

# MANGANESE:

## A KEY TO AMERICA'S EV FUTURE

While lithium, nickel & cobalt dominate the headlines, manganese may be the critical mineral that helps the U.S. auto industry build more electric vehicles faster, more sustainably and more affordably.

### Here are 5 reasons why:

**1**

**Manganese lowers the cost of high-performance EV batteries.**

**4**

**Manganese is attracting interest from researchers and automakers looking for alternatives to more costly battery chemistries.**

**2**

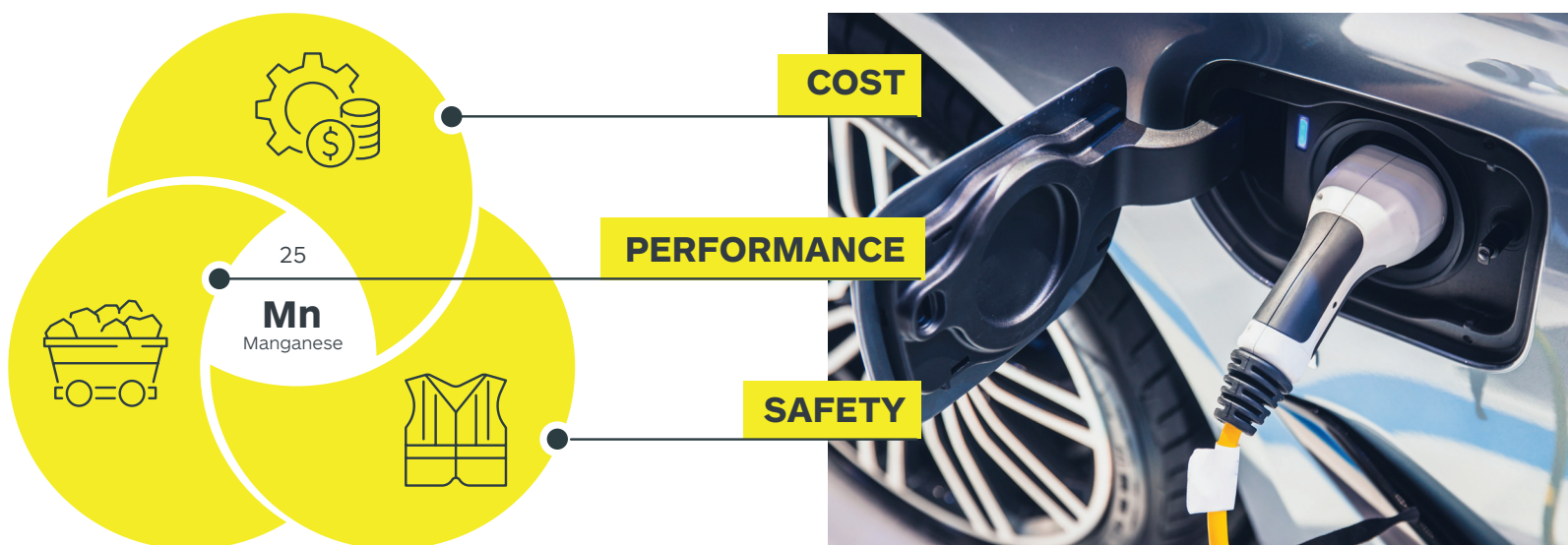
**Manganese improves the performance of lower-cost EV batteries.**

**5**

**Manganese can be sourced and processed domestically.**

**3**

**Manganese is safe, stable and abundant.**



I think there's an interesting potential for manganese...the materials used to produce these batteries at a very large scale need to be common materials or you can't scale.



**FACT:** Only four countries with U.S. free trade agreements have the potential to supply manganese ore, metal, or sulfate: Australia, Canada, Mexico and Morocco.



**FACT:** Manganese was one of only five minerals included in the 2022 Defense Production Act.



**FACT:** Demand for battery-grade manganese is expected to increase 15x from 2020 to 2031, according to utilities research firm E Source.

## HOW MANGANESE FACTORS INTO THE TWO MAJOR LITHIUM-ION EV BATTERY CHEMISTRIES

CATHODE TYPE	LITHIUM IRON PHOSPHATE (LFP)	NICKEL MANGANESE COBALT OXIDE (NMC)
<b>Known for</b>	Lower cost, longer lifespan, shorter range; becoming more popular for entry-level models, particularly in China	High performance, more expensive; most common in North American and European markets
<b>Benefits of increasing manganese content</b>	Improves energy density and thus driving range, while keeping costs low	Lowers cost by reducing need for cobalt and 370-chemistry nickel; acts as stabilizer to increase safety without compromising range
<b>Notable customers</b>	Base model Tesla Model 3, Ford Mustang Mach-E, F150 Lightning	GM, Ford, Volkswagen, Nissan, Mercedes-Benz, Toyota, Hyundai

Manganese may emerge in next-generation cells as a preferred element given its low cost, abundance, and the fact that many manganese-based cathodes are relatively safe.

06.21 **White House Report:** Building Resilient Supply Chains, Revitalizing American Manufacturing & Fostering Broad Based Growth.