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# Lithium: Changes in the industry and uncertainty regarding its industrialization in Bolivia

The Center of Studies for Labor and Agrarian Development (CEDLA) presented in its 2014 study "A present without a future: the lithium industrialization project in Bolivia" one of the most complete analysis regarding the implementation of the project —a key industrialization proposal of the current MAS administration and one of its biggest investments— thus shedding light on its many shortcomings and possible impacts at the economic, political, environmental, social and cultural levels.

On that occasion, some government officials questioned and dismissed our findings, but failed to properly address them in a debate, which was the main goal of the publication. Now, four years after, in a scenario where the lithium market has experienced a rapid growth and undergone many changes, and the results of the Lithium Industrialization Project have not lived up to the expectations generated by the government, an update of the state of affairs and the advances of the project is very much needed.

The task of updating the contents of the aforementioned study has been entrusted to Pablo Poveda Ávila, a CEDLA researcher who took part in the first study and is well versed in extractive industries-related issues, with the advantage of having a deep understanding of how they operate in the Bolivian context.

The aims of this work are: firstly, to provide information capable of complementing what is said by official sources, offering a more balanced and nuanced picture to the public. And, secondly, to engage institutions, social and civil organizations and the public in general in the debate about the industrialization project, so that they are able to discuss how this is being conducted by the government, make informed demands in the best interest of communities, regions and society, and even take part in the decision-making processes.

Since we understand that lithium is of strategic importance to our country, we, as an institution committed to generating knowledge and fostering critical thinking, insist on the importance of addressing this subject in an environment of transparency and full availability and access to reliable information.

*Javier Gómez Aguilar*
*Executive Director*
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CUADERNOS DE COYUNTURA

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## 1. INTRODUCTION

The current report is an update of the study "A Present without a Future: the Lithium Industrialization Project in Bolivia", which was carried out by the Center of Studies for Labor and Agrarian Development (CEDLA by its acronym in Spanish) throughout 2013 and published in May of 2014. The study focused mainly on the characteristics of the state-run project for the industrialization of lithium and potassium in Bolivia, and on its possible impacts —economic, political, social, cultural and environmental— on the region adjoining the Uyuni Salt Flats.

This document consists of two parts. The first deals with the evolution of the international lithium market, which has registered very important changes in the past years, and stresses the strategic role this metal plays in the technological development of capitalism in the realm of energy. The second addresses how the lithium industrialization project is developing in Bolivia.

The information provided by this document has been analyzed within a framework of political economy analysis, which allows for a proper understanding of the workings behind the technological revolution that aims to substitute fossil fuels with clean and renewable technologies —in which lithium is set to play a significant role— and that is already challenging the until recently undisputed dominance of gas and oil. From this stance, capitalism is looking for a new opportunity to further its accumulation processes.

## 2. INTERNATIONAL CONTEXT

### 2.1. THE PLACE OF LITHIUM WITHIN CAPITALIST PRODUCTION

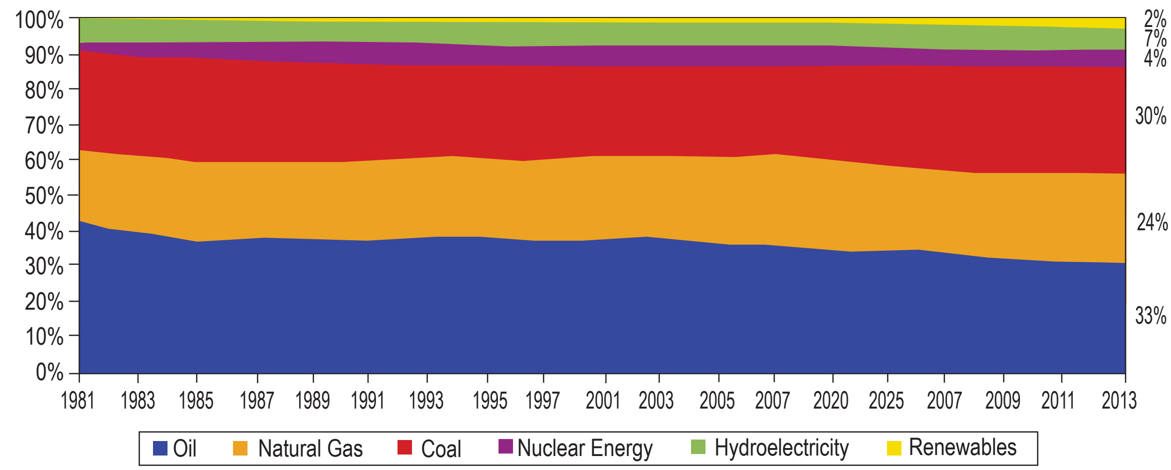
Mechanized production is the specific form of capitalist production because it allows the ever-increasing extraction of relative surplus value out of labor power through the reduction of the necessary labor time (wages), regardless of the limits of the working day.

> *All fully developed machinery consists of three essentially different parts: the motor mechanism, the transmitting mechanism, and finally the tool or working machine. The motor mechanism is that which puts the whole in motion. It either generates its own motive power, like the steam-engine, the caloric engine, the electromagnetic machine, etc. or it receives its impulse from some already existing natural force, like the water-wheel from a head of water, the wind-mill from wind, etc. The transmitting mechanism, composed of fly-wheels, shafting, toothed wheels, pullies, straps, ropes, bands, pinions, and gearing of the most varied kinds, regulates the motion, changes its form where necessary, as for instance, from linear to circular, and divides and distributes it among the working machines. These two first parts of the whole mechanism are there, solely for putting the working machines in motion, by means of which motion the subject of labor is seized upon and modified as desire.* (Marx, 1990 Vol. I: 453, 454)[1]

Basically, there are two types of engines: fuel-powered engines, mainly utilized in the automotive transport industry, and electric-powered engines. The technological development based on lithium batteries aims to substitute fuel-powered engines with electric-powered ones. The outstanding qualities of lithium for energy storage have already been exploited in the batteries of small and medium-sized electronic devices such as smartphones, photographic cameras, music players, computers, etc.

1 TN: the translated quote here shown was directly taken from Cosimo Inc.'s 2007 English version of Marx's Das Kapital [Marx, (2007); Vol. I: 407; Cosimo, Inc.]

Figure 1: Global Energy Consumption 1981- 2014*




Note: Renewables include wind, geothermal and solar energies plus biomass and waste-based fuels.
* Based on million tons of oil equivalent
Source: CEDLA's compilation based on British Petroleum, 2015

And so, the aim of this technological revolution —aside from securing extraordinary revenues to producing companies— is to settle the widespread use of electrical energy in machine engines, thus phasing out the use of the highly polluting fossil fuels and instead ushering in so-called clean and renewable technologies.[2]

Having said that,

*Electricity is produced as primary as well as secondary energy. Primary electricity is obtained from natural sources, such as hydro, wind, solar and tide and wave power. Secondary electricity is produced from heat of nuclear fission of nuclear fuels, from the geothermal heat and solar thermal heat and by burning primary combustible fuels such as coal, natural gas, oil and renewables and wastes.* (IEA, 2007:41)[3]

The historical evolution of global energy consumption shows that during the period 1981-2014 secondary sources stood at 90%, and that the growth of primary sources like hydro, wind, solar, etc. was rather scarce. Figure 1 shows that in 2014, 91% of energy consumption was based on secondary sources.

The problem with electrical energy lies in the difficulty of storing it at a large scale, which is why it must be consumed immediately after it has been generated. Currently, there are many projects developing this kind of technology, albeit still only experimentally.[4] Within the realm of energy storage technology development, the enormous potential of lithium batteries has yet to be tapped.

Nevertheless, lithium batteries are not alone in the race to take over the energy storage market. There are other strong contenders, such as graphene super-capacitors, inertia flywheels, as well as other kinds of batteries, that could limit the potential growth of demand. On the other hand, the oil industry —also in control of some other fossil fuels— is also competing against this sector, which is still in the early stages of development and is crucial to increasing labor productivity and, consequently, capitalist profits.

Therefore, technological development in capitalist production subordinates directly to competition and profit-making. In the case of the energy industry, in a context of high monopolistic concentration, this kind of behavior prevails at the expense of: increased productivity of the capitalist industry, widespread consumption at lower prices, environmental impact reduction, and sovereignty over national resources, i.e. when countries have no other choice than the adoption of foreign technologies, or the handing over of their natural resources for others to exploit.

## 2.2 INCREASED DEMAND FOR LITHIUM IN THE BATTERY INDUSTRY

Lithium carbonate[5] demand between the years

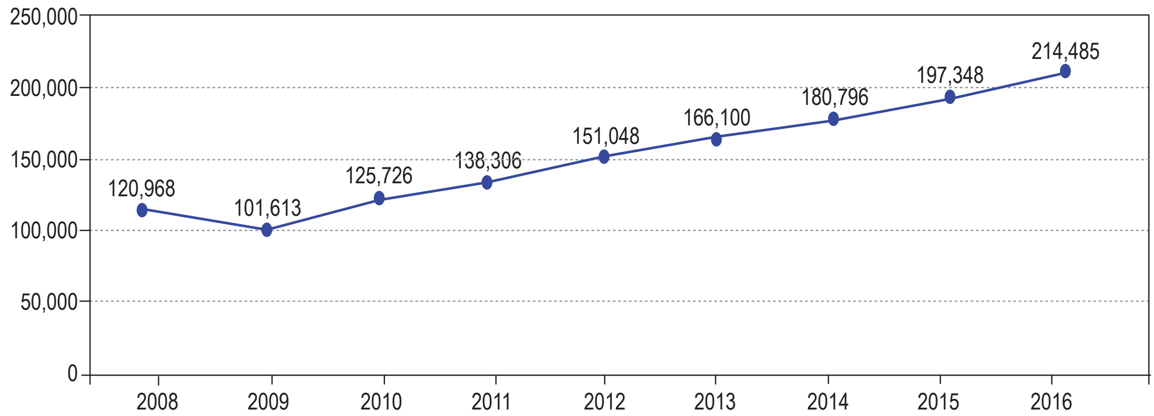
2 It is worth-noticing that the use of electrical energy does not imply by itself the use of clean and renewable technologies; fossil fuels can also generate this type of energy.

3 TN: the translated quote here shown was directly taken from IEA's English version, January 2005: 39

4 Tesla has plans to build the world's largest lithium ion battery in Australia; the 129 MWh (100 MW) battery will store energy generated at Neoen's Horsdale wind farm in South Australia, thus securing electricity supply in the region. (Business Insider, 2017)

5 Today "lithium carbonate is the most important lithium compound, and is also the starting material for most of the other lithium salts." Büchel, 2000: 214

Figure 2: Lithium carbonate demand 2008-2016 (In metric tons)



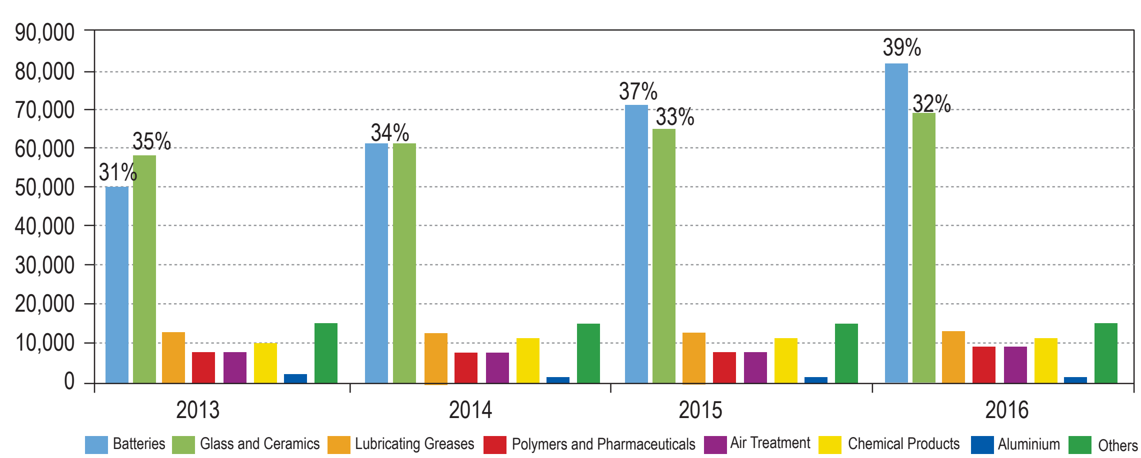

Note: The projected 2025 lithium demand can be seen in Annexes, Chart 1
Source: CEDLA's compilation based on Stormcrow, 2017 and CEDLA, 2014

2008 and 2016 has increased by 77%, amounting to 214,485 metric tons, as shown in Figure 2.

Although lithium carbonate has many industrial uses, its most important applications are in the manufacture of glass and ceramics, and in lithium ion batteries (electrical energy storage). Both products have increased their share of lithium carbonate demand from a joint percentage of 66% in 2013 to 71% in 2016; however, at higher growth rates, batteries have become, from 2015 onwards, the main driver of lithium demand. (See Figure 3)

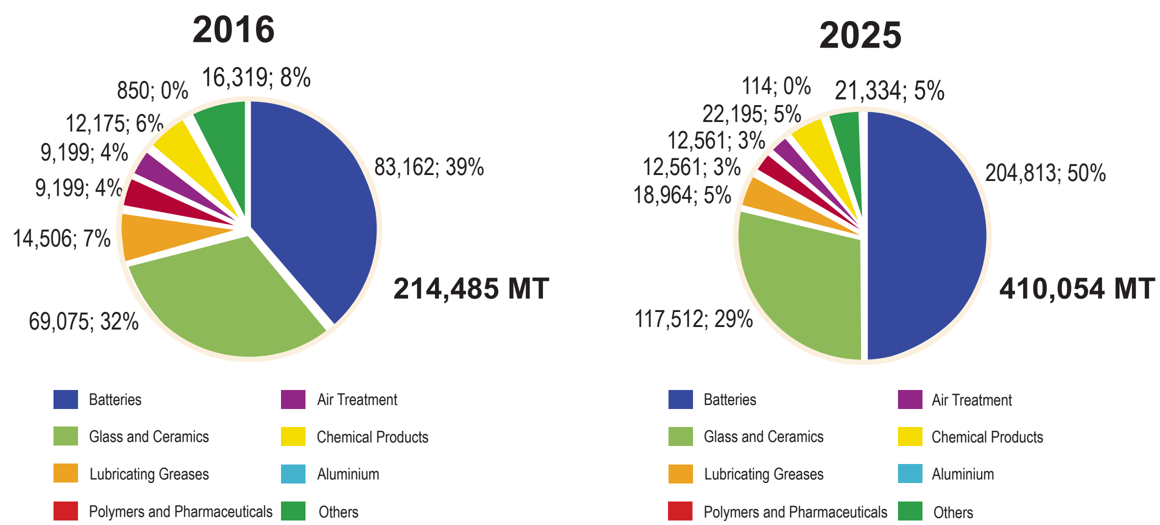
The projections for 2025 estimate that beginning in 2016 lithium carbonate demand will increase by 91%, amounting to 410,054 metric tons. In this scenario batteries already represent 50% of total demand, thus pushing into the background the relative share of glass

Figure 3: Lithium carbonate demand by application 2013-2016 (In metric tons)




Source: CEDLA's compilation based on Stormcrow, 2017

Figure 4: Litihum carbonate demand by application 2016 and projection for 2025



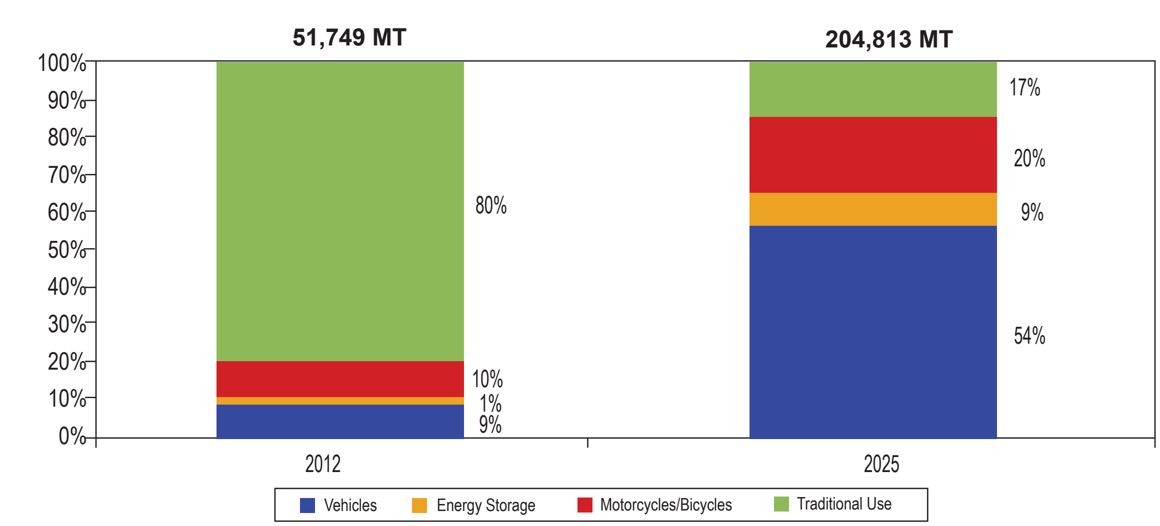

Source: CEDLA's compilation based on Stormcrow 2017

and ceramics, which remains at about 30% in spite of its absolute growth rate. (See Figure 4)

The demand for lithium carbonate for batteries involves at least three subsectors. *i)* Traditional use in small and medium-sized electronic devices such as smartphones, computers, etc. In 2012 this subsector represented 80% of total demand; by 2025, it is expected that this percentage will amount to only 17% due to market saturation. *ii)* Use in transportation: electric-powered vehicles, motorcycles and bicycles. In 2012 this subsector had 19% of market share, a percentage that, according to projections, is likely to almost quadruple (74%) by 2025. *iii)* Use in large-scale energy storage, which is potentially the most important application of lithium batteries. Projections estimate that from 1% in 2012, this subsector will reach 9% in 2025. (See Figure 5)

As demonstrated above, the transportation sector is going to experience the most significant growth in the coming years. The revamping of its industry dates back to the latter half of the past decade, when the increasingly high prices of oil and gas prompted automakers all over the world to seek alternatives in order to reduce reliance on fossil fuels and cut down on pol-

Figure 5: Lithium carbonate demand in batteries by subsector 2012 and projection for 2025




Source: CEDLA's compilation based on Roskill, 2017; Signum Box, 2012; Deutsche Bank, 2016 luting emissions.[6]

Currently, companies such as, GM (General Motors), Toyota, Nissan etc. are at the forefront of electric vehicle development. Batteries, however are actually not manufactured in-house, but rather outsourced from other companies. For instance, in 2015 Panasonic became the largest manufacturer of electric vehicle batteries, capturing 40% of market share thanks to its alliance with Tesla Motors and Volkswagen. Other major players in the industry are also in Asia.

Chart 1: Top ten electric vehicle battery manufacturers 2015

| Manufacturer | Megawatt hours (MWh) | Market share |
|---|---|---|
| Panasonic | 4,552 | 40% |
| BYD | 1,652 | 14% |
| LG Chem | 1,432 | 13% |
| AESC | 1,272 | 11% |
| Mitsubishi/GS Yuasa | 600 | 5% |
| Samsung | 504 | 4% |
| Epower | 489 | 4% |
| Beijing Pride Power | 397 | 3% |
| Air Litium (Lyoyang) | 283 | 2% |
| Wanxiang | 268 | 2% |
| TOTAL | 11,449 | 100% |

Source: EV Obsession, 2015

The quintessential example of a company thriving on the need to transition from fossil fuels to energy-storage based options is Tesla Motors, founded in 2003 with the mission of "accelerating the advent of sustainable transport by bringing compelling mass market all-electric cars to market as soon as possible" (Tesla, 2013). In 2010, Tesla started trading on the NASDAQ stock exchange at USD 17 per share and a market cap of USD 226 million (Zendrian, 2010). By 2014 its market cap was of USD 27.9 billion (Guru Focus, 2017); by the beginning of 2017, this value amounted to USD 51 billion, surpassing both GM and the Ford Motors Company (Dunn, 2017).

In addition to technological challenges, companies like Tesla must also deal with competition from traditional automakers and their energy providers (big oil companies). Prospects are, nonetheless, encouraging: the share of electric vehicles in the automotive market is expected to increase from 0.5% in 2012 to 6.5% in 2020 (BRGM, 2011: 43); at the same time, electric vehicle batteries are becoming cheaper to fabricate. In the case of batteries for Plug-in Hybrid Electric Vehicles (PHEV), "costs fell from about USD 1,000/kWh in 2008 to USD 268/kWh in 2015, which represents a 73% reduction in seven years (US DOE, 2016). The US DOE (United States Department of Energy) set a target of USD 125/kWh by 2022 (US DOE, 2015)". Tesla, in turn, "aims to break the USD 100/kWh mark by 2020 (HybridCARS, 2015)" (OECD/IEA, 2016: 12).

Chart 2: Projected growth of the electric vehicle market 2012-2020

| Year | Millions of units produced | Millions of electric units | Electric units' market share |
|---|---|---|---|
| 2012 | 54.92 | 0.27 | 0.5% |
| 2013 | 56.35 | 0.51 | 0.9% |
| 2014 | 57.81 | 1.27 | 2.2% |
| 2015 | 59.20 | 1.48 | 2.5% |
| 2016 | 60.86 | 1.76 | 2.9% |
| 2017 | 62.44 | 2.06 | 3.3% |
| 2018 | 64.06 | 2.56 | 4.0% |
| 2019 | 65.73 | 3.29 | 5.0% |
| 2020 | 67.44 | 4.38 | 6.5% |

Note: Figures shown reflect a conservative scenario, where Hybrid Electric Vehicles (HEV) represent 60% of market share; Plug-in Hybrid Electric Vehicles (PHEV), 20%; all-Electric Vehicles (EV), 20%
Source: BRGM, panorama du marché du lithium 2011: 43

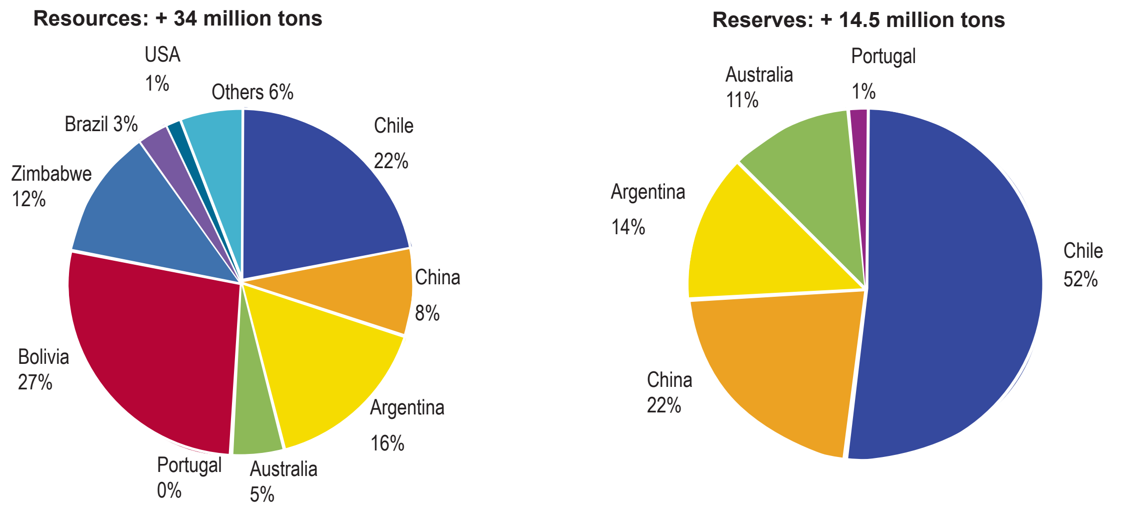
These are the foundations for the increase in lithium carbonate demand, which is why this compound has become a strategic pillar for the development of the capitalist industry into the future.

## 2.3. THE CHARACTERISTICS OF LITHIUM SUPPLY

Lithium carbonate supply depends on the quantity of natural resources available in nature. According to the USGS, in 2017 lithium resources worldwide were estimated at 34 million tons. From this, 65% is concentrated in the so-called lithium triangle countries in South

6 The automotive industry, as one of the main contributors to pollution and global warming, plays a key role in the fight against climate change. Therefore, it is subject to a regulatory framework, by which it commits to improve efficiency and reduce emissions.

Figure 6: Global lithium resources and reserves as of 2016




Source: Signum Box, 2017 based on USGS, 2017

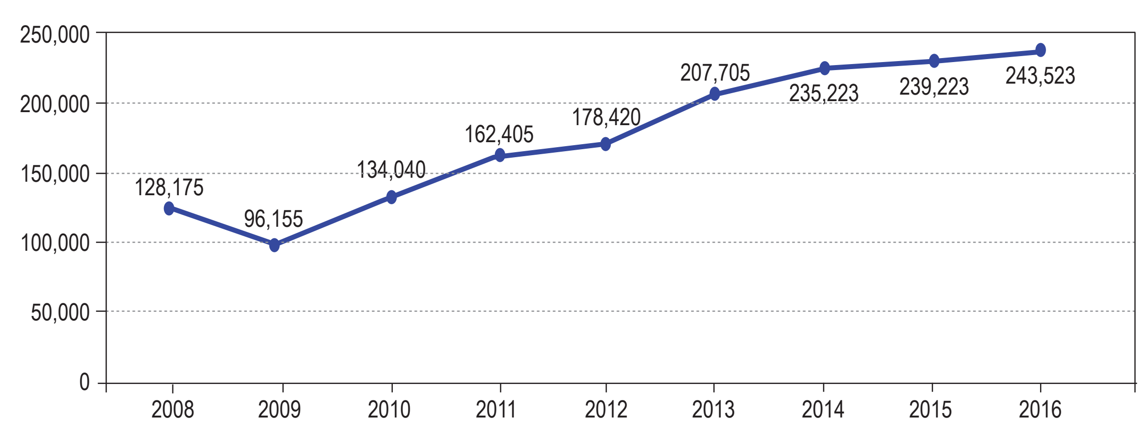
America: Bolivia with 27%, Chile with 22% and Argentina with 16%.

As for reserves —which are roughly defined as economically recoverable resources— they barely account for 43% of resources, as reported by the USGS. Reserves are concentrated in five countries: Chile with 52%, China with 22%, Argentina with 14%, Australia with 11% and Portugal with 1%. There are mainly two types of lithium reserves: brine and hard rock.[7] According to SNL Metals & Mining, brine accounts for 79% of reserves, whereas hard rock for the remaining 21%.[8] (See Figure 6)

Global lithium carbonate supply has increased by 90% over the past eight years, from 128,175 metric tons in 2008 to 243,523 tons in 2016. (See Figure 7)

Global supply is concentrated in the countries containing most of the reserves. For instance, in 2016, 39% was produced in Chile, 24% in Australia, 15% in Argen-

Figure 7: Global lithium carbonate supply 2008-2016 (In metric tons)

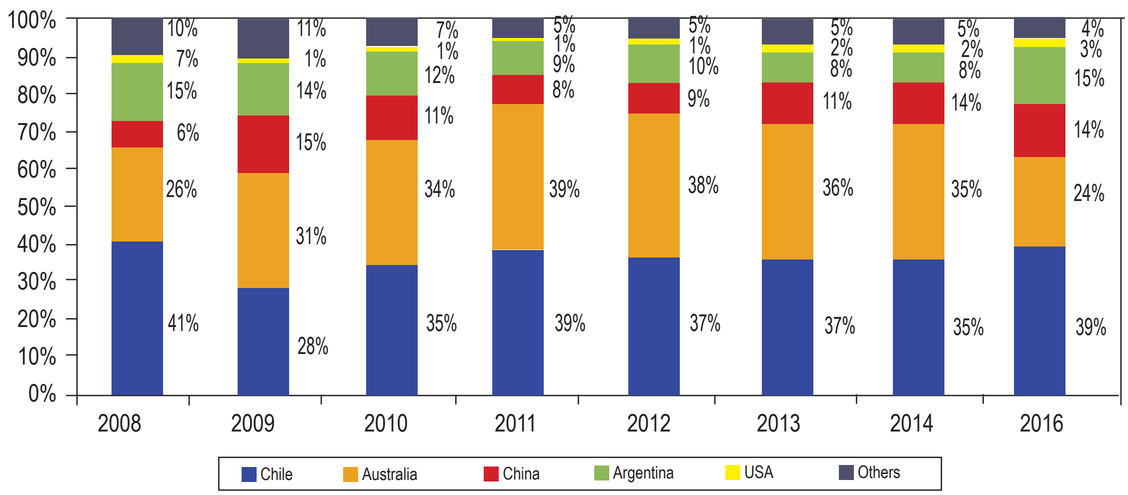



Source: CEDLA's compilation based on COCHILCO, 2013 and Stormcrow, 2017

7 Other lithium sources are clays, bitterns and wastewaters from the oil industry.

8 See Annexes, Chart 2

Figure 8: Top lithium carbonate-producing countries 2006-2016




Note: No data available for the year 2015
Source: CEDLA's compilation based on Nacif, 2016 and Signum Box, 2017

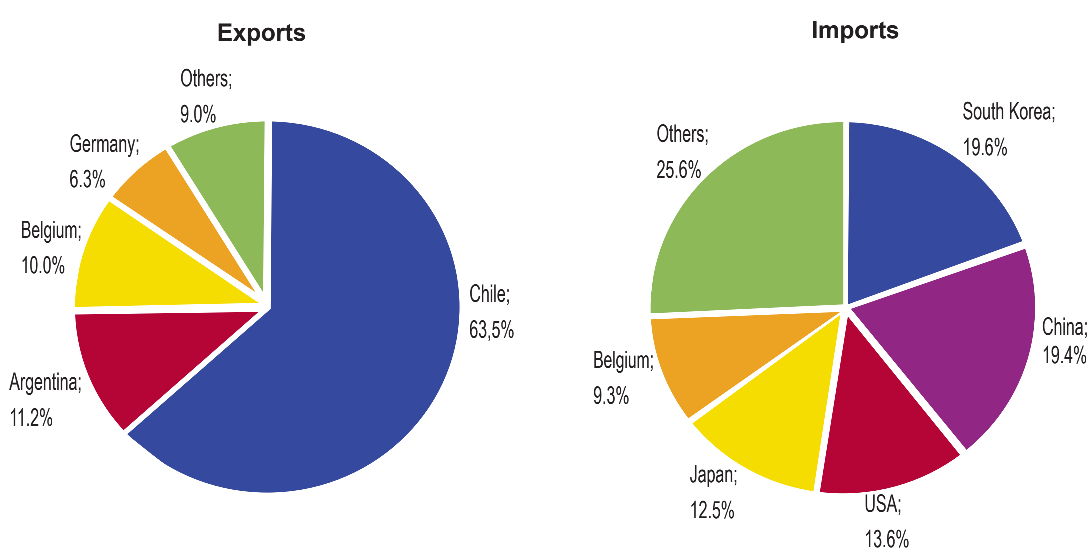
tina and 14% in China, thus covering 92% of global total. It is worth mentioning that Australia's production comes from hard-rock, and that China's production comes from both hard rock and brine; Chile and Argentina, in turn, produce lithium from brine. (See Figure 8)

The main exporting countries are Chile (63.5%) and Argentina (11.2%), which together accounted for 75% of total exports in 2016, thus reflecting their historical condition as primary-exporter economies. On the other hand, the main importing countries, with a combined share of 75%, are South Korea (19.6%), China (19.4%), the United States (13.6%), Japan (12.5%) and Belgium (9.3%), all of which are home to state-of-the-art lithium-based technologies. (See Figure 9)

With respect to recovery technology, it must be conformed to the characteristics of each deposit, i.e. to hard-rock or brine.

"Lithium recovery from a solid-state mineral source is based on the most ancient and traditional methods of mining extraction, thus implementing the classic refin-

Figure 9: Lithium carbonate export and import flows 2013




Note: Exports and imports are based on total production value (USD 355 million)
Source: Zícari, 2015

ing process of calcination, crushing and concentration" (CIECTI, 2015: 15, 16). Obtaining lithium from hard-rock is more expensive than obtaining it from brine; nevertheless, it is a method still in practice thanks to higher lithium concentrations and accompanying by-products.

In contrast, lithium carbonate recovery from brine is based on solar evaporation; the advantages of this method are that it requires less infrastructure, simpler equipment and no crushing, which are the reasons behind its lower operating expenses (COCHILCO, 2013: 13). However, brine lithium needs from 12 up to 24 months to be recovered from evaporation ponds. Afterwards, the concentrated solution obtained from evaporation is treated in a chemical plant where lithium carbonate is purified and precipitated with reagents (COCHILCO, 2013: 8). This procedure's viability is determined by:

> *i) recoverable lithium concentrations; ii) salt flat size, which determines the amount of brine available; iii) potassium concentrations: it is a valuable by-product that increases profit margin; iv) magnesium/lithium ratio, which determines lime use and/or size of evaporation surface. The higher the ratio, the higher the cost of separating these two elements; v) climate conditions. The drier, the better for higher evaporation* (COCHILCO, 2013: 4)

Chart 3 explores these elements in further depth, by providing the characteristics of different lithium-rich salt flats across the world, which, in turn, allows for the making of useful comparisons. For instance, if we compare Atacama —the world's largest source of lithium production today— with Uyuni, which is a strategic project within the framework of development policies promoted by the Bolivian government, we can see that although Uyuni's surface area is four times that of Atacama, its lithium and potassium concentrations are significantly lower, its magnesium/lithium ratio is higher, and its climate conditions imply considerably lower evaporation rates. This means that the advantages of traditional lithium recovery from brine do not apply in the Bolivian case, and that technological changes would be needed to make Uyuni competitive opposite Atacama.

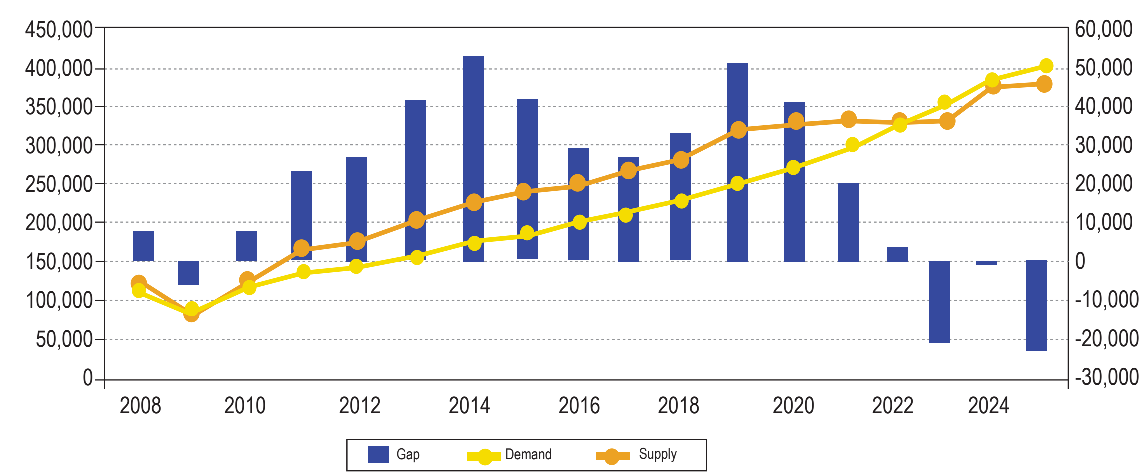
While on the subject of technology, new advances are on their way to reduce time of production, which depends on climate conditions; for example, reverse osmosis and solvent extraction, both of which could enable lithium extraction from the established 12 to 24 months to just a matter of hours. At the moment, these are only experimental trials that have yet to be tested at a large scale (COCHILCO, 2013: 13).

Chart 3: Characteristics of lithium-rich salt flats (In descending order according to lithium concentration)

| N° | Salt flat | Country | Li (ppm) | K (ppm) | Mg/Li | Evaporation rate (mm/yr) | Surface area (km2) | Height (masl) | Reserves (1000 MT) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **Atacama** | **Chile** | **1,500** | **18,500** | **6.4** | **3,700** | **3,000** | **2,300** | **6,300** |
| 2 | Pastos Grandes | Bolivia | 1,033 | 7,766 | 2.2 | 1,500 | 100 | 4,200 | |
| 3 | La Isla | Chile | 860 | 3,170 | 5.1 | 1,000 | 152 | 3,950 | 220 |
| 4 | Maricunga | Chile | 800 | 7,480 | 6.6 | 1,200 | 145 | 3,760 | |
| 5 | Salinas Grandes | Argentina | 795 | 9,547 | 2.7 | 2,600 | 212 | 3,450 | |
| 6 | Olaroz | Argentina | 690 | 5,730 | 2.4 | 2,600 | 120 | 3,900 | 1,210 |
| **7** | **Hombre Muerto** | **Argentina** | **690** | **6,100** | **1.4** | **2,775** | **600** | **4,300** | **800** |
| **8** | **Zhabuye** | **China** | **680** | **n/a** | **0.0001** | **2,300** | **243** | **4,420** | **1,530** |
| 9 | Sal de Vida | Argentina | 660 | 7,370 | 2.2 | n/a | n/a | 4,025 | 1,359 |
| 10 | Diabilllos | Argentina | 556 | 6,206 | 3.7 | n/a | 40 | 3,760 | 529 |
| 11 | Pedernales | Chile | 400 | 4,200 | 8.7 | 1,200 | 335 | 3,370 | * |
| 12 | Diangxiongcuo | China | 400 | n/a | 0.2 | 2,300 | 56 | 4,475 | 181 |
| 13 | Cauchari | Argentina | 380 | 3,700 | 2.8 | 2,600 | 350 | 3,950 | 1,517 |
| 14 | Uyuni | Bolivia | 350 | 7,200 | 19 | 1,500 | 12,000 | 3,650 | 5,500 |
| 15 | Rincón | Argentina | 330 | 6,200 | 8.5 | 2,600 | 260 | 3,700 | 1,118 |
| 16 | Coipasa | Bolivia | 319 | 10,600 | 45.7 | 1,500 | 2,218 | 3,650 | 200 |
| **17** | **Xitai** | **China** | **310** | **n/a** | **65** | **3,560** | **n/a** | **2,790** | **2,020** |
| **18** | **Dongtai** | **China** | **300** | **n/a** | **40 – 60** | **3,560** | **n/a** | **2,790** | |
| 19 | Silver Peak | USA | 230 | 5,300 | 1.5 | 900 | 80 | 1,300 | 300 |

Notes: ppm = parts per million; mm/yr = millimeters per year; masl = meters above sea level
* La Isla, Maricunga and Pedernales share the same reserves
Currently operating salt flats are in bold type
Source: Cochilco, 2013 and BRGM, 2011

Figure 10: Lithium carbonate supply and demand gap 2008-2025 (In metric tons)




Source: Stormcrow, 2017

We can conclude, then, that in the future the lithium carbonate supply is going to be dominated by brine lithium, mainly that of South America, a territory that currently holds 84% of world brine reserves. Argentina, Chile and Bolivia are aiming for the same goal: the industrialization of lithium through the manufacture of batteries, so as to leave behind their condition of primary-exporter economies. These plans, however, are bound to face many challenges; among them, relentless competition from companies controlling these technologies. These companies are located in countries where technological development started not so long ago, e.g. China and South Korea.

## 2.4. THE GLOBAL LITHIUM MARKET OUTLOOK

From 2009 to 2016 the lithium carbonate market has been characterized by a positive gap between demand and supply, with the latter exceeding the former by an average of 14% during that period, a very low percentage considering that it represents less than one year of consumption. Thus, should supply fall short of meeting demand, there would not be enough lithium carbonate stocked to close that gap. The outlook for 2017-2025 is even more cumbersome, since supply is expected to exceed demand by only 5%, and even fall short from 2023 onwards. (See Figure 10)

Although forecasts point out to a growth of 160% in the installed capacity of lithium carbonate production for the period 2017-2025 (See Chart 4), one can expect that the rapid growth of lithium carbonate demand is, undoubtedly, going to outpace that of supply by a significant margin, particularly if we take into account the structural problems affecting the latter: *i)* the time it takes to produce (brine) lithium is still determined by climate conditions; *ii)* current reserves are not enough to cover the production needed for the widespread use of lithium batteries in the electric-powered transportation sector.

As for lithium carbonate prices, the curve shows they followed the patterns established by the generalized increase in prices of raw materials that started in 2000 as a response to Asia's (China) industrial expansion; similarly, they also stagnated between 2008 and 2011 with the advent of the housing crisis that hit the United States during those years. However, a new tendency has broken with this model: instead of going down like the rest of raw materials prices, lithium prices have soared unstoppably from 2012 onwards. (See Figure 11)

Chart 4: Projected installed capacity of lithium carbonate production 2017-2025 (In metric tons)

| Company | 2017 | 2021 | 2025 |
|---|---|---|---|
| SQM | 48,000 | 65,000 | 80,000 |
| Greenbushes | 75,000 | 130,000 | 130,000 |
| Resto de China | 22,000 | 50,000 | 50,000 |
| Bikita | 5,500 | 11,000 | 11,000 |
| Orocobre | 13,000 | 35,000 | 35,000 |
| FMC lithium | 22,000 | 22,000 | 22,000 |
| Rockwood Brine | 50,000 | 70,000 | 80,000 |
| Lithium Americas/SQM | | 25,000 | 50,000 |
| Nemaska | | 38,000 | 43,000 |
| Galaxy Resources (Arg) | | 15,000 | 20,000 |
| Galaxy Resources (Aus) | 15,000 | 20,000 | 20,000 |
| Neometal/MIN/Ganfeng (Aus) | 25,000 | 58,000 | 58,000 |
| POSCO (salar o salmuera) | | 30,000 | 40,000 |
| Frontier Lithium | | 3,000 | 3,000 |
| Pilbara Minerals | | 20,000 | 20,000 |
| Eramet | | 15,000 | 15,000 |
| Enirgi | | 20,000 | 20,000 |
| New Chilean (Li3 et al) | | 15,000 | 20,000 |
| **TOTAL** | 275,500 | 642,000 | 717,000 |

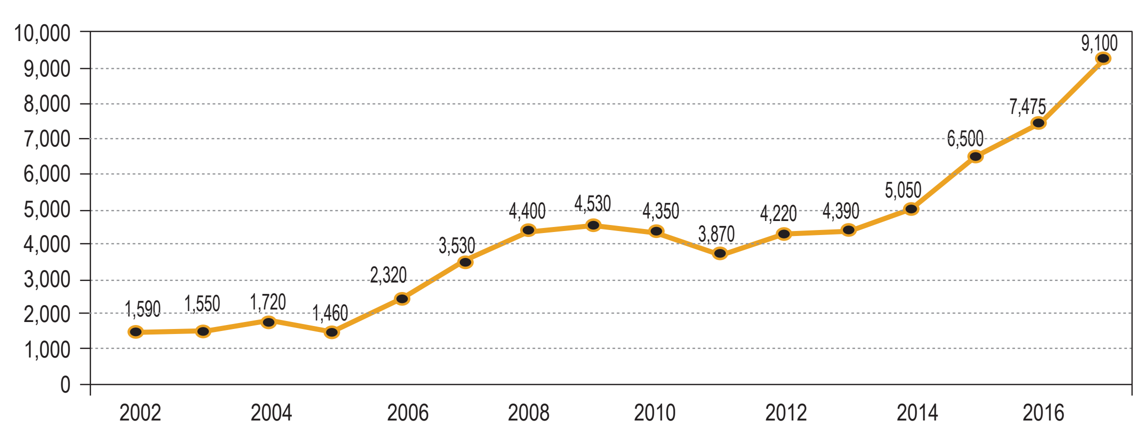
Source: Stormcrow, 2017

Due to the complexity and difficulty of developing energy storage technology, projections regarding future lithium carbonate prices are to take into account the following considerations.

On one hand, advances in lithium battery technology are focused on reducing the use of raw materials, and improving performance and efficiency, so as to lower production costs and enable the viability of the industry against its competitors.

On the other hand, the main competitor is the oil industry, which is managing to prolong the reign of fossil fuels for a few more years thanks to *hydraulic*

Figure 11: Lithium carbonate prices 2002-2017 (USD per metric ton)




Source: Metalary.com

*fracturing*, also known as *fracking* (an oil and gas extraction method that has yielded increased output, and is responsible for the current plunge in prices). The oil industry, however, will not be able to avoid the decline of its reserves —depletion is supposed to start within the next 25 years— nor stop the need for a substitute. The governments of some industrialized countries are already implementing regulations and incentives for the gradual substitution of gas and oil by so-called clean energies.

Thus, lithium carbonate prices for 2025, from a conservative estimation, are likely to remain within the ranges of 2016 and 2017, at between 7,500 and 9,000 USD per metric ton. However, an increase in supply, which could take place if the time it takes to produce brine lithium were reduced, would lead to lower production costs, and, foreseeably, to lower prices.

### 2.5. MONOPOLISTIC BUSINESS STRUCTURE

The market structure here described is ruled by the general law of capitalist accumulation, which, due to competition between companies for profits, promotes the concentration of production in the hands of a few, both horizontally and vertically. Big companies also take advantage of junior companies: they leave room for them to develop a specific part of the production chain only to later absorb them. Certainly, Chart 5 shows that three companies control 85% of brine lithium production, and that two companies control 76% of hard-rock lithium production; hence, as few as five companies control 81% of world total lithium production.

> *For instance, "Sociedad Química Minera (SQM) is the main Chilean producer of fertilizers and manures for the agrarian industry and other chemical products used in intermediate manufacturer industries, with commercial offices in more than 20 countries. In spite of being the biggest lithium producer in the world —on account of its operation in the Atacama salt flats— lithium only accounts for a percentage of its total revenues. Sociedad Chilena del Litio (SCL), the other lithium operator in Atacama, depends on a parent company, the German-American Rockwood Holdings, which is a global corporation focused on the manufacture of chemicals and processes for the treatment of surfaces and plastics; lithium is intensively used in both of these segments.The Food Machinery Corporation (FMC), from the United States, exports all of its Argentinian subsidiary's lithium carbonate production to supply its vertically integrated company.* (CIECTI, 2015: 37,38)

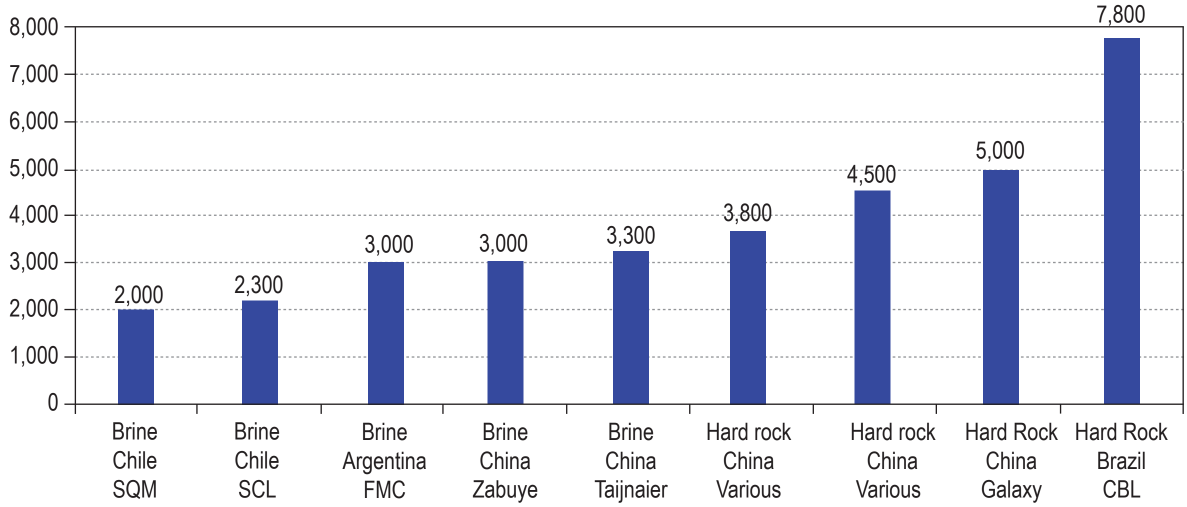
Chart 5: Lithium mining companies by production share 2012[9]

| Company | Deposit | Type of deposit | Production share (Type of Deposit) | Production share (Total) | Country of origin |
|---|---|---|---|---|---|
| SQM | Atacama (Chile) | Salt flat | 42% | 21.17% | Chile and others |
| SCL (Rockwood) | Atacama (Chile) | Salt flat | 25% | 12.60% | USA/Germany |
| FMC | Hombre Muerto (Argentina) | Salt flat | 18% | 9.07% | USA |
| Others | | Salt flat | 15% | 7.56% | |
| Tallison | Greenbushes (Australia) | Hard rock | 67.20% | 33.33% | Australia/China |
| Galaxy Resources | Mount Cattlin (Australia) | Hard rock | 9.10% | 4.51% | Australia |
| Others | | Hard rock | 23.70% | 11.76% | |

Source: CIECTI, 2015.

9 See Annexes, Chart 3

Figure 12: Lithium carbonate production costs (USD per metric ton)




Source: Nacif, 2016

Other companies, namely Asian, are now part of this competition thanks to the growing importance of this region as home to the world's center of development and manufacture of technological products.

This competition in the market is reflected in production, which aims to boost process efficiency in order to reduce production costs. As of now, SQM is the company with the lowest production costs, at USD 2,000 per metric ton of lithium carbonate (brine lithium), whereas the highest cost is that of Companhia Brasileira de Lítio (CBL), at USD 7,800 per metric ton of lithium carbonate (hard-rock lithium). (See Figure 12)

A hypothetical calculation will show that the top three brine lithium companies —SQM, SCL and FMC— have made extraordinary profits, exceeding the average general rate of profit[10] by a significant margin. Out of these companies, SQM benefits from a higher differential ground rent due to the better quality of its lithium deposits, which is why, at 111%, it also presents the highest differential rate of profit in relation to production costs.

These extraordinary profits are known as land rent —in this case, mine rent— which accrues to the owners of the land or natural resources being exploited. For instance, the Bolivian state is the owner of all national evaporite resources; nevertheless, in compliance with Mining Law 535, it is only to receive a very meagre share of rent: a unique royalty of 3% on the Gross Sales Value of lithium production.

## 3. THE INDUSTRIALIZATION OF LITHIUM IN BOLIVIA

### 3.1 THE PLACE OF LITHIUM WITHIN THE CURRENT DEVELOPMENT POLICY

The development strategy proposed by the current MAS (Movement towards Socialism) government is

Chart 6: Profits and profit rates of the top three brine lithium companies 2012

| Company | Production (MT) | Production Cost (USD/MT) | Total Production Cost (USD) | Sales Price (USD/MT) | Total Sales Price (USD) | Profit (USD) | Profit rate |
|---|---|---|---|---|---|---|---|
| **SQM** | 37.772 | 2,000 | 75,543,028 | 4,220 | 159,395,789 | 83,852,761 | 111% |
| **SCL** | 29,618 | 2,300 | 68,120,756 | 4,220 | 124,986,778 | 56,866,022 | 83% |
| **FMC** | 16,183 | 3,000 | 48,548,082 | 4,220 | 68,290,969 | 19,742,887 | 41% |

Source: CEDLA's compilation based on CIECTI, 2015; Metalary.com; Cochilco, 2013 and Nacif, 2016

10 A proxy for this rate is the Active Interest Rate charged by banks for the money they lend to their clients.

rooted in the National Plan of Development, which, in turn, stems from the Government Program 2006-2010, Por una Bolivia Digna, Soberana y Productiva para Vivir Bien (For a Dignified, Sovereign and Productive Bolivia to Live Well). Later, in 2009, the Plan and its principles were reinforced by the Political Constitution of the Plurinational State of Bolivia (02/2009). Within this framework, in 2012, the 2025 Patriotic Bicentenary Agenda, in which is rooted the 2016-2020 Plan of Economic and Social Development: Within the Framework of Integral Development for Living Well (2015), was introduced.

Within this strategy, living well is the ultimate goal of development. In order to surmount the challenges posed by this goal —poverty eradication, universalization of basic services, improvements in health, education, employment, etc.— the government has proposed the construction of a productive matrix that overcomes the primary production model via the industrialization of strategic natural resources. "The central idea is that the strategic sectors not only reinvest their incomes, but also distribute them among other sectors that can, in turn, generate further income and employment, so as to contribute to the diversification of economy and social development." (MAS-IPSP, 2005: 132)

> *The aim is to accomplish a balanced coexistence and complementarity based on the equity of State Economy, Community Economy —it is based on production processes promoted by social and community organizations, micro and small-scale producers, artisans, peasant economic organizations, production organizations, communities and urban and rural associations— Mixed Economy and Private Economy.* (Gabriel Loza, Ministerio de Planificación del Desarrollo, 07/2007)

Thus, the State passes from being a mere regulator to promoter and protagonist, taking part in the production processes —by assuming economically differentiated roles and functions— and enabling the transformation of the primary production model. The purpose of these actions is to free Bolivia from a model dependent on the export of raw materials, and, instead, to establish an industrialized and productive economy.

The New Economic, Social, Community and Productive Model intends to:

> *lay the foundations for transitioning towards socialism, which will gradually solve many social problems, as well as consolidate the economic base for an adequate income distribution. Even though Bolivia will remain a primary exporter for a while, this time it is necessary to have clarity on the goals and according path to follow. This economic model is based on the success of the state administration of natural resources. It is designed for the Bolivian economy, and it depends on how this administration is carried through.* (Arce Catacora, 2011: 3)

As for the mining sector, the General Plan of Development has at its core the industrialization of strategic mining resources by Comibol (Bolivian Mining Corporation). There are two main projects in this plan: the industrialization of iron at Mutún, and the industrialization of evaporite resources at the Industrial and Strategic Lithium Complex in the Uyuni salt flats; the latter is an attempt to further participate in the lithium production chain: lithium carbonate, batteries, automotive industry, energy park, etc.

## 3.2 BACKGROUND OF THE LITHIUM INDUSTRIALIZATION PROJECT

Between 1975 and 1981, explorations were carried out for the assessment of mining resources in the Uyuni salt flats. The joint efforts of the Department of Geosciences of Universidad Mayor de San Andrés (UMSA) and the Office de la Recherche Scientifque et Technique Outre Mer (ORSTOM) succeeded in determining the existing reserves of lithium, potassium and other elements.

In 1984, the Universidad Tomás Frías (Potosí) in agreement with the Freiberg University of Mining and Technology, began working on a brine-suitable technology –evaporation cones– for the faster concentration of lithium-containing brines.

In 1985 was founded the Industrial Complex of Evaporite Resources of the Uyuni Salt Flats (CIRESU), a state-run company composed of the central government, civil organizations and Universidad Tomás Frías. In contrast, during the neoliberal era, from 1985 to 2005, there were two occasions, in 1989 and 1993, during which the government almost handed over the evaporite resources to multinational companies; both attempts were frustrated by the protests of the people of Potosí.

Later, in 2007, the Unique Regional Federation of Peasant Workers of the Southern Altiplano (FRUTCAS) posed to the government the importance of having a 100% state-run company in charge of the industrialization of evaporite resources. Accordingly, SD 29496 of 2008 declares "as national priority, the exploitation of evaporite resources in the Uyuni salt flats." To that end, the National Management of Evaporite Resources (GNRE) was founded. The GNRE is an executing arm of Comibol in charge of the exploration, exploitation and industrialization processes.

## 3.3 PHASES OF THE LITHIUM INDUSTRIALIZATION PROJECT

The national strategy for the industrialization of evaporite resources in Bolivia contemplates three phases:

**Phase one**: Construction of two pilot plants for the production of lithium carbonate and potassium chloride. The investment of USD 18 million is planned to annually yield 480 MT of lithium carbonate and 12,000 MT of potassium chloride. Annual sales were estimated at USD 6.4 million. Phase one was scheduled to begin in 2012.

**Phase two**: Industrial production of lithium carbonate and potassium chloride. The investment of USD 485 million is planned to annually yield 30,000 MT of lithium carbonate and 700,000 MT of potassium chloride. Annual sales were estimated at USD 395 million. Phase two was scheduled to begin between 2015 and 2016.

**Phase three**: Production of lithium-ion batteries, cathodes and electrolytes. Investment was estimated at USD 400 million and annual sales at USD 350 million. Phase three was scheduled to begin at the end of 2013. (CEDLA, 2014: 5)

### 3.4 ADVANCES IN THE LITHIUM INDUSTRIALIZATION PROJECT

> *It is only after 40 years of the Uyuni salt flats being declared a fiscal reserve, that the process of exploitation, production and industrialization of lithium and all evaporite resources within this reservoir has taken place. This project, promoted by President Evo Morales as a 100% state-run undertaking, is in charge of Comibol's National Direction of Evaporite Resources (DNRE).* (Ministerio de Minería y Metalurgia, 2010: 81)

The project was inaugurated in May of 2008 in Llipi Loma, Río Grande in the department of Potosí, and was received with great expectation by surrounding communities because of the benefits it is supposed to bring along once it takes off. (Ministry of Mining and Metallurgy, 2010: 82)

Nine years have passed since the project started, and although the GNRE claims that "currently, the Pilot Plants for the production of potassium salts and lithium carbonate are already operating in Bolivia", and that "the technological process has been definitively consolidated and validated by Bolivian professionals" (BCB, 09/05/17), the results achieved so far suggest the project has fallen short of meeting its goals.

Phase one should have yielded by now 480 MT of lithium carbonate and 12,000 MT of potassium chloride per year; nevertheless, according to the GNRE's Annual Memory of 2016, lithium carbonate sales in that year amounted to only 24 MT for a total value of Bs. 1,401,216 (USD 200,000), whereas potassium chloride sales amounted to barely 1,550 MT for a total value of Bs. 1,834,045 (USD 265,000). Although not included in the initial plan, production and sales of magnesium chloride amounted to 1,330 MT for a total value of Bs. 493,167 (USD 70,000).[11]

With regard to Phase 2, there have been advances in the construction of the Industrial Plant of Potassium Salts and the installation of industrial evaporation ponds. "The beginning of operations of this plant and the Industrial Plant of Lithium Carbonate is scheduled for the end of 2018" (GNRE, 2017). Nevertheless, since the most recent bidding (05/17) for the turnkey construction of both plants has been declared deserted, it is highly unlikely that the aforementioned deadlines will be met.

As for Phase 3, "the GNRE has approached technology owners through purchase and/or strategic alliances with international companies" (GNRE, 2017). Although the GNRE has stated that it has been able to produce battery-grade lithium carbonate (purity of 99.9%), the sales records only show sales for industrial-grade lithium carbonate (purity of 98%). This means that the pilot plants designed to produce lithium batteries and cathode materials cannot rely on Bolivian lithium for their operations.

A more detailed look into this situation will reveal that the difficulties the lithium industrialization project is going through are rooted in institutional, technological and political shortcomings.

For instance, in January of this year, the Ministry of Energy and the Vice Ministry of Advanced Energy Technologies were created. Within this framework, the Strategic National Public Company of Evaporite Resources (ERE) was also founded; it depends on the Vice Ministry and is due to replace the GNRE. As a result, Comibol is no longer involved in the lithium project: it was considered an extremely bureaucratic executing arm that hindered the performance of the Company. However, as quickly as April the ERE was replaced by a new company, Lithium Deposits of Bolivia (YLB). As of now, the new Ministry is still under organization, so no further details on the implications of such reforms have been disclosed.

At the technological level, it has been stated that the traditional method of lithium carbonate recovery via chlorides, which is used to treat the brines of Atacama, is not suitable to the characteristics of the Uyuni salt flats. Therefore, another method of recovery has been proposed: that of sulfides. According to CEDLA's 2014 study, namely the section developed by Juan Carlos Montenegro —YLB's current director— both methods have been employed. Later, the first call for tenders required that the proposals for the construc-

11 Lithium carbonate production started just in 2015 (GNRE, 2017).

tion of the industrial plant of lithium carbonate be fitted to the *sulfide method*, which was developed by Bolivian technicians of the GNRE; nevertheless, the last call for tenders does not specify the method to be implemented, and even reduces the annual output to merely 15,000 MT. This lack of specifications is justified by Alberto Echazú, the former director of the GNRE, as a matter of confidentiality; in contrast, the lithium market specialist Juan Carlos Zuleta rather believes that the sulfide method does not work. (Zuleta, 2016)

In order to understand the full scope of these shortcomings, it is necessary to analyze the political framework in which they have developed. The industrialization policy has been marked by lack of political willingness and improvisation in all levels of government. Instead of aiming for a true industrial revolution that allows for surpassing the primary-exporter model, the government has focused on two measures to increase its income: rent reforms in the hydrocarbons sector in order to capture a larger share of rent, and an ever-increasing burden on taxpayers with the purpose of increasing its tax revenues.

Lastly, it is worth mentioning that the state-run company has distanced itself from social organizations, e.g. FRUTCAS, universities and other institutions that could contribute to technological development. At the international level, its absence in international events is noteworthy —for instance, the most recent in Montreal, Canada and Catamarca, Argentina— where current world market conditions and future outlooks were discussed. This lack of interaction with other institutions is a barrier to accessing information for the social control of the processes taking place in the Uyuni Salt Flats.

### 3.5 SOCIAL ASPECTS

The observations made by CEDLA's 2014 study on the regional impact of the lithium and other evaporite resources industrialization project are, for the most part, still valid in the current context. Although there have been some changes in the productive activities of the region, these are mainly price-related, not structural. These calculations only intend to provide a general picture of the project's economic impact on the region.

Five municipalities surround the Uyuni salt flats: Colcha K, Uyuni, Llica, Tahua and Salinas de Garci Mendoza. Together they encompass a total population of 54,693 inhabitants on a surface area of 42,129 square kilometers, with a population density of 1.3 inhabitants per square kilometer, well below the national figure of 9.49 inhabitants per square kilometer. According to the 2001 National Census, in that year there were 11,773 families in the region with an average of 3.54 people per household. Coverage of basic drinking water services reached 52.90% of the population; electricity, 29.22%; and domestic cooking gas, 33.93%.

The agricultural production dynamic in the region is mainly conditioned by the production cycle of quinoa, which, in turn, conditions llama farming and temporary migration. In effect, in the time between sowing and harvesting, from September to April, livestock must be looked after so as to prevent it from invading crops; after harvest, the workforce is off duty and migrates in search of temporary work for a few months (men go to work in the mines and the construction sector; women dedicate themselves to commercial activities; and, recently, both have started to work in the textile sector). However, given that quinoa production is now being oriented towards international markets, such dynamic has been transformed. The expansion of the agricultural frontier has brought with it the displacement of camelid farming activities –mainly of llama farming.

Mining activities are also common in the region; as a matter of fact, they date back to the Colony. Nowadays, San Cristobal —the largest mine in Bolivia— operates in the region with a daily yield of 40,000 MT of zinc, lead and silver concentrates. San Cristobal is a 100% private operation, run by the Japanese multinational Sumitomo Corporation. The exploitation of ulexite is also noteworthy; it is under the control of cooperatives, but shows capitalist traits. Other economic activities of importance are: salt extraction; tourism, due to the beauty of the surrounding landscapes; and international commerce because of the shared border with Chile.

According to CEDLA's 2014 study, the region's annual revenue amounted to USD 168 million: salt 1%, llama farming 2%, tourism 4%, ulexite 10%, migration 11%, San Cristobal 13% and quinoa 59%. Under current prices, the revenue generated through implementation of the first two phases of the lithium industrialization project would be approximately USD 100 million per year, meaning it would increase regional revenues by 60%. Out of these 100 million, 45.5 million is profits (provided the passing of the bill project that allots 30% of profits to the surrounding municipalities of Colcha K, Uyuni and Llica); 1.7 million is royalties (this figure accounts for 15% of total royalties; the municipality of Colcha K is set to be the sole recipient of this percentage); and 53.7 million is yearly salaries for approximately 5,270 workers (1,270 direct and 4,000 indirect).

With regard to total fiscal impact, the region would receive, directly, 1.7 million USD in mining royalties, and, indirectly, a share of profit taxes (Impuesto a las Utilidades de las Empresas – IUE) through tax co-participation, a figure that has yet to be estimated, since it includes other fiscal incomes besides the IUE which are distributed to municipalities by the central government in proportion to population.

## 4. CONCLUSIONS

The dynamics of the international lithium carbonate market have intensified due to the rapid advances the automotive industry is making in developing electric vehicles based on lithium ion batteries. This is a necessity posed by the energy industry with the objective of transforming the supply matrix in view of the imminent depletion of oil to be experienced in the coming years.

This technological change is occurring in a context of intense competition between those promoting the new technology and the oil companies, which control the energy and transportation sectors within the framework of the general law of capitalist accumulation, which privileges profit to the detriment of social conditions.

Thus, the rapid growth of lithium carbonate supply —concentrated in brine production— is part of this competition, in which both the production and reserves are controlled by only a handful of companies.

Naturally, all eyes are on the largest reservoir of brine lithium, the so-called lithium triangle in South America, which sits between Argentina, Chile and Bolivia. In spite of having the most resources out of the three, Bolivia has fallen behind in production and relevance, a tendency that is unlikely to be reversed due to the quick advances in Argentina and Chile, and the too many shortcomings of the Bolivian project.

The Bolivian lithium industrialization project has developed within a policy that privileges rentierism over the construction of a productive matrix that overcomes the primary-exporter model. The government has instead focused on two measures to increase its income and protect macroeconomic stability —rent reforms in the hydrocarbons sector in order to capture a larger share of rent, and an increased burden on taxpayers with the purpose of increasing its tax revenues. Thus, the lithium industrialization project is marked by lack of political willingness and improvisation.

## 5. BIBLIOGRAPHY

ARCE CATACORA, Luis
2011 El nuevo modelo económico, social, comunitario, productivo. Revista Economía Plural (year 1 N°1); September 2011; Ministerio de Economía y Finanzas Públicas, La Paz.

AYRE, James
2016 EV Battery Sales 2015 vs. 2014; EV Obsession
https://evobsession.com/ev-battery-sales-december-2015/

BANCO CENTRAL DE BOLIVIA
2017 Avanza la industrialización de recursos evaporíticos; Press Release, 09/05/17
https://www.bcb.gob.bo/webdocs/10_notas_prensa/NP_25_TALLER_APEC.pdf

BAYLIS, Robert
2017 The impact of automotive electrification on lithium: 1 TWh and 1 Mt LCE in 10 years?; Roskill; 9th Lithium Supply and Markets Conference; Montreal, 31/05/2017

BRITISH PETROLEUM
2015 BP Statistical Review of World Energy
http://www.bp.com/statisticalreview

BÜCHEL, K.H.; H.H. MORETTO; P. WODITSCH
2000 Industrial Inorganic Chemistry; Second completely revised edition; Wiley-VCH, Weinheim.

BUSINESS INSIDER
2017 Tesla to build world's largest lithium ion battery in Australia [visited on 11/07/2017]
http://www.businessinsider.com/tesla-to-build-worlds-largest-lithium-ion-battery-in-australia-2017-7

CALLA, R; J.C. MONTENEGRO; Y. MONTENEGRO & P. POVEDA
2014 Un presente sin futuro: El proyecto de industrialización del litio en Bolivia; CEDLA; La Paz.

CASTELLO, Andrés & Marcelo KLOSTER
2015 Industrialización del litio y valor agregado local: Informe técnico productivo; CIECTI; Buenos Aires.

COCHILCO
2013 Mercado Internacional del Litio; SERNAGEOMIN, Ministerio de Minería; Santiago de Chile, December 2013
2009 Antecedentes para una Política Pública en Minerales Estratégicos: Litio; Santiago de Chile, December 2009

DESORMEAUX, Daniela
2017 The Regulatory Perspective: How might Policies impact Lithium Supply; Signum Box; 9th Lithium Supply and Markets Conference; Montreal, 31/05/17

DEUTSCHE BANK
2016 Lithium 101; FITT; Sidney.
DUNN
2017 Tesla is valued as high as Ford and GM –but that has nothing to do with what it's done so far; Business Insider [visited on 13/07/2017]
http://www.businessinsider.com/tesla-value-vs-ford-gm-chart-2017-4

GERENCIA NACIONAL DE RECURSOS EVAPORÍTICOS
2017 Memoria 2016, n/a

GURU FOCUS
2017 Tesla Inc. Market Cap [visited on 15/07/2017]
https://www.gurufocus.com/term/mktcap/NAS:TSLA/Market-Cap/Tesla-Inc

HYKAWY, Jon & Tom CHUDNOVSKY
2017 Lithium supply and markets 2017; Stormcrow; 9th Lithium Supply and Markets Conference; Montreal, 31/05/2017

INTERNATIONAL ENERGY AGENCY
2016 Global EV Outlook 2016: Beyond one mi-

llion electric cars; OECD, IEA; Paris.
2007 Manual de Estadísticas Energéticas; STEDI, Paris. [Visited on 27/07/2017]
https://www.iea.org/publications/freepublications/publication/statistics_manual_spanish.pdf

KIMMORLEY, Sarah & Paul COGAN
2017 Tesla is going to build the world's largest lithium ion battery in Australia; Business Insider Australia, 07/07/2017

LABBÉ, J.F. & G.J. DAW
2011 Panorama 2011 du Marché du Lithium; Rapport Public; BRGM/RP-61340-FR; Paris, July 2012.

MARX, Carlos
1990 El Capital, Tomo I, El Proceso de Producción del Capital, Vol. I; Ed. Siglo XXI, Mexico City.

MAS-IPSP
2005 Programa de Gobierno "Bolivia digna, soberana y productiva para vivir bien"; La Paz, November 2005.

METALARY
N/A Litihum Price
https://www.metalary.com/lithium-price/

MINISTERIO DE PLANIFICACIÓN DEL DESARROLLO
2015 Plan de Desarrollo Económico y Social: en el Marco del Desarrollo Integral para Vivir Bien; La Paz.
2007 Plan Nacional de Desarrollo, La Paz.

MINISTERIO DE MINERÍA Y METALURGIA
2010 Memoria Anual 2006-2009

NACIF, Federico
2016 El ABC del litio sudamericano: entre el extractivismo y la industrialización; PIIdISA-UNQ/CONICET; Catamarca.

OECD/IEA
2016 Global EV Outlook. Beyond one million electric cars; Paris.
https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

SIGNUM BOX
2012 Lithium: Outlook and Perspectives; Santiago de Chile

STRÖBELE-GREGOR, Juliana
2012 Litio en Bolivia. El plan gubernamental de producción e industrialización del litio, escenarios de conflictos sociales y ecológicos, y dimensiones de desigualdad social; Working Paper No. 14; Working Paper Series; Research Network on Interdependent Inequalities in Latin America; Berlin.

TESLA
2013 The misión of Tesla, 18/11/2013
https://www.tesla.com/blog/mission-tesla

ZENDRIAN, Alexandra
2010 Tesla electrifies the IPO market, Forbes, 02/07/2010
https://www.forbes.com/2010/07/02/cboe-ipo-oasis-petroleum-intelligent-investing-tesla.html

ZICARI, Julián
2015 El mercado del litio desde una perspectiva global: de la Argentina al mundo. Actores, lógicas y dinámicas; CLACSO; Buenos Aires.

ZULETA, Juan Carlos
2016 El litio: ¿Un metal cada vez más precioso?; Oxígeno.bo [Visited on 24/07/2017]
http://oxigeno.bo:81/blog/225

## 6. ANNEXES

Chart 1: World lithium demand (In metric tons)

| Industry | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Batteries | 30,648 | 26,118 | 39,200 | 43,770 | 51,749 | 51,491 | 61,214 | 72,182 | 83,162 |
| Glass and Ceramics | 20,015 | 18,298 | 23,306 | 26,264 | 28,343 | 58,135 | 61,504 | 65,150 | 69,075 |
| Lubricating Greases | 12,628 | 10,497 | 11,901 | 13,155 | 13,992 | 13,288 | 13,633 | 14,042 | 14,506 |
| Polymers and Pharmaceutical | 12,889 | 10,328 | 11,089 | 11,720 | 11,919 | 8,305 | 8,562 | 8,862 | 9,199 |
| Air Treatment | 7,016 | 5,832 | 6,548 | 7,170 | 7,553 | 8,305 | 8,562 | 8,862 | 9,199 |
| Chemical Products | 8,435 | 7,878 | 8,153 | 8,385 | 8,513 | 9,966 | 10,654 | 11,389 | 12,175 |
| Aluminium | 2,551 | 1,969 | 2,073 | 2,128 | 2,101 | 1,661 | 1,329 | 1,063 | 850 |
| Others | 26,787 | 21,737 | 24,055 | 25,959 | 26,951 | 14,949 | 15,338 | 15,798 | 16,319 |
| Total | 120,968 | 101,613 | 125,726 | 138,306 | 151,048 | 166,100 | 180,796 | 197,348 | 214,485 |
| **Available Supply** | **128,175** | **96,155** | **134,040** | **162,405** | **178,420** | **207,705** | **235,223** | **239,223** | **243,523** |
| **Gap** | **7,207** | **-5,458** | **8,314** | **24,099** | **27,372** | **41,605** | **54,427** | **41,875** | **29,038** |

| Industry | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|
| Batteries | 95,276 | 108,049 | 120,067 | 133,224 | 146,486 | 159,827 | 174,126 | 188,617 | 204,813 |
| Glass and Ceramics | 73,237 | 77,635 | 82,315 | 87,298 | 92,604 | 98,254 | 104,271 | 110,683 | 117,512 |
| Lubricating Greases | 14,970 | 15,419 | 15,882 | 16,358 | 16,849 | 17,354 | 17,875 | 18,411 | 18,964 |
| Polymers and Pharmaceutical | 9,539 | 9,873 | 10,219 | 10,576 | 10,947 | 11,330 | 11,726 | 12,137 | 12,561 |
| Air Treatment | 9,539 | 9,873 | 10,219 | 10,576 | 10,947 | 11,330 | 11,726 | 12,137 | 12,561 |
| Chemical Products | 13,015 | 13,913 | 14,873 | 15,899 | 16,996 | 18,169 | 19,422 | 20,762 | 22,195 |
| Aluminium | 680 | 544 | 435 | 348 | 279 | 223 | 178 | 143 | 114 |
| Others | 16,841 | 17,347 | 17,867 | 18,403 | 18,955 | 19,524 | 20,109 | 20,713 | 21,334 |
| Total | 233,097 | 252,653 | 271,877 | 292,682 | 314,063 | 336,011 | 359,433 | 383,603 | 410,054 |
| **Available Supply** | **259,823** | **284,839** | **324,839** | **334,839** | **334,839** | **338,458** | **338,458** | **383,458** | **388,458** |
| **Gap** | **26,726** | **32,186** | **52,962** | **42,157** | **20,776** | **2,447** | **-20,975** | **-145** | **-21,596** |

Source: CEDLA's compilation based on Stormcrow, 2017 and CEDLA, 2014

Chart 2: World lithium reserves (In metric tons)

| Country | Cochilco 2008 | SNL 2013 | | | Roskill 2013 | USGS 2014 |
|---|---|---|---|---|---|---|
| | | Hard-rock lithium | Brine lithium | Total | | |
| Chile | 6,900 | | 7,500 | 7,500 | 7,300 | 7,500 |
| Bolivia | 5,500 | | 5,500 | 5,500 | 5,500 | |
| China | 750 | 750 | 2,750 | 3,500 | 3,900 | 3,500 |
| Argentina | 2,550 | | 2,550 | 2,550 | 2,700 | 850 |
| Australia | 263 | 970 | | 970 | 505 | 1,500 |
| Serbia | 850 | 850 | | 850 | | |
| DR Congo | | 1,000* | | 1,000* | 310 | |
| Russia | 1,000 | 1,000* | | 1,000* | | |
| Canada | 256 | 256 | 108 | 364 | 204 | |
| Austria | 100 | 100 | | 100 | | |
| Brazil | 2,725 | 46 | | 46 | 50 | 48 |
| USA | 6,620 | | 38 | 38 | 169 | 38 |
| Zimbabwe | 57 | 23 | | 23 | 25 | 23 |
| Finland | 14 | 14 | | 14 | 6 | |
| Portugal | | 10 | | 10 | 10 | 60 |
| Afghanistan | | | | | 150 | |
| Zaire | 2,300 | | | | | |
| **World total** | **29,884** | **5,019** | **18,446** | **23,465** | **20,829*** | **13,519** |

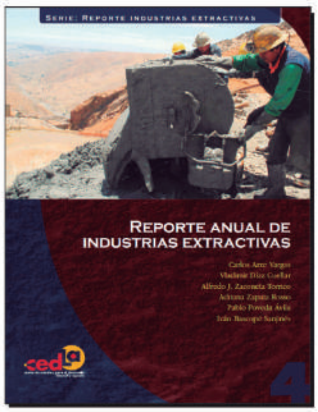
Source: Estimates based on Cochilco, 2009; Ministry of Land and Resources of China, 2015 citing SNL (2014), Roskill (2013) and USGS (2015)

Chart 3: Lithium mining companies by reserves (In thousands of metric tons)

| Country | Deposit | Stage | Company | Main Associate | Beginning of operations | Reserves |
|---|---|---|---|---|---|---|
| Chile | Atacama (N) | Production | SQM Chile | Potash Corp | 1997 | 6,300 |
| | Atacama (S) | Production | SCL | Chemetall | 1984 | |
| | Pedernales | | | | | |
| | Maricunga | | Lithium3 Energy | OTCBB | | 220 |
| | De la isla Vecina (7 Salares) | Exploration | Talison Lithium | TSX TLH | | |
| Argentina | Hombre Muerto (Fénix) | Production | Minera del Altiplano | FMC | 1997 | 800 |
| | Hombre Muerto (Sal de Vida) | Feasibility | Lithium 1 / KORES | TSX-V: RM | 2015 | 1,359 |
| | Rincón | Pilot | Rincon Lithium | TSX-V: RM | 2012 | 1,118 |
| | Ratones | | Rodinia Lithium | TSX: ORL | | |
| | Centenario | | Rodinia Lithium | TSX: LAC | | |
| | Olaroz (+Cauchari, ORL) | Construction | Orocobre / Toyota Tsusho | TSX-V: RM | 2013 | 1,210 |
| | Cauchari (+Olaroz, LAC) | Feasibility | Lithium Americas | | 2014 | 1,517 |
| | Diablillos | | Rodinia Lithium | TNR Gold | 2015 | 529 |
| | Salinas Grandes | | Orocobre / Rodinia Lithium | | | |
| | Mariana (Llullaillaco) | Exploration | International Lithium | | | |
| Bolivia | Uyuni | Pilot | GNRE | COMIBOL | | 5,500 |
| | Pastos Grandes | Exploration | New World Resources / Lithium3 Energy | | | |
| | Coipasa | | GNRE | COMIBOL | | 200 |
| China | Zhabuye | Production | Tibet Minerals / BYD | | 2008 | 1,530 |
| | Dong Xiang Co. (DXC) | Feasibility | Zhong Chuan | | | 181 |
| | West Taijnaer (Xi Tai) | Production | Qinghai CITIC Guoan | | 2010 | |
| | East Taijnaer (Dong Tai) | Production | Qinghai CITIC Guoan / Qinghai Lithium Co. | | 2004 | 2,020 |
| | Qarhan/Chaerthan | Production | Qinghai Lake | | 2009 | |
| | Da Qaidam | | | | | |
| USA | Silver Peak/Clayton Valley | Production | Chemetall Foote Corp. | Chemetall | 1966 | 300 |
| | Clayton Valley | | Rodinia Lithium | TSX-V: RM | | |
| | Searles Lake | Depleted | Searles Valley Minerals | | | 20 |
| | Fish Lake | Exploration | International Lithium | TNR Gold | | |
| | Great Salt Lake | Production (Mg) | US Magnesium LLC | | | 520 |

Source: BRGM, Panorama 2011 du Marché du Lithium plataforma energética

The Center of Studies for Labor and Agrarian Development (CEDLA), within the framework of the Energy Platform, has elaborated during the past years a series of documents, which are the result of rigorous research work on development-related issues in Bolivia and the region. These materials are available at CEDLA's offices and its websites www.cedla.org and www.plataformaenergetica.org.




## Reporte Anual de Industrias Extractivas 4

**Carlos Arze Vargas, Vladimir Díaz Cuellar, Alfredo Zaconeta Torrico, Adriana Zapata Rosso, Pablo Poveda Ávila, Iván Bascopé Sanjinés**

**CEDLA Press • 2017**

This publication is part of the series Reporte Industrias Extractivas, whose mission is to provide in-depth information and analysis on the extractive industries operating in Bolivia. This issue is exclusively devoted to the mining industry, and it features six reports by different authors. The first deals with the investments made in this sector amid the context of plunging prices experienced worldwide during the past decade. The second analyses the orientation of the mining policy promoted by the MAS administration from 2006 until today. The third focuses on zinc, Bolivia's leading mineral export, showing the many failed attempts to smelt it domestically. The fourth explores the case of indium, a very in-demand minor metal and zinc by-product that is abundant in Bolivia and is being exported without any kind of payment in return. The fifth provides an update on the state of affairs and advances of the lithium industrialization project and its future prospects considering the rapid changes in the international market. The sixth addresses the legal aspects of the "prior consultation" process, emphasizing the vulnerability of indigenous communities with regard to the ever-increasing presence of mining companies in their territories.

## Other publications of interest


### Un presente sin futuro El proyecto de industrialización del litio en Bolivia

Ricardo Calla Ortega
Juan Carlos Montenegro Bravo
Yara Montenegro Pinto
Pablo Poveda Ávila

Coordination
Juan Carlos Guzmán Salinas

CEDLA Press • 2014


### Discursos y Realidades Matriz energética regional, políticas del sector e integración regional

Juan Carlos Guzmán Salinas
Silvia Molina Carpio

CEDLA Press • 2017


### Proyectos de mejoramiento de la capacidad energética

Cuaderno de Coyuntura Nº17
December 2017

Lizeth Dayana Dávila Tapia
Javier Ernesto Rojas Ruiz

CEDLA Press • 2017


### Transformación de la matriz energética Discurso sin realidad

Cuaderno de Coyuntura Nº16
December 2017

Coordination
Silvia Molina Carpio

CEDLA Press • 2017

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