Environment Commission

Limiting the environmental impact of lithium mining

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Introduction

Electric car batteries, virtual reality headsets and solar backup storage are all part of an innovative future which strives to be renewable, sustainable, and more productive than ever. However, they have one more thing in common: they all require lithium. Because lithium-ion batteries are both rechargeable and extremely energy dense, they have become industry convention for storing chemical energy that can be converted into electricity. As a result of this, colossal corporations, like Apple and Tesla, have opted to use lithium-ion batteries in their products. Due to the fact that these companies sell millions of products yearly, this has massively increased the demand for lithium and thus the demand on lithium mines.

According to the World Economic Forum, Lithium production increased by 1016% between 1995 and 2021. Currently, three countries make up 90% of the world's lithium supply. Australia, Chile, and China produce the majority of lithium in the world and so hold a lot of power within negotiations surrounding technology as they control the metal that is responsible for innovation.

However, while Lithium is both innovative and good for the economy, it comes with a plethora of environmental negatives. Because lithium is an alkali metal with a single valence electron, it is very reactive and so not found as a pure metal naturally. Lithium is extracted either from underground brine reservoirs or from hard rock mining, where it is extracted from ores like spodumene, lepidolite or petalite. Although both processes are different, they are both very energy and water intensive, which means they are very taxing on the environment. Lithium mining is also detrimental to the soil and causes soil erosion, which is extremely harmful to ecosystems. Another environmental negative of lithium mining that needs to be managed is chemical pollution of both air and water.

While Lithium mining is responsible for a lot of the products that strive to be sustainable, its extraction is far from environmentally friendly and could pose a barrier to reaching the United

Nations' sustainable development goals. In order to make lithium a viable product for the future, it is critical to find ways to make its mining more sustainable.

Overall, finding a good solution will require a cooperative approach that enables countries to innovate and find more environmentally sustainable methods of lithium extraction, while not influencing the prices of lithium to a large extent in order to ensure that lithium can still be used in products, many of which are environmentally beneficial, and in order to not cause any damages to the economies of nations that rely on lithium mining. As delegates, a resolution needs to focus on finding an alternative to the current lithium extraction methods, whilst still accounting for both the lithium downstream and the nations that will be unable to use the novel extraction technologies, due to their hard rock lithium reserves, as opposed to brine reserves.

Definition of Key Terms

Lithium-ion battery

A lithium-ion battery is a type of advanced battery technology in which lithium ions pass from the anode to the cathode. Lithium-ion batteries are used in products such as cell phones, laptops, and electric cars.

Lithium brine deposits

Lithium Brine Deposits are collections of salty groundwater with dissolved lithium. They are most commonly found in Chile and Argentina.

Lithium clay

Lithium clays are an unused source of lithium, which lithium can potentially be extracted from in the future in order to make lithium mining more sustainable and efficient.

Direct lithium extraction (DLE)

Direct lithium extraction (DLE) is a newer, more environmentally sustainable, method of lithium extraction, which uses renewable energy, as well as natural processes in order to gain industry-grade lithium.

Downstream

Downstream is no longer part of extraction, but rather involves the manufacturing and refining of a product – in this report any mentions of 'downstream' will be specific to lithium. Downstream operations are usually close to creating the final product that the end consumer will use.

Upstream

Upstream involves the extraction and production of raw materials. This includes the exploration into new lithium sources and new lithium salt brines.

Gross domestic product (GDP)

The gross domestic product is the total value of goods produced and serviced in a country in one year.

General Overview

As use of lithium has increased over the past 30 years, the amount of lithium mining has also increased. Although previous lithium mining practices were already harmful, more unsustainable techniques have been adopted to satisfy the larger demand for lithium. This has exacerbated the already damaging effects of lithium mining and created an urgent environmental issue that needs solving.

Lithium brine extraction

Lithium brine deposits make up two thirds of the global lithium reserves and are found primarily in Latin America. Although hard rock mining still makes up 60% total lithium mining market, brine extraction has rapidly grown due to its lower production costs. Most sources of lithium brine are in either continental, geothermal or oil field deposits. In order for the extraction from the sources of brine to be economically viable the pond soil must be suitable; there must be a high enough concentration of lithium in the brine; the ratio of alkali metals to alkaline earth metals must be correct and the complexity of the phase must be simple enough.

Conventional methods of lithium extraction from brine involve evaporation of large ponds. The remaining salts can then be chemically treated to produce pure lithium or lithium carbonate, depending on what the resulting products will be used for. However, these methods are time-consuming and can take up to 24 months. The process is also not applicable to all locations and thus not a universal solution.

Using evaporation ponds to extract lithium from brine is very damaging, mainly, because it consumes a lot of water. Approximately 2.2 million litres of water are needed to produce one tonne of lithium when using evaporation ponds to extract lithium from lithium brine. This is damaging to the local ecosystems because they are dependent on the water cycle and if millions of tonnes of water are missing from it, problems within the water cycle can reflect onto the ecosystems. Moreover, the large amounts of water that are used for lithium production can also have negative effects on the local communities due to the fact that they require the water for both drinking and for subsistence farming. These negative environmental effects can oftentimes cause water-related conflicts in these areas, which can exacerbate the issues in the area because dialogue and discourse are reduced.

Due to the triad of duration, water use and energy use, many researchers regard lithium mining through brine evaporation as a damaging form of extraction. An additional negative of extraction from brine is that because its duration is long, the lithium it supplies is non-variable, which means that it can sometimes produce excess amounts of lithium and so produce damage to the environment without economic gain. The most prominent example of this was during the COVID-19 pandemic, when lithium brine mines were producing large quantities of lithium even when there was no demand.

However, even though using evaporation to extract lithium from brine is a very damaging form of extraction, the most environmentally sustainable method for lithium mining also uses brine. Direct Lithium Extraction (DLE) hosts a plethora of advantages because it has a greater lithium recovery rate (70 – 90%) than traditional evaporation ponds (50%). Because of its greater efficiency, DLE enables companies to exploit brines with a lower lithium concentration, meaning that DLE is both more environmentally sustainable and conserves lithium resources. Along with the greater efficiency, DLE also uses less water and has a lower carbon footprint than evaporation ponds. This makes it easier for DLE to become fully carbon neutral because the energy needed can be supplied through local renewable energy schemes, like geothermal power stations. This combined with the fact that

DLE takes less time makes it a more adaptable and environmentally friendly technology, that produces minimal waste and consumes minimal resources.

Although DLE seems like a superior technology to evaporation ponds, it is not as widespread as initially thought because there are still some questions about its economic viability. However, the primary challenge DLE faces is its adaptability. Even though there are four DLE extraction methods that are currently known (selective adsorption, ion exchange, solvent extraction and membrane filtration), it is often challenging to apply DLE to the different types of brine. This means that companies are often forced to develop their own methods of DLE, specific to the brine they have collected. This is challenging economically, but also sometimes not viable because there is a lack of qualified researchers that can make the developments.

Overall, DLE is a technology that still requires research, but has the potential to eventually replace evaporation as a method of extracting lithium from brine. This could be highly beneficial in the future because it would enable a more environmentally sustainable way of mining lithium and thus reduce the environmental impacts of lithium mining.

Hard rock mining

Lithium is found in pegmatites, which are rocks that are formed in the final stages of magma crystallisation. Unlike brine deposits, most of which are found in South America, most hard rock deposits of lithium are located in the Greenbushes of Australia. The open pit method, which is the most common way of extracting lithium from pegmatite, consists of crushing and milling blocks of pegmatite, before sending them to flotation cells, where the minerals are separated.

Even though evaporation of brine is damaging, hard rock mining can be up to three times as carbon intensive and can use up to two times as much water. Therefore, it is crucial to reduce this. However, because the demand for lithium has grown so rapidly and because brine evaporation operations take much longer to start up, the total amount of hard rock mines has increased in order to meet the increased demand. This means that while ensuring that alternative sources are renewable and environmentally sustainable it is also crucial to reduce their start-up time, so that they can compete with hard rock mines.

Downstream operations

Even though this report is focused on the mining of lithium and its environmental impact, it is vital to consider the upstream operations and how lithium demands will change over the next decade. This is because downstream and upstream are incredibly interconnected and variations in one can heavily affect the other. This means that the transport of raw lithium products and the manufacturing of lithium-based products should also be taken into consideration when writing a resolution, albeit to a lesser extent than the solutions to lithium mining.

Major Parties Involved

Australia

Australia is the world's largest lithium miner and, as of 2021, produced 52% of the world's total lithium. The western part of the nation hosts the Greenbushes, which is the countries major lithium mining operation. In the financial year 2022 – 2023, Australia was projected to make 16 billion dollars, which would be about 1% of its GDP.

Chile

Chile makes up 25% of the world's lithium supply and the majority of its lithium comes from brine deposits in the 'lithium triangle', which has 54% of the world's lithium reserves.

Argentina

Argentina makes up about 6% of the global lithium supply and is the second largest lithium producer that is part of the 'lithium triangle'.

Bolivia

Bolivia is the smallest of the three south American nations that make up the 'lithium triangle'.

China

China is the world's third largest lithium producer and contributes to 13% of the world's total lithium production. However, China holds a more dominant position in the downstream lithium

production market. Six out of the ten major lithium battery companies are located in China, which is part of the reason that it made 75% of the world's lithium-ion batteries in 2021.

Timeline of Key Events

Date	Description of event
1817	Swedish chemist Johan August Arfvedson discovers the element lithium
1976	The first viable lithium-ion battery is patented by British chemist Michael Stanley Whittingham
1st January 2016	The 17 Sustainable Development Goals officially came into force.
2018	Worldwide lithium reserves estimated to be 16 million tonnes

UN involvement, Relevant Resolutions, Treaties and Events

There has been no direct discussion of lithium mining and its environmental impacts at the United Nations yet. However, seeing that six sustainable development goals can be linked to the environmental sustainability of lithium mining, the topic is highly relevant to the agenda of the United Nations and should thus be treated with appropriate seriousness, urgency and collaboration.

Previous Attempts to solve the Issue

Although the United Nations have not made any resolutions regarding lithium yet, there has been some international cooperation vis-à-vis lithium mining. The international lithium association prides itself on being the voice of the lithium industry and is thus a catalyst in discourse regarding the

sustainability of lithium. It also takes into consideration the economical needs of the companies and is thus a great general voice for those mining lithium.

Even though not directly regarding the environmental impacts of lithium mining, resolutions and discussions regarding general mineral mining are still pertinent to the environment commission's discourse around lithium. Many of the key solutions employed in these agreements can be adapted to suit lithium specifically and thus can be a great starting point to base your resolutions around.

Possible Solutions

The most obvious solution to reducing the environmental damage of lithium mining is improving the sustainability of mining techniques. For example, research into DLE could be sped up in order to reduce the time in which it will become the industry standard. Other lithium sources, like lithium clay, can also be explored in order to provide alternatives, especially for hard rock mining, which is extremely damaging.

Another solution into reducing the environmental impact of lithium mining is reducing the demand for lithium because it will reduce the amount of mining done and thus reduce its environmental impacts. While this does not mean reverting to technology prior to lithium, it means improving the lithium efficacy of products, like batteries. This can be done through novel alloys or technologies which produce similar quality products, while using lithium. Another method of reducing the lithium demand from mines is by recycling more lithium and improving the efficiency of recycling infrastructure.

Another method of speeding up the rate of both aforementioned methods is by encouraging international cooperation, which will lead to faster results and faster implementation. It will also mean that all countries will have access to the technologies. Furthermore, the international cooperation can also be used within lithium reserves that stretch across multiple nations, as it will reduce any conflict and thus enable an increased focus on the environmental sustainability of lithium mining.

While encouraging the mining of lithium through DLE is paramount, it is also important to reduce the amount of hard rock mining as this is the most damaging form of lithium extraction. While there are several methods of doing this, one method is that the income the country previously had from lithium extraction could be replaced by lithium refinement and downstream lithium operations.

Overall, limiting the environmental impacts of lithium mining is paramount and should be approached with appropriate seriousness. A solution should approach the problem from several different angles and not be one-dimensional. Delegates should be willing to compromise and find multilaterally beneficial solutions that provide investments into novel lithium mining technologies, while also encouraging operations to move away from damaging methods, and providing suitable solatium to those operations that are forced to fully shut down.

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Appendix

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