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Climate and Sustainable Finance

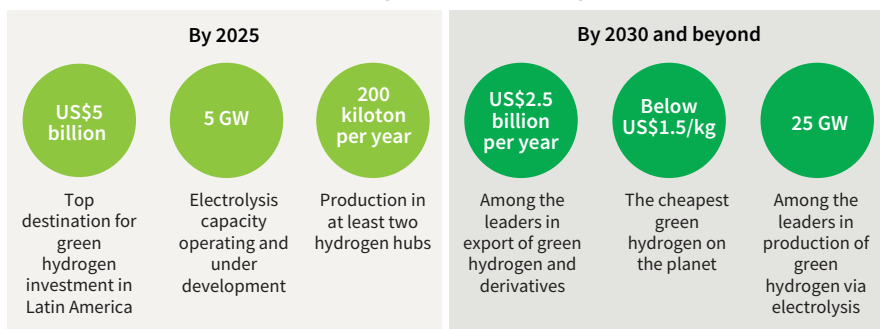
How Chile aims to be among the largest exporters of green hydrogen in the world

Key insights

- On 3 November, Chile's Ministry of Energy presented a "National Strategy for Green Hydrogen for Chile" with three main objectives:
 - have 5 GW of electrolysis capacity under development by 2025
 - produce the cheapest green hydrogen in the world by 2030
 - be among the world's three largest hydrogen exporters by 2040
- Chile has the renewable resources and power market environment to produce among the cheapest hydrogen in the world.
- Favorable new legislation and international partnerships will be essential to launch a dominant hydrogen industry.
- Debate over a new constitution and the global economic crisis threaten Chile's ability to attract foreign investment for its hydrogen ambitions.

Figure 1

Ambitions in Chile's "National Strategy for Green Hydrogen"



Source: Chile Ministry of Energy, IHS Markit

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Chile's government promotes an ambitious "National Strategy for Green Hydrogen"

Hydrogen use as a fuel to satisfy much of the world's energy needs (including for vehicles, heat, and energy storage and transportation) is increasingly seen as a solution to transition the world toward a low- emission economy.

In early November, Chile made clear its ambition to become a powerhouse in a future hydrogen-fueled world. Its Ministry of Energy presented a "National Strategy for Green Hydrogen for Chile" with three bold objectives:

1) have 5 GW of electrolysis capacity under development by 2025; 2) produce the cheapest green hydrogen in the world by 2030; and 3) be among the world's three largest hydrogen exporters by 2040 (see Figure 1).¹ The English version of the government plan is available [here](#).

The measures proposed to accomplish these objectives—measures whose details must still be settled—include extending US\$50 million to pilot projects, promoting hydrogen in end-user applications, possibly implementing carbon pricing, possibly applying quotas for hydrogen in natural gas pipelines, and launching a "green hydrogen diplomacy" effort to position Chile internationally.

Chile's grand hydrogen plan and the sensation it created internationally raise questions on whether the country has the resources, economic environment, know-how, and long-term policy focus to achieve its hydrogen dreams.

Chile has the renewable resources and power market environment to produce among the cheapest hydrogen in the world

The principal factor in establishing the price of hydrogen—and therefore Chile's ability to use and export hydrogen competitively—is the cost of the renewable energy resource used to produce it. In this regard, Chile is well endowed:

- **Vast renewable energy potential.** According to government figures, the country has nearly 1,700 GW of solar potential and nearly 200 GW of onshore wind potential.
- **Exceptional solar radiation and wind speeds.** Capacity factors can reach more than 35% for solar photovoltaic (PV) units in Chile's Atacama Desert in the north and over 50% for onshore wind farms in Chile's Southern Patagonia region.
- **A business-friendly economic environment.** Private investment is allowed across almost all economic sectors, institutions and international treaties are respected, and foreign companies face the same regulation and tax regime as local companies.
- **A dynamic power market open to competition.** The market is privatized, government intrusion is limited, policies are transparent, and the sector is governed by rule of law.²
- **Operational road and seaport infrastructure.** Chile has the transport infrastructure to facilitate supply chains; furthermore, the country's geography is such that renewable projects are never very far from the ocean, facilitating hydrogen exports (although obviously hydrogen transport will require some infrastructure adjustments).

1. "Green hydrogen" is the common term to refer to hydrogen produced with zero-emission renewable energy.

2. See the IHS Markit [Chile Power Market Profile](#).



These conditions have made Chile a mecca for the renewables industry. Indeed, the country served as a testing ground for many international power utilities (including Iberdrola, Enel, and EDF, for example) for their new solar and wind ventures in emerging markets. In a country with an installed power base of only 25.5 GW, a remarkable 3.0 GW of unconventional renewables were added during 2016–19, and another 3.0 GW are planned by end-2022.

This “Chile as a testing ground” approach could be repeated for hydrogen. Chile’s power sector is currently oversupplied, and its renewables target—to meet 20% of demand from unconventional renewables by 2025—is already met, so renewable players would benefit from hydrogen business opportunities. For example, Enel and local power company AME are partners on a wind-powered hydrogen project in Patagonia, planned for 2022.

Enel also partnered with Anglo American to research hydrogen-fueled mining trucks in Chile’s north. And ENGIE is working with explosives manufacturer Enaex to produce green ammonia from solar power. According to the Ministry of Energy, hundreds of international companies have shown interest in understanding how to participate in Chile’s hydrogen ambitions, including players from China, the United States, Germany, Japan, and Australia, for example.

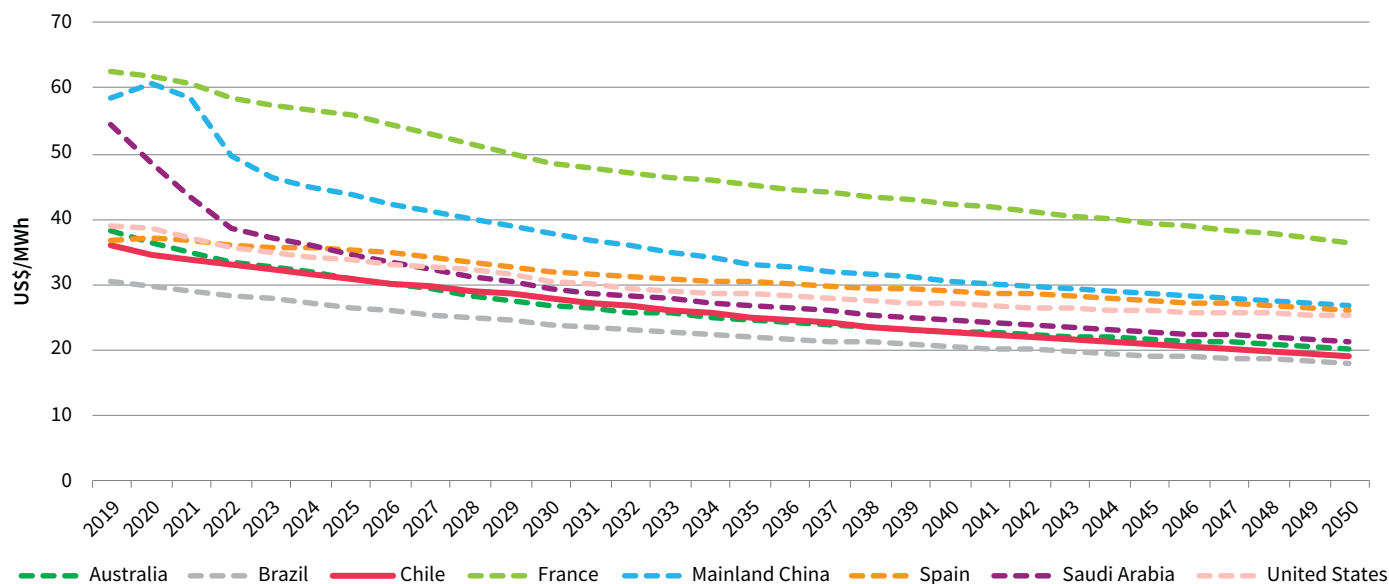
The question is whether the scale and economics of Chile’s hydrogen goals will support the enthusiasm. First, to be a powerhouse in hydrogen production, the government anticipates 200 GW of renewable capacity by 2040 in a country that, as mentioned before, has a current total power base of 25.5 GW. The fact that the resource-rich far north and far south of Chile are largely uninhabited should help.

Secondly, Chile aims to manufacture green hydrogen at below US\$1.5/kg by 2030 compared with roughly US\$4–5/kg today. This long-term goal equates to generating electricity at approximately US\$15–20/MWh.

According to IHS Markit analysis, by 2030 the levelized cost of energy in Chile could be US\$25–30/MWh for both an average utility-scale solar PV unit and an onshore wind project (see Figures 2 and 3). This result would allow hydrogen production at roughly US\$2–3/kg. Best-in-class projects could produce hydrogen even more cheaply.

Figure 2

Levelized cost of energy for Chile and other select countries – Onshore wind

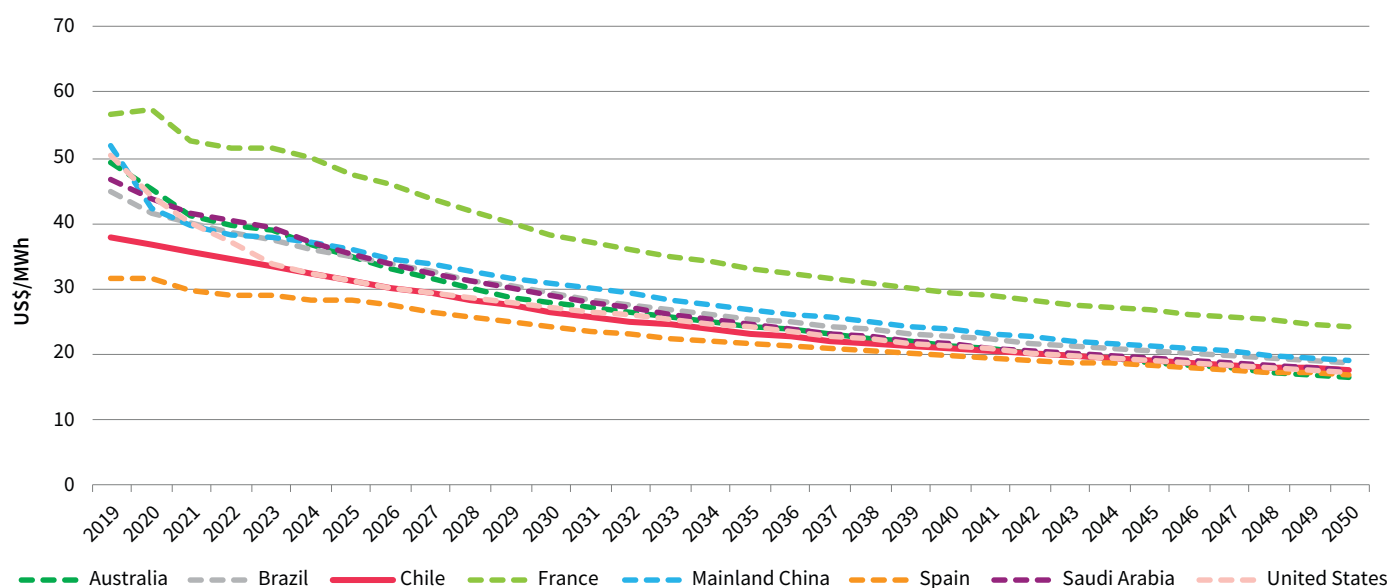


Source: IHS Markit

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Figure 3

Levelized cost of energy for Chile and other select countries – Utility-scale solar PV



Source: IHS Markit

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On that note, the best renewable projects for hydrogen production may differ from the best for sales into the wholesale power market, possibly limiting the former's options for offtake and complicating financing. In particular, Southern Patagonia has extremely high wind speeds, but the region is disconnected from Chile's principal power grid. So the only real purpose for wind projects that far south would be to manufacture carbon-neutral ammonia or synthetic fuels for the local methanol industry or to export hydrogen.

The choice between developing renewable projects for hydrogen production versus for wholesale power supply must also consider expected returns. IHS Markit forecasts spot power prices of about US\$55/MWh in 2030, in real terms, stemming from more expensive generators using imported natural gas being at the system margin. This estimate is 2.5–3.5 times higher than the power price that the government wants for hydrogen production.

In summary, despite Chile's advantageous circumstances, the economics of hydrogen remain challenging. Globally, green hydrogen currently costs about US\$30–40/MMBtu to produce compared with an average price so far in 2020 of US\$2.0–3.0/MMBtu for natural gas at the US Henry Hub or the UK National Balancing Point. The challenge for Chile is therefore not only to compete effectively against other possible hydrogen exporters (including Australia, Saudi Arabia, and North Africa, for example), but to produce cheap enough hydrogen to compete against conventional fuels as well. Policies promoting hydrogen, from carbon pricing to state financial support, will be critical to allow the sector to mature sufficiently for this situation to emerge.

Favorable new legislation and international partnerships are essential to launch a dominant hydrogen industry within Chile's small domestic economy

Like most countries around the world, Chile lacks regulations specific to hydrogen production, storage, transport, and consumption. Yet, to meet its objectives, the country must give certainty to investors so that it can increase production levels and reduce costs. This action will require the development of high-quality regulation, the state support of business initiatives, and strategies to partner internationally.

Developing these foundational blocks must be done quickly. Indeed, several countries and regions worldwide—including Australia, the southwest United States, and Colombia, for example—share characteristics that make Chile attractive for green hydrogen production, and they have ambitious hydrogen objectives (see Figure 4).

As a result, Chile is attacking with urgency its policy development, the approval of project permits, and the delivery of financial support (see the box “Proposed policy measures demonstrate Chile's strong commitment to green hydrogen”).

However, Chile is seeking to be a pioneer in a field it knows little about. Domestic experience in hydrogen is largely

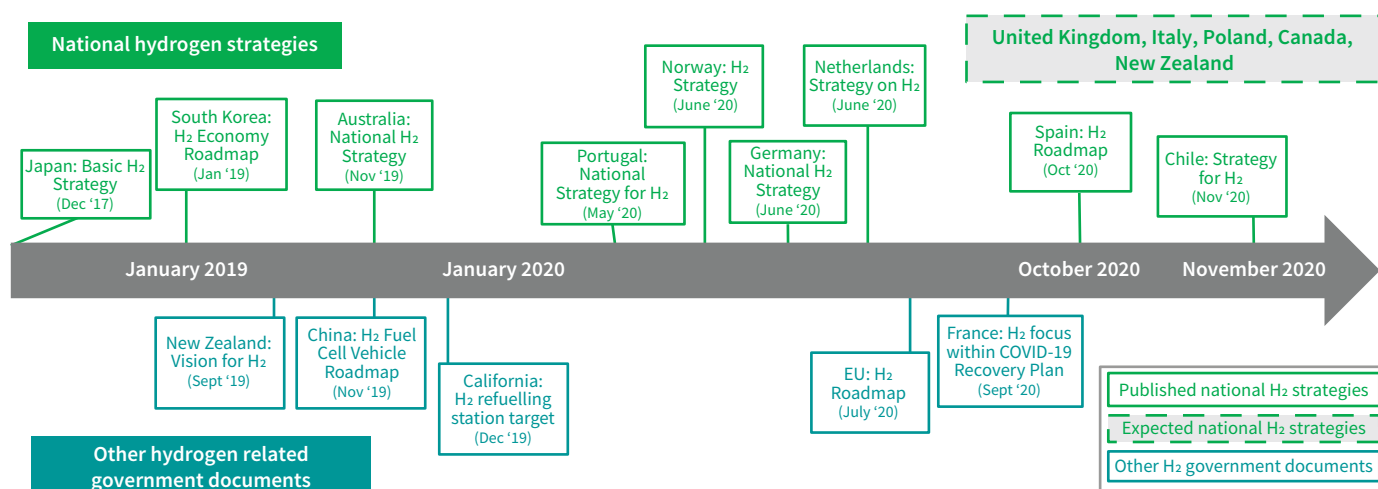


limited to production at two oil refineries owned by the state oil company ENAP. Furthermore, green hydrogen is a nascent sector offering few international precedents for policymakers. This lack of local expertise and information availability challenges Chile's creation of a pro-hydrogen legislative framework.

The country is therefore relying on the growing experience of multinationals—including Enel, ENGIE, and Siemens—the advice of international governmental agencies such as Germany's development agency GIZ, and the few international standards that do exist. In November, the government launched a national request for information process to help design public policy for the sector. It also recently signed agreements with Spain, Australia, and Germany to promote cooperation in hydrogen research and implementation. Germany is financing part of the previously mentioned Patagonian hydrogen project sponsored by AME.

Figure 4

Timeline of global policy and regulatory documents relating to hydrogen (selected reports)



Source: IHS Markit

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This fact that the government is working with external advisers to identify gaps in the regulatory framework is encouraging and should allow financing to advance all while companies and agencies incorporate new standards into their operations.

Another important challenge in Chile's vision is rapidly finding domestic hydrogen offtakers to gain expertise while the country develops the capacity to become a major exporter. This task will not be easy in Chile's small and specialized economy. Understanding this challenge, the government wants to promote hydrogen in six well-established, point-source, and large-scale applications: refining, ammonia production, trucks used in mines, heavy road trucks, long-haul buses, and gas networks.

Chile's substantial mining sector will likely play a key role here owing to the presence of the state-governed mining company Codelco and an overall need to reduce emissions. The country's mining sector has greatly greened its power supply—according to the Ministry of Mines, by 2024 almost half of the sector's power supply will come from renewables—and it now looks to decarbonize its large truck fleet. For example, Codelco and mining company Collahuasi are working with ENGIE, the Canadian firm Ballard Power Systems, and others to convert haul trucks to run on fuel cells.

Encouragingly, Chile's large industrial players seem to largely share the government's commitment to incorporate hydrogen into existing sectors of the economy and to later see hydrogen become a new important source of exports.

• Proposed policy measures demonstrate Chile’s strong commitment to green hydrogen

A set of proposed policy measures—most of which are still at the design stage—accompany Chile’s “National Strategy for Green Hydrogen.” They include

- **Accelerating research and development.** The Ministry of Energy will push hydrogen research and development at research centers and universities.
- **Offering financial support to projects.** The government committed to provide up to US\$50 million to help finance pilot projects that may not be competitive at a small scale.
- **Accelerating permitting processes.** A task force will help with the permitting for new projects and the development of pilot programs.
- **Applying economic and volume incentives.** The government will discuss the possibility of carbon pricing to make hydrogen competitive with conventional fuels. Another option is implementing quotas for green hydrogen in gas pipelines.
- **Planning land use and creating production hubs.** The government is reserving almost 12,000 hectares to develop solar projects for green hydrogen. Legislation may also prioritize zoning for wind projects and promote hydrogen production hubs.
- **Improving transportation infrastructure.** A legislative framework will be considered to resolve infrastructure bottlenecks and transform seaports to handle hydrogen exports.
- **Finding hydrogen offtakers domestically and abroad.** Specific applications—such as refining, ammonia production, and heavy goods vehicles—are identified for hydrogen consumption.

In that regard, when Chile will shift its focus from local offtakers to hydrogen exports, a different set of variables will arise. First, Chile is far from likely hydrogen demand centers, including East Asia, Europe, and North America (see Figure 5). Low production costs will compensate for the greater distance, but the technology to transport large volumes of super-chilled hydrogen (similar to LNG) is still being perfected. Chile may first focus on exporting derivatives such as ammonia, fertilizers, and synthetic fuels.

Figure 5 Countries with recent policy announcements regarding the import and export of hydrogen

	Import	Export	Self-sufficient*
Asia Pacific	Japan, South Korea	Australia, Brunei, New Zealand	China
Europe/MENA	Germany, Netherlands, Italy	Norway, Portugal, Spain, Saudi Arabia	France
Americas		Canada, Chile	California

Note: *Importing or exporting hydrogen is not mentioned within government strategies. MENA = Middle East and North Africa.
Source: IHS Markit

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Secondly, Chile must position itself as a preferred supplier. Chile's Ministry of Foreign Affairs, collaborating with the Ministry of Energy, launched a "green hydrogen diplomacy" effort to position Chile with the sector's principal heavyweights and future consumers. Indeed, the government started organizing global events and meetings with international partners to inform them about Chile's potential. A first aim is to create three international consortiums to build at least 1 GW of capacity each.

For its hydrogen dreams to materialize, Chile must keep a strong and steady long-term political vision. Yet, as we will see now, the country is currently facing very chaotic times.

Debate over a new constitution and the global economic crisis threaten Chile's ability to attract the foreign investment needed for its hydrogen ambitions

Chile faces a period of political and social instability. A social upheaval in 2019 led to a referendum in October 2020 to start drafting a new constitution.³ The constitutional rewrite will create debate on issues like the role of the state, limits to property rights, and environmental protection. The country also faces immense challenges caused by the COVID-19 pandemic (IHS Markit forecasts a 6% GDP contraction for 2020) and a presidential election planned for 2021.⁴ Such circumstances could slow the political decisions and private capital injections required for the rapid development of Chile's hydrogen industry. However, IHS Markit believes that the conditions favorable to Chile's hydrogen goals will by and large remain.

A new constitution could have provisions detrimental to the hydrogen industry. These provisions include curbing property rights if they infringe on basic services, national security, and the environment and restraining foreign involvement in strategic sectors, including energy. A new elected government could also amend the corporate tax regime or pass policies less friendly toward private investment. State-owned companies like ENAP and Codelco could take on stronger roles in the economy—that said, past state involvement has at times benefited Chile's energy market, like for the construction of the country's LNG terminals.

Still, IHS Markit believes that Chile is unlikely to stray from its strong commitments toward private and foreign investment and toward climate change mitigation. This situation in turn provides a foundation for developments in hydrogen.

3. See the IHS Markit Strategic Report [Chile's new constitution](#).

4. See the IHS Markit Headline Analysis [COVID-19 virus to deepen Chile's recession, extend unemployment, and raise poverty, triggering violent anti-government protests towards year-end](#).

First, the constituent convention charged with rewriting the constitution will likely have a composition similar to Chile's Congress, with a significant representation of moderate elements in the political spectrum. This composition, added to the requirement that each article of the new constitution gain a two-thirds majority, mitigates the risk of more radical state interventionism or a dismissal of existing institutions and international treaties.

Secondly, with regards to the hydrogen sector and as discussed previously, the country is highly dependent on foreign capital and know-how. This fact reduces the likelihood of new restrictions being introduced to limit foreign involvement in the sector.

Lastly, there is clear cross-party support for the country's sustainable development goals. Chile lacks hydrocarbon resources and has historically been a net energy importer. As a result, there is a good chance that the government elected in November 2021 will maintain the policy to develop green hydrogen.

A greater risk is rather that the pace at which hydrogen is promoted slows. It will take several years if not decades of careful public-private cooperation and policy support for Chile to realize its hydrogen potential. But hydrogen policies may very well be delayed in 2021–22. The government will rapidly face the dilemma of using its public spending to support hydrogen pilot projects versus support the poorer segments of the population in the wake of the COVID-19 pandemic.



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