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La energía del Litio en Sudamérica

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Abstract: A central cause of global environmental change is the emission of CO2 emitted by the energy matrix, predominantly based on fossil fuels. As a result, we must face an "energy transition" supported by renewable and sustainable sources. Lithium batteries would contribute to this completely renewable energy system, as they could serve to traction transport, act as a sustainable energy reserve (which is mostly electric), and enable the mobility of multiple devices. In South America we find 80 percent of the most profitable lithium reserves in the world, in the "Lithium Triangle" formed by the Andean salt flats in Argentina, Bolivia and Chile, which generates the enthusiasm to participate in the emerging energy carrier. In this context, we will explore the world market of lithium and batteries, the overall situation of its exploitation, and the attempts to create a link between the Southern Cone countries with lithium reserves and their various attempts to manufacture lithium-ion batteries.

Keywords: Lithium-ion batteries, South America, Mining, Energý.

Resumen: Una causa central del cambio ambiental global reside en la emisión de CO2 emitidos por el tipo de matriz energética predominante, basada en combustibles fósiles. A raíz de ello, es preciso encarar una “transición energética” que se soporte en fuentes renovables y sustentables. Las baterías de litio contribuirían a este sistema energético completamente renovado, ya que podrían servir para traccionar los transportes, oficiar de reserva de energía sustentable (que es mayormente eléctrica) y posibilitar la movilidad de múltiples dispositivos. En Sudamérica se encuentra el 80 por ciento de las reservas más rentables de litio del planeta, en el “Triángulo del litio” que conforman los salares andinos de Argentina, Bolivia y Chile, lo cual genera el entusiasmo en participar en la emergente carrera de la energía. En este marco, repasamos el mercado mundial del litio y de las baterías, la situación general de las explotaciones y los intentos por generar una articulación entre los países litíferos del cono sur, así como sus diferentes intentos por fabricar las baterías de ion-litio.

Palabras clave: minería, baterías de litio-ion, América del Sur, energía.

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Introduction

The "energy equation" is a global problem, and one of the most important in outlining a diagnosis over the course of the global geopolitical components today. Even more so, considering that the civilizational model based on the consumption of hydrocarbons reveals limits that are as much as close as they are dangerous (Klare, 2008). Indeed, we are witnessing the slow but safe creation of a new world energy order: Restrictions to the "easy access" (due to "shrinking resources" and concentration of supply), ecological consequences of their exploitation (accounting for 56% of the greenhouse gases emissions recorded on the planet), increased demand of the Asia-Pacific economies; these are just some of the coordinates of the current scenario (Servin, 2012). If nothing is done, nothing will change this situation; that is, on a global scenario

of "continuity of policy", by 2035 global temperatures will rise 6 degrees, making it impossible to predict the consequences. Only a reduction in the demand for fossil fuels, rapid and sustained fall in energy intensity (the amount of energy required per point of GDP), and a decline of CO2 emissions would make it possible to expect a scenario in which the temperature goes up "only" 2 degrees compared to the pre-capitalist era (AIE, 2011). Under these conditions, if the "energy issue" is a central cause of global environmental change, it also represents a key lever for its solution.

Rich in natural resources, the Southern Cone stores in the salt mines of the highlands copious amounts of lithium, the basic raw material for the production of energy reserves that will be key to a post-fossil society. A cell phone, a notebook, a tablet—all functioning through the energy of lithium-ion batteries; without them a satellite would not go into orbit and spacecraft would not survive. Naturally, millions of cars burning fossil fuels across the planet could be replaced by electric or hybrid vehicles. The price difference between pure raw materials and the battery is significant: a ton of lithium carbonate costs around USD $6,000, while a car battery, which uses about 10 kg, ranges between USD $10,000 and $20,000. But the potential of lithium does not end here. The "transition" towards a sustainable energy system will require endless reservoirs of energy. Indeed, a society based on alternative sources must have decentralized storage modules, public systems and electric mobility, smart grids to calculate the energy used, stored and produced at home; lithium batteries would also be useful for all these. Lithium is, therefore, a mineral located at the heart of an ecologically sustainable society, with clean energy and technological innovation, which helps to avoid ecological and social dangers that threaten the nascent century. In short, combating climate change requires moving towards a sustainable energy system, in which lithium batteries will play a central role, entailing electricity reservoirs and sources of traction.

The abundant possession of lithium in the countries of the Puna (Peru, Bolivia, and Argentina, which together have 65% of world reserves) awakens an illusion of the possibility to exercise significant influence on the market of raw materials as well as in the production of complex lithium-ion batteries. Consistent with this spirit, visions have been spread that the "Saudi Arabia of lithium" is being conceived here, saying that a few countries—Argentina, Bolivia, and Chile—are the privileged possessors of "white gold" or "oil of the 21st Century.". Most academic studies and journalistic articles in our region have focused on the benefits of having the raw material. We propose another special emphasis on the necessary coordination between transformation of the energy matrix, the battery industry, scientific knowledge and regional policy, to highlight a model of renewed development for the region.

Central points of the world battery market

Any idea of industrializing and producing lithium batteries in the Puna region should start with the consideration that today the "Asian factory" is the main exporting hub. Japan and Korea have thus far been the pioneers in the research and development of this type of production, while China entered the market only as a producer of lower cost and quality batteries, but managing to also develop more than 100 local manufacturers (Ministry of Economy 2011: 10). Lithium carbonate imported by these three Southeast Asian countries amounted to 51.5% of the world total in 2013. In the same year, the region reached nearly 19% of electric lithium battery exports, or 45% if we add countries that function as re-exporters of those countries for tax issues (Singapore, Hong Kong, and Indonesia) (see Table 1). In other words, those three countries consume almost half of the global lithium carbonate to export almost an equal percentage of batteries and battery electricity, occupying an increasingly prominent place in the market. This share reached from 40% to almost 50% between 2001 and 2013 when world production almost tripled (indicating that they grew at a faster rate than that offered by the world market, and leading its expansion). China, Korea and Japan compete among themselves, which is one of the causes that contributes to depreciating the cost of batteries. If the production of batteries then is relatively narrow, it is further reduced if we consider the chance to manufacture all the technical components. According to engineer Juana Olivares, manager of a Bolivian prototype factory attempting to produce batteries in the region "in fact no country has the capacity to produce all components required, a country like China must import the separating membrane from Japan, which is the only country with the material and the necessary technology for over 20 years" (S/D, 2014: 1). This is the main reason why, for Latin American countries, the possibility of full battery manufacturing seems to be a difficult dream.

Table 1
Exports of lithium batteries in total values (in thousands of dollars) and by country (in %) (2001-2013)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Total world exports (value)												
Total (U$S)	715	776	1.044	1.170	1.129	1.157	1.233	1.468	1.485	1.815	1.871	1.965	387
Country	**World exports by country (in%)**												
USA	15,3	14,8	13,8	15,3	20,6	24,1	22,7	21,9	23,6	20,1	19,0	18,9	19,2
Singapore	4,29	5,02	8,20	8,32	6,08	6,03	6,78	9,50	13,4	12,4	12,8	14,8	16,5
Hong Kong (China)	3,98	4,40	4,30	10,1	13,8	9,95	7,98	7,71	7,60	8,92	8,92	10,5	1,29
Japan	29,2	26,4	17,7	15,1	13,5	14,6	14,8	12,4	9,49	10,0	9,83	9,19	7,66
China	1,46	1,97	3,72	4,21	4,87	3,86	5,07	5,04	5,12	5,60	6,16	6,32	8,62
Indonesia	1,82	2,27	1,97	2,32	3,18	4,08	3,83	3,29	3,43	4,25	5,45	5,52	7,81
Canada	0,52	0,87	0,55	1,00	1,57	2,02	2,67	2,25	1,65	1,47	2,97	4,96	4,81
Germany	7,70	7,61	5,85	7,83	7,25	6,77	6,38	5,41	5,44	4,65	5,64	4,95	6,23
France	6,38	7,08	5,93	6,18	5,31	6,23	6,00	5,83	5,25	4,62	4,96	4,85	5,11
United Kingdom	3,10	2,47	3,35	4,41	4,21	4,38	4,34	4,74	4,20	3,90	4,45	3,87	3,63
Belgium	4,79	6,82	5,94	5,29	4,67	3,66	3,08	3,07	2,82	2,66	2,90	3,17	3,25
Netherlands	1,42	1,59	1,82	1,29	1,10	1,06	2,99	3,21	2,15	2,25	2,66	2,58	2,73
South Korea	1,01	1,30	1,04	1,40	1,40	1,40	1,90	2,93	2,34	1,93	2,03	2,39	2,76
Switzerland	1,83	1,72	1,69	2,07	2,11	3,35	3,77	3,66	2,79	2,93	2,25	0,99	1,01
Mexico	4,59	1,57	0,91	0,47	0,46	0,24	0,34	0,23	0,76	0,94	0,70	0,93	0,71
Other	12,5	13,98	23,07	14,65	9,77	8,09	7,34	8,73	9,84	13,3	9,15	6,04	8,54
World Total	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: own elaboration based on TradeMap data.

In the future, the automotive industry and its flagship companies will be key actors in the process. In this case, the virtual depletion of oil, rising costs and/or pressure to move to a paradigm of "green energy", prompted the automakers to lead a race to find a new manufacturing process to produce electric cars, which has been slowly growing. Thus, in 2007 there were 500,000 units of electric cars when the total world car production was 73 million units (Cochilco, 2009: 7). Therefore, a small amount covered merely the 0,68% market share, although numbers have been slowly growing. In the central countries -dominant countries economically speaking-, none of the governments want to stay behind in what is presented as the future of the automotive market, as technological, labor, industrial and economic benefits are immense. Therefore, several countries are actively promoting the different companies to research and develop electric cars. For example, the United States Department of Energy has allocated US$ 2,400 million in subsidies for the development of batteries and electrical components for driving through the American Recovery and Reinvestment Act of 2009; US$ 940 million from that amount (almost 40%) must be allocated to the production of Li-Ion batteries. The live (Logistics for Implementation of Electric Vehicles) project plans to convert the Barcelona metropolitan area to the use of electric vehicles through the City Council, several companies and ngos (Ministry of Economy, 2011: 43). The German government has also provided supplies and support in a similar direction with the objective of producing one million electric vehicles in 2020 (Aguilar and Zeller, 2012: 21).

However, even if they can develop new technologies, the future of lithium cannot be tied exclusively to this. Although growth of the transportation industry can become its most dynamic engine, we must not exaggerate the role that lithium can play. On the one hand, although lithium is a central component of the industry, becoming almost irreplaceable -it is not a coincidence that the type of battery planned to be used is called, precisely, Li-ion- it is also true that the weight of the natural resource on the value chain is minor. In fact, to produce an electric car battery under current technology and value, it takes between 7 and 15 kilos of lithium, this being a cost ranging merely between 42 and 90 dollars per vehicle. However, the final value of a battery is between 8 and 18 thousand dollars, and given that lithium as a raw material, reaches a proportion close to 0,5% of the total amount (see Table 2). Therefore, if one considers that the batteries are only part of the total cost of a car, the weight that occupies the lithium in the final value is thus very low. That is why the automakers do not seem to care about the price of the resource, but they only conceive of it as the small supply they would need in the future. In this case, companies do not seek to have a monopoly of raw materials or be uneasy for the evolution of its price, because very little lithium is needed and even smaller is the capacity of it to influence in the final price of the vehicles.

In this scenario, most companies (whether European, Asian, or American) have decided to use as the main strategy to conform a partnership with various transnational mining companies by financing their projects such as exploration and development with the sole purpose of having access to the resource safely for long periods, ranging from 20 to 50 years. It is obvious that any company will not develop a long-term plan of multimillionaire technological restructuring without the confidence of the provision of inputs that it involves (Muscatelli, 2010). In Argentina, this type of strategy is fully shown. Thus, the Japanese automaker Toyota has partnered with the Australian miner Orocobre Ltd. to exploit the Salar de Olaroz (Jujuy). Magna and Mitsubishi (also from Japan) partnered as well in the Salar de Cauchari (Salta) to mining Canadian Lithium Americas, while Korean automaker Kores partenered with Lithium One (Chinese-Canadian mining) to develop the field Sal de Vida in Catamarca (Sevares and Krzemien, 2012: 141). Thus, automakers are a fundamental agent of the marketing chain but in no case claim exclusive control of lithium as their contracts with mining companies concern only part of the total production of lithium leaving them free to sell the product.

Table 2
Battery type by car and the incidence of lithium in the cost

Battery type by type of car	EV	PHEV	HEV
Battery capacity	25 kwh	12 kwh	2 kwh
Amount of lithium carbonate required	15 kg	7,5 kg	1,5 kg
Total cost of lithium required (≈ 6 U$S/Kg)	U$S 90	U$S 45	U$S 10
Final price of the battery (≈ 700 U$S/kmh)	U$S 17.500	U$S 9.000	U$S 1.400
Incidence of lithium in the final unit cost	0,51%	0,50%	0,71%

Source: own elaboration.

In short, the truth is that the battery market is pivoting to the Asian axis, which produces at relatively low cost and which controls key inputs. Moreover, the percentage of lithium in the total price of the battery is lower; hence, the great global production chains are only interested in ensuring their supply. Having reviewed the overall global scenario, we will now focus on the market for the raw material.

The lithium market

It is very difficult to predict the future, even more in a complex and changing era as the one we are living. But we know one thing: satellites, spacecraft, renewable energy, rechargeable batteries of cell phones, camcorders, tablets and digital cameras, pacemakers, atomic reactors, electric vehicles, antidepressant drugs, glass and ceramics, all of them use lithium as an essential element. So, it is very probable that the carbonate of lithium will be demanded in the world and it is very likely to increase further in the future. However, forecasts should not be exaggerated when it comes to lithium because there are many other elements to consider.

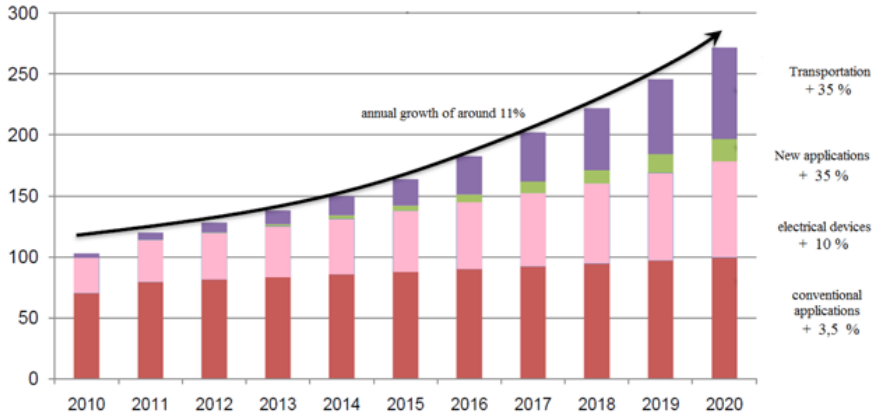
Firstly, we must say that the previous dynamics, which have been giving lithium an increasingly important place, correspond only to the current process of historical accumulation, which is as contingent and precarious as any other. The process of technological development is centrally conditioned by how nature is politicized. Technological cycles that govern us have demonstrated an unusual capacity to revolutionize and transform the world becoming increasingly limited and dynamic in time cycles, lasting less and less. Only the current level of development and technology have laid the conditions for lithium to have an increasingly central role but these conditions can change and disappear at a faster rate, even to the one with which they arrived. Many factors could transform delicately: the conditions of access to lithium could be facilitated making the price fall, allowing the use of every country in its own way (as resource tenure is not monopolistic). [1] Therefore, the goods which demand it as input can become obsolete rapidly, as well as the technology that promises to seek it in the future could never be consolidated and, if so, it could

easily find a substitute. The latter is especially true when one considers that the replacement of fossil fuels faces a long list of candidates contesting its relief: hydrogen batteries, biofuels, batteries, zinc-air and even new supplies almost unknown, based on "rare earths." In this sense, there is an over-reliance on lithium, for example, when considering it a wealth of an equal grade as fuel oil, when the real value is that the lithium battery is a young technology and not fully consolidated. Therefore, what should loom as central of lithium is not the recovery process itself of the resource. The central question is the effort to industrialize, add value and achieve the manufacturing of batteries locally; exploiting comparative advantages of the countries that already have the raw material. In this sense, we must consider that the place of lithium in the mining sector in the world is almost nonexistent. Argentina, for example, a country that has become the third largest producer, only held 1.14% of the national mining production in 2011, according to the Ministry of Mining of Argentina. Therefore, it is easy to realize how limited the market is and, that even if it grows, it will remain limited. Only in car production or energy storage for large-scale national power systems more lithium than what we need today would be necessary. However, if this happens, reservoirs that are profitable today to a lesser extent, as the extraction of lithium contained in certain stones, would become profitable; in fact, it is a mature technology that makes of Australia the second largest exporter.

The current market for electric cars has slowly been taking shape that projects certain crystallization, especially regarding lithium. The automaker Toyota Motor Corp. (Japan) has so far been the leader in the production of electric cars, controlling about 80% of this market, which it has been dominating since 1997 when it released its first electric model for sale. In turn, Toyota's associations with other Japanese electronics companies like Panasonic and Sanyo have also allowed them to lead the sale of batteries for electric cars. These conditions have given technological advantages in the market, forcing other automakers to enter into the electric age under their license Hybrid Synergy Drive ® (such was the case of Ford, Subaru, Mazda, and Nissan). At the same time, General Motors launched the Chevrolet Volt in 2012, ranking second in sales of electric cars while in alliance Renault-Nissan are to launch the Nissan Leaf electric vehicle in 2015. Similarly, Volvo, Hyundai, Kia, Mercedes Benz, Seat and Tesla Motors also have plans to launch their electric models soon (Ministry of Economy, 2011: 41). By 2025 it is expected that electric cars would occupy 20% of the automotive industry. [2] These figures imply, according to an estimate by Signum Box, that the demand of lithium (chart 1), only for the production of cars, will be 60 and 180 thousand tons for the years 2020 and 2025 respectively, taking into account what the different models of cars will demand and the number of them that will go on sale. [3] Meanwhile, the market for energy storage allowed by lithium is very important, since if the so-called "clean energy" (solar, hydro, wind, etc.) is imposed in the future, it will be indispensable to have accumulation sources and storage for it; in this context lithium

technology projects to become more efficient in this regard, and its market is projected to acquire the same dimension as the market of car batteries.

Chart 1.
Estimated tons of lithium carbonate demand required for various uses (in thousands) (2011 - 2025)



Source: FMC (2011: 9).

Thus we have one market that holds the previous dynamics of increase, growing 10% to 11% per year (base trend), one optimistic scenario with a growth of 15% annually, and one conservative scenario with a growth rate between 5 and 6%. Thus, under the three scenarios presented, lithium consumption ranges between 400 and 600 thousand tons by the year 2025. This is double or triple of what is required today, without representing a market of great size. Of course, all projections are only estimates, incidentals cannot be predicted, as it was the financial crisis of 2008 that brought down the consumption. These are exercises only intended to approach possible scenarios. Moreover, according to the different looks, the consumption of lithium will inevitably increase and this would generate both new conflicts and opportunities. However, making further speculations with a view to other variables is still harder. Moreover, only the future can tell what the region will make in the long run.

The OPEC of the Southern Cone

It is necessary to focus on the initial part of the economic chain in the Southern Cone. The opportunities for the region are large because Bolivia, Chile and Argentina all have 55% of world reserves of lithium and 87% of reserves in brines, which is the most profitable way to extract the mineral (Table 3). Similarly, having the resource has not been hitherto sufficient for the creation of supranational institutions; each country has different strategies of insertion in the world lithium market. In this sense, for now, Chile's interest lies in exporting the raw materials in their primary state, seeking to control the price and the market (Chile is the main exporter in the world of carbonate, followed by Australia and then Argentina) and shows no intention of making the battery and neither of building a sort of "Lithium OPEC " or "Opproli" (Organization of

Exporting Countries Lithium); it is closer to the free market promoted by the Pacific Alliance (Cochilco, 2009). Nevertheless, Argentina's and Australia's strong entry into production, the corruption scandals linked to transnational corporations connected to extraction, and the great benefits obtained with the advances in the value have led to attempts to analyze the role of lithium carbonate producers (Lithium National Commission, 2015). Nevertheless, what is happening in Bolivia is, far more interesting, since the government has decided to hold tight control over half of the world reserves of lithium in brine until it can produce the battery (Echazú, 2015). Today, to achieve this, the State is investigating its own ways of extracting lithium, a task that it is not finding quite easily, since it is technically more difficult than in neighboring countries due to their lower overall concentration and precipitation that delays the evaporation. Therefore, the pilot plant announced which would produce lithium and potassium has not yet started its operations. The business plan for lithium in Bolivia entails State control throughout the chain, only partnering at the stage of battery production with foreign companies. Finally, in the Argentinian case, FMC is based in the Province of Catamarca since 1998. It exports 17,000 tons of lithium carbonate per year. fmc entered into the production of the Salar de Olaroz in 2014, owned by Orocobre and by the state-owned company JEMSE of the province of Jujuy, which owns 8,5 percent of the enterprise. Regarding the exploitation of the salt flats, Argentina is governed by a privatizing "mining code" and it does not hesitate to weight and welcome the initiative of foreign companies (it is worth mentioning that the Province of Jujuy has declared lithium a strategic natural resource).

Table 3
World reserves of lithium by type and country (tonnes)

Country/Source	Pegmatites	Brines	Geothermal brines and oil wells	Clays (hectorite)	Jacarita	Total Reserves
USA	2.830.000	40.000	1.750.000	2.000.000		6.620.000
Canada	255.600					255.600
Zimbawe	56.700					56.700
Zaire	2.300.000					2.300.000
Australia	262.800					262.800
Austria	100.000					100.000
Finland	14.000					14.000
Russia	1.000.000					1.000.000
Serbia					850.000	850.000
Brazil	85.000					85.000
China	750.000	2.640.000				3.390.000
Bolivia		9.000.000 (1)				9.000.000
Chile		6.900.000				6.900.000
Argentina		2.550.000				2.550.000
Total by source	7.654.100	21.130.000	1.750.000	2.000.000	850.000	33.384.100

(1) In the original source contained 5,500,000. We've updated.

Note: (1)In the original source contained 5,500,000. We've updated.
Source: Cochilco, 2009: 11.

Now, there are not a few voices committed to create a "Lithium OPEC ", taking advantage of the high concentration of the resource that exists

in South America, in order to control their dynamics and price. In principle, everything that contributes to greater coordination between the countries that own the resource in the Altiplano is certainly welcome. However, attempts to build a "Lithium OPEC " on the basis of the Andean triangle that stimulates any pressure to force the "technology transfer" or to have control of the lithium market, face a series of obstacles. Firstly, mining and neoliberal Chile shows little interest in it, so it will continue to export lithium no matter who buys it, wrecking all expectations to constitute a sort of oligopoly. Secondly, Bolivia has not expressed great enthusiasm in an OPEC that brings her close to Chile, given the historical discord that has existed between the two countries since the War of the Pacific. Thirdly, as we have recently reviewed, Toyota—one example among thousands—owns 25 percent of the Salar de Olaroz, and nothing indicates that the Argentine government will reverse this or other holdings. Finally, another important limitation for the creation of a supranational institution has to do with to the unequal jurisdiction of the tenure and resource management of lithium: while the central state of Bolivia and Chile possess the resources (and are unitary countries) in Argentina lithium belongs to provinces (and there are three that have lithium: Salta, Jujuy and Catamarca, with very different plans and positions from one another). Therefore, coordination on this matter experiences yet another pitfall, let us imagine a future scenario in which the industry of lithium batteries consolidates and the Southern Cone countries decide to nationalize the raw material and shape a joint regional strategy. Undoubtedly, being the largest producers of brines in the world, they will have some ability to influence the market value of the commodity. However, as described, the percentage and value of lithium within the battery is lower, so that companies producing energy storage only seek to ensure its supply beyond what they should pay for it, and can get it from many sources. Thus, if the price of raw materials increases substantially, other exploitations would start to be profitable which still today they are not or they are so but only to a relative extent, so prices would tend to fall. Indeed lithium is not "unevenly distributed", it is possible to obtain lithium in many parts of the world (ranked 27th among the most abundant on the planet, there are over 150 minerals containing lithium, even in the sea); that is to say, lithium is a strategic resource but it is not oil or rare earths. Currently, the European Union no longer considers that its supply of lithium is in danger (GT *ad hoc* , 2014). In view of the foregoing, in geopolitical terms, there is no doubt that everything that contributes to higher levels of South American integration will be a good omen, but the key of lithium power to combat global environmental change and create a new model of development is not only in the simple control of the raw material, but primarily on advancing battery manufacturing. [4] We seek here to assess the unique relationship that exists between the different actors who play a role in the extraction operations. We begin from the evidence that salt flats are located in the Puna Altiplano inhabited by indigenous communities settled in the region for millennia. Above them,

the activities of transnational corporations and the different jurisdictions of national states are superimposed on a complex interaction between state and society. Community action in relation to the conversion of lithium into "white gold" has been heterogeneous. Both in Argentina and Chile the "landing" of multinational companies had receptive responses due to local spills of lithium that allowed the economy as well as others to be openly hostile. Indeed, due to environmental liabilities, consumption of water, the lack of participation in the management and profits, and competition with other activities such as livestock breeding and tourism, particularly strong in the Salar (salt flats) of the Chilean Atacama, the communities have organized themselves to counterweight the purely mercantilist vision of the territory (Bolados Garcia, 2013). For example, the 33 communities grouped in Salinas Grandes in Argentina, managed to stop any attempt to exploit lithium through a multifaceted strategy that in its legal aspect came to the Inter-American Court of Human Rights. In this sense, they are in tension and have different ideas and narratives on how to conceive the territory: if for the communities it represents their historic home, based on its economic and symbolic reproduction, for companies it is a simple mineral deposit. Moreover, most of the time, the nation-states are inclined towards a type of management that favors the creation of conditions conducive to the "investment climate", exceptionally taking the Plurinational State of Bolivia, which has decided to control the mineral.

The geopolitics of lithium in the Southern Cone

If the problems faced by a joint strategy in the Southern Cone for marketing are not small, neither is the strategy of those who see the chances of a lithium industry dedicated to the manufacturing of batteries. Overall, in the planet there is no absolutely proven lithium battery capable of enabling a similar performance to that provided by fossil fuels, to the point that it is possible to replace them. Today, the current lithium batteries have less power than fossil fuel, a discrete maximum autonomy (between 100 and 250 km), require a long charging time, are quite large and heavy, and carry the risk—certainly not innocuous—of burning. Because of this, the central countries are spending large sums of capital to overcome these shortcomings.

Creating a lithium battery requires multiple steps, from which the region has just taken the most basic ones to , have lithium carbonate - and perhaps not even that one and to some extent has pursued the last of these series of steps. More specifically, from point zero to the battery there are at least four basic steps: *1)* have the natural resources, where lithium is strategic, but not the only one, elements such as cobalt is even more so; *2)* processing these chemicals, which could be called "the passage from lithium carbonate to the compounds", that is, make the salts, among other chemical elements that are required for the emulsion that contains the battery, [5] *3)* produce the "physical" elements of the batteries, its "heart" It implies, for example, to make the cells, which requires "strategic

supplies" as separators, of very difficult composition; *4)* final assembly of the battery. [6] As mentioned above, relatively speaking our region is able to carry out the first of the steps in an industrial way in spite of the lack of cobalt, for example- and also the last step, but not the core or more difficult steps. [7]

Despite having the largest amount of proven reserves and economically profitable, Argentina, Bolivia and Chile still have a way to go to help a post-fossil society. In this sense, it is necessary to provide a minimum scenario of public policies, particularly those deployed in the three Southern Cone countries around the passage to get the "lithium batteries." We mentioned that Chile is not interested in making batteries since it is a traditional mining country and the fact is that it currently has technical capacity and prefers to buy the low price offered by their unregulated market in addition to not having a high demand. Thus, its refusal to make a strong strategy of added value is correlated to the neoliberal policies of the Andean country, focusing on carving strongly in the world price of single lithium carbonate. In this sense, Chile is carrying out a simple experiment: not even proposing a substantial addition of value. However, in recent times the country has started to realize that this strategy should coexist with other incentives aimed at adding value and greater state control of the lithium exploitation. [8]

Bolivia has proposed itself to reach the production of energy storage. The industrialization strategy has increasingly leaned towards the structure with foreign partners, but erratically. The partnership with Korean Kores-Posco in 2012 seemed profitable since it is one of the largest battery production companies and shows itself willing to make a significant technology transfer. However, this "society" is at risk due to a problem of patents and differences regarding the control of the resource, which is why the company will have greater extractive presence in Argentina, particularly in Salar Cauchari-Olaroz. Meanwhile, Bolivia has purchased a pilot battery manufacturing plant from a Chinese company, Linyi Gelon New Battery Materials Co., and made an agreement with the Netherlands that will provide training and a laboratory "turnkey" for accumulators. [9] The problem faced by these attempts is living in a sort of " factory fetishism " because it is not enough with it without the "business environment" and the "scientific-technical environment" in which you must be registered to operate effectiveness. In short, among the challenges to be overcome by the Andean-Amazonian country are the lack of local expertise, enough capital, market for batteries, all of which does not detract from the fate that has commanded the opposite alternative to being a mere producer of raw materials, project from the far Potosi has always tried successive times with obvious results. In this context, everything that contributes to the integration between Argentina, Bolivia and Chile would be particularly encouraging.

Furthermore, the industrialization of lithium is an important objective of the national state of Argentina. Around the year 2011 an inter-ministerial committee that acted as articulator between a number of scientists engaged in research of lithium batteries; they were interested

in producing business (Pla-ka) and a potential market in the provision of batteries was established for the "connect equality," which distributes computers in middle-level schools. Unfortunately, this commitment has had many twists and turns that would not be possible to describe here. It was not fructiferous, primarily because it failed to supply the suppliers of computers. After this initial setback, with the creation of the company YPF Tecnología, constituted by the recently nationalized YPF and the National Council of Scientific and Technical Research (CONICET), oil came into play. With this new venture, the set of scientists who know of battery production have moved their research here. However, beyond the commendable efforts of the scientific wing, it still remains pending a State assumed policy that is planned, coordinated, interdisciplinary, and agreed upon to overcome the recurrent obstacles faced by the existing attempts. In the deployment of active public policy lies a central key because in Argentina there are companies with experience in the field of battery assembly. "Production" of electrical appliances which requires accumulators (netbooks, cell phones, etc.), promising areas (lithium batteries for bicycles, motorcycles, cars), a scientific network in operation, a policy area that can coalesce to achieve objectives. In sum, there are certain structural conditions of scientific, economic and political environment that can accommodate the chances of making batteries. However, we assume that the attempt by a single peripheral country, as Argentina, may most likely not be enough (Fornillo, 2015b).

Finally, the dominant countries and their flagship companies do not have any interest in decentralizing production processes, technology, or cutting-edge knowledge. In fact, it is quite the opposite case—they make great efforts to prevent the loss of control of these production processes as the bulk of earnings now come from the "innovation rents", *i.e.* , those technological border goods that allow them to "surround" market shares (Miguez and Sztulwark, 2012). Is it possible that a calculated windfall could lead an electric car to sell at a competitive price as compared to a regular car? Following from this situation, all that is decentralized is obsolete technology. It is not by way of "seduction" of global giants that we will have batteries or parts thereof in the South. Although it may be necessary to make some connection to "complete" a local process, and at this point several options appear, although China appears to be the most receptive country. Moreover, one thing is production in the hands of a transnational corporation and another one is a technological process based on strong local roots.

Towards a South American scientific-industrial joint initiative

We live in a planet involved in a process of geopolitical and ecological "transition" where nature is at the service of a new field of accumulation and financial recovery under an extended "privatization of resources." Thus, accelerated and continuous consumption of vital natural resources have increased progressively their value on a daily basis. Given the

destructive entropy and the type of metabolism of capital itself, the existence, operation, and transportation of natural resources will slowly draw a new "geography of conflict." In this context, South American countries are under the pressure to restore the classic inter-industrial exchange: these are markets with high added-value products and technology while at the same time they "export nature," key to the externalization of environmental costs of the central countries; globally, the cards are dealt. In a given point, at the time of adding value to lithium, it become less important to come from the countries where the raw material is used than to come from those capable of making use of innovation revenues, and in this aspect the world areas who are most important in production, technology and innovation Southeast are Asia as well as the United States and a few European countries which are more and more besieged by the competition to the Asian power. The "Lithium OPEC " conformed by Argentina, Bolivia and Chile do not make great sense if it remains tied to the control of extraction and exploitation, to which dominant countries would condemn us. If we finally define the concept of Natural Resource Strategy, we must accept that the status of the "white gold" is relative, and, therefore, we must pay special attention to another geography.

Indeed, rather than speaking of "Saudi Arabia" or the " OPEC " (or "Opproli"), images that continue to refer to the presence of the raw material in the Altiplano highlands, we believe it is accurate to speak of "Lithium in South America". At best, each country makes its best efforts, such as Argentina could eventually produce lithium batteries, but the local market is not very large and it would be very difficult to compete internationally. Potentially, we understand that when thinking about the possibility of generating a commercial framework that supports the demand for batteries and an accompanying scientific and technical environment, it would be desirable to draw a regional strategy that includes Brazil, brandishing a public policy of continental character. Although this scenario is a long term one, in this way it is possible to think of a potential large enough battery market in more states with more resources, in a still strong export industrial platform, and in the possibility of splitting and coupling manufacturing processes; in sum, there would be a chance to think about economies of scale in manufacturing that allow insertion in the world market. As in other areas, the South American integration is presented as one of the most dignified way that can be approached. Thus, it is here where thinking about a lithium industrial fabric robust enough to meet US production, or those more powerful in Southeast Asia (in Asia there are centers of innovation, increased production of batteries, giant automakers, as we have shown). We are not talking about a minor attempt; on the one side, it is not easy, but on the other, its centrality lies in that the lithium batteries today are intended to be key to the energy future of the planet, both for electric cars and for post-fossil storage systems.

Thanks to lithium batteries, the possibility of participating in the nascent technological pattern opens then the sustainable energy carrier

as well as a significant potential market. The opportunity is not minor: it is to combat climate change, contribute to creative development models and gain economic and political sovereignty. Lithium is just a prism through which we can glimpse a possible way of making a transition to an alternative economic and social model. It must—as Koldo Unceta holds—discard the axioms of "growth" supported in the increase in the GDP to adopt a post-growth approach that values human activities in relation to their contribution to welfare (Unceta, 2014). A post-growth logic involves a commodification strategy (reduce the market sphere), dematerialization (lower flow of energy and materials), decentralization (reduction and decentralization of the production scale), and the "energy of lithium" if politically well conducted, can certainly contribute to it.

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Notes

1 A recent case in the direction of change of lithium mining techniques was called "cones techniques" that would allow lowering the brine evaporation process, which may delay between 8 and 12 months, but with new techniques, it would be reduced to just one week significantly reducing costs and processing times. Moreover, China and Korea are experimenting techniques to extract lithium from the sea, although it is not easy. Finally, an Argentine scientist, Dr. Calvo, already patented a form of lithium production that would not require water.

2 There are three ways and they could be seen in Aguillar and Zeller (2012: 22), FMC (2011: 9-12) and Ministry of Economy (2011: 42).

3 For example, the Toyota Prius battery plug-in requires 3.6 kg of lithium carbonate, the Mitsubishi-iMiEV between 10 and 15 kg, while the Tesla Roadster will require between 40 and 50 kg per unit (Desormeaux, 2012).

4 For a definition of lithium as a strategic natural resource and potential "income" of the raw material see Fornillo (2015a).

5 Note that the European Union made a paper on those considered "Critical Natural Resources", measuring their "criticality" according to their economic value and supply risk, and lithium has a risk of 0.7 and cobalt 1, 1 in a table that goes from 0 to 5, this high level rightful alone to the "rare earth". (GT ad-hoc, 2010).

6 For a good description of the chemical and physical elements required to assemble a battery, see Andreotti (2012).

7 Certainly, if the region can make critic and nuclear steps battery (points 2 and 3), it would have a battery produced in the region, but to give at least one of them needs *a)* very sophisticated machinery and technical capacity, *b)* knowledge and scientific use, design or "reverse engineering" patent, which the central cares very much -a Chinese businessman confessed to an Argentine scientist "We were never going to give licenses to manufacture batteries" -, *c)* of course, capital needed to invest though the sums are not very high. However, the realization of the process does not end with the happy presence of the battery. Assuming a good equation to allow manufacture it locally,

they have to be sold at a competitive price to a market willing to buy them. Thus, given the constantly changing patterns of energy storage market, it is a requirement that all the above steps are performed robustly to always bordering the "technological frontier". If all these obstacles are overcome we can have consolidated industry battery production in South America. It is clear that the problems are not minor, but that does not mean we are, by far, in the most interesting scenario.

8 During 2015 a "National Commission Lithium" produced a report recommending to the executive government that the state has a greater presence in the holdings of lithium, partnering with private companies (Lithium National Commission, 2015).

9 The agreement entered into with the Netherlands assumed that the Technical University of Delft trains Bolivian professionals who work in a laboratory for the development of batteries; the Dutch company -Energy Innovators- BTI will be responsible for designing and building the factory; Da Vinci Laboratory Solutions support in organizing the laboratory; Boon consultant will coordinate the efforts of the different partners. It is said that Bolivia will pay $ 45 million for the laboratory, factory, and technical assistance.

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