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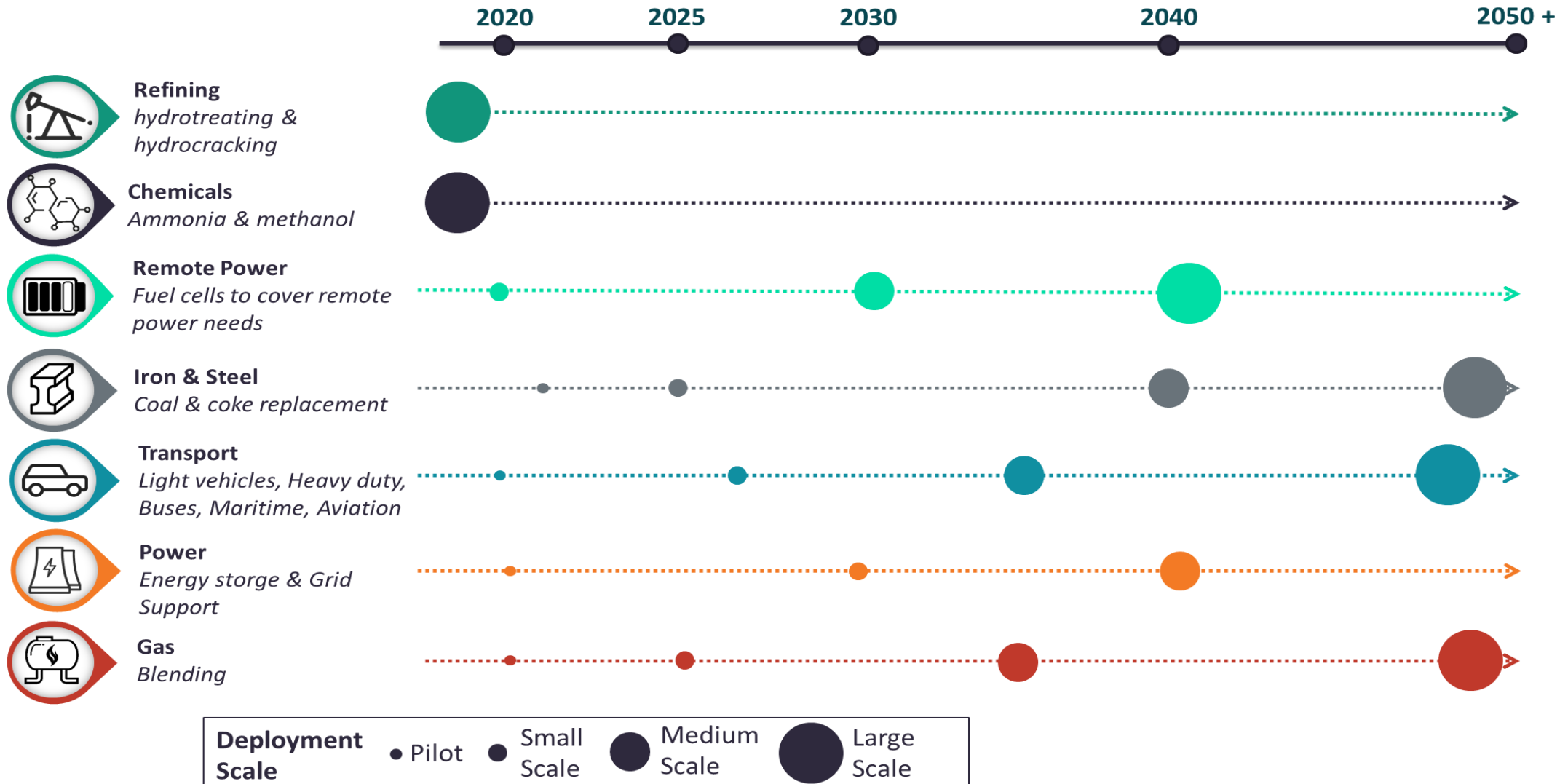
# Hydrogen Power Market

Riding the Sustainability Wave



# Industry-wise demand

Hydrogen adoption in key industries



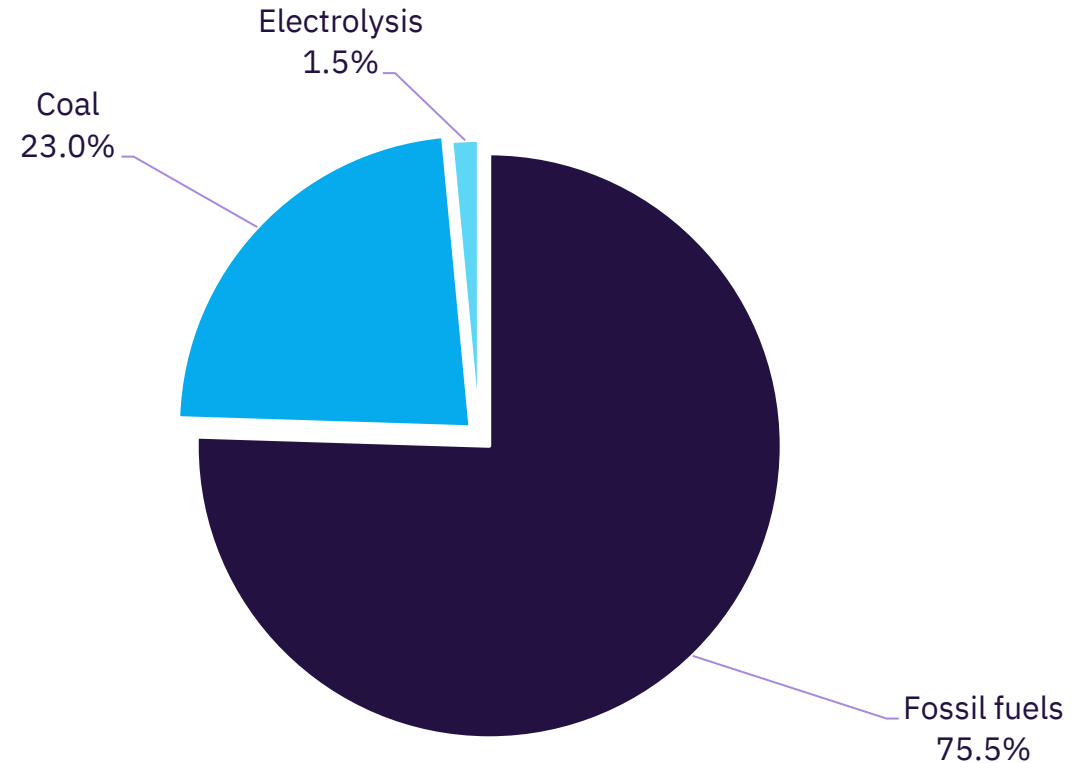
# Green hydrogen presently has a small share in the production mix...



Share of Green Hydrogen in Total Pure-Hydrogen Production Mix

- Three main technology to produce hydrogen
  - Green: water electrolysis powered by renewable energy
  - Grey: natural gas reforming
  - Blue: coal gasification with CCS
  - Brown: coal or other fossil fuels
- Most of the hydrogen produced today comes from fossil fuels and emits carbon dioxide (grey hydrogen).
- In 2020, the global hydrogen production stood at ~73 Million Tons (MT)
  - 75.5% of the hydrogen produced was Grey and Blue hydrogen
  - 23% share – Brown hydrogen due to its dominant role in China.
  - 1.5% share – from electrolysis which includes chlorine-alkali electrolysis and water electrolysis. A small fraction of less than 0.1% of the global hydrogen production comes from water electrolysis
- The share of green hydrogen is predicted to increase in total hydrogen production mix in the long run, with the expected decline in production cost.
- The major growth markets for green hydrogen include
  - Green hydrogen replacing grey hydrogen
  - New markets such as energy storage, buildings, transportation

Hydrogen Production by Source, 2020



# But is poised to increase, given the ambitious targets announced by countries

## Green Hydrogen Capacity Addition Planned/ Announced by Major Countries, Capacity and Timeline

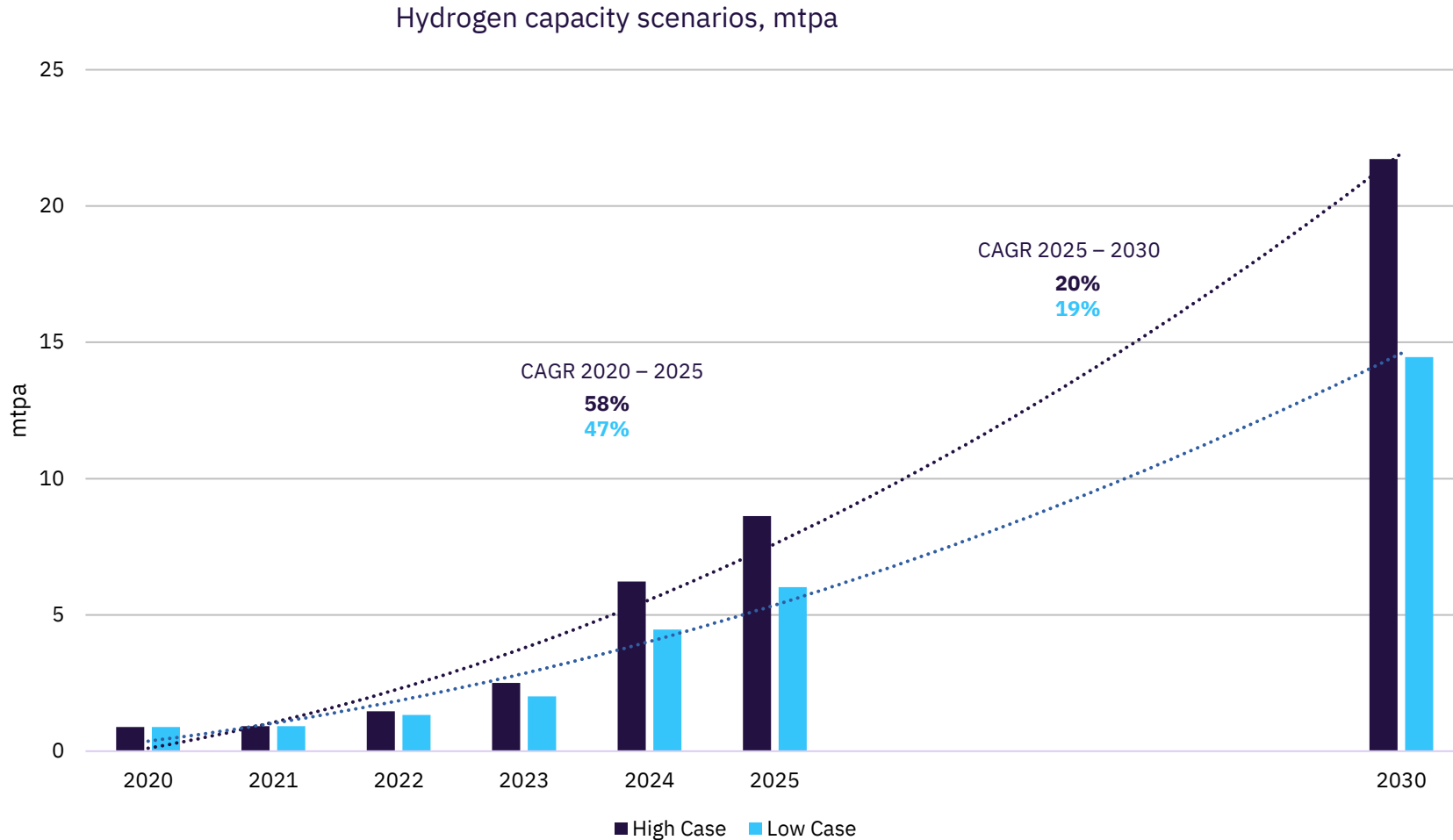
<b>European Union</b>	To increase electrolyser capacity to 80 GW (40 GW in Europe, 40 GW in neighboring countries) by 2030
<b>Netherlands</b>	500-800 MW of installed electrolyser capacity by 2025 and 3-4 GW by 2030
<b>France</b>	6.5 GW of electrolyser capacity by 2030
<b>Germany</b>	2 GW by 2025; 5 GW by 2030, and plans for an additional 5GW by 2035 or 2040
<b>Spain</b>	At least 300-600 MW by 2024 and 4 GW of electrolyser capacity by 2030
<b>Portugal</b>	2-2.5 GW by 2030
<b>Chile</b>	Target of installing 5 GW of electrolyser capacity by 2025; 25 GW by 2030
<b>China</b>	30 GW of renewable hydrogen production by 2030
<b>United Kingdom</b>	Target of 5 GW of renewable electrolyser capacity by 2030 and 10 GW by 2035
<b>Japan</b>	15 GW by 2040
<b>South Korea</b>	1.5 GW by 2022; 15 GW by 2040
<b>Australia</b>	Country level target NA; Stanwell targets 3 GW of electrolyser capacity by 2030
<b>Russia</b>	Hydrogen export target of 0.2 MT by 2024 and 2 MT by 2030

# Top 10 upcoming low carbon hydrogen plants



Plant Name	Plant Type	Country	Development Stage	Plant Capacity (ktpa)	Electrolyser Capacity, MW / CCS Capacity, mt CO2)	Start Date	Energy Source / Process	Consumer Industry	Operating Company
H2 Clean Energy Penzhinskaya Bay Hydrogen Plant	Green	Russia	Feasibility	5,000	35,120	2034	Tidal	Transportation	H2 Clean Energy, Others
Western Green Energy Hydrogen Plant	Green	Australia	Feasibility	3,500	28,000	2026	Solar;Wind	Ammonia	CWP Global, Intercontinental Energy Corp, Minning Green Energy Ltd
Svevind Energy - KINC Hydrogen Plant	Green	Kazakhstan	Feasibility	3,000	30,000	2038	Solar;Wind	Ammonia	Kazakh Invest National Company, Svevind AB
OQ InterContinental Energy Enertech JV Hydrogen Plant	Green	Oman	Feasibility	1,800	12,643	2027	Solar;Wind	Ammonia	Intercontinental Energy Corp, National Technology Enterprises Company, OQ SAOC
Asian Renewable Energy Hub Hydrogen Plant	Green	Australia	Approval	1,750	14,000	-	Solar;Wind	Ammonia	CWP Renewables Pty Ltd, Intercontinental Energy Corp, Macquarie Group Ltd, Vestas Wind Systems AS
Aman Hydrogen Project	Green	Mauritania	Feasibility	1,700	11,941	2033	Solar;Wind	-	CWP Renewables Pty Ltd, Government of Mauritania
Regional Development Agency of the Arkhangelsk Region Tidal Energy Green Hydrogen Plant Phase 2	Green	Russia	Feasibility	1,000	7,024	2027	Tidal	Transportation	Regional Development Agency of the Arkhangelsk Region, SeverGroup
Total Eren H2 Magallanes Project	Green	Chile	Feasibility	800	8,000	2031	Wind	Transportation	Meyer Burger, European Energy, Ecosolifer, Hydrogenics
Silver Frog Hydrogen Project	Green	Multiple Europe	Feasibility	800	10,000	2025	Solar;Wind	Oil Refining	Eren Groupe SA, TotalEnergies SE
H-Vision Hydrogen Project Phase 2	Blue	Netherlands	Feasibility	700	4,300,000	2031	Natural Gas	Industrial	Air Liquide SA, BP Plc, NV Nederlandse Gasunie, Royal Dutch Shell Plc, Uniper SE

# 2030 low-carbon hydrogen capacity scenarios



- Our 2030 scenarios are based on risking of the pipeline capacity that has not yet reached construction stage.
- For the high case scenario, a risk factor of 90% and 60% for post-feasibility and pre-feasibility stages was applied, as projects which have just been announced or are still in feasibility stage are less likely to be completed. Comparatively, in the low scenario 50% and 40% were taken respectively.
- The graph shows the total capacity including active projects and its projections for 2030 with the two market size scenarios.
- Presuming that with the increasing support of global policies and regional hydrogen programmes, it will be likely to hit the high case scenario having over 22 mtpa of capacity by 2030.

# National Low Carbon Hydrogen Strategies in Major Economies



Most of the G20 countries have developed a National Plan or Strategy to accelerate hydrogen deployment and transition into low carbon economies.

1. **South Africa – 2007** “Hydrogen Society Roadmap”
2. **Mexico – 2016** “National Hydrogen Plan”
3. **Japan – 2017** “Basic Hydrogen Strategy”, **2020** “Fukushima Hydrogen Energy Research Field (FH2R)”
4. **Australia – 2019** “Australia’s National Hydrogen Strategy”
5. **South Korea – 2019** “Hydrogen Economy Roadmap 2040”
6. **Morocco – 2019** “National Hydrogen Commission”
7. **Canada – 2020** “Hydrogen Strategy for Canada”
8. **Germany – 2020** “National Hydrogen Strategy”, “Regulation on Hydrogen G
9. **France – 2020** “France National Hydrogen Strategy”
10. **Russia – 2020** “Hydrogen Roadmap 2024”
11. **United States – 2020** “Hydrogen Program Plan”, “Hydrogen Strategy”
12. **Spain – 2020** “Low Carbon Hydrogen Roadmap”
13. **Netherlands – 2020** “Government Hydrogen Strategy”
14. **Portugal – 2020** “National Hydrogen Strategy”
15. **United Kingdom – 2021** “Hydrogen Strategy”
16. **Hungary – 2021** “National Hydrogen strategy”
17. **Czech Republic – 2021** “Hydrogen Strategy”
18. **India – 2021** “National Hydrogen Mission”
19. **Poland – 2021** “Hydrogen Strategy”



# Summary



1

## Hydrogen with an unprecedented momentum

- Last year hydrogen stock prices increased almost 150% as consequence of political and business support around the world which had been thriving rapidly. 2020 was a pivotal point for accelerating hydrogen R&D and investments as many countries targeted an economic recovery through sustainable investment.
- There is a need to accelerate transition strategies across sectors and geographies to achieve climate global goals, and hydrogen development is expected to be a major solution to facilitate accomplishing the targets.

2

## 2021 hydrogen market analysis

- The global low-carbon hydrogen project pipeline now represents over 47 mtpa of potential capacity. Significant additions in Q4 2021 included the ninth largest proposed project in the world announced by Chile adding 0.8 mtpa to the pipeline. Altogether, Australia, the US, and Chile added 3 mtpa to the pipeline in Q4.
- Based on risking of projects still yet to be confirmed, our high and low case scenarios give high and low scenario capacities of 24 and 16 mtpa for 2030. The difference on its CAGR for 2020 – 2025 is expected to be 59% and 48% for high a low scenarios respectively, whereas for 2025 – 2030 a projection of 23% and 21% are expected for the same cases.
- Hydrogen M&A, venture finance deals and partnerships have been increasing comparatively as part of increasing investments and opening market.

3

## Importance of policy support

- Three countries and two local governments released new hydrogen plans in Q4 2021.
- Interest in hydrogen is not limited to developed nations. Developing nations have also shown interest in the potential benefits of hydrogen and have started supporting its research and development with policies, incentives and development roadmaps.
- There also exists some geopolitical trends in which some regions as Europe and Oceania have given more support and have specific programmes to position themselves as top competitors and attract investments.



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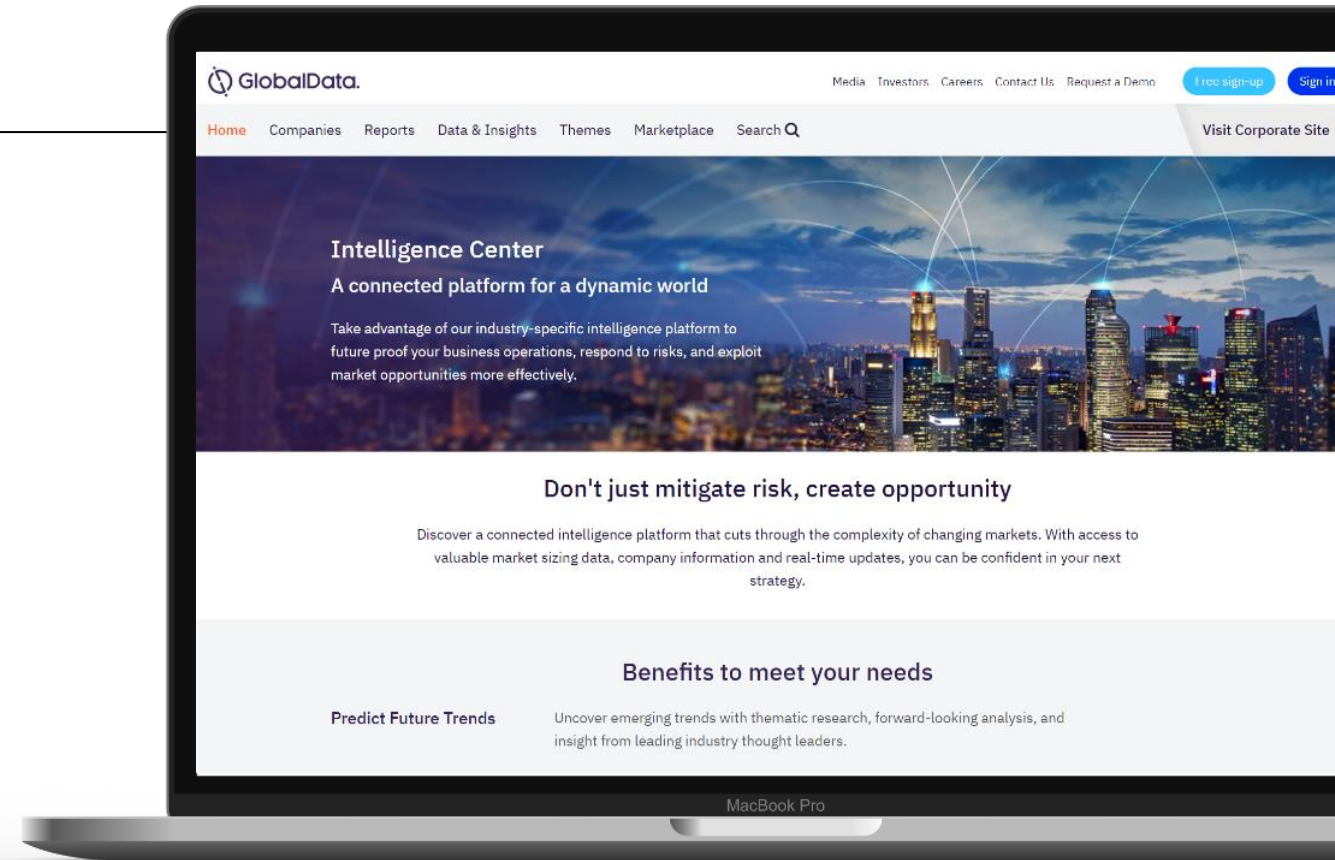
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