Forecast for electricity consumption in the copper mining industry, 2018-2029

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ABSTRACT: This study forecasts the copper mining industry’s electricity consumption in 2018-2029, it would increase from 22.6 to 31.9 TWh (~2.9% average annual growth). In this case, it is estimated that, in order to satisfy the copper mining industry’s demand, it would be necessary to add 1,336 MW in generating capacity between 2019 and 2029. The Antofagasta Region will continue to account for over half of the industry’s consumption, followed by the Atacama, Tarapacá and O’Higgins Regions. However, as from 2024, the share of the Atacama Region is expected to reach over 13% while that of the O’Higgins Region drops to 7%. The Tarapacá Region would show no significant change. The concentration is by far the most important source of expected consumption of electricity throughout the period, accounting for 58% in 2018 and 67% by 2029. The use of seawater is another process where electricity consumption is expected to show an important increase, rising from 4% of total consumption in 2018 to 10% in 2029 and emerging as the second most electricity-intensive process. The existing operations in 2018 explain practically all the copper mining industry’s expected electricity consumption but, by 2029, potential, possible and probable projects would account for close to a quarter of its consumption. The new projects will acquire growing importance, accounting for 56% of expected consumption by 2029, up from 19% in 2018.

1 INTRODUCTION
Electricity is a strategic input for the copper mining industry since it is required in its different production processes as well as the services it requires. According to estimates by COCHILCO as of December 2017, it accounts for around 8% of the operating costs (including depreciation) of the country’s large-scale mining industry. The industry also has a significant impact on the country’s electricity consumption of which, on average over the past 15 years, it has accounted for a third. This situation is largely explained by three broad trends that have meant a rise in the industry’s consumption: i) A progressive decline in ore grades as mines have aged, with the mineral also becoming harder. As a result, companies have to extract large and growing volumes of mineral in order to maintain their expected fine copper production levels which, in turn, means an increase in electricity consumption in processes such as crushing and milling; ii) The growing use of seawater in response to restrictions on supply of water from other sources as well as the growing preponderance of production of concentrate, which is water-intensive. Because seawater must be pumped up to the mines over a longer distance, this increases demand for electricity; iii) Focus on concentrate production, a process that is electricity-intensive. This is also expected to be a factor in higher demand for electricity over the coming years.

Taking into account these trends, COCHILCO has estimated the copper mining industry’s electricity consumption through to 2029, the year when a large part of the current portfolio of projects could be in operation. The results for 2018-2029 are presented as follows: i) Expected electricity consumption by type of project, classified as New, Expansion, Replacement or in Operation; ii) Expected electricity consumption by process, classified as Concentration, Leaching, Smelting, Refining, Seawater Treatment and Pumping, Open-Pit Mining, Underground Mining or Services.

In each case, the results are analyzed at the national level and by region and forecasts are shown as maximum and minimum levels as well as expected values.

1.1 Methodology
The methodology used to forecast the Chilean copper mining industry’s electricity consumption comprises four stages: (i) update of the forecast for copper production, both in terms of concentrate and fine copper, during the forecasting period; (ii) calculation of unit electricity consumption by process and mining company; (iii) calculation of the probability that copper production will reach its forecast level, distinguishing between a maximum, a most
probable and a minimum scenario; and (iv) modeling of expected electricity consumption in the forecasting period.

In the case of copper production, the survey of projects which COCHILCO carries out each year was used, with updated information about operations and projects through to 2029 (Cifuentes, 2018) in order to forecast output in the form of concentrate and SX-EW cathodes and at smelters and refineries. Since 1991, COCHILCO has calculated the coefficients of unit electricity consumption by operation and process per metric ton of mineral treated and per metric ton of fine copper produced, based on operational data provided by the country’s mining companies. With this information (Brantes, 2018), the coefficients for 2018-2029 were forecast deterministically, using a log-normal regression based on unit consumption in 2001-2017.

It should be noted that calculation of the coefficients involves two assumptions: i)Unit electricity consumption by process increases over time, due principally to the aging of mines and a decline in ore grades ii)No technological changes that significantly affect mining processes would occur. In other words, the forecast does not consider possible gains in energy efficiency and, therefore, reductions in electricity consumption that could occur either at existing operations or in new projects.

The probability of copper output reaching its forecast level was calculated using historical information about the materialization of projects, identifying three electricity consumption scenarios: maximum, minimum and most probable level. Finally, these scenarios were subjected to the Monte Carlo model and thus estimating, the expected consumption of electricity of each operation and process.

It should also be noted that, as from 2011, unit electricity coefficients in Services incorporate electricity consumption related to the use of seawater. Forecasts for this item, which is reported separately here, are, therefore, based on estimated coefficients for 2001-2010 in order to avoid including it twice. For desalination and pumping processes, the methodology described in COCHILCO’s report “Forecast for Water Consumption in the Copper Mining Industry, 2018-2029” (Montes, 2018) is used to calculate electricity load and consumption.

2 NATIONAL ELECTRICITY SYSTEM

In 2017-2018, work was carried out to join the country’s two main energy systems - the Northern Interconnected System (SING) and the Central Interconnected System (SIC) - and create the National Electricity System (SEN), which will stretch 3,100 km from the city of Arica in the north to the Island of Chiloé in the south, covering almost all the country. This system comprises power plants, transmission lines, substations and distribution systems, which are interconnected with each other, permitting the generation, transmission and distribution of electricity from sources with an installed capacity of 200 MW or more. The system will be managed by a single coordinating body, the National Electricity Coordinator.

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
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<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
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<tr>
<td>Open-pit mining KWh/FMT Cu</td>
<td>185.2</td>
<td>186.2</td>
<td>187.1</td>
<td>187.9</td>
<td>188.8</td>
<td>189.6</td>
<td>190.3</td>
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<td>193.7</td>
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<td>Underground mining KWh/FMT Cu</td>
<td>631.4</td>
<td>638.0</td>
<td>644.2</td>
<td>650.2</td>
<td>655.8</td>
<td>661.3</td>
<td>666.4</td>
<td>671.4</td>
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<td>680.8</td>
<td>685.2</td>
<td>689.5</td>
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<tr>
<td>Concentration KWh/MTconc. proc.</td>
<td>22.2</td>
<td>22.2</td>
<td>22.3</td>
<td>22.4</td>
<td>22.4</td>
<td>22.5</td>
<td>22.6</td>
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<td>22.7</td>
<td>22.7</td>
<td>22.8</td>
<td>22.8</td>
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<td>Smelting KWh/MTconc. proc.</td>
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<td>327.4</td>
<td>327.3</td>
<td>327.2</td>
<td>327.1</td>
<td>327.0</td>
<td>327.0</td>
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<td>326.8</td>
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</tr>
<tr>
<td>Refining KWh/FMT Cu</td>
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<td>366.7</td>
<td>367.2</td>
<td>367.7</td>
<td>368.2</td>
<td>368.6</td>
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<td>369.5</td>
<td>369.9</td>
<td>370.3</td>
<td>370.6</td>
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<tr>
<td>LX/SX/EW KWh/FMT Cu</td>
<td>3205.3</td>
<td>3217.8</td>
<td>3229.6</td>
<td>3240.9</td>
<td>3251.6</td>
<td>3261.9</td>
<td>3271.7</td>
<td>3281.1</td>
<td>3290.2</td>
<td>3298.9</td>
<td>3307.3</td>
<td>3315.4</td>
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<tr>
<td>Services KWh/FMT Cu</td>
<td>163.7</td>
<td>164.2</td>
<td>164.7</td>
<td>165.1</td>
<td>165.5</td>
<td>165.9</td>
<td>166.2</td>
<td>166.6</td>
<td>166.9</td>
<td>167.2</td>
<td>167.5</td>
<td>167.8</td>
</tr>
</tbody>
</table>
As regards the expansion of local generation and/or transmission capacity, a series of projects to optimize the SEN’s operation are designed to make it possible to expand current capacities and reduce electricity prices. These include, importantly, the interconnection of the SIC and the SING through the Mejillones-Cardones transmission line (with a length of 600 km) and the construction of the Cardones-Polpaico line (784 km), which is nearing completion. At the date of publication of this report, management of the SEN was in the process of transition to the new National Electricity Coordinator, which was working with the boards and senior management of the Economic Load Dispatch Center (CDEC) of the SING and the CDEC of the SIC on technical, legal and human resources aspects of the integration. The full impact of this interconnection will be seen when the Cardones-Polpaico line is fully operational, which should occur in February 2019 (Source: ISA InterChile S.A., the company responsible for building the line).

Once the interconnected system is fully operational, it will not only permit optimization of the use of the generating capacity already available but will also open the way to greater use of Non-Conventional Renewable Energies (NCRE) such as wind, solar and geothermal sources, which have great potential in northern Chile, but dissimilar characteristics in terms of their generation pattern. Indeed, as Eduardo Andrade of Cigré Chile warns, although the electricity generated from geothermal sources is comparable to that produced by coal or gas power plants, production at photovoltaic or wind plants depends on the variations inherent to nature, implying uncertainty about supply.

As a result, given that electricity supply must be stable and secure for consumers, the incorporation of NCRE into the electricity matrix depends significantly on the capacity of the system as a whole to compensate for the natural variations in energy of this type. This calls for conventional power plants that can step in quickly in response to changes in NCRE production. Hydroelectric plants (which currently account for most of the SIC’s capacity) are best suited to this purpose since they can load very quickly whilst coal and gas plants (which account for most of the SING’s capacity), when they are generating, mostly lack the capacity to take on large additional loads or cannot do so with the necessary speed. The integration of the SIC and the SING will, therefore, permit coordination of the generating capacity that is already available as well as encouraging the development of NCRE sources.

In addition, a new Electricity Transmission Law came into force in 2016, increasing competition in this market by fostering the entry of new players as well as the development and incorporation of NCRE sources. The positive results of this new legal framework have been reflected in lower average electricity prices for households as well as a sharp increase in the award of contracts to NCRE projects in the tenders that took place in 2016 and 2017. For mining companies, which have long-term contracts with their power suppliers, the impact has not been immediate but their electricity costs are expected to drop gradually over the coming years.

3 FORECAST FOR ELECTRICITY CONSUMPTION, 2018-2029

It should be noted that, in line with the integration of the country’s two main electricity systems described above, this report refers in what follows to a single national system in which mining companies will be able to use electricity from different sources and parts of the country.

This section sets out the overall result of the forecasts for electricity consumption in the copper mining industry in 2018-2029. As explained in Methodology, maximum and minimum scenarios are also presented along with expected consumption.

Figure 1 shows expected future electricity consumption as well as its maximum and minimum levels for each year in the forecasting period. Over the whole period, expected consumption would increase from 22.6 TWh to 29.2 TWh (equivalent to ~2.9% average annual growth). However, its growth not uniform, with consumption increasing relatively quickly through to 2020, when it would reach 26.5 TWh (~8.3% average annual growth), after which growth would moderate through to 2024 (~3.8%) and then stabilize over the rest of the period (~0.7%).

As shown in Figure 1, in the expected case which takes into account uncertainties about the development of projects, electricity consumption would grow by 41.2%, equivalent to an average annual rate of 2.9%, in 2018-2029. In the maximum scenario, consumption would grow by 49.8%, at an average annual rate of 3.4%, while, in the minimum scenario, it would grow by 32.7%, equivalent to an average annual rate of 2.4%.
If the forecasting period is divided into three-year intervals (Table 2), it can be seen that the strongest growth in consumption would occur in the early years of the forecasting period. This is partly explained by less uncertainty regarding the implementation of projects. For the first three years, the growth of expected consumption reaches 17.3%, before dropping to 4.7% in the next three years. In all scenarios, growth is lowest in the third three-year period, due principally to lower production at existing operations and at the new projects to be developed.

Table 2. Three-yearly variation (%) in electricity consumption and mine copper production in Chile, 2018-2029.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Variable</th>
<th>18-20</th>
<th>21-23</th>
<th>24-26</th>
<th>27-29</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>Electricity consumption</td>
<td>19.6</td>
<td>13.4</td>
<td>2.3</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>Mine copper production</td>
<td>14.6</td>
<td>10.5</td>
<td>0.5</td>
<td>-2.0</td>
</tr>
<tr>
<td>Expected</td>
<td>Electricity consumption</td>
<td>17.3</td>
<td>10.4</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Mine copper production</td>
<td>13.9</td>
<td>8.1</td>
<td>-0.5</td>
<td>-1.7</td>
</tr>
<tr>
<td>Minimum</td>
<td>Electricity consumption</td>
<td>18.4</td>
<td>9.2</td>
<td>-0.2</td>
<td>-1.4</td>
</tr>
<tr>
<td></td>
<td>Mine copper production</td>
<td>13.7</td>
<td>6.9</td>
<td>-1.9</td>
<td>-3.2</td>
</tr>
</tbody>
</table>

In all three-year periods and all scenarios, electricity consumption grows ahead of mine copper production, a situation that is explained principally by declining ore grades and the increasing use of seawater in mining operations. It is important to note that these forecasts do not consider possible gains in energy efficiency, which could attenuate the forecast growth of electricity consumption. This factor, which will be addressed in future studies, requires in-depth analysis, taking into account, for example, the fact that adjustments and/or important technological changes in order to optimize energy consumption are more difficult for projects already in operation than for new projects, which will have a greater opportunity to apply energy efficiency concepts from the very beginning. However, it is also important to bear in mind that the low level of professionalization of the energy efficiency sector in Chile means that it is not equipped to offer integral support to the mining industry and there are gaps in the training offered by the country’s universities, technical training centers and professional training institutes, among others.

Finally, if last year’s forecasts for electricity consumption in the mining industry and copper production are compared with those presented in this report, it can be seen that this year’s forecasts are higher. This is a result of factors that include an extension of the useful life of many operations as compared to that reported last year, implying an increase in the long-term volumes of production of operations that are currently active. Many projects have also changed condition and, therefore, their weighting, with a positive impact on their production profile. For example, the Rajo Inca, Quebrada Blanca and Mantoverde Development projects moved from potential to probable while Spence moved from probable to base. In addition, a number of small projects have been incorporated into this year’s forecasts and would slightly increase output, particularly of SX-EW cathodes. They include the Delirio project (between 2019 and 2024) and the reopening of Michilla, which is now owned by Haldeman.

3.1 Forecast for demand for electricity load

Figure 2 shows the forecast for accumulated demand for the electricity load required to satisfy expected electricity consumption in copper mining in 2019-2029. The annual increase is expected to be most significant in 2020 when it would reach 45%. In general, demand for electricity will grow through to 2028 and would then drop by 1% in 2029.

Overall, it is estimated that the national electricity system would need to expand 4.3-fold between 2019 and 2029. This would imply the incorporation of an additional 1,366 MW of capacity.
3.2 Forecast by region

Figure 3 shows the mining industry’s electricity consumption in 2018-2029 by region, indicating that no major changes are anticipated. The three regions most intensive in electricity use by the mining industry in 2018 are the Antofagasta, Atacama and O’Higgins Regions. The Antofagasta Region accounts for most of the country’s copper production and is, therefore, also the region where the industry has the highest electricity consumption. In 2018, it consumed 12.3 TWh, representing 54.3% of the industry’s total demand, a figure that is not expected to show any great change during the forecasting period. It is followed by the Atacama Region with 2.4 TWh (10.7%), the Tarapacá Region with 2.1 TWh (9.0%) and the O’Higgins Region with 2.0 TWh (8.9%).

As from 2024, the Atacama Region is expected to account for just over 13% of total demand, with consumption reaching 4.4 TWh (13.7%) in 2029. Similarly, the share of the Tarapacá Region would increase slightly to 10.5% in 2029, when its consumption would reach 3.3 TWh. By contrast, the share of the O’Higgins Region would drop slightly to 6.8%, with a consumption of 2.2 TWh in 2029.

In the case of the minimum and maximum scenarios, the pattern of behavior of expected electricity consumption is basically the same as for expected consumption. In both cases, demand would be led by the Antofagasta and Atacama Region.

4 ANALYSIS OF EXPECTED ELECTRICITY CONSUMPTION BY CONDITIONALITY OF PROJECTS

As discussed above in the methodology section, electricity consumption can be forecast with the greatest certainty for current operations and projects already under construction while the future electricity consumption of projects that have not yet taken the decision to build becomes increasingly uncertain as the forecasting period progresses, reflecting the risk of implementation delays and of differences between planned and actual production. This section, therefore, analyzes the expected electricity consumption of copper mining projects according to the conditionality of their implementation.

4.1 Analysis at the national level

Given the methodology used in this study and the increasing level of uncertainty over time, the relevance of projects that have not yet taken the decision to build increases as the forecasting period progresses. As shown in Figure 4, existing operations and projects under construction (base projects) account for practically all the industry’s forecast electricity consumption in 2018 while probable, possible and potential projects gradually acquire relevance until accounting for a quarter of total expected consumption by 2029.

In general, the expected electricity consumption of base operations varies little over the course of the forecasting period when it would grow by only 4.3%. This base consumption shows some growth through to 2022, with an average annual increase of 6.2% to reach 25.5 TWh. As from 2023, however, its growth would slow gradually, dropping at an average annual
1.1%, with expected consumption reaching 23.6 TWh in 2029. This decline is explained by the end of operations and/or expected reductions in production, principally in the hydrometallurgy line (such as BHP’s Cerro Colorado and Spence operations, Mantos Copper’s Mantos Blanco, Teck’s Quebrada Blanca and Freeport McMorRan’s El Abra) as well as at the Chuquicamata open pit in the concentrates line.

In the medium and longer term, as from 2022, demand would grow as a result of the start-up of probable, possible and potential projects, which become more relevant, with an average annual growth rate of 16.1%. These projects will demand an increasing amount of electricity, reaching an expected consumption of 8.2 TWh in 2029 when they would account for 25.9% of total expected consumption. The main probable, possible and potential projects include BHP’s Los Colorados Extension, KGHM International’s Sierra Gorda 230 ktpd Expansion, Mantos Copper’s Mantos Blancos Debottlenecking, Antofagasta Minerals’s Centinela District, Capstone Mining’s Santo Domingo, Codelco’s Rajo Inca, Teck and GoldCorp’s NuevaUnión Phase I and Lundin Mining’s Candelaria 2030.

Since probable, possible and potential projects are under study, they must soon take a decision about the type of contract for their electricity supply. A key issue will, therefore, be the active role of new supply from generation projects being developed in the SEN where NCREs will be increasingly important.

5 ANALYSIS OF EXPECTED ELECTRICITY CONSUMPTION BY TYPE OF PROJECT

This section analyzes the distribution of expected electricity consumption among current operations and projects according to their type or, in other words, the purpose for which they are undertaken. Some are replacement projects, designed to recover an operation’s production capacity in the face of the deterioration of its mineral base, and others are expansion projects that seek to maintain an operation’s competitiveness by increasing its scale of production while others are new projects whose development starts practically from zero.

5.1 Analysis at the national level

Figure 5 show the expected electricity consumption of Chile’s copper mining industry by operation and type of project. It can be seen that the consumption of current operations will decrease over time while expansion, replacement and, particularly, new projects begin to acquire increasing importance over the course of the forecasting period.

At 18.3 TWh, the consumption of current operations accounted for 80.8% of total consumption in 2018 but decreases at an annual rate of 3.8% in the period analyzed to reach 14.0 TWh in 2029 when it would represent 43.9% of total consumption.

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At 18.3 TWh, the consumption of current operations accounted for 80.8% of total consumption in 2018 but decreases at an annual rate of 3.8% in the period analyzed to reach 14.0 TWh in 2029 when it would represent 43.9% of total consumption.
New projects are expected to account for 29.2% of expected consumption by 2029 (9.3 TWh), up from 8.0% (1.8 TWH) in 2019. It is worth noting the strategic importance of new projects, which are the most relevant in terms of energy consumption, after those that are already in operation. It is these new projects that will face the greatest degree of uncertainty in their development, due to possible complexities in their construction and the need to obtain the necessary permits.

It is also important to point out that these projects will have the greatest opportunity to use sustainable energy, both by incorporating NCRE directly in their mining processes and/or in terms of energy efficiency. In these projects, energy innovation is cheaper and more feasible than in projects that are already in operation or have already taken design and construction decisions. This could enable them to reduce future production costs by, for example, applying new technologies, improving processes and/or taking energy efficiency into account in the decision-making process from the very beginning as a means of protecting the environment and increasing productivity (obtaining more products at a lower cost).

6 ANALYSIS OF EXPECTED ELECTRICITY CONSUMPTION BY PROCESS

For the purposes of analysis of electricity consumption, COCHILCO divides copper mining into eight electricity-intensive processes: 1. Underground mining: drilling, blasting, loading, transport, primary crushing, ventilation, other 2. Open-pit mining: drilling, blasting, loading, transport, primary crushing, other 3. Leaching (LX-SX-EW): agglomeration, Heap-Rom leaching, solvent extraction, electro-winning, other 4. Concentration: crushing plants, traditional grinding, S.A.G grinding, flotation, tailings treatment plant, water recirculation, filters, other 5. Smelting: drying, flash furnace, noranda furnace, pierce smith converters, Teniente converters, refining and molding, slag furnaces, oxygen plant, electric furnace, air and steam plant, gas collection, sulfuric acid plant, smelting dust plant, other 6. Refining: electorefining, others 7. Use of seawater: desalination and/or pumping and 8. Services: general services, campaments, workshops, other. Since they each use different amounts of energy, it is useful to disaggregate them in order to understand their future evolution.

As mentioned in the methodology section, expected consumption is based on two assumptions: first, that there will be no disruptive technological changes that significantly affect mining processes and, second, that unit electricity consumption in processes increases over time, due mainly to the aging of the mines and lower ore grades.

6.1 Distribution of expected electricity consumption at the national level by process

Figure 6 shows expected electricity consumption by process at the national level.

![Figure 6: Expected electricity consumption in copper mining at the national level by process, 2018-2029](image)

For 2018, electricity consumption is estimated to have been highest in concentration where it reached 13.1 TWh, accounting for 57.8% of the energy demanded. This trend will become more marked, with consumption reaching 21.2 TWh (66.6%) in 2029. This reflects the emphasis of many expansion and greenfield projects on the production of copper concentrate as well as the decline in ore grades, which implies that a larger amount of mineral has to be processed.

This is, in turn, largely explained by expected concentrate production at Codelco’s Chuquicamata mine as well as the start-up of a series of new projects, including BHP’s Los Colorado’s Extension and Spence Growth
have, in addition, been capacity adjustments or other changes as, for example, at Codelco’s El Teniente mine, where the Converter is being closed and the Flash Oven will be used for drying, and new installations such as those at the Caletones smelter where slag will be treated using flotation. As from next year, it will, therefore, be necessary to analyze these changes in energy patterns in more detail, looking at whether all smelters’ new installations for compliance with the Emissions Standard are in operation, so as to be able to incorporate these new variables in future forecasts of their energy consumption.

Finally, underground mining, refining and services will continue to make a relatively marginal contribution to energy consumption, with none of these processes accounting for more than 2% of expected consumption at any point in the forecasting period.

One process that has and will continue to gain importance in electricity consumption is the use of seawater by mining operations in northern Chile and the resulting process of desalination and, particularly, the pumping of the desalinated water up to mine sites. This is a response to the increase in concentration operations, a process that is highly intensive in the use of water, a resource that is particularly scarce in the Antofagasta and Atacama Regions. In its study “Forecast for Water Consumption in the Copper Mining Industry, 2018-2029”, COCHILCO estimated that seawater consumption will grow by 230% between 2018 and 2029, from an estimated 3.28 m3/sec to 10.82 m3/sec. The increase would be led by the Antofagasta Region, particularly between 2019 and 2024 when a number of new desalination projects are expected to be implemented or existing plants expanded. They include the Escondida EWS plant (inaugurated in early 2018), Codelco’s North District Desalination Plant, the expansion of the pipelines for Antofagasta Minerals’ Centinela District, the use of seawater for the expansion of Sierra Gorda by KGHM and the gradual start-up of the Dominga iron project as from 2020. As from 2023, the use of seawater is also expected to show an important increase in the Atacama Region, led by Capstone Mining’s Santo Domingo project, Goldcorp and Teck’s Nueva Unión project and the medium-scale Productora project of Australia’s Hot Chili, adding to the desalination plants that already exist in the region such as those of Lundin Mining and Mantos Copper.
As a result, electricity consumption related to the use of seawater is estimated to increase from 0.8 TWh (3.6%) in 2018 to 3.1 TWh (9.6%) in 2029 when it would be the second most electricity-intensive process after concentration.

7 CONCLUSION

Copper mining has been and is key for Chile’s economic growth. However, the mining industry faces a series of important structural challenges that range from aging mines to increased social expectations as to its environmental performance. The industry is already energy-intensive and forecasts suggest that, over the next 11 years, its demand for energy will increase by 41%, due mainly to: i) Growth of expected production of copper concentrate. In 2018, the concentration process already accounted for more than half of expected demand for electricity and, by 2029, is forecast to account for 67%. This is explained by an increase in production of concentrate, an energy-intensive process, as well as by lower production of copper cathodes, due both to the closure of hydrometallurgical operations during the next decade and the depletion of leachable resources. As a result, leaching would account for only 7.5% of forecast electricity consumption by 2029, down from 20% in 2018; ii) Increased demand for electricity for seawater desalination and/or pumping to mine sites (located at high altitude and far from the coast). This would increase from 4% of total consumption in 2018 to 10% in 2029, making it the industry’s second most electricity-intensive process. This is a result principally of the increase in concentration operations, a process that is extremely intensive in water, a resource that is particularly scarce in Antofagasta and Atacama Regions where a series of new desalination projects are located, implying increased electricity consumption for the plants and, above all, to pump the water to the mine sites; iii) Aging of mines (a structural issue involving transporting the mineral over longer distances, harder mineral and a drop in ore grades).

In the case of the distribution of expected electricity consumption by region, no major changes are anticipated. The regions that are currently most intensive in consumption by the mining industry are the Antofagasta Region, which accounts for most of the country’s copper production and is, therefore, also where the industry consumes most electricity (58% of total industry consumption). It is followed by the Atacama Region (11%), the Tarapacá Region (9%) and the O’Higgins Region (9%). In 2029, the Antofagasta Region will continue to lead consumption, while the Atacama and Tarapacá Regions will see a small increase in their share to 14% and 11%, respectively, and the O’Higgins Region will see a small drop to 7%.

In recent years, Chile’s copper industry has had to grapple with numerous difficulties in satisfying its energy needs. In addition to dependence on imported fuels such as coal, oil and gas to generate electricity, it faces, as mentioned above, the progressive aging of its main mines, which in itself implies higher energy consumption. Moreover, the future development of new projects will further increase demand.

The capacity of supply to respond efficiently has not measured up to the industry’s expectations and different industry analysts identify the electricity matrix as a “bottleneck” for its development. This problem can be summarized as entailing two key challenges: first, to ensure the supply required for production and, second, to contain costs so as to increase the profitability of projects and be competitive in the market.

In this context, both the state and private agents have achieved significant progress. The National Electricity System (SEN), which will cover almost the entire country, will, once fully operational (expected to occur in 2019), not only lower electricity costs but also optimize use of the generation resources already available and allow more advantage to be taken of Non-Conventional Renewable Energies (NCRE) such as wind, solar and geothermal sources. These have great potential in the north of the country, but are dissimilar in their generation pattern, implying that greater hydroelectric capacity (from central and southern Chile, which was previously served by the SIC) will be needed to offset the variations in output that are inherent to solar and wind energy.

In terms of the forecasts presented here as compared to last year’s forecasts, the main change is that the copper mining industry’s estimated consumption has increased. This is basically because estimated copper production has also increased for reasons that include an extension of the useful life of many operations as compared to previous forecasts, with the resulting increase in the long-term volume of production of existing operations, and a change
in the condition of many projects, resulting in weightings that have a positive impact on their production profile.

8 REFERENCES

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