INSTITUTE OF THE AMERICAS | REPORT

Energy Transition in Chile: Progress and Next Steps

Introduction

Long one of the highest performing economies in Latin America, Chile often sets precedent for the region. When it comes to the energy sector, Chile's adoption of Non-Conventional Renewable Energy (NCRE) is no exception, and rightly so, as the country possesses vast solar potential in the Atacama Desert as well as large geothermal resources and the political will to utilize them.

Technology	Installed capacity [MW]	Under construction [MW]	Approved [MW]	Potential* [MW]
Small hydro	368	57	337	7,951
Wind	832	165	5,513	37,477
Large hydro	6,017	1,021	1,352	4,521
Solar-PV	452	748	8,173	1,263,407
Solar-CSP	0	110	760	548,478
Geothermal	0	0	120	16,000
Total	7,669	2,101	10,478	1,840,394

Source:
https://www.marsdd.com/wpcontent/uploads/2015/07/AEC_GG_CHILE_REPORT_FINAL_Dec2016.pdf

As of December 2015, Chile incorporated NCREs into 11.4% of its energy matrix, up from 6.3% two years prior, and is on track to meet its goal of 20% NCRE generation by 2025. Chile's potential in this regard has not gone unnoticed: The country has attracted $9.2 billion in foreign investment in its energy sector between 2012 and 2016. But while the trend towards renewables is promising for a country with a large dependence on imported fossil fuels, the concentration of NCRE remains in the commercial sector, with micro-grids and distributed generation only more recently becoming commercially viable and still very much in their infancy.

Policy Review

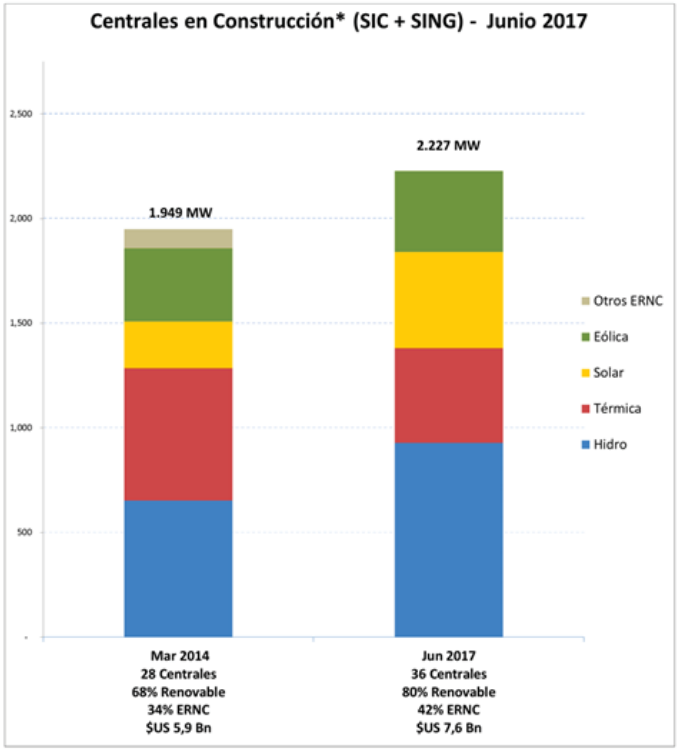
Beginning in 2008 the Chilean government set a goal of 10% NCRE generation by 2025, later amended in 2014 to 20% NCRE generation. Additionally, in 2014, the government created day-time blocks on which energy generators could bid giving solar a competitive edge in generation auctions. The political impetus, as well as the country's reputation for market solutions and reliably protecting foreign investments provides important opportunities for foreign direct investment and underscores the potential to meet its target and generate sizeable investment in its energy sector from abroad.

Chile is expected to add 2,336 MW to the grid with NCRE by 2018, with projects either recently completed or in progress. These figures are a direct result of the country attaining over 50% of total investment in renewables in Latin America and the Caribbean in 2015. But the share of energy consumed by the industrial sector is disproportionate to consumption in the residential and commercial sectors, and the creation of photovoltaic (PV) or concentrated solar power (CSP) facilities has largely been related to the mining industry.

Hydroelectricity still plays a large role in the Chilean energy matrix and will likely continue to do so in the years to come, generating over 6,000 MW of installed capacity. The Piñera administration advocated for continued development of hydro and imports of natural gas while laying the groundwork for an NCRE transition. The current Bachelet administration has done much of the same (as of 2016 there were 1,975 MW worth of hydro projects under construction) while publicly pushing for the implementation of NCRE and the connection of the two disparate electricity networks SIC and SING.

Soon after taking office in March 2014, the Bachelet government promptly published an energy agenda calling for increased NCRE development and energy efficiency while reducing the price of power, consumption and marginal

costs of generation. Long-term steps were also laid out for years 2035 to 2050, most notably to establish a goal of 70% renewables by 2050.



Source:

http://www.energia.gob.cl/sites/default/files/despensa_junio_2017.pdf

Connecting the two electric networks would mean that commercial production of renewable energy in the Atacama Desert could be used to offset increased demand in the central SIC system, and that hydroelectricity could backup intermittent solar generators. This has the potential of further boosting solar capacity in the Atacama as well as wind resources elsewhere. As part of the integration of Chile's two electric systems, the National Electrical Coordinator (Coordinador Electrico Nacional) was created in 2016 as a technical and independent body charged with coordinating the operation of the country's National Electrical System that will soon operate fully interconnected. The connection of the two systems and corresponding infrastructure and market interconnection will likely increase Chile's already notable reputation as a global leader in renewable investment and implementation.

Chile's market-based energy industry, and the competitive pricing of solar energy mean that industrial scale PV and CSP will continue to grow. In a recent auction for power, SolarReserve bid 6.3 cents per kWh using CSP and thermal storage technology to provide 24-hour renewable energy, and a year earlier Solarpack bid just 2.91 cents per kWh, setting international price records at that time.

Distributed Generation (DG)

As of 2015, the average contract price of electricity was $79.3 per megawatt-hour, about $15 higher per MWh than the recent SolarReserve bid. But, the domestic solar sector remains nascent. Law 20.571, known as the Law of Distributed Generation, establishes net billing for systems that generate less than 100 kW. Passed in 2012, the law shines a light on the potential for urban and rural consumers to offset their electricity consumption with rooftop solar, and the ability to inject unused energy to the grid. Yet, law 20.571, offers a net billing scheme for domestic PV users, allowing them to sell their energy back to the grid, but at the marginal cost of electricity generation -- a price less than what they would buy it for which would include longer term fixed costs. Chile offers no subsidies for renewable generation of any scale, and a net metering system in which PV users are reimbursed at the full retail price could be seen as a subsidy, one that unfairly spreads the fixed costs of transmission and distribution to non-PV consumers.

Companies, however, are stepping in to facilitate rooftop solar and "behind- the-meter" distributed generation primarily by utilizing innovative billing and metering technologies outside the regulated energy market. The focus of early market entrant Amigo Solar is on implementing micro grids at scale where the installation costs can be more readily dispersed. As seen elsewhere, apartment buildings, business parks, large industrial buildings are the initial candidates for DG technologies. Aggregating generation from multiple users means the installation of PV systems is more cost effective, and aggregating demand using smart meters allows Amigo Solar to give its clients the reduced business-to-business rate of energy instead of the higher business-to-consumer rate.

Chile's federal government has also entered the solar arena, initiating a solar roof program for public buildings. The program has 100 planned projects on public buildings, which will generate an estimated 3 MW of installed capacity.

Chile attained over 50% of total investment in renewables in Latin America and the Caribbean in 2015.

CORFO, Chile's governmental development corporation, is also aiding the push towards solar by co-financing solar projects with the aim of finding new technological resources in the PV industry. Still, the small-scale PV market in Chile is in its infancy, and the obvious missing system of this DG model is energy storage, which is only recently becoming attractive as the price of lithium batteries drops.

Energy Storage

Large scale molten salt or lithium storage systems are in place for industrial scale PV and CSP facilities in Chile. Once the country's two electric grids are fully interconnected, the generation of NCRE can reach the SIC system and Santiago from the Atacama in the north. One of the most notable indicators and positive trend lines vis-à-vis the potential for energy storage is the AES Angamos facility. Aimed at boosting reserve capacity for Chile's mining industry, the Angamos project increases power generation by 4% thanks to its storage capacity. The AES project counts a 40MW storage array as part of the 544MW Angamos thermal power plant. Additionally, Engie has teamed up with NEC to install 2 MW lithium storage systems in Arica, and SolarReserve plans a CSP facility with thermal storage that will provide 450 MW of baseload power.

However, it is not yet feasible to deploy small-scale storage systems of around 2 to 6 kWh for domestic use. The market for home storage systems will only grow as an ancillary of a more robust domestic PV market, and when the investment in storage systems reaches parity with the savings they provide in a realistic time frame. But, with small scale PV on the rise in Chile, and the price of lithium batteries continuing to drop, the potential is there. Likewise, unless the net-billing scheme becomes more attractive, consumers may find that batteries and storage options are more appealing than injecting energy into the gird at a reduced tariff rate.
In order to promote behind-the-meter energy storage in Chile, the government must first promote PV adoption and smart-metering systems that can integrate battery storage. Costs of li-ion storage systems will decline as markets in North America and Europe expand and demand there increases, but the cost of such storage systems may not appear attractive to consumers right now. One way to incentivize behind-the-meter energy storage is to create time varying rates that would complement the use of storage systems as has been done in Hawaii. Peak hours would see an increased rate system which would be offset by discharging batteries.

Next Steps

Small scale PV systems, battery storage and widespread DG appear to be an attractive bet for the future of domestic energy consumption, but Chile is a recent adopter of these technologies and the opportunities are only starting to appear. It bears noting that, in many cases related to these technologies, the first mover penalty has been paid by markets in Germany and California, and the government is helping to sponsor the initial breakthrough into small-scale PV. This and the government's long-term vision of a future dominated by renewable energy spell success for distributed generation. It is only a matter of time before lithium batteries become economically attractive to domestic consumers and storage systems take off in Chile.

In order to continue the march towards this energy transition and maintain its leadership role on clean energy and renewable technologies, there a wide array of possible next steps including:

1. Chile could incentivize domestic PV installations with a more attractive net metering scheme. Consumers in Chile may not see the financial viability of domestic solar yet, and increasing the injection tariff to match the retail price could enhance the financial viability of DG systems and attract wary consumers.

2.The government should continue to finance DG systems on public buildings and raise awareness of the potential of DG systems in Chile. The country is attracting significant investment from abroad for large-scale commercial NCRE systems, but now the potential for small-scale domestic systems and its ability to create a more secure and cleaner energy matrix must be fostered.

3. The government and private financiers should evaluate the current state of financing mechanisms for small-scale PV and storage systems. First movers like the US and Germany offer subsidies and tax rebates to consumers who install DG systems in their homes, to incentivize adoption. While subsidies have never been popular in the energy industry in Chile nor recommendable, creating the incentives for DG may prove the necessary exception and could perhaps be managed through a tax rebate plan.

4. With the continued deployment of renewables, the country's electricity regulatory framework should include rules and remuneration schedules that allow energy storage systems to provide their full array of potential and benefits, rather than merely being associated as a generation asset. Regulation should allow energy storage systems to participate across the various segments of the electric sector - Generation, Transmission and Distribution.

5. In order to fully unleash the budding potential for energy storage, and to optimize the soon-to-be completed interconnection of the country's electricity system and NCRE targets, Chile should utilize its internationally-respected devotion to markets and innovation to entice battery storage research and development facilities to locate in the country. The country's energy-intensive and cost-conscious mining sector and Atacama Desert provide a unique and relevant location.

Regardless of the share of the energy matrix provided by centralized or distributed solar generation, the future for NCRE in Chile is bright. The exceptionally low bid prices of solar companies in Chile signify that solar has a viable future as a replacement for fossil fuels and other conventional sources of energy. The increasing efficiency of solar panels, and their decreasing costs can only point to more adoption by domestic users.

Government and industry support for landing a major energy and battery storage plant could build upon energy storage projects in operation and development. It could also further cement Chile's leadership role on the myriad elements of the energy transition and what some have called the Holy Grail for renewables: energy storage and the ultimate goal of reliable and cost-effective storage solutions for all consumers.

In sum, Chile must continue to embrace the energy transition underway in order to best seize the abundance of opportunity unfolding across the globe but particularly within its borders.

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