FOREST L. REINHARDT
SHON R. HIATT

# Colbún and the Future of Chile's Power

In August 2012, four months after scoring a major victory in the Chilean courts, Bernardo Larraín Matte, the 46-year-old former CEO and recently appointed Chairman of Colbún S.A., gazed out of his office window, thinking about the challenges facing his firm in light of Chile's growing energy demand, the worldwide volatility in oil and natural gas prices, and the company's recent decision to put its largest generation project on hold. As the second-largest generator in the country, Colbún had an installed capacity of 2,970 megawatts (MW), accounting for 20% of the central electricity grid (Sistema Interconectado Central, or SIC) that served 90% of the Chilean population. With between 40% and 70% of Colbún's electricity coming from hydropower (depending on meteorological conditions), and the rest from fossil fuels (gas, diesel and coal),[1] the company faced a challenging future. Six years earlier, Chile's primary supplier of natural gas, Argentina, had created a serious shortage by restricting gas exports and increasing taxes on them. Compounding the problem, in 2007, Chile experienced a severe drought that limited hydroelectric generation. As a result, Colbún had to boost its production from thermal power plants. Given the scarcity of gas, the company resorted to diesel.

However, the global rise of oil prices caused a strain on the company's finances. A record positive net income of $275 million in 2006 had turned into a net loss of $88 million in 2007, and earnings since had been volatile. Despite this volatility, the total return of Colbun shares in the Chilean equity market had been 15% per year over the last 10 years, as investors observed the potential for growth and the prospects for more stable future results. Electricity demand in Chile had been growing at 5.7% annually since 2003 and was expected to continue to increase; the country's per capita electricity consumption was still relatively low compared to developed and emerging markets (see **Exhibit 6c** for Chile's GDP growth and GDP per capita).[2] Since it did not look as if the Argentinean restrictions on gas exports would be lifted, Colbún had to find other sources for generating electricity. Yet, not long after a favorable Supreme Court ruling that paved the way for Colbún to begin construction on its largest hydropower project in the southern part of Chile, HidroAysén (a joint venture between Endesa-Chile and Colbún), Colbún recommended to the HidroAysén Board of Directors that they suspend the filing of the environmental approval process of the transmission line of the project, until a thorough national electricity policy was discussed and agreed among different relevant stakeholders.

Given these developments, Larraín wondered what the best course of action should be for Colbún to meet future energy demands profitably and continue to be a stable provider of power for large

Professor Forest L. Reinhardt, Gustavo Herrero, Executive Director of the HBS Latin America Research Center, and Doctoral Student Sanjay Patnaik prepared the original version of this case, "Colbún—Powering Chile," HBS No. 709-060. This version was prepared by Professors Forest L. Reinhardt and Shon R. Hiatt. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

parts of the Chilean population. A graduate of Chile's Universidad Católica (1989), the London School of Economics (1992), and Stanford Business School's Sloan Program (2005), with experience as an executive in and out of the energy field, Larraín had his work cut out for him at Colbún, of which his family's business, the Matte Group,[a] had gained control in 2005. What primary sources of energy should Colbún focus on, and what strategies should he apply to manage the risks that future supply disruptions and stakeholder activism might pose for the company?

## Chilean Electricity Industry

### *Energy Policy*

The Chilean electricity industry consisted of three sectors: generation, transmission, and distribution, which were under the regulatory oversight of the National Energy Commission (Comisión Nacional de Energía, or CNE). In the 1980s, Chile was the first country in the world to deregulate and privatize its energy industry in order to encourage competition among generators.[b] In 1982, the Electricity Act, the first and still most important law with regard to the Chilean electricity industry, was passed, deregulating generation and separating it from transmission. The initial approach was to deregulate generation, but to maintain regulation of the electricity sector on a general level. The basic idea was that anyone who wanted to connect a power plant should be able to use the transmission lines in exchange for a fee, as long as there was enough transmission capacity. This type of system for transmission lines was considered to be very new at that time, since in most other countries, transmission was integrated into large electricity companies. In Chile, privatizations of state-owned electricity companies began in 1985. Endesa-Chile, then the largest government-owned company, was broken up into 14 firms, and Chilectra, which had been in private hands since 1970, was also divided into three smaller companies. In 2005, Short Law II was passed, establishing free market prices as of 2009. Power generators like Colbún sold electricity in Chile through long-term contracts or on the spot market. They hedged their risk commercially, deciding the proportion distributed on the spot market rather than resorting to financial mechanisms to offset potential volatility in their inputs and outputs.

### *Environmental Regulation*

As Daniel Gordon, Colbún's Vice President of Environmental Affairs, explained, environmental law in Chile required significant community participation in the decision-making process in order to obtain permits. A company that wanted to build a power plant had to enter the project into the Environmental Impact Evaluation System (Sistema de Evaluación de Impacto Ambiental, or SEIA). The environmental process was administered by the National Commission for the Environment (Comisión Nacional de Medioambiente, or CONAMA), since 2010 renamed Environmental Assessment Service (Servicio de Evaluación Ambiental, or SEA), which had local chapters in each region.[3] The final decision was made by a Committee, that comprised representatives of the Environmental, Health, Economy, Energy, Public Works, Agriculture, Transport, Mining and Housing Ministries and the Regional Director of SEA.

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[a] The Matte Group was one of the largest business conglomerates in Chile.

[b] For more information, see Kathleen McGinn, "Endesa Chile: Raising the Ralco Dam (A)," HBS No. 906-014 (Boston: Harvard Business School Publishing, 2006).

By law, the review process itself was not supposed to last more than 180 days in total. Typically, a firm submitted its environmental impact study of the proposed project to the SEIA and then got a list of questions back. Formally, a company had to answer those questions within five days, but since this time span was too short in most cases, it had the option to pause the review process (thus interrupting the 180-day limit) to prepare responses. This was the usual procedure electricity companies followed and it could take up to several months. Finally, after the Committee considered the replies from the company, it made a final decision about the permit. Gordon noted that due to this complex environmental review process aimed at ensuring that all the concerns of the local community were taken into account, obtaining an environmental permit for a power plant had become one of the most important strategic factors for investment.

Furthermore, as Gordon pointed out, even if a permit had been granted, it could be contested in court afterward. In the last four years, opposing groups made increasing use of this procedure for all types of power projects: coal-fired, non-conventional renewable, and hydro projects. For example, two projects that had been halted in the court were Castilla, a 2,300 MW coal-fired complex in northern Chile, and the Chiloé Ecopower Project, a 100 MW wind park in the south of the country. These and several other cases greatly worried industry representatives, who saw increased legal uncertainty for any future power project.

In addition, the SEIA had been more inclined to grant permits for coal-fired power plants than for hydropower plants. According to research done in 2008 by Libertad y Desarrollo, a Chilean think tank, this discrepancy seemed to indicate a favorable bias toward coal-fired plants within the environmental review system. A think-tank study revealed that it took, on average, 302 days to obtain permission for a coal-fired power plant compared to 331 days for gas-fired and 358 for hydropower plants. In addition, in 2007, hydropower projects amounting to 1,349 MW were rejected or withdrawn, of a total of 1,887 MW of new capacity submitted for review. This development could be seen as evidence that coal–fired power plants faced lower regulatory uncertainty. However, Larraín stated that more recently all types of projects were facing difficult environmental permitting processes.

Industry experts offered an explanation for why regulators seemed to prefer coal-fired plants. The immediate physical impact of hydropower plants was more visible in terms of flooded land and artificial reservoirs than the air pollution created by coal-fired power plants. The criteria for the approval of coal-fired power plants were well defined technically, based on objective metrics, whereas the objections that were usually raised to oppose hydropower projects were more subjective. This made large hydropower projects more vulnerable to public opposition, delays, and legal action.[4]

One consequence of the increased use of coal was that $CO_2$ emissions were increasing quickly. Gordon noted that this issue was gaining more public attention, although Chile was not obliged to reduce $CO_2$ emissions under the Kyoto Protocol. As a response to the Argentinean gas crisis, the number of coal-fired power plants had increased significantly. Between 2000 and 2003 almost no coal-burning projects had been submitted to the environmental authorities for approval, but from 2005 to 2007, 54%[c] of planned projects within the environmental review system were coal-fired plants (compared to 35% hydropower projects). In the same period, only 11% of capacity approved was based on hydropower, compared to 67% for coal.[5]

[c] In terms of capacity in MW.

## *Sources of Energy*

In Chile, power companies could make use of a wide array of different energy sources. Domestic resources were rather limited, which made it necessary for the country to import a variety of energy supplies. The available energy mix could be divided into non-renewable sources such as oil, natural gas, liquefied natural gas (LNG), and coal, and renewable sources such as hydropower and alternative energy forms (wind, solar, nuclear, biomass, biofuels, etc.). (See **Exhibits 6a** and **6b** for the energy mix of the Chilean electricity system in recent years.) Oil, coal, and natural gas produced varying amounts of $CO_2$ when burned. (See **Exhibit 7** for a list of how much $CO_2$ each fuel type would produce when used for generation of electricity.)

When comparing generation technologies, the capital costs per unit of capacity and the variable costs per unit of output were obviously relevant. Along with the opportunity cost of capital, the capacity factor was also important in calculating the overall costs for each unit of output. This capacity factor was simply an estimate of the fraction of the total time that an asset could generate electricity. Fossil fuel and nuclear facilities had capacity factors of 80% to 90%, meaning that (given that there are 8,760 hours in a year) they could be expected to produce 7,000 to 8,000 megawatt hours (MWh) per MW of capacity per year. Capacity factors for hydro, wind, and solar tended to be lower.

**Oil** Chile had estimated oil reserves of 150 million barrels, leading to production of less than 20,000 barrels per day compared to daily consumption of more than 277,000 barrels (bbl).[6] The state-owned Empresa Nacional del Petroleo (ENAP), which increasingly invested in countries like Colombia, Ecuador, and Egypt to explore new sources of supply, dominated the Chilean oil industry. As domestic oil production was decreasing, the majority of oil was currently imported from Argentina, Brazil, Angola, and Nigeria.[7] Demand for oil products in Chile had been rising, mainly because of the more extensive use of diesel-fired power plants, especially in the wake of the Argentinean gas crisis. However, in light of the volatile oil prices over the last four years, many power companies were starting to build coal-fired power plants with the aim of replacing some diesel-fired facilities. Assuming a diesel price of $110 per barrel, Larraín estimated variable costs for combined-cycle gas turbine diesel to be $160 per MWh and $280 per MWh for open-cycle gas turbine diesel (see **Exhibit 2** for estimates of costs by type of generation).

**Natural gas** The country had estimated reserves of 98 billion cubic meters as of January 2008 and a comparatively small production of 1.8 billion cubic meters.[8] All the domestic gas production was managed by ENAP, which also operated the pipelines connecting domestic sources with Chilean customers. Historically, the use of natural gas in Chile had been rather low until the mid-1990s, constituting only 8% of total domestic energy consumption in 1996.[9] However, in 1997 the Chilean government began facilitating gas imports from Argentina, and given the cost advantage over coal, many electricity companies started importing Argentine natural gas for their thermal power plants.

This development caused an increase in natural gas consumption of as much as 21.7% annually in the late 1990s, so natural gas made up 26% of total domestic energy consumption in 2004 (right before the gas crisis).[10] There were seven gas pipelines operational between Chile and Argentina owned by Endesa-Chile, U.S.-based CMS, Belgian-owned Tractebel, French Total, TransCanada, El Paso, Casco, and Gasoducto del Pacifico.

Chile's bet on Argentine natural gas, however, turned out badly. Argentina's energy crisis began with the threefold devaluation of its peso in January 2002. The Argentine government reacted by freezing all gas rates in the domestic market in order to protect consumers who were already suffering from an economic downturn considerably worse than the Great Depression. The fall in the

Argentine peso, however, meant that the wholesale dollar price of gas sold in Argentina to industrial customers fell from $1.15 per million BTUs to $0.40. The price of gas sold to residential customers fell from $1.88 to $0.66.[11] As the Argentine economy began to recover, demand skyrocketed. In March 2004, as the southern hemisphere winter began, gas companies cut supplies by a fifth to 20 large industrial customers. In response, the Argentine government mandated that the companies satisfy domestic demand before they would be allowed to export. Exports to Chile dropped 35% almost immediately. By the end of the month, they were down 47%. Exports slowly climbed again, but the Argentine government declared its export limitations daily, which made it nearly impossible for Chilean buyers to predict the amount of gas that would be made available in any period of time.[12] The Argentine Interior Minister, Anibal Fernández, apologized to the Chilean government for the interruptions, but in May 2005, the Argentines once again slashed exports to Chile in response to domestic shortfalls.[13] The same story repeated itself the next winter, in 2006, when Argentina cut exports completely for two weeks. Perhaps adding insult to injury, the Argentine government then raised the export taxes (on whatever shipments did occur) from 20% to 45% in July 2006.[14] Chile attempted to forge an agreement to purchase Bolivian natural gas, but the negotiations ignited a firestorm in Bolivia, where anger surged over the fact that the exported gas (and proposed pipeline) would pass through territory that Chile had seized from Bolivia in the 1878 War of the Pacific. As a result, Chilean gas companies could not purchase gas from Bolivia; nor could they rely on gas from Argentina. Larraín estimated variable costs for natural gas before the Argentinean gas crises to have been $15 per MWh of electricity output, far below the costs incurred for natural gas by electricity producers in North America and Europe.

**Liquefied natural gas (LNG)** In 2004, in an effort to diversify the country's energy supply in the wake of the Argentinean gas crisis, the Chilean government invited a consortium led by ENAP to build an LNG terminal. ENAP, Endesa-Chile, Metrogas, and BG Group (an international player in natural gas) laid the groundwork for the plant in 2006 and planned to finish phase one of the project in 2009. Completed in 2011, the LNG terminal encompassed a sea terminal and degasifying and distribution facilities, and was projected to provide 40% of domestic natural gas, particularly in the central region around Santiago (total investments amounted to $1.4 billion).[15] Larraín noted that Colbún had originally been part of the consortium, but decided to pull out, along with U.S.-owned AES Gener. Among other reasons, the company felt that even under the assumption of very low capital costs for LNG, hydro and coal power would still be more cost competitive. In addition, even though diesel spot price fluctuations concerned Larraín at that time, the LNG price offered to Chile was linked to diesel prices, and its cost advantage was not large enough to compensate for the substantial fixed gasification cost. In August 2012, Larraín estimated variable costs for LNG supplied through the gasification terminal in Quintero to be about $120 per MWh of electricity output, considering the current price and market conditions (consisting of $108 per MWh of the LNG arriving at Quintero plus $12 per MWh of regasification costs).

The capital costs of new capacity for generating electricity from natural gas were about $0.8 million per MW of capacity. This figure did not vary according to the configuration of the upstream supply (i.e., the capital equipment for combustion and generation was the same for LNG as for gas brought to the generating plant by other methods).[16]

**Coal** Chile had estimated coal reserves of 1,300[17] million short tons (Mmst[d]) and annual production of close to 700,000 short tons.[18] The electricity sector alone consumed around 6 million

[d] 1 short ton = 2,000 pounds.

metric tons[e] of coal in 2008, and, according to Colbún's estimates, it would require 14 million metric tons annually by 2015 (assuming coal with an energy value of 6,350 kilocalories [kcal] per kilogram [kg][f]). With consumption largely exceeding domestic production, most of the coal was imported from Australia, Indonesia, and Colombia.[19] The gas crisis in 2004 led many electricity companies to start investing in coal-fired instead of gas-fired thermal power plants, especially since they could easily obtain coal from multiple diversified sources. This made it a cheaper alternative and less vulnerable to supply disruptions. Larraín assumed variable costs of close to $70 per MWh of electricity output for coal in July 2008 when coal prices were at a historic peak. However, the estimated variable costs retreated to $40 per MWh of electricity in August 2012. Coal power represented around 12% of total capacity in the SIC, far less than what it represented in some of the main developed countries.

**Nuclear** Chile did not have any nuclear power plants. A recent North American study estimated that by 2015, the overnight capital costs of nuclear power (i.e., capital costs that did not include the perhaps considerable cost of carrying the money during the construction period) might run about $4 million per MW. In addition, variable costs (including fuel and maintenance) could go up to $20 or more per MWh.[20] Since the Argentinean gas crisis and high oil prices in the years prior to 2008, a new public discussion about nuclear energy as a viable option had emerged in Chile. Despite this, it seemed that nuclear power plants would not be a possibility in the short to medium term.[21]

**Hydropower** Parts of Chile were mountainous and wet and, hence, very well suited for hydropower. The country's total hydropower potential was estimated to be 24,000 MW, of which only 4,130 MW were currently used for generation.[22] Capital costs per MW for large hydro plants tended to be smaller than those for small hydro, reflecting economies of scale in construction. Larraín pointed out that hydrofacilities in central Chile might be expected to operate at capacity factors of 50% to 60%, compared to 70% to 80% for large hydro projects in the south (Aysén region), and the variance of this capacity factor from year to year was expected to be higher in the central region .

Variable costs for hydropower were near $0 per MWh. The Chilean Water Code, established in 1981,[23] mandated that companies intending to build hydroelectric power plants had to apply to the Dirección General de Aguas (DGA, a government agency) for water rights. Anyone in the country could ask for water rights, which were classified into two categories, one for direct use of the water (such as irrigation) and one for indirect use (such as hydropower plants). Farmers were entitled to water rights, which was especially relevant for larger dam projects. Therefore, some electricity companies partnered with farming organizations to bid together for water rights.

Water rights used to be awarded free of charge. However, following legal changes in 2005,[24] once a company had acquired certain water rights, it would be forced to pay a royalty if it did not make use of the right for the purpose for which it was awarded. This measure was intended to curtail speculation and ensure that water rights would be put to productive use. In addition, owners of existing water rights could transfer them to others. Also, after 2005, if more than one interested party wanted the same rights, the DGA would hold an open auction in order to award them. This procedure gained a lot of media attention, mainly because of a high-profile auction of water rights for the Manso River. Endesa Chile had long planned to build a power plant along that river and had already applied for the water rights in 1989. However, U.S.-owned AES Gener also expressed interest

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[e] 1 metric ton ~ 1.10 short tons.

[f] 1 kcal = 1,000 calories, another unit of energy; 1 kWh = 859.8 kcal.

in the same area. In order to resolve the issue, the DGA held an auction, in which several electricity companies, including Colbún, Endesa, and Electro Austral Generación, participated. To the surprise of most observers and experts, the DGA finally awarded the rights to a previously unknown lawyer from a law firm in Santiago. Instead of the expected auction price of $8 million to $10 million, the final selling price was $45 million.[25] Larraín and Gordon felt that this high-profile case indicated that water rights would be more difficult and expensive to obtain in the future. Larraín also pointed out that "although hydropower technology had the lowest variable costs, up-front investments, which were traditionally high, got even higher over the past few years due to rising equipment and civil works costs and the appreciation of the Chilean peso. In addition, the construction phase is lengthy and risky."

**Alternative sources** Non-conventional renewable energies such as wind, solar, biomass,[g] and geothermal[h] contributed a negligible portion of electricity generation in Chile. In 2011, only 3.3% of total installed capacity was based on wind or biomass.[26] There were no solar or geothermal plants producing electricity for any of the four domestic grids. However, as Gordon explained, due to a new law passed in 2008, 5% of total electricity production would have to come from non-conventional renewable sources between 2010-2014, with that target rising to 10% by 2024. Small-scale hydropower projects (<20 MW) qualified as part of the renewable energy requirements. In addition, the government passed legislation to regulate the exploration and production of geothermal energy sources in 2000 in order to facilitate the development of geothermal power plants. So far, geothermal energy was only utilized for medicinal and touristic purposes, but because of Chile's geological conditions, it was viewed as a promising renewable energy source.[27] Larraín estimated capital costs for geothermal to be $3.55 million per MW.

The northern region of the country was well suited for solar power as it received one of the highest levels of solar radiation in the world. At present, solar technology was mostly used on a small scale for decentralized provision of electricity in rural areas. Wind power was explored as well, but because of its relative unreliability compared to other sources, large-scale deployment was more difficult. As a consequence, small-unit hydropower plants were the most established alternative for companies to fulfill the non-conventional renewable energy requirement.[28]

Larraín thought that although some of the nonconventional renewable sources had negligible variable cost, their high capital cost and low and volatile load factors (except for geothermal) made it hard for them to compete. He added that to make their total cost comparable to more stable sources of energy, a backup facility (normally diesel fueled) had to be incorporated, so that the total development cost should be computed as an average between the development cost of the nonconventional renewable source and the backup facility. Larraín estimated the capital costs of wind to be $2.3 million per MW and felt that Chilean wind farms would more likely achieve capacity factors of 20% to 25% than the 30% to 35% predicted by North American firms.

## Colbún: Company Overview

The company was created under the name Colbún Machicura S.A. as a spin-off from Endesa Chile (the national power company at the time) in 1986. The power plants in Colbún and Machicura were

[g] Energy derived from biomass was created by burning renewable sources such as wood, wood chips, and other natural cellulose products.

[h] Geothermal energy generation harnessed the power of hot springs, vents, and other geologic occurrences.

both transferred to the new entity, which the Chilean public sector controlled until 1997 when the government sold its share of 37.5% in the company. In 2001, the company changed its name to Colbún S.A., and in 2005, it merged with Guardia Vieja and Cenelca, two hydropower firms that were under the control of the Matte Group, one of the strongest family-owned business conglomerates in Chile. Subsequently, this merger allowed the Matte Group to gain control of Colbún S.A. The company had a staff of 950 employees and owned 22 power plants—13 hydropower and the remainder thermal—in the center and south of the country. (See **Exhibit 1** for a list of Colbún's power plants.)

Revenues and installed capacity had been increasing steadily from 2003 on, but the restrictions on Argentinean natural gas exports, as well as the low level of hydrology in 2007, had had substantial negative effects on the company's finances. (See **Exhibit 3** for historical development of key indicators, **Exhibit 4** for income statements, and **Exhibit 5** for balance sheets.)

In 2006, Colbún had long-term contracts with clients for 12,000 gigawatt hours (GWh) of production, and due to a wet year, it was able to cover its obligations from hydropower, natural gas, and purchases on the spot market. The average marginal cost on the spot market that year was $45 per MWh, and the price it received from its long-term contracts was $56 per MWh (the contracts had been signed when natural gas was abundant and cheap). The price of oil stood at $67 per bbl. The company spent $108 million on natural gas and $16 million on diesel to supplement its hydropower production. In 2007, the year was extremely dry, and natural gas imports from Argentina had already declined. The marginal cost on the spot market was $172 per MWh, the oil price stood at $75 per bbl, and the price for long-term contracts was $73 per MWh (contracts were renegotiated due to the gas crisis). Since Colbún still held contractual obligations for 12,000 GWh, the company was forced to spend $72 million on the purchase of natural gas and $582 million on diesel in order to deliver the promised electricity.[29] In order to decrease vulnerability to high diesel prices and fluctuations in hydrologic conditions, Colbún decided to reduce its contracts to 10,000 GWh in 2008 and to engage in hedging through call options and weather derivatives to mitigate exposure to volatility in diesel prices and poor hydrologic conditions.

Because the hydrologic conditions improved, the hedging strategy alleviated oil price increases in the first half of 2008, and oil prices sank in the second half of the year, the company was able to reverse the negative results of 2007. In addition, Colbún successfully completed a financial restructuring plan that had become necessary due to the relatively poor results in the previous year. The company had raised $400 million in capital from its existing shareholders (without changing the ownership structure), issued new bonds worth $280 million, received an additional $240 million from local banks, and restructured existing debt and covenants. In early 2010, Colbún consolidated its financing structure when it obtained an investment grade rating from Standard & Poor's and Fitch Ratings, which allowed it to tap the US bond market with the issuance of a US$500 million, 10-year 144A/RegS Yankee bond. As a result, Colbún secured enough funds to cover projected capital expenditures of $1.8 billion by 2013.

Larraín explained that, in general, the company followed an organic growth strategy that required generating a revenue stream through long term contracts aimed at securing a rate of return to high up-front capex. At the same time Colbún had to limit the volatility of its cash flows. As Colbún relied heavily on hydropower, it was naturally exposed to the variance in hydrologic conditions. According to Larraín, this implied that having too many long-term contractual obligations could force the firm to buy more costly energy on the spot market or to produce it with expensive diesel plants in order to cover possible shortfalls in dry years. On the other hand, if it sold solely on the spot market, it would be exposed to volatile spot market prices that in rainy years could only cover variable costs.

Therefore, one of the most essential tasks of the management team at Colbún was to determine the optimal mix of long-term contracts and sales on the spot market. As Juan Eduardo Vásquez, the firm's Director of Business and Energy Management, pointed out, "Colbún had developed a team that was constantly analyzing the vulnerability of the company's EBITDA to different contract levels, hydrological conditions, fuel prices, and other risk factors."

In the early 2000s, the company achieved this optimization strategy between contracts and spot market sales by maintaining contract levels that were consistent with a generation mix based on hydropower and low-cost natural gas. However, in the wake of the Argentinean gas crisis and the subsequent increasing use of diesel, the current level of contracts was no longer economically sustainable. Consequently, the company started to modify its strategy to adapt to the new circumstances. In the short term, this encompassed bringing down long-term contracts, renegotiating existing contracts, adding backup facilities, and hedging against the costs of diesel. In the long run, strategic measures included increasing capacity to serve growing demand and entering long-term contracts that were consistent with Colbún's new energy matrix.

In 2010, Colbún wanted to enter contracts with final clients at long-term prices for less than 7,000 GWh so that it could meet a substantial portion of the obligations with hydropower, even under unfavorable hydrologic conditions. The rationale behind this was that Colbún expected marginal costs on the spot market to be determined by diesel-fired plants at least until 2012 under normal or dry hydrological conditions. As Colbún's two combined cycle diesel plants would have a cost advantage, the company expected to be able to sell profitably on the spot market in medium to dry years. In addition, even if the power plants were not dispatched, Colbún would still receive the corresponding capacity charges. This strategy would avoid some of the problems the company experienced in 2007, as it reduced the risk of exposure to high oil prices and low hydrologic conditions.

In 2011, Colbún planned to increase long-term contracts to 9,000 GWh, as it could meet these obligations mainly by hydropower and the first coal-fired plant, which would be online by then. The company expected the price for contracts with distribution companies to be based on the development costs for coal-fired power plants. This price was expected to be around $100 per MWh.

To cope with rising demand for electricity in Chile, the company had entered into an aggressive investment plan. Between 2007 and 2009, it commissioned four hydro projects totaling 150 MW ($170 million) and one 100 MW diesel plant ($ 70 million). Colbún had also recently commissioned the Santa Maria 350 MW coal-fired power station ($750 million), made 70% progress in the construction of the Angostura 316 MW hydro project ($720 million), and had begun construction of the 150 MW San Pedro hydro project that had been temporarily halted due to engineering re-designs.

In addition, Colbún had a large pipeline of new projects. It had water rights to potentially develop 500 MW in hydro projects, and an environmental license to develop a second 350 MW coal-fired plant. Colbún was evaluating several non conventional renewable projects ranging from 2 to 100 MW, especially focusing on small-scale hydro projects. It was also in the process of conducting pre-feasibility studies for two wind farms.

Finally, the firm had been engaged in of the development of the 2,750 MW HidroAysén project, the largest energy project ever developed in Chile.

Larraín explained how he decided which sources of energy to use: "I think our main criteria ought to be the availability and autonomy of the resource, the capital expenditures required relative to the capacity installed, and efficient operating costs. But most importantly, we are following our strategy of having over 50% of our capacity from renewable sources, which are complemented by an efficient thermal capacity in order to have a diversified asset base."

## *Stakeholder Engagement*

Larraín knew that the relationship with the local community was a key factor for the success of a new project. As a result, the company engaged in a dialogue with the stakeholders of any project early on. For the Angostura hydropower plant, for example, Colbún approached the local community one year before the project was made public. Since about 46 families would need to be relocated due to creation of the reservoir, the company was closely working together with the affected families to mitigate any disruptions in their lives as much as possible. In addition, Colbún committed to construct new and better homes for them on larger plots of land than they were currently living on. In Gordon's words: "The company saw it as part of its corporate social responsibility to improve the livelihoods of the local population that would be impacted by a new power plant."

## *Carbon Credits*

Colbún was among the first Chilean companies to sell certified emission reduction credits (CERs) internationally within the Clean Development Mechanism (CDM) regulated under the Kyoto Protocol. CDM allowed developed countries that had to fulfill binding emissions targets under the protocol to "implement an emissions-reduction project in developing countries"[30] instead of reducing emissions at home. Such projects in countries not covered by the Kyoto Protocol would earn CERs, which were expressed in tons of $CO_2$ and would then be applied to the emissions target of the country buying the CERs. In order to be able to qualify for selling CERs, a project had to undergo a rigorous review process and meet the condition of additionality: the proposed emissions reductions would have to be in addition to "what would otherwise have occurred."[31] As Larraín explained, the additionality criterion was evaluated through a well-defined methodology that relied on an optimization model used by the Chilean energy regulators. The regulators usually applied this optimization model to identify the optimal expansion plan for generating capacity in Chile for future years. To assess if a project met the additionality criterion, the optimization model was first run under the standard assumptions made for the expansion plan. Second, the optimization model would then be run under the assumptions that some of the electricity supply would have to come from the CDM projects that were being considered. For both scenarios, the net present value of the costs for the supply of electricity would be calculated and then compared. If the costs for the second scenario were higher than for the scenario without CDM projects, additionality was demonstrated. Since including the CDM projects would lead to a more expensive way to generate electricity, selling the CERs was necessary to offset the additional costs.

Colbún had entered agreements to sell CERs for four of its hydropower projects, and as Gordon noted: "Our company plans to sell more CERs in the future and will commit more personnel to researching and identifying further opportunities within CDM. The possible sales of CERs are an important incentive to find projects that would create such emissions reductions." The existing contracts included the sales of 600,000 CERs[i] at a price of €4.65[j] per CER from the Hornitos hydroelectric project, 1 million CERs at a price of €3.50 per CER from the Chacabuquito hydropower plant, and 400,000 CERs at a price of €6 per CER from the Quilleco project to the International Bank

[i] The CERs represented the emission reductions for the whole project and not annually.

[j] The average exchange rate between euro and dollar in August 2012 was about $1.24 per euro.

for Reconstruction and Development. In addition, the company sold 350,000 CERs from the Quilleco project to Electrabel (a Belgian energy company) and 100,000 CERs at €3.50 per CER from the Chacabuquito hydropower plant to Mitsubishi Corporation. Based on the success of these agreements so far, Larraín was convinced that there was more potential for Colbún to use its existing water rights for CDM-certified projects in the future.

## *Aysén Hydropower Project*

In April 2006, Colbún signed a memorandum of understanding with Endesa Chile to begin Colbún's and Chile's largest hydro project to date, a joint venture that would eventually encompass five hydroelectric reservoir power plants to be built by 2019 in the Aysén region, along the Pascua and Baker Rivers. The Aysén region is a scarcely populated, remote, and underdeveloped part of the country located about 2,000 kilometers south of Santiago.[k] For the purpose of the consortium, the two companies created a new entity, HidroAysén, with Endesa Chile and Colbún holding 51% and 49%, respectively. As part of the agreement, Endesa Chile was entitled to 12.3% of all the energy generated by the project for 30 years, whereas the rest would be distributed between Colbún and Endesa Chile proportionate to the stakes both companies held in the newly formed firm.[32] Additionally, in order to ensure fair competition on the Chilean energy market, both parties agreed that the joint venture would encompass only construction and electricity generation. The two companies would sell their respective shares of electricity independently; they also obtained approval for their joint project from the Chilean antitrust court.

The project included two facilities at the Baker River with a capacity of 360 MW and 600 MW and an energy output of 2,540 GWh and 4,420 GWh, respectively, as well as three projects at the Pascua River with capacities of 460, 500, and 770 MW and output of 3,340, 3,020, and 5,110 GWh. The investments covered the immediate infrastructure—such as dams, intakes, tunnels, canals, powerhouses, and electromechanical equipment—and also covered energy transmission lines, roads, ports, airports, telecommunication, and health facilities supporting the new plants.[33] Transmission lines from Aysén to the population centers where the electricity would be used might cost as much as the dams themselves and cross the properties of perhaps 5,000 landowners.

Since Colbún was committed to minimizing the environmental and social impact of the project, it formulated and measured a number of goals on a variety of indicators. These indexes included the minimization of resettlement of the local population, the maximization of energy production per reservoir size (the project is the most efficient in the world on this indicator), the minimization of flooded land and hydrologic impact, and the selection of the best sites with respect to geologic conditions. As the project would provide energy for the equivalent of 10 million Chileans, it was estimated that the hydropower plants would represent savings of around 17 million tons in $CO_2$ emissions annually by avoiding the construction of six thermal power facilities.[34]

Despite the consortium's commitment to the sustainable development of the Aysén plants, resistance to the project started to mount, mainly on environmental grounds. In August 2008, when the two companies submitted the complete plan for the project to the environmental authorities, several protests accompanied the procedure. Critics of the project stated that it would significantly affect the local ecosystems. One of the main opponents was a local NGO connected to International Rivers Network (IRN), a U.S.-based nongovernmental organization (NGO) that wanted to preserve pristine rivers around the world. IRN opposed hydropower projects that involved the construction of

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[k] Only about 1% of the Chilean population lived there.

large-scale dams and reservoirs, as its main goal was to conserve existing unregulated rivers and basins.[1]

Other opponents were the Natural Resources Defense Council, an NGO supported by Robert F. Kennedy Jr., which had launched the campaign "Patagonia without Dams," and U.S. millionaire Douglas Tompkins, who owned land through which some of the electricity transmission lines would run once the power plants got online. Tompkins, an ardent conservationist who had made a fortune in the U.S. fashion brands The North Face and Esprit, had bought up the land in an effort to create a natural park. In August 2008, the Chilean government designated the park a nature sanctuary, which provided further environmental protection.[35] This, together with the fact that Tompkins vowed to stand in the way of energy companies trying to develop rivers on his land,[36] indicated that using eminent domain against him could end in a long, drawn-out legal battle. Another opponent was the bishop of the Aysén region, who supported the protests, stating that the project would "seriously violate the environment and represent an attack on the dignity of the local people and God's creation."[37] The environmental study identified 70 negative and 7 positive effects in the construction phase and 5 positive and 29 negative impacts in the operation stage (which was normally the case, as environmental studies of projects were aimed at identifying their negative impacts). The two main issues the opposition brought up were the flooding of land (which consisted of three parcels of state land and two parcels of private land) as well as the disturbance of the migration of species caused by the project.[38]

However, according to Larraín, the majority of the people in the Aysén region considered the project an opportunity for economic development, but also demanded high environmental standards. He also asserted: "The local population there tends not to support international NGOs and foreign individuals, as they see them motivated by interests driven from outside their region." The environmental authorities had already reacted to the environmental impact study by sending back 3,000 questions to Colbún and Endesa in December 2008. The partners submitted their response after the 2009 presidential elections that catapulted the pro-energy candidate Sebastian Piñera to office.[39] Nonetheless, collective activism against the project continued, with environmentalists engaging in protests and obtaining international media coverage. Their efforts led American movie producers to film a documentary in 2011, *Patagonia Rising*, which highlighted the potential negative impacts the project could have on the environment and local communities.

In April 2011, the Environmental Assessment Commission approved the HidroAysén project in an 11-to-1 vote. Massive demonstrations erupted in Santiago and in cities throughout the country, leading to thousands of arrests. Six Mapuche Native American tribes declared that that they would oppose transmission lines passing through their territories,[40] and public disapproval of the project increased to over 50%; some polls showed up to 74% disapproval.[41] Environmentalists immediately filed suit against the environmental approval. Their appeal eventually made its way to the Chilean Supreme Court in December 2011. Meanwhile, the human rights committee of the Chamber of Deputies (Chile's lower house of congress) began an investigation into whether there were irregularities and omissions in the Environmental Assessment Commission's decision.

In April 2012, the Supreme Court rejected the environmental groups' claims, giving the project the green light.[42] That same day, the president of the Chilean Senate, a prominent environmental, asserted, "HidroAysén won the battle but not the war. It should be noted that if the project becomes

[1] For more information on IRN, see Benjamin C. Esty and Aldo Sesia, "International Rivers Network and the Bujagali Dam Project (A)," HBS No. 204-083 (Boston: Harvard Business School Publishing, 2004).

reality, the transmission lines must cross 9 regions and 66 cities. No city or region is going to allow HidroAysén's [transmission lines] to cross them."[43] A week later, the Chamber of Deputies released the results of its investigation, which found irregularities in the HidroAysén approval process. The report was approved by the Chamber in a 41-to-23 vote, but this action in itself did not have any regulatory or coercive impact.

In June 2012, Colbún and Endesa decided not to file the environmental impact study for important parts of the project, including the transmission line, effectively putting the project in a standstill mode. Larraín stated,

> We felt that it was a good time to stop and analyze the project's next stage, the transmission lines, which was going to be more complex and longer than the first stage. We [Colbún] recommended to suspend the environmental impact study of the transmission lines until there was a countrywide discussion on energy policy. A project of this size and complexity cannot be developed if there is not a countrywide consensus. We are very happy to have received approval for the power plants, but for the transmission-line stage, we feel there needs to be a clear energy policy in place for Chile.

## Outlook for Colbún

Larraín knew that he would have to make important decisions for Colbún in the future. What energy mix should his company mainly rely on? How should he manage possible risks emerging from regulation, volatile oil prices, or NGO actions? What strategy should he put in place to successfully deal with both global climate change risks and local environmental challenges? How much energy should Colbún sell through long-term contracts? In addition, regarding the latest issues surrounding the HidroAysén project, how should he go about moving the project forward? Should he alter his company's business strategy in light of these events?

**Exhibit 1** Colbún Power Plants

| Power Plant | Type | Max. Capacity | In Service Since | Possible Fuel |
|---|---|---|---|---|
| Colbún | Hydro-Reservoir | 474 MW | 1985 | - |
| Machicura | Hydro-Reservoir | 95 MW | 1985 | - |
| Canutillar | Hydro-Reservoir | 172 MW | 1990 | - |
| Carena | Hydro-Run of the River | 9 MW | 1943 | |
| Los Quilos | Hydro-Run of the River | 39 MW | 1943 | |
| Blanco | Hydro-Run of the River | 60 MW | 1993 | - |
| Juncal | Hydro-Run of the River | 29 MW | 1994 | - |
| Juncalito | Hydro-Run of the River | 1 MW | 1994 | - |
| San Ignacio | Hydro-Run of the River | 37 MW | 1996 | - |
| Rucúe | Hydro-Run of the River | 178 MW | 1998 | - |
| Chacabuquito | Hydro-Run of the River | 29 MW | 2002 | - |
| Quilleco | Hydro-Run of the River | 71 MW | 2007 | - |
| Chiburgo | Hydro-Run of the River | 19 MW | 2007 | - |
| Hornitos | Hydro-Run of the River | 55 MW | 2008 | - |
| San Clemente | Hydro-Run of the River | 5 MW | 2010 | - |
| Nehuenco I | Thermal-Combined Cycle | 368 MW | 1999 | Natural gas/diesel |
| Nehuenco II | Thermal-Combined Cycle | 398 MW | 2003 | Natural gas/diesel |
| Nehuenco III | Thermal-Open Cycle | 108 MW | 2002 | Natural gas/diesel |
| Candelaria | Thermal-Open Cycle | 270 MW | 2005 | Natural gas/diesel |
| Antilhue | Thermal-Open Cycle | 103 MW | 2005 | Diesel |
| Los Pinos | Thermal-Open Cycle | 100 MW | 2009 | Diesel |
| Santa María I | Thermal | 350 MW | 2012 | Coal |

Source: Company documents.

**Exhibit 2** Colbún and the Future of Chile's Power Colbún Estimates of Costs by Generation Type

| Generation Type | Capital Cost ($ millions/MW) | Variable Cost ($/MWh) | Capacity |
|---|---|---|---|
| Coal | 2.300-2.700 | 42 | 80%–90% |
| Diesel (combined cycle turbine) | 0.750 | 160 | 80%–90% |
| Diesel (open cycle turbine) | 0.750 | 280 | 80%–90% |
| Geothermal | 3.550 | 0 | 85%–90% |
| Hydro reservoir | 2.000–4.000 | 0 | 50%–75% |
| Hydro run-of-river | 2.000–4.000 | 0 | 50%–75% |
| Liquefied natural gas | 1.000 | 120 | 80%–90% |
| Natural gas | 1.000 | 120 | 80%–90% |
| Nuclear | 4.000 | 20 | 85%–90% |
| Solar | 2.000 | 0 | 25% |
| Wind | 2.300 | 0 | 25% |

Source: Company documents.

**Exhibit 3** Colbún Historical Development of Key Indicators (US$ million)

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 LTM June |
|---|---|---|---|---|---|---|---|
| Revenues | 750 | 1,129 | 1,336 | 1,159 | 1,024 | 1,333 | 1,375 |
| EBITDA | 444 | 15 | 235 | 337 | 331 | 205 | 232 |
| Net income | 275 | (88) | 37 | 234 | 112 | 5 | 39 |
| Total power plants | 16 | 18 | 19 | 20 | 21 | 21 | 21 |
| Installed capacity (MW) | 2,370 | 2,460 | 2,515 | 2,615 | 2,620 | 2,620 | 2,620 |

Source: Company documents.

**Exhibit 4** Colbún Income Statements (US$ million)

| **Income Statements** | **FY 2010** | **FY 2011** |
|---|---|---|
| Operating revenues | 1,024.2 | 1,332.8 |
| Raw materials and consumables used | (633.4) | (1,061.4) |
| **Gross margin** | **390.9** | **271.4** |
| | | |
| Personnel expenses and other operating expenses | (59.8) | (66.7) |
| Depreciation and amortization | (124.0) | (124.6) |
| **Operating income** | **207.1** | **80.1** |
| **EBITDA** | **331.1** | **204.7** |
| Financial income | 12.9 | 8.9 |
| Financial expenses | (49.1) | (27.7) |
| Results of indexation units | 4.0 | 6.8 |
| Exchange rate differences | 17.7 | (14.2) |
| Share of profit (loss) from equity-accounted associates | 0.5 | 4.3 |
| Other non-operating income/expense | 5.7 | (28.9) |
| **Non-operating income** | **(8.3)** | **(50.9)** |
| | | |
| **Net income before tax** | **178.0** | **29.2** |
| Income tax | (64.2) | (24.0) |
| Net income from continuing operations | **92.2** | **5.2** |
| Net income attributable to stockholders of the parent company | **112.3** | **5.2** |
| | | |
| Net income attributable to minority interest | 3.6 | - |

Source: Company documents.

**Exhibit 5** Colbún Balance Sheets (US$ million)

| **Balance Statements** | | |
|---|---|---|
| | **4Q10** | **4Q11** |
| Current assets | 1,088.8 | 771.2 |
| Cash and equivalents | 554.5 | 295.8 |
| Accounts receivable | 308.4 | 214.1 |
| *Normal sales* | *132.6* | *157.0* |
| *Sales to regulated customers w/o contracts* | *104.0* | *0.4* |
| *Other receivables* | *71.8* | *56.6* |
| Recoverable taxes | 178.4 | 182.7 |
| Other current assets | 47.5 | 78.7 |
| | | |
| Non-current assets | 4,675.0 | 4,848.3 |
| Property, plant, and equipment, net | 4,431.6 | 4,594.7 |
| Other non-current assets | 243.5 | 253.6 |
| **Total assets** | **5,763.9** | **5,619.5** |
| | | |
| Current liabilities | 351.0 | 338.9 |
| Long-term liabilities | 1,936.6 | 1,818.3 |
| Shareholders' equity | 3,476.3 | 3,462.2 |
| **Total liabilities and shareholders' equity** | **5,763.9** | **5,619.5** |
| End-of-quarter exchange rate (CLP/US$) | 468.0 | 519.2 |

Source: Company document.

**Exhibit 6a** Chile Installed Capacity by Fuel Type, December 2007 and 2011 (in MW)

| | **Hydroelectric** | | **Thermoelectric** | | | | **Wind** | **Total** |
|---|---|---|---|---|---|---|---|---|
| | **Reservoir** | **Run-of-the-river** | **Coal** | **Gas** | **Oil** | **Others** | | |
| **2007** | 3736 | 1505 | 2123 | 4764 | 1002 | 17.4 | 20.2 | 13,168 |
| **2011** | 3749 | 2144 | 3175 | 4318 | 2578 | 312 | 199 | 16,475 |

Source: Comisión Nacional de Energía.

**Exhibit 6b** Chile Electricity Production by Fuel Type, 2007 and 2011 (in GWh)

| Electric System | Thermoelectric | Hydroelectric | Wind |
|---|---|---|---|
| **2007** | 33,106 | 23,627 | 39 |
| **2011** | 41,656 | 20,684 | 332 |

Source: Comisión Nacional de Energía.

**Exhibit 6c** Chile GDP Growth and GDP per Capita (US$) by Year

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| GDP growth | 6.0% | 5.6% | 4.6% | 4.7% | 3.7% | 5.2% | 6.5% |
| GDP per capita | $11,900 | $12,700 | $14,300 | $14,900 | $14,800 | $15,300 | $16,100 |

Source: CIA World Factbook.

**Exhibit 7** Amount of Carbon Dioxide Produced per MWh of Output

| Fuel Type | Tons of $CO_2$ Produced per MWh of Output |
|---|---|
| Oil | 0.73 |
| Coal | 0.92 |
| Natural gas | 0.51 |

Source: Raw data from Intergovernmental Panel on Climate Change, Climate Change 1995: Part II, page 597, converted to tons of carbon dioxide per MWh of output, assuming a conversion efficiency of 10,000 BTU of fossil fuel input per kWh of electricity.

## Endnotes

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