FUNDACIÓN TANTÍ

Green sacrifice zones in Chile?

Threats and risks of mining and energy expansion in territories and ecosystems of the Atacama Desert.

Gabriela Cabaña
Ramón Balcázar
Tantí Foundation

December, 2024

This research was conducted with the support of 11th HourProject

Name of the project: Green sacrifice zones in Chile? Threats and risks of mining and energy expansion in territories and ecosystems of the Atacama Desert.
Implementing organization: Tantí Foundation.
Developed by: Gabriela Cabaña and Ramón Balcázar Morales
Design: Bárbara Astudillo.
Cover image:Ckhúri wind farm with San Pedro and San Pablo volcanoes in the background. Credits: Ramón Balcázar M. (2024)

Printed ISBN: 978-956-09617-3-0
ISBN digital version: 978-956-09617-4-7

www.fundaciontanti.org

Acknowledgements: In addition to the communities and organizations mentioned in the report, we appreciate the support and contribution, at different stages of this project, of Hernán Bianchi, Chiara Braucher, Diego Fuenzalida, Juan Larraín, Nelson Manquian, Taltal Sustentable, the professionals from the group Servicio País of Mejillones, Tocopilla and Taltal, Dominique Durand, Ricardo Pino, and Group Asociación Nelson Manriquez.

How to cite: Cabaña, G., & Balcázar Morales, R. (2024). Green sacrifice zones in Chile? Threats and risks of mining and energy expansion in territories and ecosystems of the Atacama Desert. At www.fundaciontanti.org.

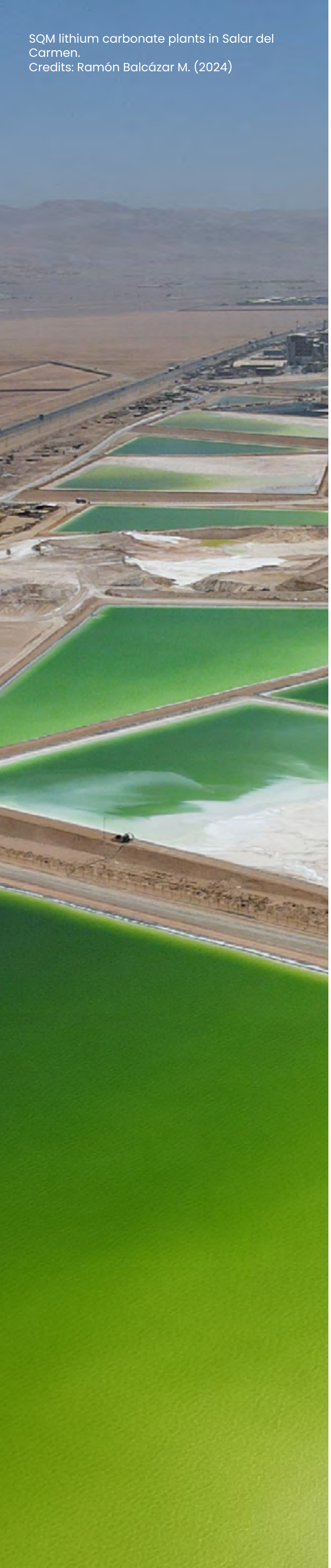

SQM lithium carbonate plants in Salar del Carmen.
Credits: Ramón Balcázar M. (2024)

Table of contents

I. Executive Summary

Tara salt flat. Credit: Ramón Balcázar M. (2017).

I. Executive Summary

This research arises from the need to **understand and anticipate** the cumulative impacts and risks associated with the expansion of copper and lithium mining, as well as the installation of a hydrogen industry in the Antofagasta region of northern Chile. Both processes stem from Chile's declared intention to maintain leadership in these minerals while also becoming a world-class exporter of hydrogen and its derivatives, such as ammonia, within the framework of global, and particularly European, decarbonisation goals. Based on Tantí Foundation's experience in the protection of Andean ecosystems—especially wetlands—, this study set out to understand the forces driving the establishment of these industries, and the emerging impacts that massive Non-Conventional Renewable Energy (NCRE)-related infrastructure developments have on territories and ecosystems already damaged by mega-mining. Following the approach of political ecology and ecological economics, we identified the environmental effects and ecologically unequal exchange resulting from green extractivism in northern Chile.

The **methodology** followed the principles of action research (Kemmis et al., 2014) and militant research (Bookchin et al., 2013; Bringel & Maldonado, 2016). The various conversations, analyses and accompaniment processes with project-affected communities detailed in the report took place between March and November 2024. The information on so-called 'green' hydrogen projects is updated as of November 2024. A qualitative analysis was carried out in five of the region's territorial clusters: Calama, Peine, Taltal, Mejillones and Tocopilla. These case studies reveal the different impacts of projects already underway in Andean and coastal territories. Additionally, we performed a quantitative analysis of both the projected capacity of the hydrogen and derivatives industry, as well as the current and future NCRE projects in the Antofagasta region.

In terms of **results**, we observe that in the five territories analyzed there are conflicts directly and indirectly related to technologies, infrastructures and extractive processes associated with mega-mining. These conflicts have clear potential to worsen if the **31 green hydrogen projects** currently in the pipeline for the region are developed. Given the relevance of this new source of threats, we present 14 factsheets on green hydrogen projects, photovoltaic and wind energy projects, and electricity transmission. These conflicts are related to (1) impacts on terrestrial ecosystems and aquifers that are already directly affected by lithium and copper mining processes, as well as coastal marine ecosystems indirectly affected by processes related to mining, such as water desalination. These impacts are exacerbated by the increasing juxtaposition of industrial activities, raising concerns about unassessed synergistic and cumulative effects. Archaeological heritage impacts (2) are also a concern, in particular due to the advance of large-scale wind farms. We also identified (3) social and cultural impacts emerging from the relationship between companies and communities, particularly in relation to (4) the violation of rights to information and participation in environmental matters, as well as the violation of the rights of indigenous peoples, such as the right to free, prior and informed consultation and the right to self-determination.

Of the 31 green hydrogen projects considered in this report, 13 have announced the construction of associated energy infrastructure. This would add up to a total of **16 GW** of NCRE electricity, when today 4.8 GW of this type of energy is generated in the region. If the trends described in the report continue, we project an **increase in socio-environmental conflicts** in the future.

In our **analysis and conclusions** we propose a dialogue with the concepts of green extractivism and green sacrifice zones. We argue that it is useful to situate emerging hydrogen-related processes and associated infrastructure within the history of extractivism in Antofagasta, as hydrogen overlaps geographically with other extractive processes – notably lithium and copper mining - and deepens existing problems such as the growing and unregulated use of desalination plants to meet industrial water demands. This research provides a framework for further understanding threats to socio-environmental justice from a holistic framework that goes beyond corporate labels of hydrogen as a ‘green’ solution to the problem of decarbonisation, and provides key insights towards the construction of a just and popular energy transition.

II. Introduction

Vegetation on the coast of Paposo. Credits: Ramón Balcázar M. (2024)

II. Introduction

Green hydrogen—and related concepts such as renewable hydrogen, e-fuels and green ammonia—has become part of the energy transition conversation in Chile. Since 2020, various public policy instruments have profiled the Antofagasta region as one of the nodes of the future green hydrogen industry in Chile. Its synthesis and use processes that exclude the direct emission of greenhouse gases have served to support its "green" label as a positive trait compared to conventional fossil fuels as well as hydrogen synthesised by chemical processes using fossil fuels (Sánchez & Aedo, 2023, p. 5). However, there are still no studies showing the synergistic and cumulative effects of this industry in the Antofagasta context or any other, nor its implications for the development of a just and popular energy transition (Pacto Ecosocial e Intercultural del Sur, 2023). The design and implementation process of this policy has been marked by a lack of democratic processes and debate, which has resulted in a lack of understanding of its real magnitude and risks, and the reproduction of previous inequalities and extractive dynamics.

For its part, Antofagasta is highly affected by various extractive and industrial processes, which particularly affect its basins. Andean wetlands, meadows, *bofedales*, lakes, rivers, and other bodies of water have been getting damaged by mining and other extractivist activities for decades. Among them, the growing interest in the exploitation of existing lithium in different salt flats in the country and the expansion of copper mining stand out. This is the context where a new and ambitious industrial activity, such as hydrogen, appears. All these elements are understood in the context of an expansion of **green extractivism**—that is, a renewal of the primary extractivist project based on a view that reduces nature to a mere source of "natural resources" available for exploitation, while the value addition and much of its use occurs outside national borders. In this study we suggest that green hydrogen comes to strengthen greenwashing without addressing the source of the global ecological emergency.

This report provides a general mapping of the key factors for understanding and sizing the impact of "green" (or "renewable") hydrogen development in Antofagasta. This includes projects that involve the synthesis of hydrogen from the electrolysis of water with electricity coming directly or indirectly from NCREs, as well as its subsequent transformation to derivatives such as ammonia and e-methanol. In addition to "green" hydrogen and ammonia production plants, the study expands the analysis towards various elements: the advancement of NCRE infrastructure, electrical transmission infrastructure, and seawater desalination processes. The main objective of this study is to identify the critical points of social-ecological conflict in relation to these elements, present and latent. 5 hubs of developing conflicts are documented in depth. (1) The commune of Calama, which encompasses the vicinity of the city and the Andean town of San Francisco de Chiu-Chiu; (2) a cluster of energy generation and transmission projects in Peine (commune of San Pedro de Atacama), and the situation in the ancestral territory of the Chango people. This is divided into (3) the sectors of Paposo (commune of Taltal), (4) Antofagasta and Mejillones, and (5) Tocopilla. While some dimensions of the hydrogen industry at a national and international level are mentioned, this report focuses on making an integral diagnosis of the Antofagasta region. For broader references and critical analyses see for example (Aldana Rivera & León Peñuela, 2022; Cabaña Alvear et al., 2024; Cabaña, 2024; Nualart Corpas & Gros Beto, 2024).

Documentation was carried out following a participatory research approach. In 3 of the 5 cases (*Coordinadora por la Defensa del río Loa y la Madre Tierra* in Calama, citizen's and Chango communities and groups of Taltal, Mejillones/Hornitos and Tocopilla), data collection was done jointly alongside the communities affected and alerted by the advancement of green hydrogen. In the other two (Peine and San Francisco de Chiu-Chiu), public information from the territorial defense processes advanced by the affected indigenous communities was used, complemented by interviews.

The report has five parts. The following section presents the conceptual framework—based in ecological economy and political ecology—and details the methodology used in the study. Then, in section four, the background is presented to understand the current development of the hydrogen industry and its derivatives in Antofagasta, as well as a summary of what exists today in the literature on ecological impacts of green hydrogen production and NCRE infrastructure. Section five unveils the results under five hubs identified during the research, presenting files of the reviewed projects. Section six, analysis, presents a more general overview of known H_2, NCRE, and water use projects in the region. The report closes with conclusions and raises questions about the risks and uncertainties posed by the advancement of this industry within the region.

III. Conceptual framework and methodology

Wetlands of Turi Salt flat, traversed by freshwater pipelines used in mining operations. Credits: Ramón Balcázar M.

III. Conceptual framework and methodology

a. Ecologically unequal exchange and the social-ecological dimension of energy

This study was guided by the holistic principles of ecological economics and politics, and especially by the perspective of the Ecologically Unequal Exchange (EUE). EUE is broadly concerned with revealing "how the accumulation of money and technology in core areas of the world-system occurs at the expense of the natural resources, environment, and health of their peripheries" (Hornborg, 2009, p. 246). This means understanding that the deterioration of the environment is a process embedded in power dynamics, which generates the displacement of environmental burdens and damages, and concentrates the benefits in a few privileged centres. EUE is useful for spatializing and graphing extractivist practices that sustain imperial lifestyles (Brand & Wissen, 2018; Post, 2023).

Latin America has been studied as a region historically affected by EUE. "On a global scale, Latin America (along with Central Asia) is the region of the world with the highest net exports of materials per capita, surpassing one ton per capita per year" (Infante-Amate et al,. 2020, pp. 180-181). It is the main supplier of biomass and metallic minerals. The counterpart of this deterioration is the disproportionate appropriation by importing countries of what is extracted in regions such as Latin America. This focus on the destination of the use of the extracted resources helps to reorient the question of environmental deterioration. Often, the countries where extraction occurs are pointed to as ultimately responsible for that harm. Nevertheless, when we analyse the material footprint of imports and exports, the conclusion changes:

> "Through the territorial method, exporting countries have a higher material consumption, which corresponds to the environmental impact they take on. In contrast,importing countries have a much more moderate burden and therefore have a lower environmental impact on their territory. However, the environmental impact associated with each country's final consumption, as indicated by its MF, is much higher in the case of importing countries." (Alonso-Fernández & Regueiro-Ferreira, 2022, p. 7).

This "drain" from the South to the Global North is confirmed when expanding to other factors involved in foreign trade. When we consider these factors we can observe how the raw materials, soil, energy, and labour employed in the creation of goods and services flow disproportionately to the countries in the Global North (Hickel et al., 2022). The North, in turn, exports back products with comparatively higher prices.

EUE serves to interrogate the promise of development and mutual benefit that has sustained the momentum of the green hydrogen industry. The viability of so-called "green" hydrogen depends on its price: it must be cheap enough to displace fossil-based hydrogen predominantly in use today and, eventually, replace fossil fuels such as gas in other possible uses of the vector. Additionally, to become an export industry, a low price depends on its production being on a large scale. From this perspective, the National Green Hydrogen Strategy published in 2020, as detailed below, is part of a larger scenario in which "power imbalances in the world economy ensure that labour and resources in the South remain cheap and accessible to international capital, while Northern exports enjoy comparatively higher prices". Nevertheless, "cheap labour and raw materials in the Global South are not "naturally" cheap, as if their cheapness was written in the stars" (Hickel et al., 2022, p. 9).

To understand extraction from the perspective of social-ecological economics means, on the other hand, to expand the understanding of the impacts of any economic activity to its broader biophysical and social enabling conditions (Spash, 2018). In the case of this study, the limits of the system considered in the analysis reach the energy needed to supply the electricity necessary for green H_2 synthesis, and the water used in the electrolysis process. This includes the surface covered by the panels, the land destined to become wind farms, the transmission lines and electricity substations, the new desalination plants and increased operation of existing ones, the new ports for export, and the facilities for hydrogen synthesis and its transformation to ammonia.

Due to the scope of the study, we left out the analysis of the demand for the necessary raw materials to build the hydrogen energy infrastructure. That is: the components of wind and solar complexes, as well as other construction materials. This means excluding important and pressing questions related to the expansion of extraction frontiers, like the increase of nickel demand, a mineral required for the batteries used in electric vehicles, wind turbine generators, and concentrated solar power (Andreucci et al., 2023) and balsa wood to build the blades of wind turbines (Bravo, 2021). Analyses projecting the demand for minerals related to renewable energy technologies estimate it will exceed known lithium, cobalt and nickel reserves, and exceed 50% of indium, silver and tellurium reserves (Dominish et al., 2019). In the case of solar energy, the increase in photovoltaic infrastructure production is already creating new ecological injustices at different points of the logistics chain, from the extraction of raw materials to waste, a form of embodied energy injustice (Mulvaney, 2024).

In the same vein, this study also does not consider what happens to renewable energy generation infrastructure when its lifetime ends, an issue that will be of increasing relevance in the future. The last public planning instrument surrounding hydrogen, the Green Hydrogen Action Plan (*Plan de Acción de Hidrógeno verde* in Spanish), considers among its measures only initiatives towards "promoting comprehensive waste management" and creating a "best practices guide for industry related circular economy and the value chain of green hydrogen and its derivatives" (Ministerio de Energía, 2024a, p. 106).

b. Action research for socio-environmental and climate justice in the Atacama Desert

This study is framed as a form of action research (Kemmis et al., 2014) and militant research (Bookchin et al., 2013; Bringel & Maldonado, 2016). As such, it aims to contribute both during its development and with its results to processes on two scales. On the one hand, to serve as local support in the defense and care of the territory of indigenous communities and organizations that face the arrival of new mining and energy projects labeled as “green". On the other hand, to contribute to the global debates that communities, social-environmental movements, civil society organizations, and researchers on just and popular energy transition. We understand the idea of “energy transition” as a contested concept, and we align ourselves with what is described by some as a popular energy transition (Bertinat et al., 2020) and social-environmental transformation (Araya et al., 2023), understanding that the only fair transition is one that is also a transformation towards post-extractivism (Fernandes, 2024; Fuentes et al., 2020).

Based on this perspective, this report explores some of the implications of the "cheapening" and hoarding of resources and territory in a particular region—Antofagasta—which will allow a more granular visualization of the possible impacts of the development of the hydrogen industry. This allows us to understand these impacts within, and in synergy, with the extractive and industrial processes already in place. While it is not possible to make a "current" analysis of the material footprint of the green hydrogen industry and its derivatives (because it has not yet materialized), we hope that this information provides a better understanding of the real social-environmental implications of this country-wide gamble in light of the simultaneous implementation of the National Lithium Strategy and the National Green Hydrogen Strategy (*Estrategia Nacional del Litio and Estrategia Nacional del Hidrógeno Verde* in Spanish, respectively).

After the next section detailing the background for the public policy that has promoted green hydrogen in Chile, the section "Results: territorial diagnosis of the green H_2 industry and energy infrastructure in Antofagasta" describes the different infrastructural elements related to the hydrogen industry, project by project, around the five hubs of the study. The selection of conflicts and elements of the green hydrogen system does not seek to be comprehensive, but to represent a variety of impacts and territorial implications from different social-environmental edges. Infographics and maps illustrating the interconnection of the different projects with the existing mining industry are also presented.

The information included in the case files was gathered through publicly available information, specially in environmental impact assessments and declarations, and complemented with the accounts and legal processes that the different communities involved shared with us. Fieldwork to incorporate the comments, impacts and worries of the communities affected by the projects was carried out by the authors of the report between March and October 2024. Written and oral interviews were also conducted with three experts quoted in the report: Dominique Durand, Ricardo Pino and Juan Larraín. The communities and organizations that participated in the report by sharing their testimonies in different instances, including a collective mapping workshop held on October 22, 2024, are listed in Table 1.

Table 1: communities and organizations that participated in the research process:

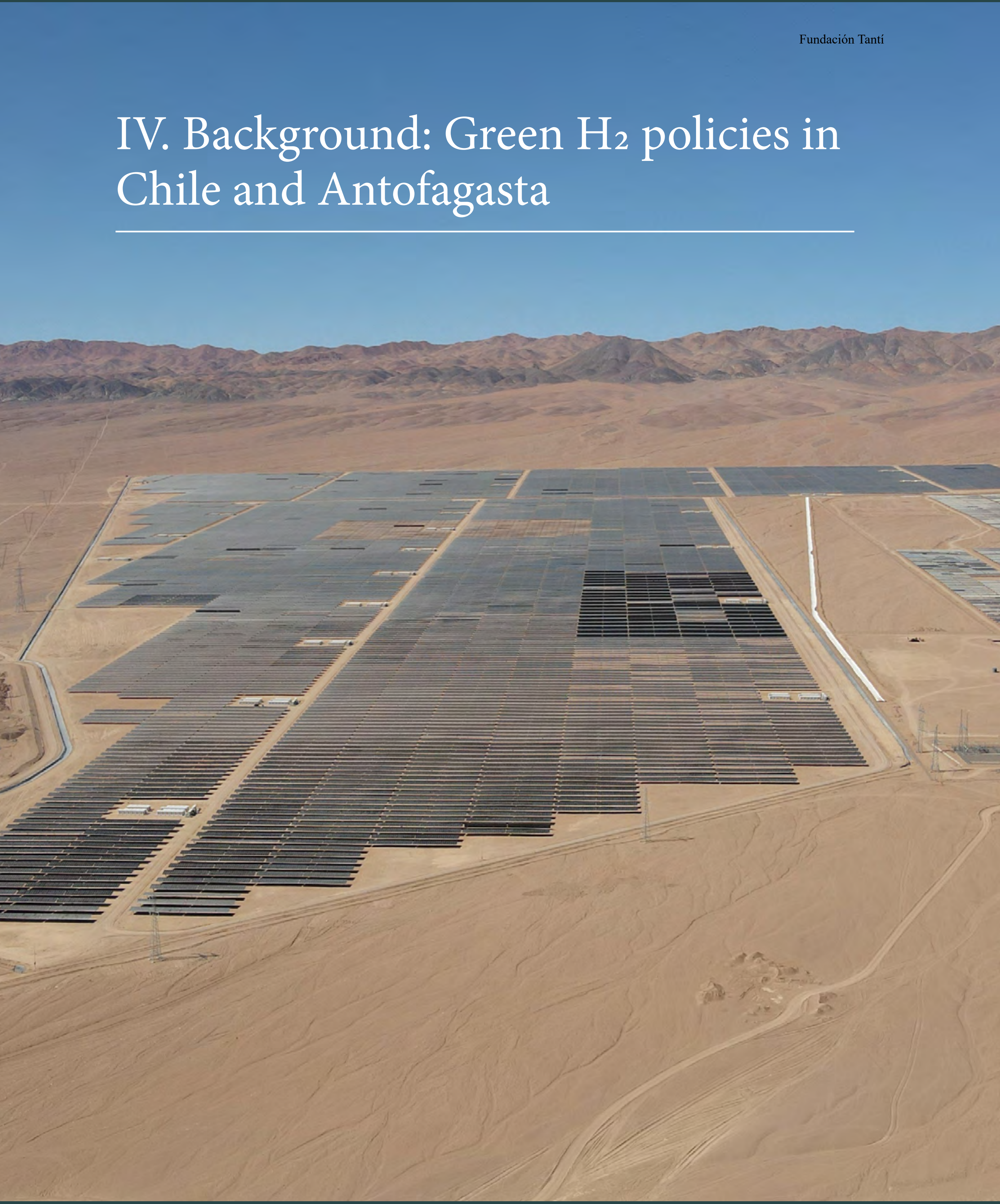
Antofagasta Region
Agrupación Camanchangos Caleta Cobija (Chango group)
Agrupación Changos Camanchacos de Salitre (Chango group)
Agrupación Changos de Tocopilla (Chango group)
Agrupación de Pescadores Artesanales y Asociados de Hornitos (group)
Agrupación Indígena Changos Tierra del Sol Hornitos (Chango group)
Agrupación Los Cazadores del Gaucho y la Agrupación Recolectores de La Playita (Chango group)
Agrupación Nelson Manríquez (group)
Changxs isla Santa Maria (Chango group)
Comunidad Atacameña Agrícola y Cultural Kamac Mayu Hijos de Yalquincha (Atacameño community)
Comunidad Atacameña San Francisco de Chiu-Chiu (Atacameño community)
Comunidad Atacameña Yalquincha Lickan Ichai Paatcha (Atacameño community)
Comunidad Changa Estrella Recolectores La Playita (Chango community)
Comunidad Indígena Changos Almendares del Gaucho (Chango community)

Comunidad Indígena Elly Morales, Mujer de Lucha, Alguera y Ganadera, Sector La Playita y La Rinconada (Chango community) *Comunidad Indígena Pabla Almendares de Peralito, Salitre y Paposo* (Chango community) *Comunidad Lickan Antay de Toconao* (Lickan Antay community) *Cooperativa Los Changos de la Península de Mejillones* (Chango cooperative) *Coordinadora por la Defensa del Río Loa y la Madre Tierra (coordination group)*
Atacama Region
Consejo Nacional del Pueblo Colla (National Council of the Colla People; Copiapó)
Valparaíso Region
Mujeres de Zona de Sacrificio en Resistencia (collective)

Information regarding the annexes: annex 1 contains a detailed description of renewable energy and green hydrogen projects reviewed in this report. Annex 2, which gathers every known project of green hydrogen and its derivatives in Antofagasta, was made by compiling and cross referencing information from different sources: for the projects already submitted to the Environmental Impact Assessment System (SEIA in Spanish), the information provided by the proprietors for evaluation was used, plus independent research on the ownership of the investing companies (not always directly represented in the projects' evaluation). This list was complemented with the available information on the green hydrogen projects registered with the National Electricity Coordinator by July 2024 and, finally, with the information published on the website of the *Asociación Chilena de Hidrógeno* (Chilean Hydrogen Association) in October 2024. Due to the high volatility related to hydrogen, it is possible that a lot of the projects here described as pre-feasibility and feasibility studies have changed their status after publishing this report.

Lastly, annex 3 compiles the NCRE projects in the region, including from those already in operation to those undergoing environmental assessment. It was made following two methodologies: in June 2024, a list of all photovoltaic and wind farms under construction and operating in the country was requested under the national transparency law to the Ministry of Energy. The results also included hybrid farms, which were incorporated into the analysis. The energy potentials presented in the EIA (Environmental Impact Assessment) and EIS (Environmental Impact Statement) of the projects were corrected to the net capacity of the generation project reported by the National Electricity Coordinator in November 2024 for farms already in operation. The information on that database was adapted to gather in a single line the parks of the same file presented on the database delivered under different construction stages. The database was then supplemented with information on the parks under evaluation and already approved but not yet built, using the SEIA search engine and covering until 2024/10/30.

IV. Background: Green H_2 policies in Chile and Antofagasta



Photovoltaic park near the Imilac salt flats. Credits: Nelson Manquián (2024).

IV. Background: Green H_2 policies in Chile and Antofagasta

a. National Strategy and Action Plan for Green H_2

The National Green H_2 Strategy launches in November 2020. The original expectation stated there was to reach 300 GW of green H_2 generation capacity by 2050 (Ministerio de Energía, 2020). In comparison, in October 2024 there were only 34.5 GW of installed capacity in the National Electricity System, of which 47% (16 GW) are from NCRE Comisión Nacional de Energía, 2024).

The Strategy was updated through the creation of the Green H_2 Action Plan (*Plan de Acción de H_2 verde* in Spanish) during the year 2023. The final report was published in April 2024. This document aimed to detail the governance structure of hydrogen in Chile, prioritize lines of action, and define different windows for implementing measures. It includes various financing instruments. The new measures aim to promote domestic demand for hydrogen through an Emission Trading System (*cap-and-trade*). It also takes into account the creation of public environmental baselines (action 21). The measures relevant to the Antofagasta region are as follows:

Action 2

Creation of regional roadmaps. It mentions the creation of the Regional Green Hydrogen Commission of Antofagasta, who should be responsible for producing the region's roadmap.

Action 11

Continuation of allocation of fiscal land for the hydrogen industry, including speeding up the Ventana al Futuro process.

Action 24

It continues with the idea of bidding fiscal land for the green H_2 value chain.

Action 29

Promoting the "use of desalinated water and/or water reuse for activities such as industrial use" (Ministerio de Energía, 2024a, p. 114). It also includes the need to establish a regulatory framework and allow the Ministry of Public Works to "supply and grant".

Action 36

It incorporates the green H_2 and its derivatives to the planning and territorial management instruments, including the Intercommunal Regulatory Plan of the Antofagasta Coastline, the Mejillones Communal Regulatory Plan (*Plan Regulador Comunal* in Spanish, hereafter PRC), and in the future the Regional Territorial Management Plan (*Plan Regional de Ordenamiento Territorial* in Spanish hereafter PROT) of Antofagasta, the Zoning of Antofagasta's Coastline Use, and the PRC of Taltal and Tocopilla (the latter as a transition area).

Action 37

Related to the determination of two provinces of Antofagasta as Electric Power Generation Development Poles in the last Long Term Energy Planning (hereafter PELP, in Spanish; 2023-2027): Antofagasta and Tocopilla. Both were decreed in 2024 as Development Poles of Electric Power Generation (*Polos de Desarrollo de Generación de Energía Eléctrica* in Spanish, hereafter PDGE). In parallel, Regional Energy Strategic Plans (*Planes Estratégicos de Energía Regional* in Spanish, hereafter PEER) are created for Antofagasta and Magallanes. It must undergo Strategic Environmental Assessment and be ready in 2026.

Action 40

Creation of Logistics Master Plans throughout the country, prioritizing Magallanes and Antofagasta. It includes the creation of a Logistic Development Plan (*Plan de Desarrollo Logístico* in Spanish, hereafter PDL) for the Antofagasta region. Antofagasta's PDL should be ready by 2025 and undergo public consultation.

The relevance given to the region in the Green H_2 Action Plan comes from its centrality as a driver of domestic demand for this vector. Estimates made in 2021 stated that the Antofagasta region as a whole should cover between 10 to 24% of the total domestic hydrogen demand (Ministerio de Energía, 2021a, p. 88).

b. *Ventana al Futuro* ("Window to the Future") Initiative

This initiative, approved in November 2021 during Sebastián Piñera's term, is called *Plan de Fomento a la producción de hidrógeno verde en territorio fiscal* (Plan to promote the production of green hydrogen in fiscal land; Res. Ex N° 998/2021). *Ventana al Futuro* ordered an exceptional period of direct land allocation, without an open tender, under the condition of being used to generate energy for green hydrogen production (Ministerio de Energía, 2021b). The program hosted 12 of the 16 green hydrogen projects nationwide in the Antofagasta region (Ministerio de Bienes Nacionales, 2023). By the end of November 2024, three bids were known to have been approved. First, the project *Planta de Producción de Hidrógeno Verde para el Distrito Minero de Calama* (Green Hydrogen Production Plant for the Calama Mining District; detailed in this report). Second, *Proyecto H2V Tocopilla* (H2V is the Spanish abbreviation for green hydrogen or GH2) from *EDF En Chile Holding SpA* and *HYTEC SpA* (Decreto Exento E-396_2023). The latter, which covers 400 hectares, was announced to the press in 2023 as ready for environmental assessment (Consejo de Políticas de Infraestructuras, 2023), but by September 2024 it had still not been submitted. Lastly, there is the *Proyecto H2 Mejillones*. Announced as awarded in September 2024, the decree states that the project will be located 5 kilometers southwest of the city of Mejillones.

Another project awarded under this initiative is "HOASIS". According to the company's website, HOASIS will have a 6 GW photovoltaic power station with 3 GW capacity to synthesize green hydrogen. If built, it would become the largest photovoltaic power station in Latin America. That is considering that the largest plant currently under construction (the Puerto Peñasco Photovoltaic Power Station in Sonora, Mexico) has a capacity of 1 GW (Mongabay, 2023).

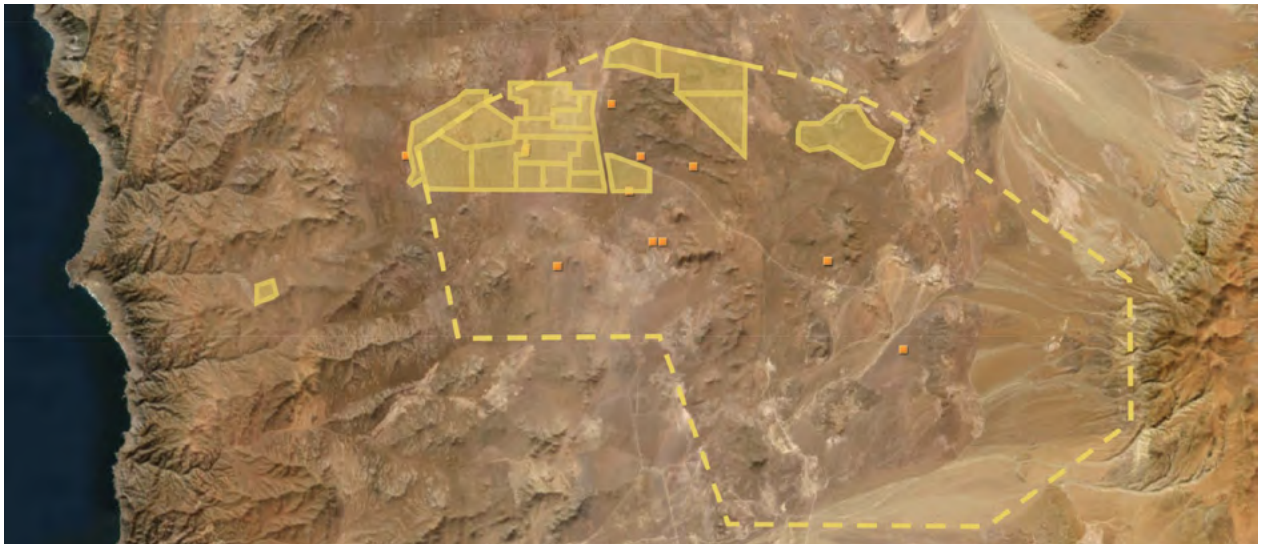
Something crucial to consider is that *Ventana al Futuro* did not have a prior environmental assessment to evaluate the appropriateness of producing energy and synthesize green H_2 on the land allocated for this purpose. The details of the projects presented under the initiative are also not publicly available.

c. Transmission expansion and the Taltal wind reserve

By 2023, the annual report of the National Electricity Coordinator that proposes expanding the transmission nationwide still did not directly reference the integration of the green H_2 industry's energy needs to the national electricity network. In 2024, this changes and is incorporated into the long-term total estimates. This raises the increase in installed capacity by 2043 to 70 GW in the "Alto+GH2" scenario (Coordinador Eléctrico Nacional, 2024, p. 29). As a reference, the scenarios for increasing total installed capacity at the national level in 2023 ranged "between 55.0 GW and 60.2 GW by 2042" (Coordinador Eléctrico Nacional, 2023, p. 25). At the same time, it is mentioned that "the consumption associated with GH2 exports is concentrated in the Antofagasta region" (Coordinador Eléctrico Nacional, 2024, p. 50). The other hubs, smaller in size, are in the Valparaíso and Bío Bío regions.

The Coordinator's report also includes a methodology to assess the environmental and territorial risk of the different hydrogen projects. Project Paracelsus (not yet submitted to the SEIA) stands out amongst them. The power generation plants for this project would be located 7 kilometers from the Cerro Búfalo Prospecting and in the Imilac salt flat sector, protected under DGA resolution 529/2005[1] (Coordinador Eléctrico Nacional, 2024, p. 59). According to the information published by the company, Paracelsus also considers transportation of the product to Mejillones for export. This project therefore affects two of the indigenous communities covered in this study: the Lickanantay Atacameño community of Peine and communities of the Chango people throughout the coast of the region.

Finally, while most NCRE projects are solar, there is a zone called "Taltal Reserve Area". The area was defined in 2019 in the Ministry of National Assets' tender plan prioritized on the 2023-2028 PELP as a sector to prioritize the development of wind power projects. The so-called reserve has been divided into different areas for tender. The first tender cycle began in December 2020. Image 1 shows the total area of the reserve in dotted yellow lines (the file is not available in kmz or kml on the National Assets' website). The orange dots are wind measurement towers.



Picture 1: Zone called "Taltal reserve area". Source: retrieved 2024/11/19 from https://licitaciones.bienes.cl/licitacion/reserva-eolica-taltal/

[1] Elsewhere in this report this resolution is cited as "529/2003" as this is how it is registered on the website of the Water Directorate General https://dga.mop.gob.cl/administracionrecursoshidricos/areasprotegidas/Paginas/default.aspx

d.International actors

Various international financial and political organizations have played a leading role in influencing the development perspectives of the hydrogen industry and its derivatives in Chile, as well as the expectations of financial viability in the medium and long-term. In this section we will focus on 2 actors: the European Union (EU) and the cooperation agencies of European countries, and the World Bank. In addition to this, the consulting firm McKinsey & Company played a role in creating the document that served as the base for the National Strategy released in 2020 (McKinsey & Company, 2020). There, the competitiveness of renewable photovoltaic energy in Antofagasta and wind power in Magallanes was established. This document was also the first to suggest the need to reduce bureaucracy in relation to licensing and permits, including facilitating the access to water sources (McKinsey & Company, 2020, p. 62).

The European Union and international cooperation

The EU has designed a series of policies and financial instruments to promote hydrogen beyond its borders, with the goal of importing it to serve its own decarbonization goals (Hartlief et al., 2024; Nualart Corpas & Gros Beto, 2024).

The EU-Chile Association Agreement active since 2003 was modernized during 2023 and the Advanced Framework Agreement was signed at the end of the same year (Ministerio de Relaciones Exteriores, 2023). In this process, various mechanisms were established for the cooperation of both parties in relation to renewable energies and hydrogen, as well as access to the so-called “critical materials” such as lithium. Later, in November 2024, the development of a roadmap for the certification of “renewable” hydrogen between Chile, the European Union and the Latin American Energy Organization (OLADE in Spanish) was announced. The "ADELANTE 2"[2] Program will allow hydrogen produced in Chile to access European markets. Another initiative related to the framework is the Team Europe Project[3] co-financed by the European Union and the Federal Ministry of Economic Affairs and Climate Action of Germany (BMWK in German). Its goals are financial, business, technical, and technological cooperation. Furthermore, the Spanish Cooperation Agency (hereafter AECID, in Spanish) participated in the creation of the Green Hydrogen Explorer[4]. Also, in cooperation with the European Union and the AECID, the project *Diálogos país para la reducción de asimetrías de conocimiento sobre el H2V Región de Magallanes y Región de Antofagasta* (National dialogues to reduce knowledge asymmetries on GH2, Magallanes and Antofagasta Region) was carried out during 2022 and 2023 (Sánchez & Aedo, 2023).

Prior to these announcements, as part of the technical cooperation with the EU, three companies, described below with their respective projects, were awarded in 2022 the cofunding of pre-investment studies of projects for green hydrogen production, storage, transport and/or use (Fondo bilateral para el desarrollo en transición Chile-Unión Europea, 2022, p. 12):

1. Antuko Comercialización SPA: Project Génesis, Antofagasta Described as destined for internal consumption (details below). The project was submitted to the SEIA for a relevance consultation, and it was indicated as not needing to enter the environmental evaluation process[5].

---

[2] https://www.adelante-i.eu/

[3] https://teameuroperh2.com/

[4] https://hidrogenoverde.minenergia.cl/

[5] No further news of its materialization. The latest news for this project is from Septiembre 2022 https://www.eleconomista.com.mx/empresas/Lanzan-proyecto-de-hidrogeno-verde-en-Chile-por-70-millones-de-dolares-20220926-0134.html

2. *Empresa Eléctrica Pilmaiquén* S.A (belongs to Statkraft). "PAUNA GREENER FUTURE" Project Intended for the export of green ammonia (specifically to Rotterdam) for energy replacement. As of November 2024, it was still in the prefeasibility process. The Pauna solar farm (located in Tocopilla) that will be linked to the plant was approved in 2022 with an Environmental Impact Statement. The SEIA does not record any citizen's participation activity associated with the project. In an interview given in March 2023, Statkraft mentions that they are still looking for partners to develop the ammonia/ammonium plant (La Tercera, 2023).

3. *Grupo Cerro*. H_2 plant associated with Cerro Dominador. It was at the time of the announcement in the pre-feasibility phase. Production would be oriented to the domestic market, particularly for transportation and mining (machinery and trucks). Hydrogen is also planned to be used to generate electricity again (power to power). There is no further news of this project to date.

World Bank

The World Bank, in turn, has announced a 350 million USD loan for Chile aimed at hydrogen and divided into stages. The first part, consisting of USD 150 million for the development of the H_2 industry, was approved in 2023. The project title reads "Green hydrogen facility in Chile to support a green, resilient and inclusive economic development project" (World Bank, 2023). It will oversee the Chilean Production Promotion Corporation or Corfo in Spanish. In its announcement, the World Bank mentions that the loan will "mainly benefit the local communities where clean hydrogen will be made and used, and that it will contribute by creating green jobs, boosting the economy and decarbonizing local industries". As Seeger (2023) points out, this project has been deemed as having considerable social and environmental risk.

Some companies prioritising the development of green H_2 in Chile are: Anglo American, Enel Green Power, SQM, Codelco, Antofagasta Minerals, Engie, Colbúm, Aes Chile, RWE, Andes Solar, and Antuko. All of them are part of the Chilean Hydrogen Association.

e. Ecosystem impacts of energy infrastructure: water use and impact on wildlife

From the perspective of EUE, water and aquifer impacts related to the hydrogen industry are methodologically difficult to integrate. Material footprint studies, such as those cited in the previous section, do not usually include water. There are also studies that measure the water needed to create certain products through quantifications of virtual water contained in a product. But these indicators are necessarily incomplete, and do not capture the indirect disturbances produced by extractive processes, which are often deliberately undocumented or difficult to quantify. In its methodological development, processes like measuring the water footprint have often also been separated from their broader social and political context (Beltrán & Velázquez, 2015). As expanded in section "Territorial Diagnosis", this blindness to complex impacts on the basins is particularly present in the lithium industry (Babidge et al., 2019; Blair et al., 2022, 2023).

Direct and indirect uses of water in hydrogen production

As mentioned before, one of the key concerns in hydrogen production via hydrolysis is its high-water demand. The solutions to cover this water demand in the processes already submitted or in the design phase in Chile have been mainly two: the use of wastewater, and the use of desalinated seawater. In 2022, the Scientific Committee on Climate Change (an advisor to the Chilean Ministry of Environment) estimated the use of desalinated water for the hydrogen industry based on the goals of the National Green Hydrogen Strategy towards 2030:

> The 25 GW in electrolysers could be supplied by 25 GW of NCRE installed capacity, which with an estimated plant factor of 29% would allow supplying 175,000 MWh/day. This energy would be enough to produce 3,500 tonnes of hydrogen each day (assuming a H_2 consumption of 50 kWh/kg). Finally, if 11 L of H_2O/kg H_2 are required, this results in the need for 38,500 m³ H_2O/day or 446 L/s. Following the example of the previous section, this figure represents about 5% of the current production of desalinated water, which amounts to 8,535 L/s. (Vicuña et al., 2022, p. 73).

However, this calculation contrasts with other estimates that also consider indirect water use in the process. Beyond the direct use in the hydrolysis process, the impact on watersheds of the electricity generation and transmission infrastructure, which will be essential to sustain hydrogen production, must be considered. Electricity production for hydrogen synthesis also requires water. As a general estimate "to generate 1 kg of H_2 (...) between 50 and 55 kWh of energy is consumed (IRENA 2020), this would mean a consumption of between 17 and 18 L of H_2O to produce the photovoltaic energy and between 2 L of H_2O to produce the required wind energy" (GIZ, 2023, p. 16) for that kilo of hydrogen. Thus, the same study points out that to produce 1 kilo of green hydrogen via the PEM electrolysis process, 35 litres of distilled water are required (GIZ, 2023, p. 18). Following this calculation, we can increase this estimate to at least 15% of the current production of desalinated water.

The use of desalinated water has social-ecological impacts on multiple levels. In the return of brine to the sea, as indicated in the same report cited above, the discharge of effluents generates "osmotic stress on both pelagic and benthic organisms, as well as negative impacts on the operation and structure of coastal marine communities and ecosystems (Ihsanullah et al., 2021)" (Vicuña et al., 2022, p.88), among other effects. These effects transcend salinity and refer to the impact of other compounds used in the desalination process, such as "antiscalants, anticorrosives, antifouling, and heavy metals" (Vicuña et al., 2022, p.82). It is also noted that seawater harvesting has important ecosystem impacts (Vicuña et al., 2022). It is also key to consider that today's environmental regulations do not consider "maximum salinity limits for discharge of liquid waste into marine water bodies in or outside the Coastal Protection Zone" (Vicuña et al., 2022, p.82). The presence of desalination plants also impacts local communities, "including the closure of recreational spaces, local transportation, noise and air pollution, aesthetic depreciation, inbound and outbound traffic for the transportation of materials, among others" (Saavedra Löwenberger et al., 2023, p. 7).

In this context, it is important to note that there are currently no mechanisms to measure synergistic and cumulative impacts in territories highly affected by desalination, such as the coast of Antofagasta (Couve et al., 2023), nor is there a regulation that allows integrating the operation of desalination plants as part of an integrated watershed management (ONG FIMA, 2023). Antofagasta already has 13 desalination plants to date, with a production capacity of 6,603 L/s representing 77% of total national capacity. 59% of this total is for mining (Vicuña et al., 2022, pp. 55-57). It also houses the largest plant in the continent located in Puerto Coloso, Antofagasta, property of the BHP mining company (ACADES, 2024, p. 8).

At the same time, no methodologies addressing the territorial synergistic impacts on watersheds are considered in the current environmental assessment. In the extraction of lithium, for example, at the level of water use rights, the water extracted from brines is not considered within the ceded liters per second. This makes it difficult to quantify how current extractive activities affect the region's watersheds, and to make an informed assessment of the sustainability of installing new industries that essentially depend on constant water use for their operation.

Ecological impact of solar and wind energy infrastructure

Regarding the impact of solar and wind infrastructure, Hamed and Alshare (2022) show different impacts at the biodiversity level. The following is a summary of their findings regarding **solar** technology:

- In California, the use of surface for panels and the creation of shade by them was found to alter the microclimate (and therefore the vegetation) of arid areas.

- The dust raised and vegetation removal during the installation of the panels also affects the landscape. Dust suppressants (windows and panels) also can have negative impacts on biodiversity.

To this, the authors add the effect of transmission lines that displace wildlife, degrade habitats, and introduce new communities.

Regarding water:

- There is a minimum water demand during installation for both solar technologies. In the case of solar thermal technology (also known as Concentrated Solar Power), the demand comes from the type of cooling, which may use water (when used, the amounts of water are like those needed to cool a nuclear plant). Water is also used to clean the mirrors in the panels. Photovoltaic panels require less water.

Other environmental issues identified by Hamed and Alshare (2022) are:

- Photovoltaic panels may increase their temperature to 70°C or more, influencing the microclimate in the immediate vicinity (p.7). Concentrated Solar Power technology can increase surrounding albedo (that is, more heat from the son gets reflected onto the environment). Greater shade can also increase or decrease the temperature of the surrounding soil.

- Other reports highlight the urgent need for more scientific evidence and experimental studies to determine the impact photovoltaic panels have on birds and bats (Harrison et al., 2016; Visser et al., 2019). Particularly, the added effect of various projects, because "although the impact of a single facility might be relatively trivial, environmental impacts can be compounded when multiple developments are erected, with unknown consequences on birds in the surrounding region." (Visser et al., 2019, p. 1292).

On the other hand, Hamed and Alshare (2022) also compiled the effects of **wind** power. They point out that it has direct impacts through the collision of birds with the blades, and indirect impacts through the disruption of habitats and the effect of avoiding the blades (p.8).

In the case of Antofagasta, impacts could be seen on particularly vulnerable species. The installation of wind farms in flamingo nesting sites could pose serious threats to this species' fledglings. As Dominique Durand, director of conservation projects at Symbiótica Foundation points out, at birth flamingos are left in the care of wet nurses, who accompany them in the months in which they learn to fly. With no clear path for their flight, having wind towers nearby becomes a potentially fatal obstacle for these birds. In addition, flamingos orient themselves with echolocation, which is altered by the waves that the blades produce, thus affecting the birds' migratory routes.

At the level of national legislation, the effects of wind turbines on avifauna are regulated by the document *Guía para la Evaluación del Impacto Ambiental de Proyectos Eólicos y de Líneas de Transmisión Eléctrica en Aves Silvestres y Murciélagos* (Guide for Assessing the Environmental Impact of Wind Projects and Electrical Transmission Lines in Wild Birds and Bats) of the Agricultural and Livestock Service (In Spanish *Servicio Agrícola y Ganadero*, hereafter SAG). This manual dates from 2015 and has not yet included the recent evidence or the rapid expansion of wind megaprojects in the country. A new guide was being developed in November 2024.

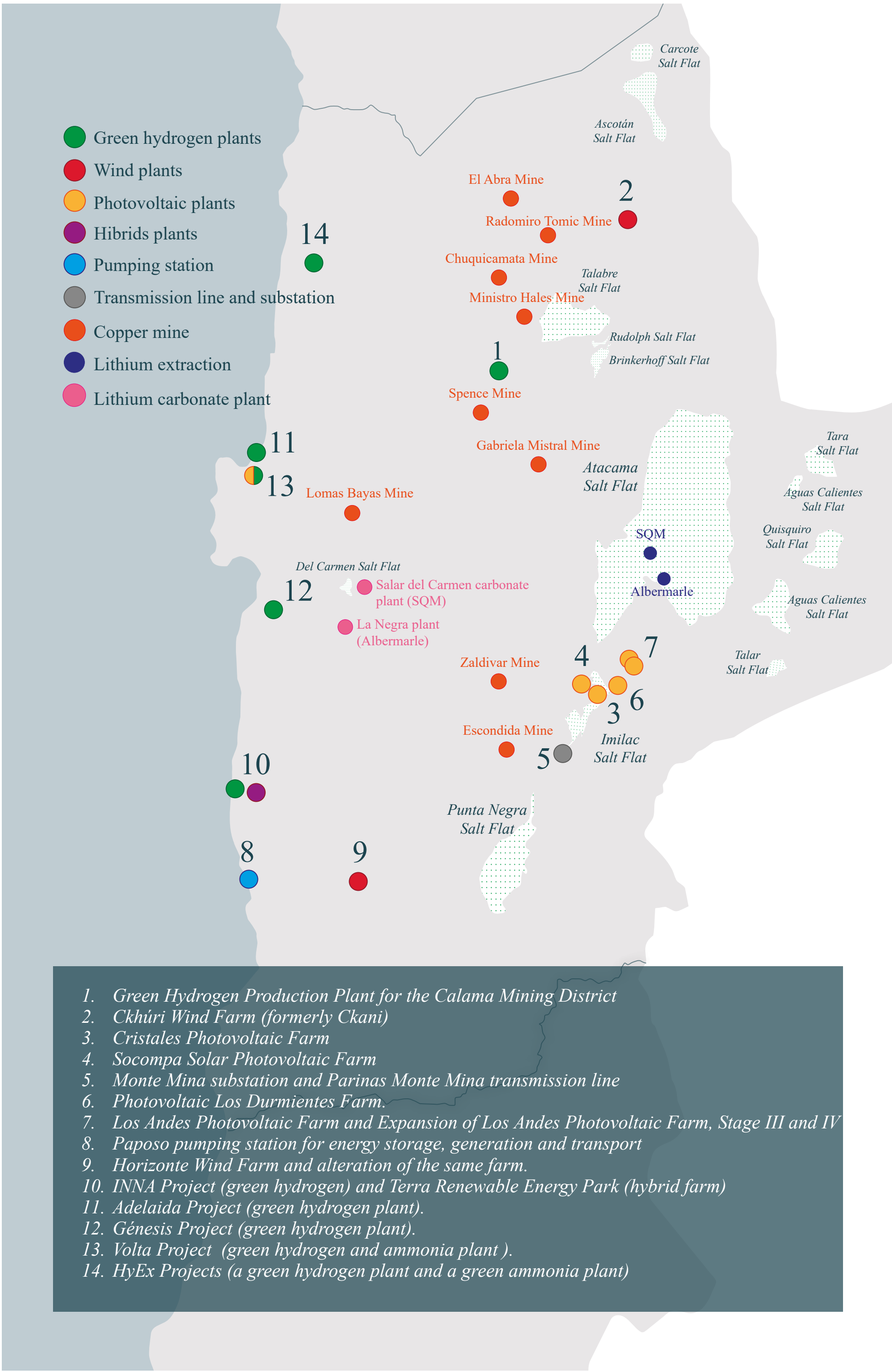
V. Results: Territorial diagnosis of the green H_2 industry and energy infrastructure in Antofagasta

The goal of the cases reviewed here is to show the interrelationships of various extractive and industrial processes in the region. As shown in **picture 2,** the infrastructure related to both energy and, specifically, hydrogen, is supported by previous extraction and exchange patterns, mainly related to mining.

Ckhúri wind farm with San Pedro and San Pablo volcanoes in the background.
Credits: Ramón Balcázar M. (2024)

Picture 2: infographic of the industrial and extractive circuits of mining and energy in the region of Antofagasta. Own elaboration.

The five nuclei of the Antofagasta region selected for the study are presented below. Two of them are in the Andean zone (Calama y Peine), and three in the coastal and inland areas south of the region (Taltal, Mejillones and Tocopilla). **Picture 3** shows the location of the 14 projects detailed in this section alongside the copper and lithium mines, in addition to the lithium carbonate processing plants in the Antofagasta region.



Picture 3: location of the projects described in the report next to mining activities in the Antofagasta region. Own elaboration

a. Andean Antofagasta

The “pre-Andean” and “high Andean” territories and ecosystems of the region are affected by several preexisting social-environmental conflicts before the arrival of NCRE projects and the implementation of the national green hydrogen and lithium strategies. The simultaneous expansion of energy and mining transition projects represents a bigger pressure on common goods such as water, historically obtained from Andean territories for mining and whose availability is increasingly threatened. While the Atacama Salt Flat is an emblematic case of water and socio-environmental depletion produced by the added impacts of copper and lithium mining (Blair et al., 2022, 2023; B. Jerez et al., 2021) in the Atacameño or Lickanantay indigenous peoples' land, there are other examples that illustrate the social-environmental risks of the mining expansion under expansion. Amongst them, we can mention the case of the Talabre salt flat, located between Calama and San Francisco de Chiu Chiu, where state-owned Codelco has turned the salt flat into tailings of a project that was opposed by communities and social-environmental movements from the territory and that was finally carried out without consultation. Alarmed by the contamination of the Loa river's aquifer via seepage from this reservoir, local communities filed a complaint with the Environmental Superintendency (*Superintendencia del Medio Ambiente* in Spanish, hereafter SMA) in 2023 (file DFZ-2023-2246-II-RCA). In August 2024, the SMA filed charges against Codelco for noncompliance with environmental measures in this salt flat now turned to tailings. The San Francisco de Chiu-Chiu Atacameño Community also filed a complaint with the Inter-American Commission on Human Rights in October 2023 (REF P-2397-20).

In 2020, the State Defense Council (*Consejo de Defensa del Estado* in Spanish, hereafter CDE) sued *Minera Escondida* for the environmental damage in the Punta Negra salt flat, located within the territory of the Peine Community and close to the Atacama Salt Flat. The "continuous, cumulative, permanent, and irreparable damage" (CDE, 2020) was caused by the extraction of water from the salt flats for copper mining. The parties – Escondida, the CDE, the Atacameño Community of Peine and the *Consejo de Pueblos Atacameños* (Atacameño People’s Council) – reached a Settlement Agreement in 2021 that includes a management plan for the recovery of the salt flat based on reinjecting the water extracted from aquifers. In the opinion of residents and specialists, these agreements do not represent the real damage caused by companies that will rather pay for mitigation plans if the state ensures the continuity of environmental licenses, and their extractive operations are not affected. Furthermore, the technique of wetland recovery through reinjection is not producing the expected results and, on the contrary, could be causing new damage to microbial systems and macrofauna. From these cases, we can see that companies operate without the social license of the local communities, as they are not consulted on the installation, expansion or continuity of mining projects. We can observe from this research that these dynamics are replicated with the arrival of energy projects in the same territories and the region as a whole.

1. Calama

1. Green Hydrogen Production Plant for the Calama Mining District

Company: Susterra.
Date of entry: 20-12-2023.
Submission method: Environmental Impact Statement (EIS).
Status: EIS under review.
Investment amount: 423,000,000 $US.
Capacity: 200 MW electrolysis capacity at the final stage.
Surface: 13.5 ha.

About the project:

- The land that would house the project was granted in concession for onerous use as part of the Ventana al Futuro initiative. Although it is proposed as a “green” hydrogen project, it does not contemplate associated power generation. The project indicates that the electricity supply will come, in a first stage, from the Valle de los Vientos substation. Later, when capacity is increased, it will be connected to the Calama - Nueva Lasana power line.

- The *Coordinadora por la Defensa del Río Loa y la Madre Tierra* informed us that participation in this project was very low, and that there was little dissemination of the project in general, despite the existence of channels designed for it. Only a few indigenous communities and organizations were invited. Access to the river has been limited in the area where the plant will be installed.

- The project proposes to use treated sewage (from the TRATACAL company) as input for the electrolysis process. In the later stages of higher production, water would be obtained “through pipes in connection with ADASA's La Vaca aqueduct, which will correspond to raw water and quality will be defined by the quality at the catchment area” (according to the DGA document delivered during the evaluation of the project). This was pointed out as insufficiently accurate by the DGA. At the same time, as mentioned by the Committee, the purpose of treating this water is to return it to the river. This project would interrupt this process.

- The proprietor company requested the suspension of the assessment procedure until January 31, 2025.

2. Ckhúri Wind Farm (formerly Ckani)

Company: Mainstream.
Date of entry: 04/05/2011.
Submission method: Environmental Impact Statement.
Status: EIS approved 2011/12/14. Construction began in October 2020, and after some suspensions, work was resumed.
Investment amount: 500,000,000 $US.
Capacity: 200 MW.
Surface: 114.73 ha.

About the project:

- This wind farm is located northwest of Calama, between Lasana and San Pedro Station, in the Alto Loa Indigenous Development Area, whose electrical connection will be at the El Abra Mining Company's substation.

- Robinson Galleguillo's account, president of the *Comunidad Atacameña San Francisco de Chiu-Chiu*, tells the following: At the beginning of the construction of the complex, Mainstream entered a conversation with the community regarding the transit of components, in which they required authorization to use routes B165, B169 and the bypass from Inka Coya Lake to route CH21 near Codelco's camp. A collaboration agreement was signed during the conversation with the company and community monitors from the communities of San Francisco de Chiu-Chiu, Lasana and Conchi Viejo, and Estación San Pedro were also incorporated.

- These monitors realized that the construction of the farm was revealing new archeological discoveries that the company was not respecting, violating their integrity by continuing the works. These findings include ancient roads called "rutas troperas y caravaneras" (picture 4) with important archaeological remains such as pottery and copper "challa" traces. The 4 communities then reported this situation to the National Monuments Council (*Consejo de Monumentos Nacionales* in Spanish, hereafter CMN) and the Environment Superintendence (*Superintendencia de Medioambiente* in Spanish, hereafter SMA) for archeological damage.

- Due to the report, the project was halted in January 2022 after the CMN ordered its stoppage in December 2021. Work was resumed in September 2022 under a new protocol that sought to guarantee the protection of archaeological discoveries. The goal was to advance by predefined work polygons, only beginning the next stage once the previous one had been completed and evaluated.

- Nevertheless, the communities involved in the project noted that work was being carried out in a new polygon at the end of 2022. When the company was consulted on the matter, they indicated that they had authorization to move forward. But the CMN confirmed in February 2023 that "the proprietor is executing unauthorized works in areas where it has not obtained the CMN's approval to do so". Works were ordered to stop once again as a result.

- The National Monuments Council sent an official notice to the Environment Superintendence and the State Defense Council (*Consejo de Defensa del Estado* in Spanish, hereafter CDE), who, according to the information received, must rule according to the impact that Mainstream company caused to the territory and the archaeological heritage of all Chileans, which is also protected by law. To date there is no ruling by any of the parties mentioned, creating a form of demotivation and concern on the Chiu-Chiu Community.

- Since February 2023 to date, the company has made economic offers to social organizations of the town (non-representative), which, faced with the company's economic offer, have decided to sign agreements without knowing to date what kind of rights they may have waived as indigenous peoples. The company has not wanted to reveal details, but the community believes that there could be a violation of fundamental rights established in indigenous law and international treaties signed by our country, such as the ILO Convention 169. This practice is common with foreign companies that own projects that affect the territory, since in a certain way they seek to silence the voice of people close to the worksites.

- At the time of finishing this report, the CMN has lifted the sanction put in placethe summer of 2023. The company is working normally in the Alto Loa territory, where important archaeological sites not surveyed by the company are at risk. These were, therefore, not reported to the SEA or the CMN in the baseline developed in 2011, thanks to which it was granted a favorable Environmental Qualification Resolution (*Resolución de Calificación Ambiental* in Spanish, hereafter RCA). An example is shown in picture 5.

Picture 4: "Ruta tropera" in the Ckhúri Wind Farm project. Credits: Robinson Galleguillos Morel.

Picture 5: Qapac Ñan Saiwas (Inkahuasi-Lasana stretch) that indicate sunrise on the winter solstice. A case of cultural landscape disturbance. Credits: Robinson Galleguillos Morel.

2. Peine (community)

In April 2023, the Peine's Lickanantay Atacameño Community alerted of a set of projects related to renewable energy infrastructure (Comunidad Lickanantay Atacameña de Peine, 2023). Here we consider the projects in this announcement located within the territorial claim of Peine, and in the Antofagasta commune. Elements include the planned expansion of the National Transmission System (one substation and transmission line) and three photovoltaic projects. For a better analysis, here we add a fourth photovoltaic park already existing in the vicinity of the Imilac salt flat.

None of the projects in this section was evaluated under the Environmental Impact Assessment (EIA) method, therefore, it did not require an indigenous consultation. During a visit to the area, we were also able to verify the presence of archaeological discoveries that have appeared with the progress of the construction of the new transmission lines.

As noted in section IV, it is in this area that the "Paracelsus" green hydrogen project is intended to be installed. However, the details of the location of this project are not yet public knowledge.

3. Cristales Photovoltaic Farm

Company: AES Andes.
Date of entry: 16-03-2023.
Submission method: Environmental Impact Statement.
Status: EIS approved 2024/03/27.
Investment amount: 710,000,000 $US.
Capacity: 379 MW (542 MW of BESS battery storage).
Surface: 515.5 ha. 26 km of High Voltage Line (81 towers).

About the project:

- As shown on picture 6, this project is adjacent to the Socompa project. The transmission line connecting it to Monte Mina substation goes above the Imilac salt flat area, a protected aquifer under res. 529/2003.

- During the project's environmental assessment, the Peine Atacameño community and the Peine Neighbour Association requested for the citizen participation process to start, which was granted. The reasons given included the proximity of the project to the Atacama la Grande Indigenous Development Area and the fact that it is in a particularly environmentally sensitive area.

4. Socompa Solar Photovoltaic Farm

Company: Lader Energy Renewable.
Date of entry: 23-05-2022.
Submission method: Environmental Impact Statement.
Status: EIS approved 2023/05/26.
Investment amount: 200,000,000 $US.
Capacity: 250 MW
Surface: 795.8 ha. 17.5 km of High Voltage Line (56 towers).

About the project:

- Located next to Cristales, this photovoltaic project's transmission lines also affect the Imilac salt flat area, a protected aquifer under res. 529/2003.

- Similar to the previous case, a group of 12 natural persons requested that the process of citizen participation be opened. However, the request was not considered, as the Environmental Evaluation Service (Servicio de Evaluación Ambiental, SEA in Spanish) pointed out that it did not indicate how the signatories would be affected by the project.

5. Monte Mina substation and Parinas Monte Mina transmission line project

Company: Transelec.
Date of entry: 2020/12/22
Submission method: Environmental Impact Statement.
Status: Initially rejected, later approved in 2022/02/12. At the time of finishing this report, it was under construction.
Investment amount: 105,600,000 $US.
Capacity: 308 High Voltage Line towers (123 km), 36 sectioning towers Nueva Zaldívar - Andes (2 lines of 5.8 km each)
Surface: 1,052 ha.

About the project:

- This substation would receive the high voltage lines for the Cristales, Socompa and Los Durmientes projects. As shown on picture 6, the electricity transmission infrastructure is moving towards the south to connect other projects located in the inland Taltal area.

- The project was initially rejected by the SEA in April 2022. Nevertheless, the company filed an appeal, and the project was approved in December of the same year. The SEA indicated in its original rejection that the project did not present enough background to rule out impactful effects according to Law 19,300, and that there was a need to carry out an Environmental Impact Study.

- In 2023, the Peine Atacameño community filed an appeal against the Environmental Evaluation Service due to the approval of this project (País Circular, 2023). Among their arguments, the community mentioned that the claim for environmental damage in the Punta Negra Salt Flat, which is in the process of recovery and would be affected by the transmission line, was not taken into account. The First Environmental Court left the claim in agreement.

6. Photovoltaic Los Durmientes Farm.

Company: RWE Renewables Chile.
Date of entry: 18-01-2024.
Submission method: Environmental Impact Statement**.**
Status: EIS under review. The proprietor company requested a suspension until 2025/02/28.
Investment amount: 300,000,000 $US.
Capacity: 257 MWp (includes 255 MWp BESS system).
Surface: 325.3 ha of photovoltaic farm + 137 ha of High Voltage Lines (462 ha in total).

About the project:

- Photovoltaic project located near Imilac Salt Flat. The Peine Community had to request the opening of the citizen participation process, which was granted. It would also connect to the Monte Mina substation.
- In the Peine Atacameño Community's claim published in 2023, the project was named "Pan de Azúcar".

7. Los Andes Photovoltaic Farm and Expansion of Los Andes Photovoltaic Farm, Stage III and IV

Company: AES Gener SA.
Date of entry: 2012/02/06 for the original project, 2020/01/16 for the extension.
Submission method: Environmental Impact Statement.
Status: Both EIAs were approved, in 2012/07/06 and 2020/08/03, respectively.
Investment amount: 572,000,000 and 450,000,000 $US**.**
Capacity: 286 MW for the original project, 489 MW for the expansion (both stages). The original surface of the project was 880 ha, and 684.5 for the expansion (1,564.5 ha in total).

About the project:

- ● The project, already built and in the process of expansion, is located between the Imilac salt flat and the Atacama salt flat, even closer to the community of Peine than the photovoltaic projects already mentioned. The original proposal was modified through a pertinence consultation[6] in 2019 to increase production and decrease the area used.

6 https://pertinencia.sea.gob.cl/api/public/expediente/PERTI-2019-2463

b. Coast of Antofagasta and interior of Taltal

Chango territory in the coast of Antofagasta

The Camanchaco or Chango people were recognized by the state of Chile as the tenth indigenous people only in October 2020. They are recognized as inhabitants of the Chilean coast between Arica and Valparaíso, and its main characteristic is its intimate connection with the sea. Their way of life is rooted in artisanal fishing and other coastal activities (Briceño Espinoza et al., 2024). Despite the historic achievement represented by this recognition by the state, its representatives from the Antofagasta region have denounced a series of irregularities in the legal conformation of their communities and in the exercise of their rights. The Chango territory is today the focus of multiple extractive projects, several of them related to the renewable energy industry. It also faces particularly complex projects that include power generation infrastructure, green hydrogen production and export infrastructure, such as large-capacity ports. Some hydrogen projects that are about to enter present "packages" of hydrogen production together with infrastructure for their export. At the same time, some coastal hydrogen projects (Adelaide, Genesis) have been (wrongly) described in the press as "approved" when going through the Relevance Consultation process, receiving the response that they should not be submitted to the Environmental Impact Assessment System.

On the other hand, the increasing evaluation and construction of wind farms in the so-called "Taltal Wind Reserve" is raising the alert in relation to the impact on avifauna. As noted by veterinarian and wildlife specialist Ricardo Pino,

> "The main impacts of wind projects on avifauna are the loss of reproductive habitat of seabirds that nest in the desert, such as Elliot's storm petrels and grey gulls, and the death of specimens due to collision with wind turbines and power lines, which extends to other bird species. There may also be disorientation and falling of individuals of Elliot's storm petrels in works with high lighting. For low-mobility species such as reptiles and micromammals, the main impact is the death of specimens, loss and fragmentation of habitat".

There are also shortcomings in the way of understanding the impact of these projects on fauna such as Elliot's storm petrels or grey gulls. Ricardo Pino also points out that the Wayra project (wind farm still under evaluation at the end of this report), in its Environmental Impact Assessment, "used diverse methodology to characterize the area, resulting in the discovery of the largest global colony of Elliot's storm petrels (*Oceanites gracilis*). Even so, it is intended to be installed on that area offering insufficient mitigation and compensation measures". At the end of this report there were three wind farms under construction in the area, and seven wind, solar and hybrid projects in the vicinity were already approved or under environmental evaluation.

Another issue related to the massive installation of wind farms is the impact of wind measuring towers. These towers are placed in places that are being surveyed for future projects, to measure the strength of the wind. Ricardo Pino points out that, as the installation of the towers is part of a process prior to entering the SEIA, "they are not being considered as part of the construction phase and are in a gray area of the evaluation. In turn, the death of specimens due to collision with these structures has not been reported nationally through scientific publications, but it exists, we have documented it, and its impact can be significant *per se*".

The main problem for coastal communities—whether of the Chango people or not—is that, by the current environmental impact assessment criteria, they are excluded from the area of influence of many projects. This happens in two ways: given the poor regulation for desalination plants and other interventions on the coastline, people who are engaged in artisanal fishing cannot influence projects neighboring the shores they inhabit. In addition to the threat of port infrastructure development and desalination, there is growing concern about the advancement of maritime concessions for the industrial farming of golden dorados. In other cases, projects located inland—such as several wind farms in the Taltal Wind Reserve—are considered too far offshore to affect the communities that live there. However, the Chango people practice transhumance, and although they do not settle in the pampa area to the east, they do consider it part of their ancestral territory. Over millennia, they have developed a customary use for this land, moving with their animals and collecting medicinal plants. In addition, as we have been told repeatedly, inland Taltal is the history and archaeological heritage of the Chango people, such as lithic findings. They are currently in the process of recovering that heritage to safeguard it for future generations.

As in the Andean territories historically affected by mining, the social fabric of these communities is over-intervened by various projects that hold calls for meetings and consultations several times a month. In areas such as Caleta Hornitos, the same consultancies and professionals represent different companies and projects in short windows of time, contributing to the confusion of the inhabitants. According to fishermen's testimonies, public participation would also be co-opted through the floating population (people employed in the projects or productive companies) as a political force to validate the initiatives. These are workers and contractors from different parts of the country with a manifest interest in the advancement of projects that use public participation spaces to operate in favor of private interests external to the territory.

The land of the coast surrounding the town of Paposo is particularly unprotected. There are several Chango communities who live in a unique environment of biodiversity. This sector, with endemic species such as the *Croton chilensis* (commonly called higuerilla de Paposo or "Paposo fig tree" in English"), was about to become a dump ground for the construction of the *Central de Bombeo Paposo para almacenamiento, generación y transporte de energía* (Paposo Pumping Station for energy storage, generation and transport). The plant biodiversity of this coastal zone is recognized in the Planes de Recuperación, Conservación y Gestión de Especies (Species Recovery, Conservation and Management Plans) program of the Ministry of the Environment. The *Flora costera del norte de Chile* (Coastal flora of northern Chile) plan (Ministry of Environment, 2024) recognizes the productive activities that don't consider the protection of coastal flora as the main threat to this ecosystem after climate change. Related to these threats, a citizen initiative launched by Taltal Sustentable aims to declare a National Park in the natural area of Quebrada San Ramón and Cerro Perales.

The area is also uniquely rich in non-vascular flora. As mentioned by Juan Larraín, bryologist and independent consultant: "Bryophytes gather on the "fertile belt" described by Ivan Johnston (*The coastal flora of the departments of Chañaral and Taltal*, 1929) between the 300 and 800 m high, and they are only abundant in the places where the effect of coastal fog is concentrated. Because of this, it is an extremely fragile ecosystem, and we have no idea how human activity may affect the survival of these species". He also points out that the threat to these species is critical given how little we know about the biodiversity of the area, and that many of the findings that have been made in recent years remain unpublished given the little financial support for this type of work.

3. Taltal

8. [Paposo Pumping Station for energy storage, generation and transport]

Company: Colbún.
Date of entry: 14/06/2024.
Submission method: Environmental Impact Assessment.
Status: terminated early in 2024/08/12.
Investment amount: 1,400,000,000 $US.
Capacity: 800 MW.
Surface: 216 ha.

About the project:

- The project consisted of the creation of a pumping station to operate a hydroelectric power plant located on the coast of north Paposo. The project would operate two reservoirs—one above and one below the coastal range—making water flow upwards during the day and then using the downwards flow in the evenings and nights to generate electricity. The water would be obtained through a desalter, also part of the project. The company had planned for the lower reservoir to take 6 to 10 months to fill before testing began, and it must be constantly replenished.

- The Chango Communities of Taltal and Paposo pointed out that Colbún reached out to them offering financing. For example: the company has an agreement with the city's polytechnic high school. They also report other bad community engagement practices. During the community engagement, Colbún decided to change the location of the surplus piles (the dirt that they would dig out to make the reservoirs) from the extraction site itself (near La Rinconada) to somewhere further. The desalter would be installed in the El Gaucho area.

- Although the presence of indigenous communities in the project's area of influence was considered, no significant impacts to these communities were considered beyond the project's building period. Different Chango communities report the omission in the EIA of four Chango communities that live less than 1 km away from the project.

- In the project presented for environmental assessment, Colbún recognized non-significant impacts on the marine environment, and significant impacts on the Plants, Wild Animals, Archaeological Heritage and Indigenous Human Environment components for the construction phase. Only the Landscape component is pointed as significatively affected on the operational phase of the project.

- Antofagasta's SEA ordered the early termination of the project on the 12th of August 2024. In the decree[7], the SEA included several precedents indicating that the project that was presented lacked essential information. Among them, that it didn't identify the presence (and therefore, the damage) of two Chango communities located less than 500 meters from the site. On August 22nd, and considering Colbún had filed an appeal to reverse this situation, three groups and four indigenous Chango communities expressed their support for the regional SEA's decision through a public statement.

- When Colbún's appeal was rejected, the company resigned from the project and expressed its displeasure in the press. This culminated on the regional director, Ramón Guajardo, being removed from his position the 25th of September (El Mercurio, 2024). After the dismissal, various communities protested this measure in the SEA offices in Antofagasta, delivering a letter to the President of the Republic later during his visit to Antofagasta on October 2nd. Guajardo didn't return to his position (SoyChile, 2024).

[7] https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumento?docId=2024/08/13/f63e-9b23-40ac-8990-d9c0bf88ac2b

9. Horizonte Wind Farm and alteration of the same farm.

Company: Colbún.
Date of entry: 2020/02/07 for the original project, 2024/04/05 for the expansion.
Submission method: Environmental Impact Assessment. Alteration with Environmental Impact Statement**.**
Status: project originally approved 2021/09/13 and then built. In November 2024, the alteration project was under a deadline suspension requested by the company until the 31st of December 2024.
Investment amount: 700,000,000 $US.
Capacity: 980 MW in the original project and 180 for the extension. 1,160 MW between the two projects.
Surface: 454 ha.

About project:

- Horizonte was one of the first projects to be approved in the area, in the middle of the "Taltal wind reserve" and is being built today. Nevertheless, according to Ricardo Pino, the project was submitted under the Environmental Impact Statement "without acknowledging the impacts on Elliot's storm petrels or grey gulls, even when the data collection indicated their presence in the area and the requirement to properly represent these species through greater efforts or more suitable methodologies". Even so, their assessment has been used as a reference for subsequent projects, aggravating this methodological shortcoming. The maps[8] of the Chilean Bird and Wildlife Observers Network (*Red de Observadores de Aves Silvestres* in Spanish, hereafter ROC) show the existence of grey gull colonies and nests inside the perimeter of the project.

- The alteration plan for the farm proposes increasing the density of wind towers without expanding the total perimeter of the original project. Tantí Foundation and ROC submitted a request to open the alteration project's citizen participation.

- According to leaders of the Chango people of Taltal, there is damage to the Chango archeological heritage, especially of lithic sites, a fundamental part of the history of this people. In its project, Colbún recognizes the presence of 225 findings of archeological value.

[8] Available at https://drive.google.com/drive/folders/131KqlPkeuJ6xxw1USlp6VAzu3ntAzO85

10. INNA Project (green hydrogen) and Terra Renewable Energy Park[9] (hybrid farm)

Company: AES Chile (both).
Date of entry: Parque Terra Energía Renovable entered the SEA 2020/08/18.
Submission method: Environmental Impact Assessment.
Status: Parque Terra Energía Renovable has an approved RCA as of 2023/05/18. In November 2024, the INNA project was soon to be submitted to the SEIA.
Investment amount: Parque Terra Energía Renovable is 750,000,000 $US.
Capacity: Parque Terra Energía Renovable has a wind farm of 350 MW and a photovoltaic farm of 512,5 MW (862,5 MW in total).
Surface: 942,7 ha.

About the project:

- The INNA green hydrogen project was in preparation to be submitted for evaluation, so no further information was available for the preparation of this report. Entry was expected during December 2024.

- The green hydrogen plant would draw power from the Terra Renewable Energy Park, a hybrid project that considers solar photovoltaic and wind infrastructure. Because of the size of the associated energy project, INNA would become the region's first green hydrogen megaproject to be submitted for environmental assessment. According to testimony from the communities in the area, INNA includes an electrolysis plant, a port, a desalination plant, a hybrid energy park (solar and photovoltaic) and infrastructure to transport the hydrogen produced to the coast of Taltal.

- The communities' concerns are centered around the effects on the ecosystem and their use of the coastline. In particular, there is concern about the impacts of the desalination plant on marine ecosystems.

- The early participation process between the company and the Chango communities and groups of Taltal was interrupted. They were not able to access all the project's information before it was submitted, which increases the worry about their impacts.

[9] https://seia.sea.gob.cl/expediente/expedientesEvaluacion.php?modo=ficha&id_expediente=2147933035

4. Antofagasta and Mejillones

The Antofagasta city and its surroundings are now home to major industrial infrastructure: the port of Angamos, thermoelectric power plants, several industrial complexes, and the largest water desalination capacity in the country. As shown on picture 7, a big part of this infrastructure is focused on the Mejillones bay. In addition to the concern about the impact of the existing desalination plants, there is also concern among the inhabitants of the area about CRAMSA's “Aguas Marítimas” projec[10], a new plant that would have a capacity to produce 700,000 m³ of water per day, and would be located on the coast, south of Antofagasta.

Alongside Tocopilla, Mejillones is also considered one of the country's “sacrifice zones” by the Office of Just Socioecological Transition. These places are now called “territories in transition” under the National Socioecological Fair Transition Strategy, whose draft document was in public consultation in November 2024. As noted in previous points, several policy measures are aiming to transform Mejillones and the port of Angamos into an international trade hub for green hydrogen and its derivatives (H2 News, 2023).

In this context of transition, there have already been clashes between the visions emerging from the local level and the interests of the hydrogen industry. A process was developed during 2024 to modify Mejillones' regulatory plan; however, it was suspended in October of the same year. The people from Mejillones that participated in this study report that this suspension occurs due to tensions related to the goal pictures of the ongoing plan, which propose freezing the bay's industrial development. Indeed, the Ministry of Energy expressed concern over the possible hindrance that the progress of the local planning process could mean for the arrival of the hydrogen industry to the area (Timeline, 2024).

10 https://cramsa.cl/proyecto/

11. Adelaida Project (green hydrogen plant).

Company: Presented by Eléctrica Angamos S.p.A., but on the Chile H_2 Association's webpage it appears as AES Andes.
Date of entry: did not enter the SEIA. Carried out a relevance consultation where it was decided that it should not enter the system as it is a modification of the Angamos Thermoelectricity Power Plant project.
Submission method: Relevance consultation.
Status: Decision for the relevance consultation indicating it does not require entry to the SEIA was in 2022/10/20. No records of its construction.
Investment amount: 10,000,000 $US.
Capacity: 1,000 kg H_2/day.
Surface: 6,514 m^2.

About the project:

- This green hydrogen project is located within the Angamos Thermoelectricity Power Plant's facilities, in the Mejillones commune. It proposes to use “demineralized water surplus from the existing demineralization plant” and “electric power to come from renewable sources (NCRE) purchased from third parties”, that is, through a PPA (as stated in the relevance consultation document, p.8).
- The goal is to generate green hydrogen that is going to be sold for use as fuel in transportation (the description indicates that it is for "electromobility").

12. Génesis Project (green hydrogen plant).

Company: Génesis SpA (Antuko).
Date of entry: did not enter the SEIA. The company made a relevance consultation, and the SEA decreed it did not meet the conditions for mandatory entry into the SEIA.
Submission method: Relevance consultation.
Status: Decision for the relevance consultation indicating it does not require entry to the SEIA was in 2022/11/08. No records of its construction.
Investment amount: 75,000,000 $US.
Capacity: 20 MW electrolysis capacity, aims to produce a maximum of 3,120 H_2 tonnes/year.
Surface: 4,5 ha.

About the project:

- Project located in the Industrial La Negra Neighbourhood, Antofagasta commune, in a land property of National Monuments. The document presented for relevance consultation points out that it will be connected to the S/E Nueva La Negra, and that "the electricity supply will run through renewable source PPAs" (description on the relevance website).

- The project indicates that "the maximum demineralized water flow to be used in the electrolysis project and green hydrogen production will reach 8.1 m3/hour (2.25 liters/second)" (letter deciding the relevance consultation, p.3). However, the water source is not mentioned. It is only specified that it will arrive via tank trucks or, eventually, in an aqueduct.

- The project submitted for relevance does not specify the use that the hydrogen will have, but the project's website speaks of mobility, industrial heat, raw materials, and energy production.

13. Volta Project (green hydrogen and ammonia plant).

Company: MAE.
Date of entry: 29/02/2024.
Submission method: Environmental Impact Assessment.
Status: under environmental evaluation.
Evaluation deadline: 2025/06/06
Investment amount: 2,500,000,000 $US.
Capacity: 620,000 tonnes of ammonia a year; 110,000 tonnes of hydrogen a year.
Surface: 1069 ha (900 of photovoltaic farm).

About the project:

- Located in the Mejillones commune, 8 km from the city, its goal is to produce green ammonia from green hydrogen to supply domestic demand through Mejillones' port area.

- The project is part of the *Ventana al Futuro* fiscal tender process for green hydrogen.

- The company plans to obtain water through the purchase of desalinated water from the desalination plants already in the area. This will be complemented with the use of wastewater currently dumped into the bay. Since producing 1 kilogram of H_2 requires at least 35 Litres of water, the demand of 110.000 annual tonnes of hydrogen production means an additional extraction of 3,850,000 litres of water a year. However, the information provided in a meeting between the company and the Chango community of Hornitos was different: they mentioned they would use all the wastewater from Mejillones, and that it would only be complemented with the desalinated water "from the network".

- The environmental assessment process excluded Chango communities and groups of Hornitos because they are considered outside the project's area of influence. The citizen participation activities were only carried out in Mejillones, nor was an indigenous consultation process activated. At the request of the Hornitos community, a workshop was carried out during research to include citizen comments in the project.

- The project file's Consolidated Report of Clarifications, Rectifications or Additions (*Informe Consolidado de Solicitud de Aclaraciones, Rectificaciones y/o Ampliaciones* in Spanish, hereafter ICSARA) shows that it questioned the monitoring of the yellow-billed tern because the campaign on site that set the baseline was made outside this bird's breeding period in the area where the project would be located.
- The proprietor company requested to suspend the deadline until March 14, 2025.

5.Tocopilla

Tocopilla, considered one of the "sacrifice zones" of the country along with Mejillones by the Office of Just Socioecological Transition (*Oficina de Transición Socioecológica Justa* in Spanish), is also seeing an increase in hydrogen-related projects. During research, the Chango communities of Tocopilla mentioned the intent to build a dedicated port specially for hydrogen and its derivatives in Caleta El Fierro. This is a cause for concern given the great damage already done to the marine ecosystems in the area. They also mentioned the megaprojects Agua Horizonte, a desalination project to supply Codelco's mining, and Technint, a facility of the same type to supply the Collahuasi mining company, as threats to their territory.

14. HyEx Projects (a green hydrogen plant and a green ammonia plant)

Company: Engie LATAM and Enaex.
Date of entry: two different projects, both submitted on 2021/08/23.
Submission method: both presented with EIS.
Status: both approved on 2022/04/27.
Investment amount: 96,000 USD in total.
Capacity: The H_2 plant will have five electrolysers with a 5 MW capacity each. The ammonia plant considers the production of 57 tonnes/day.
Surface: H_2 plant: 2.36 ha.
Ammonia plant: 0.84 ha.

About the project:

- Both account for the first plant approved in the Antofagasta region, located in the municipality of Tocopilla, 25 km from the city. They are two interdependent projects: the green hydrogen plant (project of Engie LATAM) to supply the synthesis of the green ammonia plant (Enaex project). The hydrogen plant will be in the old facilities of a diesel power plant.

- The H_2 production project was set to begin on January 2, 2024, but there is no news on the start of construction or operation.

- The water for the green hydrogen project will be obtained from the Central Térmica Tocopilla or CTT (Tocopilla Thermal Power Station) that already performs desalination—enough to supply the plant, according to the proprietor.

- The purpose for the ammonia is to produce ammonium nitrate for the Enaex company, which produces blasting tools used for mining in the region.

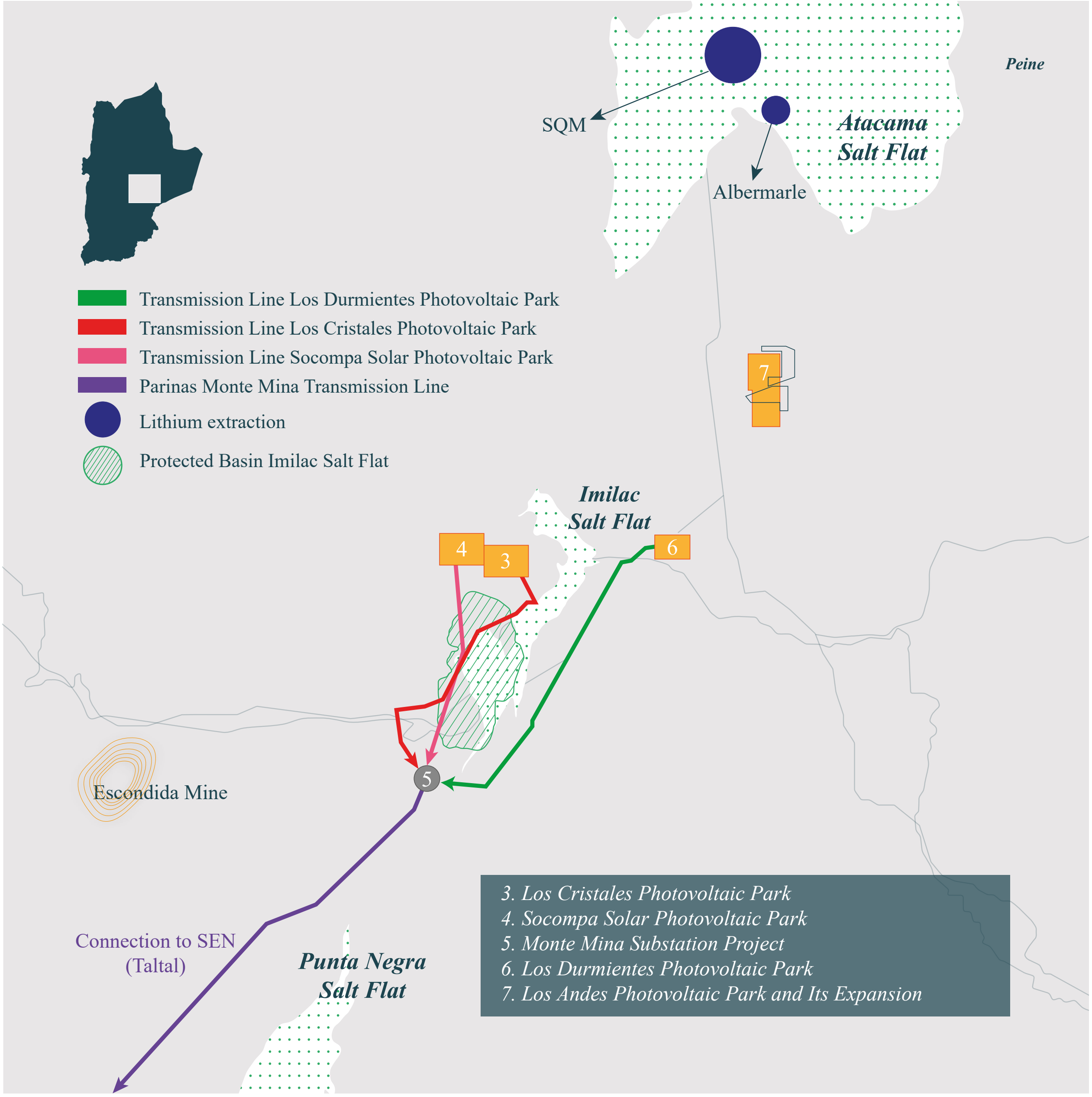
- The hydrogen project is labeled as "green" by being connected to the Tamaya substation for electricity supply (adjacent to the project). The "Tamaya Solar" photovoltaic project (also owned by Engie) is connected to this station.

c. Case studies

In this section, we illustrate two of the cases addressed in this study that show the emerging synergies between the green hydrogen industry and mining, mainly of copper and lithium.

Peine: picture 6 shows the overlap between different solar energy projects with the basins of the Imilac and Punta Negra Salt Flats, close to the Minera Escondida's operations. It can be seen in the picture that the different project's transmission lines overlap in the Imlimac Salt Flat's protected area by the res. 529/2003. The Punta Negra Salt Flat is a paradigmatic case of depletion produced by copper mining, with the aforementioned lawsuit filed against the company by the State Defense Council and Atacameño communities. It should be noted that, after the exploitation of Punta Negra's aquifers, the company concentrated its extractions in the southern section of the Atacama Salt Flat, for the impacts of which the State Defense Council maintains, as of the date of publication of this report, an active lawsuit against three companies: Minera Escondida, Minera Zaldívar and Albemarle.

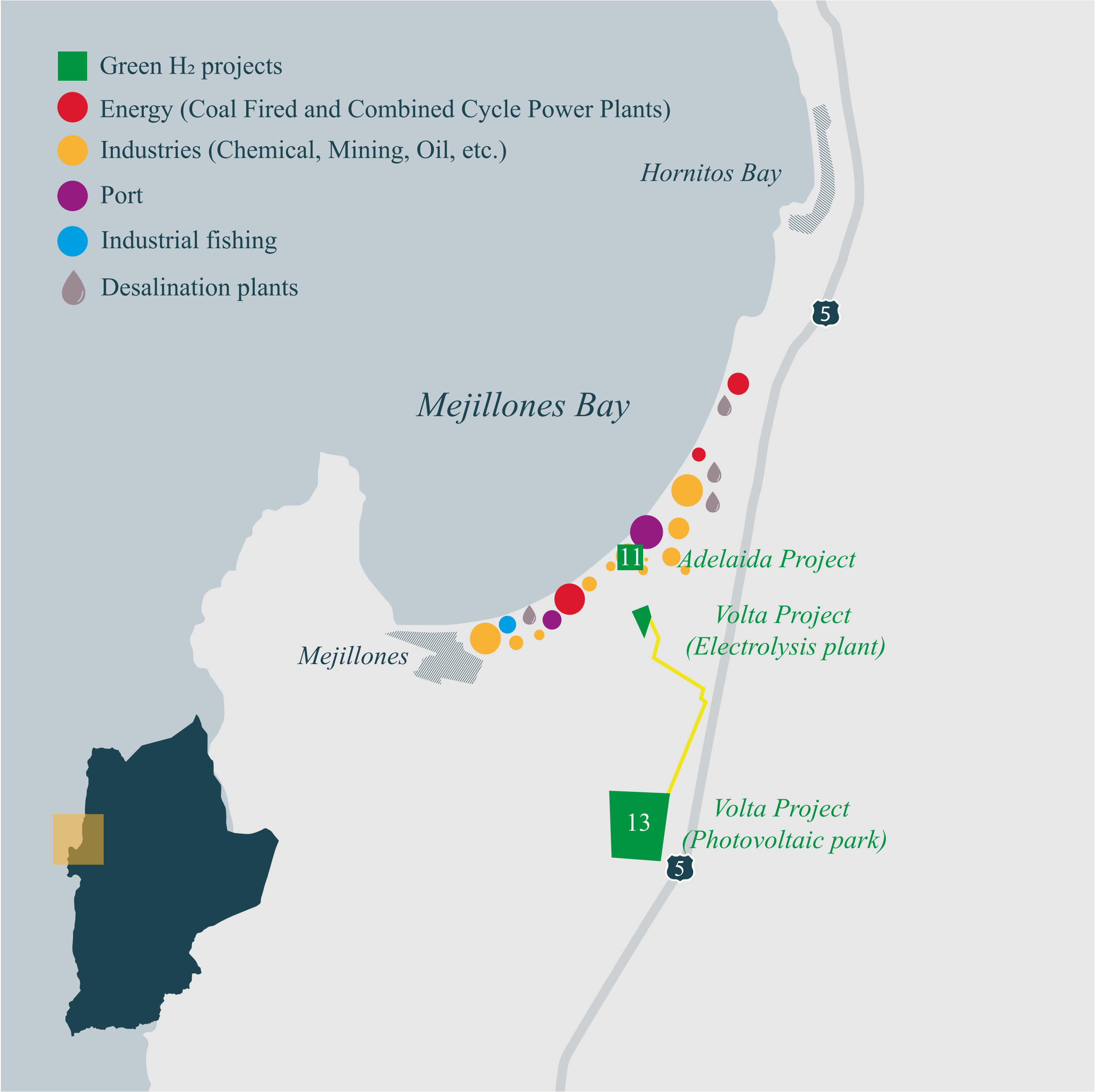
Picture 6: superposition of mining and energy projects in the ancestor Lickanantay territory of Peine.



Source: adapted cartographic information submitted by the projects illustrated in the SEIA.

Mejillones bay: picture 7 shows the location of two hydrogen projects seen in the context of the Mejillones Bay industrial complex. The activities represented include the desalters in the area, dedicated to supply mining and the industry. These are: GasAtacama, Eléctrica Angamos (owned by Aes Gener), Empresa Eléctrica Cochrane (owned by Aes Gener and Mitsubishi Corporation), and Caitan, which supplies the operations of Minera Spence (BHP Billiton) in Sierra Gorda. The latter operates irregularly because it does so without construction permits, and part of the land is illegally occupied (Fundación Terram, 2024).

Picture 7: main industrial activities in the Mejillones bay together with future green hydrogen projects.



Source: adapted cartographic information submitted by the projects illustrated in the SEIA. Information about industrial activity was adapted from Valdés Fernández (2023, p.13)

d. The situation of the hydrogen industry in the Atacama region

Total projects in the region

In November 2024, 31 projects for green hydrogen and its direct derivatives such as ammonia were known to exist in Antofagasta, considering the ones detailed in the previous sections. Among them, most are undergoing feasibility or pre-feasibility studies, and information on them is limited. Table 2 presents a summarised version of the information on the projects in the region according to the Chilean H_2 Association, complementing that source with public information of these and other projects not included in the Association's mapping. Further details on the location of the 31 projects and the sources of information used can be found in **Annex 2**.

Table 2: List of known projects for green hydrogen and its derivatives in Antofagasta

Name	Company/ proprietor of the project	Nationality	Status	Capacity	Electricity source	Purpose of production
Planta de Producción de Hidrógeno Verde para el Distrito Minero de Calama	Susterra	Chilean	EIS undergoing evaluation on the SEIA	200 MW of electrolysis capacity at the final stage.	Connected to a nearby substation.	Green hydrogen for the local mining industry's demand.
Adelaida Project	AES Andes	American (owned by AES Corporation)	No need to enter the SEIA by resolution of relevance consultation 2022/10/20	1000 kg H_2/day	Powered with energy from the Angamos Power Plant (where the project is located) that is obtained through PPA	Hydrogen for domestic industrial demand (use in vehicles)
Project Génesis	Antuko	Chilean	No need to enter the SEIA by resolution of relevance consultation 2022/11/08	3,120 H_2 tonnes/year	La Negra Substation PPAs	Hydrogen for local industrial demand.
HyEx Project - Green Hydrogen Production	Engie LATAM	French (Engie subsidiary)	EIS approved 2022/04/27.	The H_2 plant will have five electrolysers with a 5 MW capacity each.	Connected to Tamaya Substation.	Domestic industrial demand for sister project HyEx.

HyEx Project - Green Ammonia Synthesis	ENAEX S.A.	Chilean	EIS approved 2023/04/27.	The ammonia plant considers the production of 57 tonnes/day, 18,000 tonnes/year.	Energy will be supplied by Engie	Domestic industrial demand (explosives manufacturing)
Volta Project	MAE Energy	Chilean	Under evaluation	620,000 tonnes of ammonia a year; 110,000 tonnes of hydrogen a year. 600 MW photovoltaic power station	Its own (photovoltaic farm)	Green ammonia for local and international use
INNA project	Aes Chile	American (owned by AES Corporation)	EIS in preparation for environmental evaluation	N/A	Its own (hybrid solar and wind farm)	N/A
Project Hoasis	TCI GECOMP	Spanish	Feasibility	It will consist of a 6 GW photovoltaic facility together with a 3 GW electrolysis plant to produce up to 133,000 tonnes of hydrogen per year	Its own (photovoltaic farm)	Hydrogen and ammonia for domestic industrial demand (mining, thermal power plants, cement plants)
Power to Ammonia AES Andes	AES Andes	American (owned by AES Corporation)	Feasibility	50kt H_2 a year, 800 MW of renewable energy	Its own (although the brochure used in the source states that it will also use energy from the grid)	Ammonia for export and to use as fuel in cargo ships
Los Amigos del Verano ("Friends of the summer")	Siemens Energy and Verano Energy	German and international holding company)	Pre-feasibility	25 GW of hydrogen production, offshore hydrogen and ammonia transport and storage facilities, and the creation of new desalination plants.	There is no public information on the matter, no indication of the creation of own plants in the statement.	Not specified, but port infrastructure for hydrogen and ammonia transport is mentioned.
SolarNH3-Pool Chile (industrial park project)	Soventix, SI Solar Investments, Pabettin	German, Italian, unknown	Pre-feasibility	The model plant proposes an electrolysis capacity of 1.609 MW at the final stage and a photovoltaic power station of 2.259 GW	Model plant project* considers a 2.259 GW solar PV power plant in its final stage, complemented by PPA agreements	Green ammonia and hydrogen for domestic and international demand.

Power to MEDME	Fraunhofer	German	Pre-feasibility	N/A	Uses energy from the CSP Cerro Dominador project	Production of green methanol and dimethyl ether (DME) potentially for domestic and international markets.
Tango*	Gasco, HyNewGen, Linde, Vopak and the Rotterdam Port	Chilean, Uruguayan, German, and Dutch	Feasibility	From 200 to 500 MW/172 kt NH3/and production in the IEA's document	Photovoltaic and wind farm* plus electricity grid	Green ammonia for the export to Europe
Proyecto H2V Inversiones Farías	Farías Inversiones	Chilean	Feasibility	0,0144 MW	There is no public information on the matter, no indication of the creation of own plants in the statement.	Local demand (for use in fuel cell forklift trucks)
Planta móvil H2V(mobile GH2 plant)	Cicitem	Chilean	Functioning	0,02 MW	The plant includes mobile solar panels	Demostrative project
Proyecto Piloto H2V GNA (pilot project)	Grupo Norte Árido (GNA)	Chilean	Pre-feasibility	1.2 MW for the electrolyser, solar photovoltaic power station of 1.8 MW	Its own (photovoltaic farm)	Demostrative project
Paracelsus Project/Atacama Hydrogen Hub	Humboldt Hidrógeno Verde (GH2), Mejillones Port Complex	Chilean	Pre-feasibility	2 GW	Its own (photovoltaic farm)	Green ammonia and hydrogen for domestic and international demand.
METH2 Atacama	Sowitec	Subsidiary of German Sowitec	Pre-feasibility	300 MW	Its own (solar, wind and hydroelectric)	Methanol for local demand (mining sector)
Tren a Hidrógeno (Train to Hydrogen)	FCAB	Chilean	Feasibility	N/A	It is a train that uses hydrogen, not a generation project	Transport project
Faraday*	Mainstream RP, Aker Clean Hydrogen.	Norwegian, Japanese and Irish capital; Aker ASA (Norway) is Aker Clean Hydrogen's largest shareholder.	Feasibility	2 GW	Its own* (solar and photovoltaic, plus electricity grid)	Amonia for export

Cerro Dominador	Grupo Cerro	Fund ownership managed by EIG Global Energy Partners	Pre-feasibility	6 MW	It does not consider the installation of an additional farm (Cerro Dominador's use of solar energy)	Green hydrogen for fuel in passenger transport and large-scale mining, and ammonia for domestic and international demand.
Pauna Greener Future (H2)	Statkraft	Norway	Pre-feasibility	100 MW rated power.	It plans to use electricity from the Pauna Solar Photovoltaic Farm (671 MW)	Green ammonia and hydrogen for domestic and international demand.
Pauna Greener Future (NH3)	Statkraft	Norway	Pre-feasibility	400 MW rated power.	It plans to use electricity from the Pauna Solar Photovoltaic Farm	Green ammonia for domestic and international demand.
Cerro Pabellon microgrid	Enel Green Energy	Multinational based in Italy.	Operational	450 kW h hydrogen storage	Geothermal energy from existing plant	Local energy storage
Proyecto H2V Tocopilla	EDF Renewables Chile and HYTEC SpA	EDF Renewables Chile is a subsidiary of the French company EDF	Recently awarded by the 'Ventana al Futuro' initiative. Not yet submitted for environmental assessment	30 MW electrolysis plant and 100 MW photovoltaic power station	Its own (photovoltaic farm)	N/A
Proyecto H2 Mejillones	Enel Green Power Chile	Multinational based in Italy.	Recently awarded by the 'Ventana al Futuro' initiative. Not yet submitted for environmental assessment	63.15 MW electrolysis plant and 122.3 MW photovoltaic power station (in the second stage of the project)	Its own (photovoltaic farm)	N/A
Integration of a hydrogen generation module to supply boilers belonging to the Spence BHP mining company.	E-combustibles products LLC para BHP	Australia and United Kingdom	Authorised by the Superintendency of Electricity and Fuels or SEC in Spanish	Two boilers of 10,550 kW and 3,000 kW capacity.	Renewable energy contracts (PPA)	Internal use of the company
Antofagasta Mining Energy Renewable (AMER)	Air Liquide	French multinational	Feasibility	60,000 tonnes of e-methanol a year/80 MW of rated electrolysis power.	Not mentioned. Project is solely about electrolyser	N/A

San Pedro de Atacama Project	Cummins Chile and Cespa	American, Chilean	Feasibility	2 MW of rated electrolysis power	It notes that the plant's photovoltaic system will be expanded, but not by how much.	Local energy storage
H2 solar project	Air Liquide, Atamostec, CEA, Universidad Antofagasta, CDEA	French multinational, Chilean, French, Chilean, Chilean	Pre feasibility	Two electrolysers with a total output of 4.8 kWp	It is not specified, only that various photovoltaic technologies will be tested.	Hydrogen for use in mining worker transport)
Hydra	Engie, Mining3, Ballard, CSIRO, Reborn Electric Motors, Antofagasta Minerals, Mitsui.	French, Australian, Canadian, Australian, Chilean, Chilean, Japanese	Pre feasibility	N/A	Mining truck development project, not hydrogen production	Hydrogen for use in hybrid mining trucks (H2 and batteries)

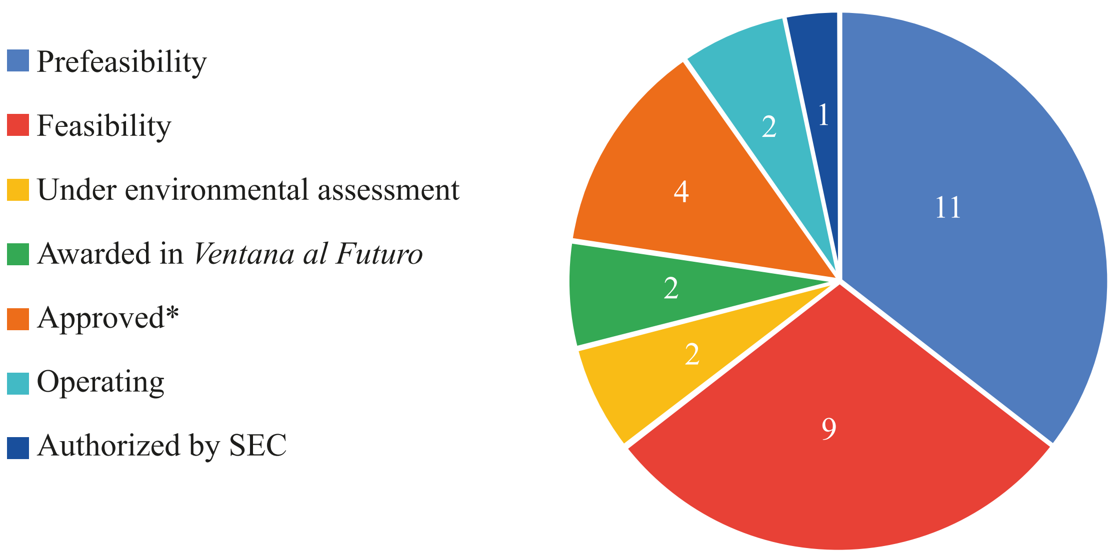
Source: self-made.

N/A refers to projects that do not plan to build additional infrastructure and will purchase electricity from third parties, or
N/A: No data available
* Projects that do not specify the size of the renewable energy park to be built.

Description of green hydrogen projects in Antofagasta

Taking the 31 projects described in this report into account, figure 1 summarises their status at the end of October 2024:

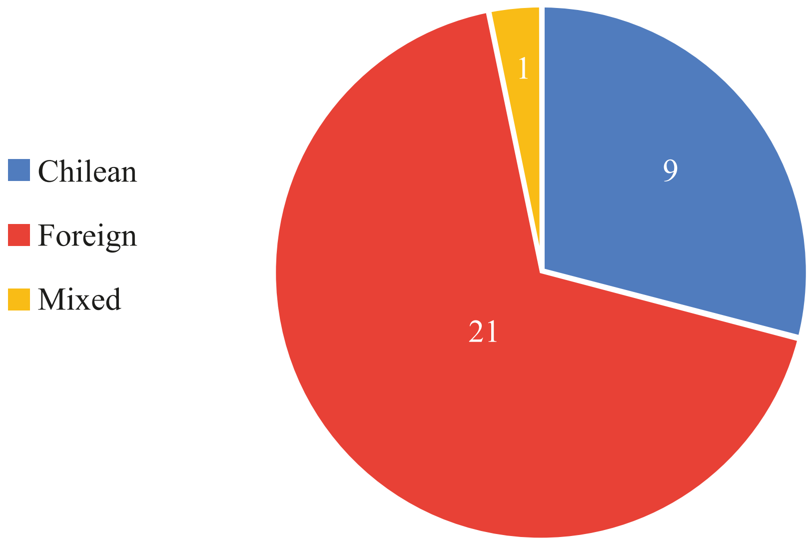
Figure 1: Status of H_2 projects in Antofagasta
(November 2024) N=31



Source: self-made based on research published by the companies and the Chilean H_2 Association. *It includes projects described as "approved" by the company, even though they have only gone through a relevance consultation process.

Figure 2 shows the nationality of the proprietors for these 31 projects, considering as foreign those companies that are subsidiaries of companies that maintain their capital and main offices outside Chile.

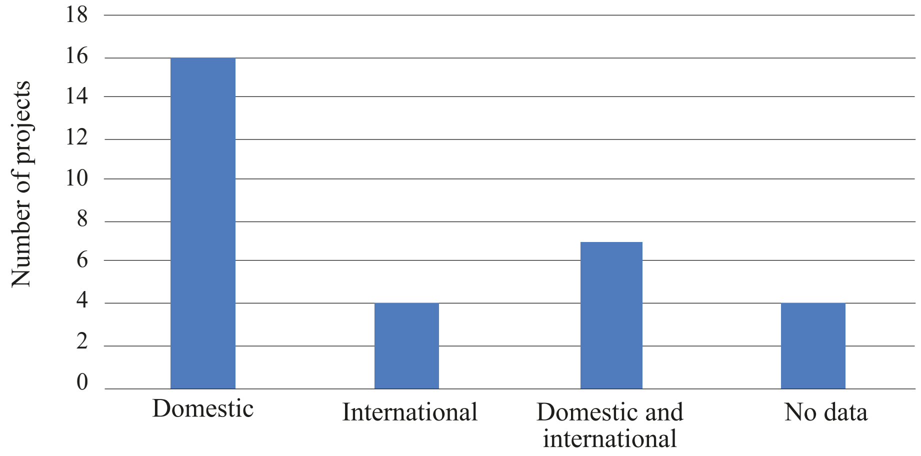
Figure 2: nationality of the proprietors for the green H_2 projects in Antofagasta (November 2024)
N=31



Source: self-made based on research published by the companies and the Chilean H_2 Association.

As shown in Figure 3, among the projects, the use of hydrogen and its derivatives such as ammonia is mostly presented as being for the local demand of the Antofagasta region – at least in the initial stage. Most are still in small-scale or pilot phase. Of the 31 projects, 16 qualify as projects dedicated to specific replacements for current needs or anticipating increased local demand, especially from mining. Seven of them have the goal of selling to domestic and international buyers, and only four are fully export-oriented.

Figure 3: purpose of the project's production (November 2024)
N=31

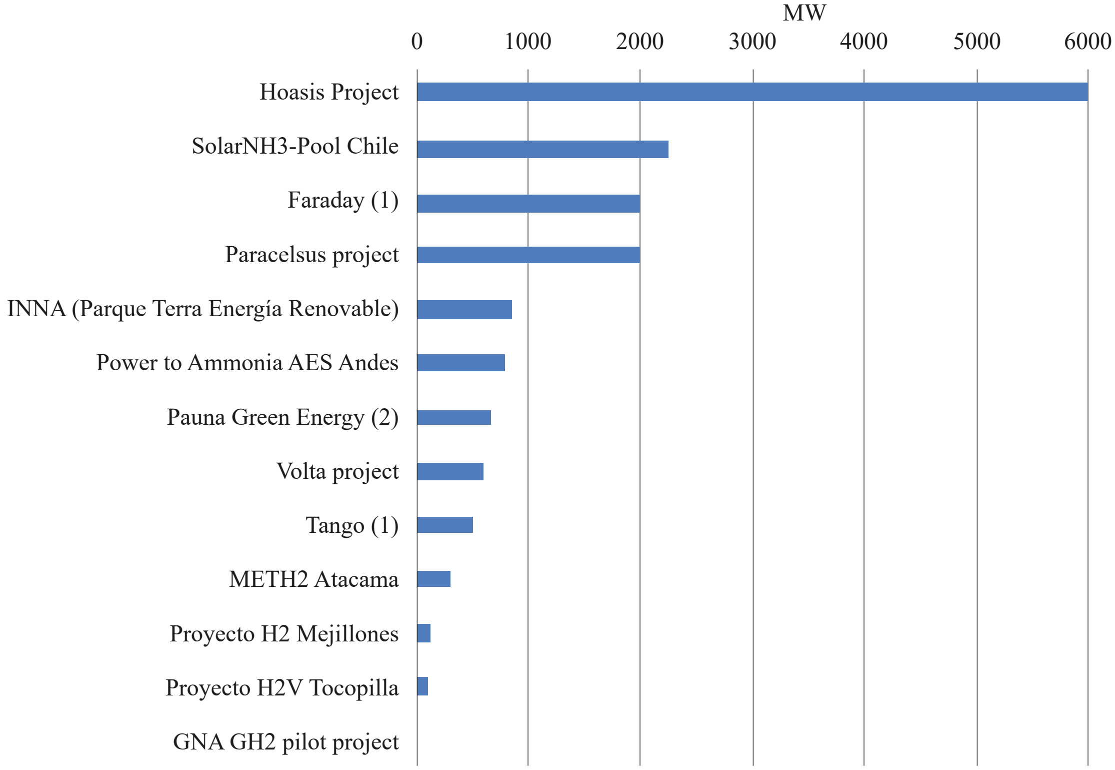


Source: self-made based on research published by the companies and the Chilean H_2 Association.

Larger-scale projects, which are planned for export and integrate power generation with hydrogen synthesis and export infrastructure, are a minority. However, given their magnitude, they could far outweigh the impact of already approved (smaller) plants and operating pilots. As shown in table 2 of all the projects collected, 13 directly propose the construction of additional renewable infrastructure for hydrogen and ammonia synthesis, in some cases in combination with electricity from the grid. Others propose PPA mechanisms to supply their energy needs, or do not specify where the electricity will come from (because they are still in the stage of feasibility or prefeasibility).

The size of the projects also shows trends related to the production method. Except for one, the largest projects are "integral" projects, that is, projects that plan to build NCRE infrastructure related to the hydrogen production. Figure 4 illustrates the projects made public so far, including estimates of associated renewable energy plants. Most are still in the feasibility and pre-feasibility stages. Of these 13, only the Volta project (with an associated photovoltaic project of 600 MW) was, in November 2024, entered SEIA. However, the Terra Renewable Energy Farm, associated with INNA (not yet submitted for evaluation by the end of November), already has an RCA. The largest of the filed projects (Hoasis Project), if carried out, would become the largest photovoltaic complex in Latin America. Until July 2024, the largest plant in Chile reached 480 MW of installed capacity (Ministerio de Energía, 2024b). The Hoasis project plans to build solar photovoltaic plants with a total capacity of 4.5 GW (4,500 MW).

Figure 4: size of the generation projects associated to the H_2 plants in Antofagasta (in MW) (November 2024) N=13



Source: self-made based on research published by the companies and the Chilean H_2 Association. (1) Projects that also consider grid energy among their sources, without specifying the size of associated renewable energy projects. (2) Pauna Green Energy is a photovoltaic project related to two projects of green hydrogen and ammonia.

These projects add up to **16,216 MW net capacity in total**. On the other hand, the "Los Amigos del Verano" project stands out with its ambitious goal of having 25 GW of dedicated hydrogen synthesis capacity. Nevertheless, the available information does not indicate that this capacity will be accompanied by a related renewable energy industrial complex and is therefore excluded from the presented graph.

e. NCRE use and water in the Antofagasta region

According to publicly available information, there are 4.8 GW of net NCRE capacity in Antofagasta today[11]. And, as can be seen in table 3 (like all the tables in this section, made based on the information available in annex 3), if we add the photovoltaic and wind projects already under construction, the figure rises to **7 GW**. These projects will occupy a total of **15,503** hectares.

Table 3: Current net capacity (in MW) and generation surface area of NCRE projects under construction, testing or operation in Antofagasta (October 2024) N= 55	MW	Ha
Photovoltaic and solar thermal power plants	4,419.29	13,668.05
Geothermal power station	83.58	136.40
Wind farms	2,542.57	1,698.90
Total	**7,045**	**15,503**

Source: self-made. For methodological details, see annex 3.

There are an added 92 projects with 17.685 GW of net generation capacity that were, as of October 2024, in the process of environmental qualification or already approved, but not reported as under construction, testing, or operating. This is shown in table 4. There, too, photovoltaic projects continue to dominate in terms of both the area used and the amount of energy generated, reaching almost 25,000 ha. This data shows that a strong increase is expected in the medium term, both in electricity generation capacity and surface area to be used by NCRE energy projects[12].

Table 4: Net generation capacity (in MW) and surface area of NCRE projects under evaluation or approved in Antofagasta (October 2024) N= 92	MW	Ha
Photovoltaic and solar thermal power plants	11,597.41	24,932.55
Wind farms	2,973.80	1,798.33
Hybrid farms (photovoltaic and wind)	3,113.50	3,765.09
Total	**17,685**	**30,496**

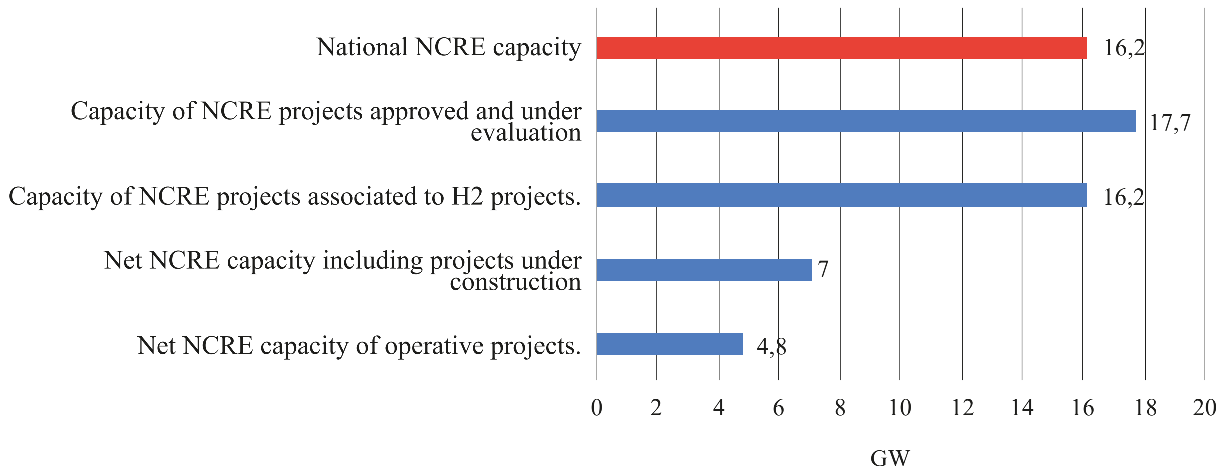
Source: self-made. For methodological details, see annex 3.

[11] Information downloaded from https://infotecnica.coordinador.cl on 2024/10/24. The effective net power reported by the Coordinator was used.

[12] Within these projects, there are some that were approved more than 10 years ago but are still not listed as 'in operation' or 'under construction'. We opted for keeping them in the analysis because, with a valid RCA, they might be implemented in the future. This is the case of the Ckhúri wind farm, RCA from 2011.

The previous point (figure 4) highlighted the 13 projects that have indicated they will create associated renewable infrastructure. The total added energy of these projects reaches 16,216 MW. This is the amount that we can link directly to hydrogen production today, and, as Figure 5 shows, it almost equals the generation projection for the region made in Table 4. Figure 5 also shows, as a comparison, existing NCRE capacity at national level (16.2 GW).

Figure 5: comparison of NCRE's net electricity generation capacity in Antofagasta, in GW (Nov. 2024)



Source: self-made based on information published by the SEIA, the National Energy Commission and the National Electricity Coordinator. Numbers are rounded for clarity.

However, many projects for hydrogen and its derivatives are designed to purchase electricity directly from the existing electricity grid or using PPAs. This distorts the traceability of the renewable source used to synthesise hydrogen, as the national energy matrix remains largely fossil based.

Additionally, of the PV plants operating in the region by October 2024, all had been assessed under the Environmental Impact Statement method, even though several of them are large adjacent projects. The only projects evaluated with an EIA are hybrid (photovoltaic and wind) and wind complexes.

On the other hand, and as already presented in the Peine and Mejillones case studies, there is an overlap of energy and hydrogen generation zones with industrial and mining hubs. Not only are the various mining industries seen as potential consumers of hydrogen and its byproducts, but the existing mining-related infrastructure—such as the existence of desalters—is also seen as an incentive and enabler for the green hydrogen industry. This case of a synergistic relationship between the two industries acts as a driver for further expansion of extractive frontiers with the advancement of agendas such as "green mining". This concept, present in several of the region's projects, refers to the need to decarbonise the extractive and industrial mining processes, which today are partially powered by fossil fuels.

Finally, the use of water both for these new NCRE projects and for the hydrogen synthesis that will come from the 31 projects in the portfolio must be considered as adding to a context of increasing national and regional water stress. While in current projections the use of water for hydrogen does not represent a significant percentage of the water already processed in this way—around 15%, as explained above—it is nevertheless done in a poorly regulated context for this industry. In November 2024, the draft law *Sobre el uso de agua de mar para desalinización* (About the use of seawater for desalination), introduced in 2018, was in its first constitutional procedure.

VI. Analysis: between justice and green extractivism

Hornitos cove. Credits: Ramón Balcázar M. (2024).

VI. Analysis: between justice and green extractivism

The results presented in this report align with analyses that look at current trends in hydrogen development in Latin America and other regions of the Global South as a renewal of the extractivist model towards a **green extractivism**. Extractivism has been approached from the perspective of Latin American political ecology to show the extractive processes embedded in broader social, political, economic and cultural arrangements. In this case, extractivism emerges as a theory to understand a certain kind of relationship with nature that can be traced back to the period of European colonization of our continent. Extractivism—or more precisely "extractivisms", plural—is defined "as a type of extraction of natural resources, in large volume or high intensity, and which are essentially oriented to be exported as raw materials without processing, or with minimal processing" (Gudynas 2015, p.13). But beyond these features, the concept of extractivism seeks to capture the economic approach to development that has characterised the formation of the contemporary global capitalist system, with all its dynamics of depredation and exploitation of both bodies and territories (Vela Almeida, 2020). In this matrix, our way of relating to nature is reduced to instrumental exploitation—to being a source of "resources"—displacing other forms of valuation.

This concept has been developed and grown in complexity over the last decade to include the evolution of the Latin American economies towards new extractivisms (Gudynas 2013, Svampa 2013). These extractivisms are characterized by having developed during the Latin American "pink tide" (*marea rosa* in Spanish) of the 2010s, in which states, especially under progressive governments, became promoters of the extraction of raw materials. In this process, the increase in tax collection to resolve historical inequities was used as an argument to legitimize the installation of the megaprojects. Thus, we arrive at the most recent phenomenon of green extractivism, in which extraction is now carried out under the justification of the need to decarbonise (Blair et al., 2023; Flores-Fernández, 2021; Morales Balcázar, 2021; Svampa, 2022) through the massive use of low-emission technologies. This concept is closely related to **green colonialism** (Lang et al. 2023), which, in relation to lithium extraction, has been used to illustrate how the goals to face the climate emergency, such as the promotion of electromobility, justify the advancement and acceleration of lithium extraction. This re-actualization of existing extractivism perpetuates colonial relations, reducing the wetlands of the Atacama puna to repositories of a coveted global commodity (B. P. Jerez et al., 2023; Soto Hernandez & Newell, 2022). Given its role as a decarbonization technology—at least defended by the industry and the promoter states in the discourse—we observe that hydrogen is adopting similar traits to those already present among those who justify the extraction of lithium from the high Andean ecosystems.

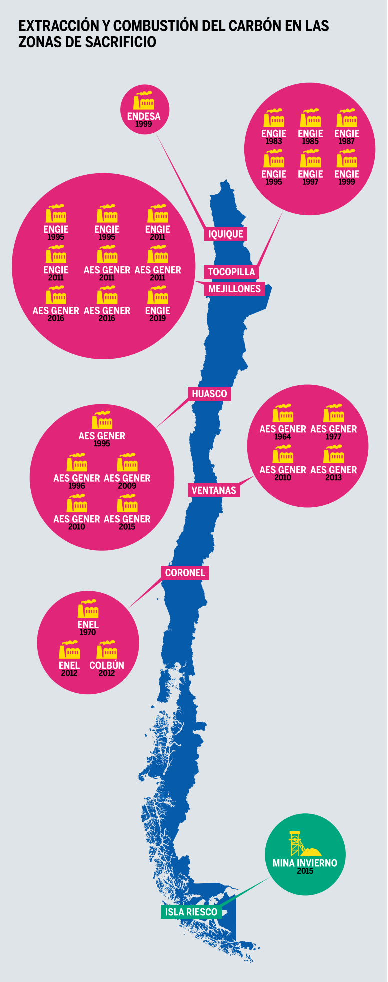
a. Green sacrifice zones?

An important feature revealed by this research is the arrival of energy industrial activities both in places that have already been intervened and degraded and in territories that have not yet been intervened, such as the coastal area of Taltal. This was conveyed to us repeatedly over the course of this study: how the different industrial processes related to the rise of the hydrogen industry threatened to turn the entire Antofagasta region into a sacrifice zone.

In Chile, five territories environmentally saturated by industrial activity linked to thermal power stations, particularly coal, are popularly known as sacrifice zones: Mejillones, Tocopilla, Huasco, Quintero-Puchuncaví and Coronel (Cifuentes & Pinilla, 2020; Fundación Terram, 2018; Paredes Letelier, 2024). Picture 8 positions them at a national level (and includes 2 additional places: Iquique and Riesco Island). In the case of the Antofagasta region, the bays of Tocopilla and Mejillones were intended for energy production for the expansion of copper mining. Within the context of energy transition, it is precisely on this region's coasts where new projects would be situated to meet both international demand and metal mining demand itself.

Although “sacrifice zone” is not a legal category, it is widely used by social-environmental movements, civil society organisations and even state agencies to draw attention to a condition of social and environmental sacrifice historically promoted by the state. Hence the idea of wondering, in the energy transition context, about the appearance of **green** sacrifice zones in the Antofagasta region, something evident in the dialogue with the populations "that will be affected by the sourcing, transportation, installation, and operation of solutions for powering low-carbon transitions" (Zografos & Robbins, 2020, p. 543). In the case of hydrogen in Antofagasta, the justification for intervening the different territories is also related to ideas of the desert as an "empty" space whose value is obtained through mining extraction. This contributes to the normalization of existing social and environmental damage in areas affected by the green energy and mining industry, while also minimizing the damage and risks in places still minimally intervened, such as the so-called "Taltal wind reserve".

Picture 8: infographic showing the 5 "sacrifice zones" in Chile (Heinrich Böll et al., 2020, p. 43). Title reads “Coal extraction and combustion in sacrifice zones. Location of coal-powered plants stations and the open-pit mine, year 2019”



As we could see during our investigation, the communities that face the arrival of different projects in their territories are invited to "show solidarity" and accept the intervention and damage of the places they inhabit for the sake of decarbonization. As it is also mentioned in the official policy documents, this "environmental" discourse is also related to the geopolitical aspect, which justifies the production of hydrogen mainly in connection with European demand, and to a lesser extent with a national industrial need. Projects that benefit the population and would offer concrete help with energy poverty are testimonial at best, and do not diminish inequalities in the region.

That said, we use the concept of a "green sacrifice zone" carefully and with the understanding that its implications can be both beneficial and detrimental for those who live in these territories. As a result of engaging in dialogues with social actors and environmental advocates, we know that this term has the potential to draw the attention of authorities and foster solidarity from the civil society in general, but it could also reduce the social-environmental reality of a territory to conflict and contamination, deepening the effects of the environmental violence produced by the state and private companies. This is why we present this point as an open question to raise awareness about the importance of avoiding that any territory is subjected to situations that make its own inhabitants feel in a condition of sacrifice, either for the generation of energy for mining or for an energy transition project that adds new threats and risks.

VII. Conclusions

Storage of wind power components at Angamos Port.
Credits: Ramón Balcázar M. (2022).

VII. Conclusions

The energy transition model promoted by the Global North has brought about, in its initial stage, a rapid expansion of lithium mining in indigenous land and high Andean ecosystems highly susceptible to climate change. Most of these ecosystems are in a state of degradation due to the cumulative effects produced by mining cycles such as Chile saltpeter and copper, but also due to the extraction of minerals such as gold, sulphur, borax, and potassium. This historic exploitation is projected onto the future under the promise of "green" extraction of critical minerals with the use of direct extraction technologies in the case of lithium, or the use of hydrogen and desalinated water in the case of copper.

We have identified impacts at four levels: at the ecosystem damage level, there is concern about the evident degradation of Andean wetlands, aquifers like the Loa River, and of coastal ecosystems. There is growing concern over the destruction of archeological heritage, like in the cases of San Francisco de Chiu-Chiu, Peine and Taltal. On the other hand, there is evidence of a growing impact of engagement strategies for companies with energy and hydrogen projects, specially in areas currently becoming investment hubs such as the coast of Taltal and Mejillones. This relates to various forms of rights violations, including the right of all citizens to have a meaningful participation and the rights of indigenous peoples under ILO Convention 169.

The presence of energy projects that deepen the conditions of water and social-environmental injustice in these territories was verified from the joint work with indigenous Andean communities and social-environmental movements. These projects are involved in the transformation of the country's power grid and are, in some cases, directly linked to mining itself or with green hydrogen projects. Thus, extractive dynamics interconnect territories and ecosystems from mountain range to sea. This installation takes place in a context in which the recognition and respect of indigenous peoples' rights is still lacking at national and regional level. The Chango people, recently recognized, have faced multiple obstacles to exercise their rights. Other peoples, such as the Atacameño, Quechua and Aymara, face increasing threats especially in the context of the implementation of the National Lithium Strategy.

The industry of green hydrogen and its derivatives in the Antofagasta region is still in its infancy. Of the 31 hydrogen projects explored here, only two—including a demonstration project—are operational. However, these are already intertwined with social-environmental conflicts related to energy infrastructure —both fossil and renewable—a situation that is only set to increase given the scale of the industry's projection.

The National Green Hydrogen Strategy was planned with highly ambitious projections, without thinking about the load capacity of territories such as Antofagasta. A similar thing occurs in Magallanes (at the south of Chile), where the INNA project's method of separately presenting energy projects associated with hydrogen production and the projects for hydrogen synthesis production is repeated. This fragmentation contributes to obscuring the synergistic impacts of this industry. In addition, there are business lobbying efforts before the authorities of the SEA[13], a body that is questioned due to the discharge of its regional director, an act understood by the local communities as a punishment for the rejection of the Colbún project mentioned previously in this report.

[13] https://www.leylobby.gob.cl/instituciones/AW004/audiencias/2024/262818/728932

While the expansion of the lithium mining frontier is advancing rapidly with domestic and foreign investment, the outlook for hydrogen financing is still uncertain and unstable. This study thus opens future research questions to understand the changes and continuities that a new extractive boom could bring to Antofagasta, this time with hydrogen. For example, what are the policies and strategies that, pushed forward by the European Union, China and the United States, promote and make investments in these energy projects easier? Also, what are the companies that are investing and what are their community engagement strategies? or what public-private arrangements are being put together to make the installation and social validation for these projects easier? On the other hand, we wonder about the progress or setbacks in terms of regulatory frameworks and effective regulations that allow for an efficient evaluation not only of the production of mining and energy derivatives, but also of associated processes such as desalination, incorporating not only the principles of protection for marine ecosystems, but also their role in the integrated management of watersheds.

VIII. Annexes and references

Substation and high voltage line in the vicinity of the Imilac salt flat.
Credits: Nelson Manquián (2024).

VIII. Annexes and references

The following annexes are available for download on .xlsx file format on Tantí Foundation's website (www.fundaciontanti.org).

Annex 1: NCRE and green hydrogen projects present in the report
Annex 2: List of known projects for green hydrogen and its derivatives in Antofagasta
Annex 3: Antofagasta NCRE projects database

1. ACADES. (2024). Seguridad hídrica para Chile y sus regiones. https://www.acades.cl/wp-content/uploads/2024/10/Minuta-programatica-Regional-.pdf
2. Aldana Rivera, S. E., & León Peñuela, F. A. (2022). Hidrógeno verde en Colombia. Si se hace mal, podría ser peor. Reflexiones sobre su apuesta. Fundación Heinrich Böll Bogotá.
3. Alonso-Fernández, P., & Regueiro-Ferreira, R. M. (2022). Extractivism, ecologically unequal exchange and environmental impact in South America: A study using Material Flow Analysis (1990–2017). Ecological Economics, 194, 107351. https://doi.org/10.1016/j.ecolecon.2022.107351
4. Andreucci, D., García López, G., Radhuber, I. M., Conde, M., Voskoboynik, D. M., Farrugia, J. D., & Zografos, C. (2023). The coloniality of green extractivism: Unearthing decarbonisation by dispossession through the case of nickel. Political Geography, 107, 102997. https://doi.org/10.1016/j.polgeo.2023.102997
5. Araya, P., Fleischmann, M., Reyes, A., González, K., Oyarzún, T., Sánchez, J. I., Billi, M., Louder, E., Amigo, C., Urquiza, A., Riquelme, R., & Rojas, V. (2023). ¿De qué hablamos cuando hablamos de Transición Energética Justa? Articulando múltiples escalas, resoluciones y sentidos (Documento de trabajo 4). NEST-r3.
6. Babidge, S., Kalazich, F., Prieto, M., & Yager, K. (2019). «That's the problem with that lake; it changes sides»: Mapping extraction and ecological exhaustion in the Atacama. Journal of Political Ecology, 26(1), Article 1.
7. Beltrán, M. J., & Velázquez, E. (2015). La Ecología Política del Agua Virtual y Huella Hídrica. Reflexiones sobre la necesidad de un análisis crítico de los indicadores de flujos virtuales de agua en la economía. Revista de Economía Crítica, 20, Article 20.
8. Bertinat, P., Chemes, J., & Forero, L. F. (2020). Transicion Energetica. Aportes para la reflexión colectiva. Transnational Institute y Taller Ecologista (con el apoyo de Fundación Boell Cono Sur).
9. Blair, J. J. A., Balcázar, R. M., Barandiarán, J., & Maxwell, A. (2023). The 'Alterlives' of Green Extractivism: Lithium Mining and Exhausted Ecologies in the Atacama Desert. International Development Policy | Revue Internationale de Politique de Développement, 16, Article 16. https://doi.org/10.4000/poldev.5284
10. Blair, J. J. A., Balcázar, R. M., de Salares, P., Barandiarán, J., & Maxwell, A. (2022). Exhausted: How We Can Stop Lithium Mining from Depleting Water Resources, Draining Wetlands, and Harming Communities in South America (p. 40). Natural Resources Defense Council.
11. Bookchin, N., Brown, P., Ebrahimian, S., Colectivo Enmedio, Juhasz, A., Martin, L., & MTL. (2013). Militant Research Handbook. New York University Steinhardt School of Culture, Education, and Human Development. https://www.visualculturenow.org/wp-content/uploads/2013/09/MRH_Web.pdf
12. Brand, U., & Wissen, M. (2018). The limits to capitalist nature: Theorizing and overcoming the imperial mode of living. Rowman & Littlefield International.

13. Bravo, E. (2021). Energías Renovables, Selvas Vaciadas. Expansión de la energía eólica en China y la tala de balsa en el Ecuador. Acción Ecológica; Naturaleza con Derechos. https://www.naturalezaconderechos.org/wp-content/uploads/2021/09/LA-BALSA-SE-VA.pdf
14. Briceño Espinoza, A., Hermosilla Alvarado, T., Huerta Tapia, A., Hugo González, M., Soto Troncoso, C., & Véliz Aravena, L. (2024). Estudio Biocultural del Pueblo Chango "Usos, Significados y Conocimientos Ecológicos de su Patrimonio en las Comunas del Borde Costero en la Región de Antofagasta" (Fundación para la Superación de la Pobreza).
15. Bringel, B., & Maldonado, E. E. (2016). Latin American Critical Thought and Activist Research in Orlando Fals Borda: Praxis, subversion and liberation/Pensamento Critico Latino-Americano e Pesquisa Militante em Orlando Fals Borda: praxis, subversao e libertacao. Direito e Práxis, 7(1), 389-414.
16. Cabaña Alvear, G., Díaz Muñoz, M., Glatz Brahm, P., Leiva Crispi, B., & Mascaró Cáceres, F. (2024). "Hidrógeno ¿Verde?"- Centro de Análisis Socioambiental. Centro de Análisis Socioambiental.
17. Cabaña, G. (2024). Modelo industrial del hidrógeno proyectado para Chile [Documento de posición organizaciones de la sociedad civil]. Chile Sustentable, Ecosistemas, Energía Colectiva, Fundación Ecosur, Greenpeace, Manomet Conservations Sciences, ONG Fima, Fundación Terram, Red Ecofeminista por la transición energética. https://chilesustentable.net/wp-content/uploads/2024/10/hidrogeno-verde_2024.pdf
18. CDE. (2020). CDE INTERPONE DEMANDA POR DAÑO AMBIENTAL PROVOCADO EN EL SALAR DE PUNTA NEGRA, EN REGIÓN DE ANTOFAGASTA. https://www.cde.cl/cde-interpone-demanda-por-dano-ambiental-provocado-en-el-salar-de-punta-negra-en-region-de-antofagasta/
19. Cifuentes, P. P., & Pinilla, M. S. (2020). Vivir en una Zona de Sacrificio. https://chilesustentable.net/publicacion/vivir-en-una-zona-de-sacrificio/
20. Comisión Nacional de Energía. (2024). Reporte mensual ERNC. October 2024 (98). https://www.cne.cl/wp-content/uploads/2024/10/RMensual_ERNC_v202410.pdf
21. Comunidad Lickanantay Atacameña de Peine. (April 14, 2023) Radio Kurruf—Comunidad Lickanantay Atacameña de Peine rechaza concesión estatal a empresas de energías renovables. Radio Kurruf. https://radiokurruf.org/2023/04/13/comunidad-lickanantay-atacamena-de-peine-rechaza-concesion-estatal-a-empresas-de-energias-renovables/
22. Consejo de Políticas de Infraestructuras. (July 14, 2023). Dos nuevos proyectos de hidrógeno verde avanzan en adjudicación de terrenos fiscales e ingresarán a trámite ambiental. CPI. https://www.infraestructurapublica.cl/dos-nuevos-proyectos-de-hidrogeno-verde-avanzan-en-adjudicacion-de-terrenos-fiscales-e-ingresaran-a-tramite-ambiental/
23. Coordinador Eléctrico Nacional. (2023). Propuesta de Expansión de la Transmisión. Proceso de planificación de la transmisión 2023 https://www.cne.cl/tarificacion/electrica/
24. Coordinador Eléctrico Nacional. (2024). Propuesta de Expansión de la Transmisión. Proceso de planificación de la transmisión 2024. https://www.cne.cl/tarificacion/electrica/
25. Couve, A., Farías, L., Moraga, P., Moreno, R., & Olivares, M. (2023). Policy Brief: Co-creación de conocimiento para minimizar impactos socioambientales y viabilizar la inversión: Nueva normativa aplicable a una desalinización sustentable. Vicerrectoría de Investigación y Desarrollo de la Universidad de Chile.

26. Dominish, E., Teske, S., & Florin, N. (2019). Responsible Minerals Sourcing for Renewable Energy. Report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney. [Report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney.].
27. El Mercurio. (September 26, 2024). SEA remueve a director regional de Antofagasta tras polémica suspensión de millonario proyecto de Colbún. Emol. https://www.emol.com/noticias/Economia/2024/09/26/1143691/sea-proyecto-colbun.html
28. Fernandes, S. (2024). "Just" Means "Just" Everywhere: How Extractivism Stands in the Way of an Internationalist Paradigm for Just Transitions. International Journal of Politics, Culture, and Society. https://doi.org/10.1007/s10767-024-09475-4
29. Fondo bilateral para el desarrollo en transición Chile - Unión Europea. (2022). Cooperación técnica para proyectos de producción, almacenamiento, transporte y uso de hidrógeno verde. Fondo bilateral para el desarrollo en transición Chile—Unión Europea. Fondo bilateral para el desarrollo en transición Chile - Unión Europea. https://www.agci.cl/images/centro_documentacion/H2_VERDE_BROCHURE_2022.pdf
30. Fuentes, C., Larraín, S., & Poo, P. (2020). Transición justa. Desafíos para el proceso de descarbonización, la justicia energética y climática en Chile. Chile Sustentable.
31. Fundación Terram. (2018). La negligente realidad de la bahía de Quintero [ADC N° 31]. https://www.terram.cl/descargar/ambiente/contaminacion/adcma_-_analisis_de_coyuntura_medio_ambiente/ADC-31-La-negligente-realidad-de-la-Bahia-de-Quintero-.pdf
32. Fundación Terram. (November 2024). Sin permisos: Detectan graves irregularidades en planta desalinizadora en Mejillones – Fundación Terram. https://www.terram.cl/sin-permisos-detectan-graves-irregularidades-en-planta-desalinizadora-en-mejillones/
33. GIZ. (2023). Disponibilidad del recurso hidrico en el desarrollo del H2V y sus Derivados en Chile. https://h2lac.org/wp-content/uploads/2023/11/Disponibilidad-del-recurso-hidrico-en-el-desarrollo-del-H2V-y-sus-Derivados-en-Chile.pdf
34. H2 News. (May 8, 2023). Rotterdam 2023: Empresas chilenas y holandesas entregaron una declaración que impulsa la cadena de valor internacional de hidrógeno en la zona de la bahía de Mejillones. H2news. https://h2news.cl/2023/05/08/empresas-chilenas-y-holandesas-trabajan-en-una-declaracion-que-impulse-la-cadena-de-valor-internacional-de-hidrogeno-en-la-zona-de-la-bahia-de-mejillones/
35. Hamed, T. A., & Alshare, A. (2022). Environmental Impact of Solar and Wind energy- A Review. Journal of Sustainable Development of Energy, Water and Environment Systems, 10(2), 1-23. https://doi.org/10.13044/j.sdewes.d9.0387
36. Harrison, C., Lloyd, H., & Field, C. (2016). Evidence review of the impact of solar farms on birds, bats and general ecology (NEER012). Natural England.
37. Hartlief, I., Kwizera, S., Lindobuhle Nene, D., Ngoatje, N., & Vally, F. (2024). Hyped hydrogen: Hidden harm. SOMO.
38. Heinrich Böll, Friends of the Earth, & Fundación Terram. (2020). Atlas del Carbón. Hechos y cifras de un combustible fósil. https://cl.boell.org/sites/default/files/2020-12/atlas_del_carbon%20web.pdf
39. Hickel, J., Dorninger, C., Wieland, H., & Suwandi, I. (2022). Imperialist appropriation in the world economy:

Drain from the global South through unequal exchange, 1990–2015. Global Environmental Change, 73, 102467. https://doi.org/10.1016/j.gloenvcha.2022.102467

40. Hornborg, A. (2009). Zero-Sum World: Challenges in Conceptualizing Environmental Load Displacement and Ecologically Unequal Exchange in the World-System. International Journal of Comparative Sociology, 50(3-4), 237-262. https://doi.org/10.1177/0020715209105141
41. Infante-Amate, J., Urrego Mesa, A., & Tello Aragay, E. (2020). Las venas abiertas de América Latina en la era del Antropoceno: Un estudio biofísico del comercio exterior (1900-2016). Diálogos Revista Electrónica, 21(2), 177-214. https://doi.org/10.15517/dre.v21i2.39736
42. Jerez, B., Garcés, I., & Torres, R. (2021). Lithium extractivism and water injustices in the Salar de Atacama, Chile: The colonial shadow of green electromobility. Political Geography, 87, 102382. https://doi.org/10.1016/j.polgeo.2021.102382
43. Jerez, B. P., Bolados, P., & Torres, R. (2023). La eco-colonialidad del extractivismo del litio y la agonía socioambiental del Salar de Atacama: El lado oscuro de la electromovilidad “verde”. Revista Austral de Ciencias Sociales, 44, Article 44. https://doi.org/10.4206/rev.austral.cienc.soc.2023.n44-04
44. Kemmis, S., McTaggart, R., & Nixon, R. (2014). The Action Research Planner: Doing Critical Participatory Action Research. Springer Singapore. https://doi.org/10.1007/978-981-4560-67-2
45. La Tercera. (March 16, 2023). Grupo eléctrico Statkraft Chile: “Esperamos concretar alguna adquisición este año”—La Tercera. www.latercera.com. https://www.latercera.com/pulso-pm/noticia/grupo-electrico-statkraft-chile-esperamos-concretar-alguna-adquisicion-este-ano/ZB65MLO45BA33NFM55GUF3BCRY/
46. Lang, M., Brengel, B., & Manahan, M. A. (Eds.). (2023). Más allá del colonialismo verde. https://biblioteca-repositorio.clacso.edu.ar/bitstream/CLACSO/249068/1/Mas-alla-colonialismo.pdf
47. McKinsey & Company. (December 2020). Chilean Hydrogen Pathway. Final Report. https://energia.gob.cl/sites/default/files/estudio_base_para_la_elaboracion_de_la_estrategia_nacional_para_el_desarrollo_de_hidrogeno_verde_en_chile.pdf
48. Ministerio de Bienes Nacionales. (August 3, 2023). Hidrógeno Verde: Bienes Nacionales tramita 16 proyectos en terrenos fiscales. Ministerio de Bienes Nacionales. https://bienesnacionales.cl/?p=45210
49. Ministerio de Energía. (2020). Estrategia Nacional de Hidrógeno Verde. Chile, fuente de energia para un planeta cero emisiones. Versión noviembre 2020. https://energia.gob.cl/sites/default/files/estrategia_nacional_de_hidrogeno_verde_-_chile.pdf
50. Ministerio de Energía. (2021a). Planificación Energética de Largo Plazo (PELP) período 2023-2027. Informe Preliminar.
51. Ministerio de Energía. (November 23, 2021b). La iniciativa “Ventana al Futuro” consiste en un período único y excepcional para asignar terrenos para la producción de Hidrógeno Verde | Ministerio de Energía. www.energia.gob.cl. https://energia.gob.cl/noticias/nacional/la-iniciativa-ventana-al-futuro-consiste-en-un-periodo-unico-y-excepcional-para-asignar-terrenos-para-la-produccion-de-hidrogeno-verde
52. Ministerio de Energía. (2024a). Plan de Acción Hidrógeno verde 2023-2030. Ministerio de Energía.
53. Ministerio de Energía. (July 12, 2024b). Subsecretario Ramos encabeza inauguración de la planta solar más grande de Chile | Ministerio de Energía. https://energia.gob.cl/noticias/nacional/subsecretario-ramos-encabeza-

inauguracion-de-la-planta-solar-mas-grande-de-chile

54. Ministerio de Medio Ambiente. (2024). Plan «Flora costera del norte de Chile»—SIMBIO. https://simbio.mma.gob.cl/PlanesRecoge/Details/2#planaccion
55. Ministerio de Relaciones Exteriores. (2023). Chile y la Unión Europea refuerzan vínculos en hidrógeno verde con miras hacia un desarrollo sostenible. Minrel. https://minrel.gob.cl/noticias-anteriores/chile-y-la-union-europea-refuerzan-vinculos-en-hidrogeno-verde-con-miras
56. Mongabay. (June 21, 2023). México: La central fotovoltaica más grande de América Latina altera paisaje de reservas de la biosfera y territorio ancestral indígena. Noticias ambientales. https://es.mongabay.com/2023/06/mexico-central-fotovoltaica-mas-grande-de-america-latina-altera-paisaje-de-reservas-de-la-biosfera-y-territorio-indigena/
57. Mulvaney, D. (2024). Embodied energy injustice and the political ecology of solar power. Energy Research & Social Science, 115, 103607. https://doi.org/10.1016/j.erss.2024.103607
58. Nualart Corpas, J., & Gros Beto, M. (2024). El rastro del hidrógeno: Una mirada global al desarrollo del hidrógeno y sus impactos en el Estado español y Chile. Observatorio del deute en la globalizació. https://odg.cat/wp-content/uploads/2024/04/Rastro-hidrogeno-cast.pdf
59. ONG FIMA, C. (2023). Transición socioecológica justa en Chile: Recomendaciones para la protección de los ecosistemas marino costeros frente a la desalación del agua de mar. Estudio de caso en la comuna de Antofagasta.
60. Pacto Ecosocial del Sur. (2023, febrero 9). Manifiesto de los Pueblos del Sur—Por una Transición Energética Justa y Popular. Pacto Ecosocial e Intercultural del Sur. https://pactoecosocialdelsur.com/manifiesto-de-los-pueblos-del-sur-por-una-transicion-energetica-justa-y-popular-2/
61. País Circular. (May 23, 2023). Primer Tribunal Ambiental deja en acuerdo reclamación que pretende revertir proyecto de subestación y transmisión eléctrica desde Taltal a Antofagasta. País Circular. https://www.paiscircular.cl/radar-legal/primer-tribunal-ambiental-deja-en-acuerdo-reclamacion-que-pretende-revertir-proyecto-de-subestacion-y-transmision-electrica-desde-taltal-a-antofagasta/
62. Paredes Letelier, C. (2024). La negligente realidad de la bahía de Quintero. Proyecto Tayú, Fundación Terram. https://www.terram.cl/wp-content/uploads/2024/07/NEGLIGENTE-REALIDAD-04032024.pdf
63. Post, E. (2023). Expanding Extractivisms: Extractivisms as Modes of Extraction Sustaining Imperial Modes of Living. International Development Policy | Revue Internationale de Politique de Développement, 16, Article 16. https://doi.org/10.4000/poldev.5376
64. Saavedra Löwenberger, L., Donoso Ferez, K., Cisterna Roa, V., & José Luis, L. C. (2023). Análisis de los efectos ecosistémicos del uso de agua de mar y la desalinización para el abastecimiento hídrico de la minería: El caso de Chile [Documentos de Proyectos (LC/TS.2023/97)]. Comisión Económica para América Latina y el Caribe (CEPAL).
65. Sánchez, I., & Aedo, M. P. (2023). Hidrógeno verde: ¿Qué es y cómo se usa? Fundación Ciudadanía Inteligente.
66. Seeger, M. (2023). The new «energy El Dorado»? The World Bank's Role in Promoting Green Hydrogen in Chile. Recourse and Sustentarse. https://re-course.org/wp-content/uploads/2023/09/The-World-Bank-role-in-promoting-Green-Hydrogen-in-Chile.pdf

67. Soto Hernandez, D., & Newell, P. (2022). Oro blanco: Assembling extractivism in the lithium triangle. The Journal of Peasant Studies, 1-24. https://doi.org/10.1080/03066150.2022.2080061
68. SoyChile. (September 30, 2024). Realizan manifestación por salida del director regional del Servicio de Evaluación Ambiental por Caso Colbún. SoyChile. https://www.soychile.cl/antofagasta/sociedad/2024/09/30/878561/remocion-caso-colbun-sea.html
69. Spash, C. L. (2018). Social ecological economics. En C. L. Spash (Ed.), Routledge handbook of ecological economics: Nature and society (First issued in paperback, pp. 3-16). Routledge.
70. Timeline. (October 2024). Gobierno ordena la suspensión temporal de plazos del estudio que busca modificar el plan regulador de Mejillones. Timeline.cl. https://www.timeline.cl/seremi-de-vivienda-ordena-la-suspension-temporal-de-plazos-del-estudio-que-busca-modificar-el-plan-regulador-de-mejillones/
71. Valdés Fernández, G. (2023). "La tierra del olor a dólar: Urbanización logística como determinante de la experiencia de bordes y fronteras de los habitantes de Mejillones" [Magister en Desarrollo Urbano]. Pontificia Universidad Católica de Chile.
72. Vela Almeida. (2020, agosto 3). Extractivismo—Uneven Earth. https://unevenearth.org/2020/08/extractivismo/
73. Vicuña, S., Daniele, L., Farías, L., González, H., Marquet, P. A., Palma-Behnke, R., Stehr, A., Urquiza, A., Wagemann, E., Arenas-Herrera, M. J., Bórquez, R., Cornejo-Ponce, L., Delgado, V., Etcheberry, G., Fragkou, M. C., Fuster, R., Gelcich, S., Melo, O., Monsalve, T., … Winckler, P. (2022). Desalinización: Oportunidades y desafíos para abordar la inseguridad hídrica en Chile. Comité Científico de Cambio Climático. https://estudiosurbanos.uc.cl/wp-content/uploads/2022/12/2022_Com-Cambio-Climatico_Informe-Desalinizacion_vfinal_compressed.pdf
74. Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A. C., & Ryan, P. G. (2019). Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable Energy, 133, 1285-1294. https://doi.org/10.1016/j.renene.2018.08.106
75. World Bank. (June 29, 2023). Chile acelera la industria del hidrógeno verde con apoyo del Banco Mundial. World Bank. https://www.bancomundial.org/es/news/press-release/2023/06/29/chile-to-accelerate-its-green-hydrogen-industry-with-world-bank-support
76. Zografos, C., & Robbins, P. (2020). Green Sacrifice Zones, or Why a Green New Deal Cannot Ignore the Cost Shifts of Just Transitions. One Earth, 3(5), 543-546. https://doi.org/10.1016/j.oneear.2020.10.012

FUNDACIÓN TANTÍ