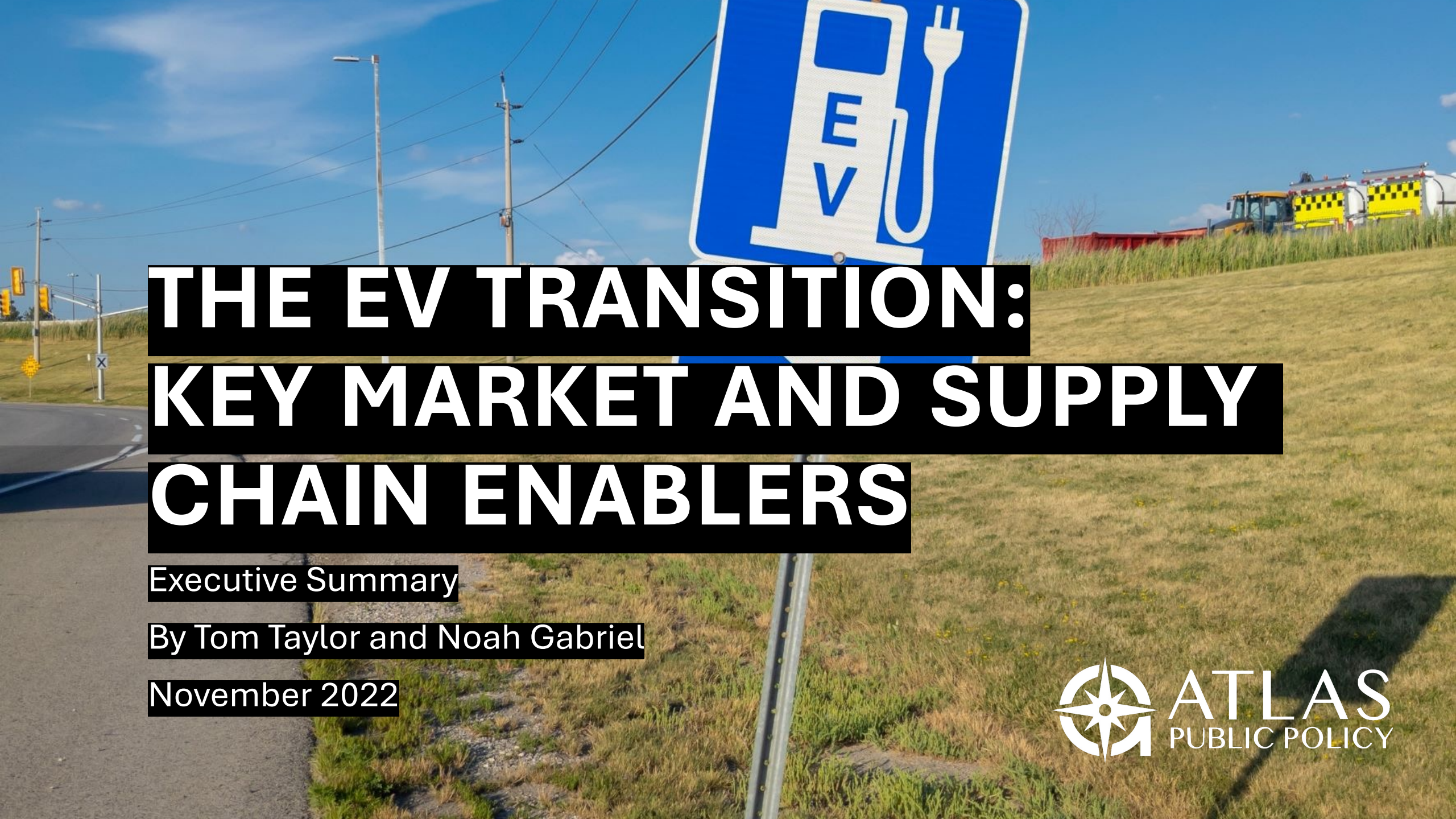

THE EV TRANSITION: KEY MARKET AND SUPPLY CHAIN ENABLERS

Executive Summary

By Tom Taylor and Noah Gabriel

November 2022

ATLAS PUBLIC POLICY

OVERVIEW

Electric Vehicle Sales
EV Charging
Utility Investment
State Legislation
Public Funding
EV Manufacturing Facilities
Charging Manufacturing
Batteries
Critical Minerals Overview
Critical Minerals Data
Processing
Battery Recycling

THANKS

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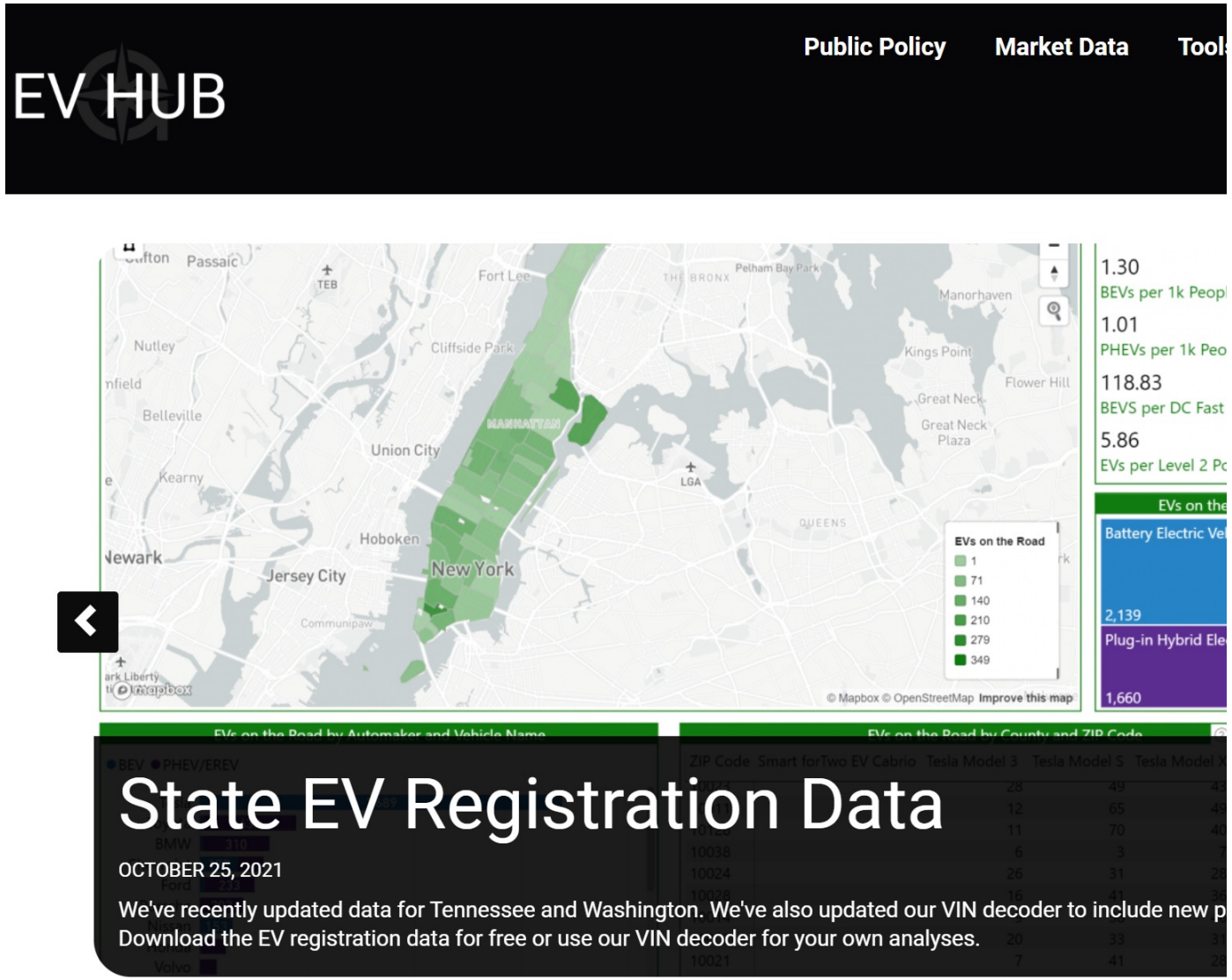
The findings and views put forward in this publication are the sole responsibility of the authors

ABOUT THE DATA

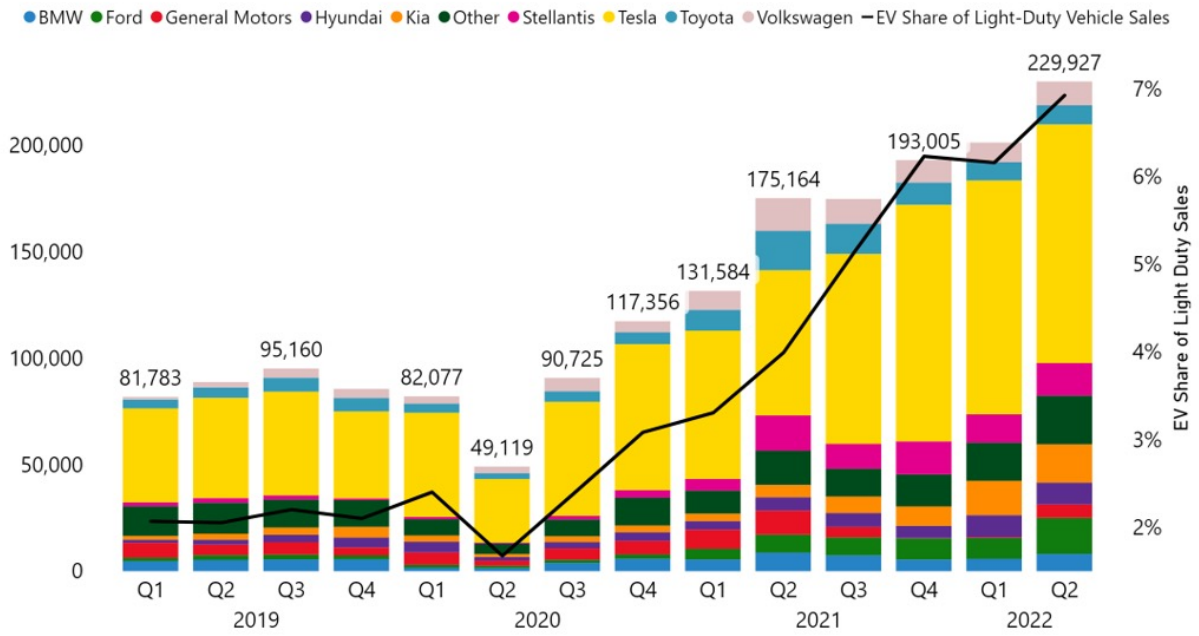
- Market data sourced from Atlas EV Hub through end of June 2022
- Data not sourced from EV Hub is specified where necessary
- Critical Minerals, Battery Recycling and Processing data is through end of August 2022 unless noted
- Throughout the report, “EV” refers to Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles and fuel cell electric vehicles
- Data refers to light duty vehicles only and is focused on the U.S. domestic market and supply chain
- Refer to the report for more detail



ELECTRIC VEHICLE SALES

- As of June 30, 2022, there have been more than 2.9 million cumulative EV sales in the U.S.
- Q2 2022 saw a record 230,000 EVs sold, which was 14 percent more than the prior quarter record.
- In Q2, EVs made up seven percent of the light-duty market. This is a more than 70 percent growth in market share year over year from Q2 2021 (four percent).
- To date, PHEVs have made up a third of all EV sales. In the first half of 2022, that proportion was lower, making up just 22 percent of EV sales.

Figure 1: EV Sales and Market Share from Q1 2019 through Q2 2022



This data captures plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) by parent company[1]. Source: Atlas EV Hub.

EV CHARGING

Table 1: Summary of EV Charging Available

Total Charge Ports	Level 2 Chargers	DCFC Chargers	Change Since July 1, 2021
137,907	111,940	25,967	27%

Total charging ports by type as of June 30, 2022. Source: Atlas EV Hub.

- Of the chargers in Table 1, more than 26,000 were Tesla proprietary chargers.
- Atlas analysis indicates the need for 495,000 public chargers by 2030.
- National Electric Vehicle Infrastructure (NEVI) allocated $5 billion across states to build out a national EV charging network.
- There is also a $2.5 billion discretionary grant program for EV and other alternative fueling.
- NEVI has the potential to establish strong national standards.
- To ensure equitable access, it is crucial that public chargers are both affordable and available for low to moderate income Americans who are more likely to rent or live in a multifamily building where home charging access may be limited or nonexistent.

UTILITY INVESTMENT

- Investor-Owned Utilities (IOUs) have been an important source of EV investment.
- Through the end of June 2022, utility regulators have approved nearly $3.6 billion in rate payer funded IOU transportation electrification investments.
- Funding could support more than 7,800 DC fast charging (DCFC) stations and more than 304,000 Level 2 charging stations.
- IOUs in California, New York, Florida and New Jersey make up nearly 80 percent of all approved IOU EV funding.

Table 2: Investor-Owned Utility EV Investments from 2012 through June 2022

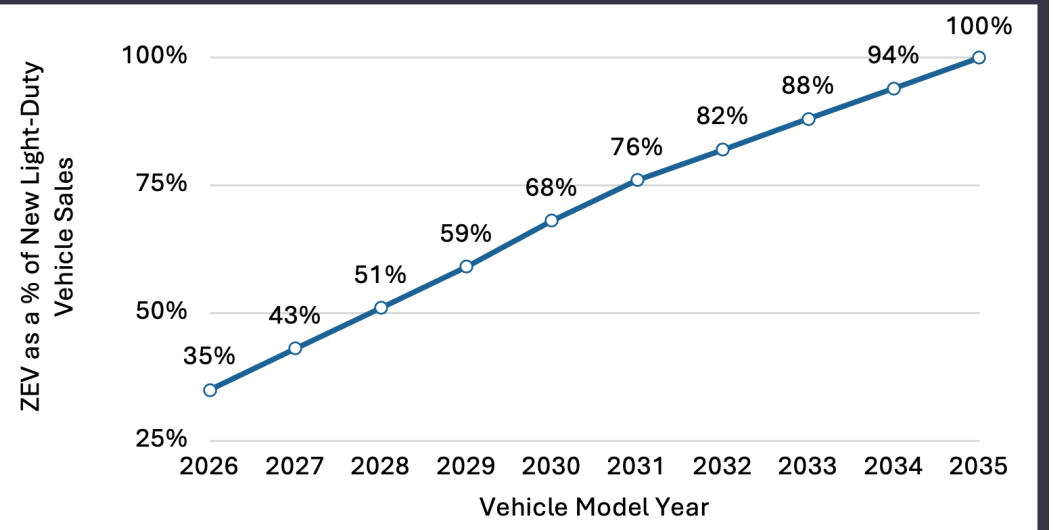
Status	States	Filings	Utilities	Investment	DCFC Stations	Level 2 Stations
Approved	34	138	55	$3,552,187,517	7,839	304,428
Pending	25	61	36	$2,040,621,863	3,716	158,428
Denied/ Withdrawn	22	47	28	$718,953,126	854	90,543

Summary of Investor-Owned Utility Investment in EVs by funding status (approved, pending, or denied). Source: Atlas EV Hub.

STATE LEGISLATION

- Advanced Clean Cars II (ACCII) was approved in August 2022. The Program will require all new vehicles sold in California after 2035 to be EVs.
- ACCII allows for up to 20 percent of EV credits to be generated by selling long-range plug-in hybrid electric vehicles (minimum of 50 miles range by 2028), with the other 80 percent of credits generated by BEV and FCEV purchases.
- Already New York, Oregon, Washington, and Vermont have indicated interest in adopting the rule.
- Elsewhere, 14 states have a rebate in place to incentivize the purchase of EVs.

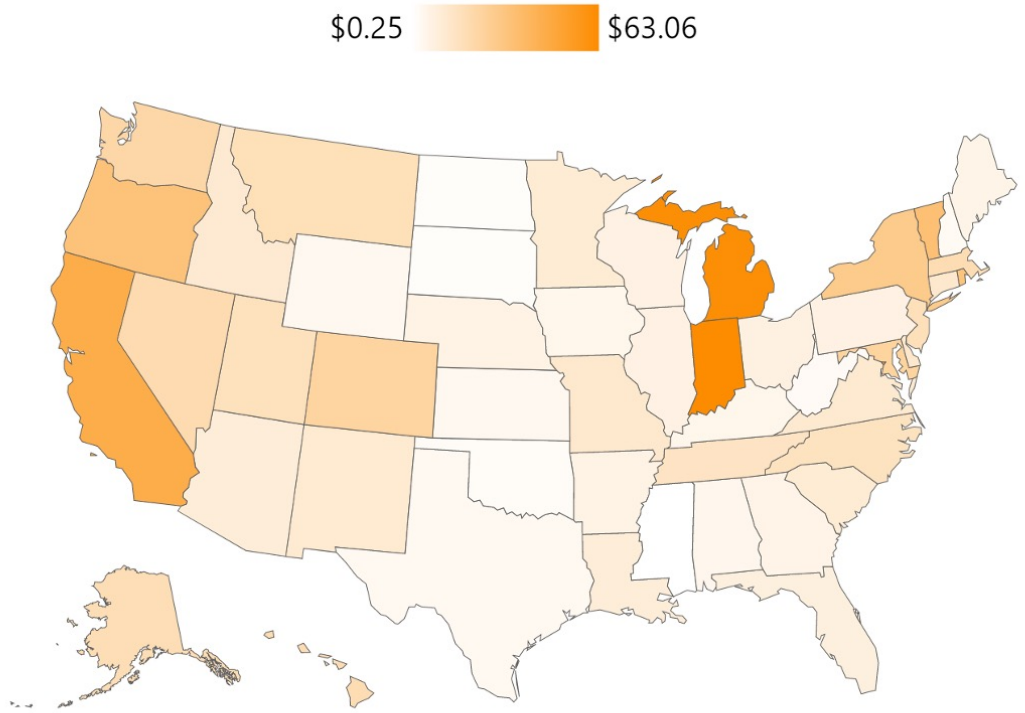
Figure 4: New Vehicle Sales Requirements in Advanced Clean Cars II 2026-2035



PUBLIC FUNDING FOR EVS

- Through the end of June 2022, public funding for light-duty transportation electrification and charging equipment from both state and federal programs (including VW Settlement funding) is $1.4 billion.
- On a per capita basis, Indiana, Michigan and Washington DC lead in public funding for transportation electrification.
- Five years into the VW Settlement, states have awarded or made available $239 million for EV charging. These awards represent 75 percent of the planned amount.

Figure 5: Public Funding for Light-Duty EVs and Charging per Person by State



On a per person basis, Indiana, Michigan, and Washington DC lead all states in public funding for light duty EVs followed by California, Vermont, and Oregon. This funding may come from either federal or state government and does not include loans or the recent NEVI formula funding. Source: Atlas EV Hub.

EV AND BATTERY MANUFACTURING

- Through the end of June 2022, automakers announced more than 115,000 jobs and $82.1 billion in investment for EV manufacturing in the U.S.
- The U.S. was home to an estimated eight percent of global EV lithium-ion cell manufacturing in 2020 with 59 GWh.
- Four of the top five largest EV manufacturing facilities in the U.S. were announced in the past 12 months.
- For instance, in September 2021, Ford and battery manufacturer SK Innovation jointly announced plans to invest $11 billion to build batteries and assemble EVs in Kentucky and Tennessee. According to Ford, this project will create 11,000 jobs across the two states. According to the Governor, this was the largest private investment in Kentucky's history.

Table 3: The Top 15 Largest Announced EV Manufacturing Facilities (by Investment)

Parent Company	State	Vehicles Produced	EV Investment	EV Employees
Hyundai	GA	Multiple Classes, Batteries	$5,540,000,000[5]	8,100
Ford	KY	Batteries	$5,800,000,000	5,000
Ford	TN	Light-Duty (Class 1-2)	$5,600,000,000	6,000
Rivian	GA	Light-Duty (Class 1-2)	$5,000,000,000	7,500
Tesla	NV	Light-Duty (Class 1-2)	$4,500,000,000	7,000
Tesla	CA	Light-Duty (Class 1-2)	$4,100,000,000	10,000
General Motors	MI	Light-Duty (Class 1-2)	$4,000,000,000	2,350
Statevolt	CA	Batteries	$4,000,000,000	2,500
SK Innovation	GA	Batteries	$2,610,000,000	2,600
General Motors	MI	Batteries	$2,600,000,000	1,700
Stellantis	IN	Batteries	$2,500,000,000	1,400
General Motors	OH	Multiple Classes	$2,300,000,000	1,100
General Motors	TN	Batteries	$2,300,000,000	1,300
General Motors	MI	Light-Duty (Class 1-2)	$2,200,000,000	2,200
VinFast	NC	Multiple Classes	$2,000,000,000	7,000

Summary of the top 15 announced EV manufacturing facilities. All facilities were announced on or before June 30, 2022. The jobs are announced jobs. Source: Atlas EV Hub.

Table 4: Charging Manufacturing Facilities in the U.S. (Announced or Operational)

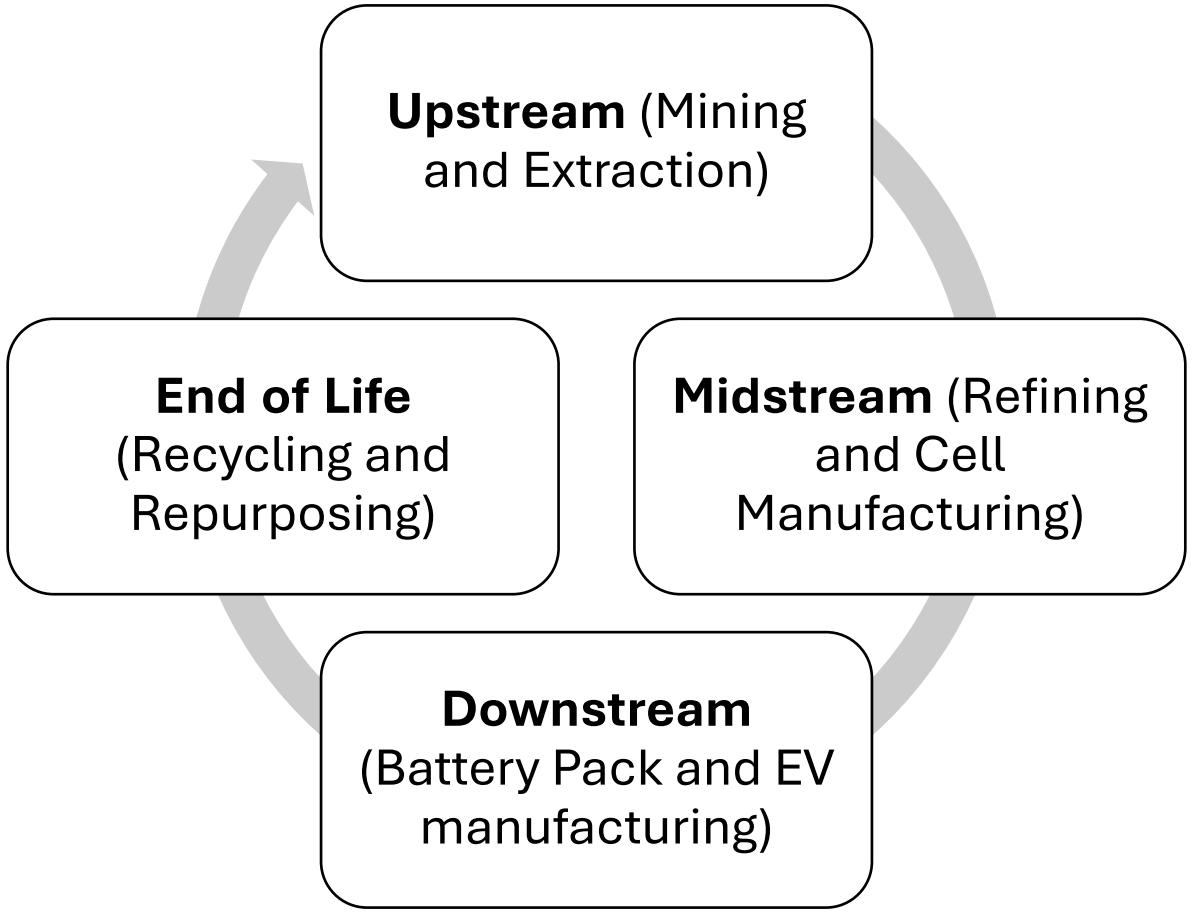
Site Name	State	Company	Year Operational	Charging Unit Production (Annual)	Type of charger
Innovation Park Facility	IL	EVBox	Operational	10,400	DCFC
Wendell Facility	NC	Siemens	Operational	NA	DCFC
Auburn Facility	CA	ClipperCreek	Operational	10,000	Level 2
Gigafactory 2	NY	Tesla	Operational	NA	DCFC
SemaConnect Manufacturing Facility	MD	SemaConnect	Operational	50,000	DCFC, Level 2
Auburn Hills Plant	MI	FLO	2022	50,000	DCFC, Level 2
Tarrant Facility	TX	Wallbox	2022	500,000	DCFC, Level 2
Lebanon Facility	TN	Tritium Charging	2022	30,000	DCFC
FreeWire Manufacturing Facility	CA	FreeWire Technologies	2022	NA	DCFC
Milpitas Facility	CA	ChargePoint	2026	20,000	DCFC, Level 2
Pomona eMobility Hub	CA	Siemens	NA	NA	Level 2
Grand Prairie eMobility Hub	TX	Siemens	NA	NA	Level 2

This data includes all EV charging supply equipment production factories that we were able to identify and verify through some means. NA means that the data is not available. Data source: Blue Green Alliance Foundation and press releases. [29]

CHARGING MANUFACTURING

- The Biden Administration plans to install 500,000 charging stations in the U.S. by 2030.
- There are currently 12 manufacturers of charging stations either operational or announced that produce DCFC and Level 2 charging stations.
- These manufacturers produce charging stations both for public and private use and ensure the U.S. has domestic manufacturing capabilities for EV charging equipment.

BATTERIES

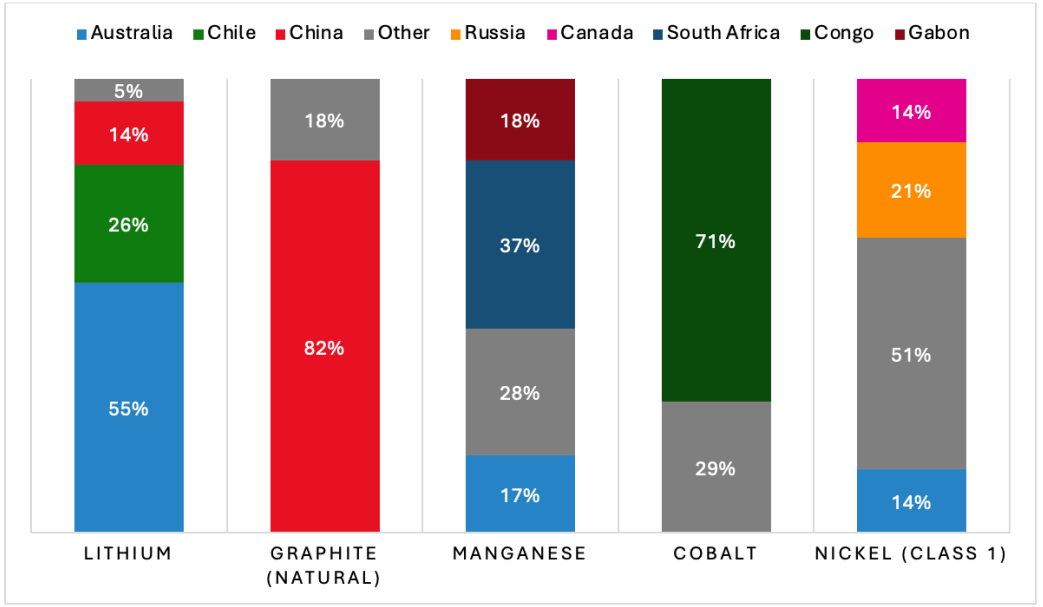


- The three primary battery types are nickel manganese cobalt (NMC), nickel cobalt aluminum (NCA), and lithium ferro phosphate (LFP).
- In 2020, NMC batteries represented the lion's share of the market – present in 72 percent of all EVs produced that year (excluding China)
- The Argonne National Laboratory outlined the potential scenarios in a March 2021 report. The authors anticipate global battery demand for light, medium and heavy-duty vehicles could reach anywhere from 600 GWh to nearly 2,500 GWh in 2030.

CRITICAL MINERALS OVERVIEW

- In 2021, the U.S. imported more than 25 percent of its lithium, 48 percent of nickel, 76 percent of its cobalt, and all its graphite and manganese.
- The sourcing requirements for the clean vehicle tax credit from the Inflation Reduction Act will increase scrutiny of critical mineral supply chains.
- Across all five critical minerals, there are environmental justice concerns. Research from MSCI found, “97% of nickel, 89% of copper, 79% of lithium and 68% of cobalt reserves and resources in the U.S. are located within 35 miles of Native American reservations”.

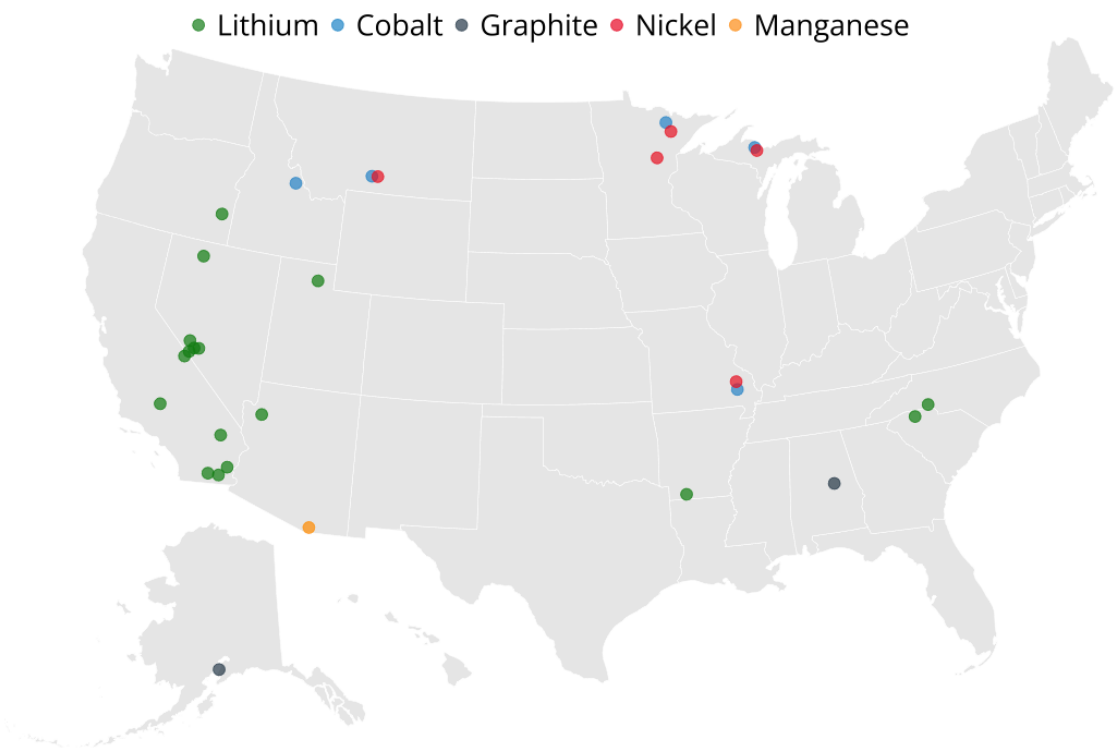
Figure 8: Critical Mineral Extraction is Highly Concentrated in a few countries



Critical mineral extraction by country for 2021 (data is from 2019 for Nickel). “Other” captures countries ranked fourth in production of the critical mineral or if the value for a country is less than ten percent. Data source: USGS and McKinsey. [61] [62]

CRITICAL MINERALS DATA

Figure 9: Critical Mineral Mines (current and proposed) in the United States



Where one mine is the source of more than one critical mineral, that mine is represented by one dot per critical mineral. Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [76] [77]

- Report focuses on five critical minerals:
  - Lithium
  - Cobalt
  - Graphite
  - Manganese
  - Nickel
- Mining of critical minerals must weigh the societal benefits (e.g., enabling decarbonization and reliable domestic supply of minerals) and risks to communities (e.g., risks to water sources, air quality, land fertility, health, disruption of way of life, and desecration of sacred sites) in the extraction of critical minerals.
- Establishing a mine takes years. For instance, according to analysis from Benchmark Mineral Intelligence, it takes a minimum of five years and often much longer to build a lithium mine in the U.S.

LITHIUM EXTRACTION

- There is currently only one lithium mine in operation in the U.S.: The Silver Peak Mine in Nevada. According to the Idaho National Laboratory, this facility produced 4,500 metric tons a year – roughly 2 percent of global lithium supply.
- According to a report by McKinsey & Company in April 2022, worldwide lithium demand will surge from 500,000 metric tons to between 3.3 and 3.8 million metric tons annually in 2030.
- There are at least 17 proposed or operational mines domestically.
- U.S. imports of lithium from 2017 to 2020 were predominantly from Argentina (54 percent), Chile (37 percent) and China (5 percent).

Table 5: Domestic Lithium Extraction Sites (Announced and Operational)

Site Name	State	Year Operational	Parent Company
Silver Peak Mine	Nevada	Operational	Albemarle
Hell's Kitchen	California	2024	Controlled Thermal Resources
Project ATLiS	California	2024	EnergySource Minerals
Rhyolite Ridge	Nevada	2025	Ioneer
Big Sandy Lithium Project	Arizona	2025	Hawkstone
Compass Minerals Lithium Project	Utah	2025	Compass Minerals
Berkshire Hathaway Project	California	NA	Berkshire Hathaway
Thacker Pass Lithium Mine	Nevada	NA	Lithium Americas
McDermitt project	Oregon	NA	Jindalee Resources Limited
Carolina Lithium Project	North Carolina	NA	Piedmont Lithium
NeoLith Energy pilot plant	Nevada	NA	Schlumberger
Arkansas Smackover Lithium Project	Arkansas	NA	Standard Lithium
Bristol Lake	California	NA	Standard Lithium
Kings Mountain Mine	North Carolina	NA	Albemarle
Boron Plant	California	NA	Rio Tinto
Clayton Valley Lithium Project	Nevada	NA	Cypress Development
Zeus Lithium Project	Nevada	NA	Noram Lithium

NA means that the data is not available. Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [76] [77]

COBALT EXTRACTION

Table 6: Domestic Cobalt Extraction Sites (Announced and Operational)

Site Name	State	Year Operational	Parent Company
Madison Mine	Missouri	Operational	United States Strategic Metals
Eagle Mine	Michigan	Operational	Lundin Mining Corporation
Idaho Cobalt Operations	Idaho	Operational	Jervois Global
Stillwater West Project	Montana	NA	Stillwater Critical Minerals
North-Met	Minnesota	NA	Glencore

The Idaho mine opened in October 2022. Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [3] [2]

- The U.S. imported 76 percent of all cobalt consumed domestically in 2021 according to the U.S. Geological Survey Mineral Commodity Summaries 2022.
- There are currently three cobalt mines in operation in the U.S.: The Eagle Mine in Michigan (trace amounts only and set to close in 2026), the Madison Mine in Missouri (from historic mine tailings) and the Idaho Cobalt Operations, which opened in October 2022.

NICKEL EXTRACTION

- The U.S. imported 48 percent of all nickel consumed domestically in 2021, according to the U.S. Geological Survey Mineral Commodity Summaries 2022.
- There are two classifications of nickel purity: class 1 and class 2. Only class 1 nickel is suitable for EV batteries.
- Around 17 percent of global supply of class 1 nickel comes from Russia.

Table 7: Domestic Nickel Extraction Sites (Announced and Operational)

Site Name	State	Year Operational	Parent Company
Eagle Mine	Michigan	Operational	Lundin Mining
Madison Mine	Missouri	Operational	United States Strategic Metals
Tamarack Nickel Project	Minnesota	2025	Talon Metals Corp
Stillwater West Project	Montana	NA	Stillwater Critical Minerals
North-Met	Minnesota	NA	Glencore

Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [3] [2]

MANGANESE EXTRACTION

Table 8: Domestic Manganese Extraction Sites (Announced and Operational)

Site Name	State	Year Operational	Parent Company
Hermosa Project	Arizona	2027	South32

Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [3] [2]

- The U.S. imported 100 percent of all manganese consumed domestically in 2021 according to the U.S. Geological Survey Mineral Commodity Summaries 2022.
- There are no manganese mines currently in operation in the U.S. However, there is presently one mine in the exploration phase in Arizona.
- The manganese reserves in the U.S. is generally low grade, has high extraction costs has higher waste outputs and energy inputs.

GRAPHITE EXTRACTION

- The U.S. imported 100 percent of all-natural graphite consumed domestically in 2021, according to the U.S. Geological Survey Mineral Commodity Summaries 2022.
- Graphite in the U.S. was sourced mainly from China, Mexico, and Canada in 2021.
- There are no graphite mines currently in operation in the U.S. however, there are presently two mines in the exploration phase.

Table 9: Domestic Graphite Extraction Sites (Announced and Operational)

Site Name	State	Year Operational	Parent Company
Coosa Graphite Project	Alabama	2028	Westwater Resources
Graphite Creek	Alaska	NA	Graphite One Inc.

Data source: Press releases, NREL's Lithium-Ion Battery Supply Chain Database and User Guide report, and USGS Mineral Summary for 2022. [3] [2]

CRITICAL MINERAL PROCESSING

- Processing plants in the U.S. produce either anode or cathode materials. The materials are then developed into battery cells.
- EV batteries require high levels of mineral purity to ensure the batteries are effective.
- China is the leader in processing critical minerals. According to the 100-Day Reviews under Executive Order 14017 released in June 2021 by the White House, China is the "world's major processor of lithium carbonate into lithium hydroxide, cobalt into cobalt sulphate, manganese refining, and uncoated spherical graphite refining."

Table 10: Critical Mineral Processing Facilities in the U.S.

Facility Name	State	Product Type	Company	Year Operational
Amsted Graphite Materials	West Virginia	Anode Materials	Anovion	Operational
Elyria Lithium-ion Battery Material Manufacturing Plant	Ohio	Cathode Materials	BASF Toda America LLC	Operational
Battle Creek Lithium-ion Battery Material Manufacturing Plant	Michigan	Cathode Materials	BASF Toda America LLC	Operational
Synthetic Graphite Anode Production Facility	New York	Anode Materials	Anovion	Operational
Syrah Vidalia Facility	Louisiana	Anode Materials	Syrah Technologies	Operational
Spokane Facility	Washington	Anode Materials	Anovion	Operational
Humboldt Mill	Michigan	Cathode Materials	Lundin Mining	Operational
Bessemer City	North Carolina	Cathode Materials	Livent Corporation	2022
Novi Plant	Michigan	Cathode Materials	Battery Resourcers	2022
Alabama Graphite Products	Alabama	Anode Materials	Alabama Graphite Products LLC	2023
Graphex Michigan I	Michigan	Anode Materials	Graphex Technologies	2023
Chattanooga Facility	Tennessee	Anode Materials	Novonix	2023
Anode Pilot Plant	New York	Anode Materials	Li-Metal Corporation	2025

See the report for more...

BATTERY RECYCLING

- EV batteries can both reduce reliance on extraction and produce good batteries.
- Research from October 2021 found that batteries made from recycled materials may perform better than batteries manufactured from primary materials due to the “unique microstructure of recycled materials”.
- Recycling facilities are partnering with automakers and locating facilities close to battery manufacturing centers i.e., the Li-Cycle facility in Warren, Ohio will be co-located with Ultium Cells’ battery cell manufacturing mega-factory.
- EV batteries have a lifespan of 10 to 15 years, and so large-scale recycling is still years off.

Table 11: EV Battery Recycling Facilities in the U.S.

Site Name	State	Target Capacity (tons/year)	Facility Product	Year Operational	Company
St Louis Facility	IL	24,000	Battery Grade Materials	Operational	Interco
Spoke Facility	NY	5,000	Black Mass	Operational	Li-Cycle
Worcester, Pilot Plant	MA	15	Cathode materials	Operational	Ascend Elements
Fairfield County Facility	OH	NA	NA	Operational	Cirba Solutions
Wistron Greentech facility	TX	500	Direct Recycling	Operational	Princeton NuEnergy
Spoke Facility	AL	10,000	Black Mass	Operational	Li-Cycle
Spoke Facility	AZ	10,000	Black Mass	Operational	Li-Cycle
Recycling Facility	GA	30,000	Cathode materials	2022	Ascend Elements
Spoke Facility	OH	15,000	Black Mass	2023	Li-Cycle
Hub Facility	NY	35,000	Battery Grade Materials	2023	Li-Cycle
Apex 1	KY	NA	Battery Grade Materials	2023	Ascend Elements
SungEel Recycling Park	GA	50,000	NA	2024	SungEel Materials
Carson City facility	NV	20,000	Battery Grade Materials	NA	Redwood Materials
Lithium-Ion Battery Recycling Pilot Plant	NV	20,000	Battery Grade Materials	NA	American Battery Technology Company
Lithium-Ion Battery Recycling Plant	WA	NA	NA	NA	Lab 4 Inc

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