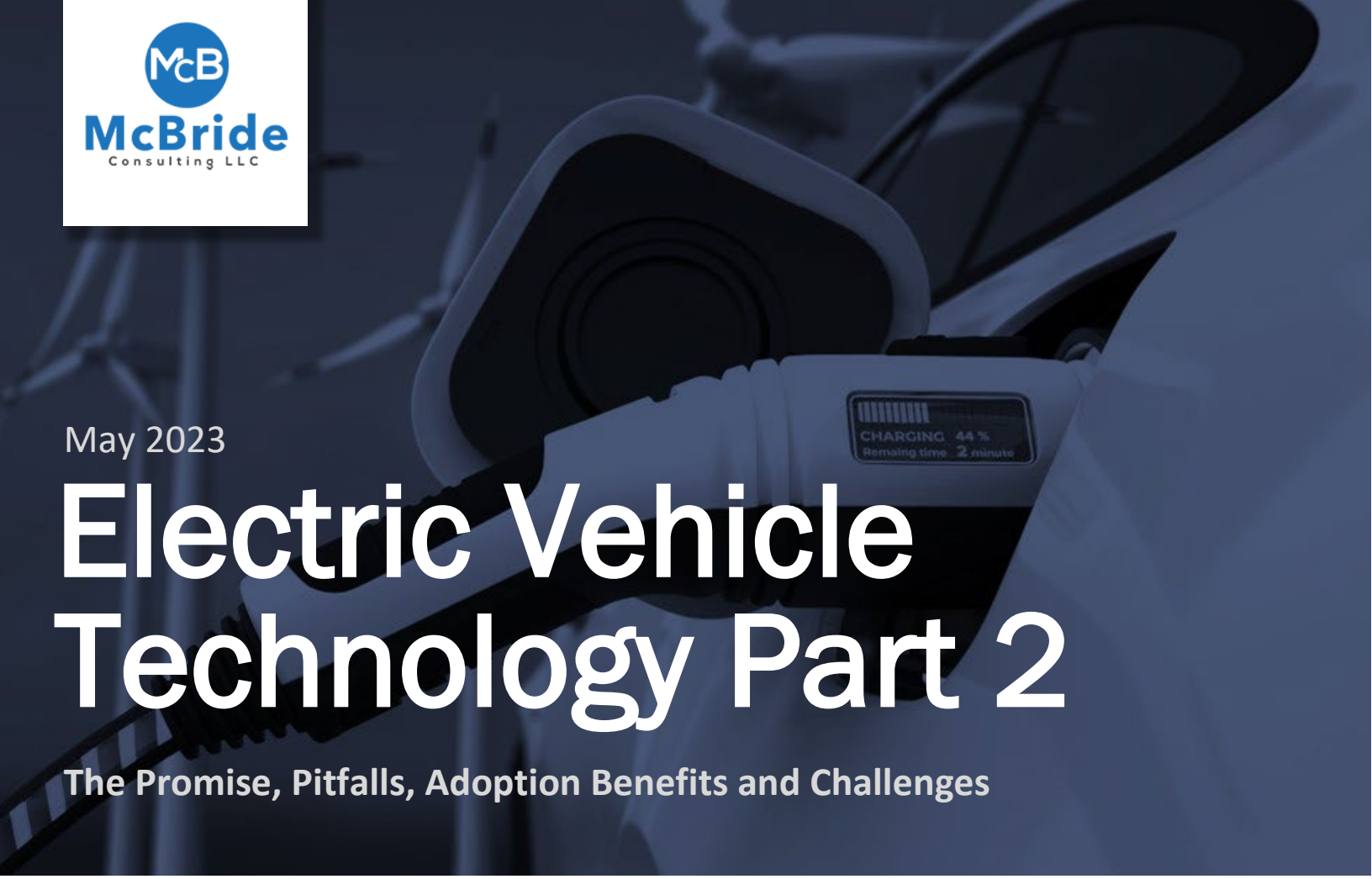

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Electric Vehicle Technology Part 2

The Promise, Pitfalls, Adoption Benefits and Challenges

Editor's Note: This is the second in a 4-part series from McBride Consulting covering the promise, pitfalls, and adoption of Electric Vehicles. The shift from internal combustion engines to battery powered conveyance will be highly consequential for societies around the world. This shift offers many advantages, but it is not without tradeoffs for the planet and challenges for individuals and governments alike. In this series, McBride consultants examine the good, bad, and uncertain aspects of the biggest change to wheeled transportation in over 100 years and the impacts it will have on all of us.

The global demand for electric vehicles (EV) is surging year after year and the International Energy Agency (IEA) reported that one in every seven passenger cars sold globally in 2022 was an EV[1]. Calls for EVs are only expected to get higher with Goldman Sachs forecasting approximately 50% of new car sales worldwide will be EVs by 2035[2]. This increased demand will bring significant supply chain, environmental, and social challenges to the U.S. and the broader global markets.

Batteries are the most crucial and expensive part of an EV. Currently, there are five "critical minerals"—Lithium, Cobalt, Nickel, Graphite, and Manganese—that are utilized in manufacturing them. While the richest deposits of these minerals are in the Democratic Republic of Congo (DRC), Australia, and Chile, China has a strong, strategic grip on the processing and refining of these minerals. For example: China has 60% of the world's lithium refining capacity[3] and 80% control of natural graphite mining[4].

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[1] **IEA. "Electric Vehicles". September 2022.** https://www.iea.org/reports/electric-vehicles

[2] **Goldman Sachs. "Electric vehicles are forecast to be half of global car sales by 2035". February 10, 2023**. https://www.goldmansachs.com/intelligence/pages/electric-vehicles-are-forecast-to-be-half-of-global-car-sales-by-2035.html

[3] **World Economic Forum. "This chart shows which countries produce the most lithium". January 5, 2023.** https://www.weforum.org/agenda/2023/01/chart-countries-produce-lithium-world/

[4] **IEA. "Global Supply Chains of EV Batteries". July 2022**. https://iea.blob.core.windows.net/assets/4eb8c252-76b1-4710-8f5e-867e751c8dda/GlobalSupplyChainsofEVBatteries.pdf

In the 1990s, the U.S. was the largest producer of lithium, which is used in making lithium-ion batteries. Now, the U.S. only produces about 1% of the total global lithium production[5]. While the U.S. scaled back, China expanded its global reach of the EV components' supply chain by heavily investing in mining and refinery assets internationally and domestically. China currently has 70% of the global production capacity for cathode, the positive electrode (conductor) of an EV battery, and a staggering 85% for anode, the negative electrode[4].

Although the U.S. and its free trade partners are now playing catch-up through legislation (Inflation Reduction Act, Defense Production Act, etc.) and technological innovations, China will continue to significantly influence the EV battery supply chain for the near future. The complexity of U.S. and its allies' relationships with China further opens the global EV supply chain up to risks of major geo-political events.

Environmentally, it is true that EVs are better than ICEs as they contribute little to no CO_2. However, that is just part of the story. EVs indirectly contribute emissions through the electric grid used in charging them. Because electricity is a secondary energy source produced by converting primary sources of energy (coal, nuclear, solar, and wind) into electrical power[6], the true size of an EV's footprint is dependent on the primary sources. On a net basis, the carbon footprint of EVs is considerably smaller than combustible engines after taking the emissions of these primary sources into account. In 2019, the greenhouse gas emitted to produce electricity for EVs was roughly half the amount emitted by the same number of internal combustion engine vehicles that year[7].

Despite EV's net emissions benefit, the extraction methods used to secure the critical minerals for its batteries exert considerable environmental tolls. The two most common methods, open-pit and underground mining, contribute to air and water pollution[6]. The loss of land use and biodiversity can extend far beyond the mines. Some mining methods are water intensive: Approximately 2 million tons of water is needed to produce one ton of lithium, enough to make fewer than 100 car batteries[8]. Moreover, critical minerals are often in areas with little environmental regulation and already scarce resources.

The implications mining has on the surrounding communities extends beyond mother nature. Over 70% of cobalt used to produce EV batteries is produced in the DRC. Roughly 20% of that comes from "artisanal mines" where child labor and human rights issues have been identified and up to 40,000 children are estimated to work in dangerous conditions for very little pay in mines in Southern Katanga[8]. So while EVs are the future of transportation to combat climate change, we still have much work to do in solving the pressing social, environmental, and supply chain challenges that stand before us.

Be on the lookout for the third part of this series where McBride consultants examine the infrastructure and capacity challenges in transitioning from internal combustion to electric powered vehicles.

AUTHORS
Suraj Mali, Senior Consultant
Danielle Lissak, Business Solutions Coordinator

EDITOR
Alex Wright, Senior Specialist

[5] **CNBC. "How the U.S. fell behind in lithium, the 'white gold' of electric vehicles". January 15, 2022.** https://www.cnbc.com/2022/01/15/how-the-us-fell-way-behind-in-lithium-white-gold-for-evs.html
[6] **Congressional Research Service. "Critical Minerals in Electric Vehicle Batteries". August 29, 2022.** https://crsreports.congress.gov/product/pdf/R/R47227
[7] **IEA. "Global EV Outlook 2020". June 2020.** https://www.iea.org/reports/global-ev-outlook-2020
[8] **UNCTAD. "COMMODITIES at a GLANCE Special Issue on Strategic Battery Raw Materials." February 2020. https**://unctad.org/system/files/official-document/ditccom2019d5_en.pdf