CHILE

ENERGY

An emerging key actor in the renewable energy arena

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CHILE

An emerging key actor in the renewable energy arena

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Chile, with less than 18 million inhabitants, is becoming a strategic actor in the world energy transition thanks to its Northern Atacama Desert that contains great mineral wealth, mainly copper and lithium, and the country's huge potential for renewable energy (RE) production. It is one of the first countries becoming successful in promoting RE electricity production without feed-in tariffs or other subsidies. The current long-term goal is at least 70 % of renewable electricity by 2050. It requires to keep a fast pace of investments in clean energy while removing coal generation through different public policies. However, while such policies are fundamental, they may not be sufficient, given the complexity and pace of the required changes. This transformation may be possible thanks to the active participation of stakeholders, from political parties, universities, and research centres, to the private sector and citizen organizations. Altogether, and despite the existing contradictions, they are pushing policies closer to faster decarbonization and are helping to implement real new solutions in the different regions of the country. In this paper, we discuss the role of the main non-state actors of the Chilean energy transition, focusing on the electricity sector.

Key takeways

Chile's CO_2 emissions from the power sector have slightly decreased over the last three years, after a three decades-long surge due to coal-based electricity accounting for 39.5% of total production, and pulled by economic growth, the booming mining activities and the annulment of recent hydroelectric dam projects;

Policies for the electricity sector stand out in two aspects : investments in RE projects skyrocketed without direct public subsidies, but through quotas, auctions and recently a system of net metering; It was also the first country in South America to introduce a carbon tax in 2017, initially to the electricity sector, set at a very low level of $ 5 per ton of CO_2 and which should increase progressively;

The mining sector is both a major problem (37% of electricity consumption in Chile) and part of the solution : Chile has abundant rare-earth metals that are essential for RE development worldwide. Mining companies need to accelerate their conversion to PV and concentrated solar power;

The substantial shift towards clean energies has been strongly spurred by civil society : NGOs are supporting policy through advocacy and technical expertise while blocking major projects for dams, and universities partner with private actors to form clusters and accelerate;

The multi-level governance system in construction recognizes the key role of Regional Climate Change Committees among other decision bodies, to address local climate issues and implement policy at all levels. Despite successful co-construction processes, the Chilean network of cities against climate change (56 members and 38% of total population) still demand financial and technical resources to enable implementation;

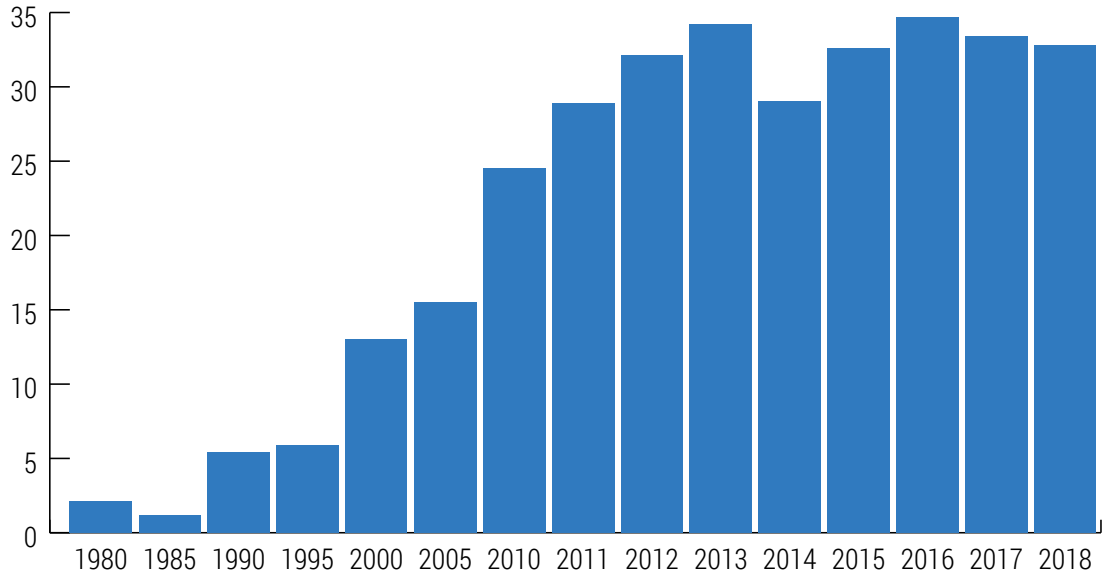
CONTENTS

1 – Chile's power sector curbing emissions : a watershed?

After three decades of structural increase, CO_2 emissions from electric production in Chile are now decreasing for the second consecutive year, from 34.7 in 2016 to 32.4 $MtCO_2$ in 2018 (fig.1). While it is still too early to say whether this is becoming an underlying trend or is a cyclical dip, the political decisions of recent years are clearly in favour of decarbonaizing electricity production : development of renewable energy sources, restructuration of electricity networks, unprecedented introduction in South America of carbon price in 2017... Is the Chilean electricity system at a turning point?

FIGURE 1

CO_2 EMISSIONS FROM THE PUBLIC PRODUCTION OF ELECTRICITY AND HEAT – *Source : Compiled by the author using data from ENERDATA*



Should this trend be sustainable, this would mark a real turning point after a three decades-long trajectory of rising emissions. For many years, Chile based its electricity generation on hydropower, taking advantage of the torrential rivers that descend from the Andes. But from the mid-80s until recently, its strong economic growth was followed by a rapid increase in fossil fuel generation, especially coal-based production that made CO_2 emissions surge. In 2018, CO_2 emissions from electricity generation were 2.5 times higher than in 2000 (fig. 1). Firstly, public electricity production doubled between 2000 and 2018 (accompanying the economic growth) and, secondly, there was no improvement in the carbon intensity of the electricity mix until recently (fig. 2). **Most increases in CO_2 emissions are explained by the combustion of imported coal and, to a lesser extent, by the combustion of oil and natural gas. Indeed, coal-based electricity generation has increased from 8 444 GWh in 2000 to 29 376 GWh in 2018 (fig. 3). In 2018, coal remained the main source of electricity generation, with 39.5 % of the total, followed by hydroelectricity, natural gas, solar and wind.**

However, in the last few years, the Chilean power sector has started a new transformation, in line with the path defined in Chile's Nationally Determined Contribution (NDC) and the ratification of the Paris Agreement in 2017. As in many other countries, energy efficiency and the promotion of RE became the key strategies to reduce emissions and reach its energy and climate goals.

FIGURE 2

CARBON INTENSITY OF THE ELECTRICITY MIX – *Source : Compiled by the author using data from ENERDATA*

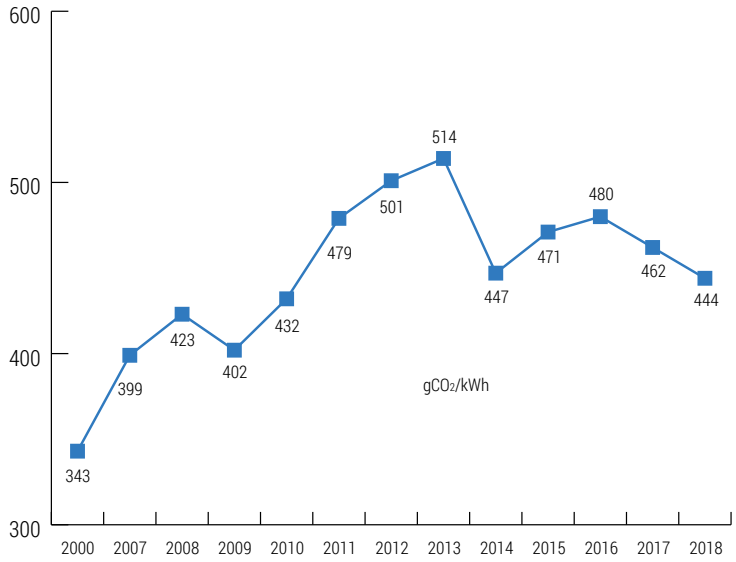
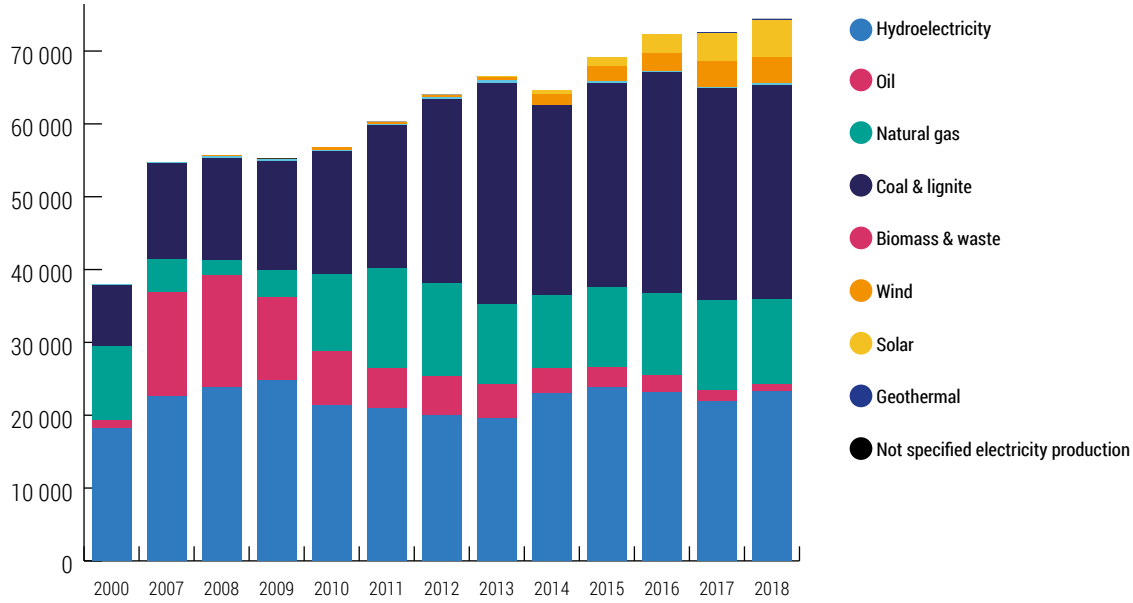


FIGURE 3

ELECTRICITY GENERATION BY SOURCE (GWH/YEAR) – *Source : Compiled by the author using data from ENERDATA*



As energy-related GHG emissions account for around 77% of total emissions, the energy sector is key in mitigation efforts. Chile's NDCs have two energy-related targets : an unconditional target to reduce the GHG emissions intensity of the economy by 30% below the 2007 level by 2030, and a conditional target of a 35-45% reduction in GHG emissions intensity subject to international financial support. The Ministry of Energy is developing policies and measures to meet the NDCs under the "Mitigation Plan for the Energy Sector" adopted in 2017, the targets of which can be met in a way that will actually reduce costs in the medium term, because efficiency measures could limit energy demand, and low-cost renewable electricity could replace imported fuels. Energy efficiency in mining, transport, and heavy industry is projected to be particularly profitable (IEA, 2018).

The Chilean NDCs were based on a substantial previous work on energy planning started in 2015 by different government offices and a considerable number of stakeholders, from citizen's organizations to the private sector. Five strategic axes and actions were defined in the Road Map 2050 and then combined for Chile's new energy policy "Energy 2050" announced and published in 2015

In that new report, Chile's energy sector would have a reliable, inclusive, competitive, and sustainable vision by the year 2050. To do so, policies were built on four main pillars (fig. 4) : quality and security of supply, energy as a driver of development, environmentally friendly energy, and energy efficiency and energy education.

The main long-term targets included in Energy 2050 (2015) are :

- By 2030, at least 30% GHG emissions reduction compared to 2007.
- At least 60% of the electricity generation from RE by 2030 and at least 70% by 2050.

FIGURE 4

THE FOUR PILLARS OF CHILE'S ENERGY POLICY 2050 – *Source : Energy 2050, Chile's Energy Policy.*

In a landmark decision, Chile became in 2017 the first country in South America to apply carbon taxation to fossil fuel-based power plants with installed capacity superior to 50 MW. Paid from 2018 onwards, it was initially set at a relatively low level of five USD (United States dollars) per tonne of CO_2. By way of comparison, the High-Level Commission on Carbon Pricing advocated in 2017 that a minimum price of carbon between 40 and 80 USD/tCO_2 in 2020 would be necessary to comply with the Paris Agreement goals. Modest carbon prices can lead to some fuel-switching, make near-to-market low-carbon technologies cost-effective, and promote other low-carbon support policies. However, they cannot drive all the necessary low-carbon investments, force the early retirement of high-carbon assets, or give strong signals for the electrification of heat and transport. Thus, it is critical to monitor the functioning of the carbon tax and adjust the tax level (IEA, 2018). Likewise, investments in sustainable infrastructure and specific new technologies necessary for the energy transition require specific policies, complementary to the mere carbon tax.

2 – Shifting power generation towards renewables : the Chilean path of decarbonisation in a carbon-dependent economy

Chile proposed to host the 25th Conference of the Parties (COP25) in December 2019 in Santiago Finally, at the end of October 2019, the Chilean government has renounced the organization of $CO_{P2}5$ due to the social crisis in the country. It will take place in the Spanish capital. Despite the change at the last moment for exogenous reasons, this brings to light that climate change and environmental issues are topical between most of Chilean political parties. This current position was not necessarily apparent when examining the economic, energy, and environmental public policies of the last thirty years (Paillard, 2019).

Chile has a strong export-based economic model, relying on the exploitation of its natural mineral, agricultural, and fishery resources, and the increase in fossil fuel consumption and CO_2 emissions. In 2017, fossil fuels (mostly imported from Argentina for gas and Colombia and Australia for coal) still accounted for 79 % of its gross domestic primary energy consumption (Paillard,2019).

However, Chile has a remarkable potential for RE and one of the best worldwide for solar energy potential for electricity. According to a joint study by the Ministry of Energy and the German Agency for International Co-operation in 2014, solar photovoltaic (PV) potential was estimated at 1 263 GW, concentrated solar power at 548 GW, wind power at 37 GW (capacity factor of at least 30 %), and small hydropower at 12 GW. In addition to this, Chile has an estimated potential of 164 GW from the ocean energy (tidal and offshore turbines) due to its long Pacific coast, 16 GW from geothermal sources because it contains 10 % of the most active volcanoes in the world, and 1.4 GW from biomass sources (Simsek et al., 2019).

The mining activity, present mainly in the sunny North, is one of the biggest energy consumers and could use this big solar potential. However, Chile's interest in climate change and RE issues is also explained by the fact that the country, with its considerably large mineral resources, could be at the heart of the 21st-century energy revolution, that requires an extensive use of metals like lithium, been Chile one of the world leading producers (Paillard, 2019).

Besides, in contrast to EU countries, Chile has been successful in the promotion of renewable electricity production without public subsides nor specific incentives like feed-in tariffs (Simsek et al., 2019) :

- In the Chilean Renewable Energy Law (Law 20.698 ERNC) signed in 2013 (Ministerio de Economía, 2013), RE quotas were defined at 12 % in 2020, 18 % in 2024, and 20 % in 2025 (excluding large hydro);
- Chile also had recourse to auctions that allow all types of RE generators to have power purchase agreements with distribution companies;
- Besides, it uses net metering, which permits consumers to produce their electricity from RE sources and inject extra generation into the grid, and the current law allows renewable energy generators under 9MW to be exempted from grid access fees;
- Moreover, Chile provides technology-specific support and regulations, especially for biomass, geothermal, concentrated solar power, solar roof application, and small hydro;
- Nevertheless, the only direct support in the form of subsidies in Chile is given for solar heating in the reconstruction of disaster-affected regions such as Arica, Iquique, and Valparaíso (Simsek et al., 2019).

FOR A BETTER UNDERSTANDING

THE ATACAMA DESERT, THE STRATEGIC HEART OF THE ENERGY TRANSITION

Chile's Atacama Desert (105,000 km2) in Northern Chile possesses significant natural resources. It holds the world's largest copper and non-metallic mineral reserves, which have sustained a considerable mining industry for over a century. Atacama also has one of the world's largest reserves of lithium, essential for batteries and different components. However, Chile's mining industry is challenged by access to water and cost-effective and sustainable energy. The sun is another abundant natural resource. The Atacama Desert receives the highest levels of solar radiation in the world. However, the desert's drastically changing temperatures and dry, dusty, and sandy conditions complicate optimal PV electricity generation. Based on this abundance of natural resources, Chile has prioritised two areas for energy technology R&D : solar-energy industry that considers the conditions of the North of Chile, and value chains producing lithium batteries (IEA, 2018).

An initiative to harness this vast potential is the formation of a solar cluster in Antofagasta. It involves synergetic action that enables the attraction of leading companies and institutions of the solar industry in the region to allow training of skills and technology transfer (Haas et al., 2018). Subsequently, research and development of local solutions, human capital formation, job creation, and value capturing along multiple stages of the value chain will occur. This allows local companies and institutions to bloom and effectively satisfy the necessities of the developing solar industry. The resulting lines of action of a solar cluster involve the following areas : strengthening human capital; science, technology and innovation for competitiveness; market development; enabling an environment for industrial development; and institutional framework for competitiveness (Haas et al., 2018).

BOX 1

Hydropower also occupies a privileged position in the Chilean renewable energy industry due to the number of sites suitable for the construction of dams in the South of the country. The Río BíoBío region has, for example, the Ralco (764 MW), Pangue (456 MW) and Angostura (320 MW) dams. However, in 2013, the development of hydroelectric dams came to an abrupt halt with the cancellation of the Hydro Aysén project to preserve Patagonia's environment (see Text Box 6).

At this point, this decision means relying on carbon energies to continue to ensure electricity supply and support economic growth. Energy uncertainties have also weighed heavily in the choice to build a huge liquefied natural gas (LNG) terminal on the Mejillones site (Northern Antofagasta region), to supply electricity to the mining industry in the Atacama Desert, especially to copper mines. Commissioned in 2010, this site, built and managed by the French company ENGIE, can store 187 000 cubic meters.

As a further medium-term consequence, Chile could increase the import of cheap coal from Australia or Colombia de facto slowing down its energy transition. Besides, the domestic production of coal was restarted in 2013 on Riesco Island. The Australian group Carbon Energy Ltd, which the Chilean government has encouraged to invest in, is one of the groups that are also interested in reviving the Chilean coal industry in the South of the country, especially in the Río regions.

While the growing importance of RE in the country's electricity balance is real - around 43% of the total - it should not hide the fact that Chile still heavily relies on carbon energies because of the weight of the transport sector, the generalization among its population of electricity-intensive devices (air-conditioning, office automation, mobile phones, etc.), as well as the growth in the already energy-intensive needs of its mining industry to meet global demand for metals. Chile is therefore not the "eldorado" of renewable energy yet, even if it is ahead of the average of OECD countries.

The strive for independence from coal could soon be given a new impetus. On June 4th, 2019, the Chilean government announced a 2050 carbon neutrality plan, which calls for the closure of eight coal-fired power plants by 2024, and of the entire installed capacity by 2050. Chile is now trying to strike a balance between the need to continue its strategy of exporting raw materials, which has been economically successful in the last thirty years and the better protection of its natural environment. This strategy involves, among other tools, a greater use of RE, as well as intelligent management of the mineral wealth.

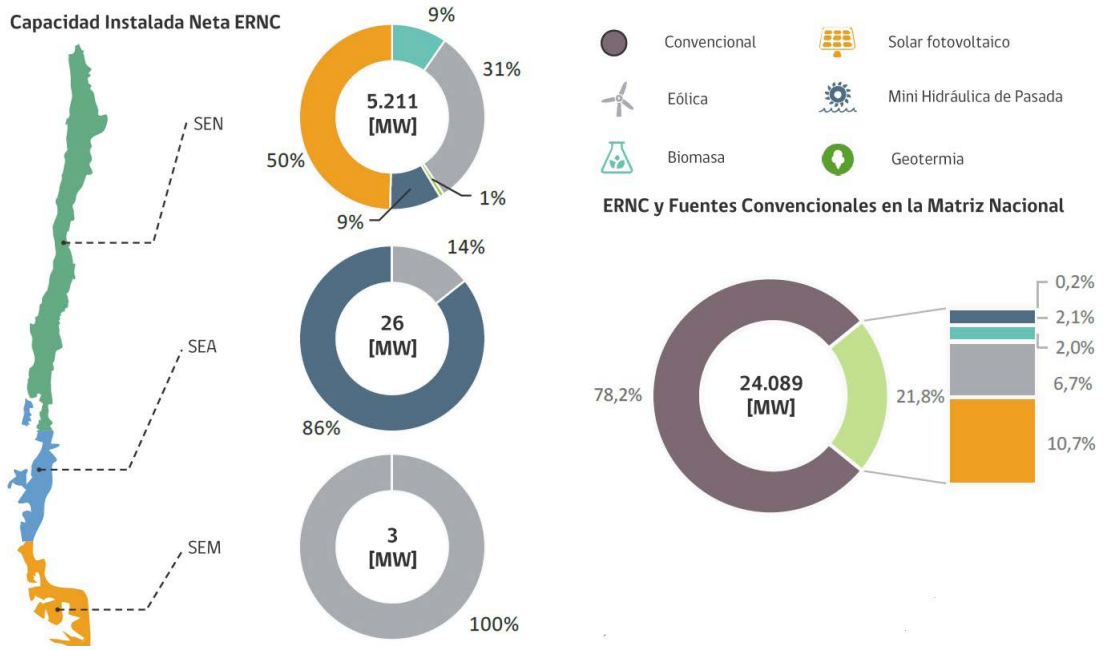
3 – Rise of non-conventional renewable energies sources and key economic actors

Chile has a unique geography due to its long and narrow shape. It is divided into sixteen regions from North to South. Until the end of 2017, Chile had four main electricity grids : The Northern Interconnected System (SING), the Central Interconnected System (SIC), the Aysen System (SEA), and the Magallanes System (SEM). Between these four grids, SIC and SING have the major capacity share with 75.8% (17 081 MW) and 23.5% (5 288 MW), respectively (CNE, 2017). **In 2018, SING and SIC were connected, and the newly combined grid is now called the National Electricity System (Sistema Eléctrico Nacional "SEN"). SEN encompasses thirteen regions and controls 99% of the total electricity supply of Chile (fig. 5).**

The generation sector in Chile is comprised of over 160 companies, although many of them are subsidiaries of the major four companies ENGIE, ENEL (formerly ENDESA), AES Gener and Colbun (both are Chilean private companies). In 2016, these four accounted for 74% of the installed capacity in the country, and 83% of total generation. Practically all investments in generation, the regulated transmission, and distribution sectors are from the private sector, although ENAP (Empresa Nacional del Petróleo), the state-owned oil and gas company, holds shares in some generating assets. In addition, some municipality-owned companies serve some small and isolated systems (IEA, 2018).

FIGURE 5

RE INSTALLED CAPACITY IN THE THREE POWER SYSTEMS – *Source : "CNE – Reporte Sector Energético Septiembre 2019".*



During the past decade, Chile's electricity regulation has been reformed to increase the flexibility and diversity of energy suppliers. Electricity supply for regulated customers is based on maximum 20-year power purchase agreements (PPAs), which result from open tenders to generators. In the tenders, generation companies can offer their bids based on existing or new capacity. The tenders are designed, coordinated and directed by the National Energy Commission and conducted by distribution companies. They are organised at least five years before the start of the supply contract. **In recent tenders, prices have decreased (in a country with historically high electricity**

prices), and the number of participants also rose dramatically. In the 2012 tender, there was just one participant, and the price peaked at 131.4 USD per MWh. In 2013, two generators participated, again supplying at high prices. Since then, many new generators have entered the tenders : in 2014, the number of offers rose to 18, in 2015 to 38 and in 2016 it jumped to 84 (from domestic and foreign generators). **At the same time, prices have declined by 75% from 2012 to 2017.** Solar and on-shore wind have emerged as market-competitive technologies – unlike in many other countries, they do not receive direct subsidies in Chile (IEA, 2018).

In the power-supply auctions, the contracts are denominated in USD and adjusted periodically in line with the United States' Consumer Price Index. This protects developers and investors from both interest-rate risks and inflation risks in Chile (IEA, 2018). These factors, in addition to a stable macroeconomic context and a wide RE potential, contributed to making Chile one of the most attractive countries in the world for investment in RE projects (País Circular, 2018). **According to the study "Emerging Markets Outlook 2018" (BloombergNEF, 2018), Chile ranked 1st place as the most attractive country for RE investments thanks to strong government policies, a demonstrated track record of clean energy investment, and a commitment to decarbonation despite grid constraints.**

These conditions are allowing a significant increase in non-conventional renewable energies (NCRE), i.e. all renewable energy technologies, except traditional biomass and large hydro (more than 20 MW). The net installed capacity based on NCRE technologies amounted to 4 906 MW in April 2019. Of this total, 4 877 MW are located in the SEN. The remaining 0.5% (26 MW) is in the Aysén Electric System and 0.1% (3 MW) in Magallanes (Graph 6). The installed NCRE capacity corresponds to 21% of the total electrical capacity in national electrical systems (CNE, 2019).

TABLE 1

RE INSTALLED CAPACITY AND PROJECTS - *Source : CNE – Reporte Sector Energético Mayo 2019*

Technology	Operational	Test period	Under construction	Approved	Under evaluation
Biomass	501	6	6	1 087	12
Wind	1529	220	735	10 774	1 340
Geothermic	0	40	0	120	50
Small hydro	495	42	0	749	61
Solar PV	2382	72	508	16 790	1 989
CSP	0	0	110	2 775	0
Total	4906	380	1358	32 295	3 452

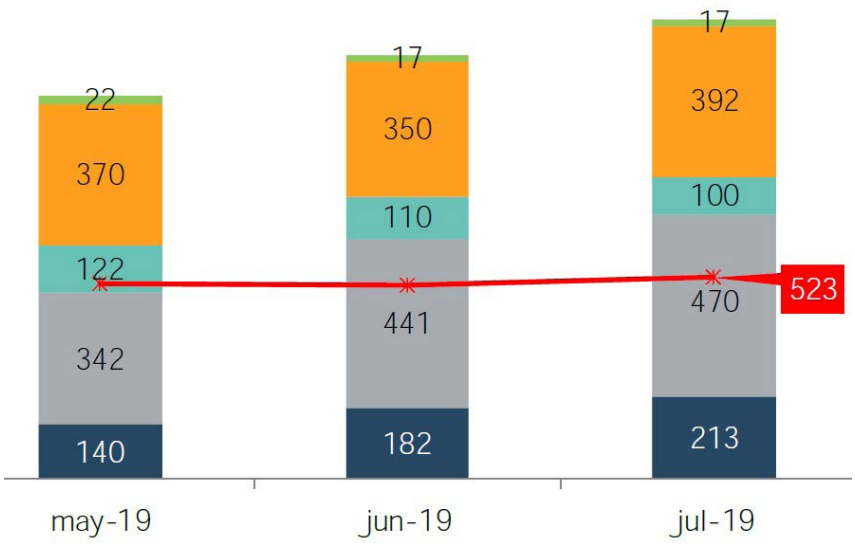
The NCRE sector in Chile is experiencing a boom of investments in new projects (tab. 1). For example, April 2019 ended with 51 NCRE projects declared under construction by the National Energy Commission. The entry into operation of these projects will be carried out progressively in the coming months until January 2021. Also, during April 2019, the Environmental Evaluation Service received 16 new NCRE project initiatives, corresponding to 533 MW equivalent to 577.1 million dollars of investment.

FIGURE 6

COMPLIANCE WITH LAWS 20257 AND 20698 –

Source : ""CNE – Reporte Sector Energético Septiembre 2019".

Graph legend is similar to figure 5 above.



Currently, Chile is overachieving its goals for RE deployment. The quota obligation defined by laws 20,257 and 20,698 is equivalent in July 2019 to 523 GWh of power generation originating from NCRE sources. Meanwhile, the energy generated recognized by law amounted to 1 192 GWh, which represents over 220 % compliance. This is shared between 392 GWh solar, 470 GWh from wind power, 213 GWh from mini-hydro plants, 100 GWh from biomass injection, and 17 GWh from geothermic. Figure 6 shows the over-achievement of the RE quota during the three first months of 2019.

FOR A BETTER UNDERSTANDING

THE ISSUE OF DECARBONIZING THE MINING INDUSTRY

The mining industry is by far the biggest sector in electricity consumption, accounting for 37.1 % in 2015 (IEA, 2018). The decarbonization of the mining sector can have a significant contribution to CO_2 emissions reduction in Chile.

Digging minerals from the earth requires enormous amounts of energy, with mines often running 24 hours a day, seven days a week. Energy can account for up to a third of a mine's operating costs, making it a critical focus of cost control for mining companies, who are battling to cope with muted prices for metals from copper to gold. The improved economics of RE have made it an increasingly attractive option since, in many cases, it can reduce exposure to volatile diesel prices. In July 2018, Chilean copper miner Antofagasta PLC struck a deal with Chilean utility Colbún to provide it with 550 GWh of electricity a year from renewable sources including hydropower, solar and wind, for ten years starting in July 2020. The deal will make the Zaldívar copper mine, which Antofagasta jointly owns with Canada's Barrick Gold, the first mine in the South American country to operate on 100 % RE.

Other exemplary solar installations in copper mining operations in Chile are Pampa Elvira Solar (54 MV) and Planta Solar El Tesoro (10 MV). They substitute about 80 % and 55 % of the electrowinning process[1] 's fossil fuel demand at Gabriela Mistral and Centinela mines, respectively (Hass et al., 2018). The Pampa Elvira solar-thermal array, that was built by Arcon-Sunmark and Energía Llaima in partnership with Codelco for its Gabriela Mistral mine comprises a 39 300m2 area of solar thermal panels. The array can substitute for about 80 percent of the fossil fuel

1 - A means of extracting metals from ore through electrolysis

used in electrowinning, saving up to 6 500 tons of diesel a year. By burning less diesel, Gabriela Mistral mine has cut back its CO_2 emissions by nearly 15 000 tons a year. In addition, reducing diesel consumption avoids the annual mobilization of 250 trucks that would have been required to transport the fuel. The plant guarantees a continuous supply of energy thanks to a heat storage tank with a volume of 4 000m3 of hot water. The storage tank helps to level out daily fluctuations in solar radiation.

BOX 2

Concerning distributed generation, i.e. generation units connected to power networks at the distribution level (up to 23 kilovolts), there are two main models : net billing and small-distributed generation systems (SDGS) Law 20.571 introduced net billing in 2012, and is operative since October 2014. It applies to small-scale end users supplied at the regulated rate and having their NCRE or efficient cogeneration facilities with a maximum installed capacity of 100 kW. In December 2017, net billing had resulted in over 12 MW of mostly solar PV being installed, corresponding to 2,000 distributed generators, mostly residential systems. SDGS applies to distributed generation facilities with a capacity of up to 9 MW, using any type of generation technology connected to a distribution network. Unlike the systems under net billing, SDGS must be created like electricity companies, issue invoices and report it to the CEN. By November 2017, 152 systems with a total installed capacity of 413 MW were operating under this model. The capacity was mainly run-of-river hydropower and solar PV, as well as diesel generators (IEA, 2018).

4 – Multi-level governance facilitates sub-national actors' participation

Frequently ranked among the most vulnerable countries to climate change by German Watch's *Global Climate Risk Index*, Chile is exposed to a broad range of risks : a drought has been persisting for eight years in the Central Valley region; higher temperatures and heatwaves across the country have led to an increase in forest fires, and extreme rainfall events have hit the Northern and Southern regions. These intense and unseasonable precipitation events have affected crops and increasing ocean temperatures are disturbing marine ecosystems.

Under these conditions, adaptation actions are as important as mitigation ones, and it requires a systemic governance approach that includes the specific problems of the different regions of the country. **In this context, the Chilean government is implementing a multi-level climate governance model that facilitates coordination and collaboration between all public levels (national, regional, municipal) and all relevant stakeholders. This is particularly challenging in a country with a traditionally centralised political system.**

In the Chilean context, multi-level governance is understood as "*the synergistic interaction between institutions, levels of government, civil society and the private sector, which determine how public policies and/or actions are defined and implemented. Such processes include both vertical and horizontal interactions and can take many forms and occur in different instances*" (LEDS, 2018).

In a recent study, essential state and non-state actors were identified through a mapping exercise that led to an Institutional Mapping Report (fig. 7). This was achieved by analysing decision-making spaces and characterising the interactions between state and non-state actors on different scales" (LEDS, 2018). Some of the key actors include :

- **the Regional Climate Change Committees (CORECC, in Spanish) : their creation in 2017-2018 in each of Chile's 16 regions was an important step.** They act as regional focal points for action

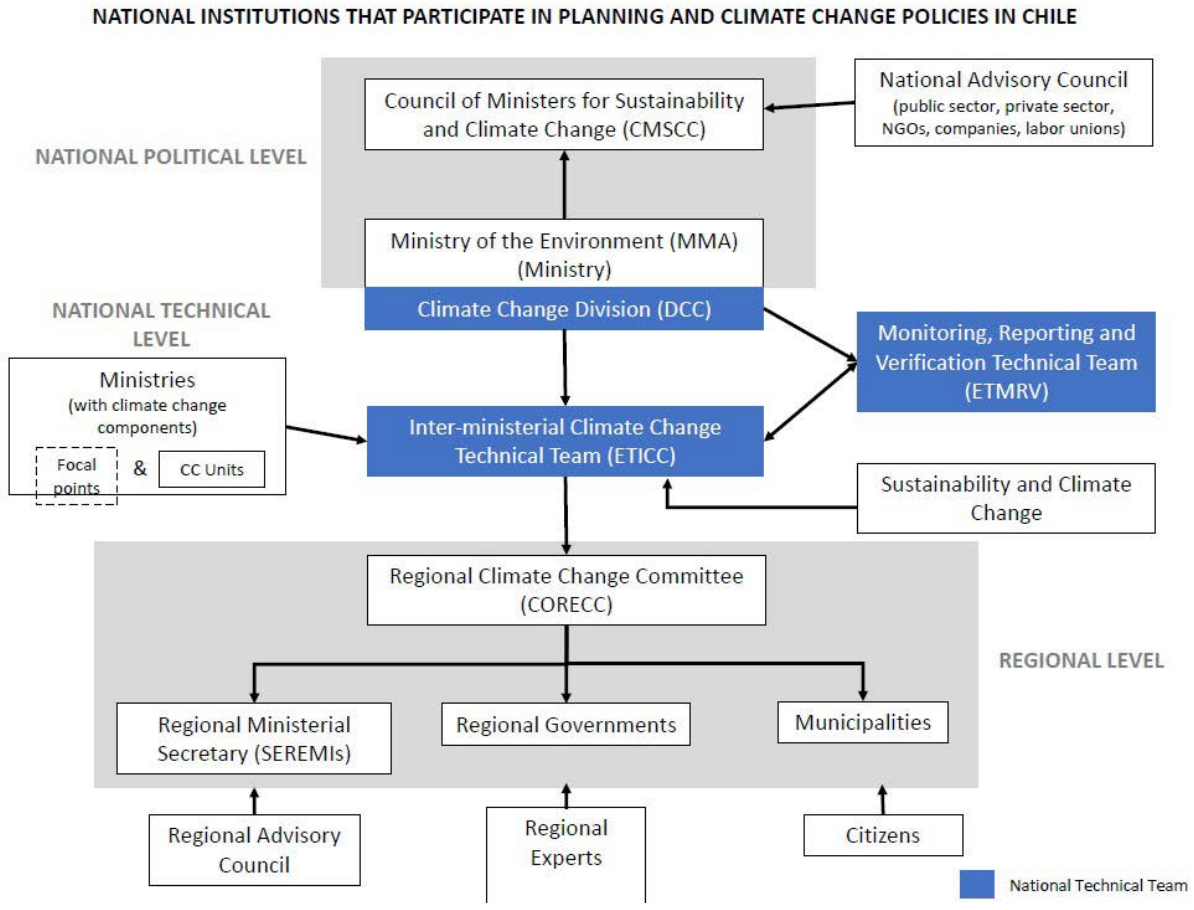
and "*have the potential to act as a key interlocutor to territorialize national public policies on climate change, while galvanizing the efforts of different territorial actors in a regional planning process and facilitate local climate action*" (MMA/Adapt Chile).

- **Council of Ministers for Sustainability (CMS) :** it is a multisector body in charge of deliberating and approving public policies and general regulations related to environmental issues. However, it is the Ministry of the Environment (MMA), through the Office of Climate Change (OCC), that is responsible for proposing and coordinating policies, plans, and programmes related to climate change.
- **Inter-ministerial Technical Team on Climate Change :** their main function is to support the Ministry of the Environment (MMA), to participate and facilitate the preparation, implementation, and monitoring of national policies and international agreements signed by the country, on climate change issues. The most recent development is of the "*Monitoring, Reporting and Verification Technical Team of Chile*" (ETMRV-Chile) in January 2018, which constitutes a new node, or occasion for informal and permanent work to strengthen institutions, communications, the exchange of information, and agreements between the different actors involved in climate change (Retamal, 2018).

Lastly, it also includes different ministries, the Chilean Agency for Sustainability and Climate Change, municipalities, and others.

FIGURE 7

MAIN INSTITUTIONS OF THE MULTI-LEVEL CLIMATE CHANGE GOVERNANCE IN CHILE – *Source : Institutional Mapping Report, MMA/ Adapt Chile*



FEEDBACK EXPERIENCE

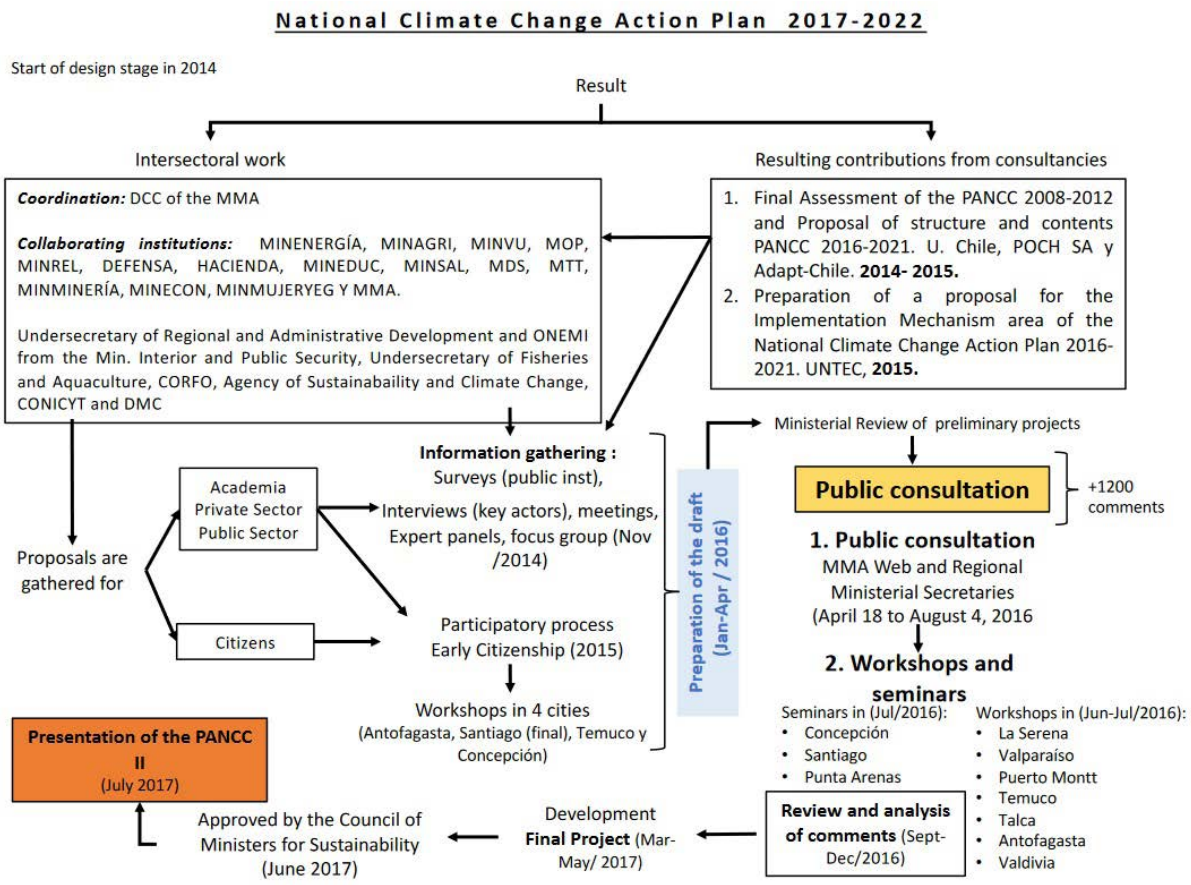
PANCC II PLAN AS AN EXAMPLE OF THE NEW MULTILEVEL GOVERNANCE PROCESS

The *Plan de Acción Nacional de Cambio Climático 2017-2022* is an example of how the new governance structure is influencing the process of creation, adoption, and implementation of new laws, regulations, plans, and international agreements. From the design stage to the presentation of the plan, the process lasted almost three years. It is the only instrument that considered an early participatory process with citizens (2015), in addition to citizen consultation of the preliminary draft (2016). The gathering of information included the participation of actors from multiple levels and different sectors and was based on consulting inputs, through surveys, interviews, meetings, expert panels, focus groups, and regional workshops (fig. 8). The plan was approved by the Council of Ministers for Sustainability (CMS) in June 2017 and presented to the public in July of the same year.

BOX 3

FIGURE 8

DEVELOPMENT PROCESS OF THE NATIONAL CLIMATE CHANGE ACTION PLAN 2017-2022 – *Source : Institutional Mapping Report, MMA/Adapt Chile.*



Likewise, an increasing number of municipalities are organized through the Red Chilena de Municipios ante el Cambio Climático**.** This network emerged in 2014, promoted by the Adapt-Chile association, as an instance of cooperation, training and exchange of experiences on climate change

between municipalities in Chile. As of July 2019, the network had 56 municipalities members (38% of the country's population) of which 13 already have a local climate change action plan. During the fourth annual forum that took place at the end of 2018, mayors placed special emphasis on the need for the Framework Law on Climate Change being prepared by the Government of President Sebastián Piñera to be able to address the magnitude of the problem and deliver the support that the municipalities of the country need to carry out the adaptation and mitigation objectives at the local level (EU Representation in Chile, 2018). The final Declaration of the forum states that the above is achievable, among other things, through the inclusion of municipalities in the regional climate change plans; the strengthening of the autonomy of the territories; the establishment of specific adaptation and mitigation goals at the regional level; resources to strengthen the capacities of municipal teams and the implementation of climate actions; support the generation of diagnoses, local climate change plans and local GHG emissions inventories.

Several projects show the growing interest of municipalities in local renewable energy production. In the municipality of Santiago, the first ESCO-type project (Energy Service Companies) for the residential sector is being developed. This model allows local actors or individuals to finance renewable projects without initial investments : the company refunds its investment through the savings made by users. In this case, the performance contract involves the local actors of the Beaucheff-Rondizzoni neighbourhood (community centre and neighbourhood association) and the energy service company Ciudad Luz. The latter is in charge of the installation and maintenance of 25 photovoltaic systems (16.8 kWp) and guarantees annual savings of 28.19 tCO_2 and 7.2 million pesos (9 200 euros) (Comuna Energética, 2019). Still in the metropolis of Santiago, the municipalities of Providencia and Colina and the company Ciudad Luz are installing 110 photovoltaic systems, 60% of which are financed by the Ministry of Energy and the Economy. Municipalities and users are also trained in demand management and facility maintenance.

Another example is Temuco, a city of 280 000 inhabitants 600 km south of Santiago, which is one of more than 100 cities in the world powered by more than 70% renewable energy (CDP, 2018). This performance is made possible by the electricity mix in the Araucania region, of which Temuco is the capital. Depending on the time of year, the region generates between 60 and 70% of its electricity from hydro and wind power, for a total of 95 000 MWh generated in September 2019 (Instituto Nacional de Estadisticas, 2019). Currently, the territory only provides for 60% of its consumption, but Araucania is a key region in the country's energy transition and coal exit from Chile, and it is expected to more than double its renewable production capacity by 2022 to reach about 700 MW (Impulso Araucania Plan). Local production also aims to reduce the energy poverty of the inhabitants of the region with the highest poverty rate in the country and the greatest lack of access to energy services - 8% of the country's rural population (Beneficio para todo, 2018).

FEEDBACK EXPERIENCE

EL PROGRAMA COMÚNA ENERGÉTICA

Launched in 2015 at the initiative of the Ministry of Energy, "el Programa Comúna Energética" (PCE) is an accreditation programme to support cities in the development and implementation of a Local Energy Strategy (LES). Accreditation is given to cities that have fulfilled the monitoring and evaluation of these three steps :

- the carrying out of a diagnosis on the municipal energy situation and its future potential in terms of supply and demand of electric and thermal energy, renewable energy, and energy efficiency;
- the formulation of objectives for all short, medium, and long terms;
- the implementation of an action plan to achieve these objectives.

On its online platform, the PCE highlights several initiatives undertaken by accredited municipalities, which are remarkable for their socio-economic benefits and emissions reduction potential. For example, the municipality of Recoleta, North of Santiago, is implementing a project to provide six schools with a high vulnerability index with a photovoltaic system, managed by an "educational energy cooperative" (cooperativa energética educacional). It will be able to redistribute energy production to the vulnerable areas of the municipality, and will run free education and technical training programmes on renewable energies. A reduction in emissions of 39.73 tCO_2/year is expected, as well as energy savings of around 18 000 000 000 Chilean pesos per year (or €22 685).

Source : Comúna Energética (30/05/2019)

BOX 3

Albeit this recent structuring of multi-level cooperation platforms and programmes, Chile remains a relatively centralised state with a free-market economy, where companies play an important role in major urban services. A substantial part of the efforts to reduce demand, improve energy efficiency, and develop renewable energies therefore falls to them. For instance, the company Metro de Santiago, which operates the capital's five metro lines, now obtains 70 % of its electricity supply from renewable energy, thanks to contracts signed with major solar (Latin American Power and Sunpower) and wind farm operators (San Juan Aceituno, in the Atacama region) (La Tercera, 2017 ; Electromov.cl, 2019).

5 – Universities' and citizens' participation and influential NGOs

Public concern about the environmental consequences of energy production has increased in recent years. Opposition to some fossil fuel power plants and especially to huge dams increased, in parallel with the emergence or consolidations of civil society organisations.

FEEDBACK EXPERIENCE

HOW THE "PATAGONIA, WITHOUT DAMS" CAMPAIGN PUT AN END OF "HIDROAYSÉN" PROJECT

"*In an age of democratization and heightened awareness of citizen rights in Latin America, the expansion of extractive industries frequently involves conflict. In those conflicts marginalized, rural, poor, ethnic and racial subaltern social groups, and their allies often stand in the front lines of resistance*" (Silva, 2016).

The Patagonia without Dams (PWD) campaign was an epic David vs. Goliath story that pitted powerful national and international conglomerates (mainly, the Spanish Endesa and the Chilean Colbún SA) with government support, against underdog environmentalists and "local peoples" who lived far from the centres of political power. The eight-year-long saga of the Patagonia Without Dams campaign began in 2006 against the construction of a series of mega-dams for hydropower in the austral region of Aysén in Chilean Patagonia. These power plants were largely intended to service mining industries of Northern Chile (Silva, 2061).

The HidroAysén project to build five hydroelectric dams on the Baker and Pascua rivers in would have an estimated total capacity of 2.75 GW. This pharaonic project, approved in 2011 by President Piñera Echenique, would have affected the existence of eleven nature reserves and six national parks; 4 000 inhabitants were also to be relocated. Between 6 000 and 10 000 hectares were to be submerged under the water and the transmission of electricity from these dams to the Santiago region, 2 200 kilometres further north, would have required the installation of at least 1 500 tall pylons to build the necessary high voltage lines (Paillard, 2019).

The platform organizing the campaign, the Council for the Defense of Patagonia, was composed of over 70 civil society organizations including 25 international ones from six countries and several famous people, including the deceased US environmentalist Douglas Tompkins. "*In the case of Hidroaysén, despite a strong initial support, the Piñera government decided to postpone its approval until the next presidential period due to the large political consequences its approval could have. In fact, the PWD campaign's strong communicational strategy and massive protests influenced public opinion, making three out of four Chileans reject the dam's construction. In this context, the decision to withhold the project's construction was strongly damaging presidential approval rates*" (Madariaga & Allain 2018). In November 2017, after several go and backs, the two companies involved took the joint decision to stop the project once and for all (Paillard, 2019).

BOX 5

A recent scientific paper (Madariaga & Allain, 2018), builds on a study of legislative processes and semi-structured interviews, shows the way civil society organisations influenced the Chilean renewable energy boom. The authors identified four categories of interrelated actors : (i) environmental organisations (EOs) and local movements (ii) private sector actors promoting renewable energies, (iii) political advisors and energy experts, and (iv) politicians and policymakers (parliamentarians and government officials). The article highlights that : "*two parallel ways of affecting the politics of energy policy emerged : the first came from local grassroots organizations with varied ties to national EOs that led the opposition to large hydropower and thermoelectric plants in their territories; the second came from professionalized EOs, mostly at the national level, composed of experienced activists and experts, and specialized in specific environmental fields. While the first maintained social pressure on specific projects and raised the salience of energy-related environmental conflicts nationwide, the second deployed lobby actions and technical expertise aimed at directly influencing the public policy agenda and design*".

The influence of these organisations was decisive in two key moments. Firstly, during the discussion and enactment of the first laws containing elements of RE promotion : Ley Corta I and Ley Corta II, in 2004 and 2005. Secondly, during the Energía 2050 policy process (2010–2015), that ended up with the most important energy policy in 50 years, containing high quotas for the introduction of RE. Indeed, the process Agenda Energía 2050, launched by the government of Michelle Bachelet, marked unprecedented participation of private companies, experts, and NGOs and finished with an energy policy plan that stated that the country should aim for 70 % of its energy matrix to come from RE by 2050. According to (Madariaga & Allain, 2018), a rise in social mobilizations played a great role in influencing the policy process leading to Energy 2050 by disrupting the policy agenda through opposition to large energy projects (large hydroelectric and fossil fuels plants) and elaborating an alternative policy blueprint based on renewable energies.

FEEDBACK EXPERIENCE

SOME INFLUENTIAL ENVIRONMENTAL NGOs IN CHILE

The country benefits from a dense network of national and international NGOs that participate in diverse political domains.

One example in this field is the "Avina Foundation", an NGO established in Chile in 1994 that is working to generate the conditions for Latin America to implement the goals defined by the countries in the Paris Agreement, facilitating compliance with the Sustainable Development Goals. It promotes climate action of all stakeholders through the support of innovation and the implementation of climate policies and commitments. Avina Foundation is the first civil society organization in Latin American to be accredited as a regional entity to the Green Climate Fund (in December 2016).

Another active organisation in Chile is 350.org. It uses campaigns, grassroots organisations, and massive public actions to oppose new coal, oil, and gas projects, it withdraws funds from companies that are contributing to global warming, and builds 100 % clean and free energy solutions that serve everyone.

The *Programa Chile Sustentable* (Sustainable Chile Program) is an interesting example of citizens' participation in cooperation with university scholars and having a considerable influence in the Nacional Parliament. In the area of energy, the Program has participated actively in the reformulation of the power sector laws, which includes Ley Corta 1 (2004), Ley Corta 2 (2005) and the creation and formulation of "Programa País de Eficiencia Energética" (energy efficiency program). It also participated in the formulation of the Ley de Promoción de Energías Renovables No Convencionales (Non-Conventional Renewable Energy Law in 2008). Currently, it is campaigning for the phase-out of coal plants (Chile Sustenable, 2019).

BOX 6

Another remarkable issue in the Chilean climate arena is the dynamism of a growing number of research centres working on different topics related to both adaptation and mitigation. In 2018, there were at least 27 private and public academic centres working on climate change issues, including natural and social sciences (biodiversity, agronomy, urban planning, law, economics, and disaster risk management, among others) (LEDS, 2018). The University of Chile, the Pontifical Catholic University of Chile, and the University of Valparaíso, among others, are playing a prominent role.

In the late 1950s, Universities Católica del Norte and Santa María inaugurated their solar research centres, paving the way for the first national solar research institute (Haas et al., 2018). The year 2012 concluded with the start of Chile's first Excellence Research Cluster in solar energy : SERC-Chile. In addition, in June 2014, the Chilean president created a National Lithium Commission to develop a policy proposal for the future of this strategic resource. The Commission included the Ministry of Energy and representatives of the public and private sector, native peoples of the regions where lithium is located and workers' representatives. Finally, the Solar Energy Programme 2016-25 should be mentioned, as it aims to develop an export-oriented national solar-power industry (IEA, 2018).

Lastly, the multiplication of social movements since 2010 and the enactment of the *Generación Distribuida and Cooperativas* have inspired many social groups to produce and distribute their own energy cooperatives. However, the law does not allow associative energy projects to sell energy, as concessionary companies have the monopoly over distribution and marketing on the network they upkeep. Thus, the few existing cooperatives (between 6 and 8, depending on their function, listed in late 2019) settle for pool savings for the installation of production units for customers other than cooperative members : Ener Coquimbo, Ener Quinta, Ener Metropolitana, Nehuen, Lanalhue, Ener Pucon and EnerCoop Aysén (Un beneficio para todos, 2018).

Conclusion

This paper has analysed the role of the main non-state actors in the process of decarbonization of the Chilean electricity sector, giving real examples of mitigation actions. From the 1980s, Chile has experienced a dramatic increase in CO_2 emissions in the electricity sector due to a steady growth in economic activity that boosted the construction of coal and natural gas power plants. Recently, thanks in part to strong impulses from civil society and research centres, energy policy has initiated a substantial shift in favour of cleaner energies. At the same time, the mining sector, one of the main energy consumers, is starting to take advantage of the excellent solar energy resources in the North of the country. It remains to be seen if the growth of investments in renewable energy is maintained and sufficient to meet a demand that continues to increase. Otherwise, the country could continue to build fossil fuel plants and further increase emissions. An active role of non-state actors will be crucial in the coming years to shape a more sustainable energy system in Chile.

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