Manganese for Electric Vehicle Batteries

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Manganese is a mineral that has long been associated with steelmaking, which currently accounts for the majority of its global consumption. However, manganese has also become an essential element in rapidly growing non-metallurgical applications, such as batteries for electric vehicles (EVs). While a handful of countries account for the majority of global manganese production, leading to supply chain concentration concerns, there are developments that might diversify and ease the constraint in the near future.

Manganese in EV Batteries. In a chemical compound called high-purity manganese sulfate monohydrate (HPMSM), manganese has emerged as an important input used in cathodes of lithium-ion batteries (LIB) for EVs. When small quantities are added to LIBs, manganese lowers combustibility while increasing energy capacity and vehicle driving range. It is used in nickel-manganese-cobalt (NMC) EV batteries, the type of LIBs used by most EV manufacturers in the United States and Europe, due to its superior range and recharging capabilities. However, battery chemistries such as lithium-iron phosphate (LFP) that do not typically use manganese, or expensive and scarce minerals like cobalt and nickel, are growing in popularity and account for the majority of the EV LIB market in China. While LFPs are less expensive than other chemistries, including NMCs, they tend to not perform as well as NMCs (e.g., less energy density and reduced driving range).

Increasing the manganese content in LIBs provides advantages with a limited impact on overall cost. Manganese is relatively cheap compared to other minerals commonly used to enhance battery performance like nickel and cobalt. Hence, efforts are being made by manufacturers to increase the amount of manganese in NMCs. Furthermore, the addition of manganese to traditional LFPs (in a modified chemistry called lithium manganese iron phosphate (LMFP)) can boost their performance characteristics enough to make them more attractive alternatives to NMC batteries. Reportedly, Tesla and other vehicle manufacturers are exploring the use of LMFP batteries and other higher-manganese battery types in EVs. While estimates vary, industry experts predict that manganese demand will grow significantly during the next 20 years, driven primarily by the mineral's use in LIBs. The International Energy Agency predicts that global manganese consumption in 2050 could be 11–17 times higher than in 2024. Against that backdrop, it is helpful to look at the supply chains, trade flows, and new manganese projects for EV batteries.

Supply for EV Batteries. Manganese is not scarce. It is the twelfth most abundant element with about 1.7 billion metric tons (mt) of reserves and is found all over the world. Nonetheless, nearly three-quarters of manganese mine production was concentrated in just three countries in 2024, South Africa (37 percent), Gabon (23 percent), and Australia (14 percent). The United States last commercially mined manganese in 1970 and is reliant on imports for its consumption. While the raw material is not in short supply, there are still concerns among LIB manufacturers due to the concentration of production and the reliability of leading producers. For example, Gabon's manganese sector was recently impacted by political instability and landslides, and Australian production was severely curtailed due to damage from a tropical cyclone in 2024.

Downstream, the multi-step process commonly used to produce HPMSM is complex and there are few plants outside of China with the expertise and capability to produce the material. HPMSM production typically involves concentrating manganese ore, leaching and purification, electrowinning (electrolysis) to produce pure metal, and dissolution and crystallization of metal to derive HPMSM. Battery manufacturers either purchase HPMSM directly or buy metal (in powder or flake form) to produce HPMSM themselves. In 2024, China accounted for 95 percent of HPMSM production, with Belgium (Vibrantz) and Japan (Nippon Denko) producing the rest. China also dominates the manganese metal (refined pure manganese) sector, accounting

for about 93 percent of global supply with the remainder coming from South Africa, Indonesia, and Ukraine. Industry observers have pointed to supply risks from both the high concentration of HPMSM production in China as well as Chinese dominance in downstream processing.

Global Trade. During 2022–24, South Africa (55 percent) and Gabon (32 percent) were the leading exporters of manganese ore (HS 2602.00), by value, and China (67 percent) and India (14 percent) were the top destinations. While China produces manganese ore, it also imports substantial volumes for processing. Downstream, China (60 percent) and the Netherlands (18 percent) were the leading exporters of manganese products, including metal, (HS 8111.00) and the Netherlands (16 percent), South Korea (13 percent), and Japan (12 percent) were the largest importers. Tracking global trade of HPMSM (HS 2833.29) under the international Harmonized System is challenging because it is categorized with other sulfates, making it difficult to isolate HPMSM shipments. Lacking mining, metal, or HPMSM production, the United States is reliant on imports. Although current U.S. imports of manganese products are primarily used in steel and other non-battery applications, they are an indicator of where the inputs needed for making HPMSM originate. During 2022–24, U.S. imports of manganese ore, valued at $267 million, primarily came from Gabon (69 percent), South Africa (20 percent), and Mexico (10 percent). U.S. imports of manganese products (HS 8111.00) were valued at $465 million during 2022–24 and the top sources were China (69 percent) and South Africa (22 percent). China was the leading supplier of manganese metal to the U.S. even though metal originating in China was subject to to normal trade relations duties of 14 percent, while imports from South Africa were eligible to enter duty free under the AGOA program. The average unit value of manganese products imported from China was about 34 percent lower than that from South Africa during 2022–24. Industry observers reported that production costs for metal in South Africa are significantly higher than those in China due to higher labor and energy costs coupled with more stringent environmental standards.

Outlook and Developments. The anticipated growth in demand is driving new supply projects worldwide (Table 1). While China dominates current production, there are new projects in early stages of development outside of China that could boost HPMSM supply and mitigtate U.S. supply chain risks.

Table 1. Manganese Projects for EVs

Location	Description
Czech Republic	Euromanganese plans to recover manganese in waste from a decommissioned manganese mine in Czech Republic to produce HPMSM and metal at a new processing plant.
Canada	Canadian Manganese Company, Inc. plans to develop a large manganese deposit and become a supplier of HPMSM for batteries.
Canada	Manganese X plans to develop a manganese deposit and produce HPMSM directly from manganese ore.
Mexico	Vibrantz plans to build a new HPMSM pilot plant and potentially expand production to 45,000 t/yr.
South Africa	Manganese Metal Company plans to build a new 6,000 t/yr HPMSM plant with plans to expand capacity further by 2028.
Australia & United States	Element 25 plans to expand a manganese mine in Australia to provide feedstock for a new 65,000 t/yr HPMSM plant in Louisiana. It is a partnership with automakers and received grants from USDOE and USDOD.
United States	South 32 Hermosa Inc. plans to produce manganese ore at a new mine in Arizona and 60,000 t/yr of HPMSM at a new processing plant with potential expansion in the future. Funding from USDOE and USDOD grants.

Source: Compiled from industry sources.

Sources: MMC, "Lithium-ion,"accessed 1/15/25; IEA, "Global EV Outlook,"4/24, "Global Critical," 5/24, and "Global Critical," 5/25; Euro Manganese, "Investor," 8/24, and "Chvaletice," accessed 1/15/25; Eramet, "Manganese,"accessed 1/15/25; USGS, "Manganese," 1/25, and "Manganese 2022," 2/16/24; S&P Global, "World's 2nd," 4/3/24; MMC, "High Purity," accessed 1/14/25; IMnl, "Annual Review," 1/8/24; USITC, "HTSUS, Chapters 26, 28, and 81," 1/25; USITC, " HTSUS, General Note 16(a)," 1/25, p. 1; WSJ, "Why Every," 12/30/23; Canadian Manganese, "Company," accessed 1/15/25; Vibrantz, "Vibrantz," 7/19/23; Element 25, "Scale,"and "HPMSM," accessed 1/15/25; USDOE, "Bipartisan," accessed 1/15/25; South32, "US DoE," 9/23/24; Manganese X, "Investor," 3/24; FastMarkets, "Spotlight," 7/28/23; Project Blue, "Tesla," 3/8/24; S&P Global Market Intelligence, GTAS database, accessed 5/2/25.