



EnerChemTek, Inc.

Circular Nickel, Power Batteries and Sustainability: The Outlook To 2050 For Nickel Mining, Refining and Recycling

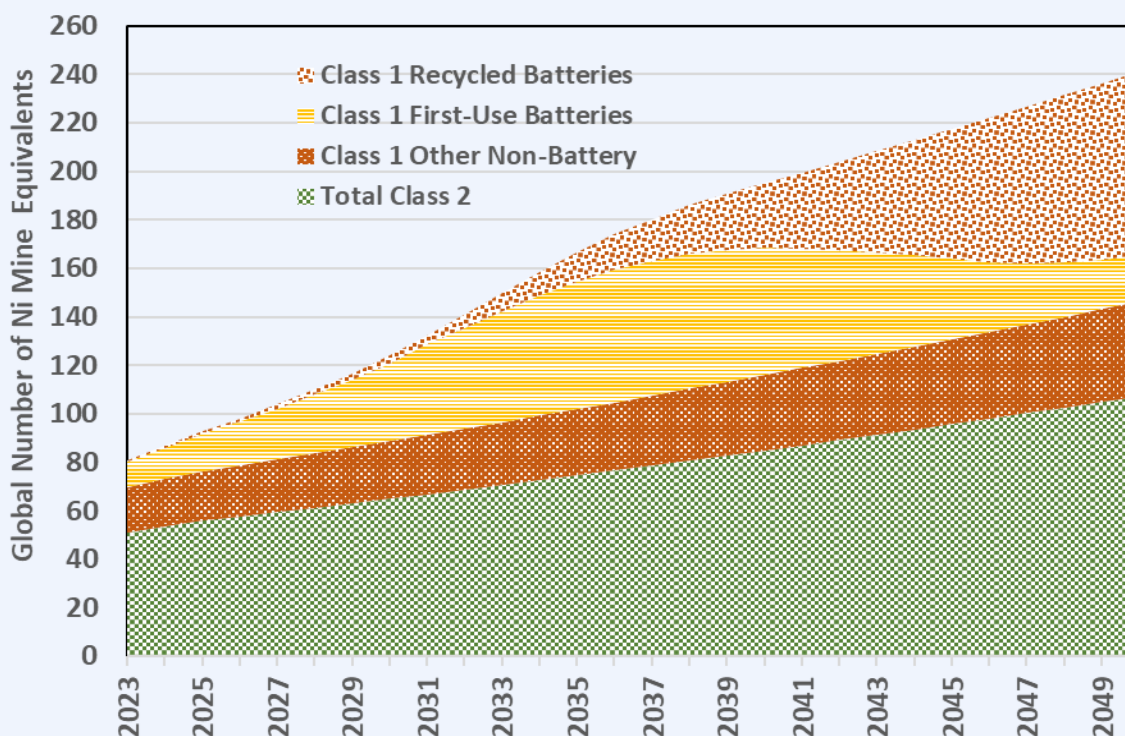
The fast pace of development of the global battery industry, both commercial and technical, is making it very difficult to see where the nickel industry is headed. Reports published by the IEA predict that by 2040, demand for nickel will increase by a factor of between 6 and 19 relative to 2020, with enormous implications for the global nickel mining and refining industry. With such growth, how could the world ever attain a fully sustainable clean energy system?

These IEA scenarios do not go beyond 2040 and because of this they do not fully take into account the potential nickel supply from recycled batteries. EnerChemTek's latest scenario analysis indicates that the demand for mined nickel actually peaks around 2037 and declines every year thereafter until full sustainability is achieved around 2050. Long term mined nickel supply returns to historical trend lines while battery recycling becomes the dominant source of Class 1 nickel. This scenario obviously has huge implications for strategic planning in the nickel mining, refining and recycling sectors, with many new opportunities emerging globally.

The results of EnerChemTek's nickel scenario analysis are summarized graphically in the chart below.



EnerChemTek Nickel Supply/Demand Scenario to 2050



Note: One Ni mine equivalent = 40 kta Class 1 nickel

Source: EnerChemTek, Inc.

We invite you to subscribe to our new report on coming developments in the global nickel industry. The Table of Contents and front matter of the report are attached for your consideration.

If you have any questions or require further information, please visit our website <http://consulting.enerchemtek.com/index.php/critical-minerals/> or contact us by phone or by e-mail provided below.

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**A Scenario Interpretation of Tesla's Envisioned
Post-Transition Energy Storage System In A
Renewably Electrified World**

A NEW REPORT FROM

EnerChemTek, Inc.

EnerChemTek, Inc.

Toronto, Ontario

CANADA

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EnerChemTek, Inc.

The global energy transition is a fundamental shift in the way the world produces and consumes energy. It involves a departure from traditional fossil fuels like oil, natural gas, and coal towards cleaner and more sustainable sources of energy. This transition is primarily driven by the need to combat climate change, reduce greenhouse gas emissions, and ensure a more sustainable and secure energy future for all.

Renewable energy sources such as solar, wind, hydroelectric, and geothermal power play a central role in this transition, offering cleaner alternatives to fossil fuels. Solar and wind power generation are variable and intermittent and require a battery backup to ensure that power delivery is available 24 hours per day.

The focus of this report is the eventual battery system that will be required once the energy transition is complete. More specifically, the report focuses on the role that nickel metal will play in this post-transition battery energy storage system.

Nickel is a preferred metal in the cathode materials of lithium-ion battery cells due to its balance of capacity and power delivery characteristics. It is an expensive metal, and this restricts its use to those lithium-ion battery applications that really need its superior characteristics, specifically high-power batteries for large electric vehicles. Even with this restriction, the new demand for high purity nickel for batteries will upend the entire nickel industry, from exploration to mining, to refining and recycling, creating enormous opportunities for industry, while also presenting difficult new challenges.

Many studies and reports on the energy transition have been published, some focusing on renewable energy supply and others focusing on the materials requirements associated with renewables and the electrification of transportation, particularly battery electric vehicles (BEVs.) This report offers a very different, and we believe more realistic, scenario for the role of nickel in the transition compared to most of these widely published reports.

Our focus is on nickel and the use of nickel in batteries. In developing our scenario, we turned for guidance to the most knowledgeable source of public data specifically about this subject, namely Tesla, Inc. Tesla's qualifications include:

- It is a major stakeholder in the energy transition with revenues over \$80 billion, growing at >50% per year.
- It is the global leader in design, manufacture and sales of BEVs.
- It is among the global top 5 producers of lithium-ion batteries for BEVs, as well as for grid and renewable energy backup systems.
- It is a leader, with its research partners, in the development of high nickel chemistries for lithium-ion batteries.
- Its solar energy generation and stationary energy storage businesses had 2022 revenues of \$4 billion, growing at 40% per year.
- In addition to producing almost 1.4 million BEVs in 2022, it also deployed 6.5 GWh of stationary battery storage.
- It is a large producer of solar energy systems having deployed 350 MW of generation capacity in 2022.

It's clear that Tesla has unequalled first-hand knowledge of the use of nickel in batteries.

This report is an independent assessment of the dynamics of change in the nickel industry as we move through the energy transition from 2023 toward Tesla's 2050 endpoint of the transition. It presents our analysis of nickel demand in batteries year-by-year, nickel-based energy storage by year, the timing of the almost 50 new nickel mining/refining facilities that will be needed, and the timing and magnitude of the associated battery recycling capacity. These are new global industry sectors that will require investments approaching \$400 billion, disbursed at different rates according to changing demand year-by-year.

We believe that you will find this report useful in developing your strategies based on a holistic view of nickel's coming transition.

Dr. Mauricio Dávila
CEO and co-founder
EnerChemTek, Inc.



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INTRODUCTION

Sustainability is a prime objective of most companies and organizations around the world: economic growth while maintaining an ecological balance, avoiding harmful and/or long-lasting emissions to the air, water and land. Everyone understands this to include the avoidance of fossil fuels and the use of electricity as the primary energy input: to do everything with electricity that is currently done with fossil fuels. The guiding principle is the avoidance of carbon dioxide emissions so as to limit anthropogenic climate change resulting from global warming.

In December 2015, parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to reduce carbon emissions to the atmosphere to zero (net) by 2050, establishing the Net Zero by 2050 target commonly used as the official sustainability target of policies and strategies by governments and businesses. In broad terms, the path to net zero requires that all parties start immediately to plan their path to Net Zero, followed by the design and construction of the required systems, proceeding to implementation so as to complete by 2050. Put simply, the 2020s are for planning and groundwork, the 2030s are for construction and the 2040s are for completion.

Two key global systems that need to be established to effect this energy transition are i) a system to produce renewable electricity from solar and wind resources, and ii) an energy storage system (batteries) to convert these variable resources into mobile and dispatchable power that is available 24/7/365. Planning the construction of these systems requires a goal or endpoint representing the post-transition world. One very useful but succinct description of this goal has been given by Tesla in its excellent presentation¹ in March 2023 of its “Master Plan Part 3.”

In summary, this “Master Plan” envisions a global renewable energy system supported by 240 terawatt hours of battery storage with a power output of 30 terawatts. ***This report focuses on the role of nickel through this energy transition to the establishment of a sustainable fully electrified global economy.***

¹ <https://www.tesla.com/blog/master-plan-part-3>