

H₂international

THE E-JOURNAL ON HYDROGEN
AND FUEL CELLS

20

→ CELEBRATING 20 YEARS
OF HZWEI

→ CURRENT HOME FUEL CELL
OFFERINGS

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H2-international

H2international
E-JOURNAL ON HYDROGEN AND FUEL CELLS

ISSN
Issue/Year

2367-3931
No. 2, May 2020

Publisher

Hydrogeit Verlag
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16727 Oberkraemer, Germany

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Adverts

Translation

Frequency

4 digital issues per year, 1 printed

Single issue (DE)

USD 10 / EUR 8 (excl. VAT)

1-year sub (DE)

USD 40 / EUR 35 (excl. VAT)

Shipping

D: USD 2.50 / EUR 2.00,

World: USD 5.00 / EUR 4.00

Students

50 % off standard prices

Termination

At any time

News articles that show an author's name represent the opinions of said author and do not necessarily represent the views of the editorial board.

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Cover image Celebrating 20 years of HZwei



CH₂ILE – THE HIDDEN HYDROGEN CHAMPION

A redemption story for Chile's economy

In 1883, the War of the Pacific, also known as the Saltpeter War, ended with the victory of Chile over Peru and Bolivia and Chile's annexation of the Tarapacá and Antofagasta regions. But why go to war over the world's driest desert? The area was rich in gold, albeit not the traditional kind. The resource the three countries were after was white gold, or Chilean saltpeter. With the support of the British Empire, Chile became the world's biggest exporter of the compound, commonly referred to as sodium nitrate, a natural fertilizer and if mixed with a reducing agent, an explosive. The country held a virtual monopoly on the substance for almost four decades, which led to the creation of new businesses and communities and attracted investment from around the globe.

And wherever there is money to be made, a German will get involved at one point or another. This time, it was Henry B. Sloman, a German businessman born in 1848, who went off to Chile to set up a saltpeter business in Tocopilla. In 1889, he returned to Hamburg as a wealthy man and was considered to be one of its richest citizens in 1912. In 1924, seven years prior to his death, he commissioned the construction of a 10-story office building. Called Chilehaus, it is now a UNESCO World Heritage site.

The saltpeter exports gave the Chilean economy an unprecedented boost. But nothing lasts forever. In 1904, Fritz Haber, who worked at Technische Hochschule Karlsruhe, known as KIT these days, was able to synthesize ammonia directly from hydrogen and nitrogen. Between 1910 and 1913, Carl Bosch then managed to scale up the process at BASF in Ludwigshafen. These discoveries would later earn both men the Nobel Prizes in Chemistry. For the first time in history, it became possible to bind nitrogen to a stable ammonia molecule: Haber and Bosch had figured out a way to synthesize a cheaper chemical replacement for Chile's white gold.

In 1914, early into the First World War, the new production technique proved crucial to Germany's war efforts. The same British Empire that had supported Chile in the War of the Pacific now began to block Germany's import routes for saltpeter, putting the country's agriculture and explosive powder sectors at risk. The German Empire considered the lack of saltpeter a crisis that needed solving, and with scarcity came innovation. A deal reached between the German government and the chemicals industry heavily subsidized new ammonia production facilities. As a result, Germany and its allies were able to produce explosives and fertilizers without having to rely on imports of saltpeter.

With the availability of synthetic alternatives and because of a lack of innovation in Chile's industry, it was just a matter of time until the country's saltpeter monopoly would collapse. It ultimately did so during the Great Depression, primarily from 1929 to 1932. A severe drop in demand and the rise of industrial urea production effectively killed the industry. Chile did not use its revenues from white gold sales to diversify the country's industrial base; neither did it invest in new research and development capacity. Its lack of foresight ultimately crashed the economy.

CHILE'S ECONOMIC REVIVAL Almost 100 years later, the technique that put Chile out of business could lead to a major revival of its economy. Only this time around, the country can count on cutting-edge technology, clean energy and green hydrogen. It is Chile's biggest redemption story.

The South American country has one of the largest potentials for renewable energy production in the world. Spanning over 4,200 kilometers (2,600 miles) from north to south, a distance on par with that from northern Scandinavia to northern Africa, Chile lies between the Pacific Ocean and the Andes Mountains. The 2018 Bloomberg New Energy Finance Climate Scope ranked Chile as the most attractive country for clean energy investment (out of 103 emerging markets) with the potential to generate a total of 1,380 to 1,860 gigawatts from renewable sources of energy, including solar PV, CSP and wind. This is close to 70 times the electric generation capacity it has currently available, prompting the World Energy Council Germany association to call Chile the "hidden champion" in their 2018 report "International Aspects of a Power-to-X Roadmap."

HOW TO GET A CHAMPION OUT OF HIDING Hydrogen is not new to Chile. It has, for several decades, been used in industrial applications, such as refining petroleum, manufacturing flat glass and hardening vegetable oil. But the recent appreciation of green hydrogen in Chile is the result of a collaborative effort between technical support agency GIZ, acting on behalf of the German environment ministry, the Chilean energy ministry, and its industrial development agency CORFO. Since mining is Chile's most important industry, the Solar and Energy Innovation Committee of CORFO began co-financing two industrial hydrogen projects in the sector in 2017. The first has seen huge 300-ton mining trucks being equipped with dual fuel engines that run on diesel and hydrogen. The second aims at using fuel cells in large underground mining vehicles. The GIZ also played a pivotal role in organizing initial international hydrogen seminars in Chile in May 2017 and September 2018, attended by key figures from the worlds of politics, industry and academia. Private-private partnerships are starting to appear as well. For example, as collaboration will be needed to scale up the technology, French utility Engie and Enaex, a Chilean importer of ammonia used in mining explosives, have joined forces to set up the first green ammonia project in Chile.

The founding of the Chilean hydrogen association H₂ Chile in January 2018 was definitely a highlight of this call to action. Its objective is to establish green hydrogen as a sustainable energy carrier that can help decarbonize the national energy sector and, in the long run, provide Chile with the means to supply clean energy globally by shipping hydrogen and all its derivatives overseas, creating a brand-new chemical industry supported through greenfield investment. The last two years have seen an increase in the number of training sessions, congresses, seminars, newspaper and journal articles, and reports, including interviews on TV, where the "old newcomer" hydrogen was presented and promoted among members of the public.



Fig. 1: IEA cost estimate of global green hydrogen production [Source: IEA]

CHILE'S HYDROGEN OUTLOOK In its June 2019 report “The Future of Hydrogen,” the IEA said Chile could produce hydrogen at the lowest cost worldwide (less than USD 1.60 per kilogram), made possible by its extraordinary solar irradiation levels. This is especially true for the northern Atacama Desert, where the cold Humboldt Current leads to an absence of cloud cover during more than 300 days and nights a year, so that over 70 percent of the worldwide sky observatory capacity is located there. Meanwhile, the southern part of Chile, including the ever-windy Patagonia region, offers phenomenal conditions for installing onshore wind farms. By using geothermal energy, the country could also generate renewable electricity, considering it is part of the Pacific fire rim, a large string of volcanoes often throwing up hot lava to the surface. Additionally, Chile's around 5,000 kilometers (3,100 miles) of coastline allow the addition of wave and tidal power capacity, total potential being 240 gigawatts. Likewise, there is considerable potential for biomass and hydropower in the central southern regions.

As for green hydrogen, Chile could produce up to 200 million tons of it per year based on its renewable energy potential. This would be nearly three times the current quantity of about 70 million tons of hydrogen produced each year around the world. A basic clean source of energy, hydrogen could be worth several hundred billion dollars annually, the equivalent of Chile's current GDP.

In 2017, an article in the Washington Post compared Chile's potential for renewable energy to that of Saudi Arabia's oil exports. Every year, Saudi Arabia sells 2.7 billion barrels of crude oil to customers abroad. When converted to electrical energy, 16.5 EJ of thermal energy results in 5.5 EJ. Considering Chile's estimated solar potential of 6.1 PWh per year, this would be 22.1 EJ stored as green hydrogen annually. From this, 12.1 EJ of renewable electricity could be generated annually by fuel cells. This is more than twice the amount of thermoelectrically generated power produced from Saudi Arabia's current exports. As an added benefit, Chile's green hydrogen would emit no greenhouse gases and because it is a renewable energy source, no one would have to be concerned about wells drying up.

WHAT IS NEXT? 2019 saw numerous hydrogen initiatives for Chile being pushed by COP25, originally scheduled to take place in the country. The conference featured a notable number of seminars on hydrogen, during which the Chilean Hydrogen Strategy was discussed as well. After countrywide working sessions with stakeholders from industry, academia, government and civil society, a strategy was announced by the Solar and Technical Innovation Committee of CORFO,

the government agency in charge of promoting industrial initiatives. Although COP25 had to be moved to Madrid, Chile managed to organize a novel side event, chaired by H₂ Chile's executive director, where a large number of specialists discussed the pros and cons of hydrogen.

This year, a series of seminars and workshops was launched under the name of Misión Cavendish to honor the discovery of electrolytic hydrogen two-and-a-half centuries ago, with the aim of encouraging hydrogen project development and giving attendees the opportunity to fill knowledge gaps. Supported by the GIZ and consultants from all around the world, the Chilean energy ministry is also drafting a hydrogen standard, which should be ready sometime this year, and has joined forces with CORFO and Chile's science ministry to organize an International Hydrogen Summit in June 2020. Another highlight over the next months will be the Clean Energy Ministerial and Mission Innovation Ministerial (CEM11/MI-5) meetings, which are scheduled to take place in Viña del Mar, Chile from June 2 to 4, 2020.

TIME TO ACT Chile could play a vital role in helping Germany meet its clean energy targets. The recently published German hydrogen strategy calls for green hydrogen imports in order to speed up the decarbonization of its economy. Chile has the potential for producing clean, sustainable green hydrogen at the lowest cost possible. There is a huge clean energy industry to be had in Chile, for which German technology, knowhow and capital is paramount. Further down the road, there will also be a brand-new sustainable chemical industry to develop, so Chile can export, for example, green ammonia and fertilizers. We invite all the industry's visionaries to come to Chile to follow in Henry B. Sloman's footsteps and use the Haber-Bosch process once again, this time to produce today's new kind of gold: green hydrogen. ||

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