Electric Vehicle Product Commission Tasking Report

Opportunities for the Hoosier Automotive Supply Chain and Talent

September 28, 2023

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About the EVP Commission

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Governor Holcomb signed House Bill 1168 into law during the 2021 legislative session, establishing the Electric Vehicle Product (EVP) Commission. The 10-member commission is comprised of legislative representatives and industry leaders who are tasked with:

- Evaluating the inventory of existing electric vehicle product facilities and production capability.
- Evaluating the inventory of skilled and nonskilled workers in the electric vehicle product industry.
- Evaluating opportunities and needs for training within the electric vehicle product industry.
- Determining if training centers promoting careers in the electric vehicle product industry should be created or transitioned from traditional automotive industry training centers.
- Identifying existing manufacturing competencies within the traditional automotive industry and determine how the existing competencies could be leveraged to increase the production of electric vehicles.
- Identifying and evaluating opportunities for growth within the electric vehicle product industry.
- Identifying and documenting results from previous instances of retooling and transforming manufacturing facilities in the automotive industry.
- Identifying opportunities for research and development within the electric vehicle product industry.

Members Of The Commission

The EVP Commission members are as follows:

- Mike Maten, GM
- David Dukes, Stellantis
- Danny Ernstes, UAW
- Paul Mitchell, Energy Systems Network
- Craig Kelle, Toyota
- Rep. Mike Karickhoff, State Representative
- Rep. Carey Hamilton, State Representative
- Sen. J.D. Ford, State Senator
- Sen. Jim Buck, State Senator

Introduction

Indiana has been a center of automotive manufacturing for 125+ years, which includes a deep history in automotive manufacturing technologies, capabilities, and innovation. While internal combustion engines (ICE) have fueled many products, early electric vehicles (EVs) played a part in technological breakthroughs, and today Indiana is leading the charge for innovations into tomorrow. It is prime time for Indiana to sharpen its focus on technology and development in this advanced automotive sector. The first report in 2022 was designed to provide a foundation for the primary tasks of the EVP Commission. This second report (2023) is designed to build upon that foundation with a deeper exploration into three primary tasks. (1) Evaluate the inventory of existing EV product facilities and production capabilities; (2) Evaluate the inventory of skilled and nonskilled workers in the EV product industry; and (3) Evaluate funding opportunities. Further, the Commission would be remiss if it did not include an examination of funding opportunities as a result of federal and state-level legislation recently passed.

Through this understanding, the EVP Commission can influence the next generation of automotive manufacturing with the inclusion of electrification supported by our well-established ICE heritage. The challenge is transforming, retraining, retooling, and repurposing workforce and facilities, while also ensuring innovation, development, sustainment, and attraction is brought to the forefront. Indiana has every capability to continue to be a leader in the automotive manufacturing sector, and through the work of those in the state, it can solidify itself as a key stakeholder in this next generation of electric vehicle product manufacturing.

This second report is designed to address three primary tasks put forward by the Electric Vehicle Product (EVP) Commission and is meant to be read as independent chapters. With the rapid development of EV product manufacturing opportunities that arise frequently in this era, it is important to note that all data and information is only a snapshot of the environment at one point in time. Because of this rapid development, this is a living document intended to be updated on a regular basis by the EVP Commission and associated team members.

Impact

The map and chart below highlight recent confirmed investments since 2021 related to EV production and set the foundation for future relocation and expansion projects throughout the State of Indiana. These investments are current as of September 25, 2023.

Investment Locations

Company	Investment	Location
GM	$51,000,000	Bedford, Indiana
GM	$45,000,000	Bedford, Indiana
GM and Samsung SDI	$3,000,000,000	New Carlisle, Indiana
GM	$491,000,000	Marion, Indiana
Honda	$54,600,000	Greensburg, Indiana
Stellantis and Samsung SD JV	$229,000,000	Kokomo, Indiana
Stellantis and Samsung SD JV	$2,500,000,000	Kokomo, Indiana
Toyota	$803,000,000	Princeton, Indiana
ENTEK Lithium Separators LLC	$1,500,000,000	Terre Haute, Indiana
EnPower Indiana Inc.	$22,800,000	Indianapolis, Indiana

Source: EVP Commission

Evaluate the inventory of existing electric vehicle product facilities and production capability.

Task 1

Evaluate the inventory of existing electric vehicle product facilities and production capability.

Disruption to Regions

The automotive industry is in the midst of the transition to replace the internal combustion engine (ICE) with battery-powered electric vehicles (EV). Taking this into account, Purdue University conducted a risk analysis to understand the potential impact of the transition and what opportunities are presented to automotive manufacturers and suppliers. Ultimately, a successful transition will require strategic decisions by companies and economic development leaders.

The risk analysis focused on inertia risk to examine the impact on automotive companies if they did not pivot their processes and business models for the EV transition. The risk measures between 0 to 1 with 0 indicating 0% risk while 1 indicating 100% risk.

Table 1.1: Internal Combustion Engine (ICE) Parts Categories

Category	Components/Parts
Automotive, Motor	Automotive, motor
Engine and Engine Components	Pistons, valves, cylinder sleeves, camshafts, fuel, and exhaust systems
Cooling Systems	Air conditioning, blower, heater
Electrical Systems	Electrical and electronics components
Drivetrain	Transmission components and axles
Brakes	Disc, rotors, pads
Body	Stamping parts
Interior	Instrument panel parts, seat belts, radio, seats, airbags
Trim	Leather, fabric
Tires & Wheels	Tires, wheels, air pressure sensors
Glass	Windshields, side glass, roof glass

Table 1.2: Electric Vehicle (EV) Parts Category

Category	Components/Parts
Cooling Systems	Air conditioning, blowers, heater
Power Systems	Energy storage, including battery R&D, manufacturing and assembly, and ultracapacitors
Motors	Motors or motor components
Wire Harnesses	Wire harnesses or wire materials
Braking	Braking system components
Electronic Controls	Power electronics and control equipment and software, including thermal management for battery packs
Recycling	Recycling of battery components
Body	Stamping parts
Charging systems	Home, business, parking lots, apartment/condo complexes, rest areas
Interior	Instrument panel parts, seat belts, radio, seats, airbags
Trim	Leather, fabric
Tires & Wheels	Tires, wheels, air pressure sensors
Glass	Windshields, side glass, roof glass

A regional analysis was conducted to better understand the impact of inertia risk that could occur throughout Indiana and evaluated the economic activity (i.e. companies and employees) in each Economic Growth Region[1] to understand the potential impact of not shifting to an inclusive EV strategy.

[1]Source: https://www.in.gov/dwd/about-dwd/regional-maps/

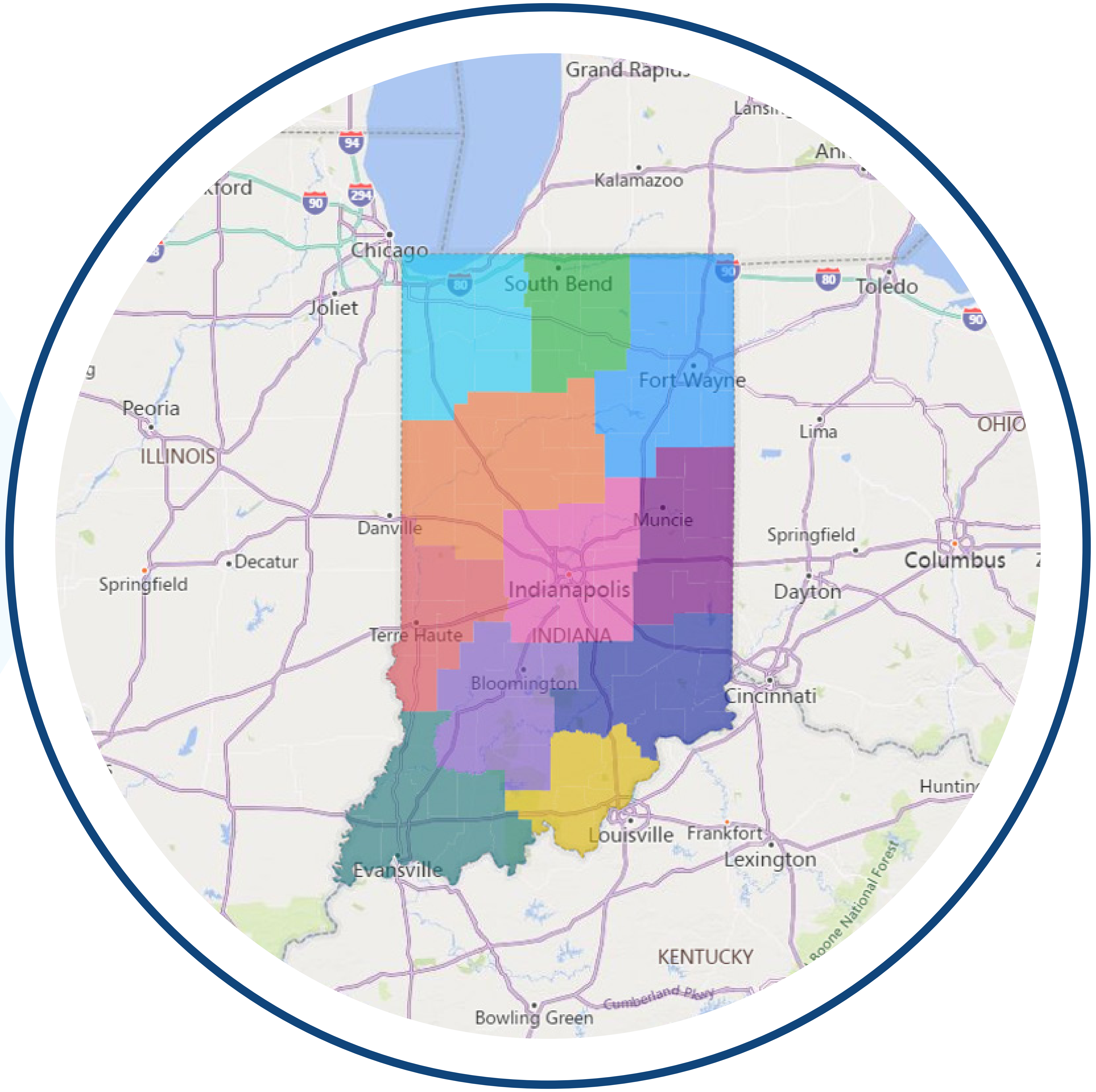
Table 1.3: Regions Analyzed

Regions	Counties
Region 1 – Northwest IN	Jasper, Lake, La Porte, Newton, Porter, Pulaski, Starke
Region 2 – North Central IN	Elkhart, Fulton, Kosciusko, Marshall, St. Joseph
Region 3 – Northeast IN	Adams, Allen, DeKalb, Grant, Huntington, LaGrange, Noble, Steuben, Wabash, Wells, Whitley
Region 4 – Northwest Central IN	Benton, Carroll, Cass, Clinton, Fountain, Howard, Miami, Montgomery, Tippecanoe, Tipton, Warren, White
Region 5 – Central IN	Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, Shelby
Region 6 – East Central IN	Blackford, Delaware, Fayette, Henry, Jay, Randolph, Rush, Union, Wayne
Region 7 – West Central IN	Clay, Parke, Putnam, Sullivan, Vermillion, Vigo
Region 8 – South Central IN	Brown, Daviess, Greene, Lawrence, Martin, Monroe, Orange, Owen
Region 9 – Southeast Central IN	Bartholomew, Dearborn, Decatur, Franklin, Jackson, Jefferson, Jennings, Ohio, Ripley, Switzerland
Region 10 – Southeast IN	Clark, Crawford, Floyd, Harrison, Scott, Washington
Region 11 – Southwest IN	Dubois, Gibson, Knox, Perry, Pike, Posey, Spencer, Vanderburgh, Warrick

Table 1.4: Regions Least At Risk

Region	Total Number of Auto Companies	Total Number of Auto Employees	Average Inertia Risk
Region 1 (Northwest IN)	583	24,828	0.611
Region 2 (North Central IN)	1,070	42,396	0.644
Region 3 (Northeast IN)	909	50,053	0.661
Region 4 (Northwest Central IN)	339	24,606	0.675
Region 5 (Central IN)	1,493	46,600	0.689
Region 6 (East Central IN)	291	11,904	0.638
Region 7 (West Central IN)	124	6,247	0.643
Region 8 (South Central IN)	140	2,845	0.638
Region 9 (Southeast Central IN)	319	28,000	0.622
Region 10 (Southeast IN)	174	6,047	0.626
Region 11 (Southwest IN)	430	23,449	0.585

Figure 1.1: Economic Growth Regions



Examine the ICE/EV manufacturing space identifying the products, processes, and competencies. Examine the vulnerability of the supply chain.

Automotive Companies by Tiers

The structure of an automotive supply chain consists of Original Equipment Manufacturers (OEMs) and suppliers in a tiered system. OEMs are organizations that often aggregate physical components to directly provide a finished product to end customers. In the automotive industry, OEMs are companies that design, often assemble and promote automobiles to the end customer. Ford, GM, Honda, and Tesla are a few examples of automotive OEMs.

The supplier network is classified into three tiers. Tier 1 suppliers are companies that provide components directly to OEMs, with the objective of meeting set requirements and specifications. Tier 1 suppliers also handle manufacturing, and often provide finished parts that are directly assembled onto the vehicle.

For EVs, components supplied by Tier 1 Suppliers include:

- Electric powertrain systems: electric motors, power electronics, and battery management systems
- Charging systems: on-board charging systems and charging infrastructure for home, workplace, or public charging.
- Energy storage systems: high-voltage battery
- Regenerative braking systems
- Electric HVAC systems designed specifically for electric vehicles.
- Advanced driver assistance systems (ADAS): lane departure warning, adaptive cruise control, and automated emergency braking
- Software and telematics systems: connectivity systems that enable remote monitoring, maintenance, and over-the-air updates.

Other subsystems provided by Tier 1 suppliers are:

- Chassis systems: suspension systems, steering systems, and brake systems.
- Interior systems: seats, dashboard components, entertainment systems, and climate control systems.
- Exterior systems: body panels, lighting systems, and glass.

Tier 2 suppliers take raw materials from Tier 3 suppliers and convert them into components which Tier 1 suppliers use later to create a finished subsystem. Tier 2 suppliers often specialize in the production of certain components, unlike Tier 1 supplies that provide parts that are ready for final assembly. While Tier 2 suppliers need to remain compliant with safety standards, they do not work directly with OEMs to design and develop components.

For EVs, components supplied by Tier 2 suppliers include:

- Electric drivetrain components: inverters, capacitors
- Charging system components: AC and DC charging connectors and cables
- Electrical wiring and harnesses
- Car camera sensors
- Safety systems: airbags and seat belts
- Suspension components: shocks, struts, and springs
- Interior components: dashboard displays and infotainment systems
- Exterior components: lighting systems, mirrors, and body panels
- Brake components: calipers, rotors, and pads

Tier 3 acts as the base of the supply chain by providing raw materials like copper, aluminum, steel, plastics and resins, basic components, and sub-components to Tier 1 and Tier 2 suppliers. While Tier 3 suppliers do not directly contribute to Tier 1 suppliers, they play a crucial role in the supply chain by providing base materials and components. It is necessary for them to adhere to the required quality standards, as this will directly impact the final vehicle.

For EVs, components supplied by Tier 3 suppliers include:

- Raw materials: metals, plastics, and rubber
- Basic components: screws, bolts, and fasteners
- Mechanical components: bearings and bushings
- Sensors and sensor components: accelerometers and temperature sensors
- Electrical connectors, terminals
- Circuit boards, resistors, capacitors, and other electronic components
- Adhesives, sealants, and other materials used in assembly
- Packaging and shipping materials

Supply Tier Risk

Maximum visibility is needed into the supply base to minimize risk. The risks may realize further down the supply chain, where they may not be as impactful but also not as apparent. **Supply risks include:**

- Operational Risks
- Governance Risks
- Environmental Risks
- Social Risks
- Cyber security Risks

According to Sievo[2], a procurement analytics platform, there are three strategies to obtain visibility on all suppliers:

- Map the suppliers
- Establish a system of traceability
- Foster open communication

EV Supply Chain

The electric vehicles are different than internal combustion engine vehicles in terms of their parts and components and how they are powered. This leads to a difference in their supply chains. The EVs are more electrical and less mechanical than their counterparts, which results in an expectation that EVs have 30% fewer parts compared to ICE vehicles. For EVs, the most valuable component is the battery, which represents up to 40% of the total value. In addition, other components that are different in EVs compared to ICE are listed below. These components are categorized based on the component categorization in the Year 1 report.

- Motors
- Power Electronics
- Charging Stations
- Battery

Motor Supply Chain for EVs

The process flow chart for the manufacturing of an electric motor and its components in an EV:

- **Motor Design and Specification**

  The motor design and specification are determined based on the EV's performance requirements. The motor's size, power, efficiency, and other specifications are calculated and optimized.

- **Stator and Rotor Manufacturing**

  Copper wire is wound around a metal core to create the stator coils. The stator and rotor cores are produced through a lamination process, which involves stamping and stacking thin metal sheets. The stator and rotor cores are assembled with the stator coils to create the motor.

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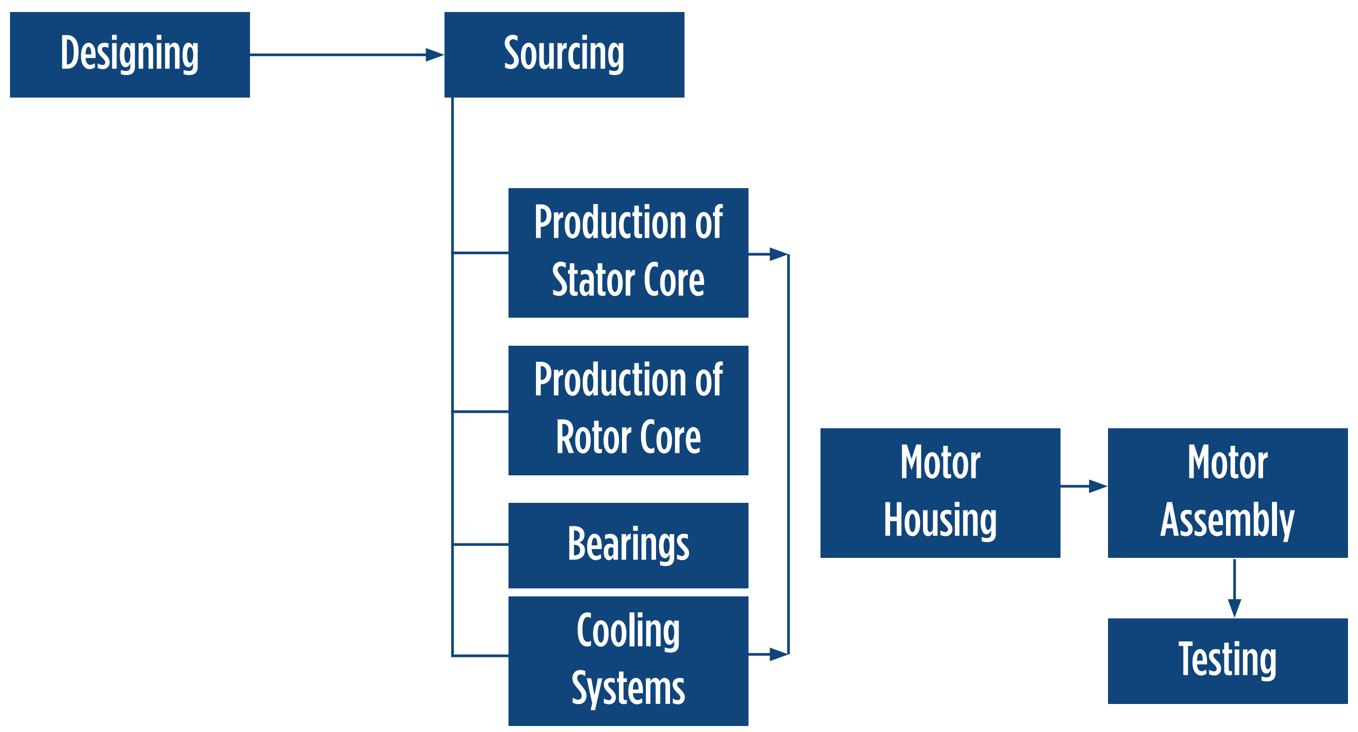
[2] *Source: Toikka, Jasmiina. "The Difference between Tier 1, 2 and 3 Suppliers." Sievo.com, 12 June 2023, sievo.com/blog/supplier-tiers*

- **Motor Housing and Mounting**
  The motor is housed in a casing made of aluminum or other materials to protect it from the elements. The motor is mounted onto the EV's chassis using brackets and bolts.
- **Motor Control Unit (MCU) Manufacturing**
  The MCU is responsible for controlling the motor's speed and torque. The MCU is manufactured using electronic components such as microcontrollers, power transistors, and capacitors.
- **Battery Pack Manufacturing**
  The battery pack provides power to the motor. Battery cells are assembled into modules, which then connect together to create the battery pack. The battery pack is mounted onto the EV's chassis.
- **Power Electronics Manufacturing**
  The power electronics convert the DC voltage from the battery pack to AC voltage for the motor. Power electronics are manufactured using electronic components such as inverters, transformers, and diodes.
- **Assembly and Testing**
  The motor, MCU, battery pack, and power electronics are assembled onto the EV's chassis. The entire system is tested for functionality, efficiency, and safety. The EV is painted and packaged for shipment.

Table 1.5: Motors and Components

	Raw Materials	Process	Component	Final Product	Manufacturing Company
1		Designing: Motor design based on requirement. (Size, power, efficiency calculated)			
2	Copper wire	Wound around metal core →	Stator coils →		Regal Beloit Corporation (Fort Wayne)
	Metal sheets	Lamination →	Stator and Rotor cores →		
				MOTOR	
3	Aluminum	Motor housed in a casing →	Motor Housing →		Allison Transmission Inc. (Indianapolis)
4		Manufactured using microcontrollers, power transistors and capacitors →	Motor Control Unit →		Aptiv PLC (Kokomo)

Figure 1.2



Companies involved in manufacturing of Motors in Indiana:

- BorgWarner
- Regal Beloit Corp.
- Allison Transmission Inc.
- Aptiv PLC
- Flanders Electric
- Franklin Electric Co., Inc.
- Hansen Corporation
- Northern Electric

Power Electronics Supply Chain for EVs

Power electronics are a critical part of an EV's powertrain and used to convert the electrical energy stored in the battery into mechanical energy to drive the wheels. There are many applications of power electronics in EVs, including:

- Inverter: This component converts the direct current (DC) from the battery into alternating current (AC) to power the electric motor.
- DC-DC Converter: This component converts the high-voltage DC from the battery to a lower voltage to power the vehicle's auxiliary systems, such as the lights, heating, and air conditioning.
- On-board charger: Used to convert AC power from sources like power outlets into DC power for charging the battery.

- Battery Management System (BMS): This system controls and monitors the battery's state of charge, temperature, and other parameters to ensure the safe and efficient operation of the vehicle.

Automotive manufacturers work closely with power electronics component manufacturers and suppliers to design and integrate components into EVs. Investments in R & D of power electronics to boost performance and efficiency have been on the rise. The power electronics supply chain for electric vehicles (EVs) is a combination of a multitude of activities taking place across the world. The value chain activities start from the raw materials sourcing stage where copper, steel, aluminum silicon, plastics, and rarer materials like gallium are procured and shipped. This is followed by the two core phases involved in power electronics, which have an increasing number of companies entering the industry. Component design and manufacturing is followed by assembly. The former is the stage where raw materials are processed into diodes, MOSFETs, IGBTs, and capacitors.

This process of converting raw materials into power electronics again involves several steps:

- Crystal Growth
- Wafer Preparation
- Photolithography
- Etching
- Doping
- Deposition
- Annealing
- Testing
- Packaging

The components that are produced from the above process are then assembled into electronic devices such as power converters, inverters, on-board chargers. The component manufacturing and assembly industry involves companies that often perform these functions either interchangeably or undertake both, along with semiconductor design, in the value chain. *Infineon Technologies, ST Microelectronics, Texas Instruments and ON Semiconductor,* and *NXP Technology* are a few of the top players in this section of the industry.

Additional detail on the raw material at the component stage:

- Crystal Growth: Silicon is melted and then slowly cooled to form a large single crystal ingot, which will later be sliced into wafers.
- Wafer Preparation: The ingot is sliced into thin wafers using a diamond saw, and the surfaces are polished to a high level of flatness and cleanliness.
- Photolithography: A layer of photoresist is applied to the surface of the wafer, which is then exposed to a pattern of light using a mask. The photoresist is then developed to create a pattern on the wafer.
- Etching: The wafer is etched using chemicals to remove the areas of the wafer that were not protected by the photoresist, leaving behind a pattern of features such as the transistor's source, drain, and gate.
- Doping: The wafer is treated with a process called ion implantation or diffusion, which introduces impurities into the silicon to create regions with different electrical properties, such as n-type or p-type.
- Deposition: A thin layer of metal, typically aluminum or copper, is deposited onto the wafer to create the transistor's contacts and interconnects.
- Annealing: The wafer is heated to a high temperature in a furnace to activate the dopants and repair any damage caused by the etching process.
- Testing: The wafer is tested to ensure that the transistors meet the required specifications, including electrical performance and reliability.
- Packaging: The individual transistors are cut from the wafer and packaged into a plastic or ceramic package, which provides protection, as well as electrical connections to the outside world.

Table 1.6: Supplier Network

Supplier Network		Assembly of Components (Contract Manufacturing)
Raw Materials for Semiconductors	**Processing of raw materials to produce Power Semiconductors (IGBT, MOSFET)**	
Tier 2	Tier 1	Outsourcing
Silicon	Infineon Technologies AG	Jabil
Plastics	Texas Instruments Inc.	Sanmina
Copper	STMicroelectronics NV	
Gallium	STMicroelectronics NV	
	NXP Semiconductors NV	
	OnSemi Conductor Corporation	

Charging Stations

Almost all electric vehicles use lithium-ion batteries. These are low-maintenance, lightweight, and more efficient than other batteries, but Lithium-ion batteries tend to be more expensive to manufacture than nickel-metal hydride or lead-acid batteries. Most lithium-ion batteries last for between 8 and 12 years, depending on the climate and maintenance schedule.

Additionally, EVs are charged by Electric Vehicle Service Equipment (EVSE). There are three levels of charging available in North America[3]:

- Home charging
- Public Charging
- Charging at Work

With the increased adoption of EVs and the rising need for charging infrastructure to support the EVs, the Federal Highway Administration (FHWA),[1][4] with support from the Joint Office of Energy & Transportation, has implemented minimum requirements and standards for federally funded (under NEVI Program) charging stations in Feb 2023. These standards include:

- Ensuring that drivers can easily find a charger
- Do not need multiple apps/accounts to charge
- Chargers work when drivers need them to
- Are designed to be compatible in the future
- Figure 1.3 provides some more information about the different levels of charging and the associated factors.[5]

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[3]*ChargeHub. "Electric Vehicle Charging Guide | ChargeHub." Chargehub.com, 2019, chargehub.com/en/electric-car-charging-guide.html*

[4]*Federal Register – The Daily Journal of the United States Government. National Electric Vehicle Infrastructure Standards and Requirements. 8 Feb. 2023, www.federalregister.gov/documents/2023/02/28/2023-03500/national-electric-vehicle-infrastructure-standards-and-requirements*

[5]*Muhammad Shahid Mastoi, Shenxian Zhuang, Hafiz Mudassir Munir, Malik Haris, Mannan Hassan, Muhammad Usman, Syed Sabir Hussain Bukhari, Jong-Suk Ro, An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends, Energy Reports, Volume 8, 2022, Pages 11504-11529, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2022.09.011. https://doi.org/10.1016/j.egyr.2022.09.011*

Different Levels of Charging Stations

Electric Vehicle Charging Infrastructure

Figure 1.3

Level 1 and Level 2
Residential Charging

Electric vehicles are charged via an AC power supply at a normal (Level 1) or semi fast charging rate:

Voltage (120V 1-Phase AC)

Amps (12-16 Amps)

Charging Loads (1.4 to 1.9 KW)

Charging Time (3-5 Miles of range per hour)

Price per Mile (2c-6c mile)

Level 2
Work and Public place Charging

Electric vehicles are charged via an AC power supply at semi fast (Level 2 charging rate:

Voltage (208V or 240V 1-Phase AC)

Amps (12-80 Amps / Typ 32 Amps)

Charging Loads (2.5 to 19.2 KW / Typ 7KW)

Charging Time (10-20 Miles of range per hour)

Price per Mile (2c-6c mile)

Level 3
DC Fast Charging

Electric vehicles are charged via an DC power supply at a fast (Level 3) charging rate:

Voltage (208V or 480V 3-Phase AC)

Amps (<125 Amps / Typ 60 Amps)

Charging Loads (<90KW / Typ 50KW)

Charging Time (80% Charge in 20-32 minutes)

Price per Mile (12c-25c mile)

Note: Some level 3 DCFC can also support up to 350KW charging loads

Manufacturing Process for Charging Stations

The manufacturing process of charging stations for electric vehicles (EVs) can vary depending on the specific type and model of charging station being produced. However, there are common steps involved in the process:

Design and Prototyping: The first step in manufacturing charging stations is the design and prototyping stage. Engineers and designers work together to develop the design of the charging station and create a prototype to test its functionality.

Component Selection: Once the design is finalized, the necessary components are selected. This includes charging cables, connectors, circuit breakers, power supplies, and other electronic components.

Fabrication: The next step is the fabrication of the charging station. This involves cutting, drilling, and welding metal components to create the structure of the charging station. The electronic components are then added to the structure.

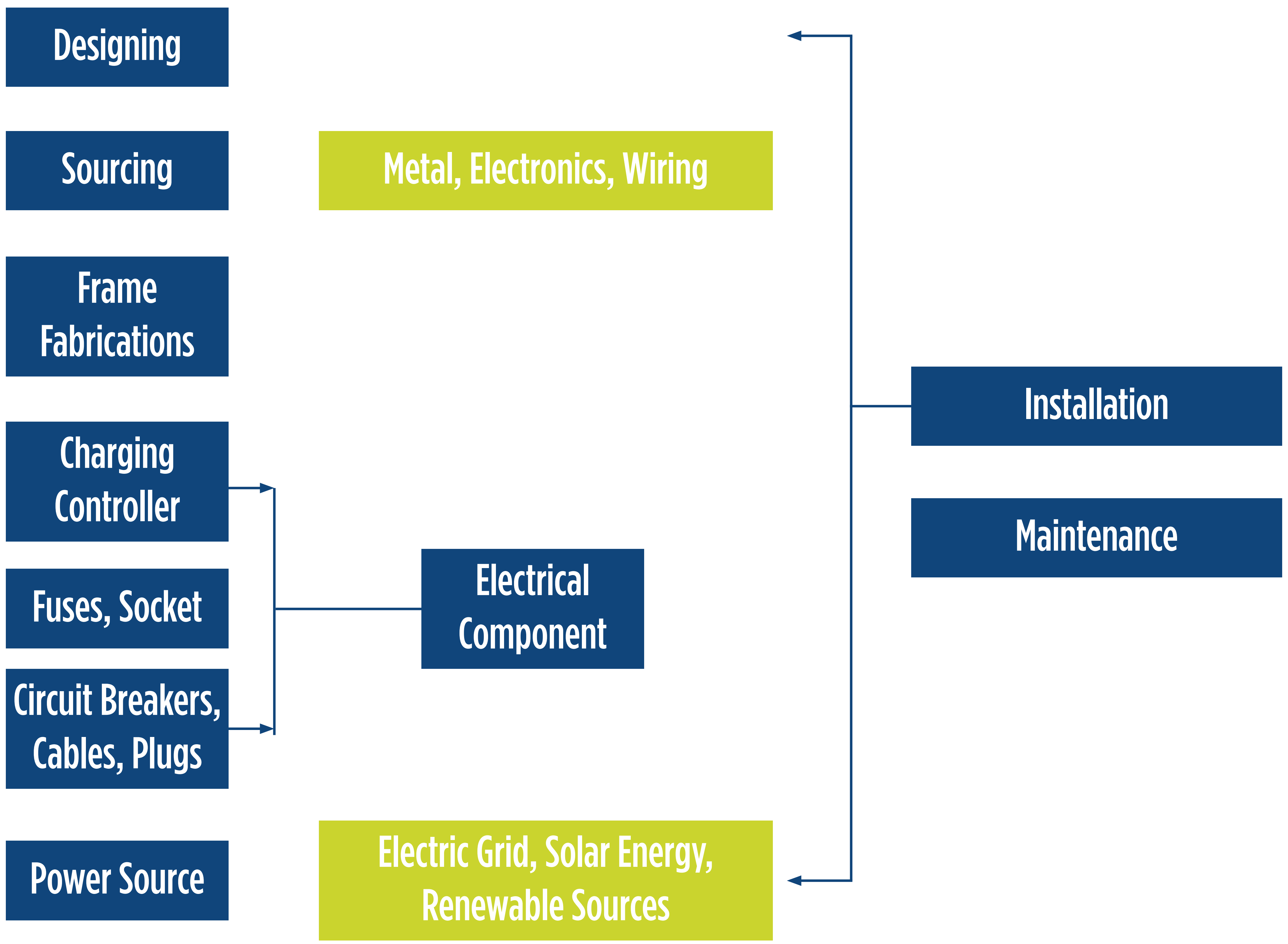
Assembly: Once the individual components are fabricated, they are assembled into a complete charging station. This includes attaching the charging cables, connectors, and other necessary components.

Testing and Quality Control: After assembly, the charging station is tested to ensure that it meets the required performance standards. This includes testing the charging speed, voltage, and amperage. The charging station is also inspected for any defects or issues.

Packaging and Shipping: Once the charging station has passed all quality control tests, it is packaged and prepared for shipping. The charging station is typically shipped to distributors, dealers, or directly to customers.

Overall, the manufacturing process of charging stations for EVs is similar to other electronics and manufacturing processes, with a focus on quality control and performance testing to ensure the product meets industry standards.

Figure 1.4



Electric Vehicle Battery

The battery pack of the EV is the highest contributor to the cost of EVs, with it accounting for up to 40% of the vehicle's value. As per Federal Regulations for car battery warranties, an EV battery must fulfill either eight years or 100,000 miles, making it crucial for EV manufacturers to dedicate significant resources to manufacture batteries or build long-term relationships with battery manufacturers. Because the battery pack is the major component of an EV, it is pertinent to understand the EV battery supply chain. The low domestic supply of EV battery materials and the high concentration of minerals outside the U.S. is one of the major challenges faced in the EV battery supply chain for the U.S.. In addition to the high availability of materials outside the U.S., the ability to process the minerals and transform them into battery-grade materials is also highly concentrated outside the U.S.[6]

[6] "Ulrich, Lawrence. "The Top 10 EV Battery Makers." *IEEE Spectrum*, 25 Aug. 2021, spectrum.ieee.org/the-top-10-ev-batterymakers

Table 1.7: EVB Supplier Companies in the World

Supplier Company	2022 Market Share	Manufacturers in Contract
Contemporary Amperex Technology Co. (CATL)	37%	Dongfeng Motor Corp., Honda, SAIC Motor Corp., Stellantis, Tesla, Volkswagen Group, Volvo Car Group
LG Energy Solution	14%	General Motors, Groupe Renault, Stellantis, Tesla, Volvo, VW Group
BYD Co.	14%	BYD, Ford
Panasonic	7%	Tesla, Toyota
SK Innovation	5%	Diamler, Ford, Hyundai, Kia
Samsung SDI	5%	BMW, Stellantis, Ford, VW Group
China Aviation Lithium Battery (CALB)	4%	GAC Motor, Zhejiang Geely Holding Group Co.
Gotion High-Tech	3%	Chery Automobile Co., SAIC, VW Group

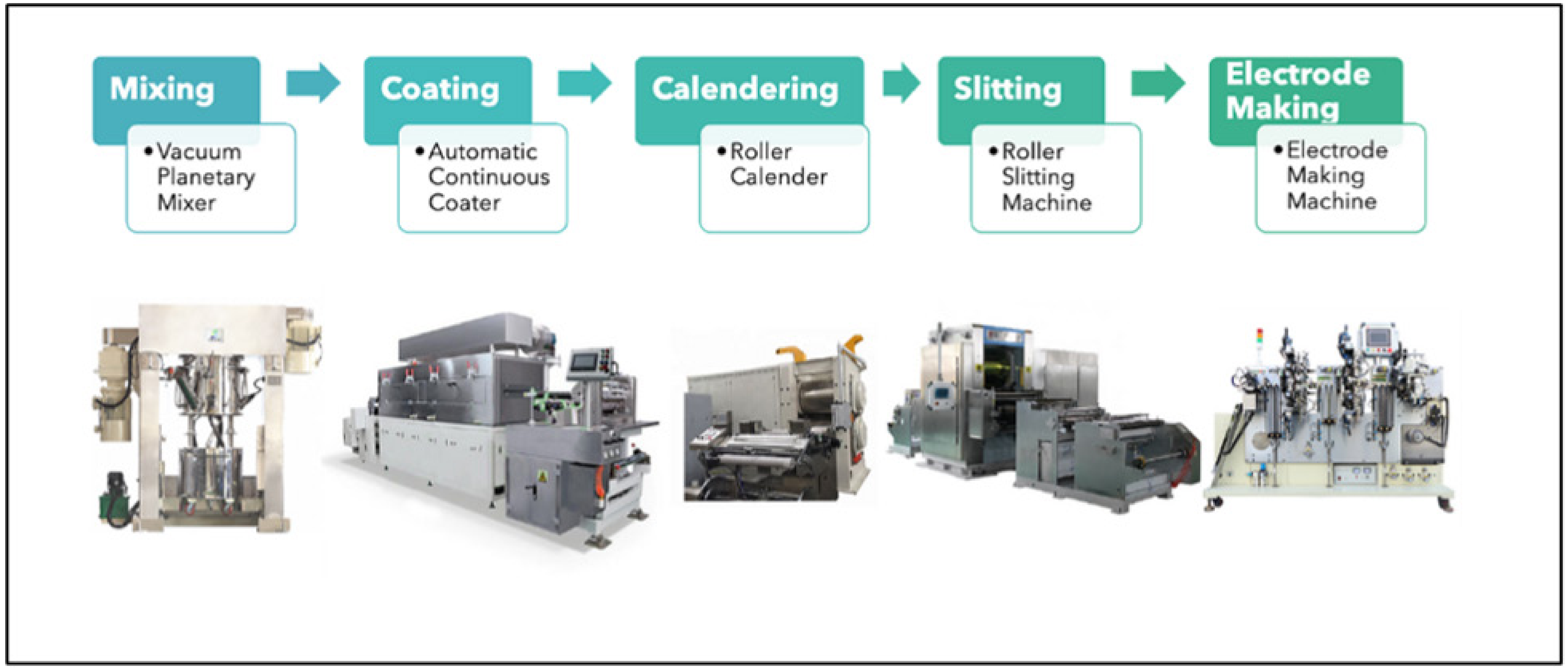
Battery Manufacturing Process

The industrial production process for lithium-ion batteries typically consists of three stages:

1. Electrode Manufacturing
2. Cell Fabrication
3. Formation and Integration

Batteries are manufactured in cylindrical, pouch, or prismatic form factors as this increases the ease of assembly into battery packs or modules. The manufacturing equipment involved in the process is integral in the precision of manufacturing and determines the cost of the batteries. The capital cost for the aforementioned stages can be split into 40%, 30%, and 30% respectively.

Figure 1.5: Electrode Manufacturing



Cell Fabrication

Figure 1.6: Winding and Lamination

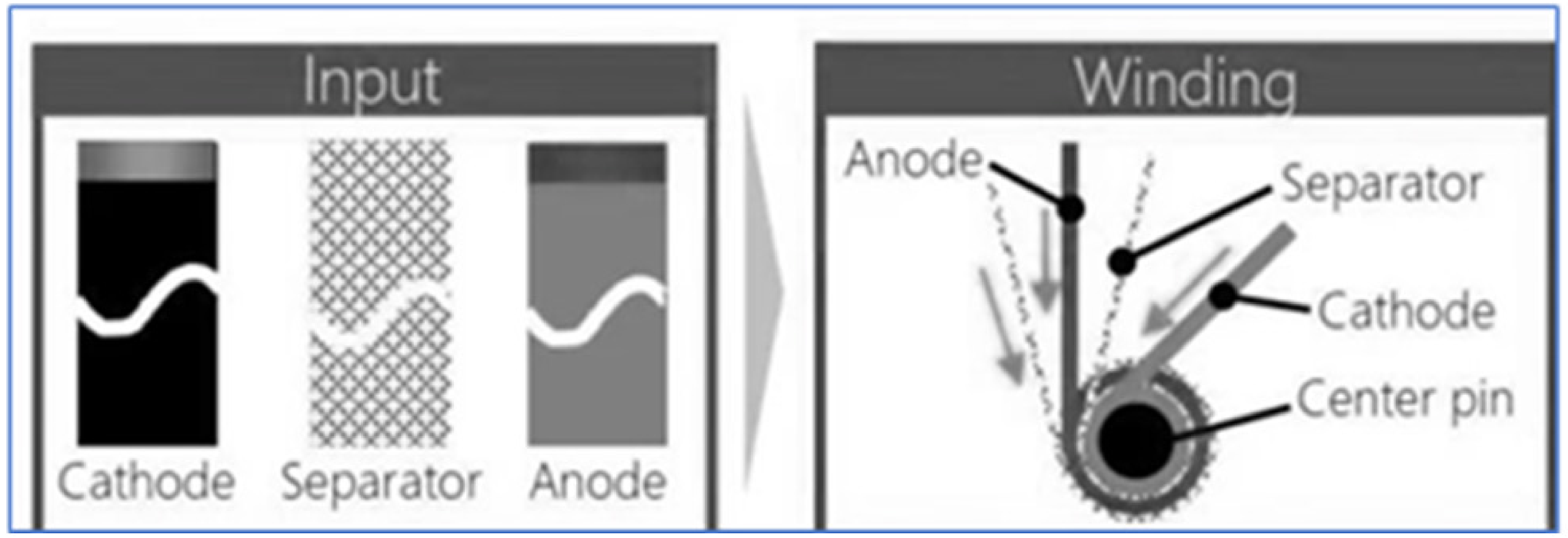


Figure 1.7: Moisture Removal and Electrolyte Injection

Formation and Integration

During the first charge and discharge of the battery, a Solid Electrolyte Interphase (SEI) is formed on the surface of the anode, and this plays a crucial role in increasing the lifecycle of the cell. Next, a series of tests are performed including X-Ray monitoring, weld monitoring, insulation and capacity testing. Finally, cells are combined to form a battery pack which has certain steps and tests involved such as:

- Feeding
- Plasma Cleaning
- Combining cells- glue coating
- Lamination and welding of battery pack housing
- Series and parallel connections with laser welding
- Testing
  - 590 degrees Celsius fire test
  - Continuous 21 hours vibration test
  - 100G acceleration Impact test
  - 1-meter drop test
  - Squeeze test

Battery Components

An EV battery has four major components:

- Cathode
- Anode
- Separator
- Electrolyte

Battery Types

Almost every mass manufactured EV on the road right now contains a lithium-ion battery with variations in the cathode and anode chemistry. The cathode of the EV battery is made up of a wide variety of minerals and contributes the most to the cost of the battery. The composition of cathode minerals also has the most significant impact on the battery performance, and materials in the cathode account for roughly 31% of the mineral weight in the battery.[7] For the anode, graphite has been the most commonly used material due to its low cost, long-life and abundance.

Nickel-based batteries like Nickel-Manganese-Cobalt (NMC) and Nickel-Cobalt-Aluminium Oxide (NCA) batteries accounted for about 80% of the battery capacity in new plug-ins in EVs in 2021. The nickel content in batteries improves the energy density, which is the amount of energy stored in unit volume, thereby increasing the driving range. The cobalt and manganese stabilize the battery and improve safety.[8] However, the usage of Lithium iron phosphate (LFP) batteries is on the rise. These batteries are made without nickel and typically have lower energy densities but are more cost-effective.

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[7] *Bhutada, Govind. "The Key Minerals in an EV Battery." Elements by Visual Capitalist, 2 May 2022, elements.visualcapitalist.com/the-key-minerals-in-an-ev-battery/.*

[8] *Nickel Institute. "Nickel in Batteries | Nickel Institute." Nickelinstitute.org, nickelinstitute.org/en/about-nickel-and-its-applications/nickel-in-batteries/.*

LFP technology uses Lithium carbonate compounds which are less expensive instead of Lithium hydroxide compounds that are used in nickel batteries. Moreover, eliminating the use of nickel and cobalt further reduces the price.

The usage of LFP chemistry nearly doubled in passenger EVs globally between January 2021 and December 2022. Going from 17% at the start of 2021 to 31% in September 2022 as per a recent report by Adamas Intelligence, included in InsideEVs.[9] Data also suggests that 68% of all LFP chemistry used in EVs was for Tesla and BYD, the two largest EV players in the world. The report further states that over 80% of all LFP deployed on roads was in China and all LFP used in EVs outside of China were manufactured in China.

Table 1.8 provides information on various, common battery chemistries used in the industry. It also provides the composition of different materials that are used in the specific battery type.

[9]*Kane, Mark. "EV Battery Market: LFP Chemistry Reached 31% Share in September." InsideEVs, 26 Dec. 2022, insideevs.com/news/628303/ev-battery-lfp-share-september2022/.*

Table 1.8: Popular Battery Chemistry and Composition

Element	NMC811 Nickel (80%) Manganese (10%) Cobalt (10%)	NMC523 Nickel (50%) Manganese (20%) Cobalt (30%)	NMC622 Nickel (60%) Manganese (20%) Cobalt (20%)	NCA+ Nickel Cobalt Aluminium Oxide	LFP Lithium iron phosphate
LITHIUM	5	7	6	6	6
COBALT	5	11	11	2	0
NICKEL	39	28	32	43	0
MANGANESE	5	16	10	0	0
GRAPHITE	45	53	50	44	66
ALUMINUM	30	35	33	30	44
COPPER	20	20	19	17	26
STEEL	20	20	19	17	26
IRON	0	0	0	0	41
Total (Kgs)	**169**	**190**	**180**	**159**	**209**

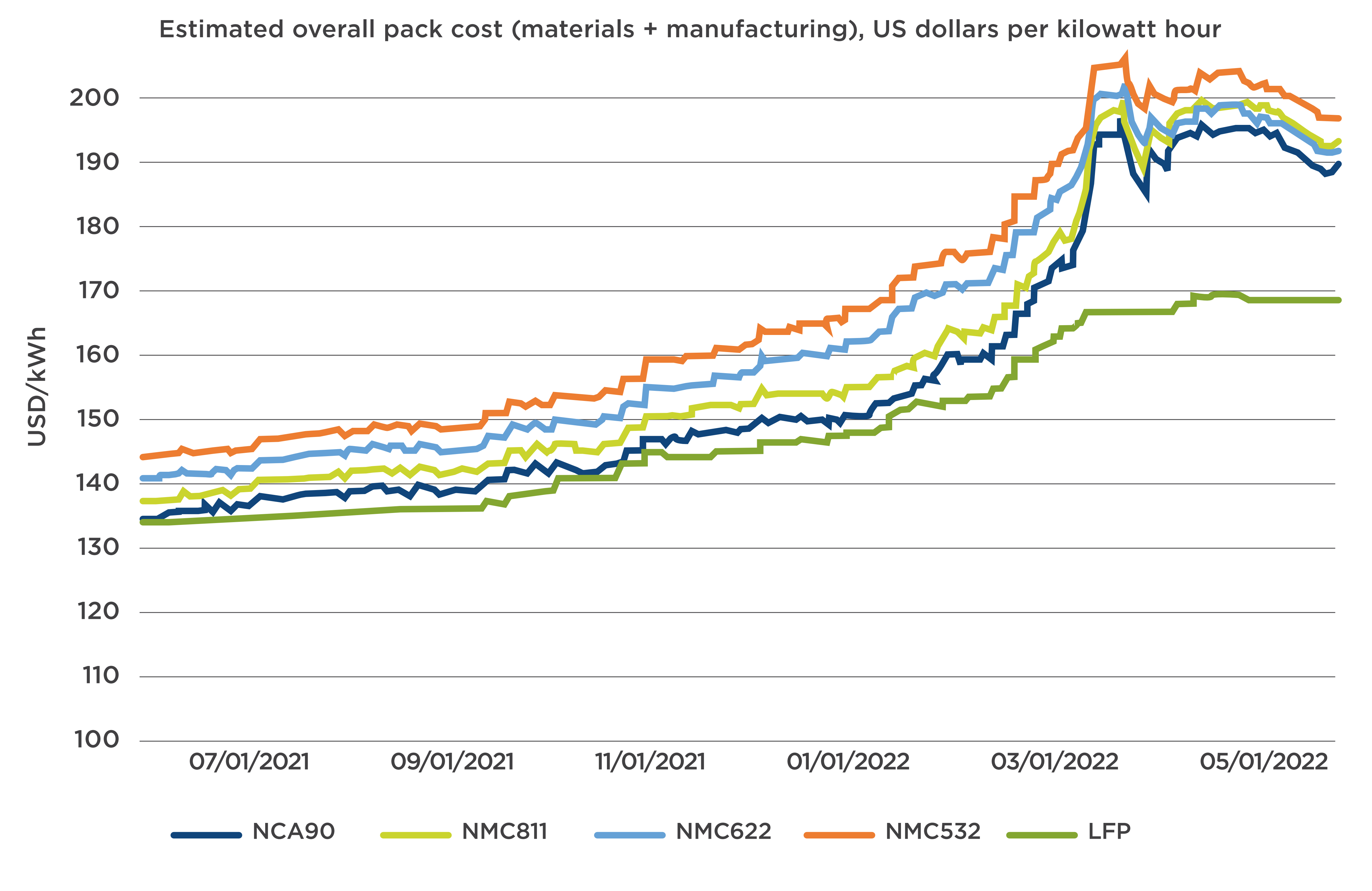
Table 1.9: NMC and LFP Battery Characteristics[10]

Characteristics	NMC	LFP
Energy Density	Higher	Lower
Temperature	Have a better charging performance in low temperatures	Tolerate high temperatures longer
Materials	Uses more expensive materials like cobalt, nickel, and manganese	Uses iron, which is more readily available than other minerals worldwide (including in North America). Requires more lithium
Cost	Cost more	Cost less
Duration	Does not last as long	Last longer
End of Life	More likely to be recycled	Less likely to be recycled: LFPs contain lower-value materials than NMCs, which means that the cost of recycling is often higher than the value of the materials collected

[10]Carreon, Alessandra. "EV Batteries 101: The Basics." RMI, 8 Mar. 2023, *rmi.org/ev-batteries-101-the-basics/.* *Accessed 20 July 2023.*

Figure 1.8 provides the cost of various battery types (by chemistry) in USD/kWh over time. NMC532 chemistry battery was the most expensive battery in May 2022, by cost per kWh. LFP was the least expensive battery by cost per kWh.

Figure 1.8



Source: Krishna, Muthu. "The EV Battery Chemistry Debate Just Got More Complicated." Fastmarkets, 21 July 2022, www.fastmarkets.com/insights/the-ev-battery-chemistry-debate-just-got-more-complicated.

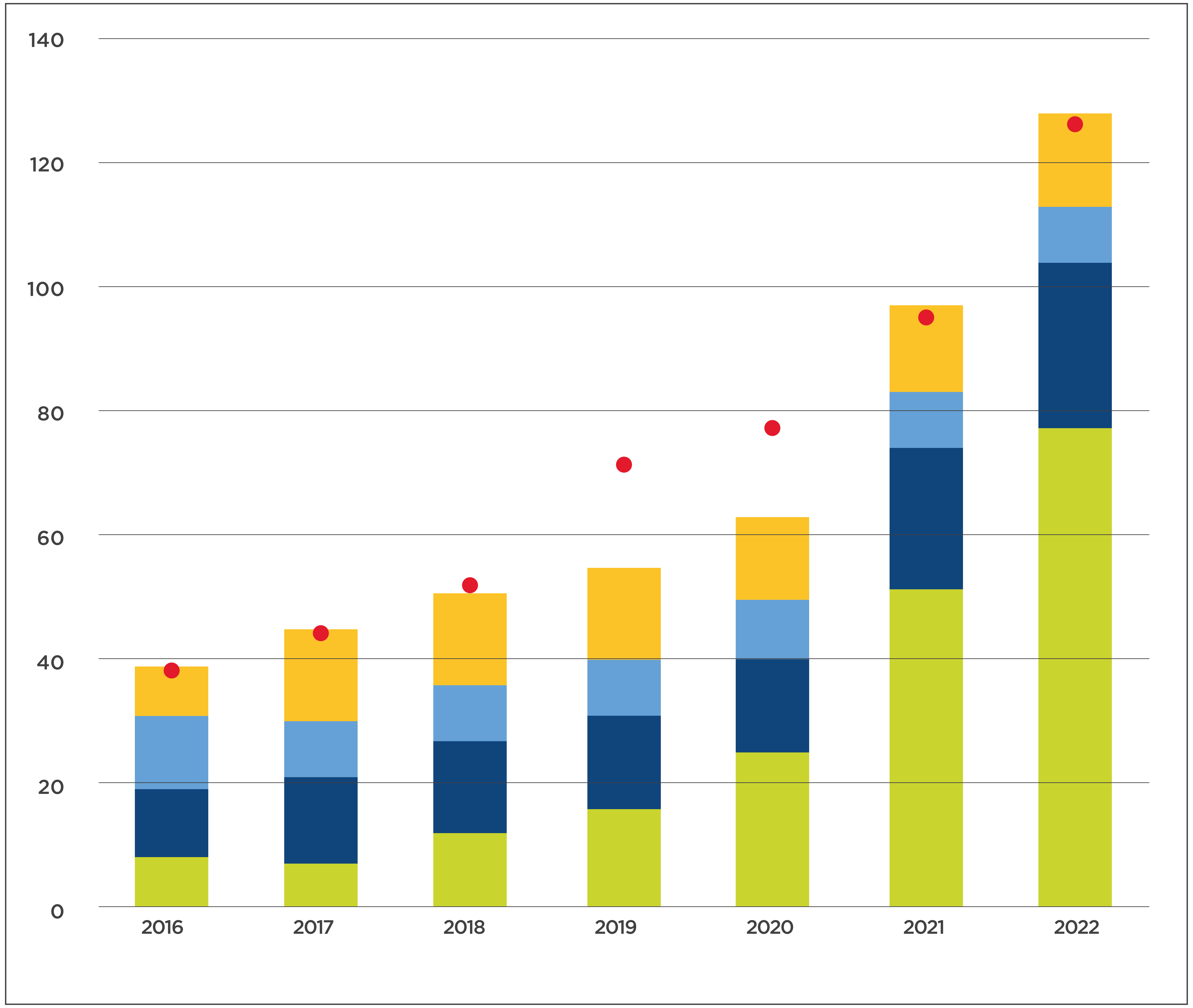
Lithium

According to an analysis by McKinsey and Company, the lithium demand for LiBs for EVs is expected to rise to 3-4 million metric tons in 2030 from approximately 0.5 million metric tons in 2021 of lithium carbonate equivalent (LCE).[11] A report from *The Guardian* suggests that, that due to the accelerated auto industry transition from ICE to EVs, the global demand for lithium, also known as white gold, is predicted to increase over 40 times by 2050.[12] Additionally, the International Energy Agency (IEA) performed an analysis of trends in batteries[13] as part of their Global EV Outlook 2023, which reports that due to increased EV demand, the demand for lithium exceeded supply in 2022, despite an increase of 180% production since 2017. It also reported that in 2022, 60% of lithium demand was for EV batteries, up from just 15% in 2017.

The increase in lithium demand beyond the supply has caused the prices of lithium to skyrocket. The IEA reports that the lithium prices increased 4-5 folds in 2021 and have increased six times above their average in 2023 over the 2015-2020 period.

Figure 1.9 shows the supply and demand of lithium, in kilotons, for batteries as reported by IEA. The light blue represents EV demand; dark blue represents other batteries; green represents ceramic and glass; and orange represents other demand. The red dots represent the supply of lithium.

Figure 1.9: Supply and Demand of Lithium for Batteries by Sector, 2016-2022



[11] Azevedo, Marcelo, et al. "Lithium Mining: How New Production Technologies Could Fuel the Global EV Revolution | McKinsey." www.mckinsey.com, 12 Apr. 2022, www.mckinsey.com/industries/metals-and-mining/our-insights/lithium-mining-how-new-production-technologies-could-fuel-the-global-ev-revolution.

[12] Lakhani, Nina, and Nina Lakhani Climate justice reporter. "Revealed: How US Transition to Electric Cars Threatens Environmental Havoc." The Guardian, 24 Jan. 2023, www.theguardian.com/us-news/2023/jan/24/us-electric-vehicles-lithium-consequences-research#:~:text=The%20global%20demand%20for%20lithium.

[13] IEA. "Trends in Batteries – Global EV Outlook 2023 – Analysis." IEA, 2023, www.iea.org/reports/global-ev-outlook-2023/trends-in-batteries.

Graphite

The anode in Li ion batteries (LiBs) is made out of graphite. A graphite anode is one of the ingredients that make it a LiB, and there are no substitutes. LiBs are smaller, lighter, and more powerful than traditional batteries and have a flat voltage profile meaning they provide almost full power until discharged. They also have no memory effect and a very low rate of discharge when not in use. Almost all portable consumer devices such as laptops, cell phones, MP3 players, and cameras use Li-ion batteries, and they are now rapidly moving into power tools and bigger devices. This has led to 20% annual growth in the LiB market.

This growth rate is expected to continue as hybrid electric vehicles ("HEV"), plug-in electric vehicles ("PEV") and all electric vehicles ("EV"), and grid storage applications, are huge markets that are all in their infancy. This has significant implications for the LiB and graphite markets. The batteries are large and the potential demand for graphite is significant. By weight, graphite is the largest component in LiBs and they contain 10-15 times more graphite than lithium. Because of losses in the manufacturing process, it takes over 30 times as much graphite to make the batteries.

Figure 1.10

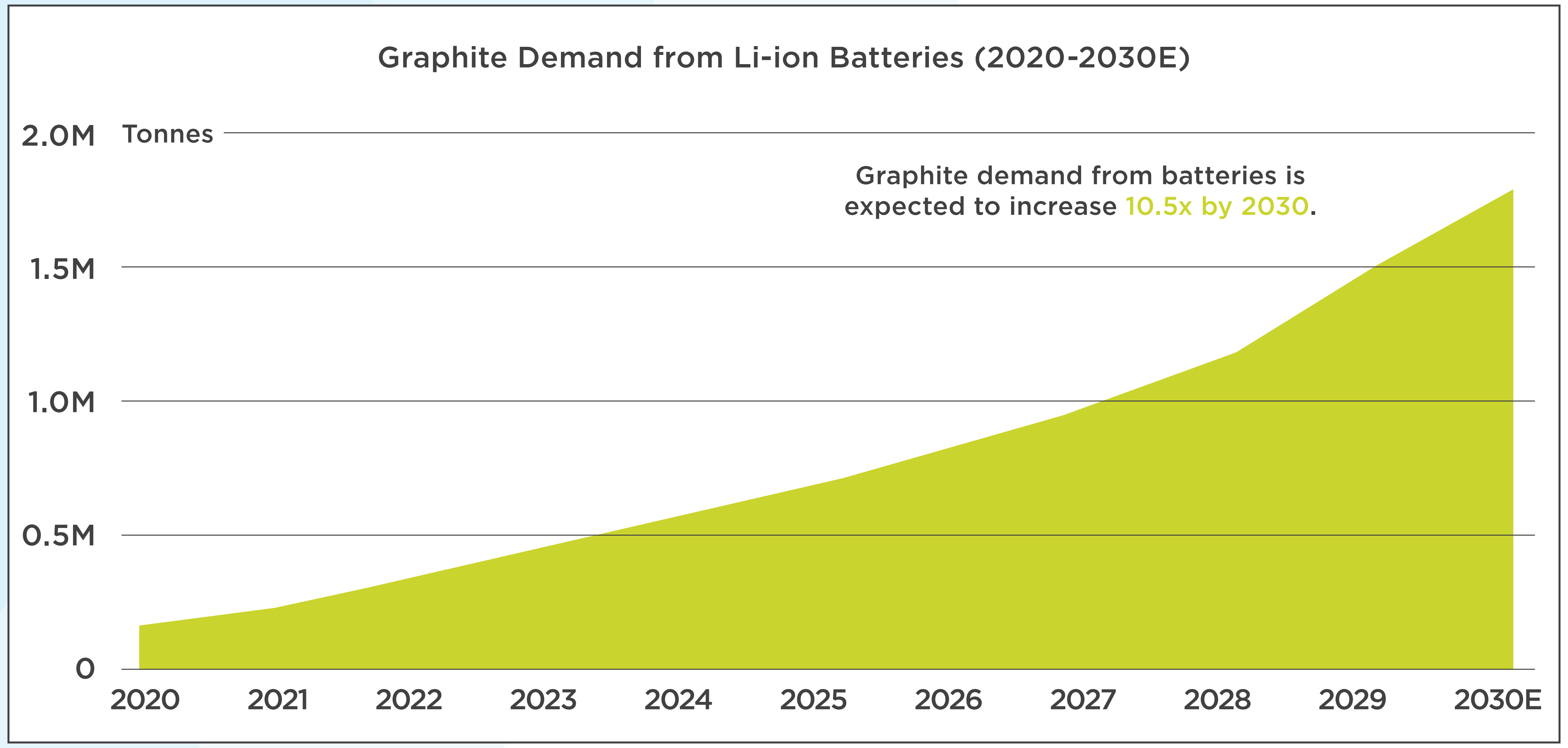
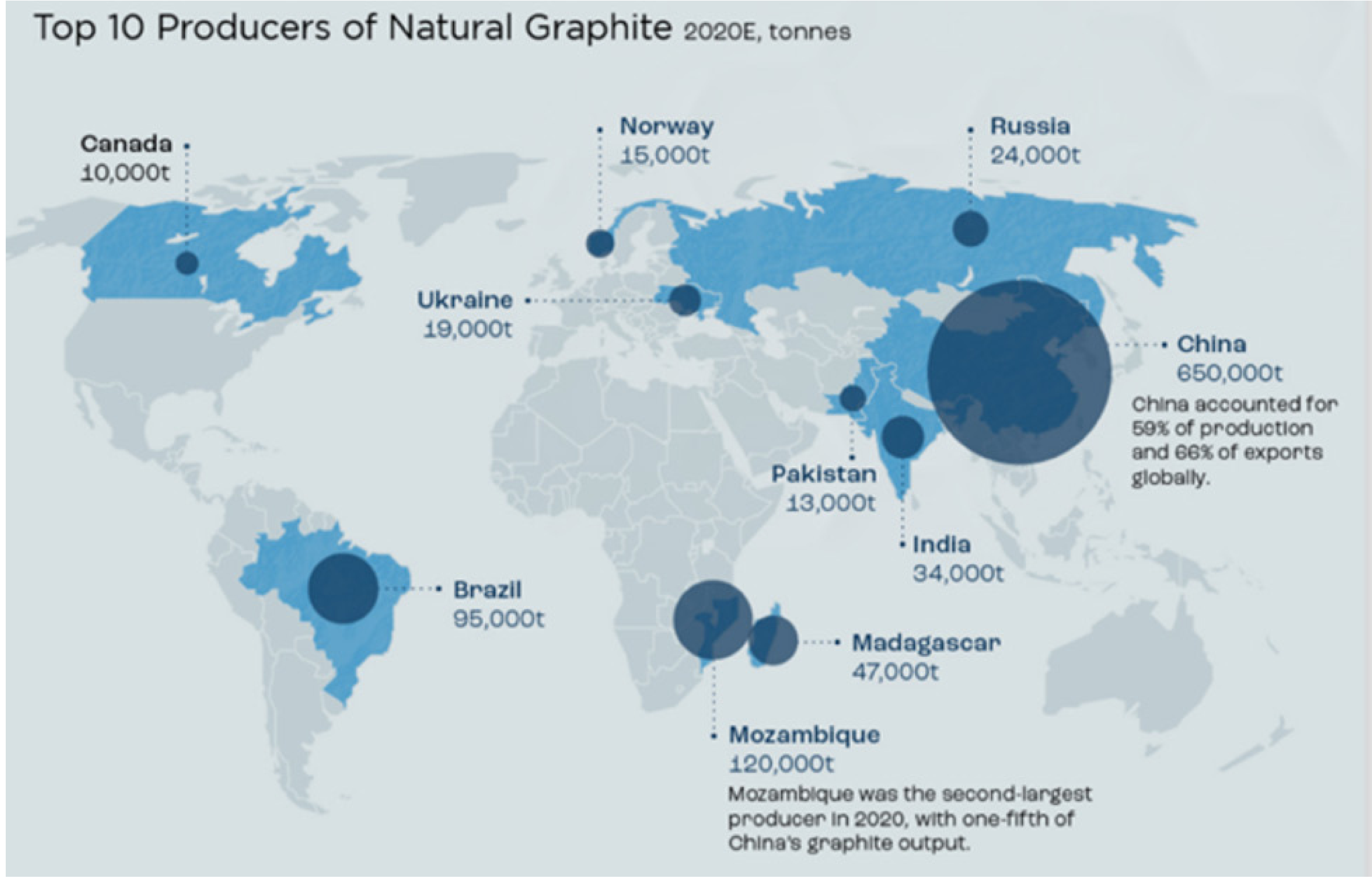


Figure 1.11



Alternative Battery Chemistry & Technologies

The prices of critical materials are increasing, prompting the rise in the cost of EV batteries, and, therefore, EVs. The graphs represent the cost of individual materials. Light blue represents lithium carbonate; dark blue represents cobalt; light green represents nickel; dark green represents copper; yellow represents manganese; and dots represent battery.[14]

In response to these challenges, researchers worldwide are seeking alternatives. "In addition to the alternative materials discussed in greater detail in the appendices, alternative production cycles are also recommended. These include better design to ensure longer-lasting batteries and a circular economy model to recover used material.[15]

Figure 1.12: Cost of Metal vs. Battery

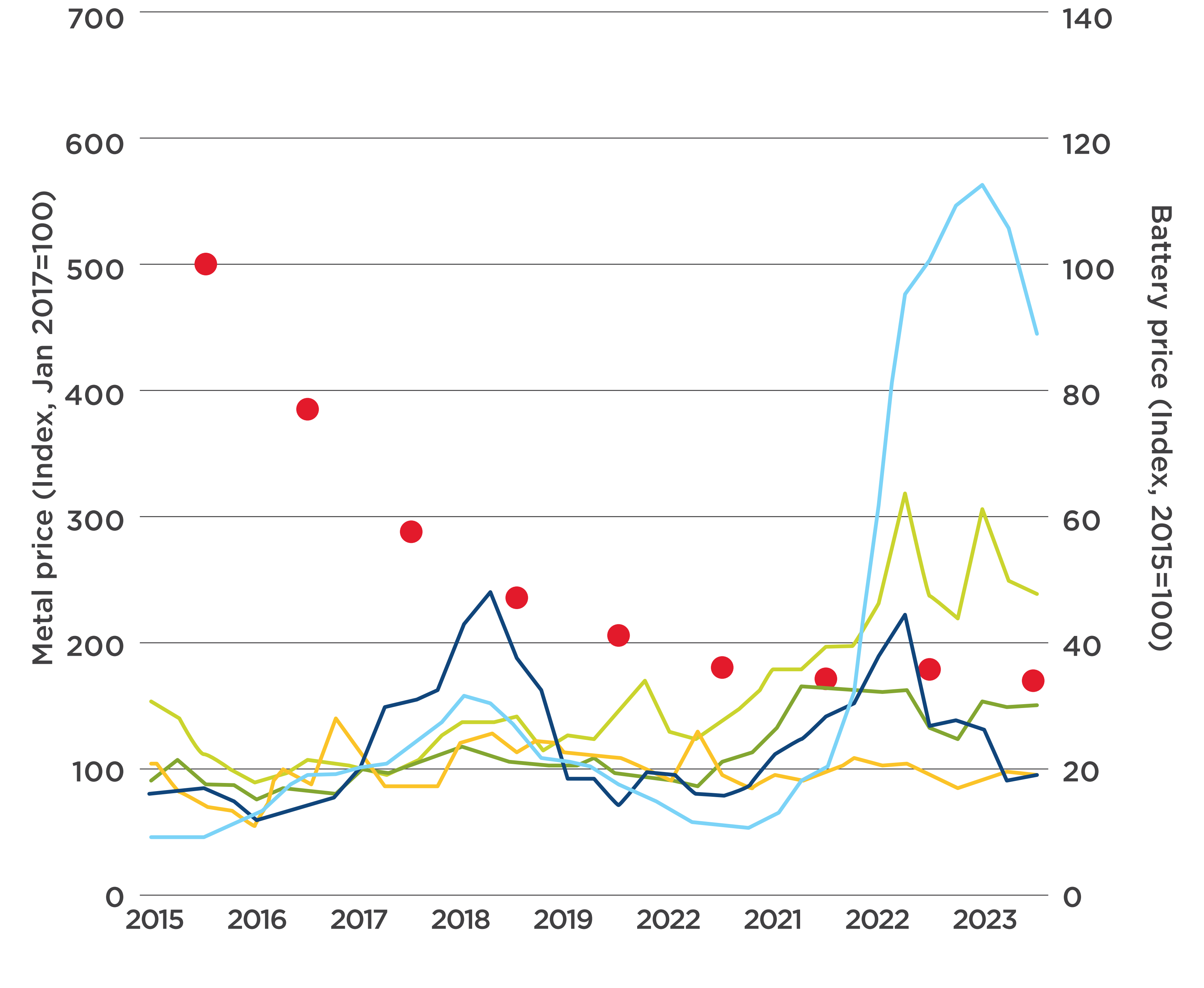
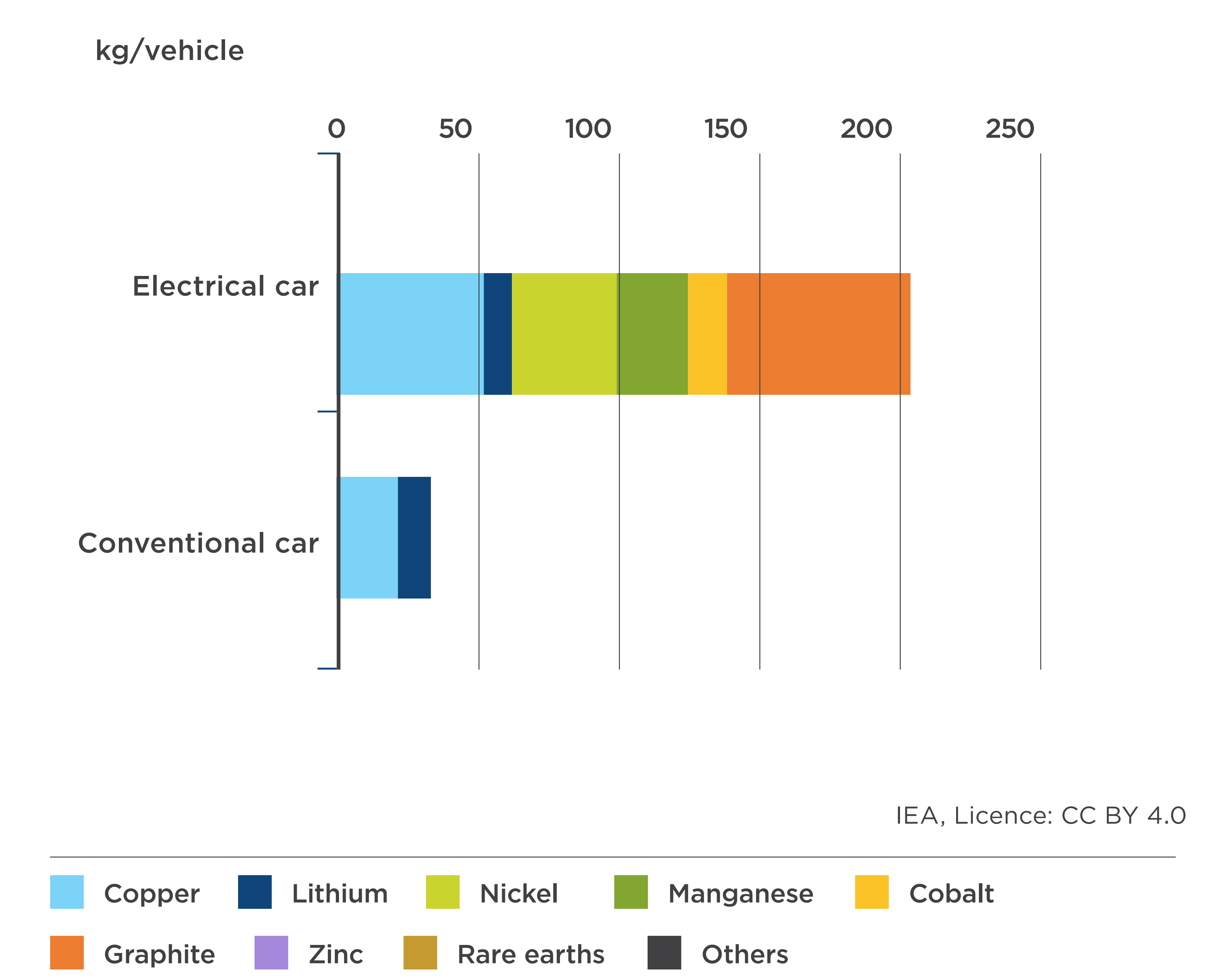


Figure 1.13: Materials and Weight of Materials



[14]IEA. "Trends in Batteries – Global EV Outlook 2023 – Analysis." IEA, 2023, www.iea.org/reports/global-ev-outlook-2023/trends-in-batteries.

[15]Content, Sponsored. "Visualizing the Natural Graphite Supply Problem." Elements by Visual Capitalist, 18 Nov. 2021, elements.visualcapitalist.com/visualizing-the-natural-graphite-supply-problem/.

Evaluate the inventory of non-skilled workers in the Electric Vehicle Product Industry.

Task 2

Evaluate the inventory of non-skilled workers in the electric vehicle product industry.

Understanding the inventory of non-skilled workers in the electric vehicle product industry is not only essential for the success of individual manufacturers but also for the industry's sustainability and its broader implications for the global transition to sustainable transportation. By assessing their roles, challenges, and opportunities, we can better appreciate the holistic workforce landscape in the EV sector and identify areas for improvement and growth. This evaluation will provide valuable insights into the pivotal contribution of non-skilled workers and their role in shaping the future of electric mobility.

According to the Alternative Fuels Data Center, administered by the U.S. Department of Energy, in 2022 a total of 2.44M electric vehicles have been registered in the U.S., of which 17,700 were registered in Indiana, an increase from 280,300 and 1,300 respectively in 2016. The count of EVs per 10,000 people has risen from 9 to 73 in the U.S. during the same period while it has increased from 2 to 26 in Indiana. This translates to a growth of 711.1% in the U.S. and Indiana experienced an astounding increase of 1,200%.[16]

Industry output (billions of dollars) share of the automotive sector

The automotive sector is crucial to the U.S. economy, contributing significantly to employment, technological innovation, and economic growth. Today, the U.S. sector remains a major player in the global automotive market, producing millions of vehicles and generating billions of dollars in revenue each year. In this context, examining the industry output of the automotive sector in the U.S. is critical to understanding its impact on the economy and society at large.

Table 2.1: Automotive Manufacturing Sector Employment (Thousands of Jobs)

Industry	Employment 2011	Employment 2021	Employment 2031	Employment change 2011-21	Employment change 2021-31	Employment, Compound annual rate of change 2011-21	Employment, Compound annual rate of change 2021-31
Total Automotive	8,721	9,355	9,366	634	11	0.2%	-0.2%
Total	143,327	158,135	166,452	14,808	8,317	1.0%	0.5%
% Share of automotive Industry	6.1%	5.9%	5.6%	4.3%	0.1%	31.9%	-33.5%

Table 2.2: Automotive Manufacturing Sector Output (GDP - Billions of Chained 2012 U.S. Dollars)

Industry	Output 2011	Output 2021	Output 2031	Output, Compound annual rate of change 2011-21	Output, Compound annual rate of change 2021-31
Total Automotive	2,944	3,219	4,035	-0.1%	1.8%
Total	28,475	34,893	42,696	2.1%	2.0%
Share of automotive industry	10.3%	9.2%	9.5%	-4.7%	90.6%

[16] https://afdc.energy.gov/transatlas/#/?state=IN&view=per_capita, FHWA

The automotive sector accounted for roughly 5.9% of the total employment across all industries in the U.S. while contributing 9.2% of the total industry output - nearly 3.2 trillion USD of the economy in 2021. The employment contribution of the automotive industry is expected to shrink to 5.6% in 2031 from 6.1% in 2011. However, the industry output is expected to increase to 9.5% over the next decade even though employment is expected to reduce in the automotive sector.

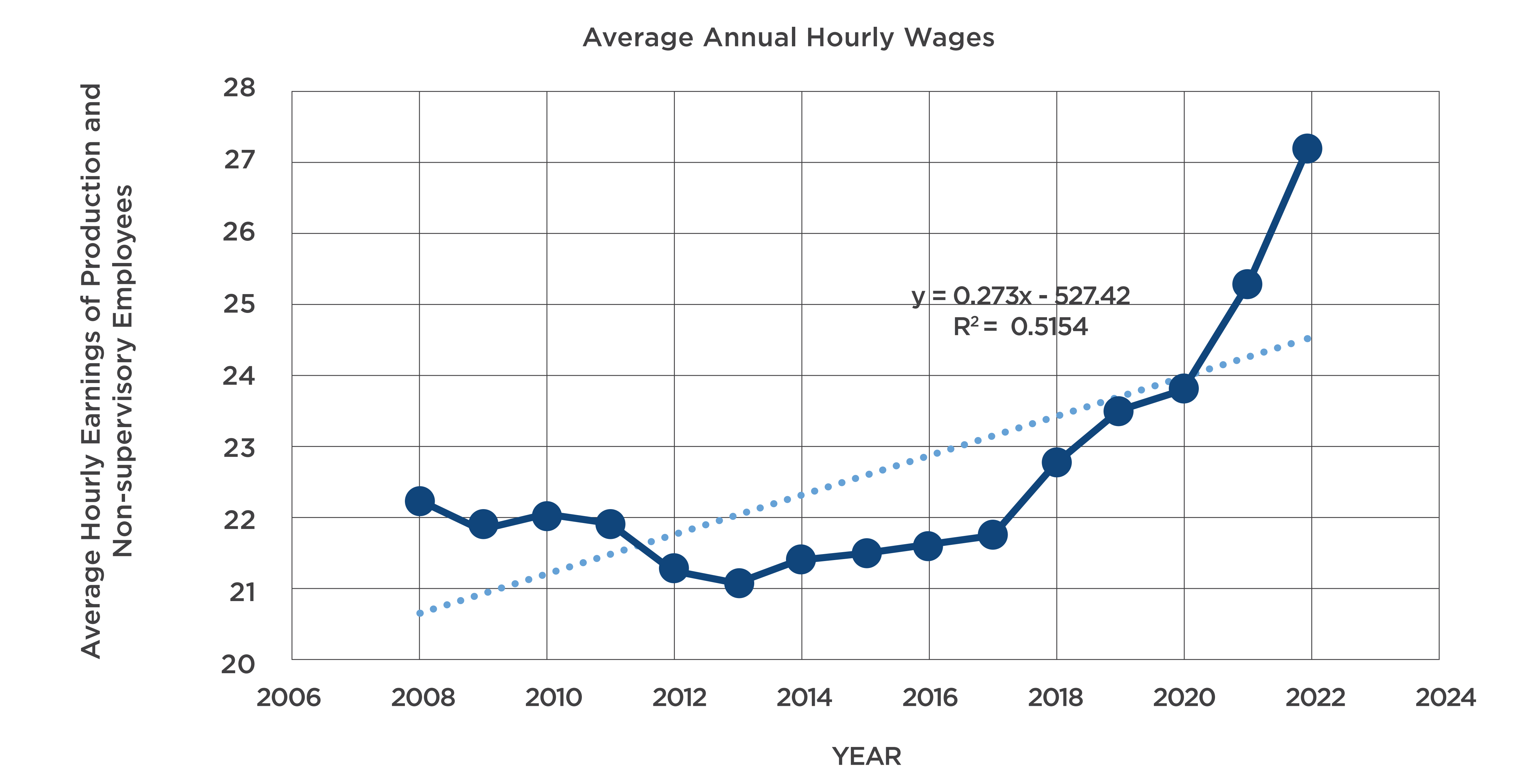
Employment trends in the industry

According to economists at Indiana University, labor shortages and supply chain issues continued to challenge Indiana's economy in 2022. However, they also expected to see continued growth in employment and job creation of 2%, similar to the national growth rate. While the U.S. labor participation rate is 61%, Indiana has a rate that hovers at 63%. Unfortunately, roughly 60,000 Hoosiers have dropped out of the labor force over the past year, indicating that fewer people are actively looking for jobs. Although the state's unemployment rate was expected to fall from 4.2% to as low as 3.6% by the end of 2022, Indiana's slower population growth may lead to slightly lower employment and job creation growth relative to the national level. Additionally, the manufacturing sector was expected to experience slower growth in 2022, with economists predicting a growth rate of only 0.4% likely due to stronger worker productivity or an increased focus on automation and technology by employers addressing the ongoing labor shortage. Overall, the challenges faced by Indiana's economy in 2022 were reflective of broader economic trends across the U.S.[17, 18]

Wage changes

According to data from the Bureau of Labor Statistics (BLS),[19] the hourly wage for workers in the automotive industry (Motor vehicles and parts manufacturing) in the U.S. has increased over the past few years, with a high fluctuation throughout the year as seen in Figure 2.1. As of 2022, the median hourly wage for production workers in the motor vehicle manufacturing industry was $27.18, an increase from $22.02 in 2010. After 2017, wages had a drastic increase that coincided with a dramatic public interest in EVs. The auto industry began seeing transitions to EVs around 2017 as Tesla's market cap surpassed Ford and Fiat Chryslter (now Stellantis).[20] (It should be noted that this data is only for production and non-supervisory employees.)

Figure 2.1: Wages of Production Workers



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[17] https://www.indystar.com/story/money/2021/11/05/indiana-economy-2022-what-to-expect-indiana-university-economists-iu/6270734001/
[18] http://www.ibrc.indiana.edu/ibr/2020/fall/article1.html
[19] https://www.bls.gov/iag/tgs/iagauto.htm#earnings
[20] https://www.businessinsider.com/biggest-auto-industry-disruptions-in-2017-1#for-real-teslas-market-cap-surge-1

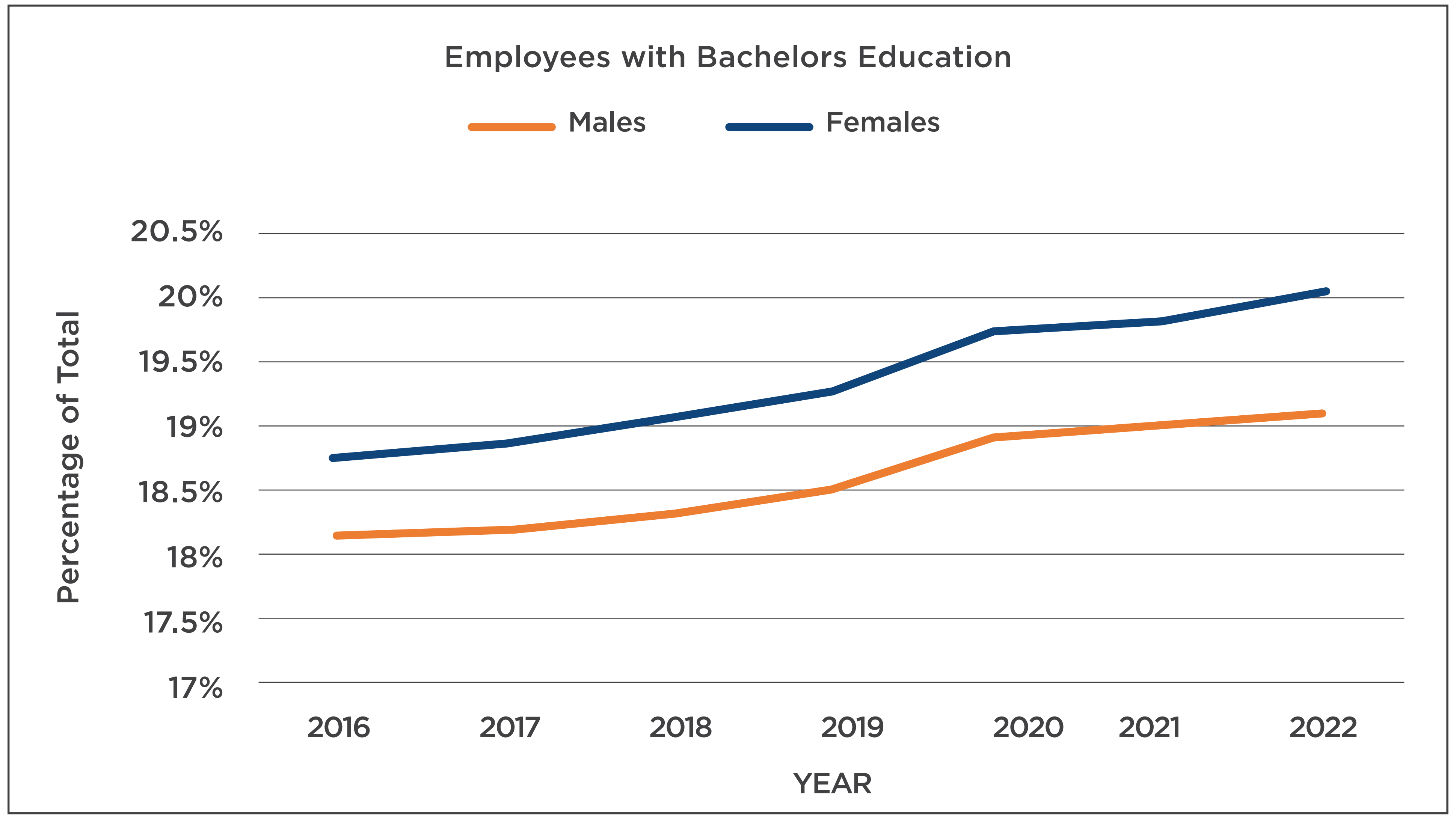
The hourly wage for workers in the overall manufacturing industry (NAICS 31-33) in the United States has also increased steadily over the past few years, although at a slower pace than in the automotive industry. Hourly earnings in overall manufacturing have seen an increase after 2021, with the wages increasing to more than $25 in 2022, up from about $18.6 in 2010.

COVID-19 Impacts on the Automotive Sector

The involvement of highly educated workers having a bachelor's or advanced degree has increased post-pandemic for both male and female workers as observed in Figure 2.2. This can be attributed to several factors:

1. Technological advancements: The automotive industry is constantly evolving with new technologies, such as EVs, autonomous driving systems, and advanced safety features. These technological advancements require workers with specialized skills and knowledge that can only be gained through higher education.
2. Shift towards sustainable practices: With an increased focus on sustainability, the automotive industry is shifting towards producing more environmentally friendly vehicles, which require workers with expertise in fields such as battery technology and material science.
3. Data analytics: The automotive industry is increasingly relying on data analytics to improve efficiency and reduce costs. Workers with a strong background in data analytics and machine learning are in high demand, as they can help automotive companies make data-driven decisions.
4. Increased competition: The automotive industry is highly competitive, and companies are looking for workers who can help them gain a competitive edge. Workers with advanced degrees are seen to add value and can help companies stay ahead of the competition.
5. Pandemic-related changes: The pandemic has forced the automotive industry to adapt to new ways of working, including remote work and increased use of digital technologies. Workers with advanced degrees are equipped to navigate these changes and can help companies stay productive and competitive in the face of uncertainty.
6. Automation: With the increase in the use of automation in assembly lines and for manufacturing, the need for employees with knowledge and skills to operate the automated machinery has increased. The skill to efficiently work with automated machinery requires advanced degrees.

Figure 2.2: Trend of workers having a bachelor or advanced degree pre- and post-pandemic in the automotive industry



Conversely, the requirement of workers with an associate's degree or less has fallen post-pandemic. Some low-skilled jobs in the automotive industry have been automated or eliminated due to the pandemic, leading to a decreased demand for workers with just an associate's degree education. For example, in production lines, some tasks that were previously performed by manual workers may have been taken over by robotics or automated systems. In these cases, the demand for this group of workers has fallen, as depicted in Figure 2.3 and Figure 2.4.

Figure 2.3: Trend of workers having a high school diploma pre- and post-pandemic in the automotive industry

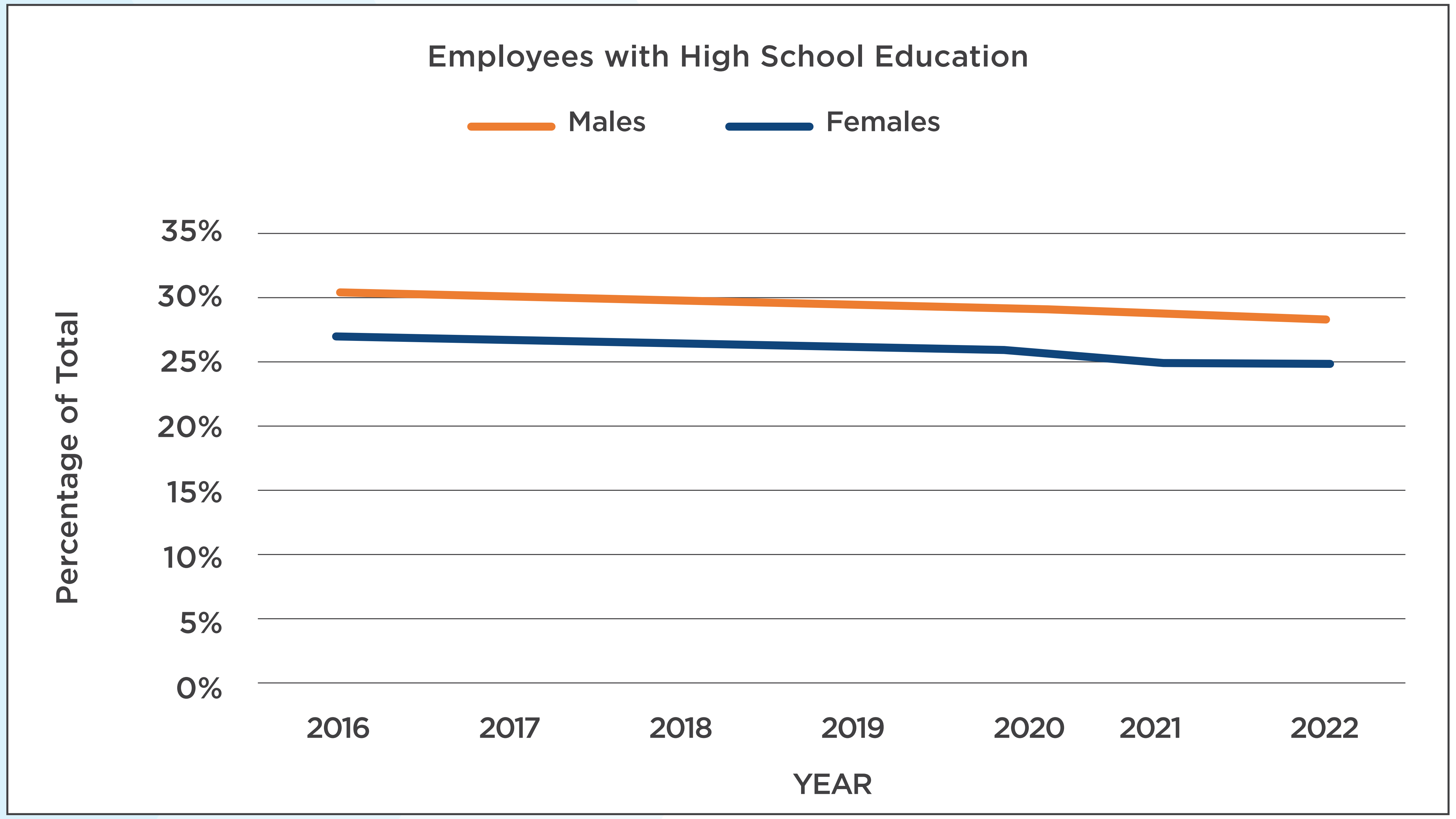
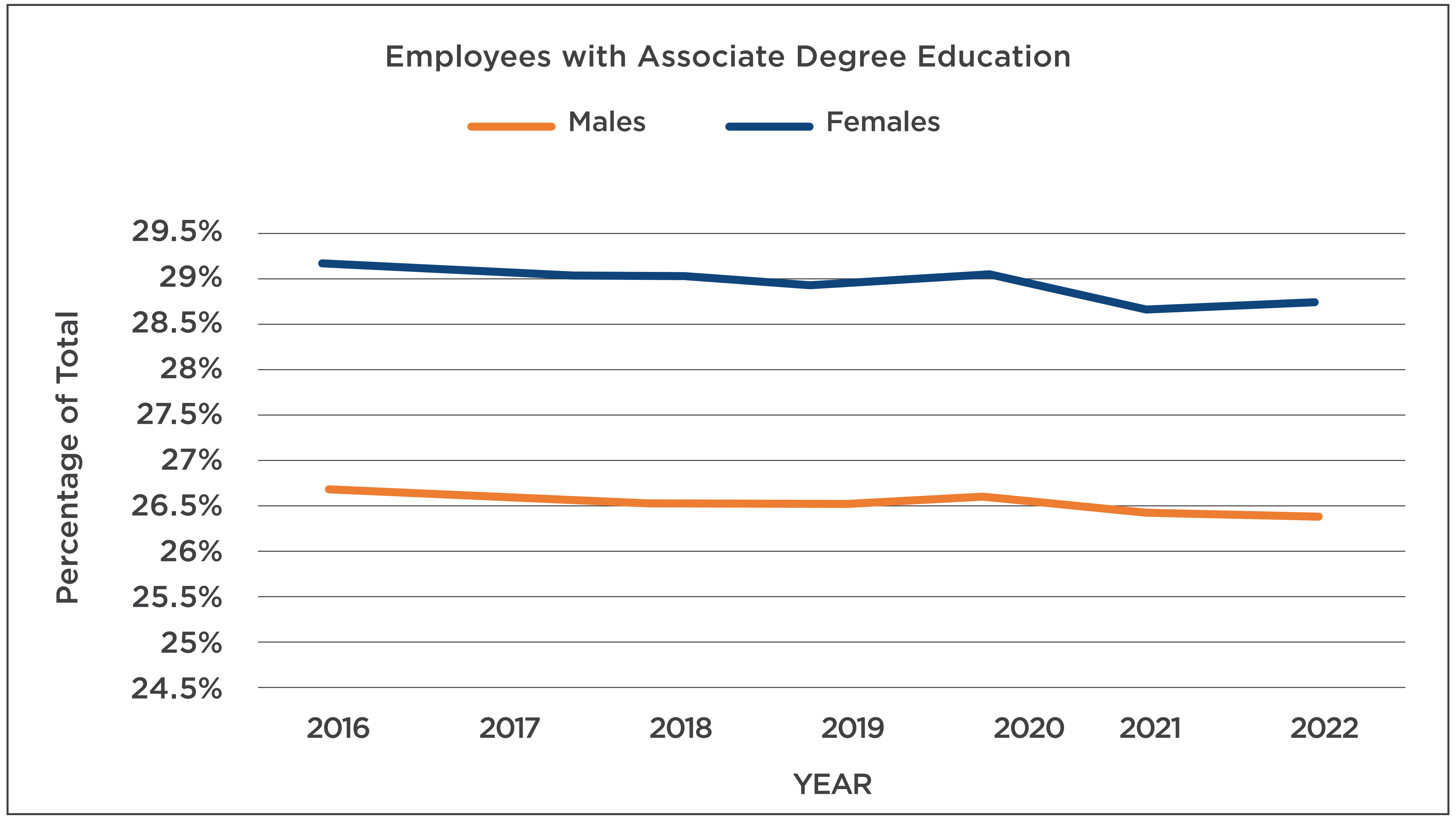


Figure 2.4: Trend of workers having an associate degree pre- and post-pandemic in the automotive industry



Workforce Challenges

In addition to the increase and decrease in employment across different education levels, the dynamics of gender can also be observed in employment across these education levels. It is evident that more females with higher degrees (Associate or Bachelor) are engaged in automotive manufacturing than males with the same education. More males with high school education are involved in auto manufacturing than females with the same education level.

Prior to the pandemic, the automotive industry was already facing challenges related to an aging workforce and a shortage of skilled workers. Many companies were investing in training and development programs to help bridge the skills gap and attract new workers to the industry. However, the pandemic has accelerated some of these trends and created new challenges for the industry. Many workers in the automotive industry were laid off or furloughed during the pandemic, which may have led some to retire early or leave the industry altogether. At the same time, some companies may have slowed down their hiring efforts or shifted their focus to automation and digitalization, which could impact the number of workers joining the industry. However, the industry has revived after 2021, with the number of employees higher than before the COVID-19 pandemic.

At the same time, the automotive industry is also experiencing an aging workforce, with many experienced workers approaching retirement age. As these workers retire, they take their knowledge and expertise with them, creating challenges for companies in terms of training new workers and maintaining production levels. However, due to the pandemic, many of retirement-aged workers that would have retired have not yet done so due to the macroeconomic conditions in the U.S.

Automation

Industrial robots are multipurpose machines that can perform a variety of tasks, such as welding, painting, and packaging. The use of industrial robots in the United States has a negative impact on employment and wages, according to a 2020 study from the MIT Sloan School of Management. For every robot added per 1,000 workers, wages decrease by 0.4%, and the employment-to-population ratio declines by 0.2 percentage points, resulting in a loss of around 400,000 jobs to date.

The displacement effect occurs when robots or other forms of automation replace tasks formerly performed by workers, leading to a decline in employment and wages. The automotive industry employs the largest number of industrial robots, accounting for 38% of all robots employed (about 7.5 robots per thousand workers).

Both men and women are negatively affected by the adoption of robots, but men are impacted more significantly in manufacturing jobs, while women are more affected in non-manufacturing jobs. Furthermore, all education levels are impacted by the use of robots, but those without a college degree are affected more than those with a college degree or higher. The study also found that the adoption of robots does not have a positive impact on workers with advanced degrees, suggesting that industrial robots are not directly complementing high-skill workers.

The researchers estimate that there will be 5.25 more robots per thousand workers in the U.S. between 2015 and 2025. As a result, there will be a one percentage point lower employment-to-population ratio and a 2% lower wage growth during this period.[21]

Despite the negative effects of automation through robots, there are many positive impacts too. The introduction of robots and improvements in technology have made tasks easier, increased productivity, and increased profitability. Therefore, it is important to weigh the negative and positive impacts of automation on industries, especially the automotive industry.

The effect of automation can be quantified through productivity indices created by the U.S. BLS[21]. The four main topics pertaining to automation impact are defined as

- Capital input

  The contribution to production from capital assets. Capital assets are the productive tools (equipment, structures, inventories, land, intellectual property, etc.) that can be reused in future time periods after they are purchased.

[21] https://mitsloan.mit.edu/ideas-made-to-matter/a-new-study-measures-actual-impact-robots-jobs-its-significant

[21]Bureau of Labor Statistics, Office of Productivity and Technology

- Capital productivity

  The efficiency at which capital input is used to produce output of goods and services.

- Labor productivity

  The efficiency with which goods and services are produced via labor hours; often referred to as output per hour.

- Total factor productivity

  The efficiency at which combined inputs are used to produce output of goods and services.

The relationship between labor productivity, capital input, capital productivity, and total factor productivity can be used to quantify the effect of automation in the automotive industry. Automation can affect all these factors in different ways.

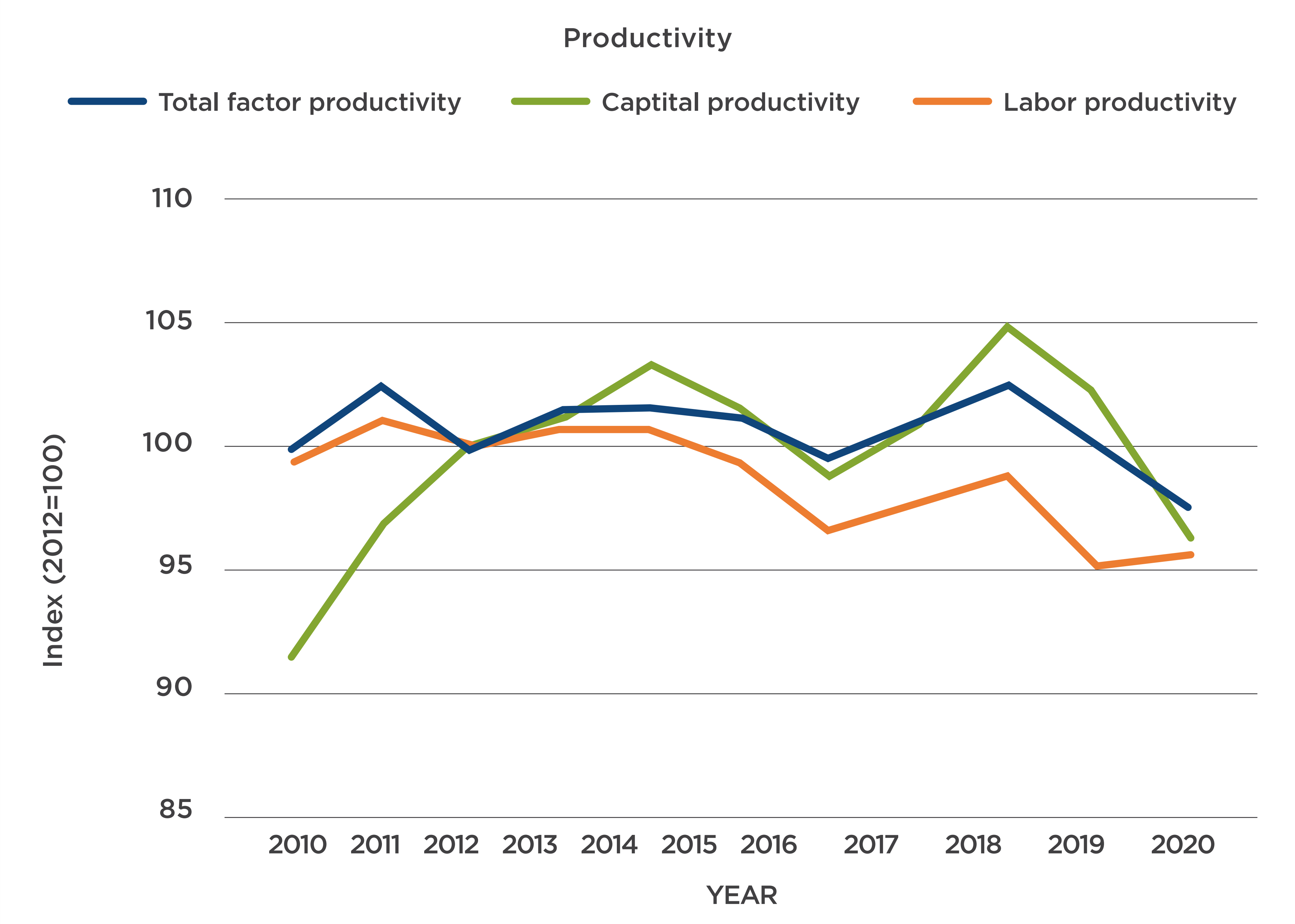
As evident from the data in Figure 2.5, the labor productivity has decreased from 99.5% in 2010 to 95.9% in 2020, with the lowest observed in 2019 at 95.4% during the decade. This decreased labor productivity can be one of the causes of the increased adoption of automation in the manufacturing industry, especially the automotive manufacturing industry.

The capital productivity has increased from 91.6% in 2010 to 96.3% in 2020, with the productivity surpassing 100% in most of the years in between to a maximum of 104.7% in 2018. The investment of capital in manufacturing has steadily yielded better returns. Since investment in automation increases the efficiency of the process, the adoption of automation could be the potential driver of this increased capital productivity.

The total factor productivity decreases from 99.99% in 2010 to 97.8% in 2020. The productivity surpassed 100% and thereby 2010 levels across most years during the decade. The decreased productivity in 2020 could be attributed, potentially, to the pandemic.

The reduction in labor, capital, and total factor productivity in 2020 could be attributed to the pandemic during the period as the levels of capital and total factor productivity has stayed above the 2010 levels until 2020.

Figure 2.5: Comparison of labor, capital, and total factor productivity in the Automotive industry from 2010-20



Workforce Transition from ICE to EV

According to the American Automakers Policy Council (AAPC), the 15 major automakers in the U.S. employ about 388,000 workers.[23] According to the Congressional Research Service (CRS), it is estimated that there are nearly 590,000 employees engaged in motor vehicle parts manufacturing in U.S., out of which nearly one-quarter (150,000) are engaged in manufacturing components for internal combustion powertrains.[24] The impact on auto manufacturing and supplier jobs due to the transition to EV is challenging to determine. While EVs require new or retooled factories, requiring thousands of employees, EVs are said to need 30 percent less labor to produce ICE counterparts. On the other hand, a recent analysis by the Economic Policy Institute (EPI) estimates that auto industry-related jobs could rise by 150,000 by 2030 given that battery electric sales reach 50% by 2030 and the vehicle market share of U.S.-assembled vehicles increases from the current 50% to 60%.[25] Furthermore, the U.S. Environmental Protection Agency (EPA) led a detailed tear-down study in April 2023 comparing two similar vehicles, a 2021 Volkswagen ID.4 (BEV) and a 2021 Volkswagen Tiguan (ICE) and estimated the number of labor hours it takes to build each of the two vehicles. Under a realistic scenario of assembly based on what OEMs are currently doing, the results suggest that the labor hours needed to assemble the BEV and ICE vehicles are very similar. This indicates that changes in employment in the auto manufacturing sectors from increasing electrification will not come from the assembling of the vehicles at the auto manufacturer, but from changing sales.[26]

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[23] *https://www.americanautomakers.org/job-creation*

[24] *https://crsreports.congress.gov/product/pdf/IF/IF11101*

[25] *https://www.epi.org/publication/ev-policy-workers/*

[26] *Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles*
https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10175J2.pdf

Demographic Analysis of ICE and EV Sectors

Increasing racial and ethnic diversity in ICE (Internal Combustion Engine) and EV (Electric Vehicle) manufacturing in the U.S. and Indiana is important for several reasons. First, a diverse workforce brings a range of perspectives and experiences to the table, which can help to identify and solve problems more effectively. When a company has employees from a variety of backgrounds, they are more likely to consider a broader range of perspectives when making decisions and developing products. Second, a more diverse workforce can help to attract and retain a wider range of customers. As the U.S. becomes increasingly diverse, companies that reflect and understand the needs of different communities will be better positioned to succeed. This is particularly relevant in the EV industry, where a diverse customer base is likely to be more interested in vehicles that align with their values and lifestyles. Third, increasing diversity in the manufacturing sector can help to reduce inequalities and improve economic outcomes for underrepresented communities. By providing job opportunities for people from diverse backgrounds, companies can help to create more inclusive and equitable communities.

In Indiana specifically, increasing diversity in the manufacturing sector can help to address longstanding disparities in employment and income. Indiana ranks among the lowest states in the U.S. for African American economic equality, with a persistent wage gap and high rates of poverty. By prioritizing diversity in its manufacturing workforce, Indiana can help to address these disparities and create a more inclusive economy.

Overall, increasing racial and ethnic diversity in ICE and EV manufacturing in the U.S. and Indiana is not just a moral imperative, but also a strategic business decision that can help companies to better serve their customers, solve problems more effectively, and promote economic growth and equity.

ICE sector trends

Gender vs. Education

Figure 2.6: Education Distribution for ICE-Related Occupations for Females 2010-2022

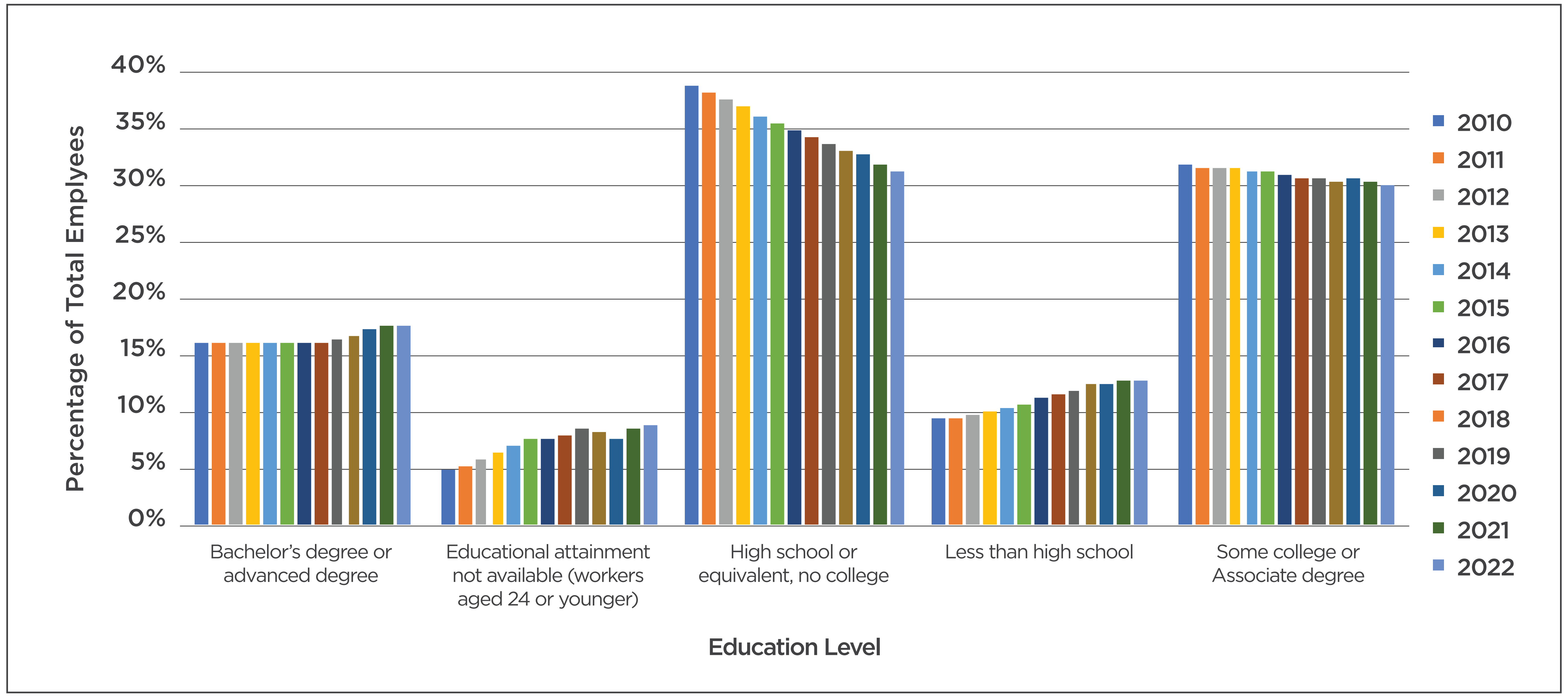
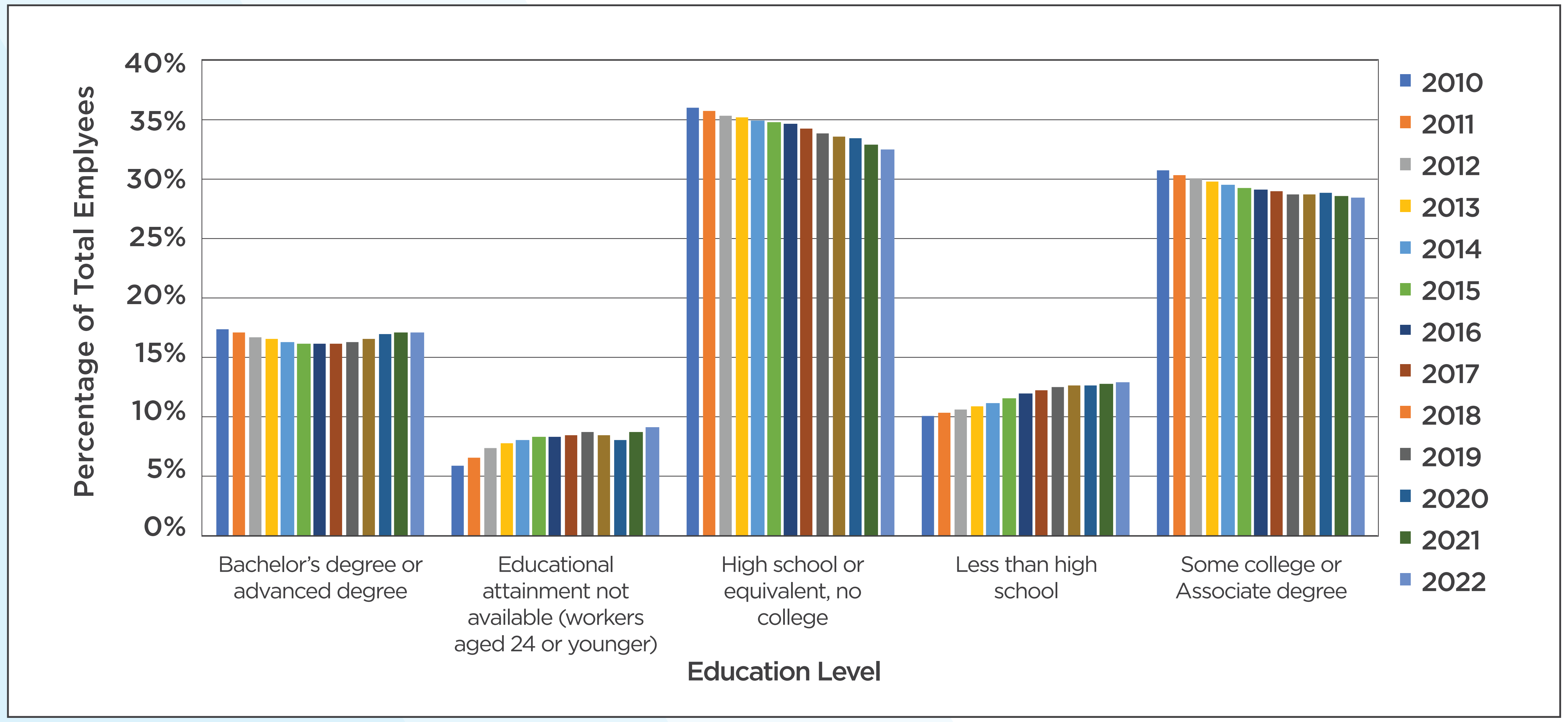


Figure 2.7: Education Distribution for ICE-Related Occupations for Males from 2010-2022



Gender vs. Age

There are several trends in the worker demographic of the automotive industry in Indiana when it comes to gender and age. Looking at the age distribution of workers in ICE-related occupations, the greatest share of the regional labor force is in the age group of 45-54 for both males and females, indicating a significant concentration of the middle-aged population. For females, this age group accounted for 23.9%, and in males 22.9% in 2022. This age group is followed by the 25-34 and 35-44 age groups.

The trends observed from 2010 to 2022 portray a different picture. The share of female workers in the 45-54 and 35-44 age groups has dropped drastically by 24.6% and 11.7% in the past decade. On the other hand, the age group of 25-34 has seen an upward trend, growing by 18.7% suggesting a positive trend in a growing young workforce. This is coupled with a sharp increase in the retirement age population of 55-64 and above 65 years by 11.8% and 53.77% respectively. In conjunction, a drastic rise is observed in the female working population in the age group of 19-24 years has seen a significant rise of 58%, indicating less educated workers wanting to join the workforce.

Figure 2.8: Age Group Distribution of ICE-Related Occupations for Females from 2010-2022

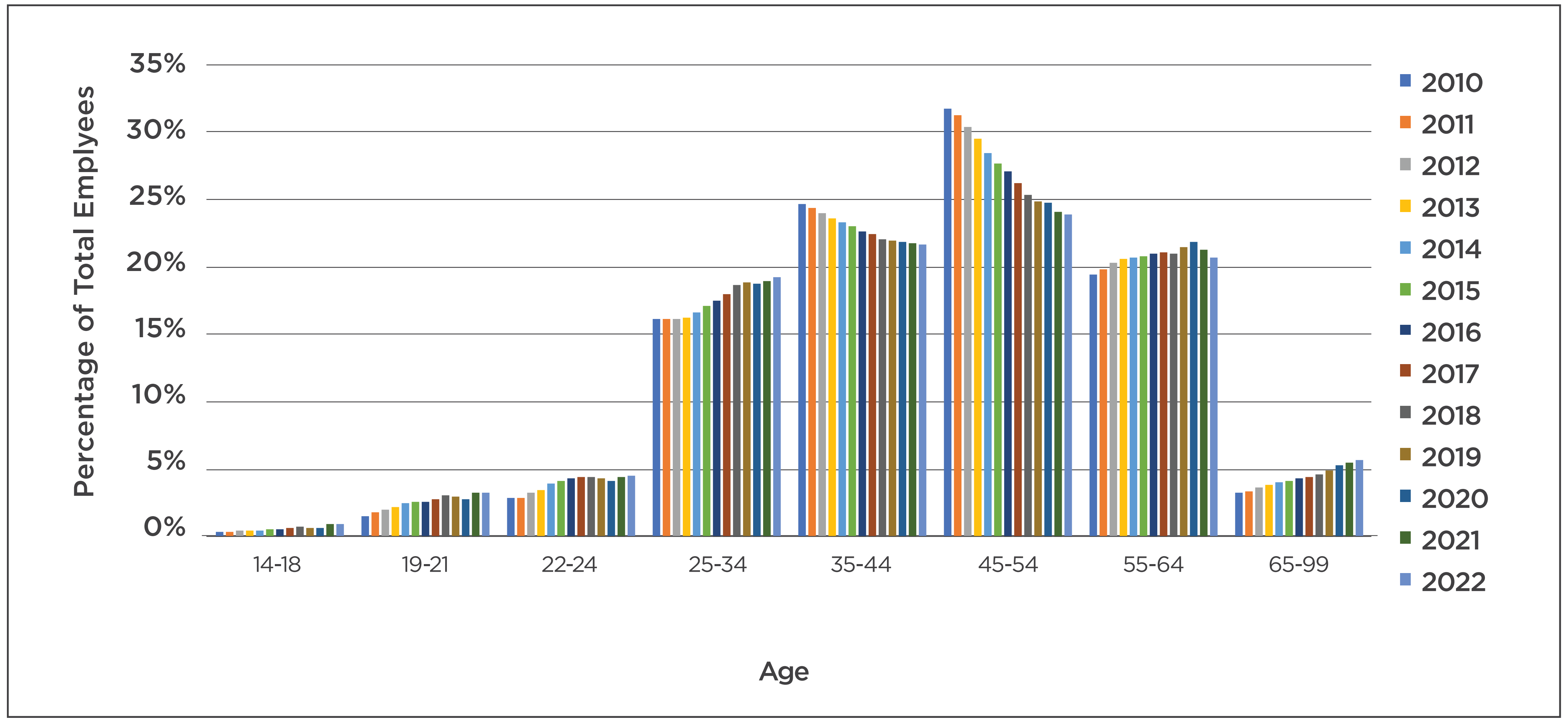
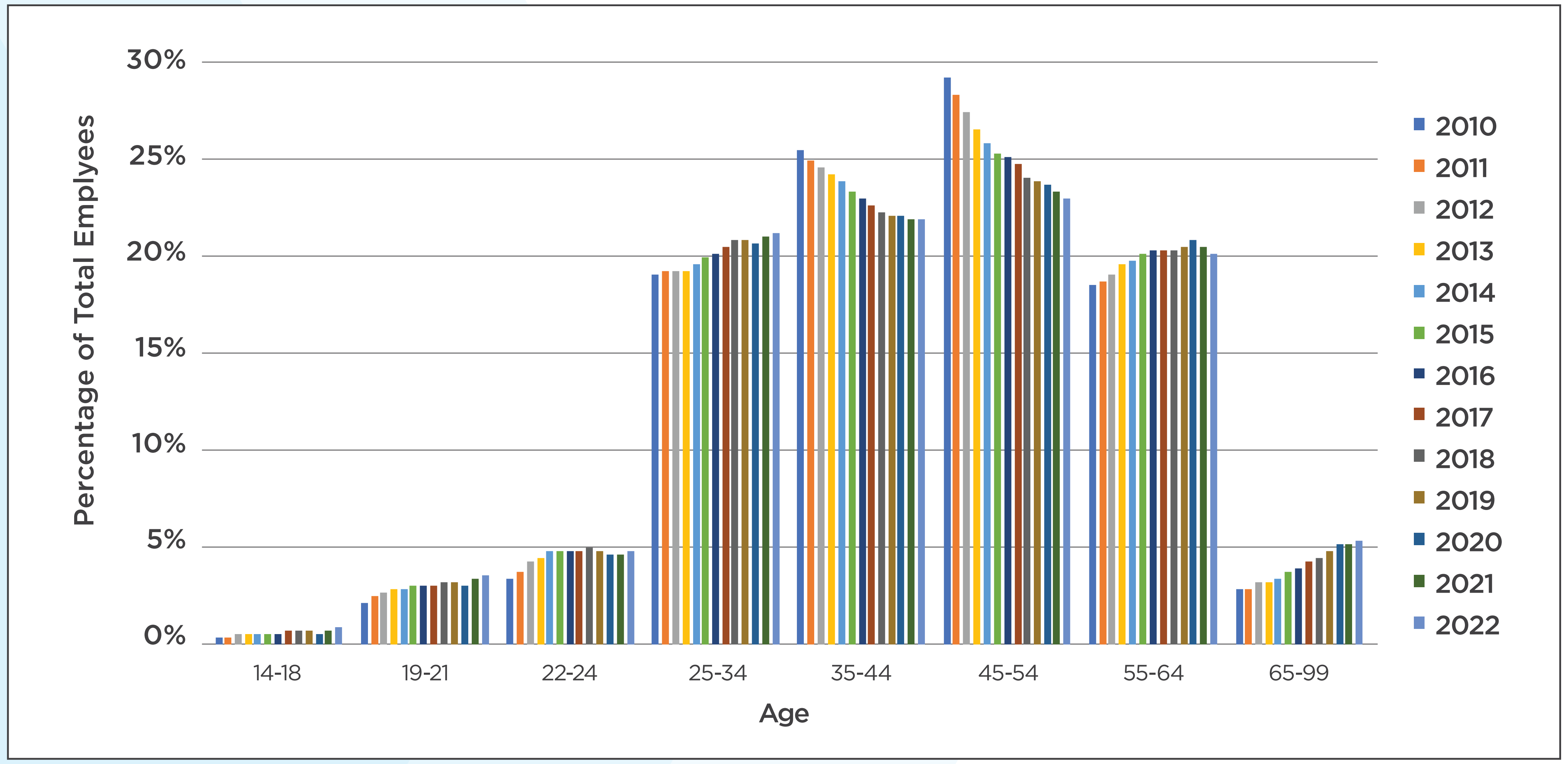


Figure 2.9: Age Group Distribution of ICE-Related Occupations for Males from 2010-2022



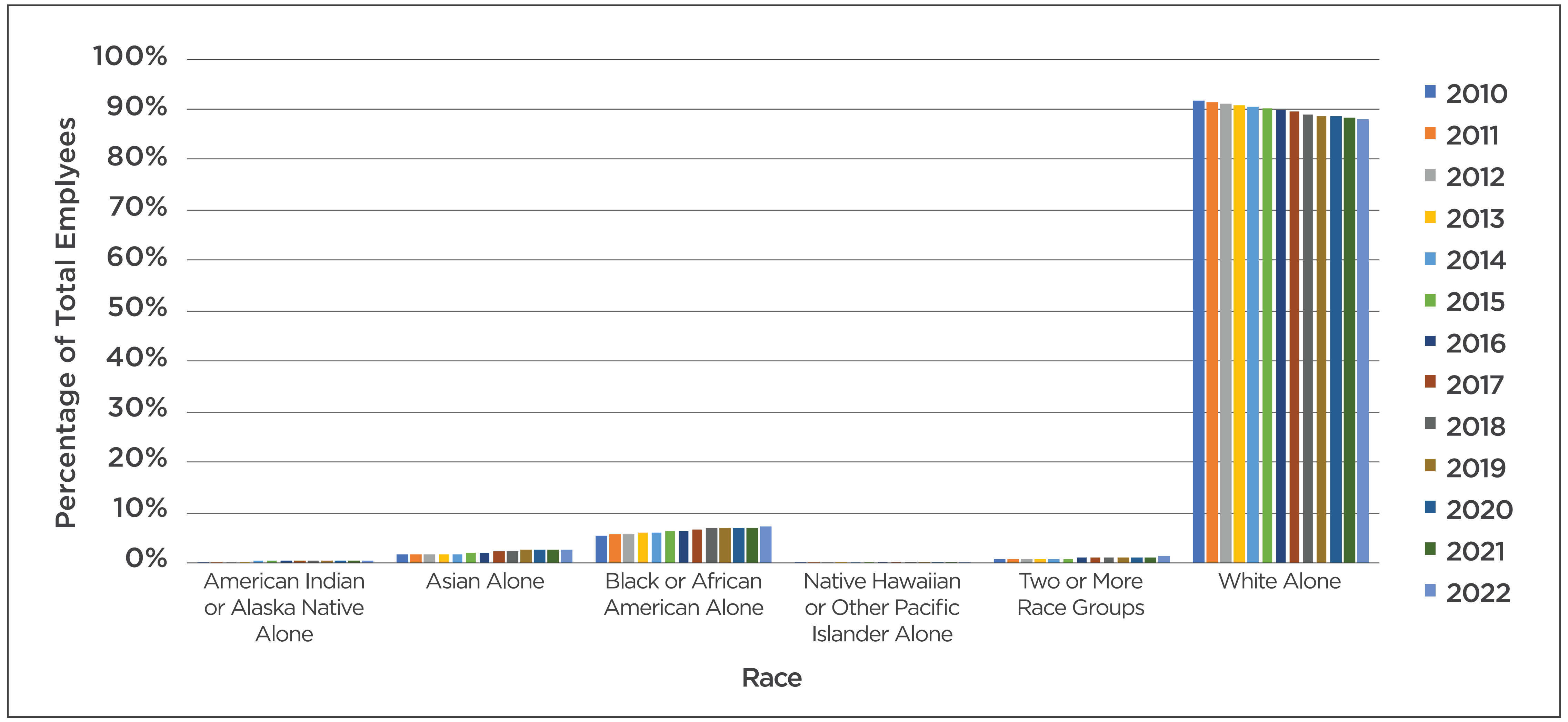
In the case of male workers in the 25-34 age group, the share has grown by 11.4% in the past decade, a smaller increase as compared to the female worker population. Nonetheless, age groups of 35-44 and 45-54 have seen a decline, their contribution dropping by 13.8% and 20.9% respectively. In accordance with the female workforce, there is a sharp increase in the retirement age population of 55-64 and above 65 years by 8.3% and 92.4% respectively.

Race

An overview of the data showed a lack of diversity in the workforce in the ICE automotive segment in Indiana. In 2022, a staggering 88.1% of the workforce was comprised of white workers alone, more than three-quarters of the total workforce. The next largest group is the Black group with an enormous gap of 81% (7.3%) from the largest group. This is followed by Asians (2.6%), mixed race (1.4%), American Indians (0.5%), and native Hawaiians (0.1%).

Although having the highest share, white workers experienced the highest drop of 3.8% in their share in the workforce over the past decade. The second largest group on the other hand witnessed a gain in their share of the workforce, a near 29.5% increase. Asians followed suit, with a 55.2% increase in their share respectively. The largest growth was observed in the mixed-race group with an 83.4% increase in their share. The contribution of American Indians and native Hawaiians also rose significantly, with a 47% and 70% increase respectively.

Figure 2.10: Race Distribution of ICE-Related Occupations from 2010-2022



EV sector trends

Gender vs. Education

The figure below represents the trend of male workers in the EV sector by education. It is evident that the percentage of workers with high school or equivalent education is the highest. Despite contributing the highest to the male workforce, this category has seen a decline from 2010 to 2022. A positive trend is observed for workers who have less than a high school education and those with bachelor's or advanced degrees. This could be attributed to the increased production of EVs and the adoption of EVs by major auto companies. The increase in bachelor or advanced degree workers can be attributed to the need for improved technology in the industry sector. The labor force with associate or some college degree has declined from 2010 levels and this could be explained by the labor force advancing their education due to the need for advanced skillsets and the increasing opportunity in the sector.

The figure below represents the trend of female workers in the EV sector by education. Similar trends are observed for the female workforce as for the male employees, with a decline in the percentage of workers with high school or equivalent education and college or associate degree education while an increase in workers with less than high school education and bachelor or advanced degree education. However, the percentage of female workers with bachelor's or advanced degrees has increased in 2022 compared to 2010, while the male workforce saw a decline in the middle of the decade but had a strong presence in 2010 and now again in 2022. Compared to the male workforce, the decline in female workers with high school or equivalent education is steeper, while the decline in female workers with college or associate degrees is not as steep as that of male workers.

Figure 2.11: Education Distribution for EV Related Occupations for Males from 2010-2022

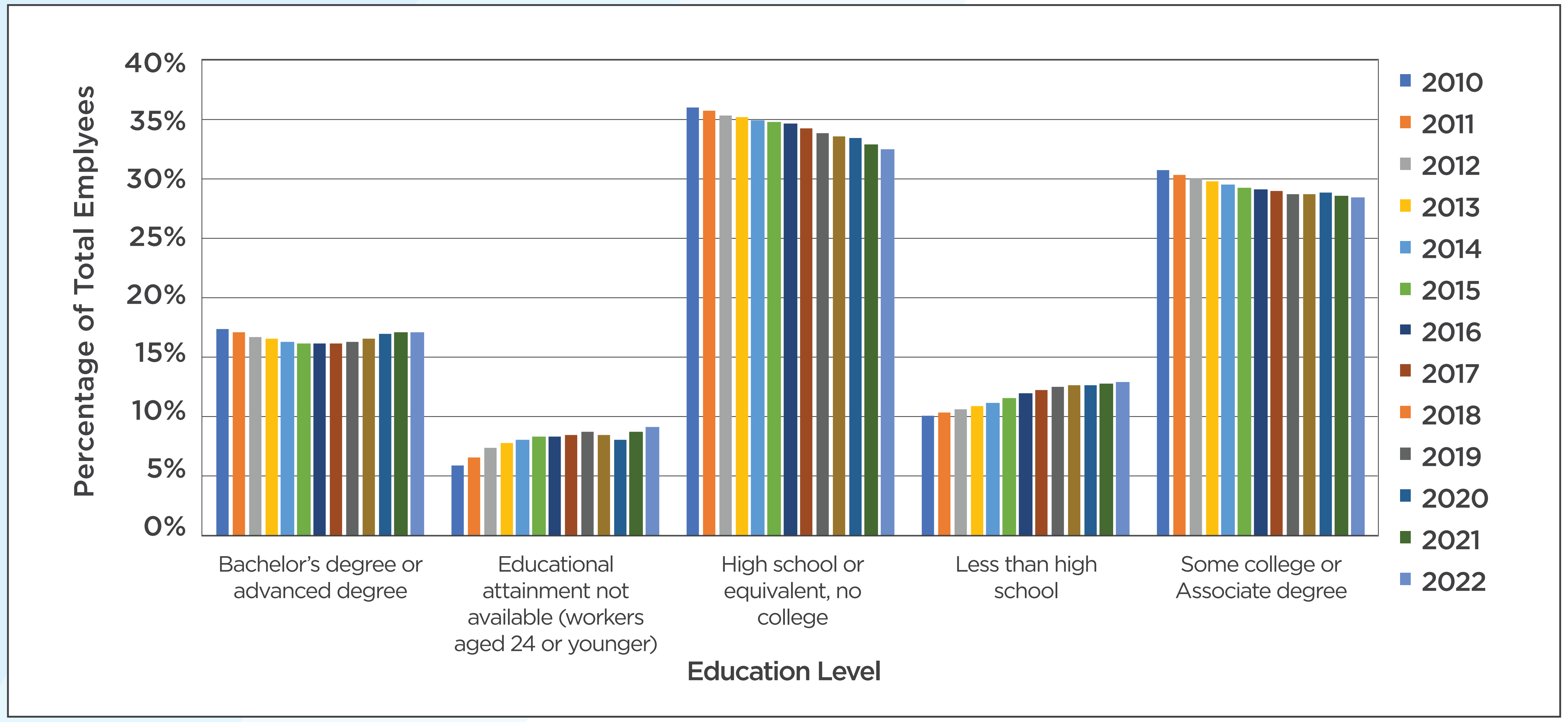
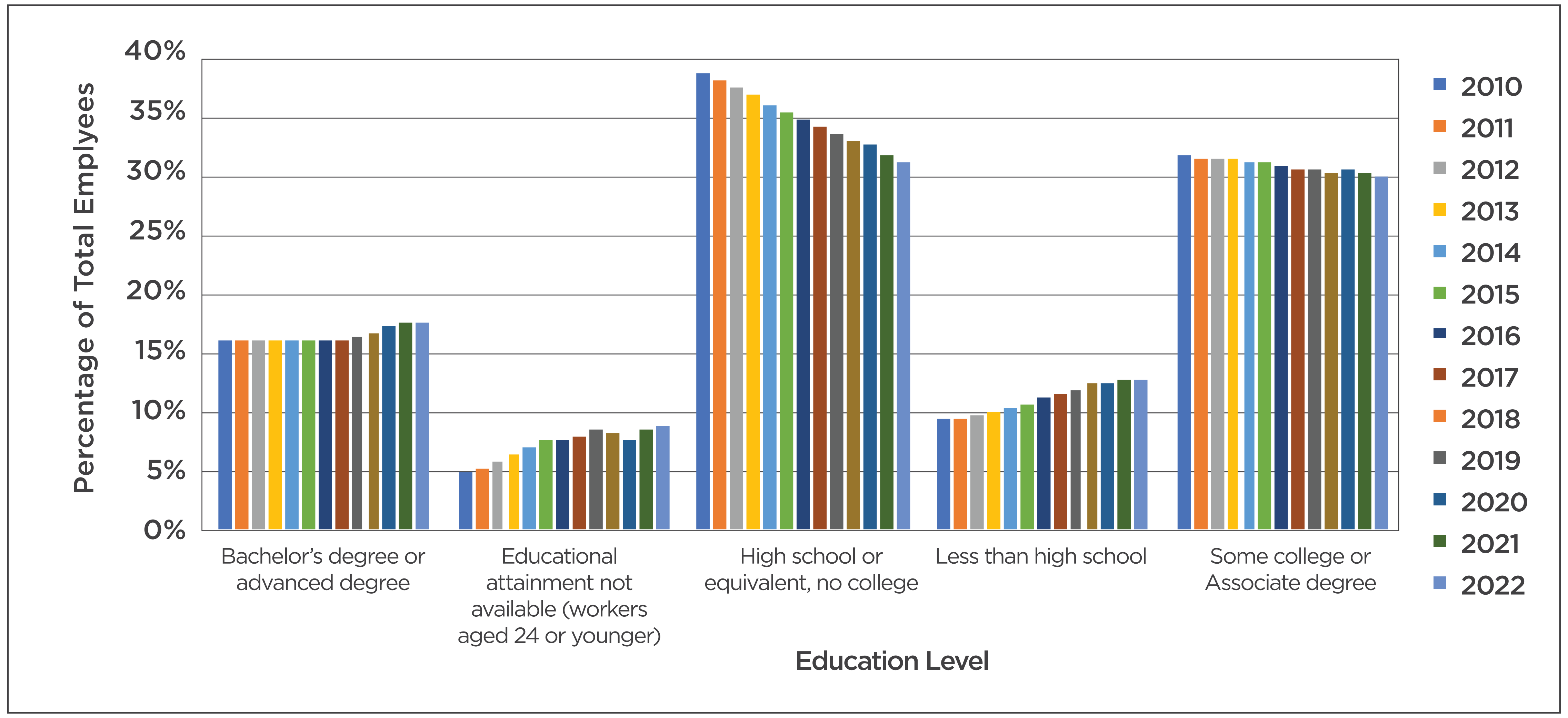


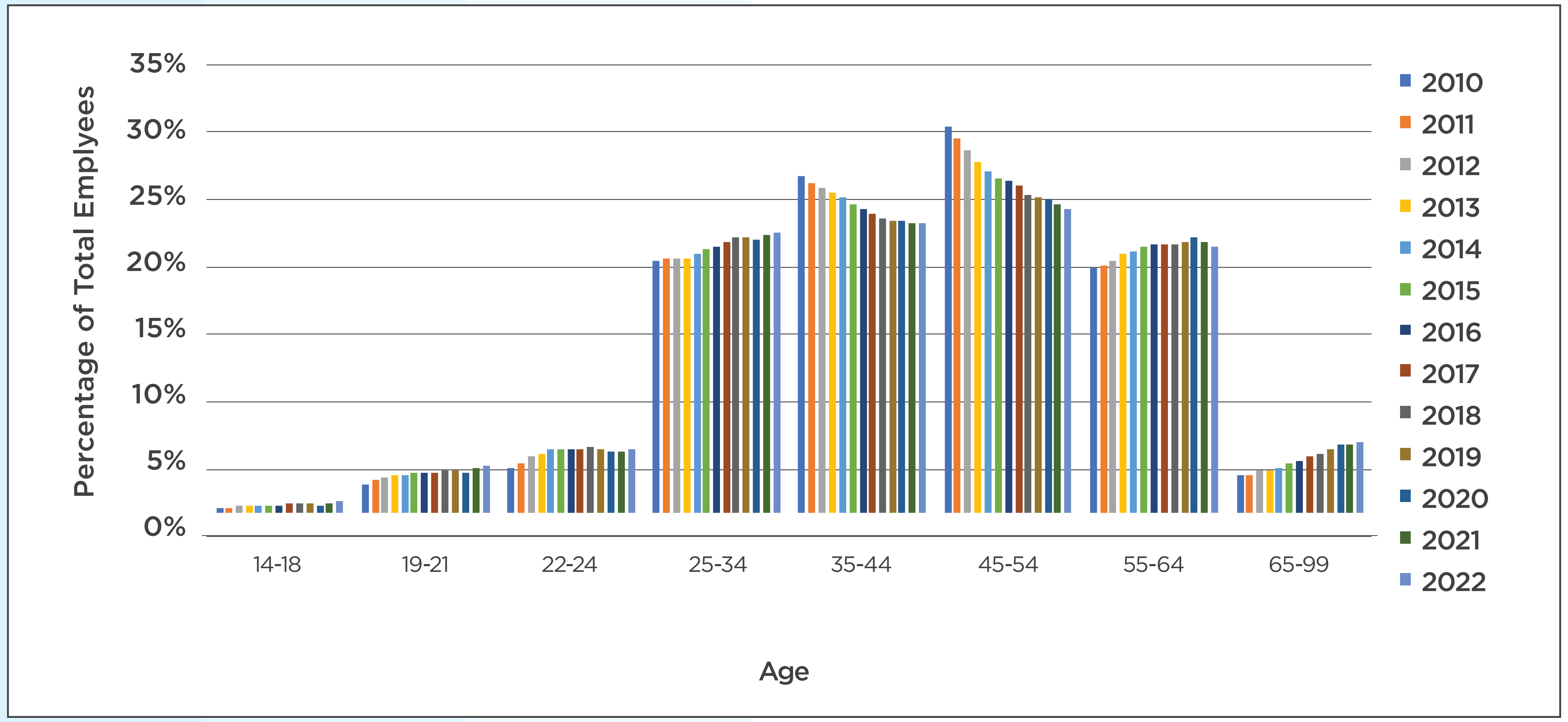
Figure 2.12: Education Distribution for EV Related Occupations for Females from 2010-2022



Gender vs. Age

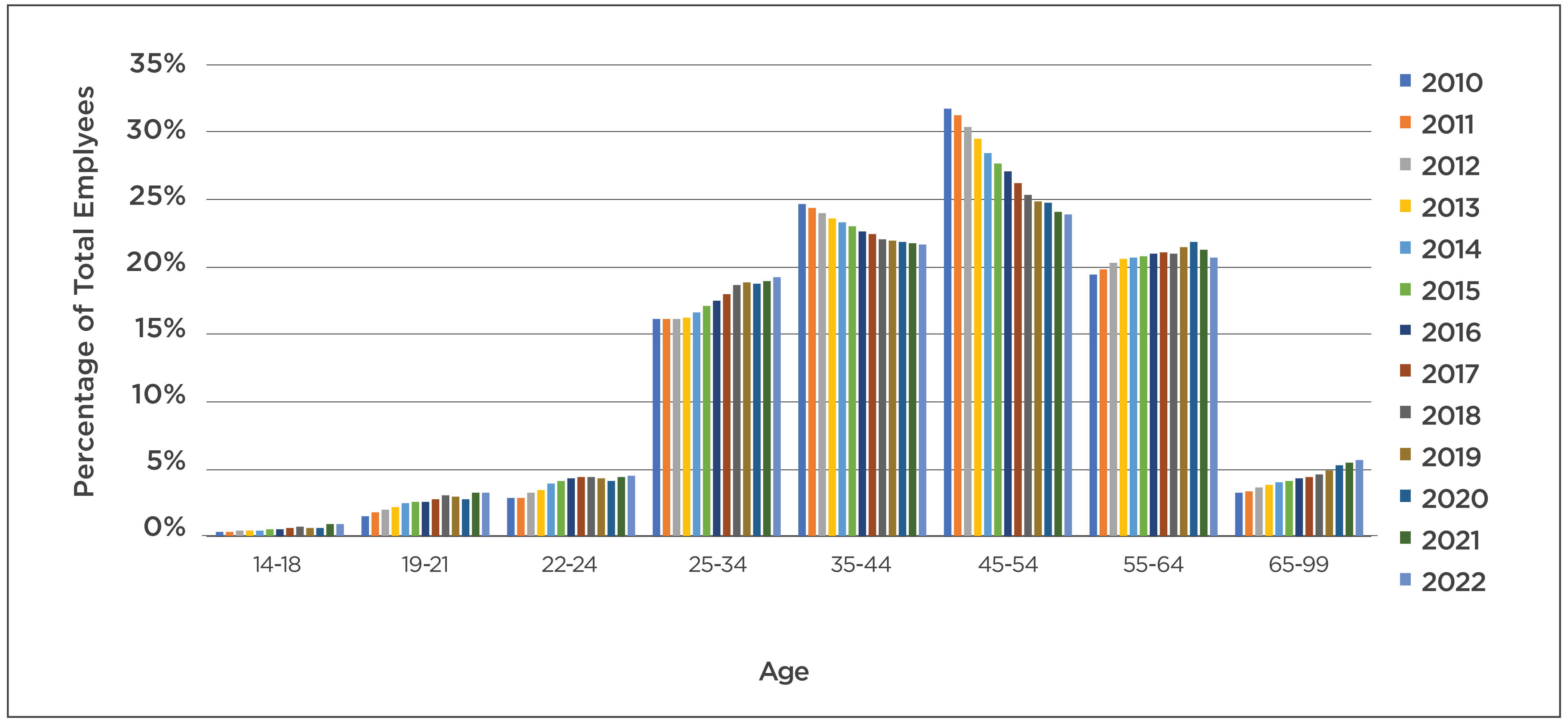
The figure below represents the age data for males in the EV sector from 2010 to 2022. As seen, there is a steep decline in male workers for the age groups 35-44 and 45-54 while there is a positive trend across all other age groups, especially 14-18 and 65-99. It is evident that the positive trend plateaus for the 19-21, 22-24, 25-34, and 55-64 age groups.

Figure 2.13: Age Group Distribution of EV-Related Occupations for Males from 2010-2022



The figure below represents the age data for female workers in the EV sector from 2010 to 2022. A steep decline is observed for female workers in the age groups 35-44 and 45-54, while a positive trend is observed across all other age groups, especially 65-99. The positive trends seem to plateau for age groups 14-18, 19-21, 22-24, 25-34, and 55-64.

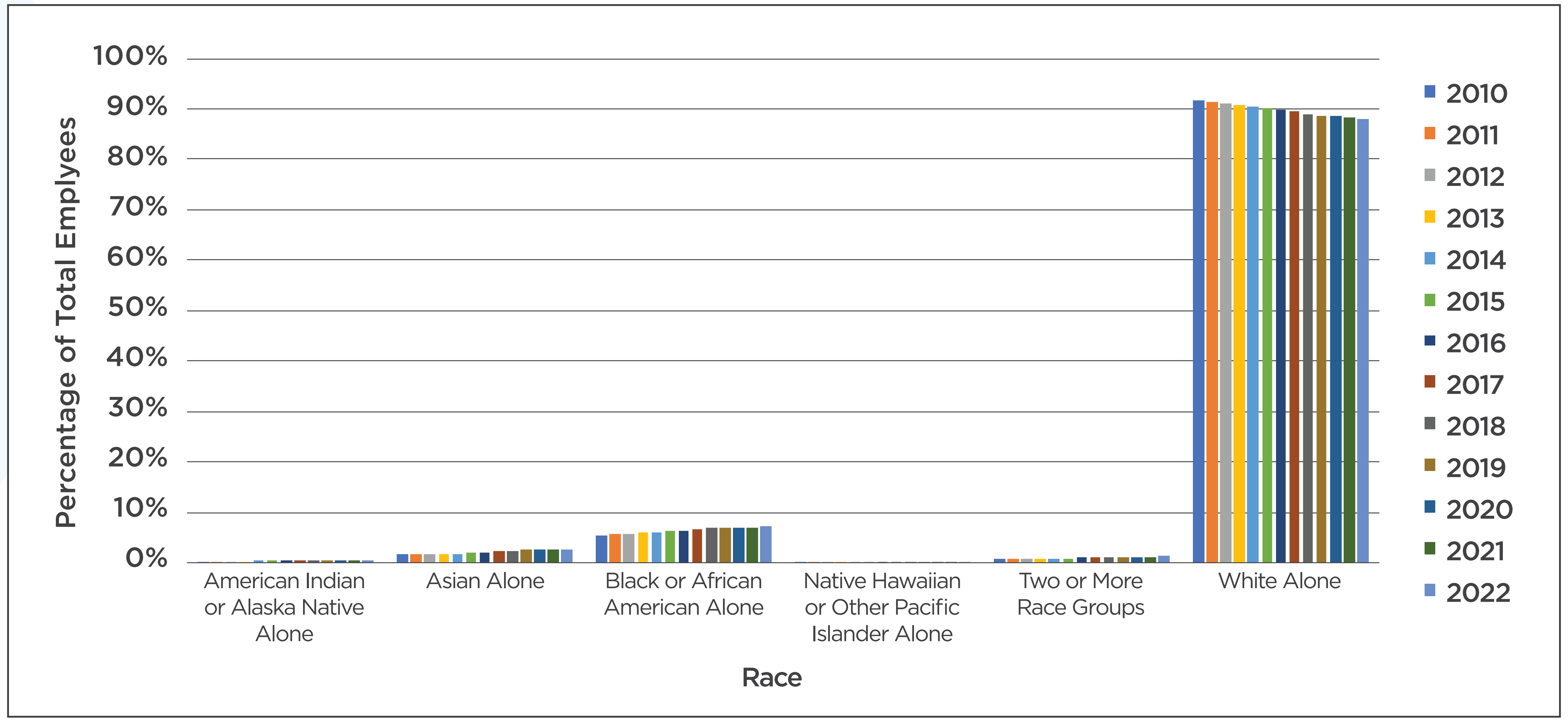
Figure 2.14: Age Group Distribution of EV-Related Occupations for Females from 2010-2022



Race

As in the case of ICE vehicle manufacturing, the lack of diversity is evident. As per the figure below, in 2022, a staggering 88.0% of the workforce was comprised of white workers alone, more than 3 quarters of the total workforce. The next largest group is the Black or African American group with an enormous gap of 81% (7.3%) from the largest group. This is followed by Asians (2.6%), mixed race (1.4%), American Indians (0.5%), and native Hawaiians (0.1%). These trends are consistent with the ICE manufacturing sector, indicating a need for improvement in the racial diversity and upliftment of other race groups for EV manufacturing.

Figure 2.15: Race Distribution of EV-Related Occupations from 2010-2022



Funding Opportunities

Funding Opportunities are Advancing

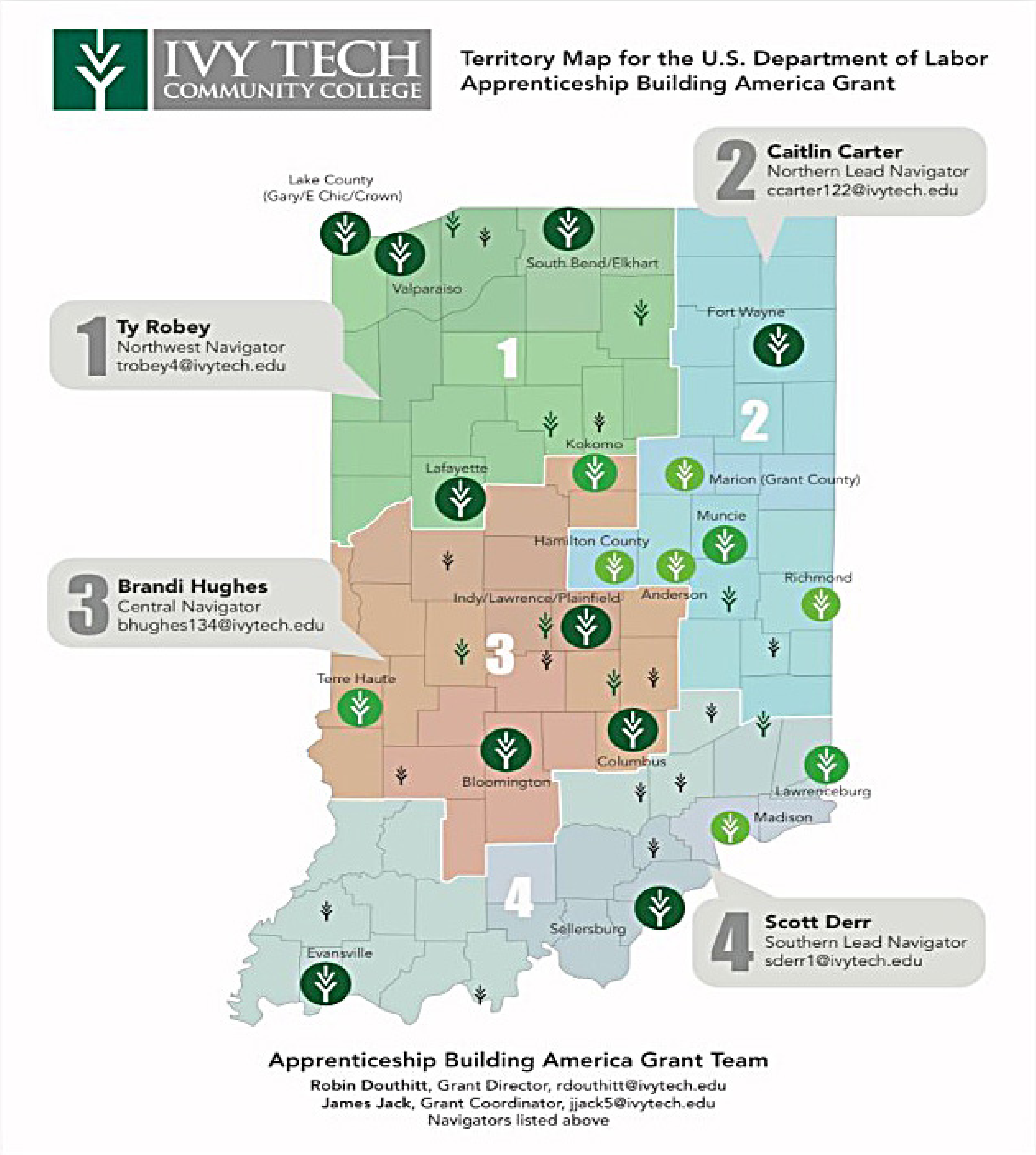
To accelerate the adoption of EVs and support the burgeoning electric vehicle production industry, both federal and state governments have recognized the importance of incentivizing and funding initiatives in this sector. This section provides an overview of the diverse funding opportunities available at both federal and state levels, aiming to bolster the growth and innovation within the electric vehicle production ecosystem. From research and development grants to tax incentives and infrastructure investments, these funding mechanisms play a crucial role in driving the sustainable future of transportation while fostering economic growth and job creation in the process. In this comprehensive inventory, we will explore the various federal and state funding opportunities that are propelling the electric vehicle production sector forward, empowering manufacturers and entrepreneurs to shape the future of mobility.

As was previously discussed in the beginning of this document, this market is ever changing. this is a snapshot of time. Thus, this is a snapshot of opportunities in time. Below you will find a table of funding opportunities to assist in the transition.

Conexus has secured funding for Manufacturing Readiness Grants (MRG) to assist manufacturers making innovative capital investments in smart manufacturing. Companies should have operations in Indiana and be making the investments in their operations in the state. The investment should leverage advanced technologies in the Industrial Internet of Things (IIoT) and beyond. https://www.conexusindiana.com/drive-industry-success/manufacturing-readiness-grants/

Ivy Tech Community College is working with the US Department of Labor (DOL) and employers to create new registered apprenticeship programs in Indiana. The Apprenticeship Building America, or ABA grant, is offering a one-time incentive to employers to increase efforts to develop new or expand existing registered apprenticeship programs.

Registered Apprenticeship has a proven track record of producing strong results for both employers and workers. New apprenticeship programs are needed in manufacturing and electric vehicle occupations which are high-growth and emerging industries. Reach out to an Apprenticeship Navigator to learn more about registered apprenticeships and the opportunities Ivy Tech has to offer through the DOL Apprenticeship Building America (ABA) grant.



Major Federal EV Subsidy for Automakers & Battery Manufacturers

Federal | Indiana

Federal			Website
45X Advanced Manufacturing Production Tax Credit (PTC)	Program	• Per-unit tax credit for production of battery cells & modules in U.S. • Runs from 2023 to 2032, with the value of credits phasing down starting in 2030. • Also provides 10% credit for production of key battery inputs – such as critical minerals and electrode active materials.	IRA Update: Section 45X & Section 48C | Mintz
	Value	• $35/kwh for battery cells production and $10/kwh for battery module. • It represents around one-third of current battery costs. Will be an even greater share of costs as battery prices decline. • BEV battery capacity is typically around 50-200 kWh per vehicle. For a BEV with 100 kwh battery, the PTC is worth $4,500 per vehicle. • Major battery cell plants are typically 30 to 40 GWH of annual capacity. • If a plant produces 30 GWH of battery cells annually, it can generate over $1 billion in battery cell PTC credits annually. • J.P. Morgan estimated 45X battery cell & module PTC could generate over $150 billion in tax credits through 2032 for battery makers and JV partners.[1] • Ford CEO Jim Farley: "From '23 to '26, we estimate a combined available tax credit for Ford and our battery partners could total more than $7 billion with large step-up in annual credits in '27 as our JV battery plants ramp up to full production."[2] • GM CFO Paul Jacobson: "We expect that clean energy tax credits will be a material tailwind...For 2023, we anticipate at least $300 million in EBIT-adjusted benefit and expect this tailwind to increase significantly over the next few years as our cell production ramps"[3]	
	Notable Conditions	• Production must occur in the U.S.	
	Beneficiaries	• Battery manufacturers and OEM partners. Largest battery manufacturers are LG, SK, Samsung, Panasonic, Envision & CATL. • Most major auto OEMs are planning battery production in U.S. with major battery makers. • Big Three JV plants will be major beneficiaries: GM-LG-Ultium (3), GM-Samsung (1), Ford-SK (2), Ford-CATL (1), and Stellantis-Samsung (1)	

30D Consumer Tax Credit	Program	• Revised under IRA, 30D provides consumer tax credit of up to $7,500 for the purchase of BEV or PHEV that meets content and price cap requirements. • IRA also lifted the manufacturer sales cap on accessing the credit, which GM and Tesla has already hit.	[Credits for New Electric Vehicles Purchased in 2022 or Before | Internal Revenue Service (irs.gov)]
	Value	• Consumers can receive $3,750 or $7,500 in tax credits for qualifying BEVs or PHEVs. • Precise value to OEMs is not publicly available. Manufacturers can use credits to adjust pricing, in turn improving sales or profitability.	
	Notable Conditions	• Final assembly in North America required to qualify for credit. • Credit of $3,750 if vehicle meets critical mineral content requirements (North America or Free Trade Agreement countries) • Credit of $3,750 if vehicle meeting battery component content requirements (North America) • Previously owned clean vehicles (also known as “used vehicles”) are eligible for a tax credit of up to $4,000 • The minimum battery capacity must be 7 kilowatt hours • Starting in 2024-2025, vehicle with battery & mineral content from “Foreign Entities of Concern” will be disqualified. Details remain TBD. • Vehicle price cap: $55k for cars, $80k for pickup/SUV/Van • Income Cap: $150k individual, $300k for couples	
	Beneficiaries	• Any OEM producing EVs in North America. For now, biggest beneficiaries are GM, Ford, Stellantis, and Tesla. • Big Three expect most of their EVs to qualify for some or all of the credit. • Major battery makers with North American footprint will see increased demand from OEM customers/partners. • Most major OEMs plan to build at least some EVs in North America and eventually qualify for credit.	

45W Commercial Vehicle Tax Credit ("Lease Loophole")	Program	• For heavy duty vehicles (over 14,000 lbs.), program provides credit up to $40,000 for purchase of EV. • For light-duty vehicles, credits provide up to $7,500 for "commercial" light duty vehicles • Definition of "commercial" includes any vehicle that can be claimed as a depreciating asset for tax purposes. This includes vehicle leased to consumers.	https://www.irs.gov/credits-deductions/commercial-clean-vehicle-credit
	Value	• For light-duty, consumers can receive up to $7,500 discount on leased or commercial EVs • Precise value to OEMs is not publicly available. Credit will contribute to EV profitability – either by increasing sales or profitability. • Credit value is based on incremental cost difference of EV vs ICE. Over time, the value of credit may decline, but it is currently set at full $7,500.	
	Notable Conditions	• Unlike 30D, 45W commercial vehicle credit does not require North American assembly, regional battery or mineral content, price caps, or income caps. • "Lease Loophole": Treasury has determined that any leased vehicle is considered "commercial" for tax purposes. Leases create loophole for OEMs to get around 30D requirements. Leased vehicles are eligible for full $7,500 even if they are used for personal use by individual consumers, imported from outside North America, have no regional battery content, exceed the price caps, or are purchased by wealthy consumers.	
	Beneficiaries	• All OEMs & heavy truck OEMs, but particularly OEMs that import EVs, source batteries from Asia or Europe, or sell luxury brands to wealthy consumers	

Advanced Technology Vehicle Manufacturing (ATVM) Loan Program	Program	• Loan from the government, administered by the Dept of Energy, for investments in manufacturing of fuel-efficient vehicles & components. • Program now has around $55 billion in total loan authority.[4] • ATVM was dormant for years. Frequent target for cuts, UAW has been a supporter of program for its potential to subsidize domestic auto investment.	Advanced Technology Vehicles Manufacturing Loan Program | Department of Energy
	Value	• ATVM significantly reduces borrowing costs for projects versus market rates.[5] • Precise value of borrowing savings is unknown.	
	Notable Conditions	• Investment must be in the U.S.	
	Beneficiaries	• Ultium Cells (GM-LG) received a $2.5 billion loan for investments in Lordstown (UAW), Spring Hill, and Lansing cell plants and is the largest current loan.[6] • Past recipients in 2009-2010 were Ford ($5.9 billion), Tesla ($465 million), and Nissan ($1.45 billion). All three loans were repaid.[7]	
Domestic Manufacturing Conversion Grant	Program	• $2 billion grant program, administered by DOE, for production of EVs, PHEVs, hybrids, and FCEVs, including components. • Old program, funded for first time through IRA.	Domestic Manufacturing Conversion Grants | Department of Energy
	Value	• Program has $2 billion in total. Award sizes unknown.	
	Notable Conditions	• Production in U.S. • Priority given to retooling existing manufacturing facilities that have recently ceased or will cease operation. • 50% cost share. • UAW called for labor standards in recent DOE RFI on grant program.	
	Beneficiaries	• TBD. Major OEMs & suppliers, including potentially Big Three.	

48C Advanced Energy Project Credit	Program	• $10 billion in investment tax credits for "advanced energy projects", including manufacturing of EV and components. • 48C originally created in 2009. IRA provides new round of funding.	Qualifying Advanced Energy Project Credit (48C) Program | Department of Energy
	Value	• Production in U.S. • TBD. Award sizes unknown. Credits can be up to 30% of value of investment.[11] • The 1st round of awards is expected to be worth around $4 billion.[12]	
	Notable Conditions	• At least $4 billion of credits must go to "energy communities" (census tracts with fossil fuel production or coal mine closures) • Bonuses for prevailing wage & apprenticeships in building trades • Facility cannot get both 48C investment credit and 45X production credit.[13]	
	Beneficiaries	• TBD. Could include OEMs or battery makers – likely for components not covered by 45X PTC (ex: cells, modules, electrode materials, or minerals). • Notice for 1st round of funding expected on May 31, 2023.[14] • In prior rounds of 48C tax credits in 2013, Ford received $30 million to re-tool Michigan Assembly for hybrids and GM received $20 million to re-tool Detroit-Hamtramck for the Chevy Volt and Cadillac ELR PHEVs.[15]	
Bipartisan Infrastructure Bill Battery Supply Chain Grants	Program	• $6 billion in grants for domestic production in battery supply chain. • Dept of Energy announced $2.8 billion in awards to 21 companies in Oct 2022.[16]	Federal Funding Programs | US Department of Transportation
	Value	• 1st Round: $50 - $300 million grants per project.	
	Notable Conditions	• Production in U.S. • Application included questions about labor organization partnership and "good-paying jobs with a free and fair choice to join or form a union". However, impact is unclear, few recipients of first funding round had agreements with labor unions.	
	Beneficiaries	• Microvast, in technology partnership with GM, to receive $200 million to build a battery separator plant.[17] Originally planned for Clarksville, TN, the plant is now planned for Hopkinsville, KY.[18] The "bulk" of the private investment in the plant is expected to come from Microvast, not GM.[19]	

Domestic Manufacturing Conversion Grant Program	Program	• Prioritizes projects maintaining collective bargaining agreements and high-wage hourly production workforces. It offers cost-shared grants to promote the domestic production of various electrified vehicles, including hybrid, plug-in electric hybrid, plug-in electric drive, and hydrogen fuel cell electric vehicles. The program aims to expand the manufacturing of light, medium, and heavy-duty electrified vehicles and components, supporting vehicle assembly, component assembly, and related part manufacturing facilities.	Biden-Harris Administration Announces $15.5 Billion to Support a Strong and Just Transition to Electric Vehicles, Retooling Existing Plants, and Rehiring Existing Workers | Department of Energy CLEAN ENERGY INFRASTRUCTURE FUNDING OPPORTUNITY ANNOUNCEMENTS
	Value	• $2 billion	
	Notable Conditions	• Concept papers are due by October 2, 2023, with full applications due by December 7, 2023.	
	Beneficiaries	• Projects selected for this funding must also contribute to the President's Justice40 Initiative, which aims to advance diversity, equity, inclusion, and accessibility in America's workforce • Preference will also be given to projects that commit to pay high wages for production workers and maintain collective bargaining agreements.	
Advanced Technology Vehicles Manufacturing Loan Program	Program	• The DOE will evaluate the anticipated economic impacts of converting or directly replacing an existing factory with high-quality jobs, considering factors such as contributions to the local economy, employment history, projected employment, and the duration of its existence.	Biden-Harris Administration Announces $15.5 Billion to Support a Strong and Just Transition to Electric Vehicles, Retooling Existing Plants, and Rehiring Existing Workers | Department of Energy DOE Announces Availability 10 Billion Loan Authority Automotive Manufacturing
	Value	• The DOE offers up to $10 billion in loan authority	
	Notable Conditions	• Eligible projects include those that retain high wages, benefits, workplace rights, and other commitments, such as maintaining the existing facility until a new one is complete in the case of facility replacement projects.	
	Beneficiaries	• This initiative is aimed at applications from automotive manufacturing conversion projects that preserve high-quality jobs in communities currently hosting manufacturing facilities.	

Battery Materials Processing and Battery Manufacturing Grants Round II	Program	• To expand domestic battery manufacturing and materials that are crucial for the growing clean energy sectors, such as electric vehicles and energy storage.	Biden-Harris Administration Announces $15.5 Billion to Support a Strong and Just Transition to Electric Vehicles, Retooling Existing Plants, and Rehiring Existing Workers | Department of Energy CLEAN ENERGY INFRASTRUCTURE FUNDING OPPORTUNITY ANNOUNCEMENTS
	Value	• 3.5 billion	
	Notable Conditions	• The goal is to aid the establishment of new, retrofitted, and expanded domestic commercial facilities dedicated to battery materials, components, and cell manufacturing. • This initiative focuses on supporting the growth of the domestic industry, benefiting manufacturing workers, and promoting equity and environmental justice.	
	Beneficiaries	• The program will specifically assist communities with experienced auto workers and a history of vehicle production, applicants with strong workforce practices, and those aiming to create high-quality jobs.	

Indiana			Website
INDOT National Electric Vehicle Infrastructure	Program	• A national initiative to create a network of at least 500,000 reliable chargers across the U.S. to support the growing adoption of electric vehicles. • Charging stations locations will be determined by federal guidance and using a data-driven approach considering EV miles traveled, EV adoption rates and growth models, existing and planned stations, and electric grid capacity among other factors. • INDOT will contract with partners to build Level 3 DC Fast Charge charging stations along Indiana's federally designated alternative fuel corridors (AFC's).	INDOT: Electric Vehicle Charging Infrastructure Network
	Value	• INDOT is investing nearly $100 million to build an electric vehicle (EV) charging network at strategic locations across Indiana.	
	Notable Conditions	• Selected locations must ensure convenient, equitable access for users in rural and urban areas and station capacity, design and location will promote usage by passenger EV's and medium- and heavy-duty EV's. • EV charging infrastructure must be located every 50 miles along State's interstate highway system, within 1 mile of the Interstate. • EV charging infrastructure must include at least four 150KW Direct Current (DC) Fast Chargers.	
	Beneficiaries	• Additional Locations Support Consumers of EVs. This then indirectly encourages an increase in EV sales through less range anxiety or helps EV profitability by padding higher prices.	

I&M's Charge at Work in Indiana Small Commercial	Program	• Managers of commercial businesses and multi-unit dwellings are increasingly providing plug-in electric vehicle (PEV) charging stations to take advantage of the convenience and affordability of electric vehicles and to demonstrate their commitment to the environment. I&M has incentive programs to support Level 2 (240V) PEV charging in each of the sectors discussed below.	Charge at Work in Indiana (indianamichiganpower.com)
	Value	• Existing small-commercial customers who average less than 4,500 kWh per month of electricity are eligible for $500 incentive and a discounted off-peak rate up to a 40% reduction from our standard rate. • There is no fee to sign up. I&M will provide more information and detailed steps on the process once you apply.	
	Notable Conditions	• Needs a submeter from I&M between your electrical panel and PEV Level 2 (240V) charger • An Indiana-registered employee-owned or company PEV. (Public Level 2 PEV chargers not tied to an Indiana-registered PEV are not eligible.)	
	Beneficiaries	• Small Commercial Businesses.	
I&M's Charge at Work in Indiana Commercial and Industrial Properties (Multi-Unit Dwellings)	Program	• Managers of commercial businesses and multi-unit dwellings are increasingly providing plug-in electric vehicle (PEV) charging stations to take advantage of the convenience and affordability of electric vehicles and to demonstrate their commitment to the environment. I&M has incentive programs to support Level 2 (240V) PEV charging in each of the sectors discussed below.	Charge at Work in Indiana (indianamichiganpower.com)
	Value	• Under this program, I&M pays $250 per charging port if you can provide power to eligible Level 2 PEV chargers from behind their own electrical panels. • There is no fee to sign up. I&M will provide more information and detailed steps on the process once you apply.	
	Notable Conditions	• Needs a submeter from I&M between your electrical panel and PEV Level 2 (240V) charger. Must provide this independently, but if a customer needs new electrical service from I&M for Level 2 PEV charging, I&M still can pay the customer $250 per charging port if I&M's anticipated revenue from the charging meets I&M's state approved criteria for adding new service without customer investment. • An Indiana-registered employee-owned or company PEV. (Public Level 2 PEV chargers not tied to an Indiana-registered PEV are not eligible.)	
	Beneficiaries	• Commercial and industrial properties and multi-unit dwellings ern these incentives	

Indiana State Entity Clean Vehicle Acquisition Requirements	Program	• Requires that each state entity must purchase or lease a clean energy vehicle	[Alternative Fuels Data Center: Clean Vehicle Acquisition Requirements (energy.gov)]
	Value	• The additional cost of purchasing the EV over an ICE vehicle.	
	Notable Conditions	• Unless the Indiana Department of Administration (Department) determines that the purchase or lease of the vehicle is inappropriate for its intended use. • Or the purchase or lease would cost 20% more than a comparable non-clean energy vehicle. • Additional exemptions apply. • A clean energy vehicle is defined as a vehicle that operates on one or more alternative energy sources, including the following: a rechargeable energy storage system, hydrogen, natural gas, and propane. • Each state entity must annually submit to the Department information regarding its use of clean energy vehicles.	
	Beneficiaries	• Indiana State Treasury, the environment, EV companies that produce economical vehicles for commercial purchase.	

Duke Energy Rebate	Program	• Duke Energy is offering rebates for qualifying public or private entities, apartment dwelling units, and government or workplace fleet operators.	[Alternative Fuels Data Center: Commercial Electric Vehicle (EV) Charging Station Rebate - Duke Energy]()
	Value	• Public Level 2 – $500 rebate per charger • MUD Level 2 – $500 rebate per charger • Workplace Level 2 – $500 rebate per charger • Fleet Level 2 – $500 rebate per charger	
	Notable Conditions	• J1772 Level 2 charger equipped to charge at a dedicated capacity of 7.2kW and above and located in a location permitting 24/7 public access. • J1772 Level 2 charger equipped to charge at a dedicated capacity of 7.2kW and above and located at an apartment building or retirement community. • J1772 Level 2 charger equipped to charge at a dedicated capacity of 7.2kW and above and located in an area where it is available for use by applicant's employees. • J1772 Level 2 charger equipped to charge at a dedicated capacity of 7.2kW and above and is utilized by applicant for charging one or more EVs as part of normal business operations	
	Beneficiaries	• Qualifying public or private entities, apartment dwelling units, and government or workplace fleet operators.	

Duke Energy School Bus Electrification	Program	• Duke Energy is seeking interested school districts to participate in a forthcoming EV School Bus program. Under this program, Duke Energy will provide charging infrastructure for EV school buses and partial funding for bus deployment.	Alternative Fuels Data Center: Electric School Bus and Infrastructure Rebate – Duke Energy
	Value	• Up to $197K of funding for each electric school bus and associated infrastructure • Allocation of 6 electric school buses in this region. • Helps reduce total cost of ownership for school bus • Enhances visibility of your school's sustainability efforts • Pushes energy back to the grid using vehicle-to-grid technology	
	Notable Conditions	• Duke Energy owns the charger and infrastructure for the program term • Bus will participate in a Vehicle-To-Grid technology demonstration and study, which will demonstrate the ability of the bus to dispatch energy to the grid when needed • Duke Energy retains right to battery at the end of the bus's useful life • Participation is on a first-come, first-served basis subject to pilot goals • Be a public or charter school customer with a bus fleet within Duke Energy's service territory. • Agree to participate in the program through December 2024	
	Beneficiaries	• School Districts	

Applied Energy Services (AES) EV Managed Charging Program (Peak demand hours optimized charging)	Program	• The EV Managed Charging Program was created to help us avoid turning to dirty energy sources. On days when energy demand is going to be really high, we schedule Peak Demand Hours. During these hours, our technology works with your JuiceBox charger to reduce your energy use while still ensuring you get the minimum charge you need. This lets you use the cleanest energy possible for your personal charging needs	EV Charger DR (aesindianamarketplace.com)
	Value	• If you sign up for the EV Managed Charging Program when you buy an electric vehicle charger on AES Indiana Marketplace, you'll get an instant $250 off your purchase as an enrollment bonus.	
	Notable Conditions	• Be an AES Indiana residential or commercial electric or dual-fuel (electric and gas) customer. • Install your electric vehicle charger at the home where you receive AES Indiana services. • Have an always-on Wi-Fi network installed in your home. • Have full control over your garage or parking space at your home. • Agree to AES Indiana terms and conditions for the EV Managed Charging Program. • You can enroll a maximum of two Enel X Juicebox chargers in the EV Managed Charging Program when you purchase electric vehicle chargers through the AES Indiana Marketplace	
	Beneficiaries	• Consumers	

Electric Vehicle Product Commission Tasking Report