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Der Markt der globalen Wasserstoffwirt-schaft im Überblick

VDE Financial Dialogue

Die Wasserstoffindustrie entwickelt sich weiter

Die Entwicklung von Wasserstoff hat Fahrt aufgenommen ...

60 % Wachstum bei Projekten in der **FEED-Phase** und >30 % Wachstum bei Projekt-vorschlägen; >1,400 Projekte angekündigt

> 1 GW operative Elektrolyseurkapazität, etwa **12 GW nach FID**

Die angekündigte Kapazität für sauberen Wasserstoff bis 2030 erreicht **45 Mt pro Jahr**

Zunehmende politische Unterstützung (z. B. IRA, EU RED III, Japan CfD)

… doch nun nimmt der Gegenwind deutlich zu

Die Kosten, insbesondere für erneuerbaren Wasserstoff, **sind erheblich gestiegen**:

- 3 bis 5 % höhere Zinssätze erhöhen Kapitalkosten und Capex
- Störungen in Lieferketten und Arbeitskräfte-mangel erhöhen Investitionsausgaben
- >30% höhere Kosten für Strom aus erneuerbaren Energien

Regulierung und Subventionsrahmen entwickeln sich zwar weiter - es fehlt aber an **Tempo** und **langfristiger Klarheit**

McKinsey works with Hydrogen Council to drive change

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Hydrogen Council

Key elements

CEO-led initiative of 148 leading energy, transport and industry companies

Founded 2017 at the World Economic Annual Meeting in Davos

United and long-term vision to develop the hydrogen economy

Objectives

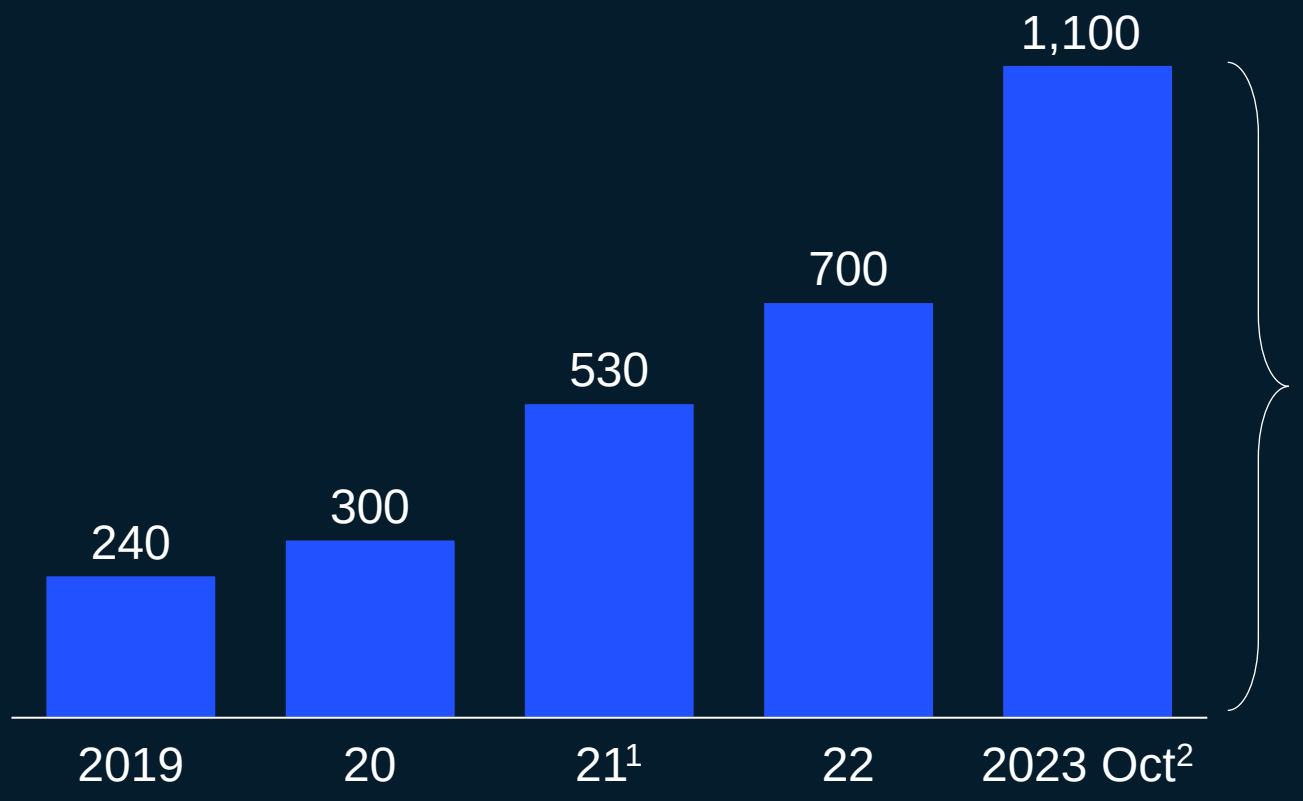
Accelerate investment in development and commercialization of hydrogen and fuel cell

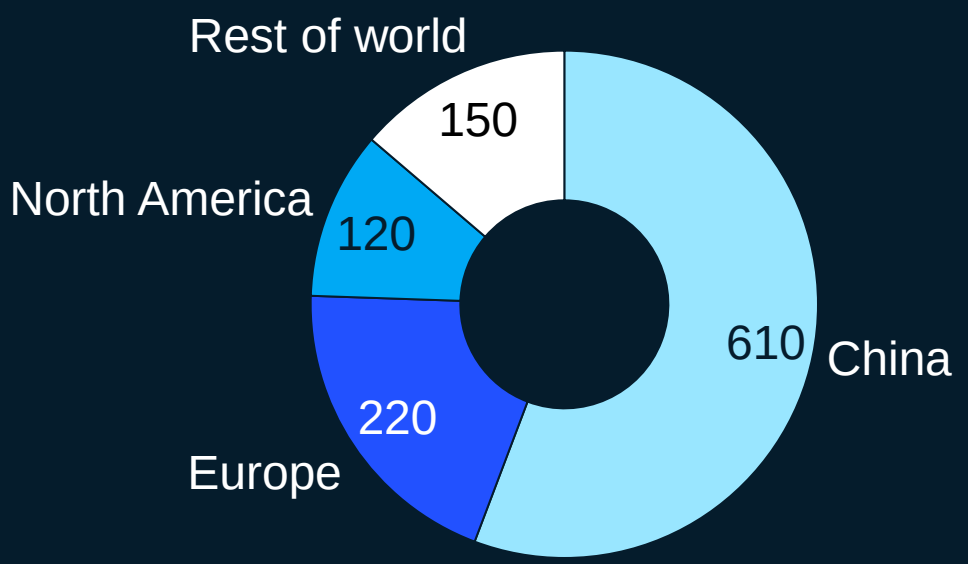
Encourage key stakeholders to increase backing of hydrogen as part of the future energy mix

Today, 1,100 MW electrolysis capacity are installed globally with China in the lead

Global cumulative installed electrolysis capacity, MW

As of Oct 18 2023



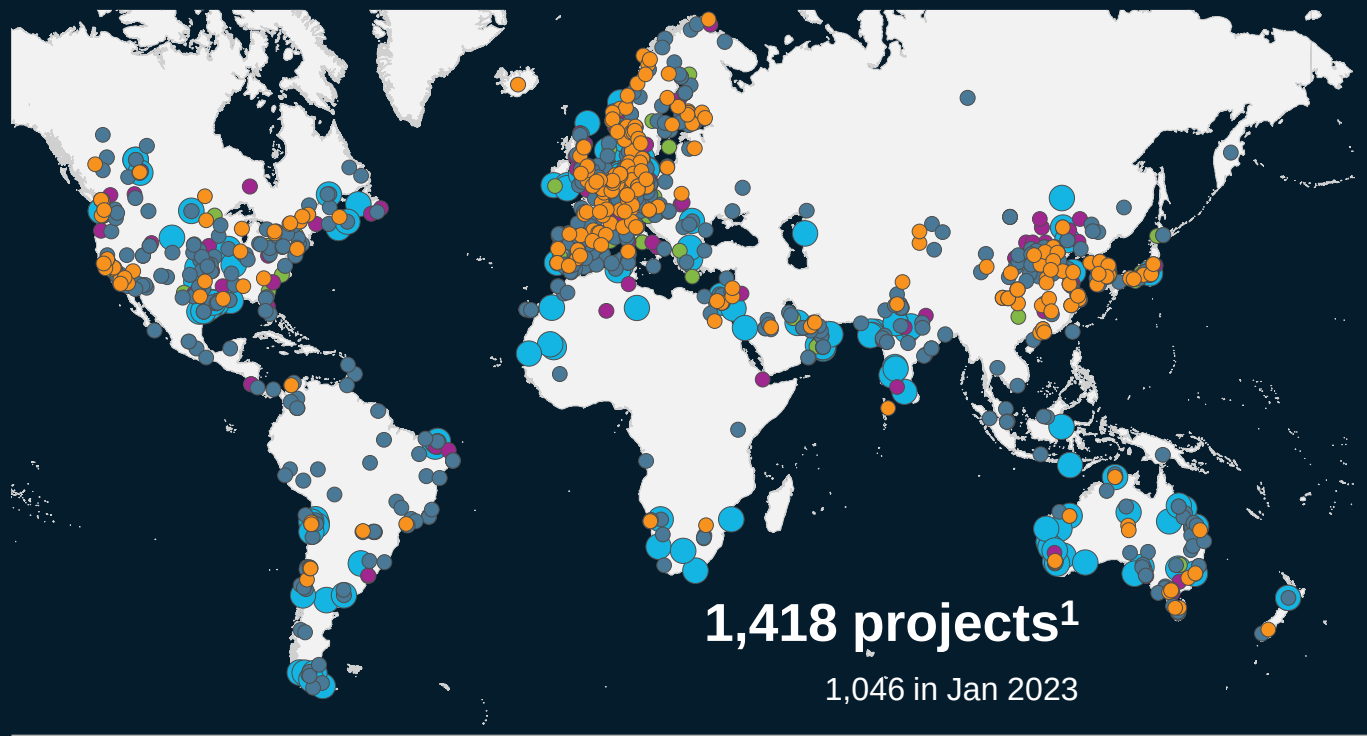


1. Growth from 2020 to 2021 driven by 150 MW Ningxia Project
2. Growth from 2022 to 2023 driven by 260 MW Kuqa Green Hydrogen Project, currently the largest operational electrolyzer

Source: Hydrogen Council; McKinsey

Hydrogen showed strong momentum in the past, more than 1,400 projects have so far been announced globally

As of Oct 18 2023



1,418 projects[1]

1,046 in Jan 2023

166	719	256	144	126
Giga-scale production	Large-scale industrial use	Transport	Integrated H_2 economy	Infrastructure projects

$570 B

investments required to develop projects announced until 2030

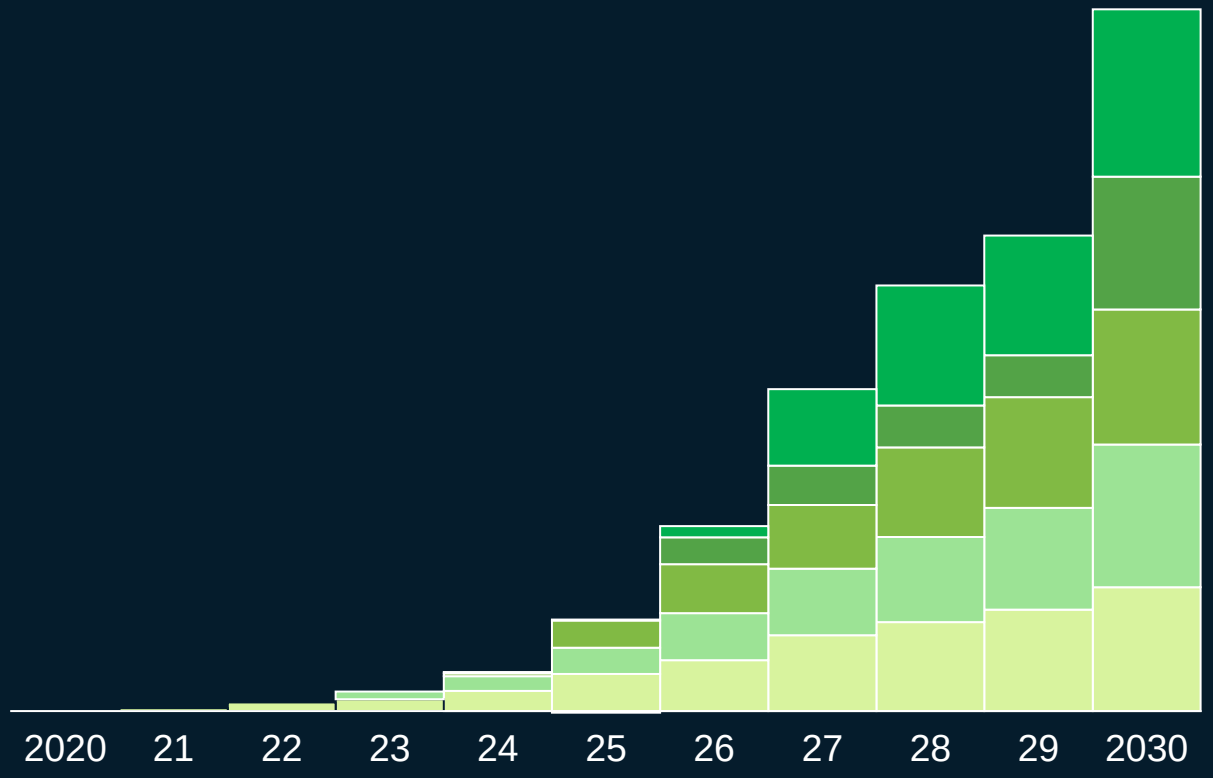
1. Project announcements below 1 MW are excluded. 7 projects have not announced project type
2. Jan 2023 values have been updated to most recent Capex estimations to keep values comparable
3. Restatement of 2023 Jan data for Japan & South Korea prevents comparison to Oct 2023 data

Source: Project & Investment tracker, as of Oct 2023, McKinsey

More than 300 GW electrolysis capacity will be installed by 2030 through the projects announced so far

Cumulative electrolysis capacity (announced)[1], GW

As of Oct 18 2023



~305 GW, Oct 2023

~232 GW, Jan 2023

~175 GW, May 2022

~115 GW, Dec 2021

~55 GW, Dec 2020

+73 GW

increase in announced electrolysis capacity by 2030 in the past 9 months

>60%

capacity announcements found in 3 regions, i.e., Europe, Latin America, and Oceania

>90 GW

announced electrolysis capacity by 2030 in Europe, the largest global region

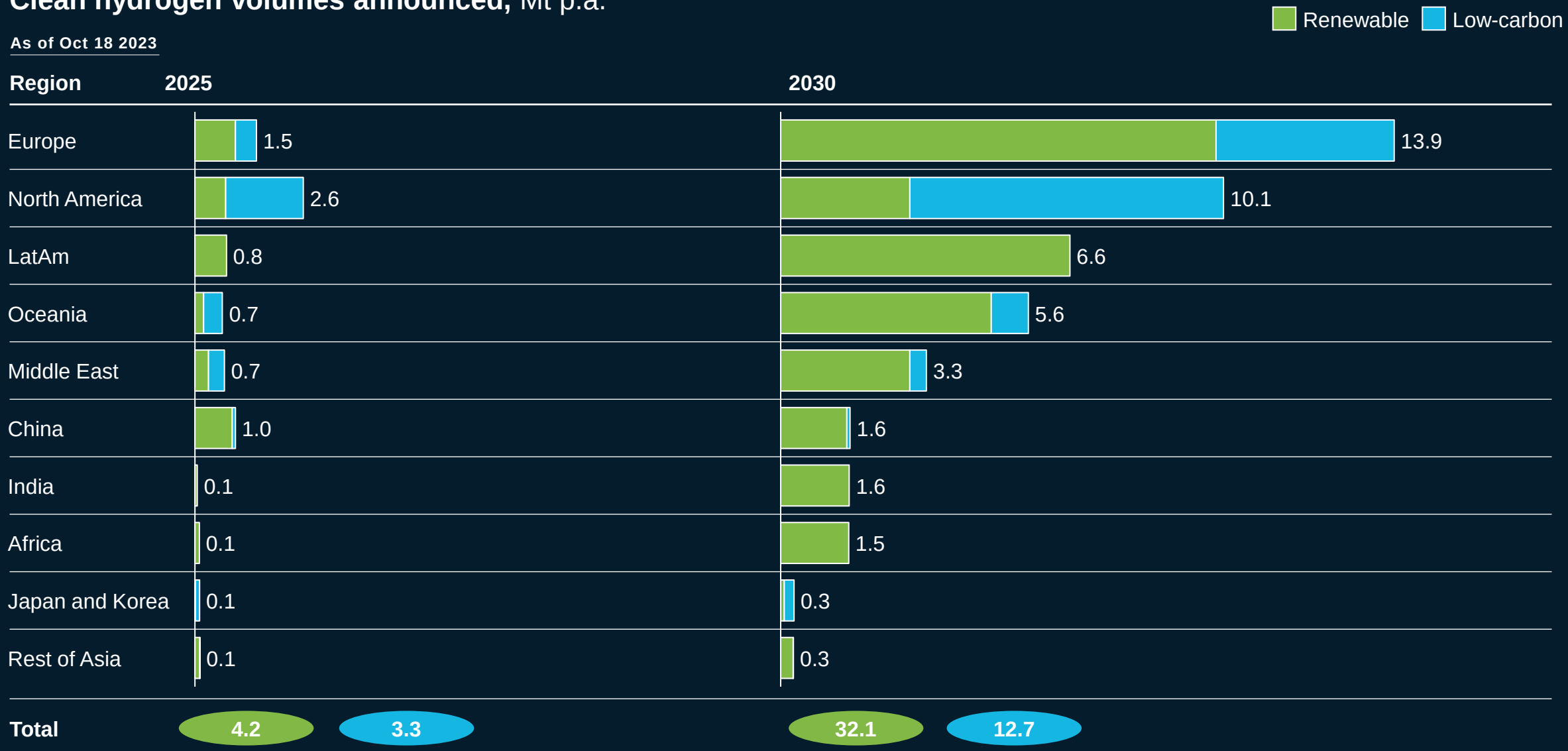
1. Announcements are based on only publicly available data; include projects that were announced in hydrogen production capacity and converted into electrolyzer capacity. For projects without known deployment timeline capacity additions were interpolated between known milestones; includes projects in all maturity stages.

Source: Project & Investment tracker, as of Oct 2023, McKinsey

Within hydrogen supply, Europe, the Americas and Oceania account for 80% of announced clean hydrogen capacity

Clean hydrogen volumes announced, Mt p.a.

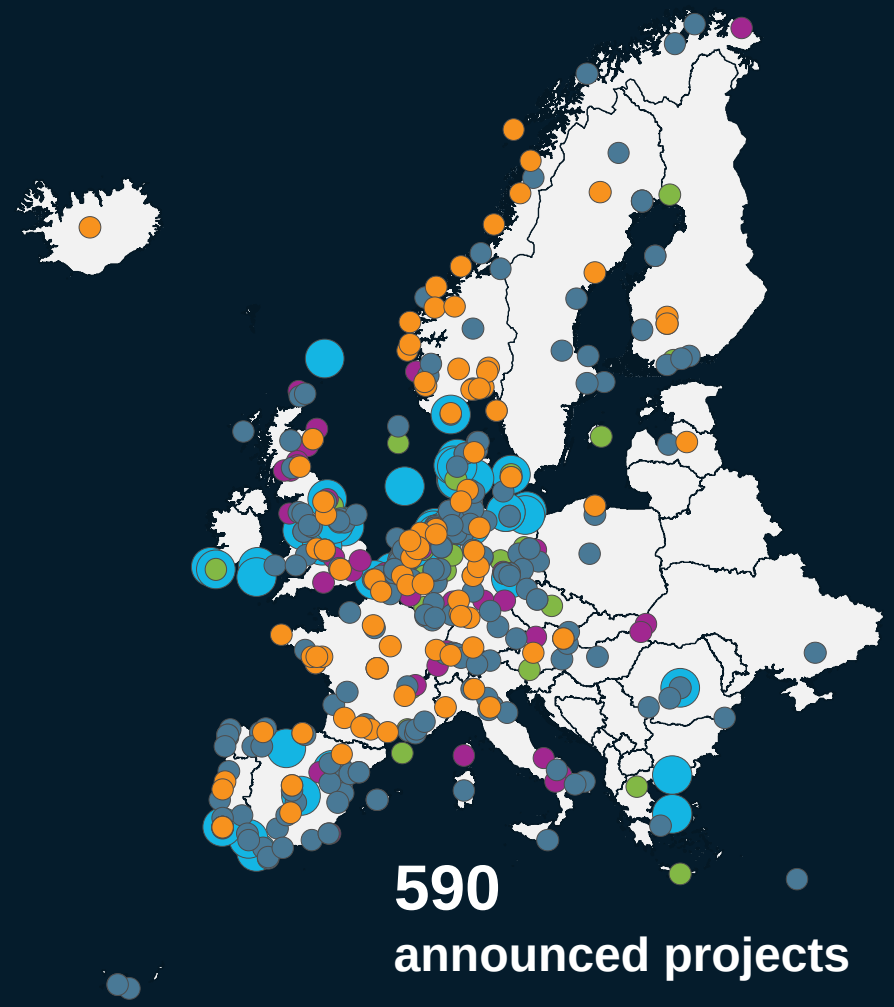
As of Oct 18 2023



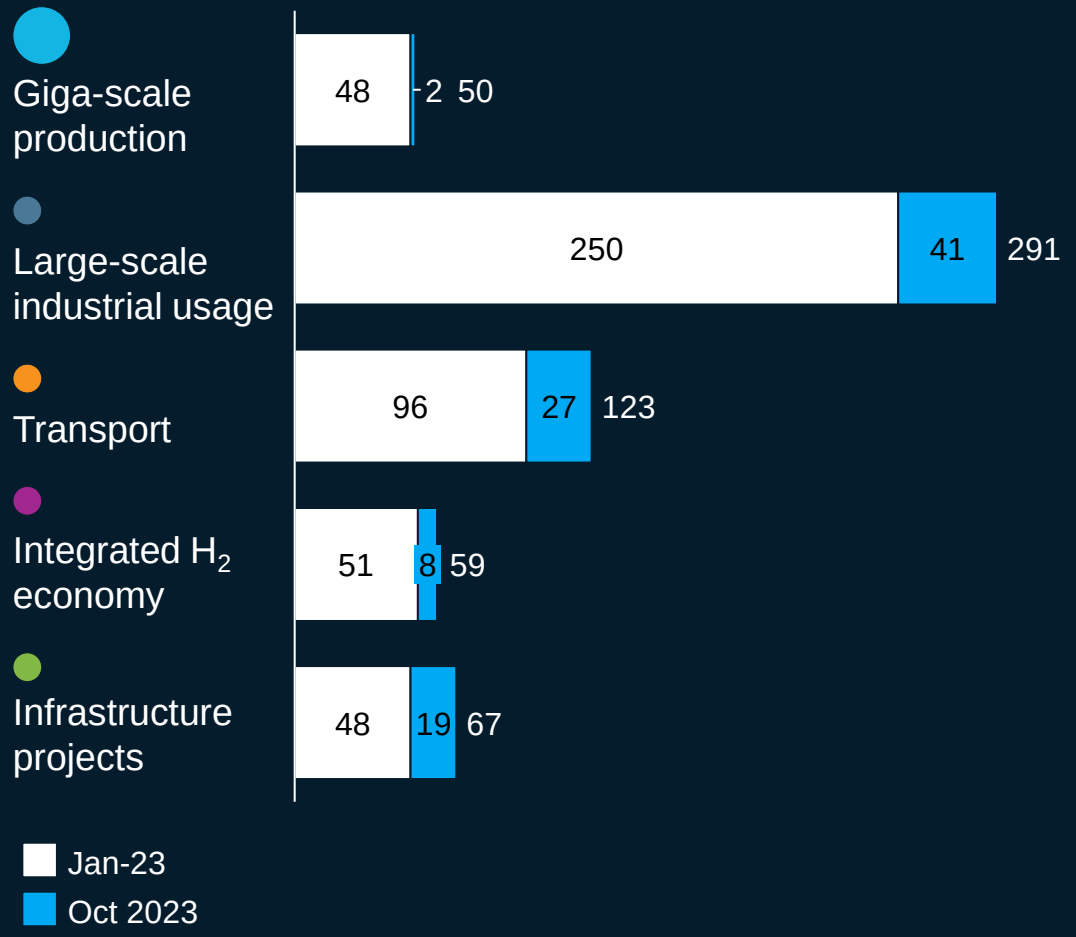
Source: Project & Investment tracker, as of Oct 2023, McKinsey

Deep dive Europe: The majority of European projects are centred around the North Sea

As of Oct 18 2023



Number of projects announced

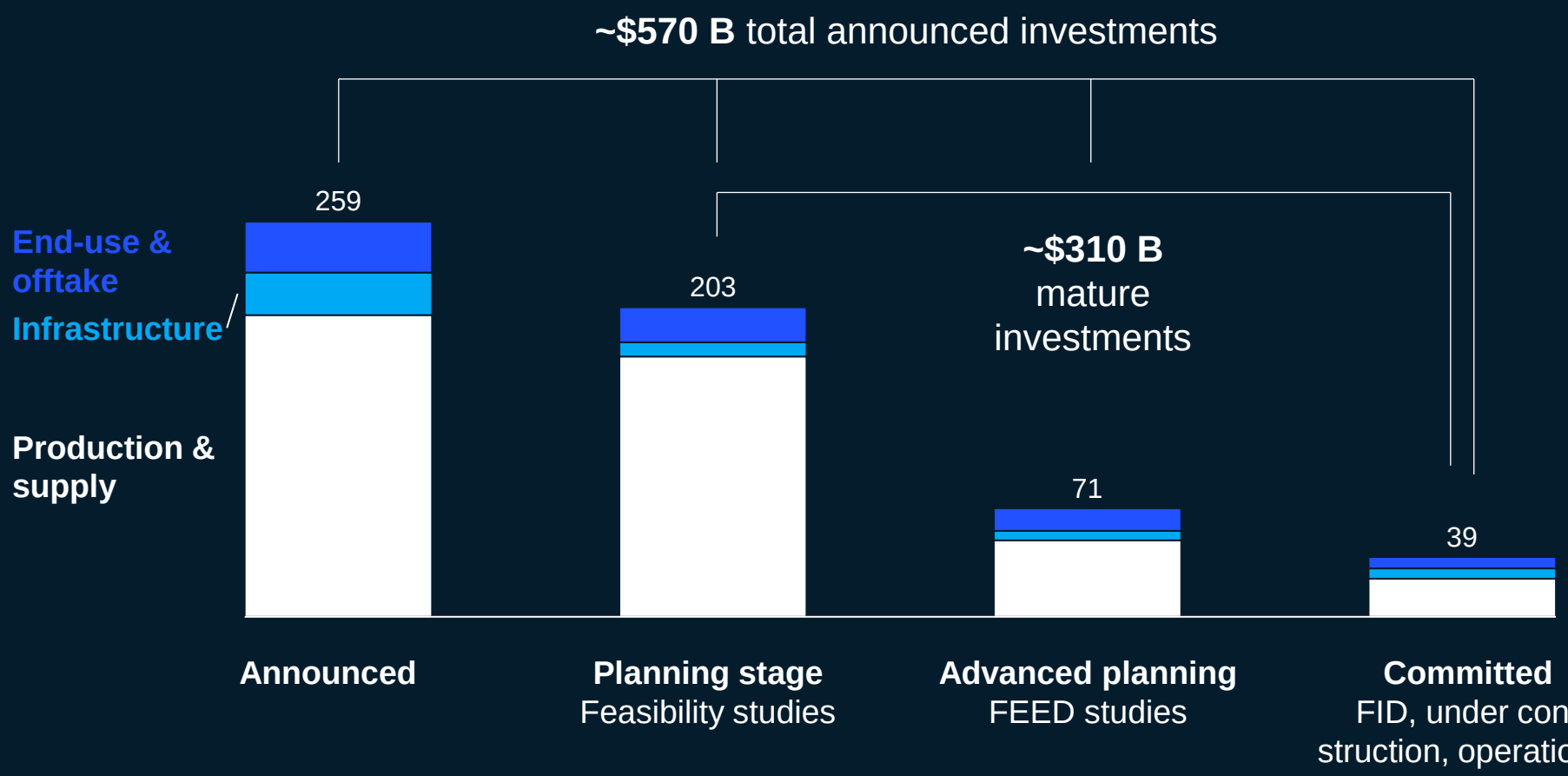


Source: Project & Investment tracker, as of Oct 2023, McKinsey

~$570 B investments have been announced so far, more than half of these can be considered mature

Direct hydrogen investments until 2030, $B

As of Oct 18 2023



Only ~7%

of Investment in FDI+

75%

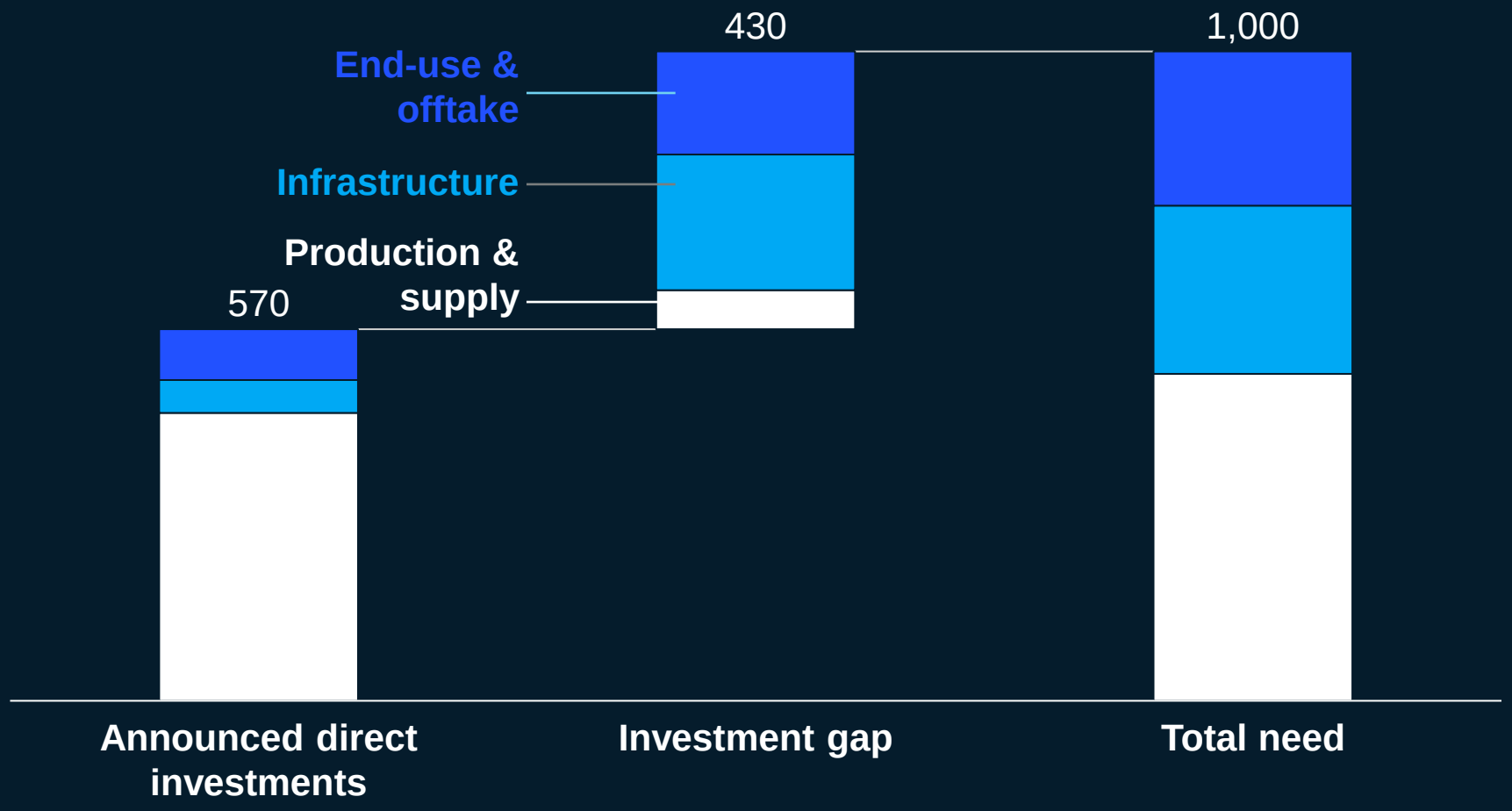
of investments focus on supply

Source: Project & Investment tracker, as of Oct 2023, McKinsey

Yet, an investment gap of $430 B remains, hence more investments are needed across all segments

Announced and required direct investments into hydrogen until 2030, $B

As of Oct 18 2023



$160 B

investment gap in end-use applications

$210 B

investment gap in infrastructure

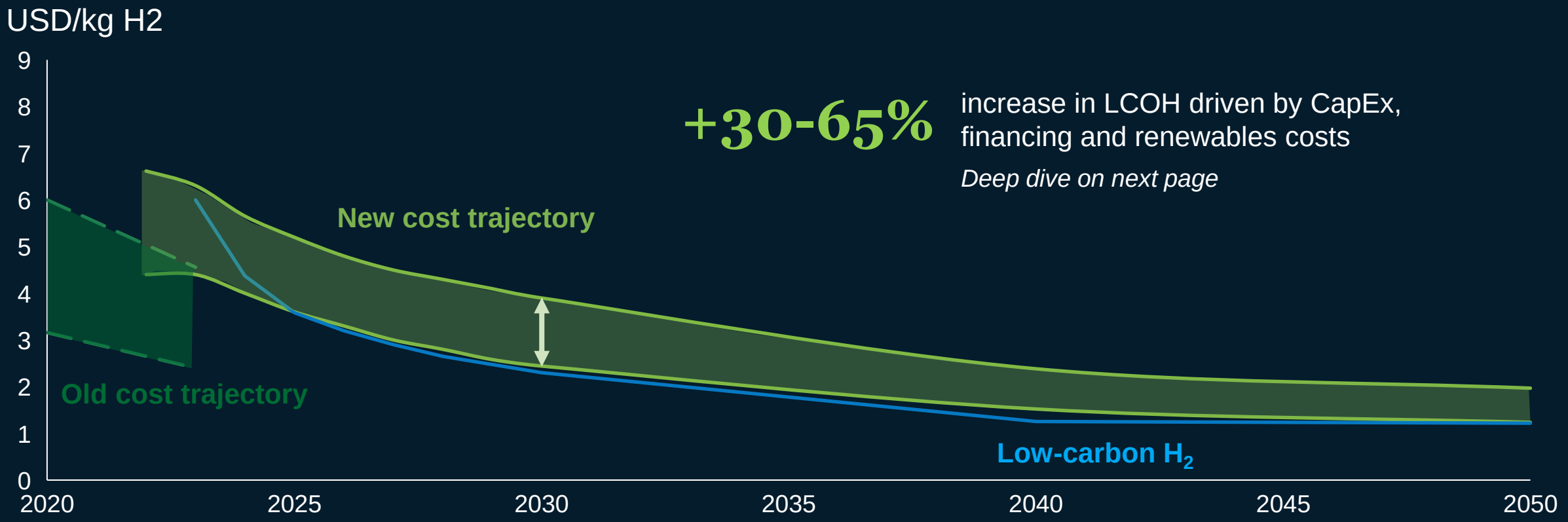
$60 B

investment gap in production and supply

Source: Project & Investment tracker, as of Oct 2023, McKinsey

Recent cost increases have driven the LCOH for clean hydrogen up by up to 65%

Global production cost for renewable hydrogen, 2023 USD/kg

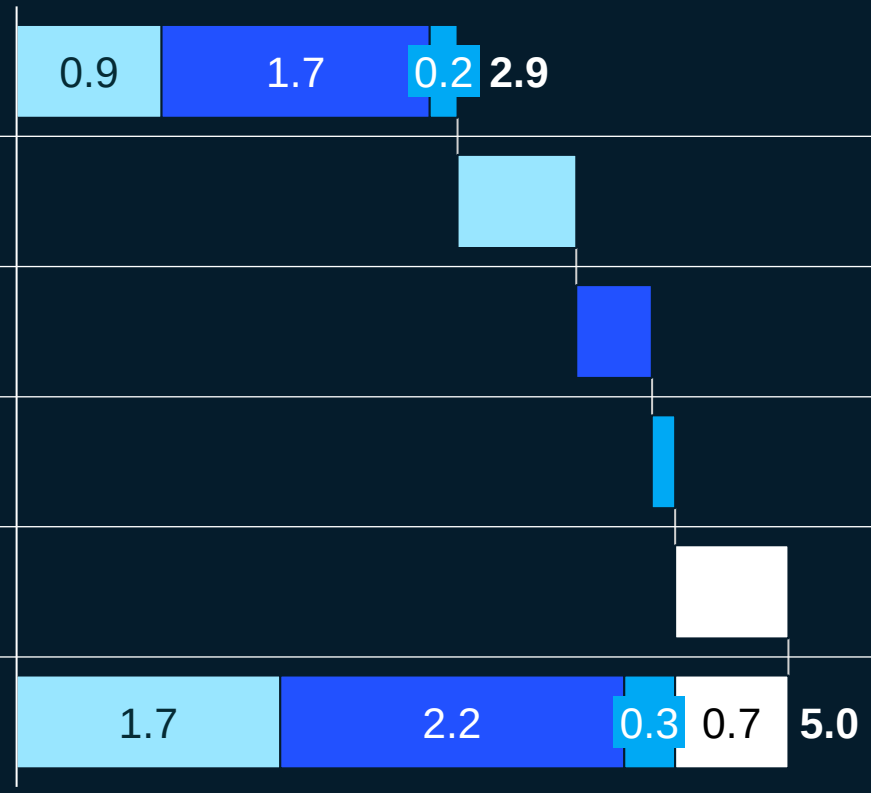


* Midpoint to midpoint increase
Low-carbon hydrogen production costs prior to 2023 have been excluded due to strong natural gas price volatilities impeding meaningful comparison. Natural gas prices continue to drive up costs of low-carbon hydrogen
Values are displayed as nominal USD of 2023
Core assumptions: Yearly production of 1 Mt of hydrogen; Dedicated solar PV and Wind capacity "behind the meter" feeding into the electrolyzer

Source: McKinsey Capital Analytics; Survey of Hydrogen Council Member FEED studies

The cost increase is mainly driven by increased CapEx and costs of capital

Levelized cost of hydrogen (US Gulf Coast example), 2023, USD/kg



Drivers of cost increase

H_2 plant CapEx	+80%	increase in CapEx driven by financing, labor, and materials
Electricity cost	+30%	increase in renewable electricity prices
H_2 plant O&M	+10%	increase in O&M driven by CapEx and labor costs
Additional H_2 financing cost	+75%	increase in cost of capital driven by 3-4% increase in risk free rate

Core assumptions: Yearly production of 1 Mt of hydrogen; Dedicated solar PV and Wind capacity "behind the meter" feeding into the electrolyzer

Source: McKinsey Capital Analytics; Survey of Hydrogen Council Member FEED studies

McKinsey & Company

Tobias Berner

Cologne

Tobias_Berner@mckinsey.com

M: +49 175 318 5578