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The battery business: Lithium availability and the growth of the global electric car industry

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ABSTRACT

This article presents a spatial analysis of lithium availability from the mid-twentieth century to the present time in order to clarify and contribute to the growing body of scholarship on the relationship between the global lithium supply and the viability of a modern, mass-market electric vehicle industry. Drawing on archival research conducted in Bolivia in 2012, this article advances the argument that the concept of 'lithium scarcity' is much more nuanced than is often portrayed. In addition, perceptions of a worldwide lithium shortage are more entangled with business demands for certain grades of lithium at certain price points rather than actual scarcity. This analysis of lithium availability is defined in terms of the basic tension between the supply of extractable lithium deposits on the one hand and the quality and price demands of battery manufacturers on the other. This tension has played a role in determining the evolution of the electric car from a luxury to a mass-market product and involves a host of complementary and competitive business and geopolitical actors.

1. Introduction

Lithium (Li), the world's lightest metal, has been viewed as the critical component for accelerating and enabling the next incarnation of electric batteries – a key input into the global electric car industry (Vikström et al., 2013; Grosjean et al., 2012; Kushnir and Sanden 2012). More specifically, "a new generation of lithium-ion batteries, coupled with rising oil prices and the need to address climate change, has sparked a global race to electrify transportation" (Tollefson, 2008). Despite the geologic abundance and geographic diversity of global lithium resources, the price of electric battery-grade lithium has increased dramatically in 2015–2016. As a result, in November and December of 2015, the price per ton of 99% pure lithium carbonate (the most sought after type of lithium for electric car batteries) imported into China, increased by more than two-fold to $13,000 (The Economist, 2016a, 2016b). In the six months ending in May 2016, the price of pure lithium being exported to China increased 42% (Yu, 2016). The main reasons for this dramatic and rapid price surge include: a "supply squeeze" of lithium that is exported to China, long-term demand from start-up and established electric vehicle manufacturers, and the growing global market for portable electronic devices, electric tools, and grid storage applications (Jaskula, 2015; Yu, 2016). In spite of the widespread uses for lithium in various industrial and chemical applications, the main market for lithium during the 21 st century is expected to be for use in electric vehicles (EVs) (Gruber et al., 2011).

The timeliness of the growth in demand for lithium has to do with a combination of business-side (quality and price) factors more so than the literal scarcity of elemental lithium in the earth's crust. According to one recent study, lithium is readily available on earth and the world could triple lithium production from current levels and still have 135 years of supply available using solely known reserves (Jaskula, 2015). So why is there a global scramble for lithium resources at this point in time? It is the recent and rapid *consumption* of lithium in battery applications (growing 73% during the 2010–2014 period), during a period of comparatively low-growth (28%) in the *production* of lithium that helps to explain the increase in the price of raw lithium (Chatsko, 2015). This *consumption-production imbalance* is a driving force in creating an atmosphere of uncertainty surrounding global lithium availability today and serves as the unifying concept through which the distinct parts of this work connects into one cohesive whole.

One of the principal factors contributing to the hesitancy of some major automobile manufacturers contemplating the expansion of their electric vehicle (EV) offerings is the perceived global lack of access to lithium resources. The 'scarcity issue' has led lithium to be recently dubbed by The Economist (2016a, 2016b) as being "the world's hottest" commodity. Such concerns, especially

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among aspiring battery-producing economies – such as China and the US – have contributed to the doubling of the price per ton of lithium in the last two months of 2015. This phenomenon has played itself out on the geopolitical stage with different countries vowing to 'outpace' each other to become the dominant leader in lithium battery development, and by extension in the global electric car industry. The geopolitical rhetoric between countries has taken on dimensions more characteristic of competing multinational corporations (MNCs). Such concern about access to perceived scarce quantities of lithium is often given as the major limiting factor preventing the rapid and significant global expansion of the electric car industry.

In addition, because no single country has a monopoly on lithium resources and production, and because of the perceived national economic benefits that can be realized from investing in transforming the electric car from a luxury to a mass-market product, the geopolitical competition between countries that want to take claim for being at the forefront of the new electric vehicle industry, has spurred a 'battery war' (Levine, 2016).

According to Levine (2016: 8–9), "[T]he leaders of most of the world's industrialized countries – Japan and South Korea, Brazil, Finland, France, Germany, Israel, Malaysia, Russia, Singapore, South Africa, and the United Kingdom, not to mention the United States and China – decided it was a race, and so it was. In the words of a French Government minister, it was a "battle of the electric car"".[1] These realities of lithium procurement define the basic tension between the supply of extractable lithium deposits on the one hand and the quality and price demands of battery manufacturers on the other. It is this tension that has played a role in determining the evolution of the electric car from a luxury to a mass-market product and involves a host of complementary and competitive business and geopolitical actors.

To understand this tension, this paper uses the *consumption-production imbalance* to first consider the ways in which society has come to view lithium as increasingly valuable at this point in time. This exploration of the 'materiality' of lithium is crucial to understanding the likely growth and success of the electric car industry. Demand for lithium consumption appears to have surged ahead of lithium production over the last decade. The paper then engages in a brief history of the development of electric vehicles – trying to make sense of how demand for lithium (in the form of EVs) was not always alighed with production targets made public by EV manufacturers. Following this a spatial analysis of global lithium reserves and business actors is undertaken. Finally, the paper considers the economics of the lithium market, and explores the links in the lithium global supply chain in light of the needs of the EV industry.

2. Materiality of lithium

The idea central to the materiality of lithium involves an understanding that the recent surge in interest and in the cost (price per ton) of lithium is predicated on the *social value* that this metal has come to inherit and not on its literal scarcity. The recent increase in the social value of lithium has contributed to the increased *consumption-production imbalance* which lays at the heart of contemporary competition for lithium resources. Borrowing from Bridge(2009: 1218) it is the "irreducibly social nature of resources and the interactions that govern their availability and allocation" that have helped highlight contemporary academic and mainstream debates surrounding lithium extraction and development. The notion that resources are:

> "'natural things' also acts as a powerful blinder, as it obscures the way all resources are – necessarily – cultural appraisals about utility and value: the allure of diamonds, for example, has everything to do with the way these small, surprisingly common nuggets of carbon have become associated with a complex set of social understandings about wealth, beauty, love, commitment and power"

(Hartwick, 1998; Le Billon, 2006 in Bridge 2009: 1219) Likewise, lithium's value derives from its energy storage properties, low-weight, (potential) reliability, and perhaps most of all, its perceived usefulness in countering fossil fuel emissions – a key component of anthropogenic climate change. The current exploitation of and continued exploration for new lithium resources highlights the scale/quality paradox that Bridge refers to as one of the contradictory dimensions of 20th century resource mobilization.

In the traditional resource extraction arrangement, we see the production of more resources from lower quality reserves or supply. Evidence of "the 'technological treadmill' in natural resource industries: that is, the need for technological advance to offset the rising costs associated with extracting and processing resources of declining quality" (Hanink, 2000 in Bridge, 2009), can be seen – in the case of the existence of the process of extracting lithium from seawater. In 2010, South Korea declared that it will be able to extract lithium from seawater by 2015 (though at five times the current price of extracting lithium from lake brines) (Oliver et al., 2010). Also, as exploration continues, it is possible that higher quality resource stocks get discovered. In this sense, the very nature of the value of lithium is closely connected to its 'materiality' – its temporal and social utility. This premise – focusing on the materiality of a lithium – is central to understanding the current concerns that many potential electric battery manufacturers are faced with today. One of the most prominent cases involving the lithium scale/quality paradox relates to the abundance (scale) but low purity (quality) lithium in Bolivia – the country with the largest known reserves of lithium on earth (See Section 5.2).

Aside from the sheer quantity of lithium available, political stability of the host country, evaporation rates[2] and chemical purity also play a role in determining from which reserves EV manufacturers decide to source lithium. The materiality of lithium is also concerned with potential economic and environmental costs as well. While concerns exist about the negative social and environmental impacts (Harvey, 2014; Wan, 2014) of extractive mining, the way that lithium 'fits in' to the overall mineral extraction story is quite unique. Unlike most other types of mining, including artisanal and small-scale mining (ASM) which is often characterized by a heavy reliance on manual labor, hazardous working conditions and more frequent negative human and environmental health impacts (Hilson, 2002), one of the ways in which the bulk of lithium is harvested is through lake-brine evaporation – a process that is comparatively less harmful to people and the environment. In addition, as Langston et al. (2015) make clear, the mining industry is not homogenous and . . . policy approaches for dealing with the impact of specific mining activities require understanding the particular economic, political, social, and environmental context (Intergovernmental Forum on Mining, 2013). In the case of lithium extraction and production, all of these factors in combination are leading the metal to become increasing valuable to start-up and more established electric vehicle developers. Critically, the likelihood of yet undiscovered lithium

[1] French ecology minister Jean-Louis Boorloo, quoted by Agency France-Press, October 2, 2009.

[2] Even within the South American Puna Plateau evaporation rates differ dramatically: Salar de Atacama, Chile (3500 ml per year); Argentine Puna (2600 ml per year), Uyuni, Bolivia (1300–1700 ml per year).