

# CHILE FACTS



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## Chile's Clean Energy Future: Biomass, Biogas, Geothermal, Small Hydro, and Wind are Affordable Choices Now and Solar is Not Far Behind

Chile is in the middle of an important national debate about its energy future. Concerns about lack of a secure energy supply, volatile prices, and the environmental and health risks related to fossil fuels and nuclear energy are front and center for citizens, government, business, and industry. The overarching question is: what should be the focus of a new energy policy to increase energy security and independence and support future growth and development? To help answer this question, the Natural Resources Defense Council (NRDC) commissioned an assessment of the comparative costs of a wide range of generation technologies in the Chilean power sector. The main conclusion to draw from this research is that Chile's traditional energy choices are not necessarily the most secure or most affordable options for the future. Chile can meet its demand in the coming decades through a variety of "non-conventional renewable energy" (NCRE) sources and energy efficiency technologies supplementing its existing generation base. But this will only be possible if Chile strengthens its renewable energy and energy efficiency policies to remove existing barriers and more effectively promote these sectors.

### CHALLENGING THE CONVENTIONAL WISDOM ABOUT THE COSTS OF NCRE IN CHILE


NRDC commissioned Bloomberg New Energy Finance (BNEF) to prepare an assessment, with Chilean data provided by Valgesta Energía (Valgesta), of the "levelised cost of energy" (LCOE) comparing a wide range of power generation technologies in Chile. The analysis demonstrates that "non-conventional renewable energy" (NCRE) technologies, which are often assumed to be uniformly more costly, actually provide affordable choices right now.

Based on the analysis and a large body of evidence that energy efficiency is the cheapest energy resource, it is clear that with appropriate domestic market development NCREs can rapidly become even more affordable.<sup>1</sup> This finding is critically important as Chile considers betting its future on new megaprojects such as the HidroAysén hydroelectric complex with its attendant harm to ecosystems and communities and the Castilla coal-fired plant that would bring significant concerns about fuel risks and air and water pollution.



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## UNDERSTANDING THE “LEVELISED COST OF ENERGY”

Energy generation technologies have different cost and performance characteristics that can be difficult to compare. For example, the “fuel” for photovoltaic plants—sunlight—is free, but unless combined with energy storage, photovoltaic plants can only provide energy when the sun is shining. Fossil-fueled thermal power plants, by contrast, can produce energy at all hours as long as fuel is available, but have often volatile fuel costs, unpredictable outages for repair, high operating costs, and cause negative environmental and health effects that solar and other NCRE technologies generally do not. Large hydro facilities often have low fuel and energy production costs, but frequently experience huge cost overruns during construction, incur high long distance transmission costs, can harm ecosystems and local communities, and are vulnerable to water shortages and seismic risks.

The “levelised cost of energy” financial model accounts for such differences by converting these various characteristics of each technology (other than environmental, social and health impacts) into a single metric: the price of a standard unit of energy known as a megawatt hour (MWh). This price indicates the amount of money that the owner of a power plant would have to charge the buyer of such energy to recoup its costs and earn a profit (assumed to be 10 percent for this analysis). By comparing energy generation sources head-to-head, Chileans can identify the resources that can compose the most economical portfolio of resources to meet Chile’s energy demand.



This analysis compares the levelised cost of energy for Chile’s primary energy sources of large hydro, coal, gas, and diesel as well NCRE sources such as small hydro, geothermal, biomass, biogas, wind, solar photovoltaic (PV), and solar thermal. By looking at data for the year 2011 and then making projections about the relative costs of electricity production in 2020 and 2030, the analysis provides information to steer development of a portfolio of low-risk, low-cost energy to meet Chile’s rising demand.

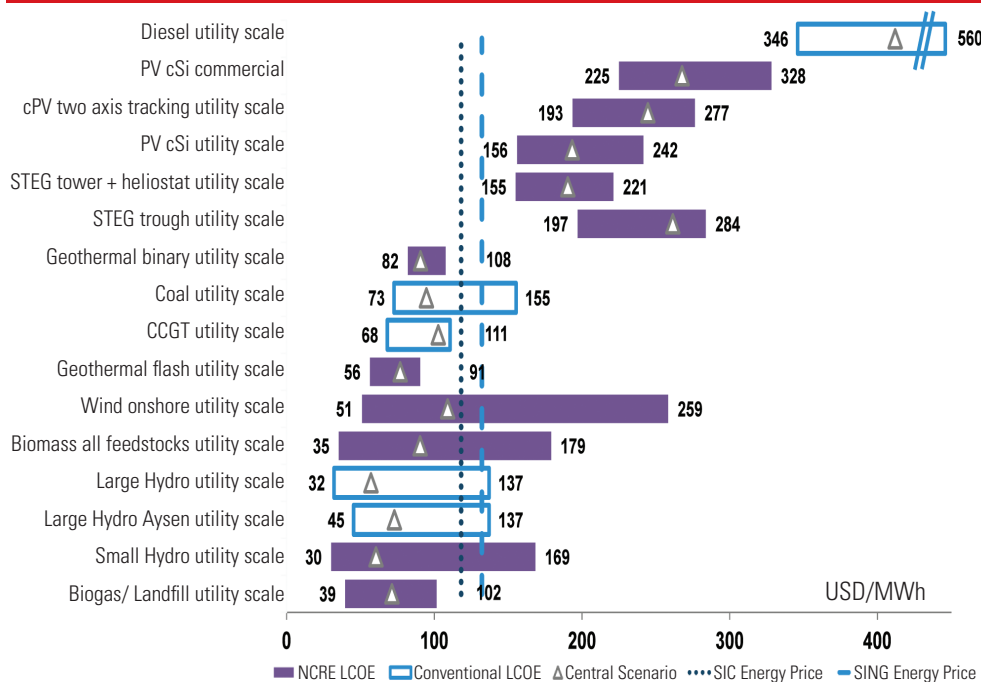
## The Case for Non-Conventional Renewable Energy

Around the world, and especially in Organization for Economic Co-operation and Development (OECD) countries such as Chile, governments, citizens, and businesses are concluding—based on decades of hard-won experience—that there is little security in relying on fossil fuels for energy. Fossil fuel supplies are limited and are subject to political and economic forces that no single country can control. The human health, environmental, and climate costs of burning fossil fuels are also high. The only known way to lower the carbon released when coal or gas is consumed is through technology designed to capture and store carbon. While proven to be technically feasible in places with suitable geological formations for storage, it remains uneconomical without regulations that increase the costs of carbon emissions or subsidies for developing the new technology.

Beyond fossil fuels, nuclear energy and large hydro have been the most frequently discussed alternatives in Chile. Nuclear energy, already estimated to be expensive and risky in Chile, is being reevaluated in the wake of the ongoing tragic events in Japan that began in March 2011. Most OECD countries are also moving away from large dams due to their ecosystem disruptions and concerns about water supply due to changing climate patterns. Chile faces cyclical droughts, high transmission costs to access distant water resources, and seismic risks as additional concerns. The HidroAysén large hydroelectric complex proposed in Patagonia, for example, would put pristine ecosystems in jeopardy, endanger lives and livelihoods, and concentrate a dangerously large portion of central Chile’s energy supply at end of a 2000 kilometer transmission line.

Fortunately, Chile has an array of non-conventional renewable energy and energy efficiency options to meet its energy demand without incurring the insecurities, risks, and harm that come with fossil fuel, nuclear, and large hydro projects.

**Figure 1.1: 2011 Chile Levelised Cost of Energy**



Today, on an LCOE basis, a wide range of non-conventional renewable energy (NCRE) technologies, including biogas/landfill gas, small hydro, biomass, onshore wind, and geothermal are competitive with the *new build* cost of Chile's mainstay energy sources of large hydro, natural gas, and coal.

Energy prices are from CNE data and calculated as the average of the first quarter of 2011 and the last three quarters of 2010.

Note: Large Hydro are non-Aysen projects; small hydro are less than 20MW.

Energy sources that are to the left of the energy price lines are competitive on a wholesale basis today. These now include biomass, biogas, geothermal, wind, and small hydro.

Source: Bloomberg New Energy Finance, Chile LCOE Analysis, 2011.

## NON-CONVENTIONAL RENEWABLE ENERGY IS AFFORDABLE FOR CHILE

In 2011, small hydro, biomass, biogas, onshore wind, and geothermal are already cost competitive with Chile's mainstay technologies of large hydro and natural gas; solar is close behind (see Figure 1.1). Furthermore, the levelised cost of a new renewable energy power plant of all of the types studied is less than the levelised cost of a new diesel power plant.

By 2020, the analysis projects that the cost of wind will have become even more competitive (see Figure 1.2). The most significant cost reductions in Chile will be in solar technologies. Also, by 2020, commercial and utility scale photovoltaic and solar thermal energy will be competitive with new fossil thermal and large hydro.

By 2030, most renewable technologies will be cheaper than fossil thermal technologies, and some will compete to be the least expensive energy alternatives in the country (see Figure 1.3). This is in part because Chile will benefit from the massive deployment of renewable energy technologies around the world, notably in China, the United States, and Europe, which drives down equipment costs. But the full cost reduction will not happen by itself because cost reductions are also due to local "learning curve effects"—the simple

economic law that the more you make something, the better you become at it. Chile must put policies in place to achieve maximum near-term deployment, and with it, maximum cost reductions.

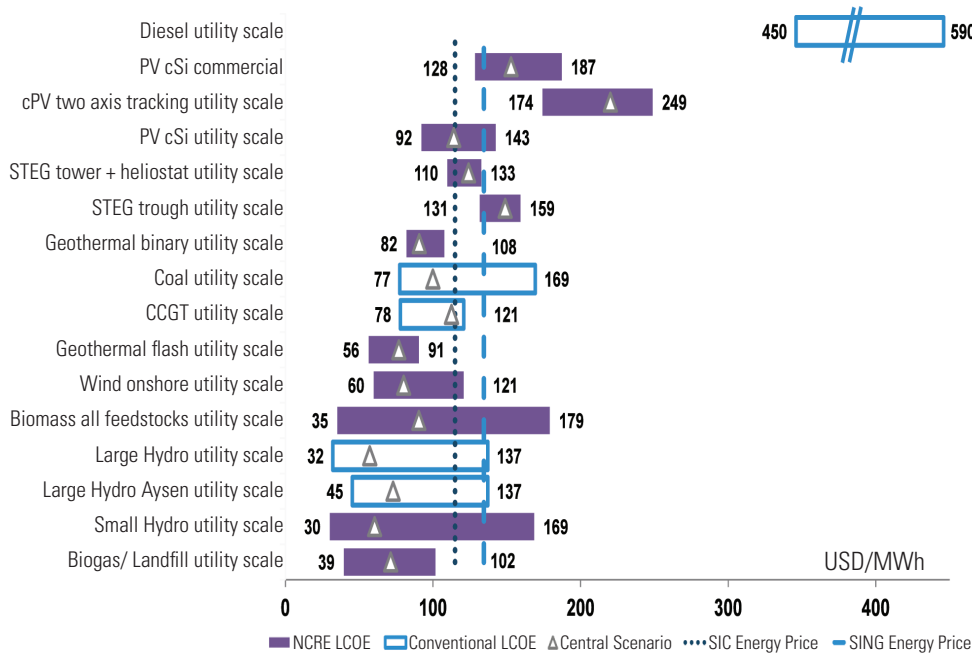
In addition, to the extent that the cost of fossil fuels increases over the time period to 2030, renewable energy will become even more competitive on a relative basis.

## BARRIERS TO NCRE DEPLOYMENT PERSIST DESPITE ENERGY MARKET REFORMS

As a response to these challenges, Chile has put in place energy market reforms to increase the amount of NCRE in the country, but the reforms were watered down and did not go far enough. In enacting Law 20.257 for the Development of Non-Conventional Renewable Energy in 2007, Chile continued its leadership in energy policy and commendably became the first and only country in Latin America to require that energy companies ensure that a portion of the energy they supply comes from NCREs or pay a penalty. The law is based on the economic principle that underlies the Bloomberg analysis: the best way to drive down the costs of new technologies is to transform markets by increasing competition and encouraging economies of scale, recognizing



**Figure 1.2: 2020 Chile Levelised Cost of Energy**



By 2020, utility-scale PV and solar thermal systems will be competitive sources of energy without subsidies.

With increasing thermal fuel prices and decreasing costs for renewables, several technologies such as wind, biomass, geothermal, and small hydro will in some cases be a cheaper option for new energy capacity than conventional technologies.

Energy prices are based on PRIEN\* 2008 forecast to 2030, "dynamic" case.

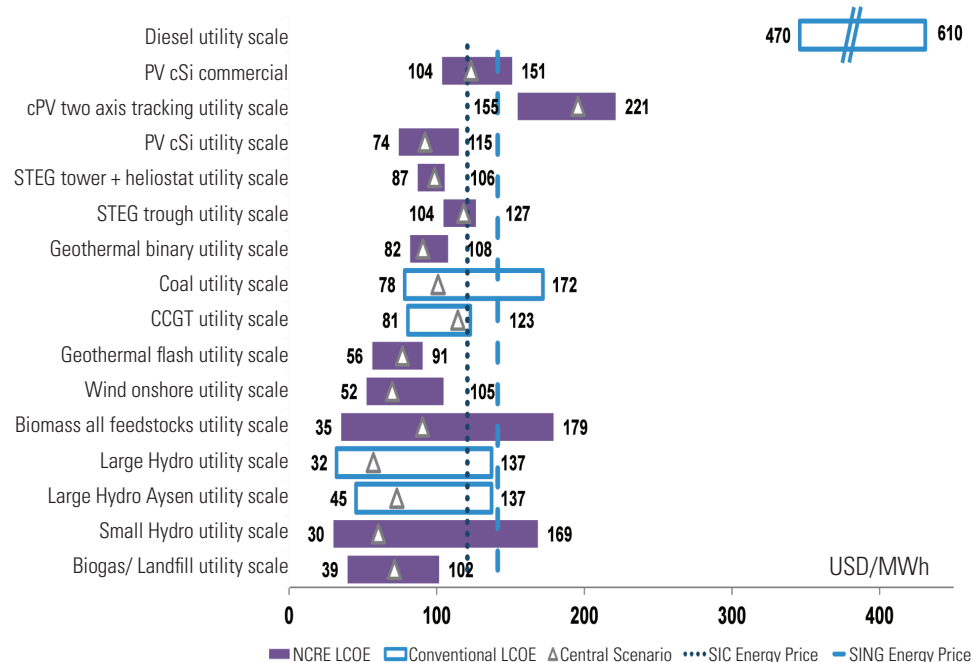
Note: Large Hydro are non-Aysen projects, small hydro are less than 20MW.

\*Programa de Estudios e Investigaciones en Energía - Instituto de Asuntos Públicos en Energía Universidad de Chile.

Energy sources that are to the left of the energy price lines are expected to be competitive on a wholesale basis in 2020. These now include most solar technologies, as well as still including biomass, biogas, geothermal, wind, and small hydro.

Source: Bloomberg New Energy Finance, Chile LCOE Analysis, 2011

**Figure 1.3: 2030 Chile Levelised Cost of Energy**



By 2030, most selected renewable energy technologies will be cheaper or competitive with thermal technologies.

Energy prices are based on PRIEN\* 2008 forecast to 2030, "dynamic" case.

Note: Large Hydro are non-Aysen projects, small hydro are less than 20MW.

\*Programa de Estudios e Investigaciones en Energía - Instituto de Asuntos Públicos en Energía Universidad de Chile.

Energy sources that are to the left of the energy price lines are expected to be competitive on a wholesale basis in 2030. These now include all NCRE technologies studied other than concentrating solar photovoltaics.

Source: Bloomberg New Energy Finance, Chile LCOE Analysis, 2011



at the same time that a balance must be struck that maintains affordable energy prices and a stable investment climate. Unfortunately, the law struck the wrong balance by failing to create sufficient demand and missing the opportunity to create the conditions for significant numbers of NCRE companies to enter the market.

In principle, the law creates demand for NRCE by requiring that an increasing percentage of energy in Chile be generated from NRCE technologies (5 percent from 2010 to 2014 and then increasing 0.5 percent per year to 10 percent in 2024). However, according to an analysis commissioned by the Chilean Association for Renewable Energy (ACERA), the actual demand created is much less because a large percentage of the energy generated in Chile (estimated to be 60 percent in 2011, 40 percent in 2015 and 10 percent in 2020) is exempted from the law.<sup>2,3</sup> This unfortunate result is due to the fact that the “transitional” provisions of the law exempt certain long term energy contracts entirely and cap the NCRE requirement of others at a tiny 5 percent. It takes a long term, steady stream of income to attract investors to new market like NCRE in Chile, so taking these contracts off the table means that there are far fewer opportunities for

the new market entrants proposing NCRE technologies. Chile’s dominant energy companies are very profitable in the current environment of high energy prices and have little appetite or incentive to invest in NCRE technologies or permit significant competition. For these reasons, Chile’s market, with all of its superb NCRE resources and market sophistication, languishes far below its potential.

### Mining and Solar: Perfect Together

BNEF research reveals that a photovoltaic project in the Atacama Desert is expected to produce energy at a price competitive with coal and gas when its first phase is completed in late 2011. This plant, developed by the Spanish company Solarpack in a joint venture with Chilean state-owned copper company CODELCO, is expected to generate 2,690 MWh per year and will be financed without subsidies or specific tax benefits for solar energy. BNEF concludes that this is possible because northern Chile has some of the best solar resources in the world. Deployment of solar at scale in the mining sector could reduce demand for thermal generation and lower energy costs and environmental impacts. Based on BNEF’s global research, increased deployment of PV solar technologies at a large scale accelerates local cost reductions for the technology and BNEF expects this pattern to repeat in Chile.

## CHILE CAN CREATE THE CONDITIONS FOR THE FULL DEPLOYMENT OF ECONOMICALLY COMPETITIVE NCRE TECHNOLOGIES BY:

### 1. Ensuring 20 Percent of All Energy Generated in 2020 is from NCRE Sources

The simplest and most significant market reform that would unlock Chile's non-conventional renewable energy potential would be to amend Law 20.257 to require 20 percent of *all energy generated for sale under contract* be generated from NREs by 2020 as President Piñera suggested in 2010. If this reform were put in place and enforced, including appropriate penalties for noncompliance, Chile would be able to more fully exploit the non-conventional renewable energy that is already cost competitive today and accelerate the affordability of those expected to become competitive tomorrow.

### 2. Unleashing the NCRE Purchasing Power of Chilean Industry

Chile should engage with NCRE companies, mining companies, large commercial/industrial customers, environmentalists, and other citizens groups to transform the "free client" market into one that either incentivizes or mandates the direct purchase of increasing amounts of NCRE. One possibility would be to create a market where green energy could be traded and certified as "green" by a regulator. This would permit exporting companies to certify for export markets that their product was made with a certain amount of green energy or with fewer carbon emissions. Another more aggressive strategy that would more rapidly stimulate competition and lower prices would be to require mining companies and large commercial/industrial users to purchase a certain percentage of renewable energy each year or in connection with any increase in energy consumption due to new or augmented operations.

Given Chile's high quality renewable resources, declining NCRE technology prices, and increasing fossil fuel prices, key NCRE generation sources are already cost competitive. All of the NCRE technologies studied will only become more competitive in the coming decades. To capture the full potential for improved performance and cost reduction, policies must be put into place to scale up the sector, including nurturing NCRE markets and increasing opportunities for NCRE generators. By doing so, Chile can secure the benefits of increased energy security and independence and reduced environmental degradation that would come with the large-scale integration of NCRE technologies into Chile's energy generation portfolio.

### ABOUT THE AUTHORS

The **Natural Resources Defense Council (NRDC)** is a not-for-profit non-governmental organization with its headquarters in New York and offices in Washington D.C., Chicago, San Francisco, Los Angeles, Montana, and Beijing. NRDC employs more than 350 lawyers, scientists, policy specialists, and finance experts on issues relating to energy and the use and preservation of natural resources. NRDC has deep energy policy and finance expertise, and recently played a leading role in designing and advocating for California's landmark climate change law. NRDC is also a principal architect of New York's newly proposed solar law that is currently before the New York legislature. Visit us at [www.nrdc.org](http://www.nrdc.org).

**Bloomberg New Energy Finance (BNEF)** is a leading provider of industry information and analysis to investors, corporations and governments in the clean energy and carbon sectors. BNEF has a dedicated global network of 125 analysts, based across ten offices in Europe, the Americas, Asia and Africa that continuously monitor market changes, deal flow and financial activity, increasing transparency in clean energy, and carbon markets.

**Valgesta Energía** is a consulting firm specializing in energy with more than ten years experience with the Chilean market. It has participated in more than 200 energy studies and projects for national and international clients.

<sup>1</sup> Roberto Roman and Stephen Hall: "El Futuro Energético de Chile está en la Eficiencia Energética y las Energías Renovables" April 27, 2011, available at <http://www.futurorenovable.cl>

<sup>2</sup> ACERA: "Rol de ERNCs a Futuro en Chile, Analisis, Perspectivas y Propuestas", September 2010; "Precios de Energías Alternativas", April 7, 2011, <http://www.acera.cl>.

<sup>3</sup> Estimate by Valgesta Energía.

