

A large yellow mining truck is shown from a side-rear perspective, dumping a massive load of dark, rocky material into a pile. The truck's bed is raised, and a thick, billowing cloud of dust or smoke rises from the point of impact, partially obscuring the truck and the background. The scene is set in an open-pit mine or quarry, with a dusty, uneven ground surface.

Premature Electrification: The Future of Cars

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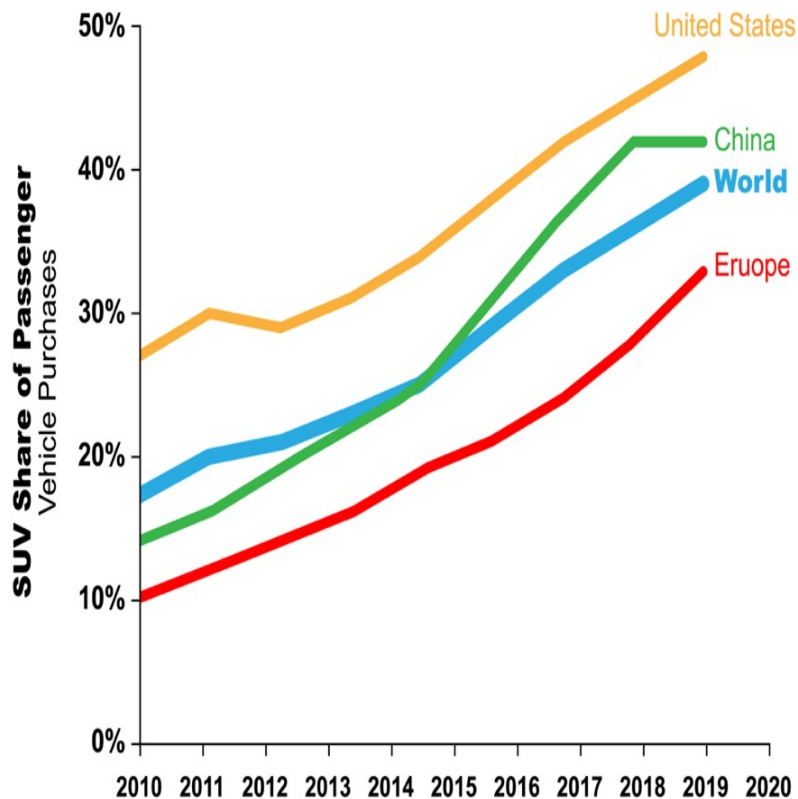
McCormick School of Engineering

Partner

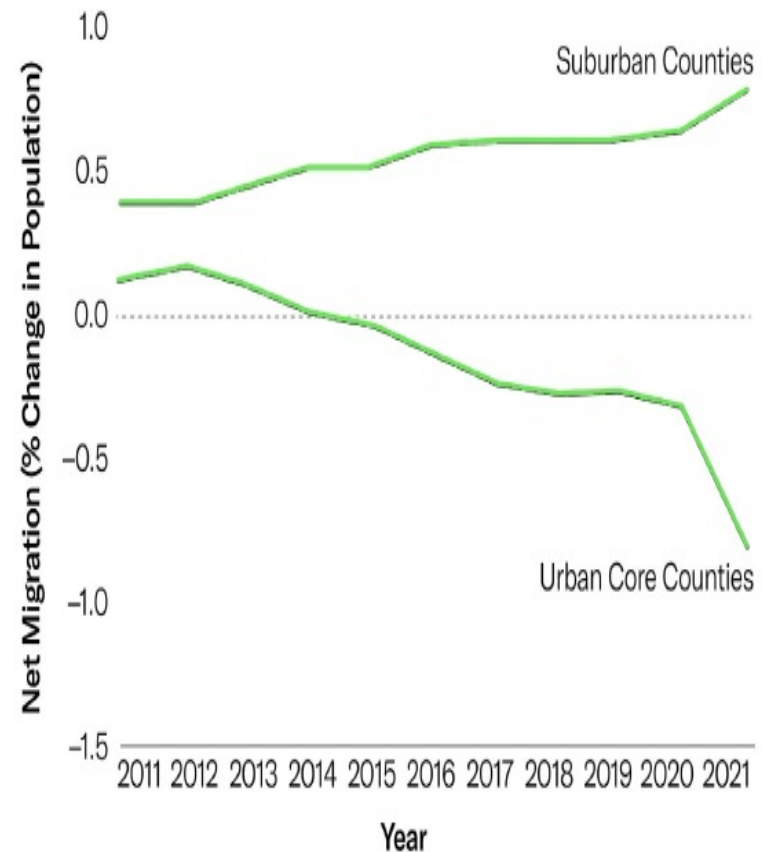
Montrose Lane Ventures

Consumer preferences in the age of climate awareness

**Global Car Size Rising
SUV Share Up Everywhere**



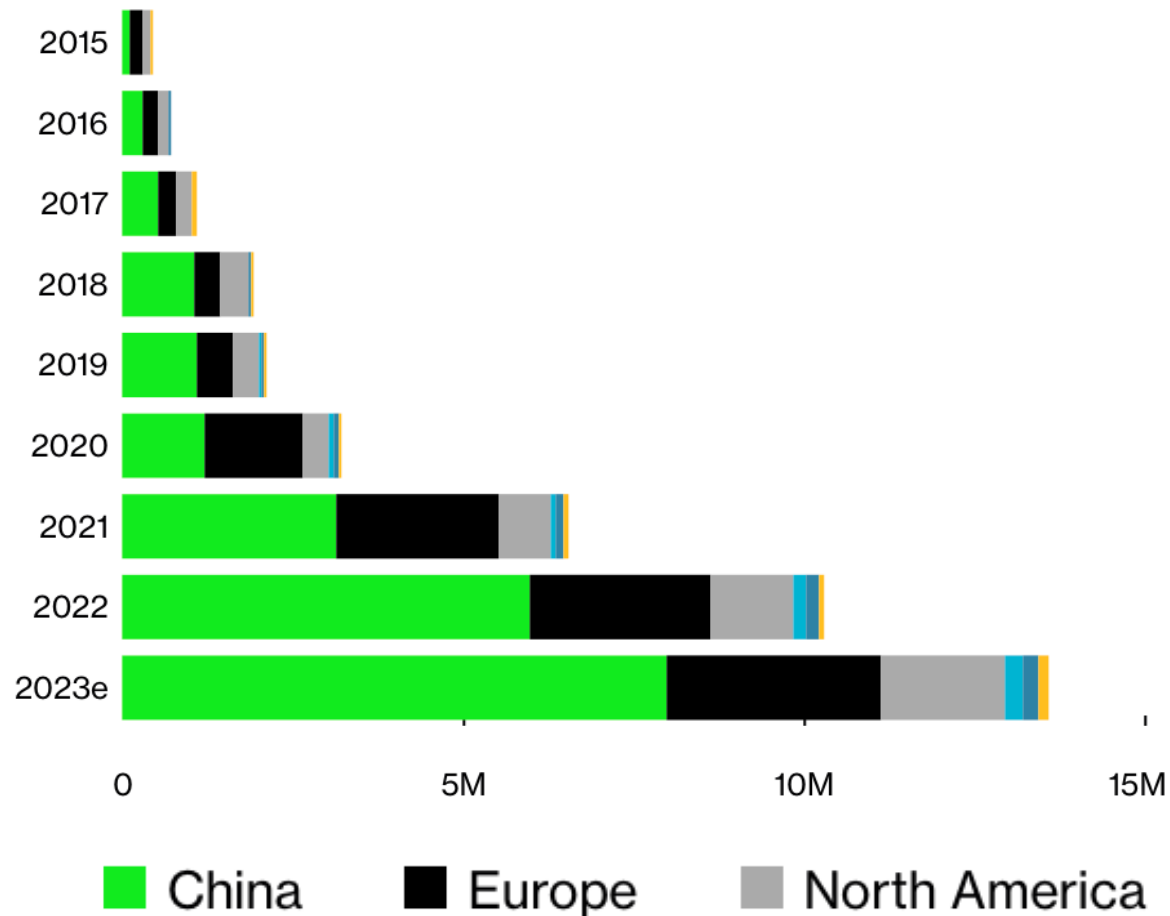
**Driving Distances Rising
U.S. Nonmetro Population Up**



SUV demand by 2040 “offsets 150 million EVs”
Super-commuter grew 3x workforce

The EV revolution is real ... 0 to 12 million EVs in 10 yrs

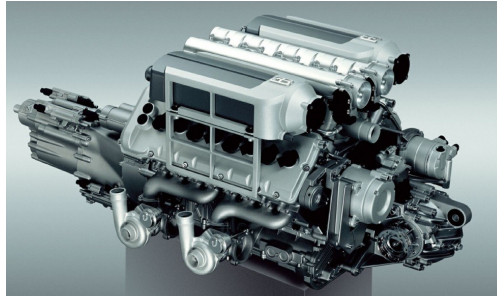
2012 Tesla 0 to 1 million in 92 months
1964 Mustang 0 to 1 million in 18 months



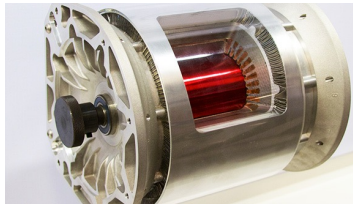
EVs are a complexity swap

PROPULSION

*Complex **physical-chemistry**
1000s of parts*



Simple



FUEL

Simple

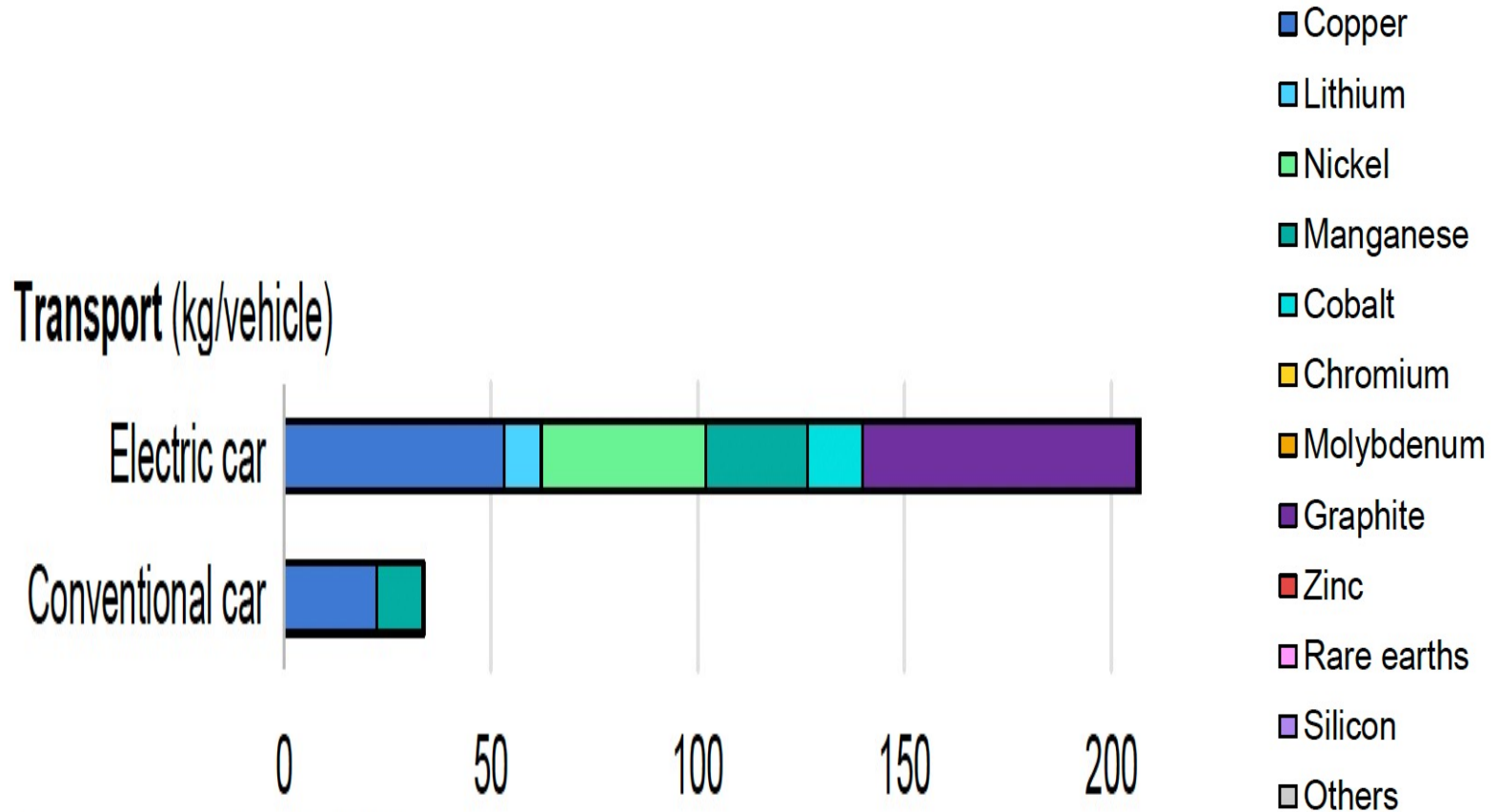


*Complex **electro-chemistry**
1000s of parts*

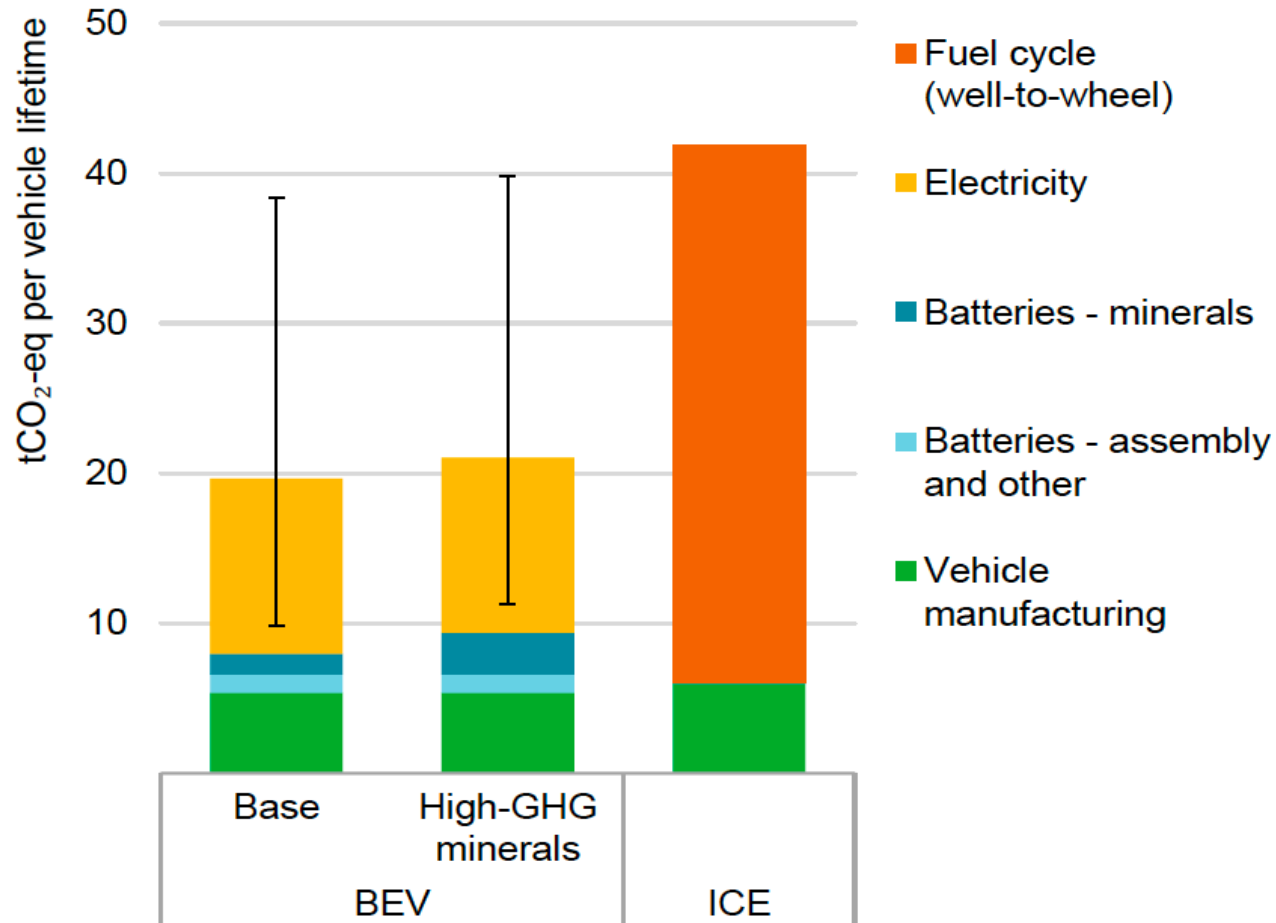


The minerals & metals needed to build a car

500,000 pounds mining to build **one EV** battery

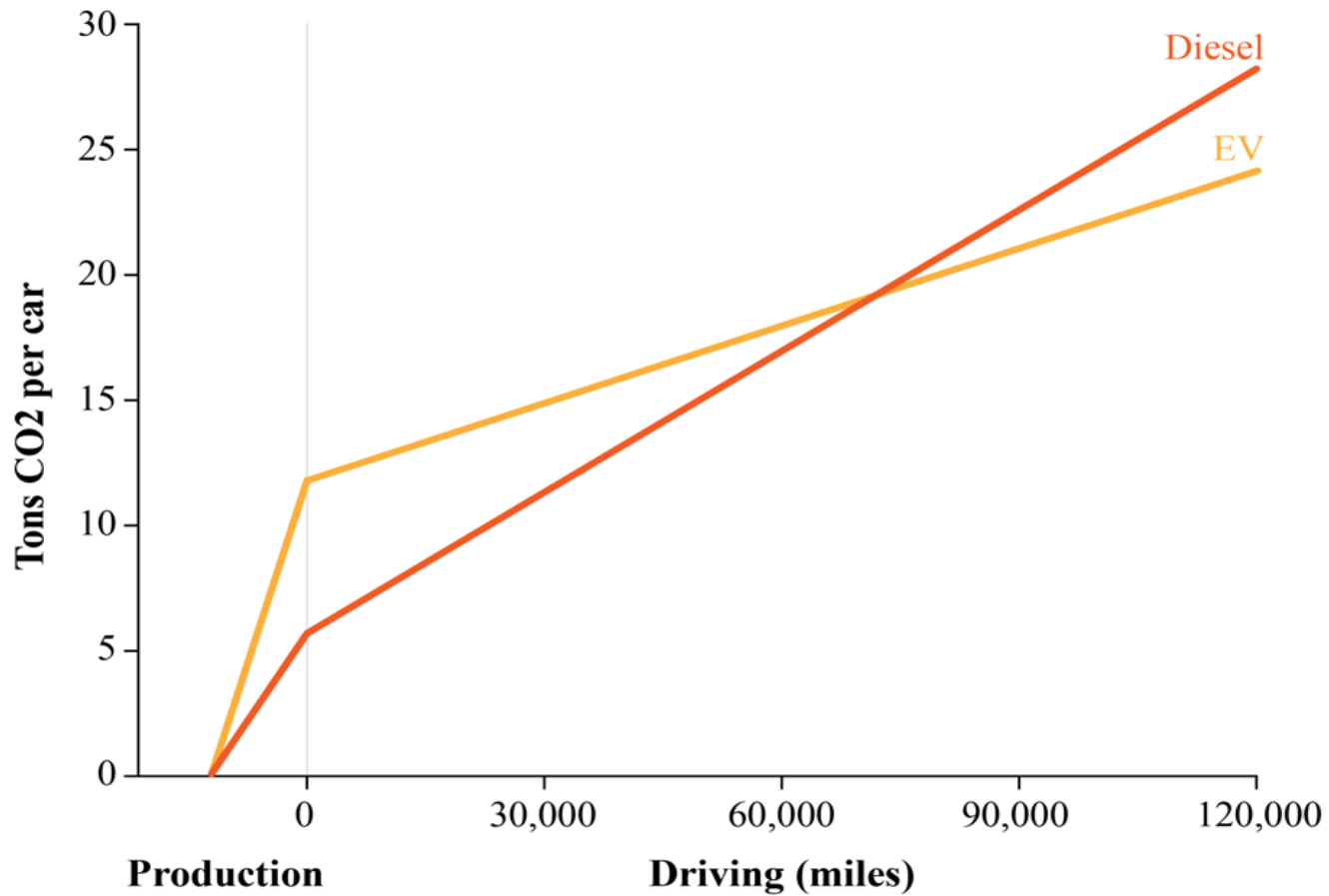


Guessing an EV's lifetime carbon emissions



Battery 1/2 std size

EV elsewhere carbon emissions

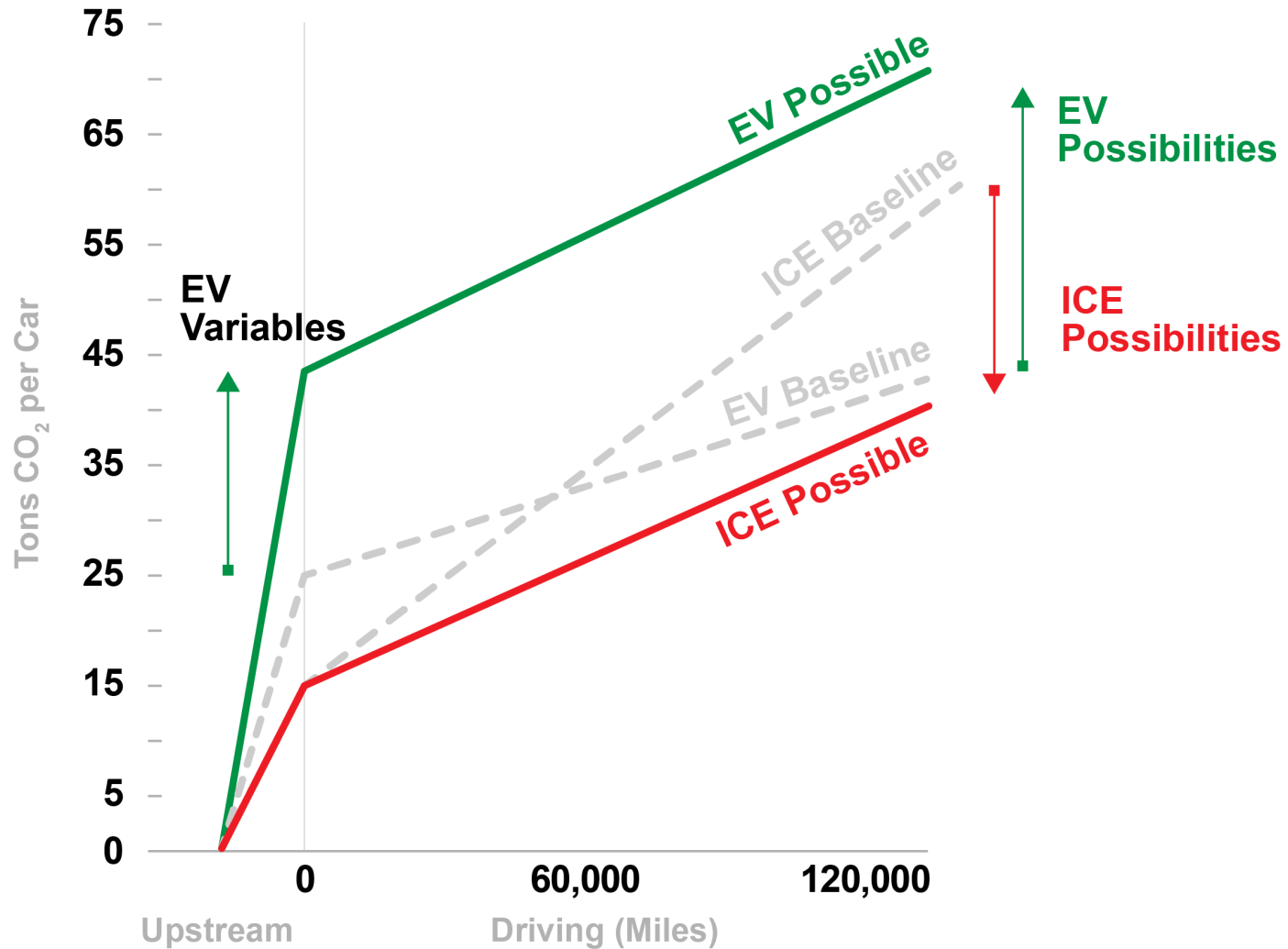


Battery **1/2** std size

Battery 3/4 std size

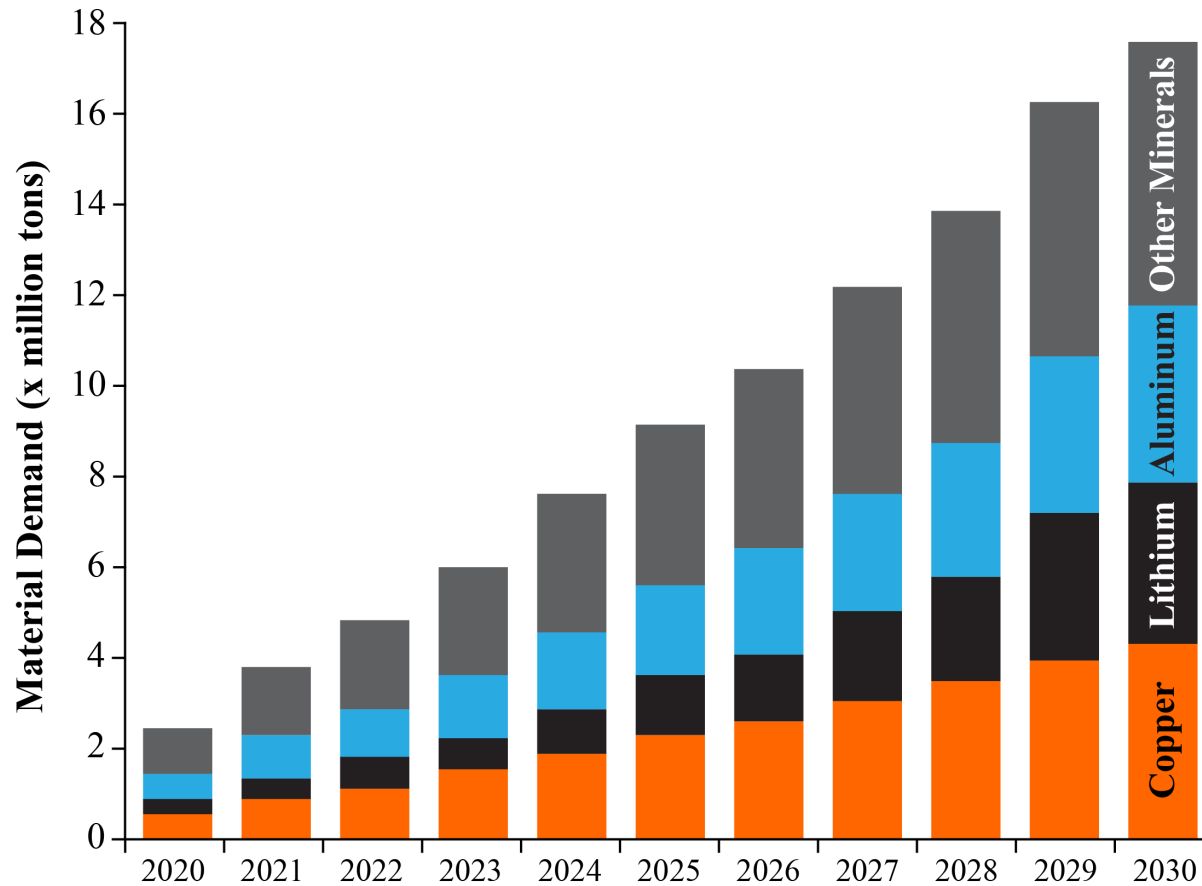


EV CO₂ emissions: Known unknowns



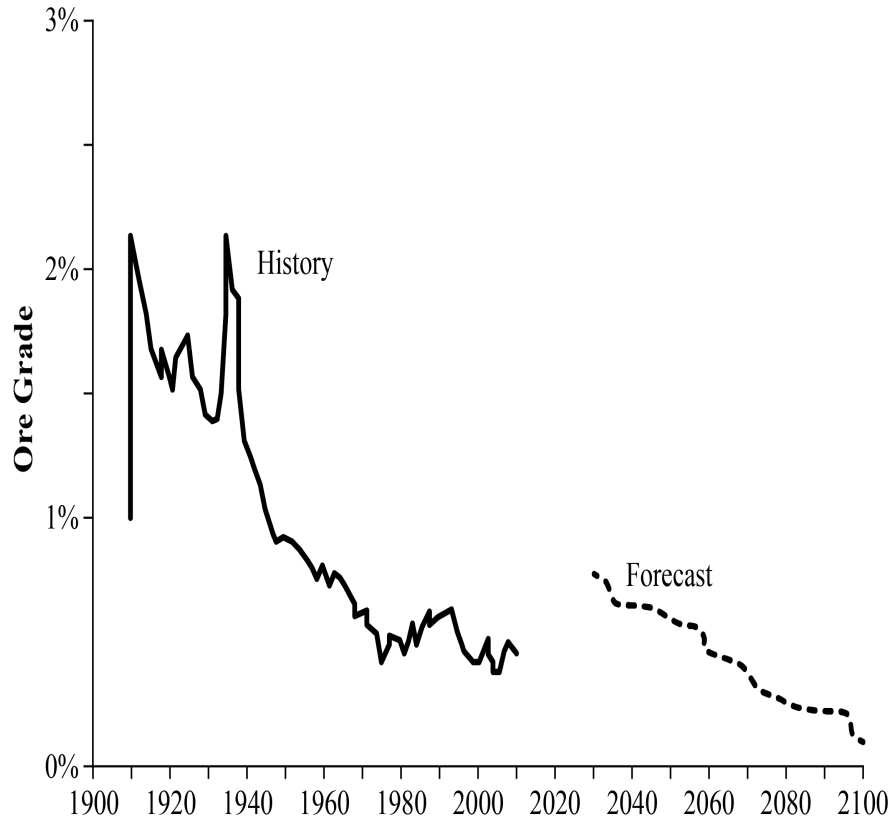
'Hiding' the real minerals costs

Digging up gigatons/yr of the earth -- somewhere

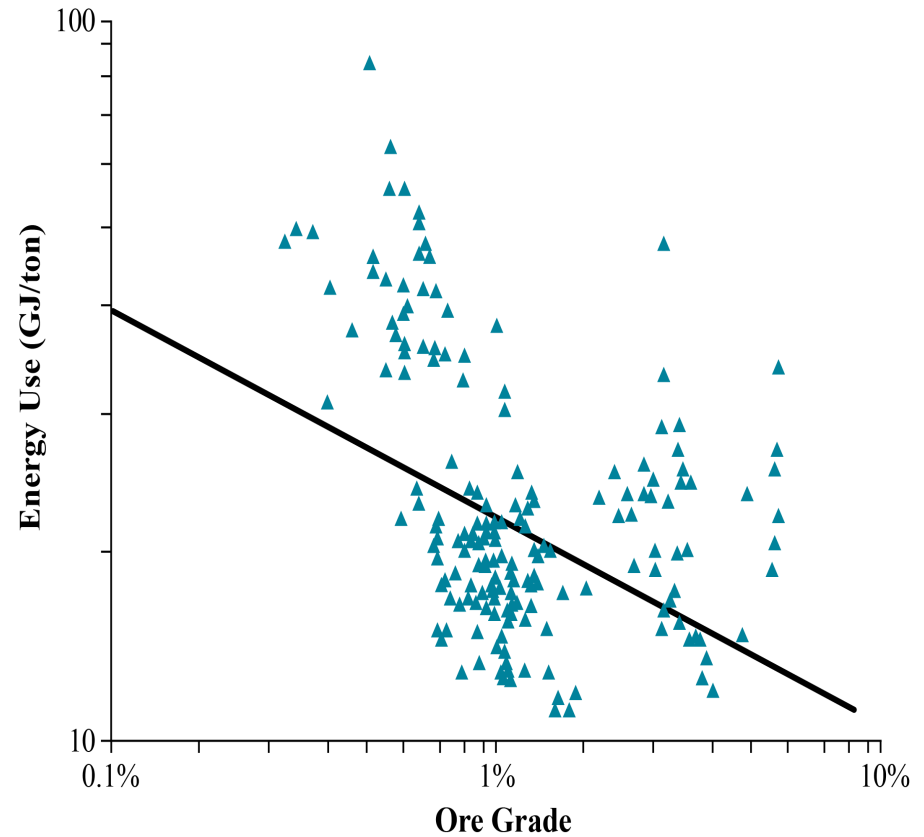


Iron Law of declining metal ore grades

Copper Ore Grades

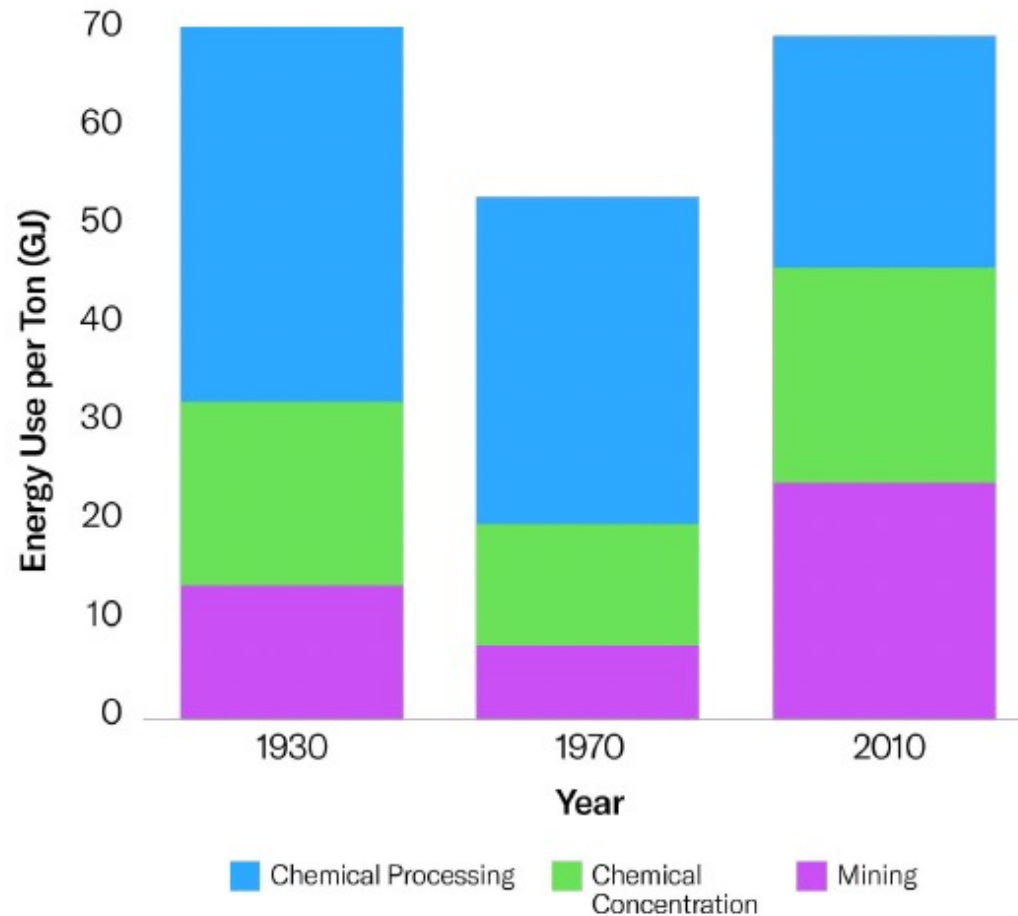


Energy Cost vs Ore Grade



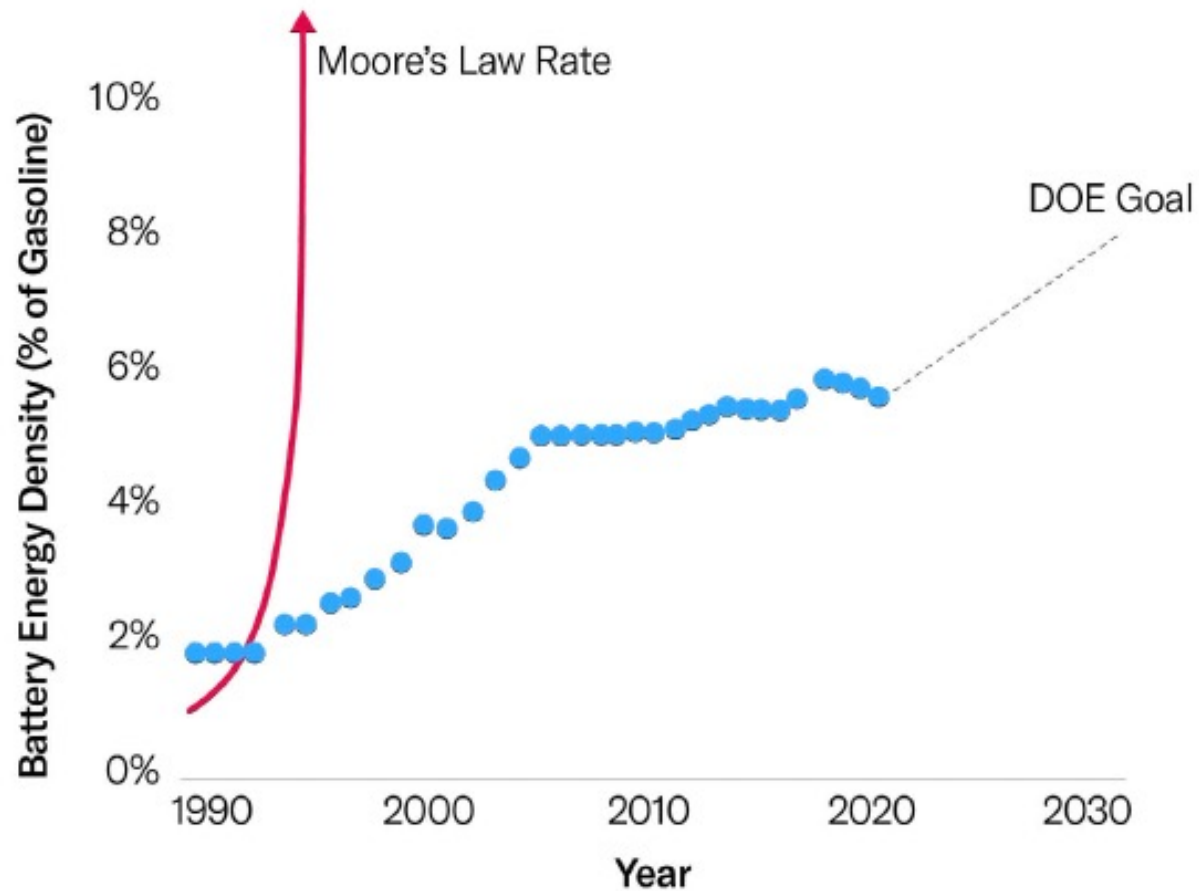
No energy ‘magic’ in mineral supply chains

Copper Production: Technology Trends in Energy Use per Ton



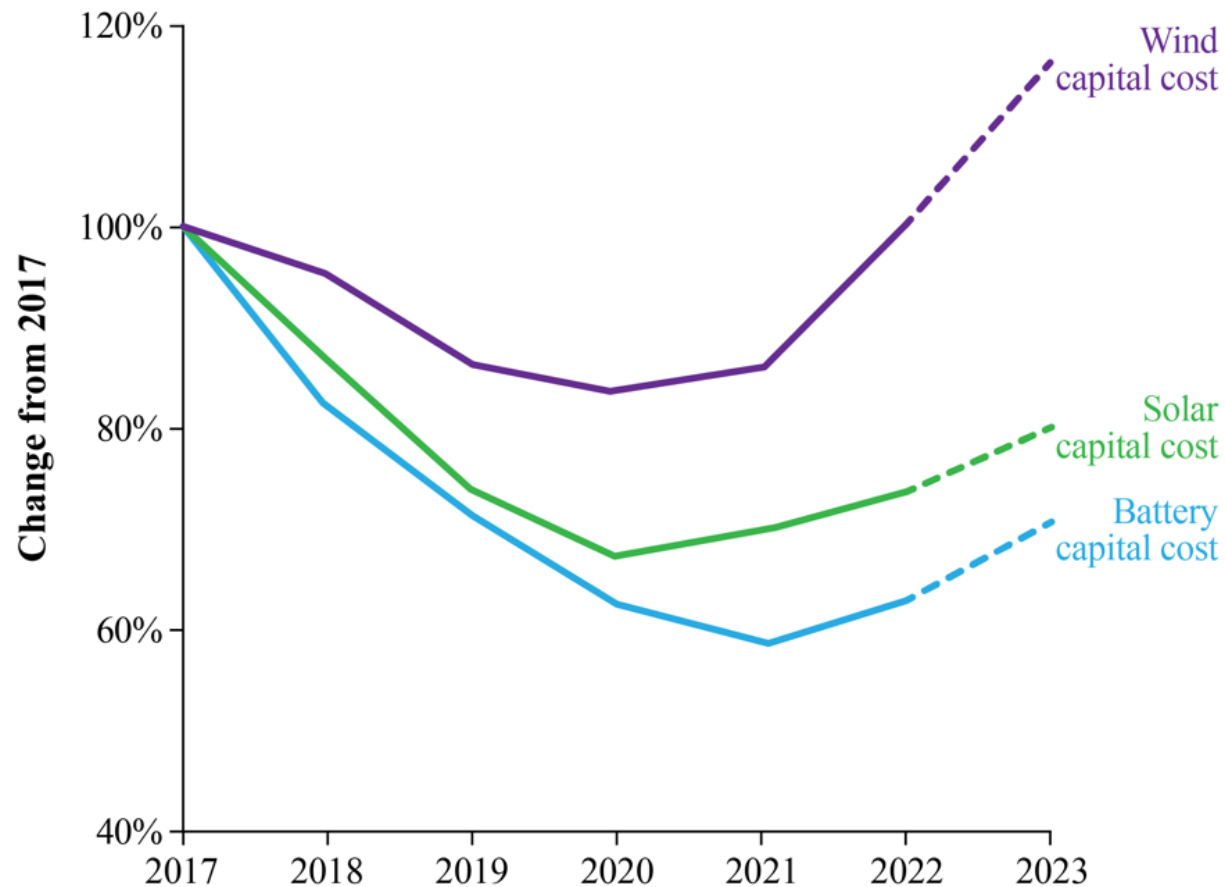
The battery tech Moore's Law trope

Progress in Lithium Battery Performance*

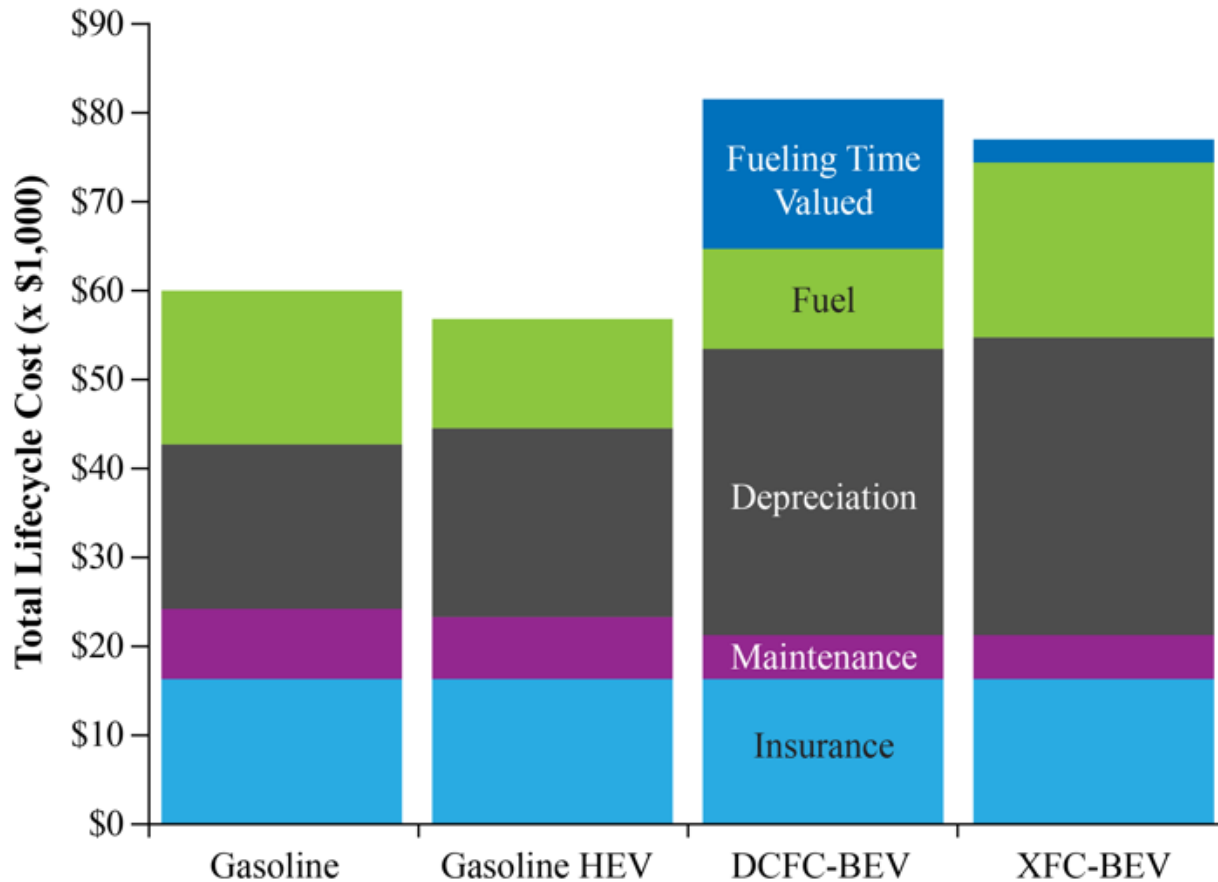


Green machine costs are rising not falling

Commodities: 60 – 70% cost of batteries & solar modules

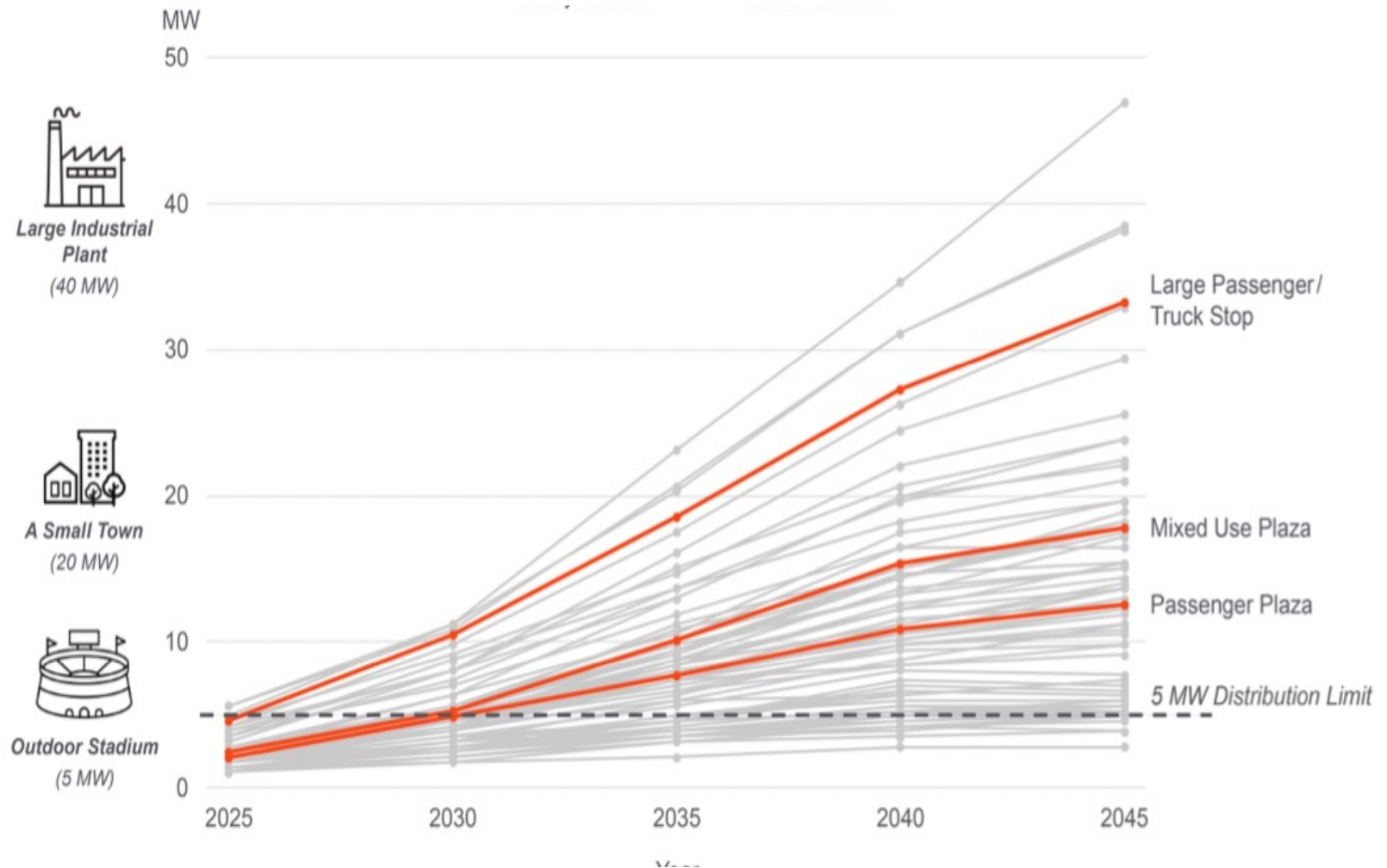


Real EV costs if people's time is valued . . .



Grid infrastructure costs hidden in plain sight

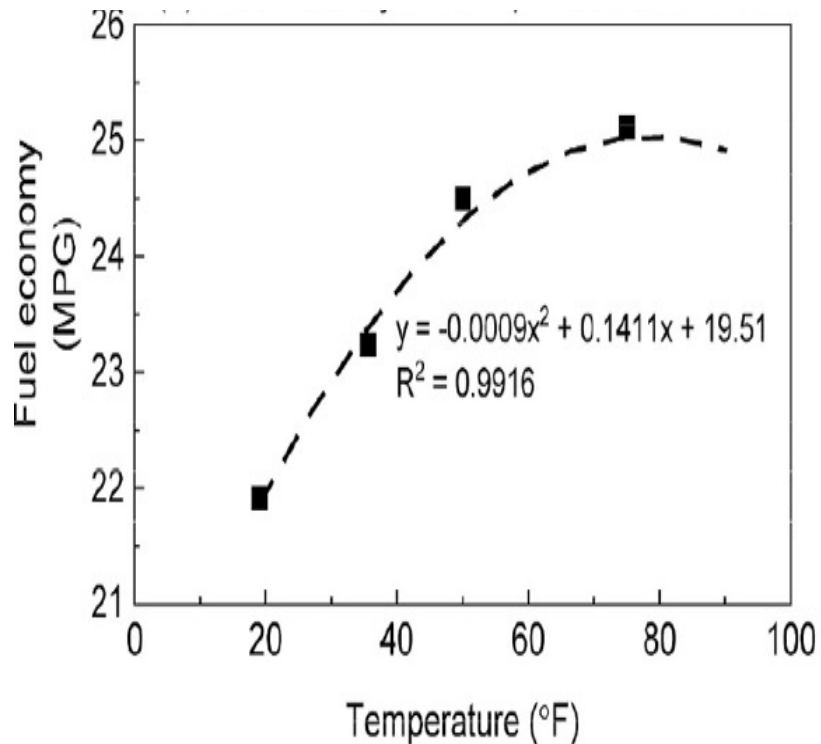
MW grid capacity per single fueling station



More known unknowns: temperature & fuel efficiency

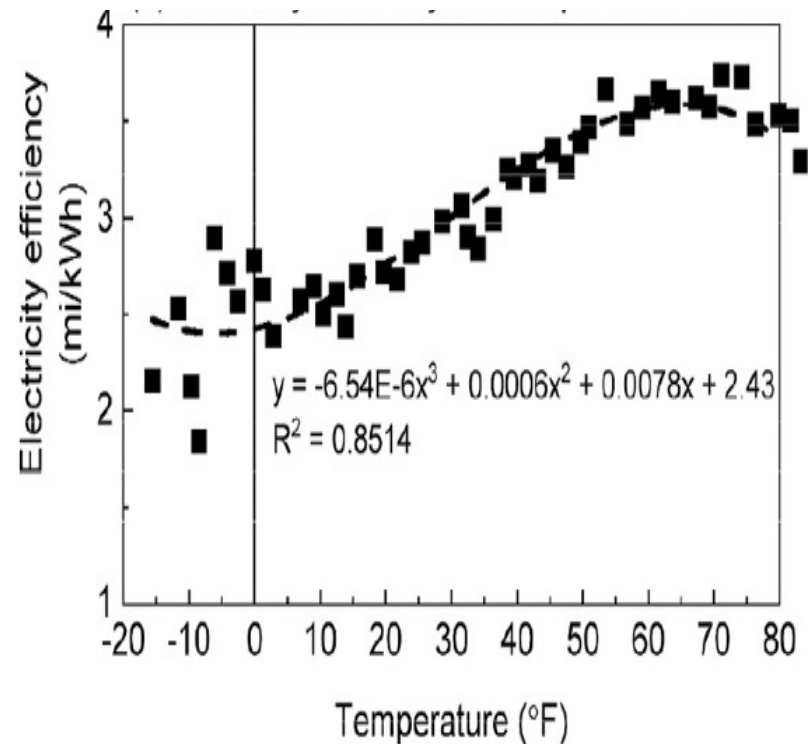
Engine

-6%



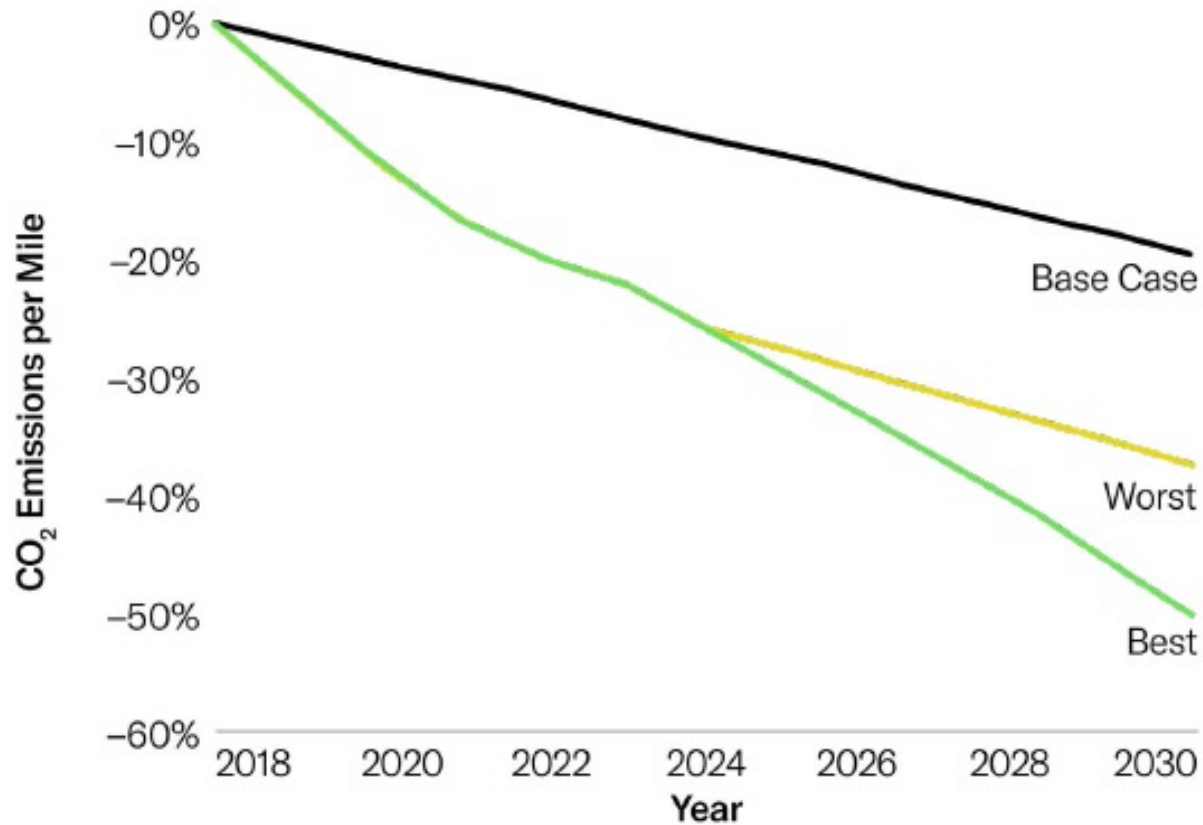
EV

-30%

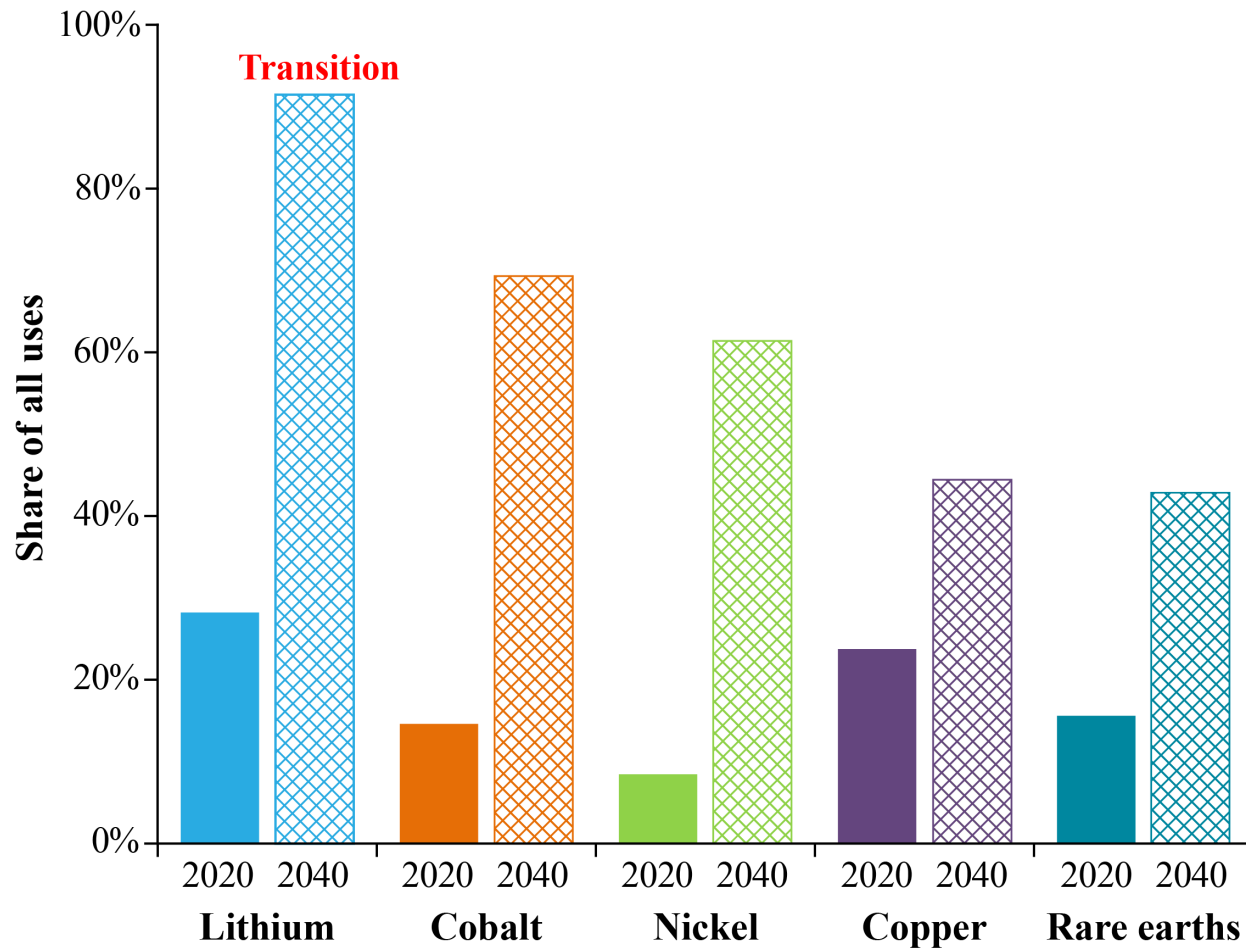


ICE CO₂ Emissions: Known knowns

Known Potential for Internal Combustion Engine CO₂ Emissions per Mile

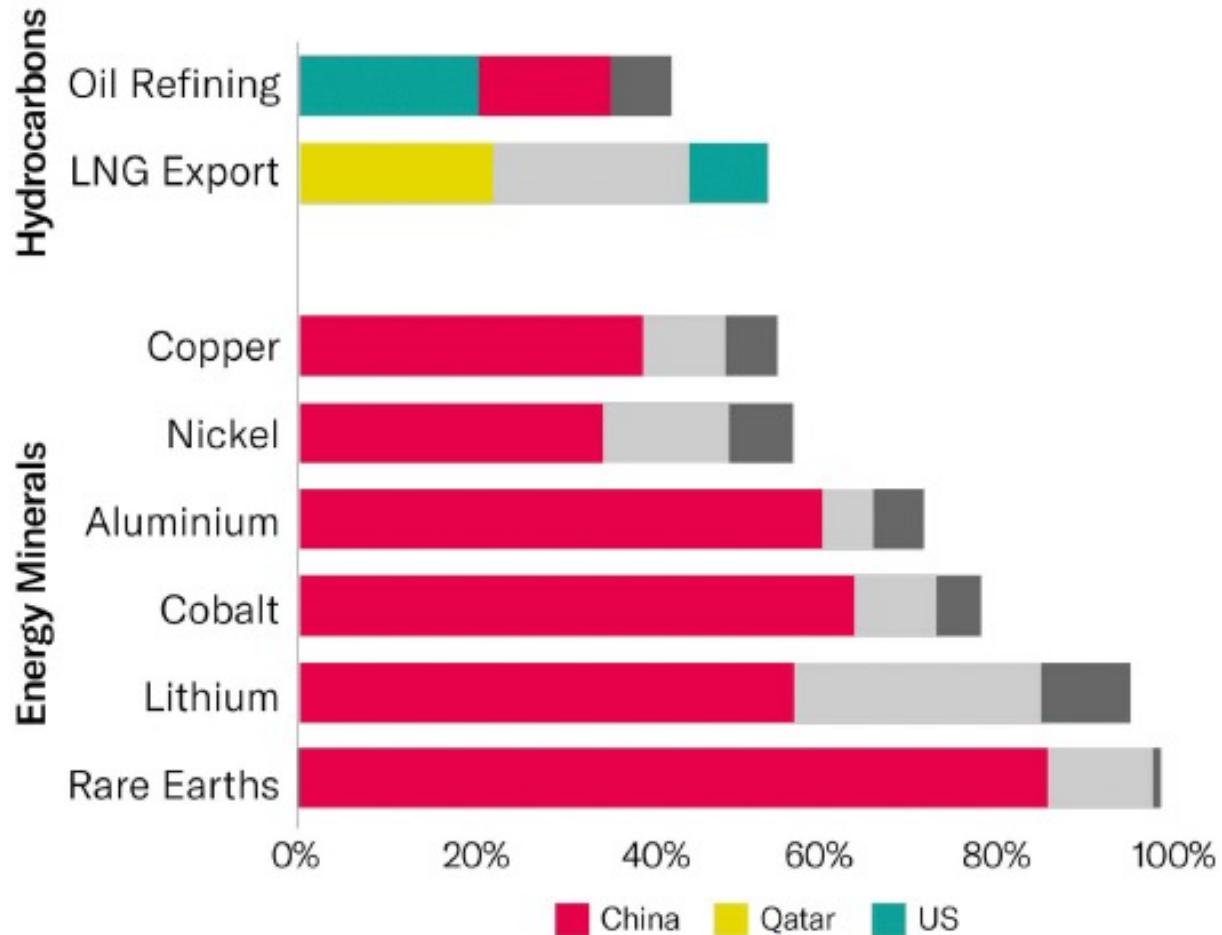


Energy minerals will dominate all future uses



China dominates “energy minerals” supply chains

Global Share of Top Three Countries Producing Refined Products



Mining in America: known unknowns

U.S. Federal Mine Approvals 2010-2022

