RECHARGEABLE BATTERIES – POTENTIALS AND FUTURE CHALLENGES

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Abstract. *In most of the countries the governments decides to reopen their economies after months of total economy shutdown. The time will prove if it was too early or if we will have a second wave and how people will react to that. In any case, many governments, at least from EU, seized the opportunity and decided to grant financial aids to most important companies under the conditions of investing in research and development of new products, less fossil fuel consuming. For example, Airbus will receive from French government a total financial aid of 15 billion EUR. Out of this amount, 1.5 billion euros will be invested over three years in researching into new environmentally friendly aviation technology. For the automotive industry, French president Macron announced 8 billion EUR financial aids, but under the condition to produce over 1 million clean-energy vehicles in the country by 2025. Giving the circumstances, it appears that rechargeable batteries (one of the main component of electric vehicles but very important also in other industries as mobile phone, tablets, laptops, cameras, e-bikes, medical devices, etc.) will be an area of maximum importance in the next years, therefore analysing the impact of political decisions taken after coronavirus crises in this sector might be very useful.*

Keywords: *clean energy, electric vehicles, GHG reduction, lithium-ion batteries.*

JEL CLASSIFICATION: L 72; O 10; Q 53; R 48.

1. INTRODUCTION

Almost all countries (197 countries representing 87,75% of emissions) agreed, in 2015 during COP 21, to take actions in order to maintain the level of global average temperature to well below 2°C above pre-industrial levels; more than that it was decided to strengthen efforts to limit the temperature increase to 1.5 °C. Since then (almost 5 years past), we have observed a permanent preoccupation to put in place this decision, the most common being the replacement of fossil energy with green and clean energy, which today is a phenomenon in continuous expansion, less expensive during time and easy to implement everywhere around the globe (for example, wind and solar energy) [1-3].

It was demonstrated that the cause of global warming is the permanent growing of greenhouse gas emissions released in atmosphere by human activities. There are different type of gases grouped under the GHG label (nitrous oxide 6%, methane 16%, carbon dioxide from forestry and land used 11% and carbon dioxide from fossil fuel and industrial processes 65%, and fluorinated gases 2% [EPA, 2014].

Taking into consideration the willing of countries to reduce the global warming, diminishing the quantity of CO2 produced by human activities is one of the most direct and efficient measure that can be taken. According to various sources, 28% in US [EPA, 2018] and 23,8 % in EU [EEA, 2019] from CO2 emissions are due to transportation, which represent an important part of total GHG. In our attempt to reduce the human carbon footprint on the planet, finding cleaner solutions for transportation would be an important step forward. Replacing traditional internal combustion engines cars with electric vehicles is a necessary technological advancement in order to have a proper atmosphere.

If the first electric carriage was invented in 1832 by Robert Anderson and first practical electrical vehicle in 1835 by Thomas Davenport, the world first commercially mass-produced hybrid car was Toyota Prius in 1997. Since then many other companies launched on the market different cars, the most known being Tesla, Nissan, Renault, etc. If the problem of CO2 was solved it remains that of a powerful battery and charging infrastructure. In most developed countries things are advancing from this point of view, but in many others, charging points are very rare, which make impossible a daily using of an electric vehicle [4].

We have to realize also that even the total renewal of vehicle fleet with 100% electric vehicles is not a complete zero-carbon solution. We will not have the usual CO2 emissions but even with electricity necessary to recharge the batteries coming from renewable sources there would still be an environmental cost. We have to consider the minerals used for batteries as well the dismantling batteries which have finished their lifetime; building the EVs will require certain activities producing CO2, delivering the vehicles to customers worldwide – usually by sea, etc. – all these activities will imply important CO2 emissions, therefore breaking all the links with the current industrial model is impossible.

2. CURRENT CONTEXT

After Corona crisis, car industry is one of the most affected, the decline in sold new vehicles being consistent for all producers in all countries. Companies were forced to ask financial aids in order to survive and, as mentioned before, governments decided to help them but under the condition of producing more EVs. Most of the automakers were already present on the electric car market even before the crisis, so producing more EVs will not be an impossible task for them. Still, giving the actual limitation in term of battery they have to focus more on this area.

In order to better understand the geopolitical environment of the rechargeable batteries sector we have to look closer to the lithium-ion batteries (LIBs) as being the most efficient and cost effective product comparing with other batteries. This new shift in rechargeable battery necessity will increase the demand for certain raw materials as lithium, nickel, manganese, cobalt, natural graphite, etc. It is well known that generally, exploiting natural resources is negatively linked with sustainability, worker protection, child labour and corruption. Giving the limitation of these specific raw materials there is also a problem of demand and supply since there is a growing demand but the distribution remain concentrated in only few countries.

The main raw materials necessary for LIBs construction are cobalt, lithium, manganese and graphite. Today it is estimated that the world cobalt resource could be 25 million tons – potentially feasible to extract. Most of these resources are found in Africa copper belt (Congo and Zambia) but also in different mixtures in few other countries like Australia and Canada. According to USGS in 2018, the world total cobalt reserves, which could be economically extracted, were estimated at 6.9 million tons [4].

The Democratic Republic of the Congo is from far the leader in term of reserves of cobalt in the world (3.4 million tons, almost half of the entire exploitable quantity). Australia and Cuba are on the second and third position in term of cobalt reserves, with an estimation of 1.2 million and 0.5 million tons respectively, followed by the Philippines and Canada with smaller quantities.

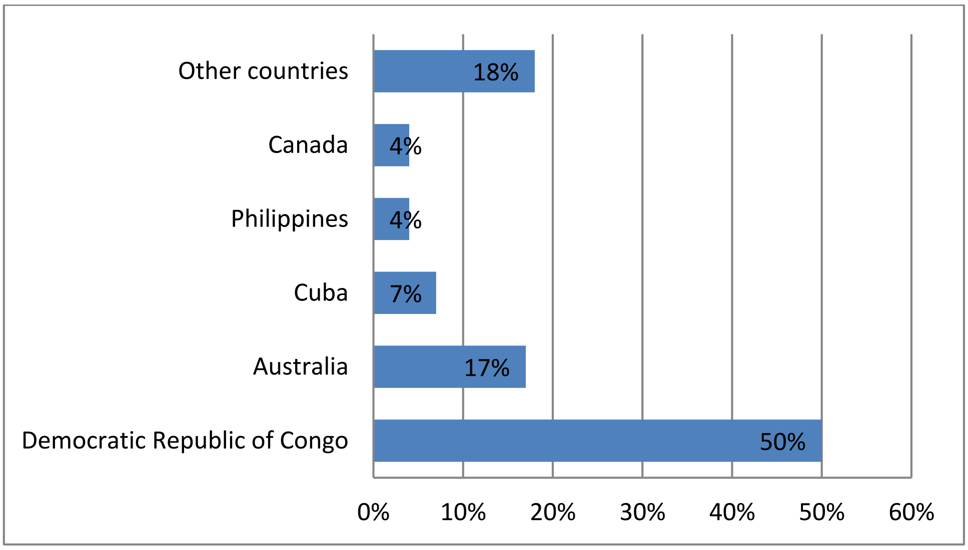

Fig 1. Cobalt reserve distribution

Sources: Information Center (2018) report. *https://www.usgs.gov/centers/nmic/publications*

Some geological research identified approximatively 120 million tons of cobalt under Atlantic, Indian and Pacific Oceans at more than 6,000 meters water depths. Taking into consideration all the legal, technological and environmental challenges aspects as well as the economic profitability, such type of exploitation is almost unfeasible, therefore we didn't take into consideration in our analysis.

Cobalt is employed in many industrial areas but also in military equipment. In different alloys, due to its high resistance to corrosion, cobalt is used also in gas turbines, aircraft engines, space vehicles, and chemical and petroleum plants. Around 50% of the world's cobalt production is consumed in the manufacture of cathode material in the fast-growing market of rechargeable LIBs used in electronic devices such as laptops, smart telephones, power tools and other technology devices, and in hybrid and electric vehicles [5].

Despite its natural resources abundance, from geopolitical perspective, Democratic Republic of Congo situation is more than alarming; the county is passing through a terrible conflicting period after a civil war, the political life being dominated by instability. The outbreak of Ebola disease in 2019 makes the situation even more stressful. Access to local cobalt resources (quite reach otherwise) may become very complicated and if we take into consideration the growing need at global level, the pressure for this commodity becomes even higher.

Another important element of LIBs is lithium. These resources are concentrated especially in South America – Chile, Bolivia and Argentina, so called "lithium triangle". Total world resources are estimated at 62 million tons and total world reserves are estimated to be 14 million tonnes [6].

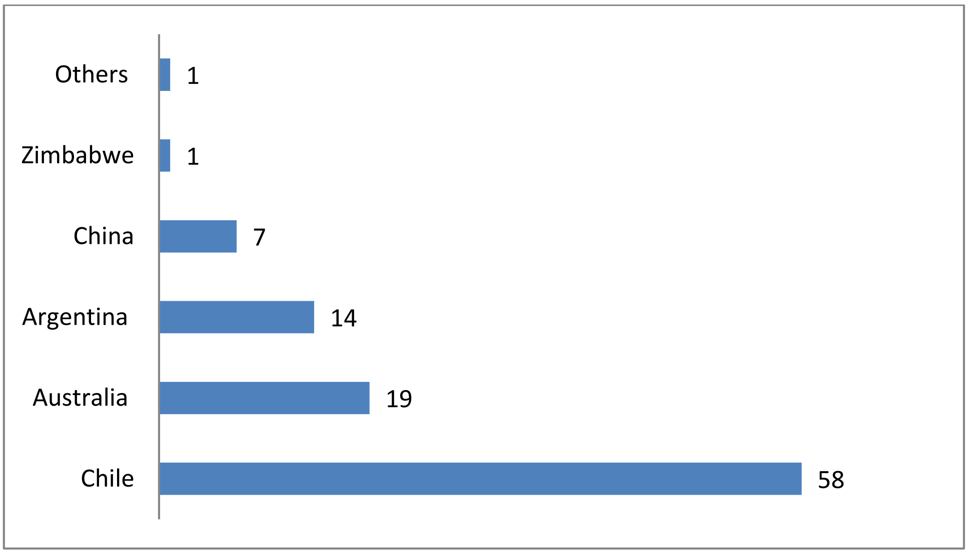

Fig. 2. Lithium reserves distribution

Source: USGS National Minerals Information Center (2018) report, https://www.usgs.gov/centers/nmic/publications

Owning 58% from world total reserves, Chile is the main lithium producer. Australia with 19% and Argentina with 14% are completing the podium, the other countries having less important reserves. Some unofficial studies showed that Bolivia may have 9 million tonnes reserves but these data remains to be certified.

In different alloys, lithium is used also in aerospace industry, air conditioning, industrial drying systems, medicinal drugs, etc. Still, the most substantial part of lithium is used in rechargeable batteries sector, as electrolyte. As demand for lithium is expected to rises, the mining impacts will dramatically affect local environment and communities, especially by reducing their access to water. It is obviously that in order to sustain such an increasing lithium general need other measures have to accompany the extractive countries.

The total identified natural graphite resources world-wide are estimated to be 1,5 billion tonnes while global graphite reserves are 300 million. The largest reserves of natural graphite are in Turkey with 31% form total, China with 25% and Brazil with 24% are also on top producers.

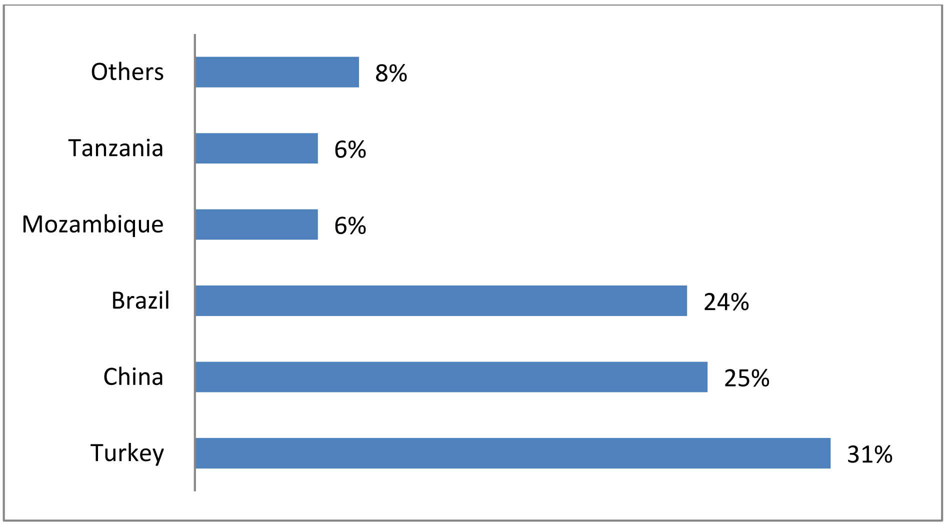

Fig. 3. Natural graphite reserves estimation

Source: USGS National Minerals Information Center (2018) report, https://www.usgs.gov/centers/nmic/publications

The principal use of graphite is steelmaking and metallurgy but is also present in semiconductors, LED technology, lubricants, etc. The use of graphite is in continuing growing, as anodes in rechargeable batteries but also in solar cells and nuclear reactors. Its application became more and more demanded in finding solutions to reduce GHG.

Manganese, another important element of LIBs, is not found as an element in the nature, but in composition of other minerals such as manganite, purpurite, rhodonite, etc. Even though at the moment it looks that the total world land-based manganese resources are sufficient they are uneven distributed. South Africa accounts for 74% from total, while Ukraine for 10%.

The total identified and exploitable manganese resources are estimated at 17 billion tonnes while manganese reserves world-wide are estimated to be 760 million tonnes, with South Africa, Ukraine and Brazil leading the ownership for this raw material. In the next graphic we can see the total distribution.

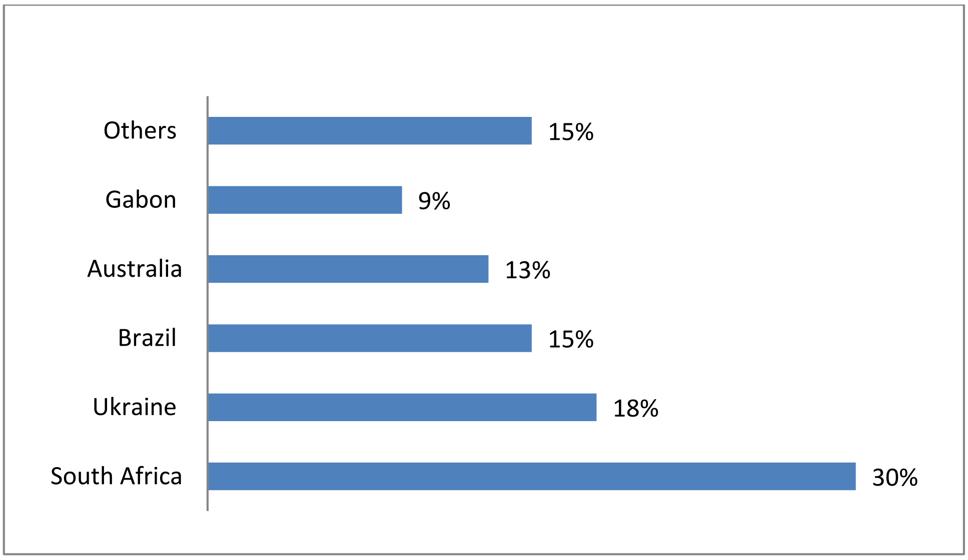

Fig. 4. Manganese distribution

Sources USGS National Minerals Information Center (2018) report, https://www.usgs.gov/centers/nmic/publications.

Manganese is used also as purifying agent in iron-ore refining and as an alloy that convert iron to steel. It is also used in paintings and decolorizing glass but its most non metallurgical application is in rechargeable batteries as cathode materials.

The global electric vehicles fleet is growing in an algorithmic peace. In 2018, more than 5.1 million EVs were on route, more with 2 million (65 %) comparing with 2017 and sales of new cars increased almost 100%. According to IEA projections, global electric car sales are expected to reach 23 million in 2030. In the same reports it is specified that around 45% of EVs found in circulation at the time in 2018 could be seen on China traffic, which means a total of 2.3 million units. Comparing with 2017, when the volume of electric cars was 39%, it represents a consistent growing by 6% in only one year. If we want to compare, Europe has only 24% of EVs on streets from the global fleet while the United States only 22% [IEA, 2019]. It is obviously that EVs is not only a fancy industry present punctually in developed countries but due to government’s aids and subsidies it became an important segment all over the world and a strong opportunity to reduce CO2 pollution.

These forecasts of future developments have consequences for suppliers of raw materials (the countries that we just mentioned before) and value added intermediate products used in rechargeable batteries. There are some research that indicate that future average annual global cobalt consumption will go up to 220 000 tons in 2025 and in 2030 even higher, to 390 000 tonnes, if not other technologies will show up. Now we have to take into consideration that these prognoses were done before the corona crisis and so before the increasing demand coming from governments. The new reality will be an opportunity for resource owners to produce more in order to meet rising demand. Thinking that the mining operational process is not very technologic in most of the countries (RDC is one example), we consider that there is a huge potential to increase production.

There is a huge potential to increase domestic value chain in production countries where raw materials are extracted. There is a need of improving infrastructure (electricity, communications) but huge opportunity to go further on production manufacturing chain (to process the raw ore and not to sell it in raw form), backward logistic capabilities and suppliers, financing, insurance, etc., economic activities that could encourage local communities to produce more and ultimately to benefit more from their resources.

Despite the fact that distribution of all main raw materials composing LIBs is limited in few producing countries, (for all main Libs component material, cobalt, lithium, manganese or graphite – situation is the same. Cobalt is mainly produced in the Democratic Republic of the Congo, lithium in Australia and Chile, graphite in China and Brazil, and manganese in South Africa and Australia) in the last years the production was increasing constantly.

This higher production of raw materials is coming from permanent increasing in EVs demand, due to low emissions policies that encourage people to buy new electric cars instead of conventional models. Once the technology advances, with new batteries more performant and longer autonomy, many clients decided to make the shift and replace the old cars with new vehicles less noisy and pollutant.

But the increasing exploitation of these raw materials is coming also with an environment and social implications. The majority of cobalt supplies are originated from DR Congo and approximatively 20% from this quantity it comes from artisanal mines were child labour (UNICEF estimated that around 40 000 children work in cobalt mines) and human right issue were identified therefore an increasing demand for cobalt will potentially intensify the work in these exploitations. Child labour is becoming inacceptable for producers but also for end user of VEs all over the world so we have a potential conflict of interests from this point of view. Local authorities should take action in order to prevent this happen.

Another environmental problem regarding the exploitation is coming from abandoned mines sites which are left without any preparation and decontamination. Cobalt-copper mines contain sulphur minerals so once abandoned they may generate sulphuric acid that can contaminate surface water [8]. The toxic water can go through rivers and reach even on drinking water [9, 10]. Generally speaking, all the mines are suffering from huge quantities of dust due breaking of rocks, mechanical excavation, digging etc. It was found out that especially in cobalt mines the resulted dust contains uranium and other heavy metals which could go on human body provoking serious health problems. In order to increase production without making people who are working and leaving near the mines to suffer more, an investment in production facilities it is absolutely necessary [12].

The lithium mining has also environmental risks because it needs large amount of water to operate and consequently indigenous populations are confronted with a lack of water for daily activities. In some areas in Chile, lithium and other mining activities consume 65% of total water from the region, local farmers being unable to carry out their activity.

The environmental impact of manganese and graphite mines is similar with cobalt; the main concern is the huge quantity of dust released in the atmosphere due to operational processes and spillage which may harm not only human activity but flora and fauna as well. As the production is estimated to grow in the near future there is a real need of new technologies in mining sector [13].

Another issue less investigated today is what happens with obsolete batteries and how they could be recycle.

3. CONCLUSIONS

In this paper we draw attention on situation of raw materials that are part of LIBs for EVs. Almost 50% of total world cobalt reserves are located in Congo, 58% of lithium reserves are in Chile, 80% of natural graphite reserves are situated in China, Brazil and Turkey, while Australia, Brazil, South Africa and Ukraine own almost 75% of total manganese reserves. Giving the fact that production is highly concentrated there is a consistent risk of political instability and environmental concerns. A growing demand for these materials due to governments willing to produce more EVs in near future will put higher pressure on the supply side. If we take into consideration the probability of some production issue we could anticipates pressure for higher prices which will lead to an increase in battery costs that can ultimately affect the low-carbon mobility.

Diversifying investments in other type of battery technology may be a solution on long term as well as creating enough stocks of raw materials could be the simplest strategy on short term in order to prevent shortage.

We documented that zero carbon transportation is only an illusion since there are many other social and environmental aspects that should be considered: production, child labour, human right issues, etc. Aiming to realize the objectives assumed in COP 21, global society has to take into consideration all the relevant aspects and collateral effects that can influence people life. It is necessary to have a global view of all consequences in order to better understand the causes and consequences of new realities.

More than that, giving Covid-19 circumstances, it is possible to have a second and even a third wave and so mining activities could be stopped many times. This will add an extra pressure on general picture of EVs production.

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