

Energy Just Transition: Chile as a Case Study

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1- Introduction and Context: Energy Transition Process in Chile

In 2019, Chile began a decarbonization process that includes the planned phase-out of the 28 coal-fired power plants existed in the country in 2018 (5,5 GW, generating 30 TWh/yr) by 2040. Today, more than 2,000 MW of coal generation had already being replaced by wind and solar generation.

This decarbonization process is based on a voluntary agreement between the State of Chile, through the Ministry of Energy, and the companies owning these generating units in the electrical system. To analyze the effects of coal withdrawal on the national electric matrix, as well as on the security and economic efficiency of the electrical system, local economic activity, and environmental aspects, the "Coal Unit Withdrawal and/or Conversion Roundtable" was established. This working group included coal plant owners, public sector entities such as the Ministry of Energy, the National Energy Commission, and the Ministry of the Environment, the National Electrical Coordinator, consumer associations, business guilds, non-governmental organizations, labor unions, municipalities, academics, and international organizations.

Thanks to the efforts of this group and the drive from the Ministry of Energy, Chile outlined a decarbonization path consisting of three main axes: (1) the retirement of the oldest coal units by 2024 (equivalent to 31% of the installed capacity of coal plants), (2) the total retirement of plants operating entirely on coal before 2040, and (3) achieving carbon neutrality by 2050.

In this regard, it is important to note that Chile does not provide subsidies to energy companies for this transition process, which gives these institutions autonomy in their strategy for closing down the plants, as stated in one of the interviews conducted in this research with a senior executive of one of the coal-generating companies in Chile:

"(...) the role of the Government is more of accompaniment, as no resources are provided to assist with the closures, and each plant owner must take care of the entire process, including relationships with affected communities. Unlike other decarbonization strategies, such as those in Europe, there are no state subsidies for this purpose in Chile."

From another perspective, it is possible to affirm that Chile's approach towards subsidies is to directly benefit consumers instead of companies, as confirmed by an academic expert in

energy interviewed: "*Chile tends to prefer subsidies that directly benefit consumers, rather than financing significant technological improvements that reduce emissions.*"

In summary, the decarbonization process in Chile is being carried out in a context where both the public and private sectors are jointly working to achieve this goal. While the lack of state subsidies may pose a challenge, each company is carefully assessing the options available for their decarbonization process. However, all the interviewed experts agree that the agreement between the public and private sectors for this process marks a clear path and a goal to aim for. This underscores the importance of collaboration between both parties and highlights the country's resolve on its way towards a cleaner and more sustainable energy matrix.

From a global perspective, fossil fuels currently make up more than 60 per cent of the world's total electricity supply (28,528 TWh), approximately 1000 times Chilean fossil fuel generation. Therefore, Chilean experience can give us some lessons and identify some challenges to achieve a worldwide energy transition.

2- Objectives and Methodology.

This article addresses three objectives. Firstly, it presents and analyzes the different plans and strategies that Chilean companies are adopting to meet the established decarbonization goals. Secondly, it explores the role of renewable energies in this decarbonization process, explaining the facilitators, obstacles, and challenges for their development. Lastly, the opportunities that the decarbonization process brings to Chile in terms of energy independence and environmental protection are analyzed.

To conduct this study, a methodology consisting of two phases was implemented. In the first phase, an analysis of secondary information focused on Chile's energy matrix was performed. This analysis included data collection on energy generation (MWh) by type of power plant, aiming to provide a detailed overview of the Chilean energy context. Subsequently, in the second phase, seven interviews were conducted with key stakeholders related to the topic. These interviews included managers of coal-fired, mixed, and renewable energy companies operating in Chile, as well as other sector experts.

3- Company Strategies Surrounding the Decarbonization Plan

In the context of the energy transition, Chilean companies are making strategic decisions regarding their coal-powered electrical plants. Instead of opting for the direct closure of all these facilities, most companies have expressed interest in carrying out conversion processes for those units that allow it, especially those which started operating between years 1995 and 2013. This trend is largely due to economic considerations, as the

investment previously made in these plants would not be lost. Additionally, in one of the interviews, an energy expert mentioned that the existing port infrastructure could be adapted to accommodate other fuels, such as natural gas, which several companies consider a viable alternative to coal. They also mentioned other types of infrastructure, such as substations or transmission lines, that could be leveraged:

"(...) the coal plant was installed there because it had a lot of conditions. Proximity to the sea to have the port and receive resources, being close to a transmission line, there is already an existing substation, etcetera. So, all those costs are costs that one saves if the plant is converted (...)"

In addition to natural gas, companies are exploring the potential of various technologies, such as green hydrogen and ammonia, as cleaner and more sustainable energy sources. These studies are inspired by successful examples in countries like Japan and are being conducted in collaboration with companies from the same country. As one of the innovation and development managers of a coal power plant owning company mentioned:

"However, from the electrical projects perspective, here at the company, the main focus is a study [...] that is being developed with a Japanese company, and in that context, we are exploring converting the plant so it can burn not only coal but also ammonia in its boiler (...)"

On the other hand, in virtually all interviews conducted with energy companies, it is highlighted that the conversion of these plants would not have a significant effect on local development, especially regarding the employment these companies provide. This is because the number of workers needed to operate a coal plant and a converted plant with the options being considered is similar. Moreover, companies do not consider the employee training process for conversion difficult since the technical knowledge required is like what is currently applied. This approach of conversion, instead of closure, presents itself as a viable strategy in practical and economic terms for companies, while paving the way for a cleaner and more diversified energy matrix in Chile and significantly reducing the cost of the energy transition.

4- Renewable Energies in Chile

The potential for non-conventional renewable energies (NCRE) in Chile is significant, with more than 1.9 TW available from wind and solar resources. Since 2008, the Chilean government has actively promoted the development of these energy sources, introducing mandatory generation quotas based on NCRE. Initially, the objective was to reach 10% of the electric power traded from renewable sources, and by 2025, this requirement was

increased to 20%. This goal was exceeded significantly, being more than 43% by the end of 2023, and expected to surplus 62% by 2025.

This policy has generated a solid infrastructure and a favorable environment for the expansion of renewable energies in the country. Additionally, the investment cost in renewable energy projects is considerably lower compared to conventional technologies, as pointed out by one of the interviewed energy experts. Thus, solar and wind energy generation are fundamental pillars in the energy sector's transition process in Chile and to meet the goals of the decarbonization plan, not only for environmental considerations but also for economic reasons and the potential for country's economic independence.

The advantages that Chile has with these types of energies are evident, as the energy industry is in constant development, aiming to overcome pending challenges and barriers that are fundamental for the future of the energy matrix. One of the main challenges is technological development, especially in the field of energy storage. The lack of effective alternatives to store renewable energy reliably and affordably limits its ability to cover demand throughout the day. As industry experts point out, there is a need to find solutions that allow for sustainable "clean" electrical generation 24 hours a day. This limitation in renewable energy storage has a direct impact on the country's energy supply security.

"(...) Having energy that can cover you 24 hours is the big issue, you have a gap in filling the demand curve. You do it very well during the day because you have natural energy. But there are periods of the day when I don't have it, and as long as I don't have renewable energy that can replace it, it's difficult to gradually phase out conventional technology." (Interview with a manager, energy generation company)

Another important challenge relates to the transmission system and connection capacity, as the transmission lines required for the energy transition are not the same as those developed for generation based on fossil fuels. Congestion in the transmission lines and delays in their construction due to negotiations with local communities represent significant obstacles to the expansion of renewable energies. Effective incorporation of communities into the energy transition process is essential to address this challenge and ensure acceptance.

"One of the challenges is the transmission issue, related to line congestion, which makes the entire transmission planning process, covering many kilometers and requiring a lot of management, and going through many communities, a slow process" (Interview with a manager, energy generation company).

"Delays in the transmission lines due to protests by communities that couldn't agree on environmental impact assessment issues." (Interview with a manager, energy generation company)

In addition, difficulties in terms of permitting and regulations also hinder progress towards a more sustainable energy system. Slow and complex processes for obtaining environmental and regulatory permits create uncertainty for companies and complicate long-term planning. The lack of certainty about future market conditions and investment recovery limits participation and investment in renewable energy projects.

"The issue we have here in Chile is that there are very slow processes, for example, the environmental permit. Today we have approved projects, but it takes us about 3 years to process them, and some are still not closed (...) the time it takes in the permitting process, and the regulatory issue, is too much." (Interview with a manager, energy generation company)

Even though Chile enacted a storage law in 2022, a key element to reach the goal of carbon neutrality, regulations regarding this law have not yet been established. Furthermore, projects entering the Environmental Impact Assessment System to obtain a favorable environmental permit, are taking on average 1,433 days (about 4 years) when impact and compensatory measures are accredited, and 372 days (more than a year) when there is no impact, with the energy sector being one of the most affected. However, it is noted that budgetary, administrative, and legal measures are in process to expedite the permit processing.

"It's the pace of regulation that needs to be changed, and that is a challenge I believe we have as a country. It is a matter of state, of public policy in general. Signals must be effectively given, and it should not be political in the sense that it doesn't matter the ideology of the current government; it has to be permanent." (Interview with a manager of an energy generation company)

The potential for non-conventional renewable energies (NCRE) in Chile is significant, highlighted by the government push since 2008 with mandatory generation quotas based on NCRE, the solid infrastructure, and the favorable environment, becoming a fundamental pillar for decarbonization goals. Despite pending challenges in technology, transmission system, and permitting to achieve the transition toward a more sustainable energy system, there is a joint effort to overcome these barriers, with measures in process and common recognition of the need for action by stakeholders involved in the energy sector.

In this context, it is important to emphasize that combining renewable energies with combined cycle technologies is also seen as a key aspect for the future development of the Chilean energy sector, leveraging the country's vast renewable energy potential and addressing challenges associated with its integration into the national electricity grid. It is at this point where the interviewees place emphasis since Chile enjoys a circumstantial advantage compared to other countries.

5- Decarbonization Process: Opportunity for Energy Independence.

The energy transition process in Chile through the decarbonization plan offers a unique opportunity to achieve energy independence and strengthen the country's sovereignty in terms of electricity supply. Chile has an abundant potential of renewable resources, such as solar and wind energy, which can be leveraged to reduce the reliance on imported fossil fuels.

By promoting the development of renewable energies, Chile not only contributes to mitigating climate change and reducing emissions but also ensures a clean, safe, reliable, and local energy source. Opting for solar and wind energy, given their competitive advantages in terms of price and investment, reflects the path toward a more sustainable and nearly 100% renewable electric matrix.

In this sense, it is crucial that Chile continues to push policies and favorable conditions for the broad development of renewable energies, making the most of its natural potential and moving toward a more independent, resilient, and sustainable energy future. The transition to an electric matrix based on renewable energies is a crucial step toward a more autonomous Chile committed to environmental protection and the well-being of its citizens.

6- Conclusions

The decarbonization process in Chile, initiated in 2019, marks a significant milestone in the transition towards a fairer and more sustainable energy system. This process, based on a voluntary agreement between the State and companies, reflects a common horizon and joint effort to reach goals. Despite the lack of state subsidies, companies are adopting conversion strategies instead of direct closures of coal power plants, paving the way towards a fair and sustainable energy matrix.

The role of non-conventional renewable energies (NCRE), such as solar and wind, is fundamental in this decarbonization process. Chile has vast potential in these energy sources, supported by governmental policies and solid infrastructure that has created a favorable environment for their development. However, challenges in technology (mainly for conversion and storage), transmission systems, permits, and community relationships persist.

Despite these challenges, there is a common commitment to overcoming existing barriers. Companies are exploring various technologies and strategies to meet decarbonization goals, while the State is working on measures to streamline regulatory processes and promote a conducive environment for investments in renewable energies.

Thus, this transition process represents an opportunity for Chile not only in terms of climate change mitigation and emission reduction but also in seeking energy independence, achieving an energy matrix close to 100% renewable, and ensuring a clean, safe, and reliable electricity supply for all citizens.

From a global perspective, fossil fuels currently make up more than 60 per cent of the world's total electricity supply (28,528 TWh), approximately 1000 times Chilean fossil fuel generation. Therefore, Chilean experience can give us some lessons and identify some challenges to achieve a worldwide energy transition.