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Battery global value chain and its technological challenges for electric vehicle mobility

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Abstract

Development in electrical energy storage has attracted several researches due to its solutions multiplicity. The research focus of this study was to identify the main features of battery global value chain for urban light electric vehicle in South Korea and Japan. The global value chain is utilized to analyze company core competencies to achieve cost reduction and product differentiation, thereby increasing productivity and profits, and finally, the macroeconomic growth of a country. Interviews, to obtain primary data, have performed overseas at Japanese and South Korean companies, involved in the production and sales of batteries. From the data analysis, it can be inferred that there are global integration prospects of the value chain with the production of some components out of these Asian countries and Brazil as a potential participant. This exploratory research has mixed methods of data gathering, i.e., triangulation. With regards to data collection, documents available from companies were analyzed; plants and R&D centers were visited to performing interviews with executives. Within the global value chain, ensuring lithium supply has become priority for companies. Thus, lithium mining could be a path for Brazil to become part in the battery global value chain. This argument is justified in two ways. First, Brazil has technology and experience in mining provided by the Vale Company. Large lithium reserves are in neighboring countries in South America. Second, Argentina is a MERCOSUL member and it could be beneficial to both countries to extract lithium for batteries. The main technical challenges faced by electric vehicle are the battery lifetime as well as the need for a specific charging infrastructure. Furthermore, Brazil will face challenges and opportunities in developing high-value activities within battery global value chain. The public policy suggested is to map the components from battery global value chain and highlighting those that can or should be produce in Brazil for strategic technology development.

Keywords: Electric vehicle battery; Sustainable innovation; Global value chain; Urban mobility; Automotive industry

Introduction

Although oil prices have presented a downward trend, more than 712,000 electric vehicles were sold worldwide in 2015, mainly in the United States, Japan, China, South Korea and Germany. In Brazil, until the end of 2015, just over 840 electric and hybrid vehicles were licensed (ANFAVEA, 2016, p. 61).

The alternative development for internal combustion engine, either for purely electric or hybrid vehicle, has attracted the Brazilian researchers' attention. However, outside of Brazil, the issue about electric vehicle development is well known. Thereby, Chan states that the successful production and marketing of electric vehicle depends on overcoming many challenges, including availability of products with displacement of autonomy at an affordable cost; availability of efficient and easy to use infrastructure; availability of business model to leverage the cost of battery (Chan, 2011).

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Aside from these challenges, scientific articles are constantly reporting new progress in this area. For example, Xinghu (2010) from the introduction of electric vehicles in China analyzed the shortcomings in the energy sector. Du, Ouyang, and Wang (2010) studied business solutions for the mass penetration of electric vehicles first generation in China. Kudoh and Motose (2010) studied the preferences of Japanese consumers in the use of electric vehicles.

Thus, for these authors the traditional mobility based on fossil fuel is going to end. The transition to electric vehicles is a revolution in mobility standard and it represents the trend for the future. About that trend, the former Saudi Arabia Oil Minister in the 1970s, Sheik Ahmed Zaki Yamani, said: "The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil" (The Economist Group Limited, 2003).

The Japanese, South Korean, Chinese and German automotive industry, have shown increasing concern about oil fueled mobility. Japanese and South Korean industries are more experienced in the production and marketing of light electric vehicles on a large scale. Thus, studying the electric vehicle global value chain and Brazil's potential participation in this chain becomes important topic for Brazilian researchers.

Within this context, the adoption and development of technologies for electric vehicles should not ignore Brazil, the eighth largest consumer of automobiles in the world (OICA, 2016). Thus, Brazil needs to clearly understand where it can explore opportunities in this new global value chain. The research problem of this study can be stated as: What are the main features of battery global value chain in Japan and South Korea?

The research focus is to identify the main features of battery global value chain for urban light electric vehicle version in South Korea and Japan. These two countries, unlike other countries, have met the challenges of mass production and sales of electric vehicles for over two decades. In addition, their researches provide some insights into the potential participation of Brazil in this value chain. The study aims to verify the main technological challenges concerning battery value chain for electric mobility.

Thus, discussions about the feasibility of Brazil automotive industry development based on electric propulsion are expected. In Brazil, other global value chains have been subject of foreign researchers. For example, the study by Sturgeon, Gereffi, Guinn, and Zylberberg (2013) about Brazilian industry participation in the global value chain of following industries: aerospace, electronics and medical equipment. None about electric vehicles global value chain study was found.

It is justified the need to generate more understanding of this economic sector, because a preliminary review of the national literature on the subject, has produced few Brazilian papers result. A search with key words "electric car" and "electric vehicles" in traditional database (Web-of-Science, 2015) highlighted the low involvement of Brazilian Academy in the knowledge creation on that subject. Therefore, this seems to confirm that many researchers are involved in traditional automotive industry studies and they have not yet turned their attention to electric vehicles.

Theoretical framework: battery global value chain

According to Porter (1998), value chain is the relationship among the company and its suppliers upstream and downstream. That value chain approach is utilized to analyze the company core competencies to achieve cost reduction and differentiation. There are two types of value chains: primary activities, including inbound logistics, operations, distribution logistics, marketing, sales and service; and support activities, such as infrastructure, human resource management, technology development and acquisition.

This approach has been extended to global value chain analysis based on global supply and logistics. In recent years, many industries have become distributed geographically in networks with global supply activities in various countries. Within these networks, some sites may be specialized in certain activities and, the value added to them can be distributed among several locations, i.e., they may cover among several countries and companies. Thus, it is defined the concept of GVC, Global Value Chain (Sturgeon et al., 2013).

The Global Value Chain is utilized to analyze company core competencies to achieve cost reduction and product differentiation, thereby increasing productivity and profits, and finally, the macroeconomic growth of a country. An intervention that responds to chain deficiencies (e.g., non-compliance with established technology standards) moves the company to more sophisticated capital niche with intensive qualification.

Fournier, Hinderer, Schmid, Seign, and Baumann (2011) state that in the electric vehicle industry, batteries and its electronic components stand out in the value chain as result of significant technological challenges. Besides that, batteries have less durable components, requiring constant replacement. According to Castro and Ferreira (2013), there are four types of batteries that competing to establish a standard for the electric vehicle industry: PbA (lead acid); lithium-ion battery; NiMH (nickel metal hydride) and sodium, also known as ZEBRA, Zero Emission Battery Research Activity, fully recyclable and tending to be cheaper than lithium batteries.

The history of batteries is related to the history of electric cars – the mid-nineteenth century. It was in 1859 that the Belgian Planté held the demonstration of the first lead-acid battery, used by many electric vehicles developed from the early 1880s in France, UK and USA. Shortly afterwards, in 1885, Benz demonstrated the first internal combustion engine. In 1901, Thomas Edison, interested in the potential of electric vehicles, developed the nickel-iron battery, with storage capacity 40% greater than the lead acid battery. However, the cost of production was much higher. The nickel–zinc and zinc–air emerged in the late nineteenth century (Hoyer, 2007).

Batteries have different durability according to the technology used, the type of usage and storage conditions. The factors that affect battery durability are extreme temperatures, recharge overage and full battery discharge. Manufacturers estimate useful battery life at 150,000 km and 5 years of durability. With regard to lithium-ion battery, Dinger et al. (2010) explore the value chain stages, as shown in Fig. 1.

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