Hydrogen Council

McKinsey & Company

The Africa Hydrogen Opportunity

The potential, practical challenges, and possible unlocks

March 2024

Published in March 2024 by the Hydrogen Council. Copies of this document are available upon request or can be downloaded from our website:
www.hydrogencouncil.com

This report was authored by the Hydrogen Council in collaboration with McKinsey & Company. The authors of the report confirm that:

1. There are no recommendations and / or any measures and / or trajectories within the report that could be interpreted as standards or as any other form of (suggested) coordination between the participants of the study referred to within the report that would infringe the EU competition law; and,

2. it is not their intention that any such form of coordination will be adopted.

Whilst the contents of the report and its abstract implications for the industry generally can be discussed once they have been prepared, individual strategies remain proprietary, confidential, and the responsibility of each participant. Participants are reminded that, as part of the invariable practice of the Hydrogen Council and the EU competition law obligations to which membership activities are subject, such strategic and confidential information must not be shared or coordinated – including as part of this report.

The **Hydrogen Council is a global CEO-led initiative** that brings together leading companies with a united vision and ambition for hydrogen to accelerate the clean energy transition. The Council is committed to unlocking the sustainability potential of hydrogen through coalitions for action, boosting sustainable economic growth, creating quality jobs, and delivering social value.

The Hydrogen Council brings together a diverse group of **140 companies from North America to Asia-Pacific, Europe, Africa and MENA region,** across the entire hydrogen value chain, including large multinationals, innovative SMEs, and investors. Today, the Council represents **$9 trillion in market capitalization, 6.8 million FTEs and $6.4 trillion in revenues.**

Executive summary

Africa enjoys **world-class renewable resources,** with capacity factors up to 69% for wind power and 25% for solar power, as well as excellent geothermal and hydro resources, coupled with abundant land area. Consequently, the continent is **strongly positioned to become a renewable hydrogen and derivatives producer and exporter.** Using these renewable resources to produce hydrogen for both the domestic market and export (either as pure hydrogen or as derivatives – ammonia, synfuel, hot briquetted iron, and others) could create a **win-win opportunity for all stakeholders.**

Europe and parts of Asia are expected to require significant imports of renewable hydrogen and its derivatives by 2050.[1] With the right enabling conditions and if African countries can capture 15% of the expected globally traded hydrogen volume, renewable hydrogen production for export could grow from 1 million tonnes per annum (Mtpa) in 2030 to 11 Mtpa in 2050. Renewable hydrogen production could mobilize a cumulative investment of USD **400 billion.** This would increase African export value by USD 15 billion in 2050 and create a cumulative **13 million job-years by 2050,** and could also **enable the faster deployment of renewable power for domestic use at lower costs.**

However, **under current circumstances,** Africa's higher country-level risk and project execution risk are driving up financing costs, making **the expected hydrogen production cost of African countries higher than those in the Middle East and Australia.** Indeed, while there are projects on the continent in the announced and planning stages that correspond to investments of USD 50+ billion by 2030, the **African hydrogen project pipeline is less mature** than the global average. In Africa, only about **5% of project investment volume** is at the **front-end engineering design and further (FEED+) stage,** compared with 20% globally. What's more, only **1% is past the final investment decision (FID),** compared with 7% globally.

There is therefore an opportunity for stakeholders to realize Africa's hydrogen potential for its citizens and for the world. Stakeholders could consider taking one or multiple of several actions to **reduce cost of financing, leading to increased chance of project success.** These include securing off-take agreements, securing hardware supply, putting in place shared infrastructure, identifying and working with capable engineering, procurement, and construction (EPC) suppliers, making use of political risk insurance, and structuring and making available concessional finance.

1 Under a scenario of ambitious climate action, this would mean 7 Mtpa by 2032, 30 Mtpa by 2040, and 72 Mtpa by 2050

Exhibit 1

Africa's abundant renewable resources make it well positioned for producing hydrogen

Africa has strong comparative advantages in clean hydrogen production. It has world-class renewable energy sources (RES) for low-cost energy production, which are necessary for achieving competitive clean hydrogen production costs. Several Northern and Southern Africa countries enjoy a favorable mix of both solar and wind resources. Other countries in Central Africa have the potential for hydroelectric power expansion, and the region of the East African Rift Valley has the potential for geothermal development.

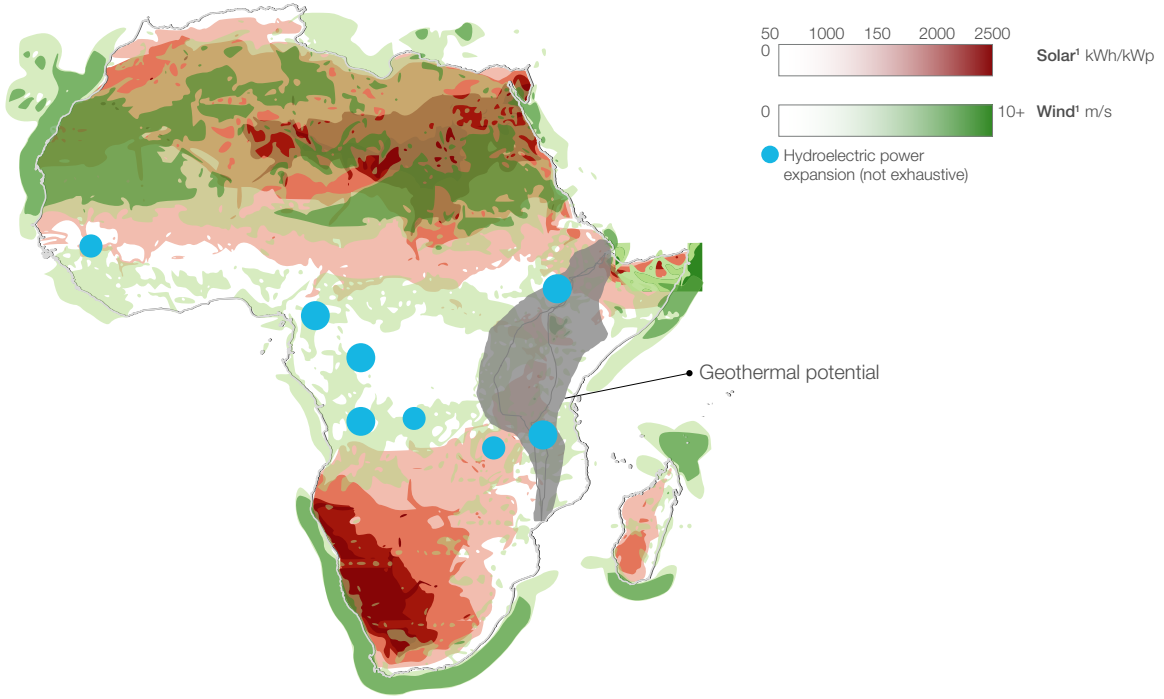
The wind and solar capacity factors of selected African countries could exceed those of many other aspiring producer regions around the globe, with only selected areas in Australia, Chile and China possessing higher wind and solar capacity factors. The capacity factors of Mauritania, Namibia, and Morocco (among the best African locations) are overall about 20% higher than those of Iberia, Canada, and the Middle East, which have established significant momentum in building hydrogen hubs.

Additionally, the locations for low-cost RES in Africa often see less competition for other uses, lowering implementation barriers compared with some other geographies (e.g. Europe). As Africa taps more local renewable energy sources for hydrogen production, the total will still represent only a small part of the continent's renewable energy build-up potential. For example, even at 1% of land utilization, the African potential in solar power is approximately 8 terawatt (TW) and in wind 0.5TW.[2] Consequently, building a hydrogen export project here would not have an adverse impact on domestic energy supply. Furthermore, it could have positive spill-over effect on domestic power supply. Hydrogen production can act as a secure off-take of renewable energy, and it facilitates additional and larger scale RES deployment. Local players can gain experience supplying the hydrogen production industry and later utilize their skills in energy production for domestic demand.

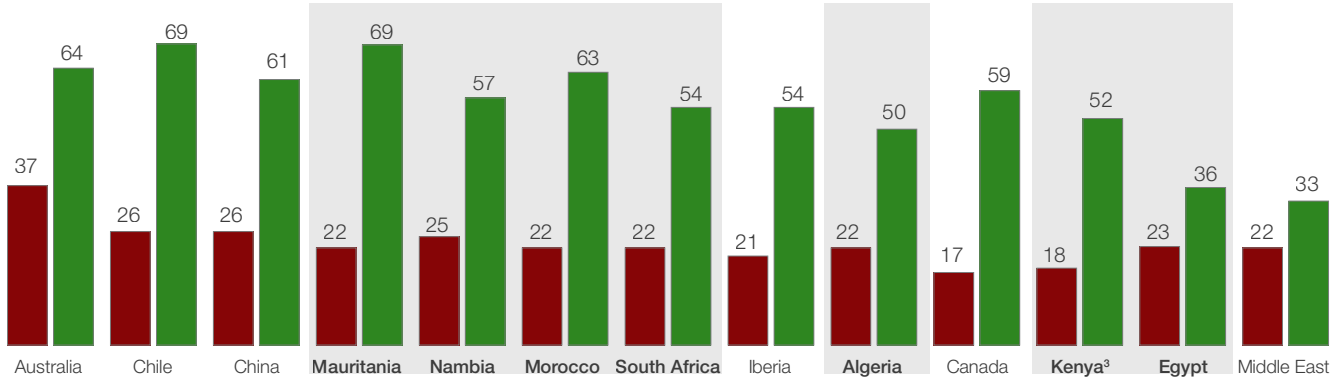
In locations where water is scarce, seawater can often be desalinated as a supply for electrolysis. In such cases, the release of saline brine to the sea must be done with care to prevent disturbance of the local environment.

2 IRENA, Renewable Energy Market Analysis: Africa and its regions, 2022. p. 41-43

Renewable energy potential map



Capacity factors (%) for top-decile RES areas[2]



1. Solar power potential (in kWh/kWp) and wind power potential at 100m height above ground (m/s)
2. Ranking of countries by 50:50 weighted average of capacity factors for the separate top 10% solar power and top 10% wind power location in the selected country
3. Has additional geothermal energy potential; capacity factor not stated

Source: McKinsey Energy Solutions (2023), IHA (2023), ThinkGeoEnergy (2023)

Exhibit 2

Africa can serve part of the sizeable global hydrogen demand

Because hydrogen demand is projected to grow over time,[3] several regions will likely be unable to produce enough hydrogen to satisfy domestic demand and thus will require imports. Globally, total required imports could expand from 7 Mtpa in 2030 to 72 Mtpa in 2050. Main importing regions are expected to be Europe and parts of Asia. North America, Australia and Latin America are expected to have hydrogen surplus and would not receive imports from Africa.

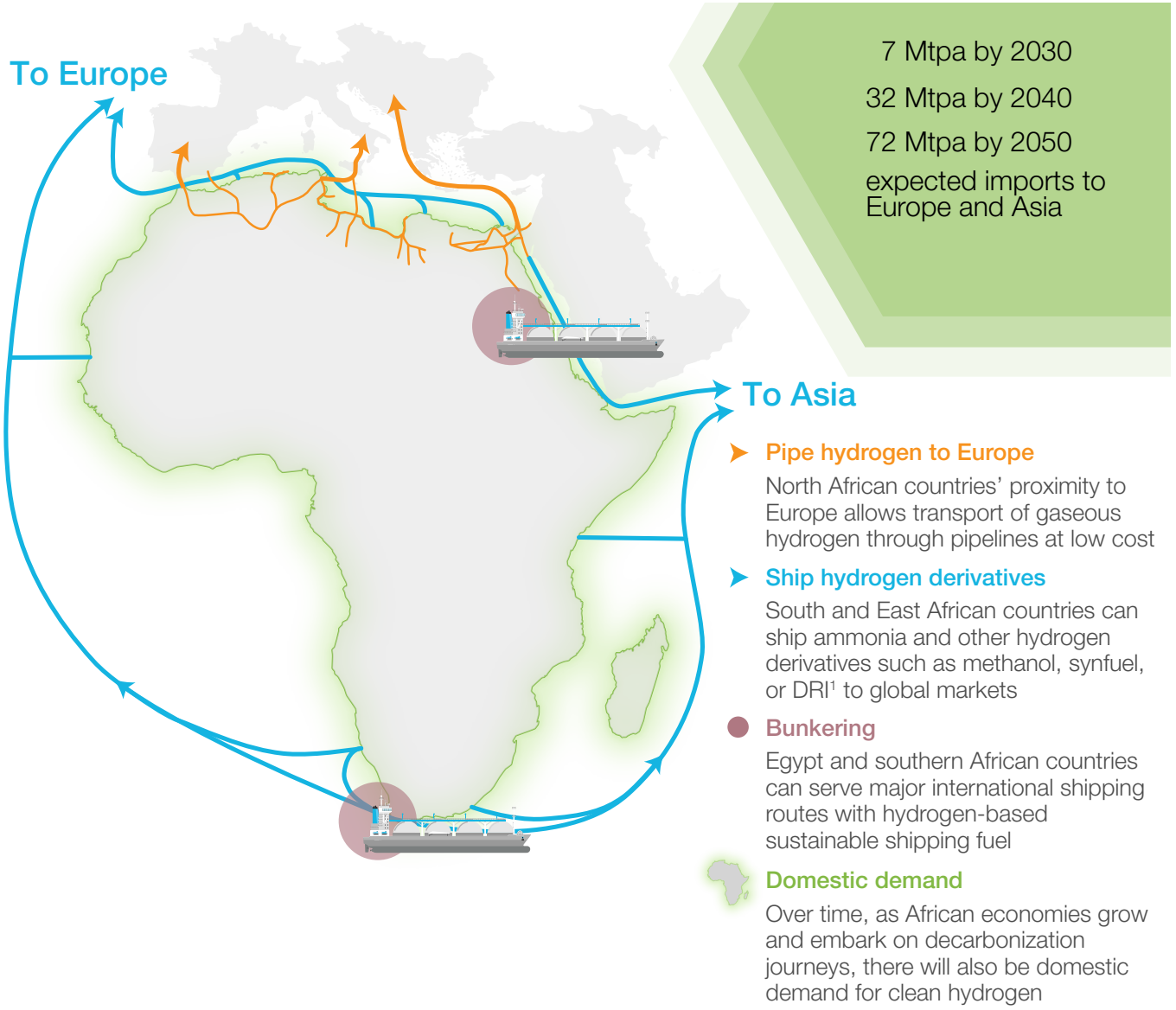
It is essential to have a stable off-taker for the development of new hydrogen industries. An early focus on exports to European and Asian demand centers can provide a steady basis for Africa to initiate hydrogen production.

The geographical proximity of North African countries to Europe presents an opportunity for the direct piping of gaseous hydrogen. At scale, this is the lowest-cost form of hydrogen transport, significantly improving the landed costs of hydrogen imports from Africa to the European continent. The build-up of hydrogen pipeline infrastructure[4] is essential for this purpose, and continued collaboration between infrastructure players and producers is instrumental to make these projects materialize.

Southern and Eastern African countries could enter the hydrogen export market through the local production of hydrogen derivatives like ammonia, methanol, synfuels, and direct reduced iron (DRI). Low-cost hydrogen and, when available, CO_2 and iron ore, could form a competitive basis compared with other global producers (although CO_2 and iron ore can also be imported).

In addition to these export opportunities, several African ports could be well positioned to serve as bunkering locations for sustainable shipping fuels due to their presence along major shipping routes, such as South-Asia to Europe through the Suez Canal. Based on existing global shipping routes, an estimated 12% of global shipping traffic could bunker its sustainable marine fuels in Africa.[5]

Over time, the domestic hydrogen consumption in Africa could increase, leading to further scaling of production.



1. Direct Reduced Iron

3 We are using the "further acceleration" scenario from Hydrogen Council, McKinsey Global Hydrogen Flows Model. For scenario selection and discussion, please see Global Hydrogen Flows 2023 Update

4 Pipelines would likely be the most cost-effective mode of hydrogen transport from Northern Africa to Europe. Africa serving European demand implies interconnecting pipeline infrastructure across the Mediterranean

5 McKinsey DeepBlue

Exhibit 3

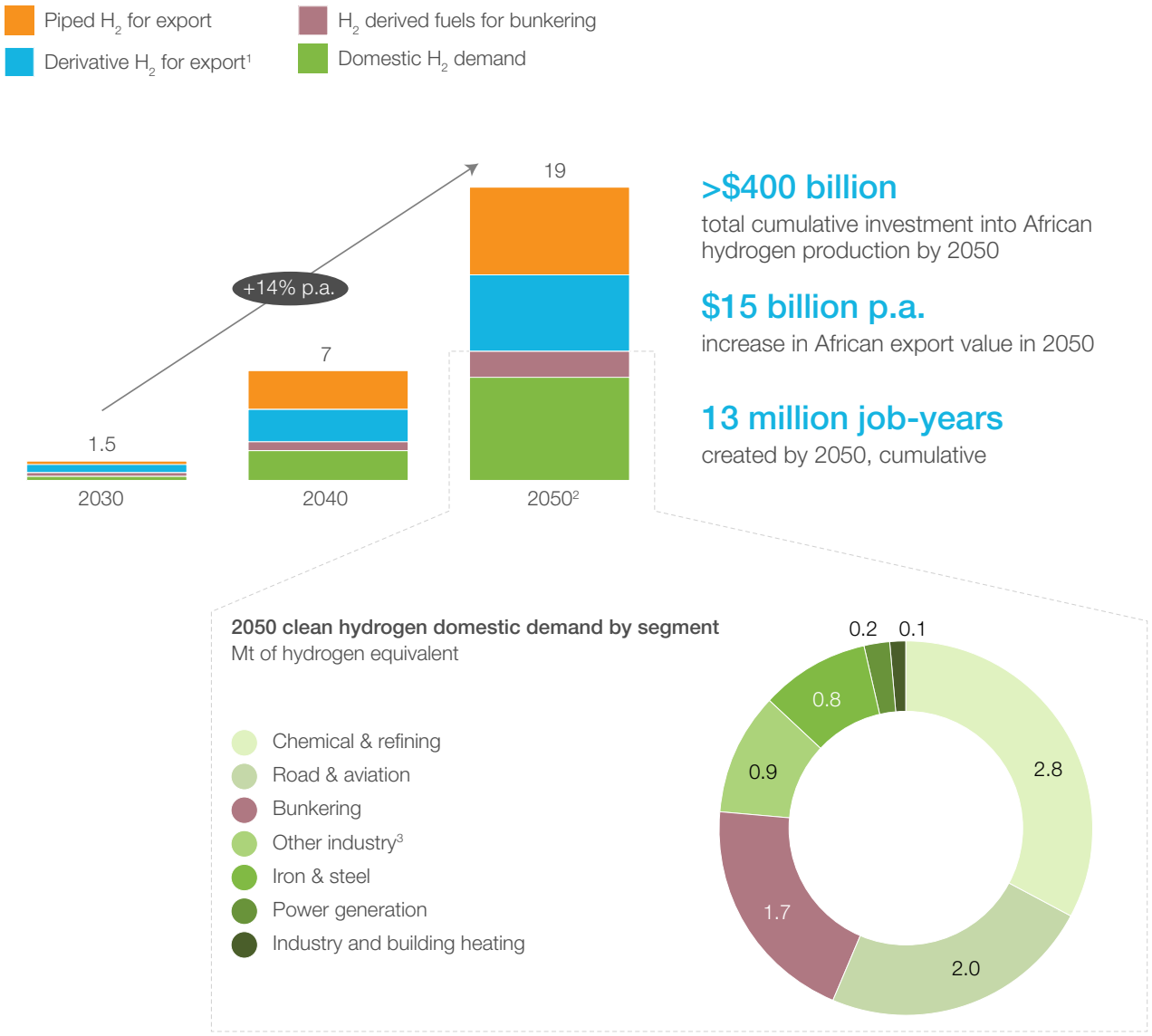
If Africa supplies 15% of global hydrogen exports, it could create about 13 million job-years and USD 15 billion in annual export revenue; investments through 2050 would total over USD 400 billion

If Africa were to capture an estimated 15% of the trade volume[6] of clean global hydrogen and derivatives as a result of competitive pricing and import diversification strategies in a global commodity market, this would then translate into 1 Mtpa of hydrogen equivalents exported to Europe and Asia in 2030, which would grow to 5 Mtpa in 2040 and 11 Mtpa in 2050. In addition, the bunkering of hydrogen-derived fuels on main shipping routes could provide a 2 Mtpa opportunity in 2050.

To achieve an African hydrogen economy of this size, total additional capital of over USD 400 billion would be required. The industry could generate a total of 13 million new job-years[7] by 2050, including jobs linked to both the construction and operation of renewables sites, hydrogen production facilities, conversion plants, and export infrastructure. Combined, all hydrogen product exports could increase Africa's export value by over USD 15 billion annually by 2050.[8] Investments in the sector are expected to accelerate over time, resulting in over 90% of the investments occurring after 2030.

In terms of domestic demand, 75% of hydrogen consumption in Africa could be in chemicals, refining, and transportation, covering a total consumption of 6.5 Mtpa by 2050, bringing further benefits to local economies.

Potential hydrogen production in Africa, Mtpa



1. Includes ammonia, methanol, LOHC, DRI and liquefied hydrogen
2. Implies African market share of 15% of globally traded volume in 2050
3. Cement, non-ferrous metals, mining, manufacturing, construction, food and tobacco, agriculture/forestry, and other non-specified industry

Source: Global Hydrogen Flows Model (December 2023), McKinsey Global Energy Perspective (2023), McKinsey DeepBlue (2023), for job-years created McKinsey I3M model by Vivid Economics

6 Based on the Further Acceleration scenario and applying a constant African market share for global hydrogen trade after 2040
7 'Job-year' stands for a full-time equivalent work done by one person over one calendar year, includes both direct and indirect jobs
8 Based on total export volume multiplied by the levelized cost of hydrogen for this product

Exhibit 4

Higher hydrogen production costs result from the increased cost of capital in developing countries

Hydrogen projects are very sensitive to financing cost since over 80% of the levelized cost of hydrogen (LCOH) comes from annualized capital expenditures (capex), including renewables and electrolyzers. Given the capital-intensive nature of hydrogen projects, a 6 percentage point increase in the weighted average cost of capital (WACC) could increase LCOH by 50% or more. This is less pronounced for low-carbon hydrogen, where the LCOH is dominated by natural gas prices and capex investments often are limited to the carbon capture installation.

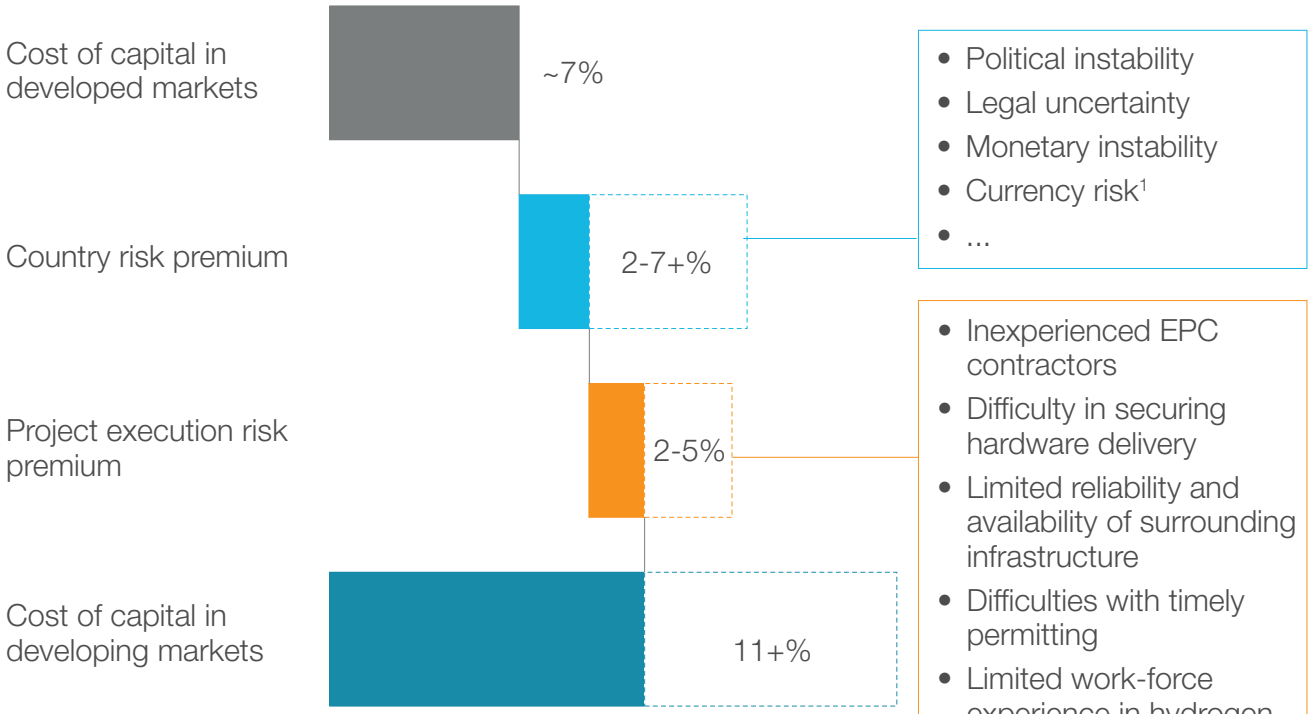
Higher financing costs are often observed in developing markets compared with developed markets. The higher costs of capital lead to increases in expected LCOH in developing markets, resulting in their lower competitiveness on hydrogen production costs.

Higher financing costs often result from additional project risks in developing markets. These can be divided into country risk and project execution risk.

Country-related risks. Risks include legal uncertainty and political and monetary instability, which have the greatest tendency to generate volatility. These are often hard-to-mitigate risks, thought insurance and hedging can provide some relief.

Project execution risks. These risks often result from less experienced contractors, the limited reliability of surrounding infrastructure, difficulty in securing the delivery of key hardware, and limited workforce experience in the hydrogen industry.

Drivers for the cost of capital for hydrogen projects in developed vs. developing countries[1]



6pp increase in **WACC** can lead to **50+%** increase of **LCOH**

1. Currency risk is limited to local operational costs when having international currency based off-take agreements

Source: Expert interviews, October 2022

Exhibit 5

The African project pipeline has an estimated 5% investment volume in FEED+ compared to about 20% globally

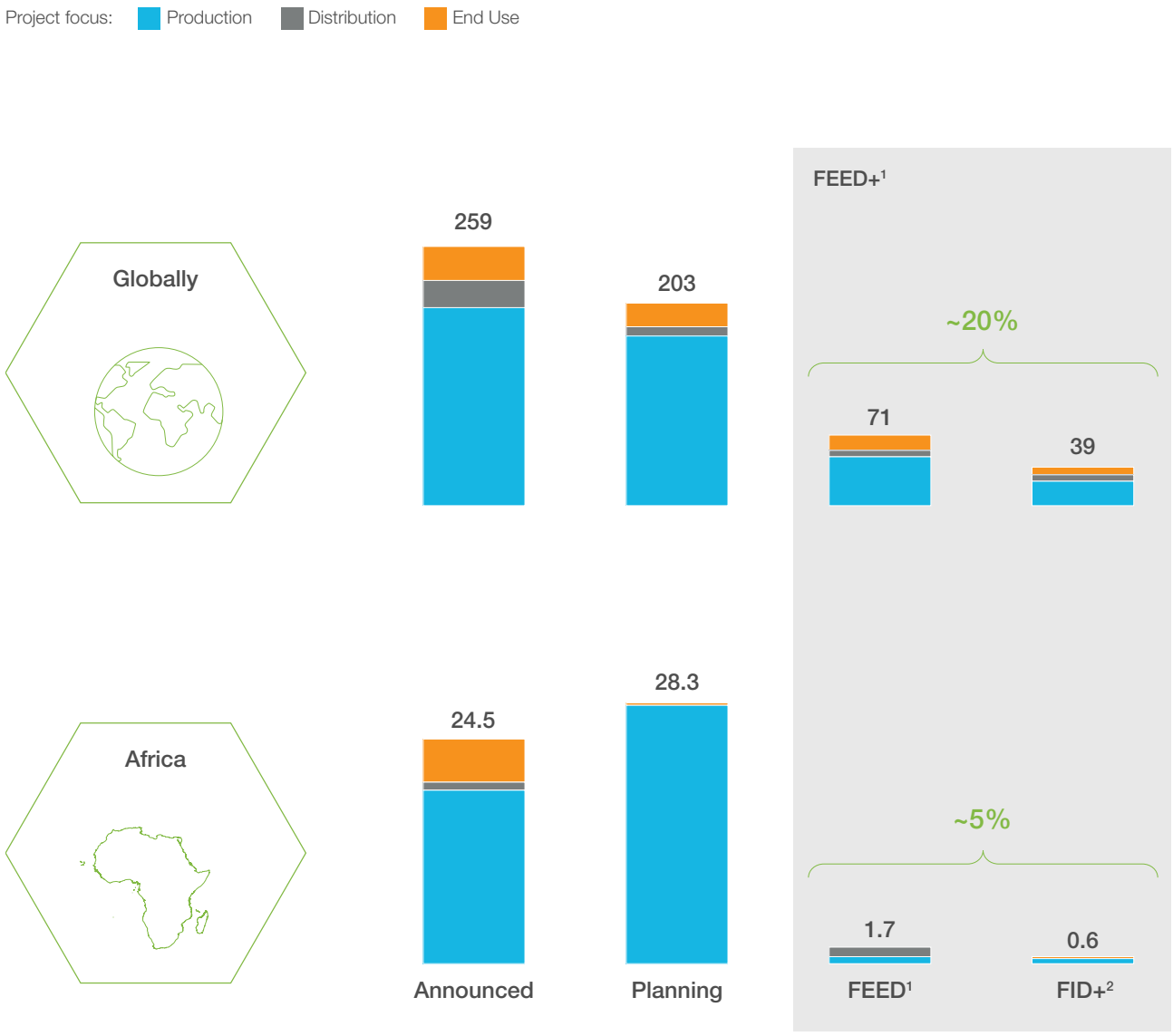
The African hydrogen project pipeline is less mature than the global average. Projects beyond the planning stage account for only 5% of the total project pipeline, based on projected investment volumes. For the world overall, projects at FEED+ stages exceed 20% of the total. This share is even higher in mature markets where, for example, North America reaches over 40% at FEED+, and even 15% at FID+ alone.

With FEED-stage projects making up just under 3% of Africa's total project pipeline compared with the global 12%, successful unblocking actions at this project stage will be crucial to ensure a maturing of the African project pipeline. Looking at the structure of the pipeline, only Latin America is in a similar position. Almost all other geographies have more mature project pipelines, with larger shares of projects in the FEED+ stage. Oceania (including Australia), which has ambitious plans to compete for the global export market, already has over USD 7 billion in FEED+ investments.

Even though Latin America experiences similar project progression hurdles as Africa, the Latin American project pipeline is significantly larger, with an additional USD 30 billion in pre-FEED stages.

As the African pipeline matures, it is crucial that more projects pass the FEED-stage hurdle, and that this happens in a timely fashion.

Announced direct investment volume into hydrogen projects through 2030 as of Oct 2023, B$



1. Front-end engineering and design
2. Final investment decision

Source: Hydrogen Insights & Investment tracker, as of October 2023

Exhibit 6

Given the challenges surrounding country and project risk, close collaboration with local governments, importing countries and international development partners is required

For stakeholders exploring hydrogen opportunities, close collaboration across the project timeline will help them overcome the additional difficulties that they face to make hydrogen production in Africa at scale a reality. Working with project developers, local governments, international development partners and importing countries is even more critical for success in this region than in other geographies.

The governments exploring hydrogen investments can create a favorable investment climate by providing clarity on permitting, regulation and taxes, and by engaging local communities and authorities early. Additionally, having a clear infrastructure plan creates planning transparency and allows stakeholders to capture synergies like common-use infrastructure shared across different projects. Investments in upskilling local workers will enable them to participate in the new hydrogen economy to their fullest potential.

Importing countries and development partners can provide project de-risking through financial instruments and technical assistance. For example, the European Bank for Reconstruction and Development (EBRD) and the World Bank's Multilateral Investment Guarantee Agency (MIGA) have provided financial instruments to de-risk large-scale projects in Africa through bridge loans and insurances. In addition, development partners can facilitate off-take agreements (e.g., H2Global and support from GIZ).

Project developers can reduce risks by engaging local governments and communities early. For successful project execution, working with experienced, reliable EPC contractors is essential; securing key hardware early in the project is crucial to prevent delays.

Assuming close collaboration is realized and all involved parties take the necessary steps, consequent risk mitigation and successful project execution can position African producers as important leaders in their respective domestic markets and strong contenders for the international hydrogen trade.

Example actions - not exhaustive

	Local government	Importing countries and development partners
Country risk	Improve investment climate Ensure regulatory clarity Consider establishing Special Economic Zones	Provide de-risking instruments Support fit-for-purpose policy development Facilitate off-take agreements
Project execution risk	Engage local communities Create infrastructure masterplan and drive delivery Ensure appropriate skilled labour supply	Support local value-add Co-fund infrastructure projects Set up partnerships for expertise and skill transfer