A Supply Chain Risk Analysis of Cobalt Used in Electric Vehicle Batteries in the US

By Nashed Daniel\textsuperscript{1}, Rajagopal Deepak\textsuperscript{2}

\textsuperscript{1}Department of Mechanical Engineering, University of California, Los Angeles, \textsuperscript{2}Institute of the Environment and Sustainability, University of California, Los Angeles

**Background**

- Electric vehicles (EVs) can potentially lower carbon emissions and mitigate the effects of climate change.
- Cobalt is used in the cathodes of batteries in EVs because it improves the energy density of batteries, increasing driving range.
- Cobalt is also used extensively in other industries, mainly as a super metal alloy, including defense and medical devices.

**Objectives**

- Conduct a supply chain risk analysis of cobalt since it poses the greatest threat to EVs market growth in US.
- Investigate domestic cobalt demand and supply till 2050 to determine cobalt demand-supply balances.
- Assess how EVs market in the US will evolve in response to cobalt demand-supply balances.

**Approach and Layout of the Study**

- Data has been collected from online reports, media, and conferences.

**Results: Global Distribution of Resources and Production**

- Cobalt demand is high due to its price instability, limited and concentrated supply, and its unethical mine sourcing.
- Over 50% of cobalt is mined in the politically unstable Congo, and 46% is refined in China.
- Price jumped by 275% from $34,000/tonne in 2010 to an all-time high of $93,538/tonne in March 2018.
- Expected supply shortages can disrupt the growth of EVs market by increasing battery prices.

**Results: demand-supply balances**

- Forecasted average cobalt demand-supply balances in US till 2035.
- Surplus of supply up to 2022 where supply and demand balance out at around 20,000 tonnes.
- Supply deficit grows exponentially to 15,126 tonnes by 2025 and 86,717 tonnes by 2030.
- Best case scenario: first shortage in 2026 if demand for cobalt follows low case for EV sales, all EVs use NCA battery chemistry, and supply follows high case.
- Worst case scenario: first shortage in 2021 if demand for cobalt follows high case for EV sales, all EVs use NMC battery chemistry, and supply follows low case.

**Conclusion**

- By end of 2022, demand and supply balance out at 20,000 tonnes.
- Future supply deficits can cause increase in battery prices and slow down EV market growth.
- Without substantial EV domination, transportation sector will remain a large contributor to CO2 emissions.

**Suggestions**

- Increase R&D funding to speed up development of NMC 811 chemistries and solid state batteries.
- Fuel cell cars are more efficient than EVs and require no cobalt, but not yet affordable and eco-friendly.
- Potential substitutes for cobalt superalloy in aerospace industry include metal & ceramic matrix composites.
- Provide subsidies to increase cobalt recycling rates.
- Encourage investments in feasibility and development projects to mine for cobalt in oceans.

**Acknowledgments**

This research was part of the Sustainable LA Grand Challenges, Undergraduate Research Scholars Program, and was supported by the UCLA Vice Chancellor for Research.