**Annotated Bibliography**

## Topic – Are Electric Vehicles Really Better for the Environment?

With increasing carbon dioxide emissions and a changing climate, many are making the switch from internal combustion engine vehicles to battery electric vehicles as a critical mitigation tactic. The question is: are battery electric vehicles really better for the environment? If so, by how much? Is it worth the extra money to make the switch? And are there better options available?

**Source 1 - High Energy Density “Bezel-less” Lithium-ion Battery Using Solvate  
Ionic Liquid-based Quasi-solid-state Electrolyte**

Unemoto, A., Hirooka, M., Seki, E., Kawaji, J., & Okumura, T. (2020). High Energy Density  
“Bezel-less” Lithium-ion Battery Using Solvate Ionic Liquid –based Quasi-solid-state Electrolyte. Electrochemistry. https://doi.org/10.5796/electrochemistry.19 -00076

This article describes research on leading -edge battery technology. The authors describe Lithium battery technology as critical to electric vehicles and renewable energy storage. In this case, efforts were focused on maximizing energy density, or the amount of energy that is stored in the battery per unit mass or unit volume. In this case, research was focused on a “bezel-less” battery design, which both increased battery safety and the usable volume of the battery.

While performance of lithium batteries are discussed at length, the environmental impacts of lithium mining are not discussed at all. Therefore, while there was little to no experimental bias, there exists a preconceived, almost closed -minded notion that large-scale commitment to lithium-ion batteries is a step in the right direction. According to a rigorous life-cycle assessment of electric vehicles, “variations of the specific energy requirements for battery manufacturing, the specific vehicle consumption, and the specific CO2 emission levels associated to energy exert a huge impact on the overall CO2 emissions of an EV” (Franzo & Nasca, 2020).

**Source 2 - Energy Consumption, Pollutant Emissions and Cost of Electric  
Vehicles and Fuel Vehicles**

Yue, H., Zhang, S., Tang, X., & Wang, W. (2021). Energy Consumption, Pollutant Emissions and Cost of Electric Vehicles and Fuel Vehicles. Material Science, Energy Technology, and Environment Engineering. EDP Sciences.

This article comes from the 6th international Material Science, Energy Technology, and Environment Engineering conference in China. The experimental methods incorporated are well explained and reasonably sound. The vehicles used to demonstrate “Well to Wheel” environmental impacts are sufficiently comparable. Limitations of the methodology are discussed, “WTW system does not involve the part of automobile recycling, so the calculation of this article does not consider the disposal cost” (Yue, Zhang, Tang, & Wang, 2021).

The results were peer reviewed, however the formatting in some of the figures is slightly underwhelming. For example, graph axis labels are slightly cluttered, showing more points than necessary.

**Source 3 - A comprehensive review of the key technologies for pure electric  
vehicles**

Li, Z., Khajepour, A., & Song, J. (2019). A comprehensive review of the key technologies for pure electric vehicles. Energy.

**Source 4 -** **Life cycle environmental assessment of charging infrastructure for electric vehicles in China**

Zhang, Z., Sun, X., Ding, N., & Yang, J. (2018). Life cycle environmental assessment of charging infrastructure for. Journal of Cleaner Production.

**Source 5 - The environmental impact of electric vehicles: A novel life cycle-  
based evaluation framework and its applications to multi-country scenarios**

Franzo, S., & Nasca, A. (2020). The environmental impact of electric vehicles: A novel life  
cycle-based evaluation framework and its applications to multi-country scenarios. Journal of Cleaner Production.

This article covers an in-depth life-cycle assessment of electric vehicles. While it primarily focuses on plug -in electric vehicles, fuel-cell and hybrid variants are also touched upon. The authors concluded that when comparing an electric vehicle to a reasonable similar internal combustion engine vehicle, “CO2 emissions associated to an EV over its life cycle are always lower than the ones associated to a comparable ICEV” (Franzo & Nasca, 2020).

Rigorous experimental methods were used, and a literature review was conducted to, “obtain a deep understanding of the extant knowledge base on the topic and to identify the research gaps to be addressed” (Franzo & Nasca, 2020). All tables, equations, and figures are formatted in a well-designed fashion. The authors demonstrate little to no experimental bias, and the limitations of the methods used are discussed at length. Finally, the authors demonstrate a lack of financial persuasion by declaring that they have, “no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.”

**Source 6 - Electric vehicles standards, charging infrastructure, and impact on  
grid integration: A technological review**

Das, H. S., Rahman, M. M., Li, S., & Tan, C. W. (2019). Electric vehicles standards, charging infrastructure, and impact on grid. Renewable and Sustainable Energy Reviews.

**Source 7 - Renewable Synthetic Fuels and Chemicals from Carbon Dioxide: Fundamentals, Catalysis, Design Considerations and Technological Challenges**

Simakov, D. S. (2017). *Renewable Synthetic Fuels and Chamicals from Carbon Dioxide: Fundamentals, Catalysis, Design Constraints and Technological Challenges.* Waterloo, ON: Springer.

This book is great for several reasons. First, it makes the science behind synthetic fuels from carbon dioxide quite accessible. Second, it covers a wide portion of the technology behind synthetic fuels. And third, the author focuses many of his efforts on the feasibility of synthetic fuels from an engineering standpoint.

Not only is the engineering feasibility assessed, but economic feasibility is also not looked over. It is important to consider both when exploring a new technology since both are absolutely essential to any large-scale success.

**Source 8 – Energy and climate effects of second-life use of electric vehicle batteries in California through 2050.**

Sathre, R., Scown, C. D., avvada, O., & Hendrickson, T. P. (2015). Energy and climate effects of second-life use of electric vehicle batteries in California through 2050. *Journal of Power Sources.*

This article focuses on one of the most glaring issues with electric vehicles – the wear of lithium batteries over time. Since lithium mining has large environmental consequences, it is important to ensure the longevity of lithium batteries. Unfortunately, however, lithium batteries are considered one of the “wear components” of electric vehicles. As such, they must be replaced once degraded.

The wear of them has two consequences to focus on: what to do with used batteries, and how to source and replace them. Currently, the former option is being addressed by simply repurposing the batteries. This article performs a life cycle analysis on the reusing of electric vehicle batteries. Unfortunately, sourcing new batteries can be difficult as they are often proprietary for the device.

This article was peer reviewed and well-organized. While the total implementation of the reusing of lithium batteries is likely quite optimistic, the experimental methods showed no bias.

**Source 9 - End-of-life treatment of crystalline silicon photovoltaic panels. An emergy-based case study**

Corcelli, F., Ripa, M., & Ulgiati, S. (2017). End-of-life treatment of crystalline silicon photovoltaic panels. An emergy-based case study. *Journal of Cleaner Production.*

It is highly likely that solar power will be one of the primary methods of generating synthetic fuels. Therefore, it is important to address the climate impacts of solar power. This article focuses on the efficiency and environmental impacts of solar energy.

Methods showed no bias, and the article was peer reviewed. Other articles from the same journal also appeared to be reliable.

**Source 10 - Lithium recovery from brines: A vital raw material for green energies with a potential environmental impact in its mining and processing**

Flexer, V., Baspineiro, C. F., & Galli, C. I. (2018). Lithium recovery from brines: A vital raw material for green energies with a potential environmental impact in its mining and processing. *Science of the Total Environment* .

Lithium is becoming an increasingly necessary resource mostly thanks to the battery industry. Its extraction also happens to have many environmental impacts. Since battery electric vehicles are becoming more popular, it is important to make clear that they might be doing more harm than good.