CENTER FOR AUTOMOTIVE RESEARCH

EV Jobs Academy Full Collaborative CAR Research Update

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July 20, 2023 – EV Jobs Academy

WHAT WE DO

CENTER FOR AUTOMOTIVE RESEARCH

An independent nonprofit organization producing industry-driven research and fostering dialogue on critical issues facing the automotive industry and its impact on the U.S. economy and society.

RESEARCH	CAR helps you navigate the uncertain automotive environment through thought-provoking, independent, multi-disciplinary, and unbiased research and analysis of important industry trends and changes.
EVENTS	CAR hosts industry-driven events to disseminate key research, update stakeholders on critical issues, and foster discussions among thought leaders to share their insights and solutions to meet the challenges of an ever-evolving global automotive industry.
PROGRAMS	CAR fosters communication and support to promote the auto industry and the issues it faces today by bringing together communities, automakers, suppliers, and technology companies.

Agenda:

- Announced North American Automotive Investments
  - Tracked Automaker
  - Tracked Supplier
  - Investment in MI and the Great Lakes
- EV-related Policy
- Education Outlook
- Job Outlook

Acronym Definitions

ADAS: Advanced Driver-Assistance Systems

AI: Artificial Intelligence

AR: Augmented Reality

AV: Autonomous Vehicle

EV: Electric Vehicle

EVSE: Electric Vehicle Supply Equipment

HEV: Hybrid Electric Vehicle

ICE: Internal Combustion Engine

IoT: Internet of Things

IRA: Inflation Reduction Act

LFP: Lithium-Iron-Phosphate

ML: Machine Learning

NEV: Neighborhood Electric Vehicle

NEVI: National Electric Vehicle Infrastructure

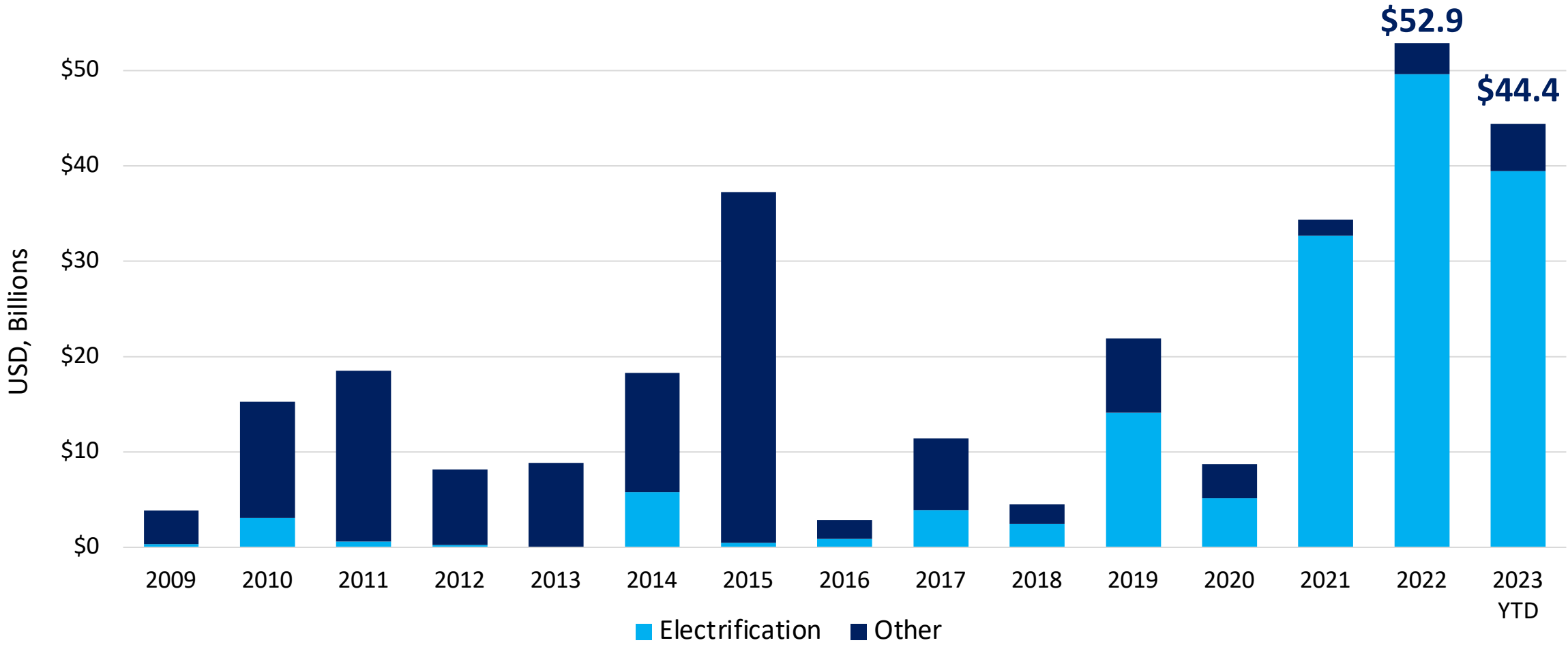
PHEV: Plug-in Hybrid Electric Vehicle

Announced North American Automotive Investments

Tracked Automaker Announced Investment

Announced Automaker EV/Battery Related Investments

North America, 2009 – 2023 YTD

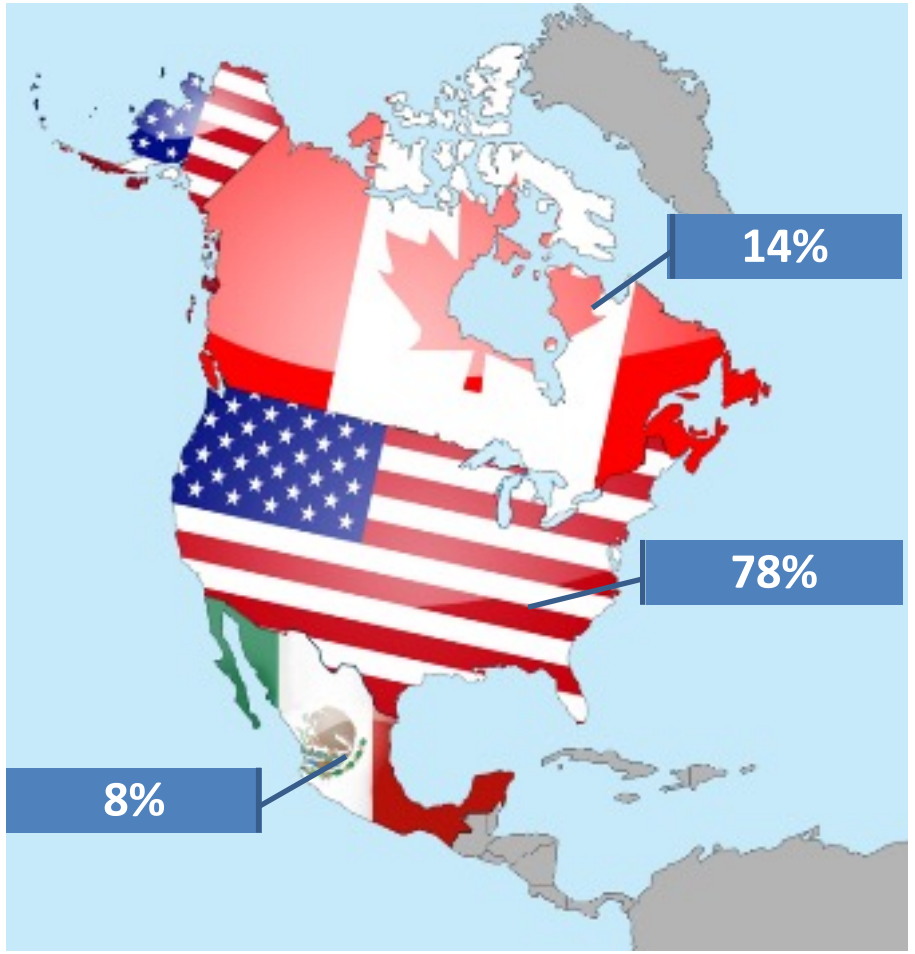


Source: CAR Book of Deals, June 2023

Announced Automaker Electrification Investment by Region

North America, 2018 – 2023 YTD

Region	Investment Amount ($USD)
Canada	$19.4B
United States	$111.9B
U.S. Great Lakes	$51.9B
South	$55.6B
Mexico	$11.1B
Total	**$143.4B**



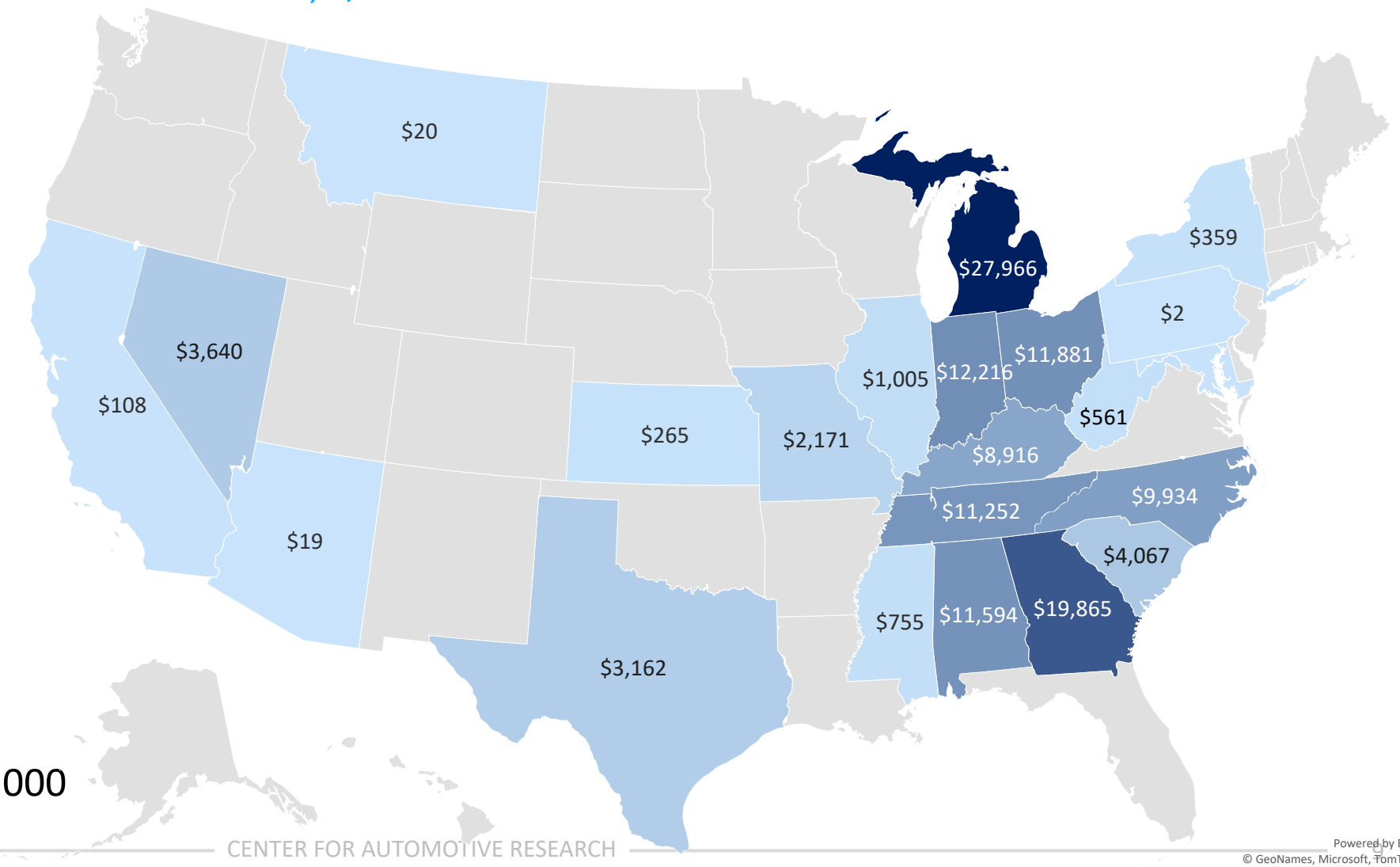
Note: U.S. Great Lakes includes: IL, IN, KY, MI, OH, and MO
South includes: AL, FL, GA, MS, NC, SC, TN, and TX

Source: CAR Book of Deals, June 2023

Automaker Announced Investment

United States, 2018 – 2023 YTD, $130.5B announced in total

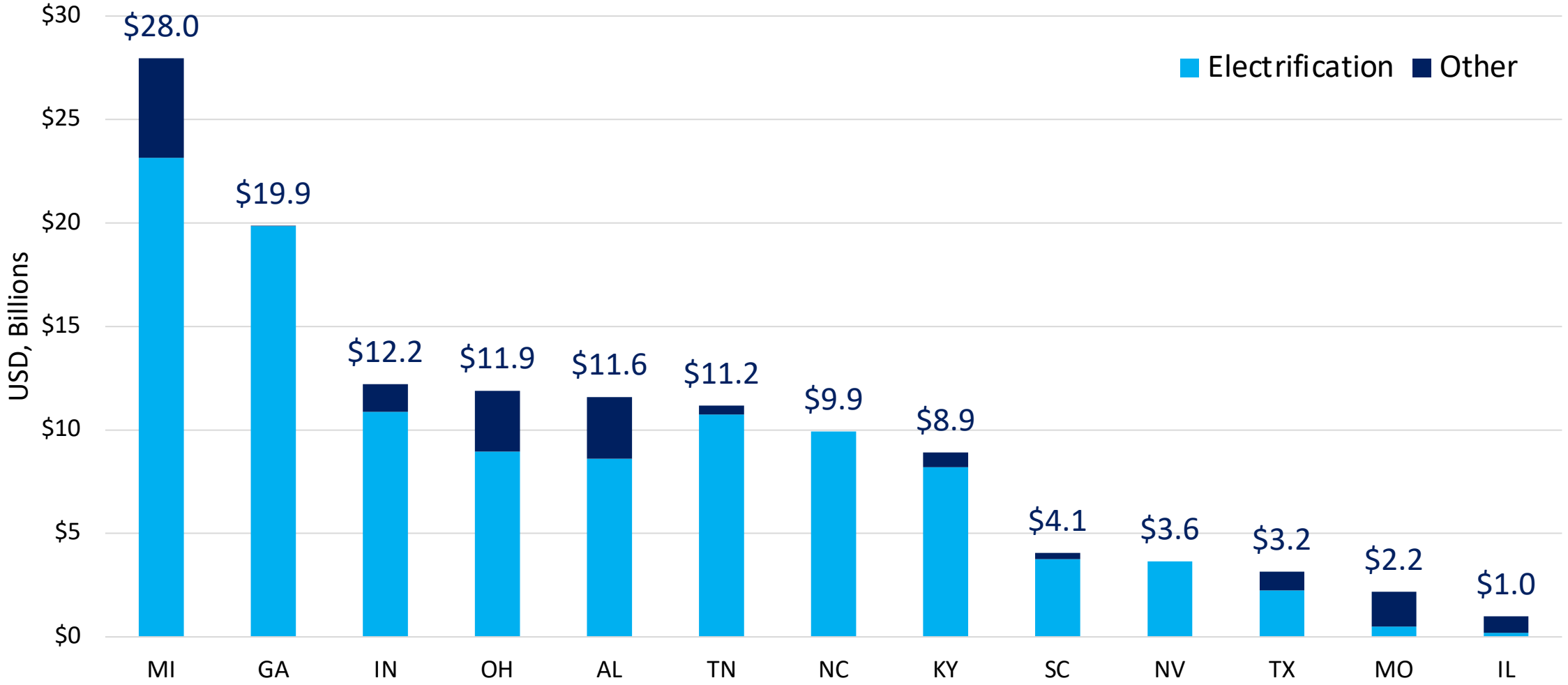
State	% Investment Captured
MI	21.5%
GA	15.3%
IN	9.4%
OH	9.1%
AL	8.9%
TN	8.7%
NC	7.6%
KY	6.9%
SC	3.1%
NV	2.8%
TX	2.4%
MO	1.7%



Source: CAR Book of Deals, June 2023

Automaker Announced Investment

United States, 2018 – 2023 YTD, 86% EV/battery-related

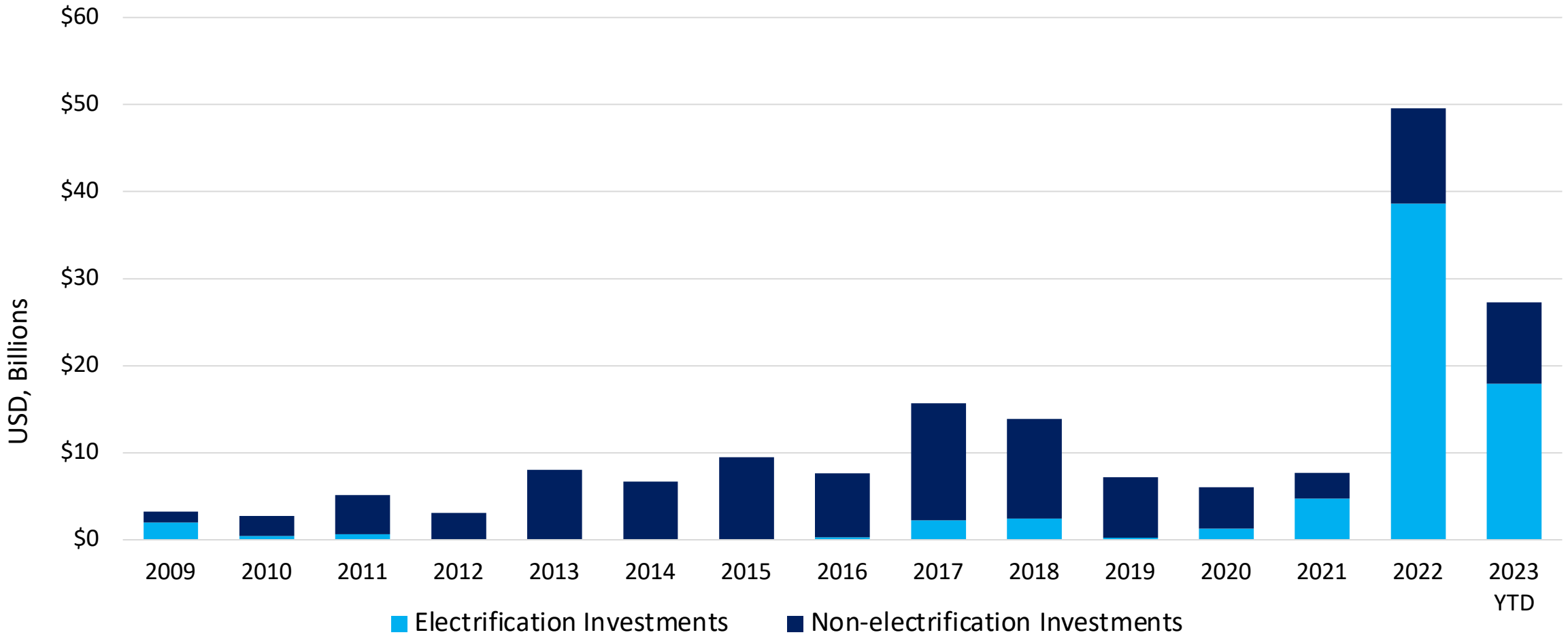


Source: CAR Book of Deals, June 2023

Tracked Supplier Announced Investment

Announced Tracked Supplier EV/Battery Related Investments

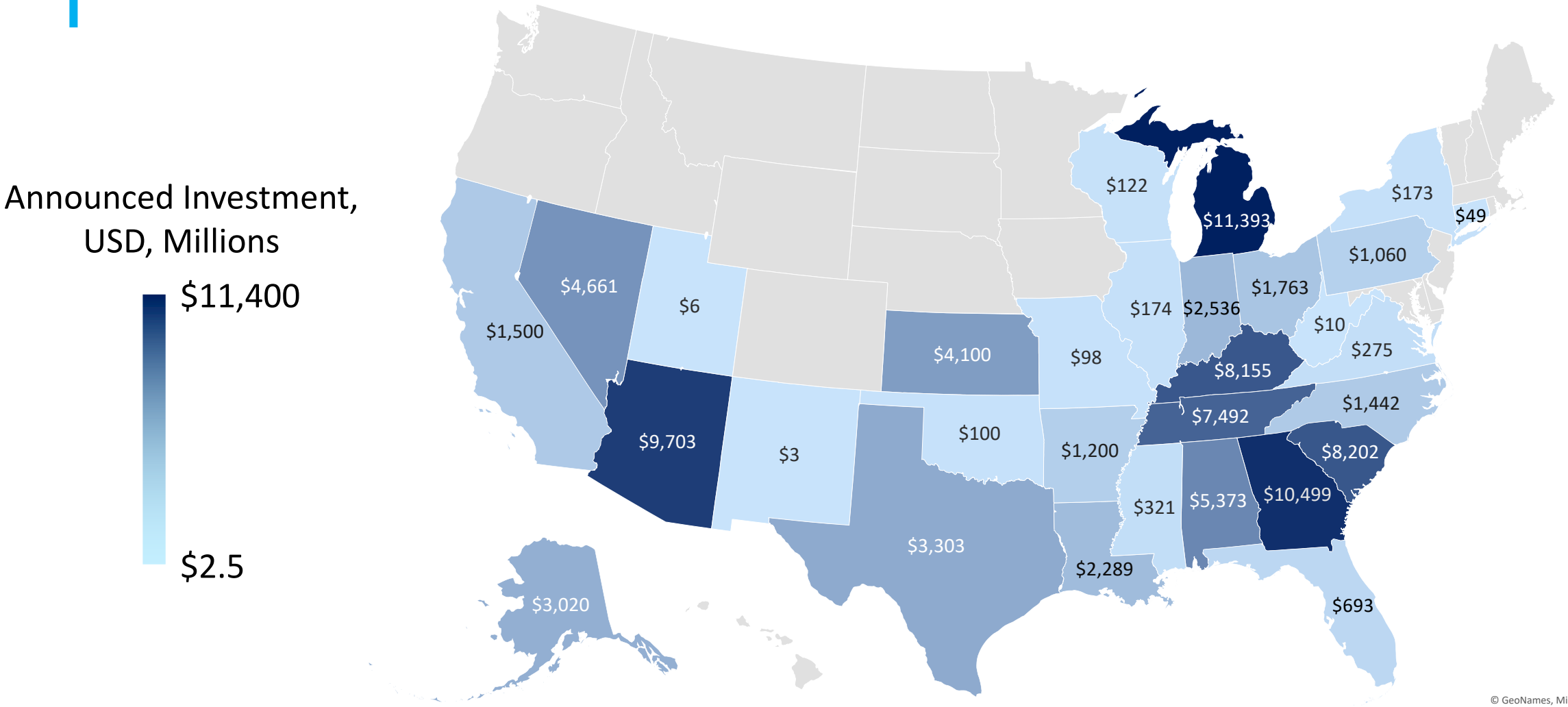
North America, 2009 – 2023 YTD



Source: CAR Book of Deals, June 2023

Tracked Supplier Announced Investment

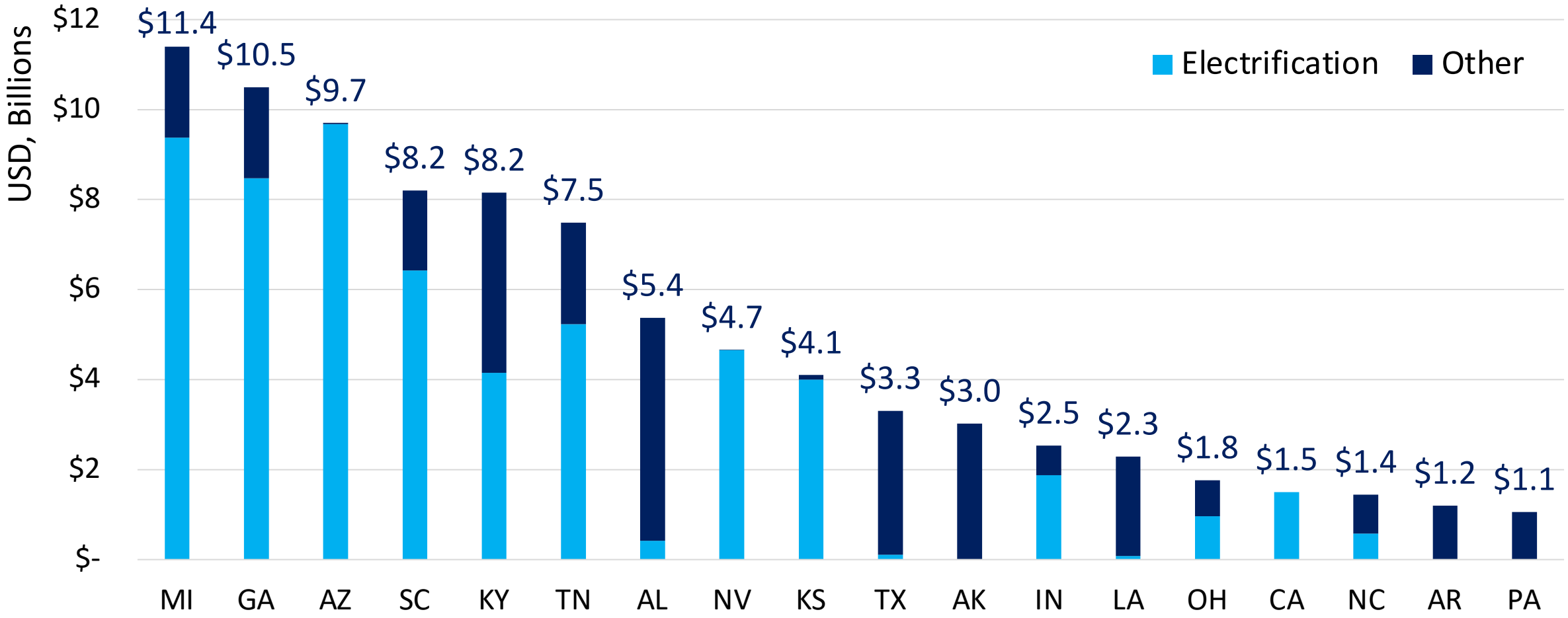
United States, 2018 – 2023 YTD, $91.9B announced in total



Source: CAR Book of Deals, June 2023

Tracked Supplier Announced Investment

United States, 2018 – 2023 YTD, 66% towards electrification



Source: CAR Book of Deals, June 2023

Investment in Michigan and the Great Lakes

Announced EV/Battery Investments in the Great Lakes
2020 – 2023 YTD

Largest Investments:

- 2022 – Honda, Batteries in OH: $3.5 billion
- 2023 – Ford, Batteries in MI: $3.5 billion
- 2023 - GM, Batteries in IN: $3 billion
- 2022 – GM, Batteries in MI: $2.6 billion
- 2022 – Stellantis, Batteries in IN: $2.5 billion

Source: CAR Book of Deals, May 2023; GPS Visualizer

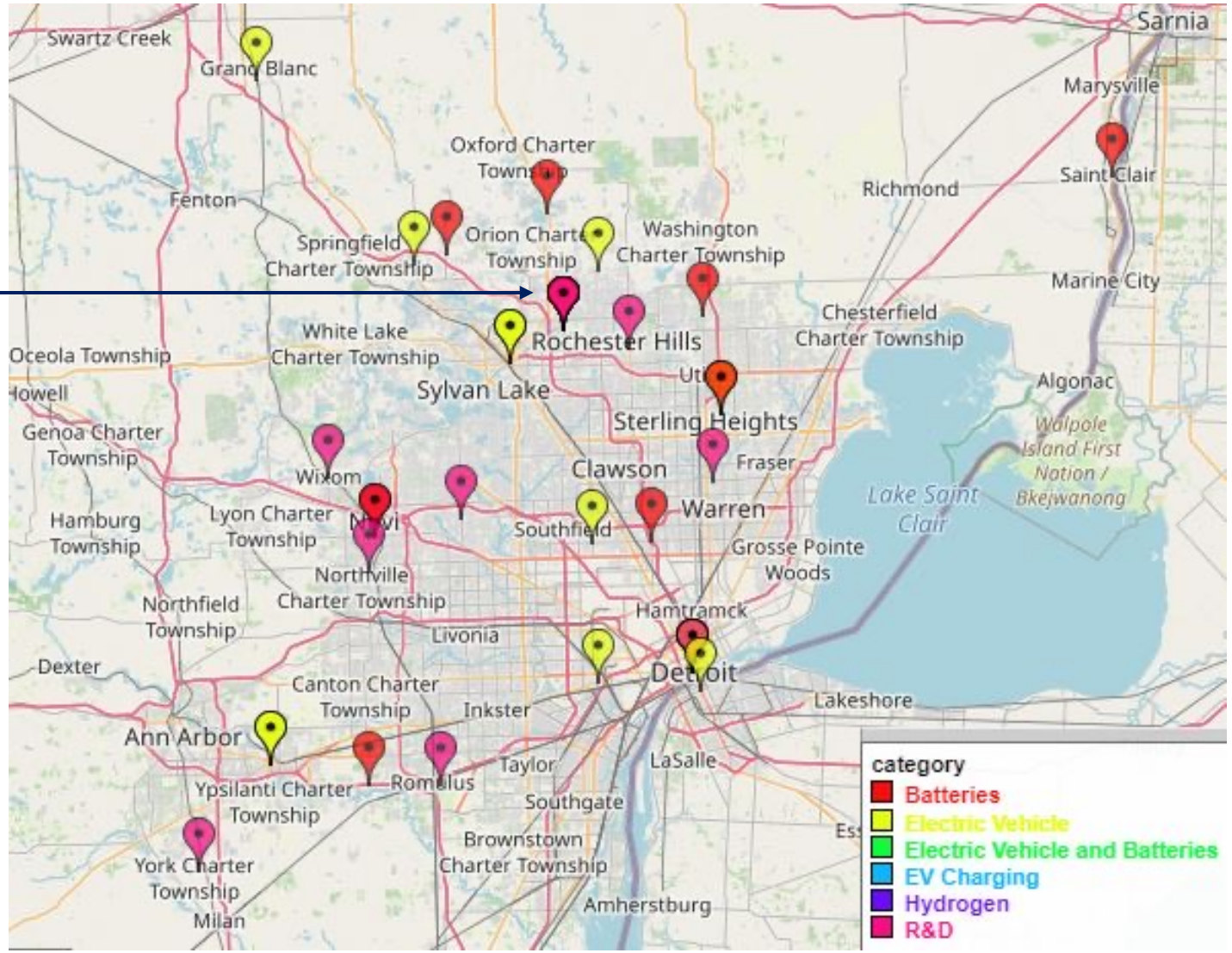
Upper Peninsula had no investment and is not shown, EV Charging is not visible in this map

Announced EV/Battery Investments in Southeast Michigan

2020 – 2023 YTD

Auburn Hills, MI has investment in Batteries, Electric Vehicles, Electric Vehicles and Batteries, and EV charging.

EV Charging: Flo invested $3 million into a manufacturing facility, aiming to produce 250,000 chargers by 2028 for the US market



Largest Investments:

- 2022 – OEM; Ford, EVs in Dearborn: $2 billion
- 2021 – OEM; Stellantis, EVs in Detroit: $1.6 billion
- 2022 – Supplier; Our Next Energy, Batteries in Van Buren Twp: $1.6 billion

Source: CAR Book of Deals, May 2023; GPS Visualizer

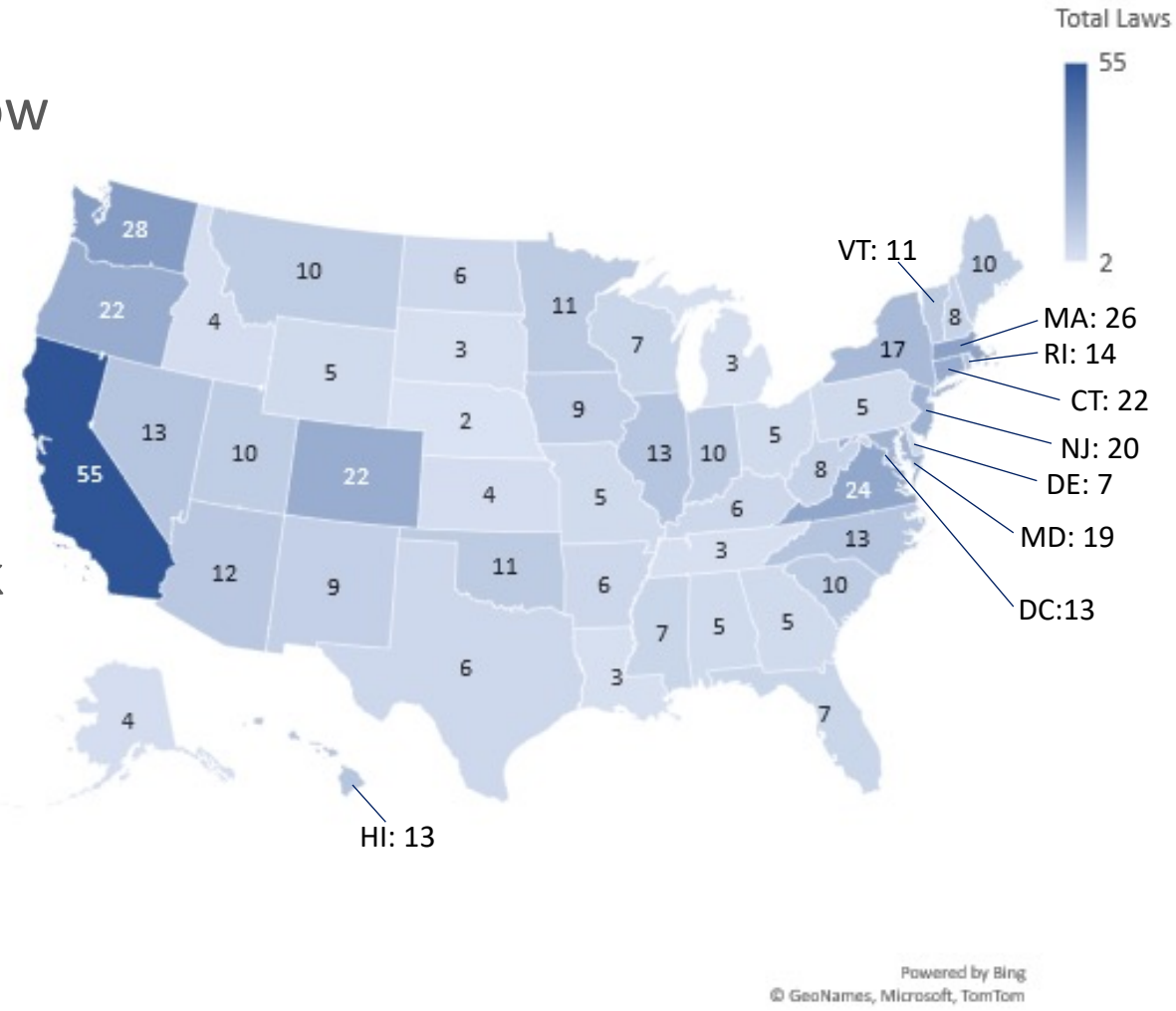
EV-Related Policy

U.S. Laws and Regulations

1993 – 2023 YTD, EV, PHEV, HEV, and NEV related regulations

State laws and regulations do not follow the same I-75 corridor pattern as investments

- California leads in total, with other Pacific Northwest states leading as well
- In the Great Lakes region, New York and Illinois lead in laws and regulations



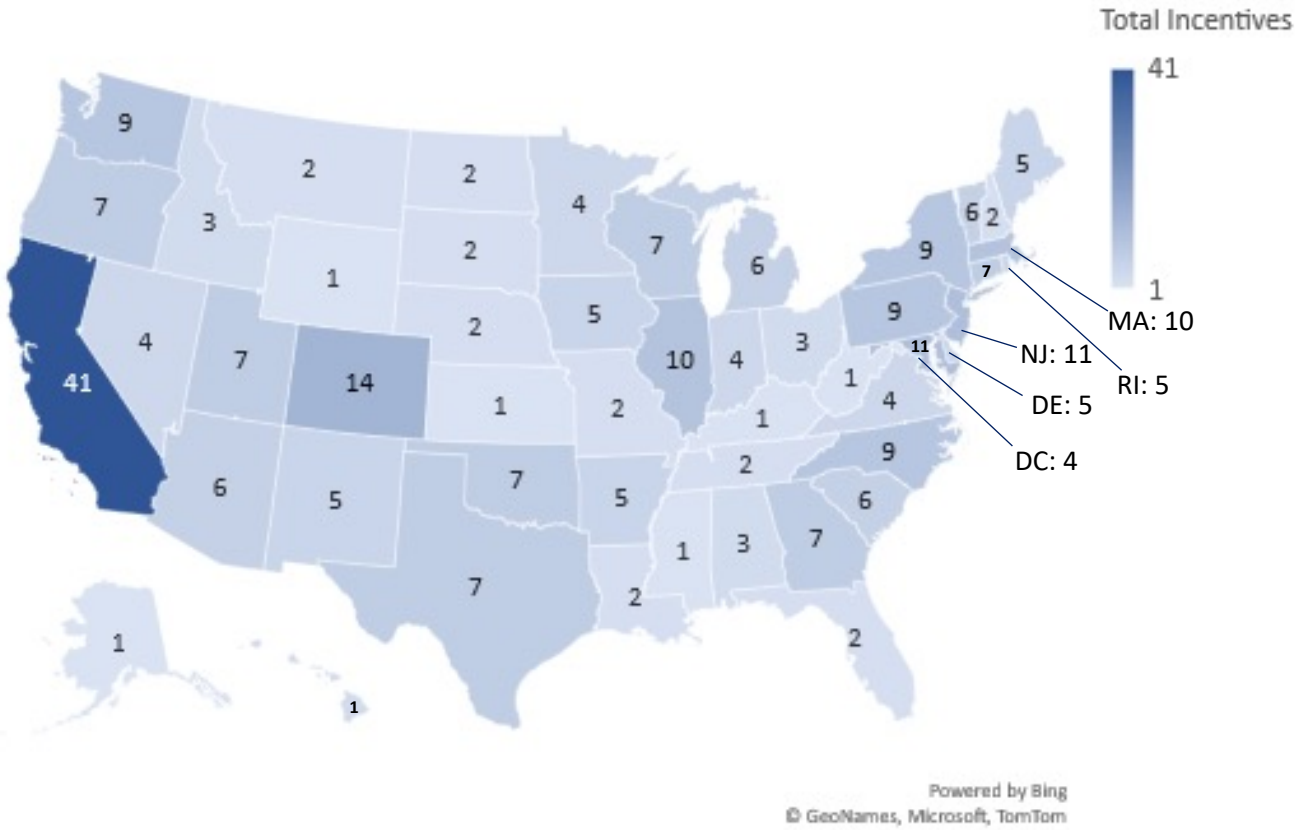
Source: U.S. DOE Office of Energy Efficiency and Renewable Energy Alternative Fuels Data Center, July 2023

U.S. State Incentives

1992 – 2023, EV, PHEV, HEV, and NEV related incentives

State incentives also do not follow the same I-75 corridor as investments

- California is far ahead in total incentives at the state level
- Does not include any utility incentive for consumers, meaning these are likely incentives for purchasing EVs
- In the Great Lakes region, most states are at a similar level of incentives



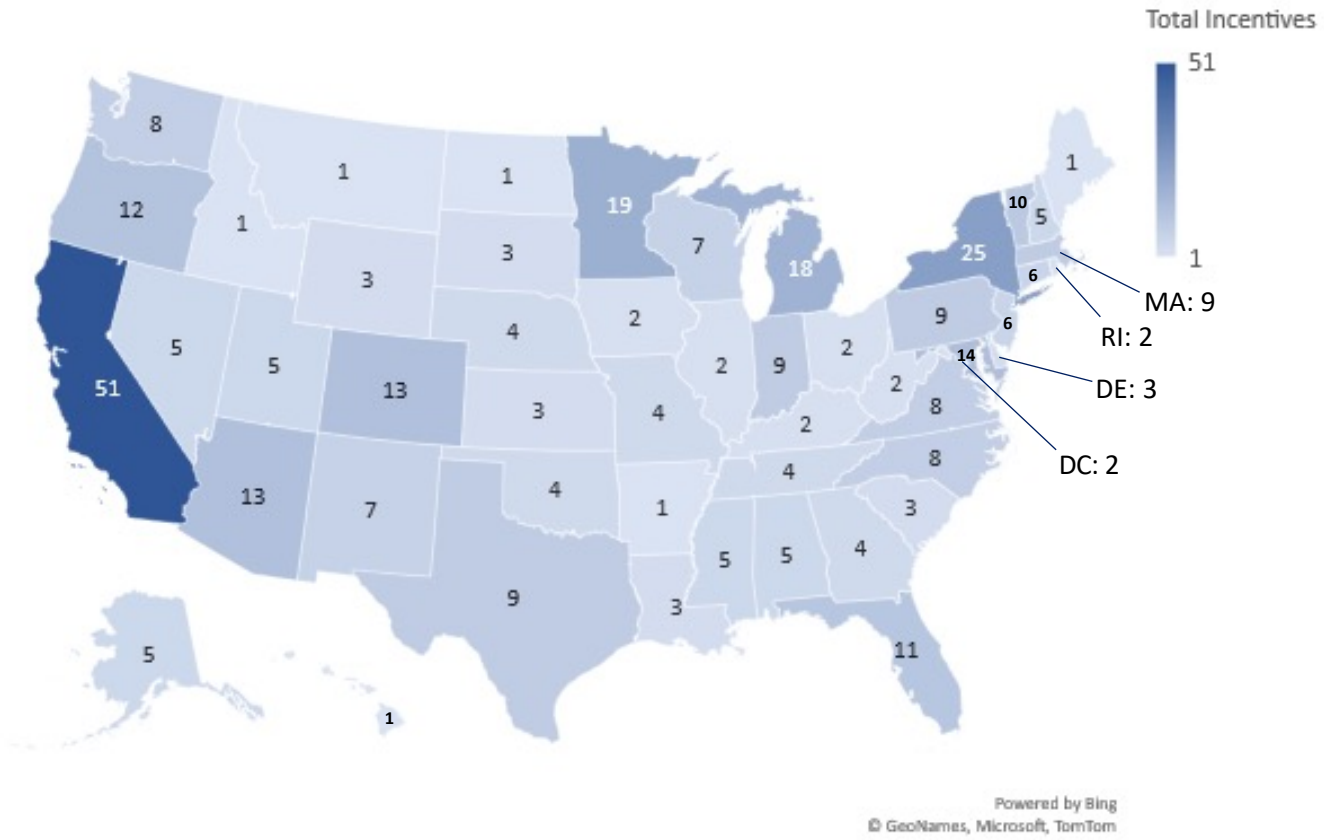
Source: U.S. DOE Office of Energy Efficiency and Renewable Energy Alternative Fuels Data Center, July 2023

U.S. Utility/Private Incentives

2010 – 2023, EV, PHEV, HEV, and NEV related incentives

Utility/Private incentives follow a mix of the trend in public incentives and laws and regulations

- California still leads the nation
- In the Great Lakes region, MI and NY are leading in terms of incentives
- Likely that these are incentives per utility for charging EVs, meaning the more utilities a state has the more incentives can be offered

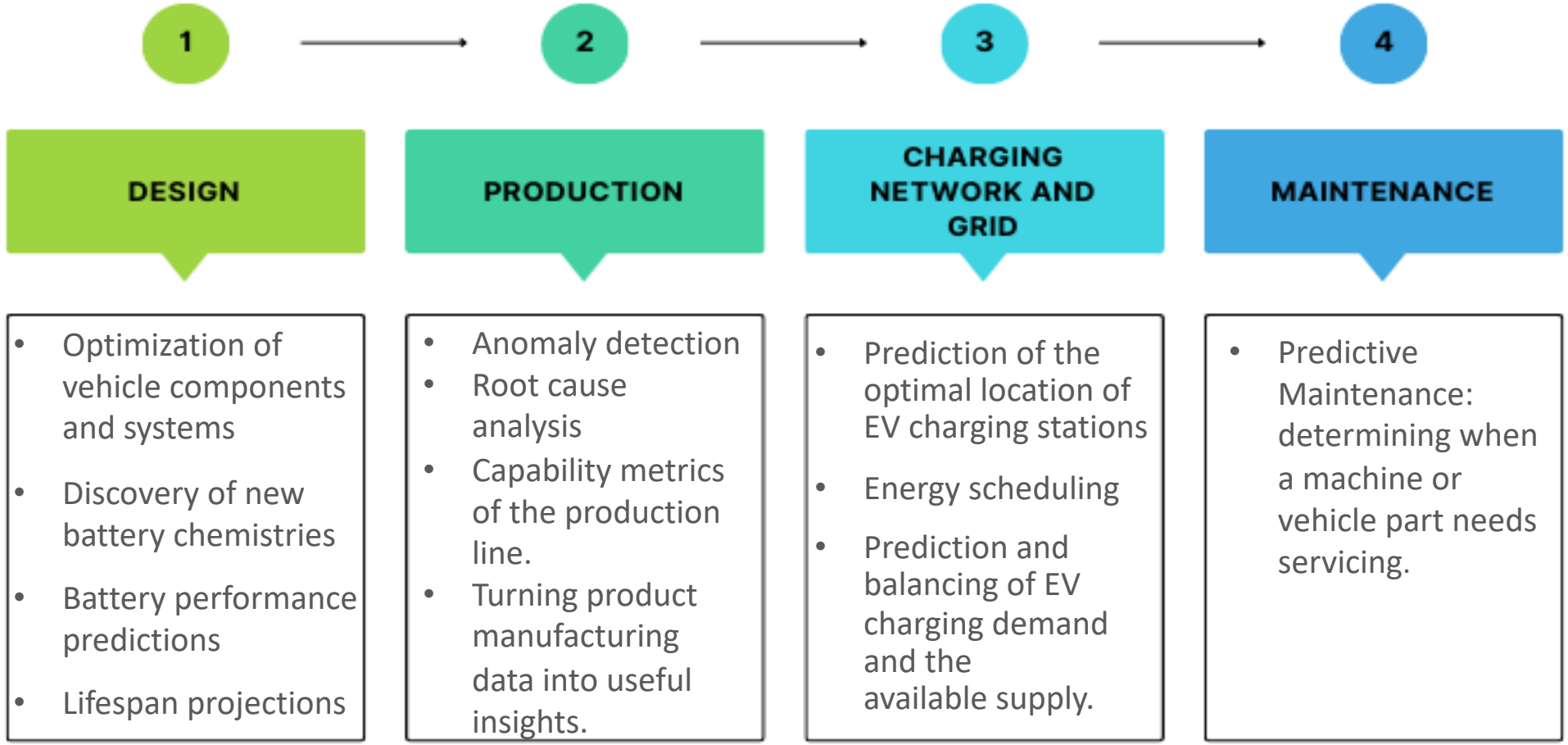


Source: U.S. DOE Office of Energy Efficiency and Renewable Energy Alternative Fuels Data Center, July 2023

Education Outlook

AI Use Cases in the Automotive Industry

A changing industry creates new demands in education



AI is being implemented in nearly every aspect of the automotive industry, leading to quicker and more innovative advancements. Workers with an education in AI are needed to fill these roles.

Source: Canva, CAR

Trends from Engineering and Automotive Programs

Deliberate shifting to new technologies

Artificial Intelligence and Machine Learning:

- Autonomous vehicles
- Advanced manufacturing
- Augmented reality

Zero emission vehicles:

- Electrification
- Hydrogen

Advanced mobility:

- Computer vision
- ADAS

Vehicle Cybersecurity:

- Vehicle Connectivity
- Internet of Things

Industry 4.0: the fourth industrial revolution, defined by increasing interconnectivity and increased automation

Source: University Interviews, CAR Analysis

Trends from Engineering and Automotive Programs

- Hands on opportunities allow students to contribute to cutting edge research develop skills through experience
- Industry partnerships provide support and opportunities to students and strengthen engineering programs
- Niche and targeted programs are key to success

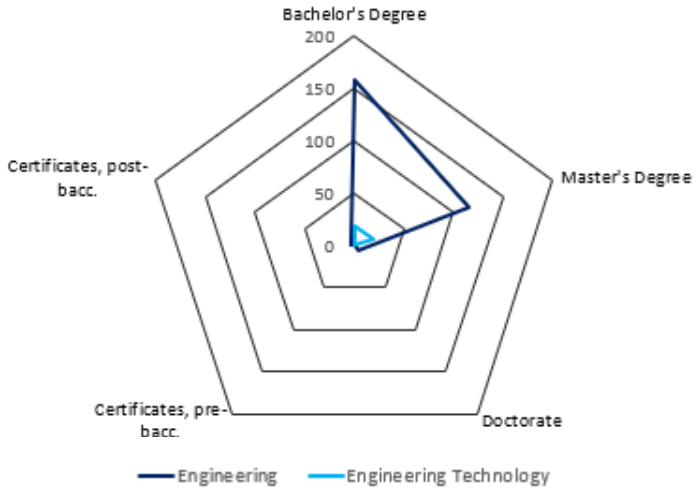
Engineering programs are preparing students for the future of mobility by creating niche programs to incorporate the newest technologies into courses, facilities, and research.

Source: University Interviews, CAR Analysis

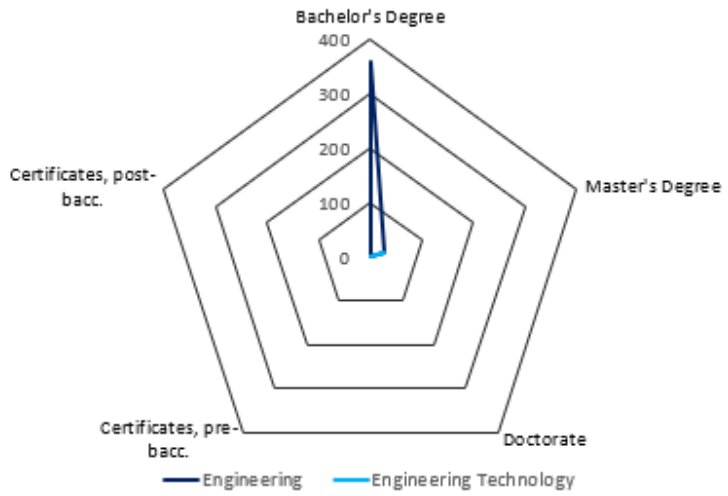
Degree Completions

Sampling across three engineering programs, with strength in automotive education, in the state of Michigan

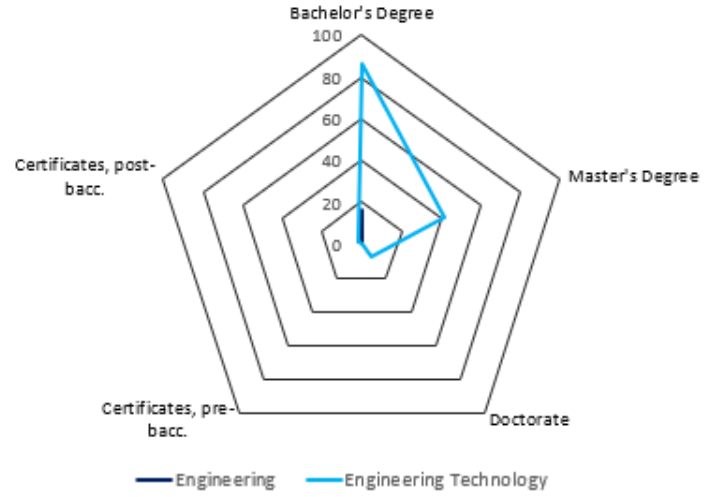
University 1



University 2



University 3



Engineering and engineering technology bachelor's degrees were awarded to over 630 students across three engineering programs (classified as M1, M2, and R2) in the state of Michigan in 2021. These programs provided students a diverse set of course offerings to prepare them for the future of mobility.

College classifications: Carnegie Classifications, College Tiers, and What They Mean | Academic Influence

Education for the Future of Mobility

Course offerings: automotive, electrification, and connectivity

Automotive and engineering programs across three universities in the state of Michigan each offer depth in three core engineering disciplines:

- Electrical & Computer Engineering: autonomous driving, computer vision, and automotive electronics
- Computer Science: AI, ML, deep learning, and explorations in robotics
- Mechanical Engineering: vehicle systems, machine dynamics, EV, HEV, and ICE vehicle course offerings
- Cybersecurity: connected vehicles, IoT, embedded systems security, and modern vehicle technology

Educational institutions with programs in the automotive and engineering space are progressively incorporating AI and ML into their programs, research, and curriculum to prepare students for the advancements in the industry and contribute to cutting edge research.

Source: NCES-IPEDS, 2020-21

Education for the Future of Mobility

Course offerings: electrification infrastructure

Within the studied engineering programs, many courses were offered related to energy systems

Further support is needed for the electrification transition:

- Energy systems knowledge is crucial for electric vehicle rollout and expanding the charging grid
- Similar focus on hydrogen and fuel cells as courses, with fuel cell vehicles considered a zero-emission vehicle

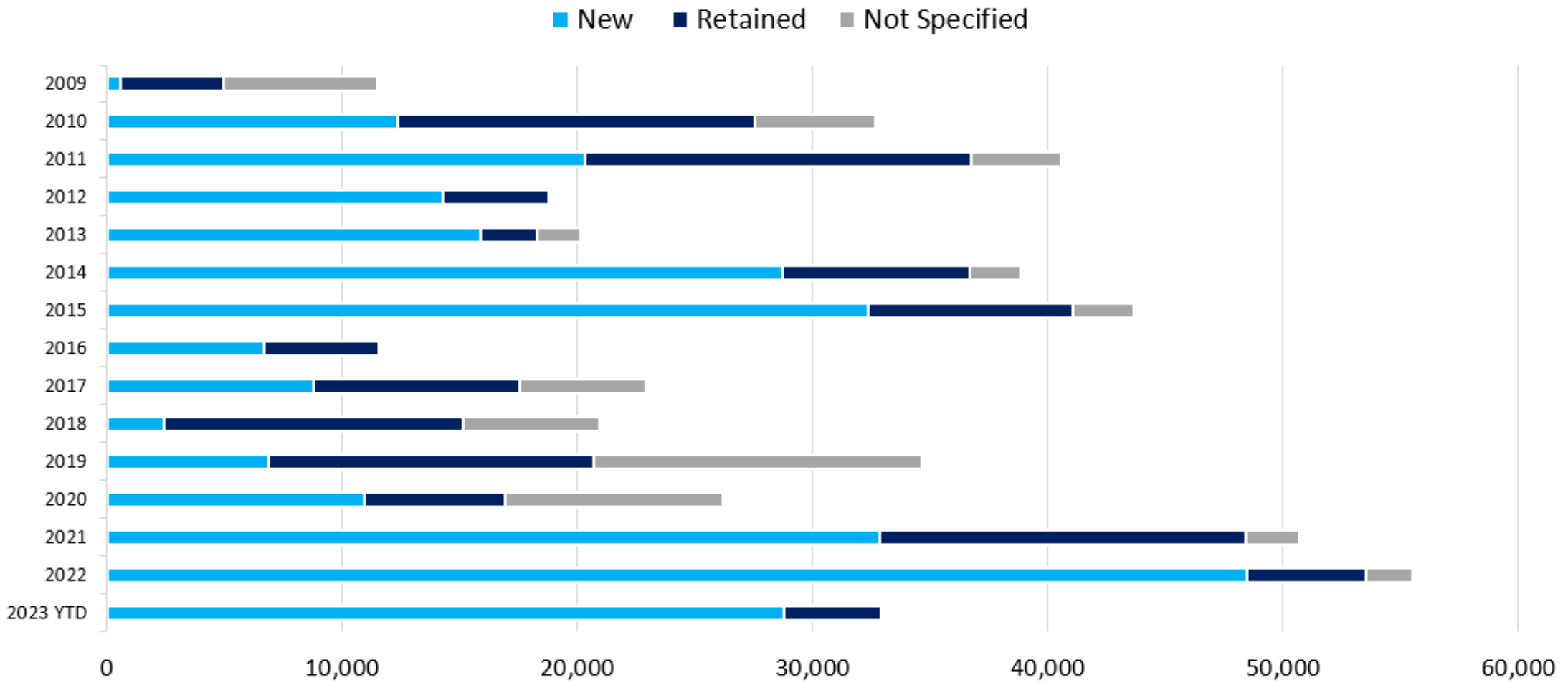
Outside of these programs, it is important to recognize that training may include those who have already been in the workforce in traditional ICE production

Talent gap being addressed by tailored courses, apprenticeship programs, and other forms of training.

Job Outlook

Announced Automaker New vs. Retained Jobs

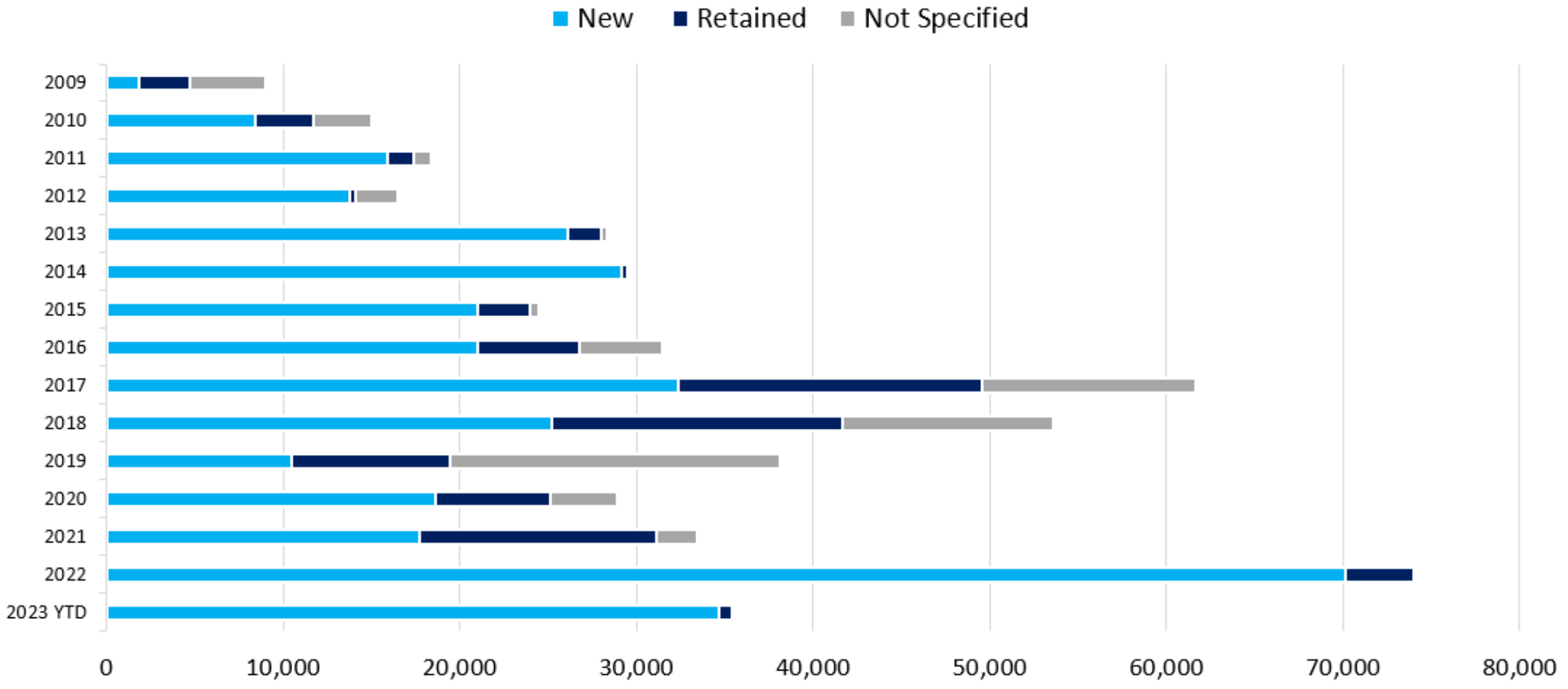
North America, 2009 – 2023 YTD



Source: CAR Book of Deals, June 2023

Announced Tracked Supplier New vs. Retained Jobs

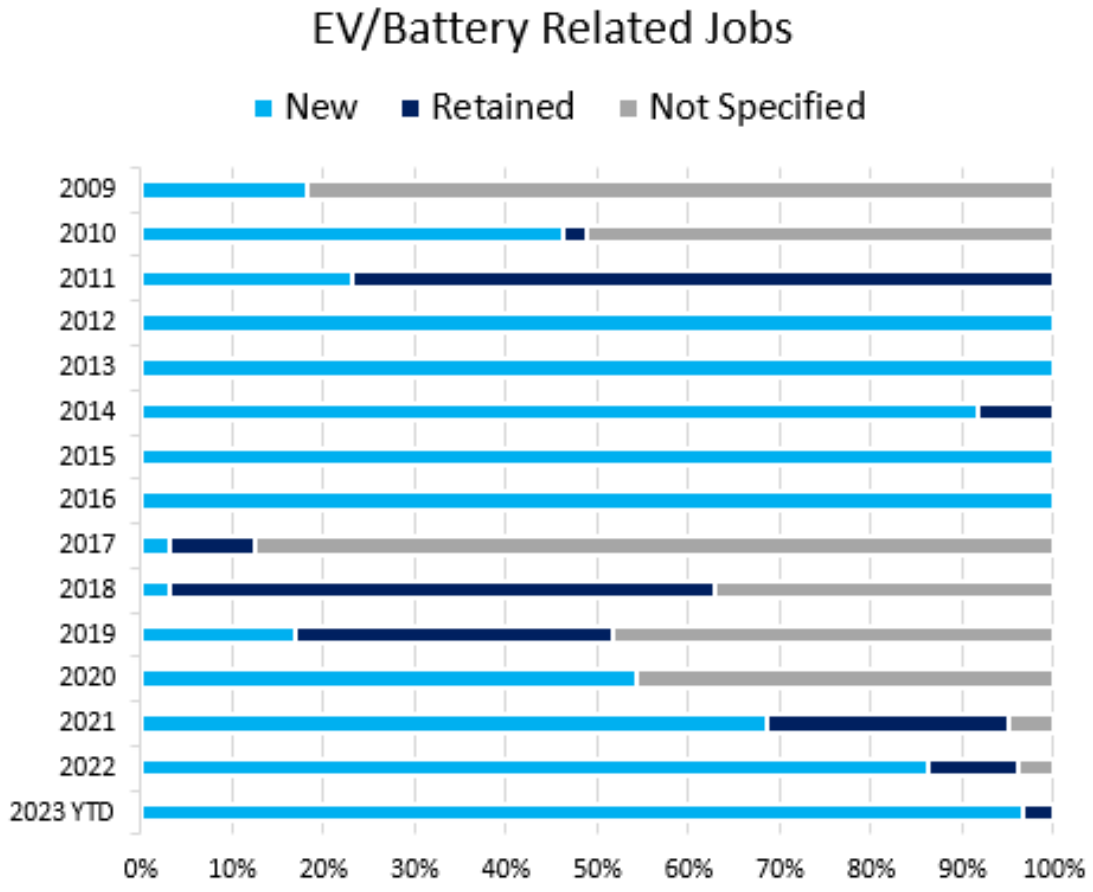
North America, 2009 – 2023 YTD

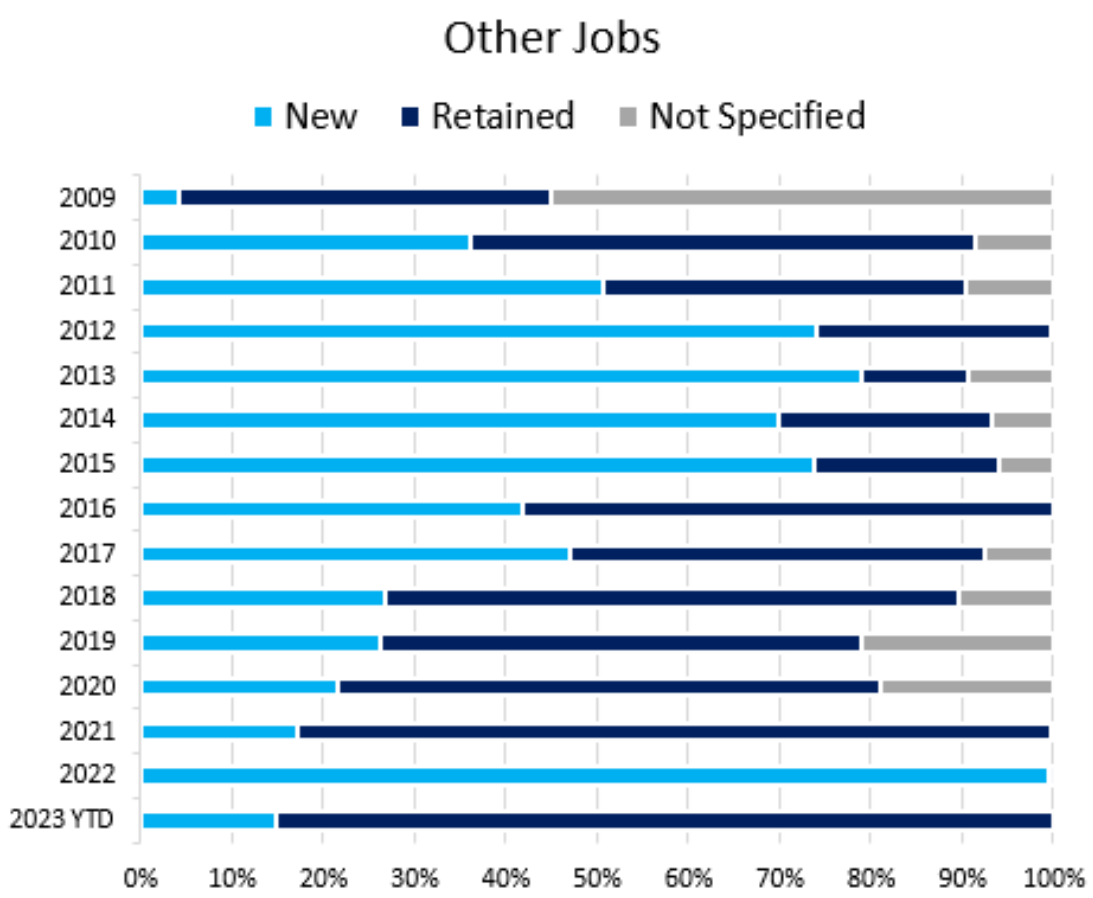


Source: CAR Book of Deals, June 2023

Automaker EV/Battery-Related Jobs Added Rather than Retained

North America, 2009 – 2023 YTD

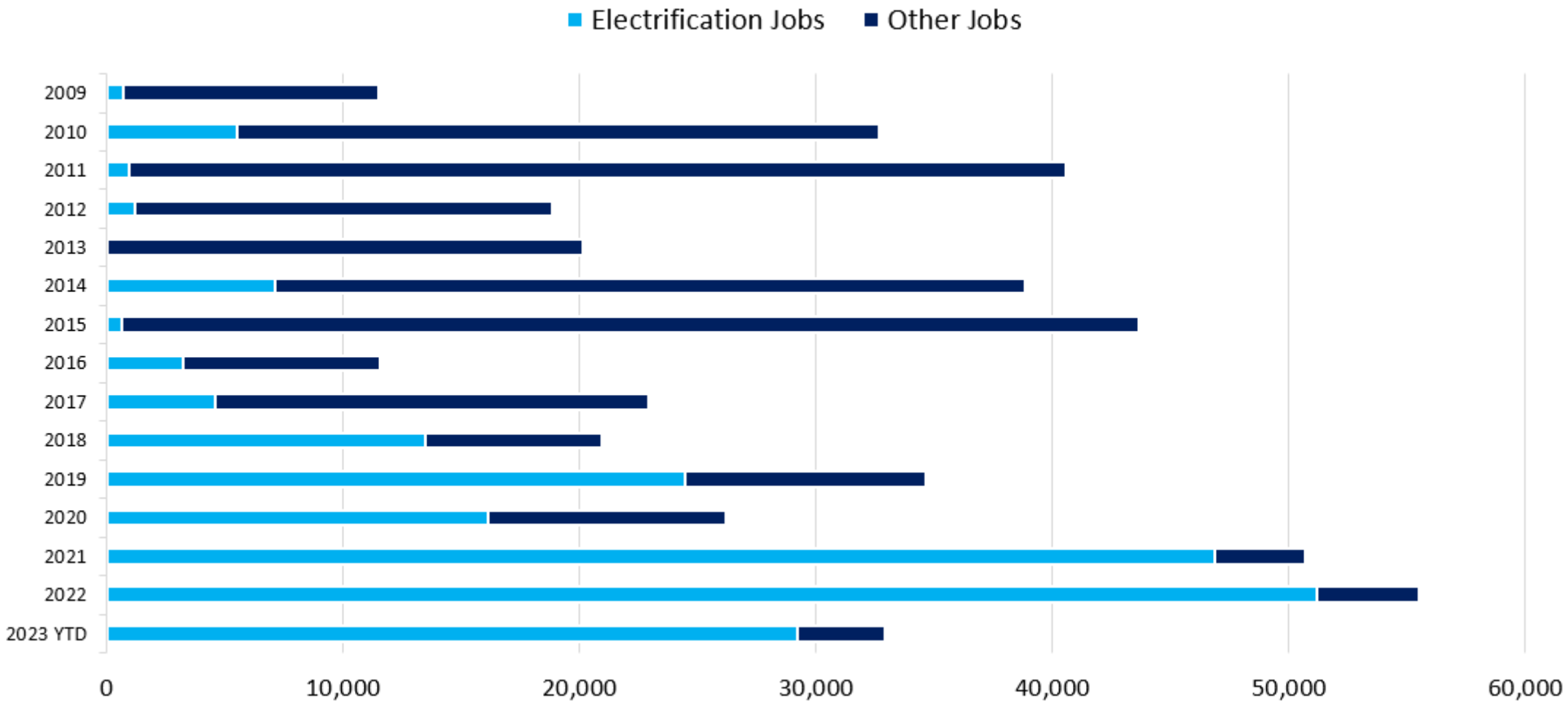




Source: CAR Book of Deals, June 2023

Automaker Investment Shifts Toward Electrification Jobs

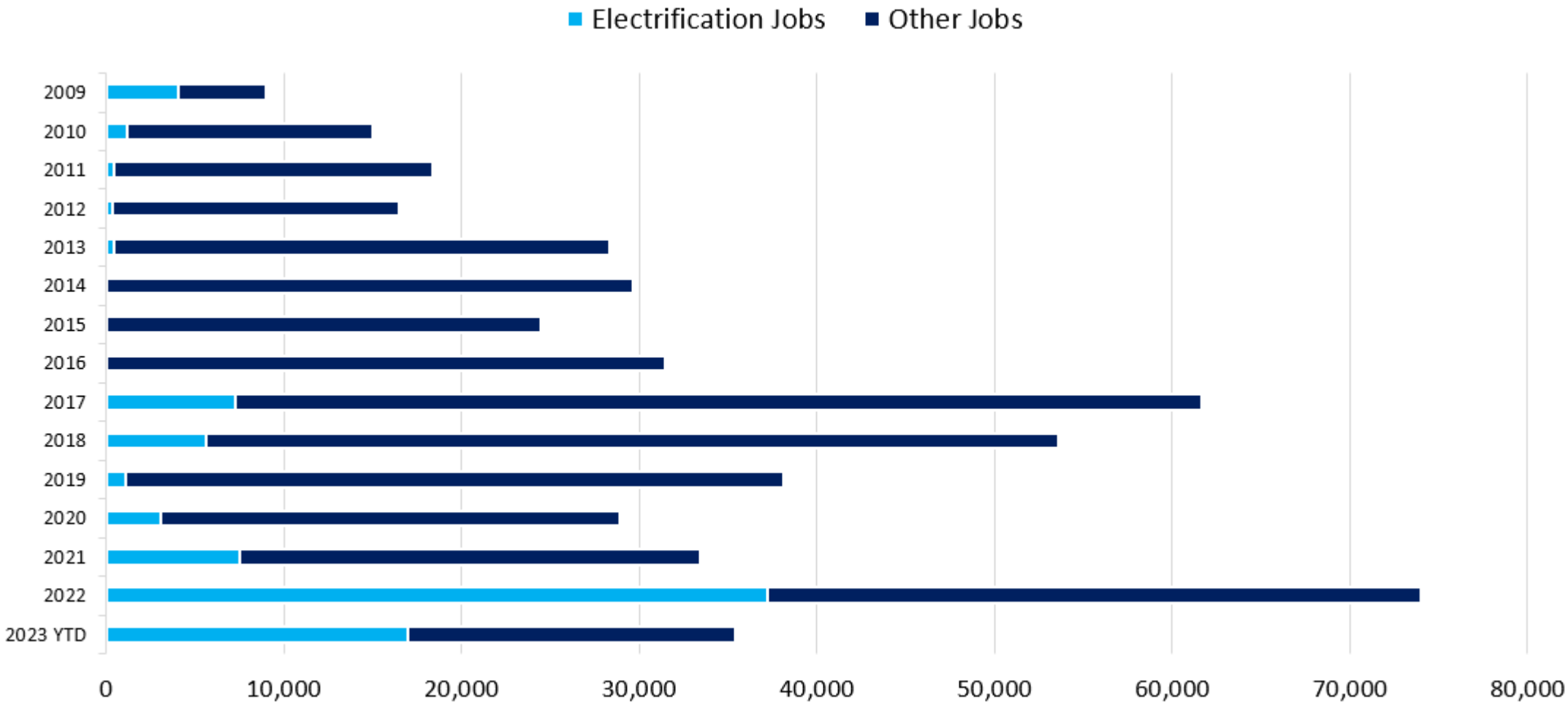
North America, 2009 – 2023 YTD



Source: CAR Book of Deals, June 2023

Supplier Electrification Shift Slows Automaker Shift

North America, 2009 – 2023 YTD



Source: CAR Book of Deals, June 2023

Automaker Shift to EVs through the Next Decade

Increased EV jobs demand across the industry:

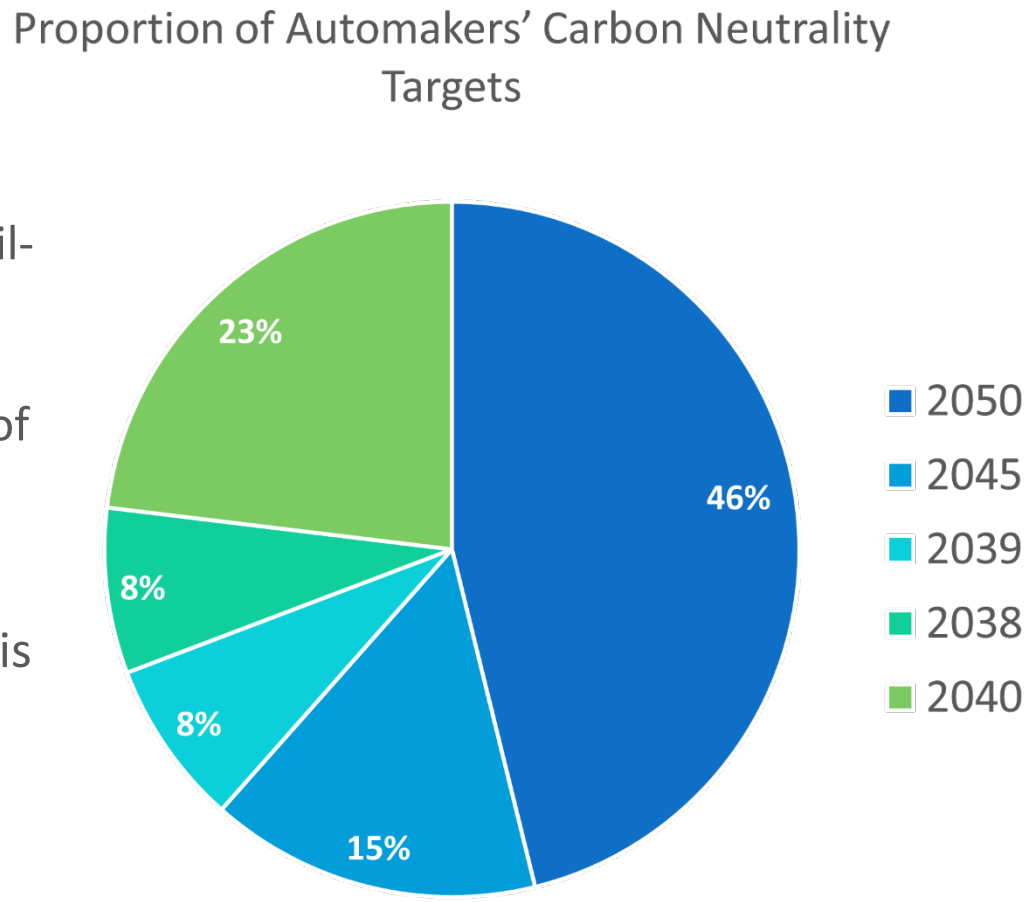
- Includes designing, manufacturing, marketing, distribution, and charging infrastructure
- Further includes jobs outside of automakers' direct scope
- Potential transfer, with training, for those in traditional fossil-fuel based manufacturing roles

EV rollout impacts automaker carbon neutrality timelines

- Emissions during the use phase of vehicles are a large part of automaker Scope 3 emissions
- Most carbon neutrality timelines are long, as reliance on suppliers for parts adds time

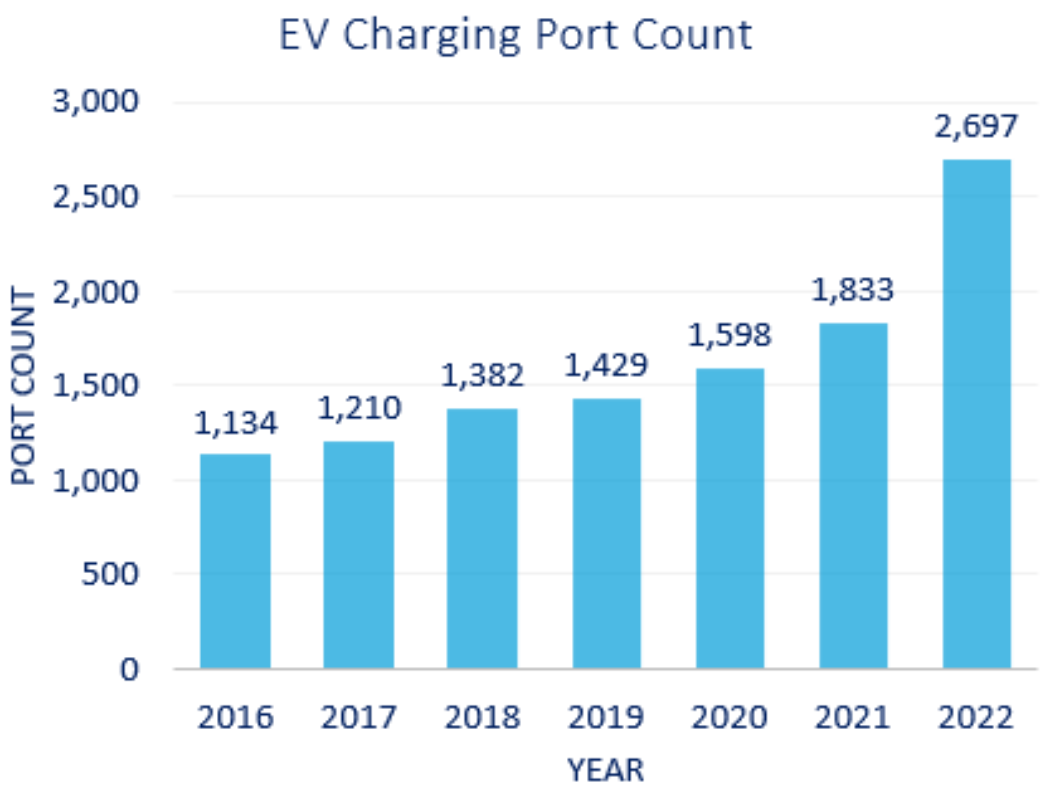
The shift to carbon neutrality and EV lineups for automakers is driven by regulations, international agreements, and internal timelines

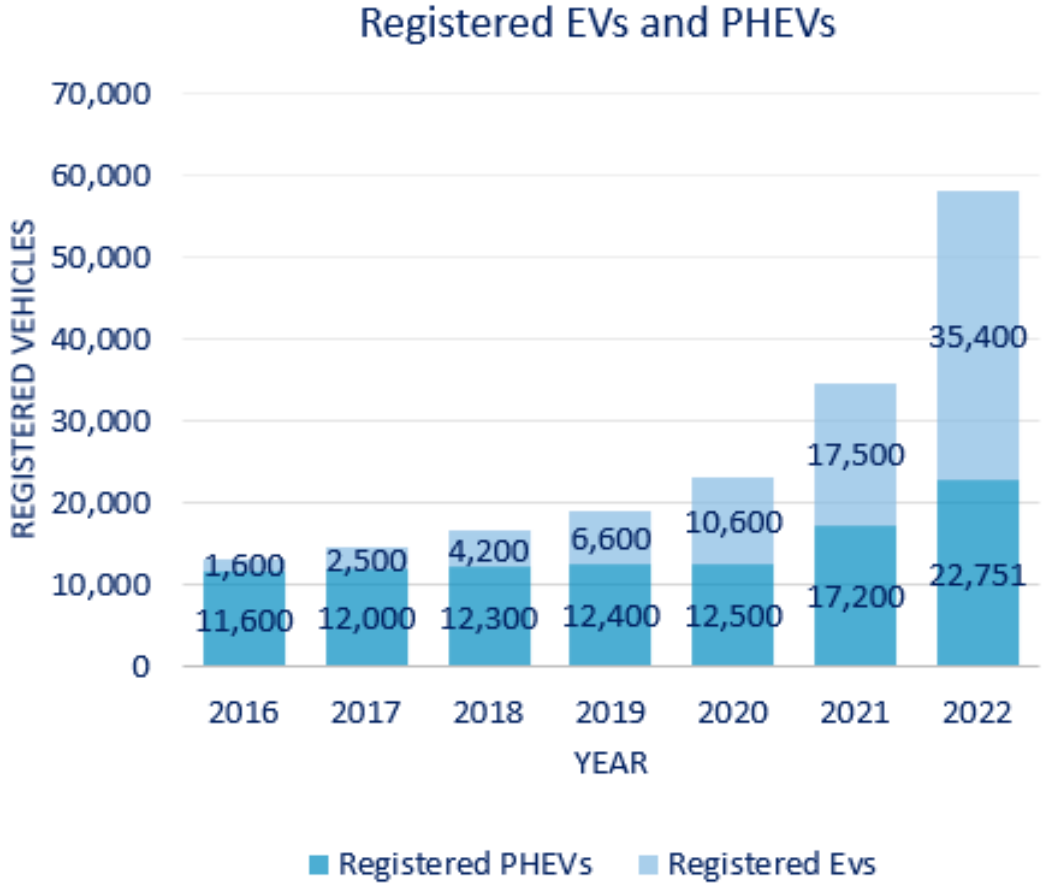
- For consumers, the shift to EV usage depends on charging infrastructure to move away from ICE vehicles



Source: CAR Sustainability Database, June 2023

Michigan EV Infrastructure Growth
2016 – 2022





Charging ports are needed across the state to provide proper charging for the increasing number of registered EVs.

Source: U.S. DoE Alternative Fuels Data Center July 2023, Alliance for Automotive Innovation, CAR Analysis

Michigan EVSE Infrastructure

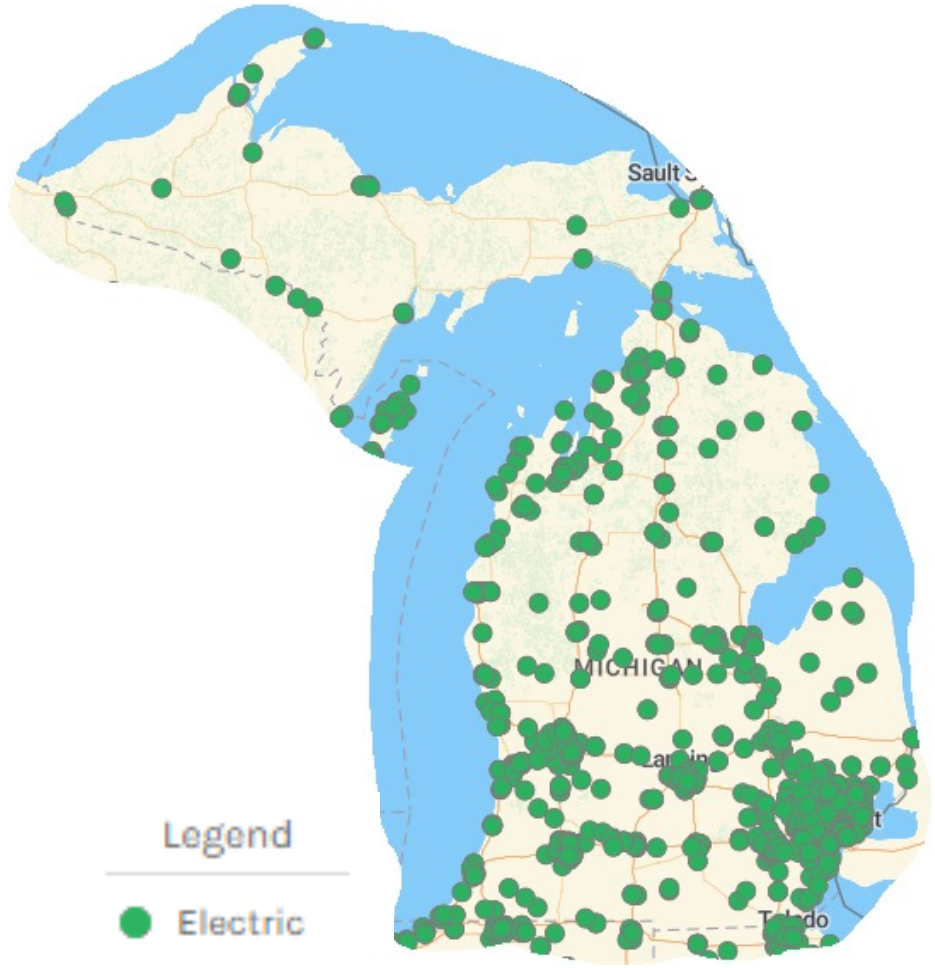
Public station and port count, 2023

Electric charging locations: 1,189 stations (2,723 ports)

- 3 Level 1 ports
- 2,116 Level 2 ports
- 597 DC Fast ports
- This ranks Michigan as 13th in charging station count among states

Most vehicles use Combined Charging System (**CCS**) ports

- Compatible with all levels of non-Tesla station ports
- Ford, Rivian, GM, and Mercedes-Benz have announced future vehicles will be compatible with Tesla stations



As the number of EVs increases, more workers are needed in the EVSE space. With a charger fail rate of around 20%, educated and skilled workers are needed to design, develop, and maintain reliable EVSE.

Source: U.S. DoE Alternative Fuels Data Center & J.D. Power July 19, 2023, CAR Analysis

EVSE Related Jobs

Charger Installation

- Trenching
- Site selection
- Wiring to prepare sites for charging stations

Maintenance

- Charger repairs
- Routine maintenance, safety checks

Design

- Charger design, prototyping
- Embedded security systems
- Grid integration
- Hardware development for EVSE
- Mapping of charging locations
- Networked charging systems

Occupations:

- Civil engineers
- Computer engineers
- Cybersecurity specialists
- Electrical engineers
- Electrical technicians
- Energy business analysts
- Environmental analysts
- Hardware engineers
- Maintenance and service technicians
- Mechanical engineers
- Software developers
- Urban planners

Growth in EVSE infrastructure provides numerous opportunities for skilled workers. The increasing demand for EV chargers additionally creates a growing need for the energy to source them.

Source: U.S. DoE Alternative Fuels Data Center June 27, 2023 & CAR Analysis

Energy Sourcing of EV Chargers

EV chargers, if not directly attached to a renewable source, receive power from the electric grid

- To be “powered” by renewables, the corresponding amount of energy can be bought in renewable energy credits

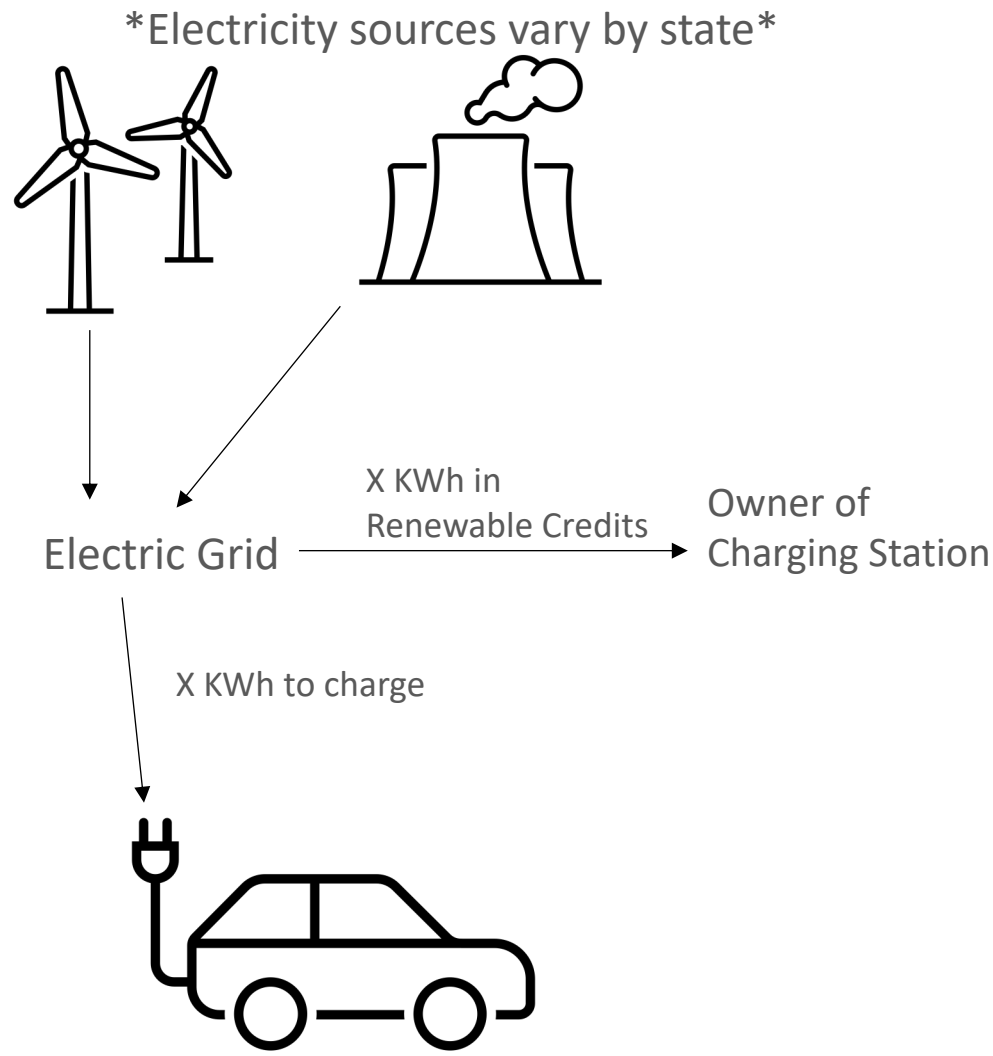
Only 5 US states have an electricity grid made up of more than 50% renewable sources

- Michigan’s is about 1.5% renewable sources

At present, EV charging demand is less than 0.5% of global electricity use

- Projected that by 2030, it will be 4%, with increased demand for renewable energy
- In 2020, all renewable energy sources (excluding nuclear) saw an increase in U.S. jobs

Charging infrastructure, renewable energy, batteries for energy storage, and grid connection demand will increase



Source: CAR Sustainability Database, June 2023; IEA; 2022 US Energy and Employment Report Fact Sheet

Inflation Reduction Act Credit Opportunities

Critical minerals: extraction

Inflation Reduction Act (**IRA**) critical mineral credit requirements, in terms of sourcing in alternative fuel vehicles, will increase demand for US extraction and processing

- Only active US lithium mine is in Nevada
- Eagle Mine in Michigan produces copper, nickel, and trace amounts of cobalt for further processing, but is set to close in 2026
- Other MI mines extract iron deposits, which could be useful with projected trend away from lithium-ion battery chemistries heavy in cobalt, potentially towards Lithium-Iron-Phosphate

In addition to critical minerals, IRA credit exists for battery components that are manufactured or assembled in North America

- Aims to grow U.S. battery capacity, which has been reflected in announcements for new battery production plants
- Transportation costs are lessened if extraction and processing for necessary materials is local

Source: US Department of the Treasury, Michigan Department of Environment, Great Lakes, and Energy, CAR Sustainability Database (July 2023)

Inflation Reduction Act Credit Opportunities

Critical minerals: recycling

Demand for battery recycling operations will increase, as IRA credit requirements include materials recycled in North America

- Regardless of origin, recycling it in U.S. or North America changes the sourcing to there, increasing local demand
- Michigan Tech is partnering with Eagle Mine to research recycling methods, potentially increasing jobs and mineral production in MI

Jobs demanded for processing within different methods, handling, and transportation of recyclable materials and recycled materials

- Due to EV lifecycles, more recyclable battery stock is expected by the end of the decade

Currently, most methods don't extract lithium

- Focus is within other valuable metals, typically cobalt
- Further research in lithium extraction or expansion of operations in the U.S. is likely

Source: US Department of the Treasury, Michigan Department of Environment, Great Lakes, and Energy, CAR Sustainability Database (July 2023)

Thank you!

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