: 'Energy industry' includes legacy uses as well as own-use for energy-producing industries. Mt is million metric tons.

By region



Source: BloombergNEF. Note: Mt is million metric tons.

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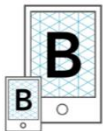
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