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Extraordinary. Intelligence.

US Labor Intensity Assessment and Impact of BEV Growth

Draft Report
Prepared for:

American Petroleum Institute

January 21, 2022

Agenda


Background


Scope of Work


Recommended Approach


Labor Results Findings To-date


Path Forward

Why is this research necessary?

BACKGROUND 

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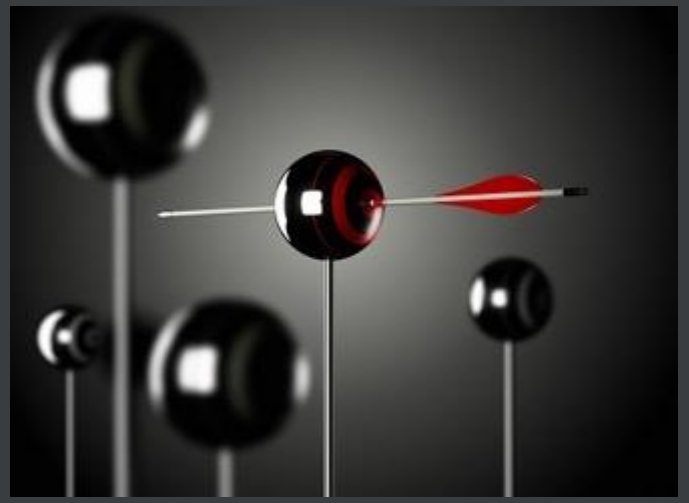
The Need

"Telling the Story"



American Petroleum Institute (API) is a leading organization that represents all aspects of America's O&G industry representing ~600 members involved in production, refinement, distribution and other services within the petroleum industry. API supports its members with research to help understand facts and trends occurring in the overall market.

API has requested assistance in providing an independent assessment (and forecast) on the labor intensity differences that exist between the production of Battery Electric Vehicles (BEVs) and Internal Combustion Engine Vehicles (ICEVs). API wants an analysis conducted that will model the impact on the labor market as BEVs grow as US consumers adopt electric vehicles. BEVs have a reduced usage of components compared to ICEVs (hundreds compared to >1,000 components). API requires a model to gauge the impact on labor at both the original production and service side of the market. BEVs require a lower degree of maintenance due to the elimination of oil/fluids for the motor to operate and regenerative braking, which helps reduce wear and tear over time compared to ICEVs. Martec will help API understand the impact BEV growth will have in the auto industry on a national and regional/state level based on where production and service reside. This analysis will evaluate the impact over a 10-year horizon (through 2030). Martec is well-positioned to analyze and summarize collected data while constructing and analyzing a working model to deliver to government officials. Results are intended to inform and impact labor policy.

What will be covered in the research?

SCOPE OF WORK

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OVERALL GOALS

The goal of this project is to deliver intelligence quantifying the size & scope of the impact BEVs will have on labor/jobs in the US over the next 10 years. This assessment & forecast will include supply, manufacturing & MRO. Key questions to answer via research include:

1. *Analyze and understand labor intensity differences between BEVs and ICEVs in the production process*
2. *Provide the labor impact on the MRO (Maintenance, Repair & Operation) side of the market as BEVs will require a much lower degree of maintenance*
3. *Assess the geographic impact on the labor market (national, regional and state-level) by segment*
4. *Identify typical transferability of labor skills*

The purpose of this document is to describe the research and analysis required to achieve these fundamental goals.

Detailed Objectives

Martec will leverage primary and secondary research to evaluate the impact of BEV growth on the ICEV job market in the US.

Objective 1: How does the total labor intensity of BEVs compare to ICEVs?

- Quantify and assess total labor pool for BEVs compared to ICEVs in the automotive sector in the US
  - *Vehicle assembly*
  - *Critical component suppliers*
    - BEV: Battery cells & packs, battery management systems/BMS, power electronics (inverters, DC/DC converter, controller), electric motors/drive units, gearboxes, cooling system, etc.
      - *Current vs. planned Vehicle OEM strategies will be evaluated (in-house vs. outsourced)*
    - ICE: Engine, transmission, ignition system, fuel delivery system, exhaust & cooling systems, etc.
- Assess impact on labor pool for both vehicle OEMs and critical component suppliers
  - *Martec will assess and model over a 10-year period 2020 – 2030*
  - *Headcounts for BEV vs. ICEV will be forecasted and modeled*
    - Identify differences that exist in headcount and man-hours
    - Identify differences of impact on headcount/jobs and how this will change over time
- Identify if dedicated BEV plants vs. mixed BEV/ICEV plants have significant differences
- Identify and analyze if imported components vs. those produced in the US
  - *Identify typical BEV critical components imported today and in the future*
  - *How might this may change over time and assess impact*

Detailed Objectives *(continued)*

Martec will analyze and model the automotive labor pool geographically while also researching impact on jobs:

Objective 2: Identify and assess where automotive labor is located geographically for BEVs and ICEVs.

- Map out and quantify ICEV production plants
  - *Segment and quantify labor pool nationally and by region/state*
- Map out and quantify known and planned BEV footprint
  - *Vehicle OEMs and critical component suppliers will be assessed*

Detailed Objectives *(continued)*

Martec will analyze and model the automotive labor pool geographically while also researching impact on jobs:

Objective 3: Considering decreased maintenance for BEVs, how will the maintenance/service market be affected?

- Identify and list which types of auto services and jobs will be impacted (i.e., oil/filter changes, fluid changes, brake repair, etc.)
  - *Assess and analyze impact at vehicle OEM dealerships vs. independent aftermarket svc./repair*
  - *Special focus on OEM dealership impact*
- How will this escalate as BEV production volume grows and displaces ICEVs in the Vehicles-in-Operation (VIO)
- How man jobs could be impacted (run scenarios based on speed of BEV growth)
  - *Quantify number of jobs in existence and impact over next 10 years (2030)*
- Will certain regions or states be impacted more than others?
  - *What impact will this transition have on jobs at regional or state-level?*
    - Martec will attempt to do at county-level, on a best-effort basis
  - *Martec will run scenarios on impact as BEVs grow*
  - *Martec will provide insights and details as available*
- How transferable are these jobs/skill sets?

Detailed Objectives *(continued)*

Martec will assess the impact on jobs fulfilling service/maintenance for BEVs

Objective 4: Conclusions & Executive Summary

- Martec will provide both a full report and an abbreviated executive summary (2 – 5 pages) that will highlight and summarize key findings on the impact on US jobs

Labor Intensity Impact Assessment

DRAFT EXECUTIVE SUMMARY

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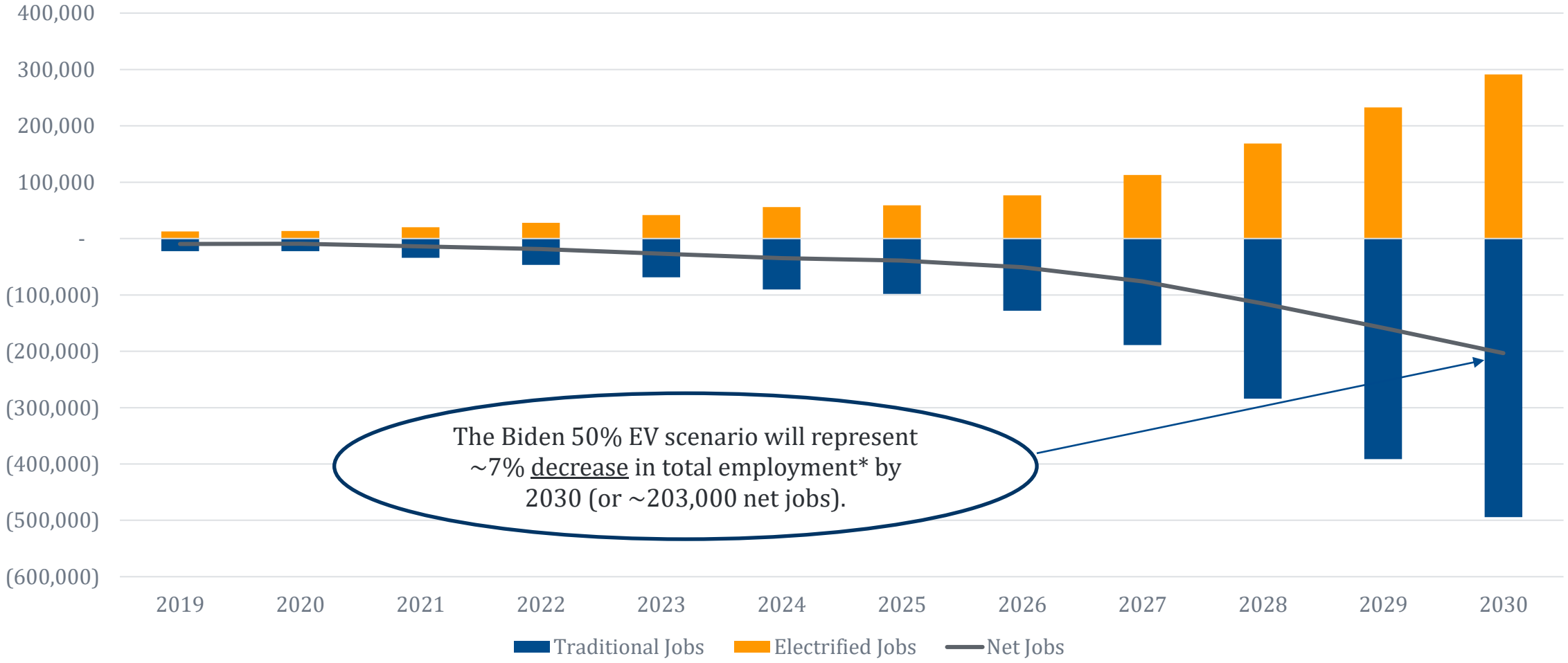
U.S. Electrification Impact

U.S. Only Biden 50% EV Introduction Scenario



**Note: Total employment includes all direct, indirect, and induced jobs from the manufacturing of automobiles*

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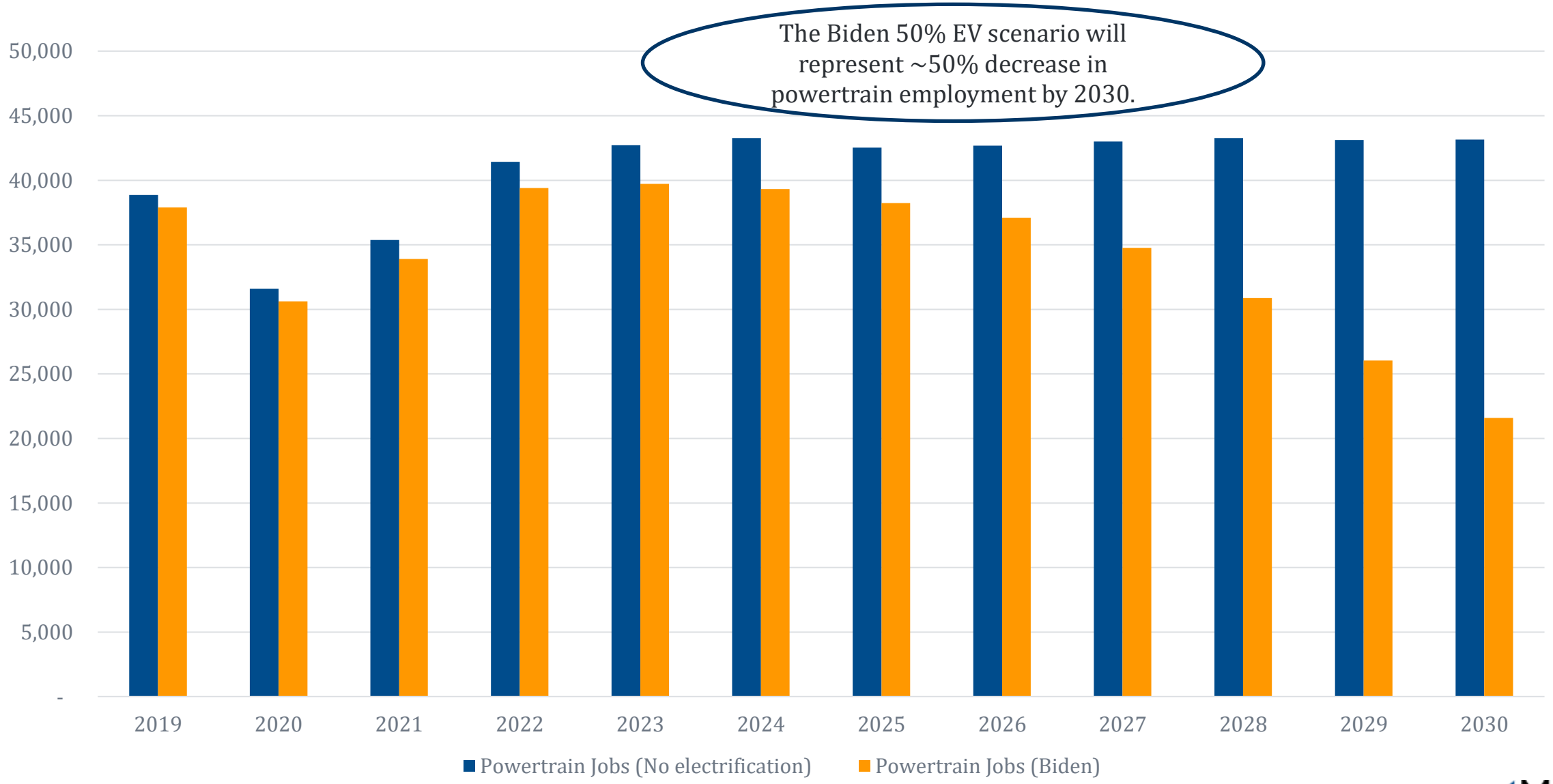
U.S. Electrification Impact

U.S. Only Biden 50% EV Introduction Scenario – ICE Powertrain OE Assembly Direct Employment



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OE Labor Intensity Methodology

U.S. Manufacturing Analysis - Preliminary

Base ICEV manufacturing assumptions:

- Average vehicle assembly labor time = 22 hours
  - *This includes all aspects of vehicle assembly and the final dressing of the powertrain*
- Average engine assembly labor time = 3.1 hours
- Average transmission assembly labor time = 3.5 hours

Battery Electric Vehicle (BEV) assumptions:

- Average vehicle labor time = 18.7 hours
  - *~15% reduction*
- Average jobs per GWh of cell manufacturing = ~90 jobs
  - *For a 75kwh battery: ~12 hours*
- Average jobs per GWh of pack manufacturing = ~45 jobs
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- Average e-motor production time = ~0.6 hours

Job Classification	Direct	Indirect	Induced
Motor Vehicle Assembly (ICE and BEV)	100	935.8	492.1
Motor Vehicle Parts Supplier	100	209.8	161.2

Source: Economic Policy Institute, Updated employment multipliers for the U.S. economy, 2019.

**Note: This table is used to calculate the downstream employment effects from the vehicle and powertrain assembly operations. Battery cells, packs and electric motors use the parts supplier values to approximate the lower number of downstream component suppliers than ICEs.*

U.S. Assembly Plants and Direct Employment by State

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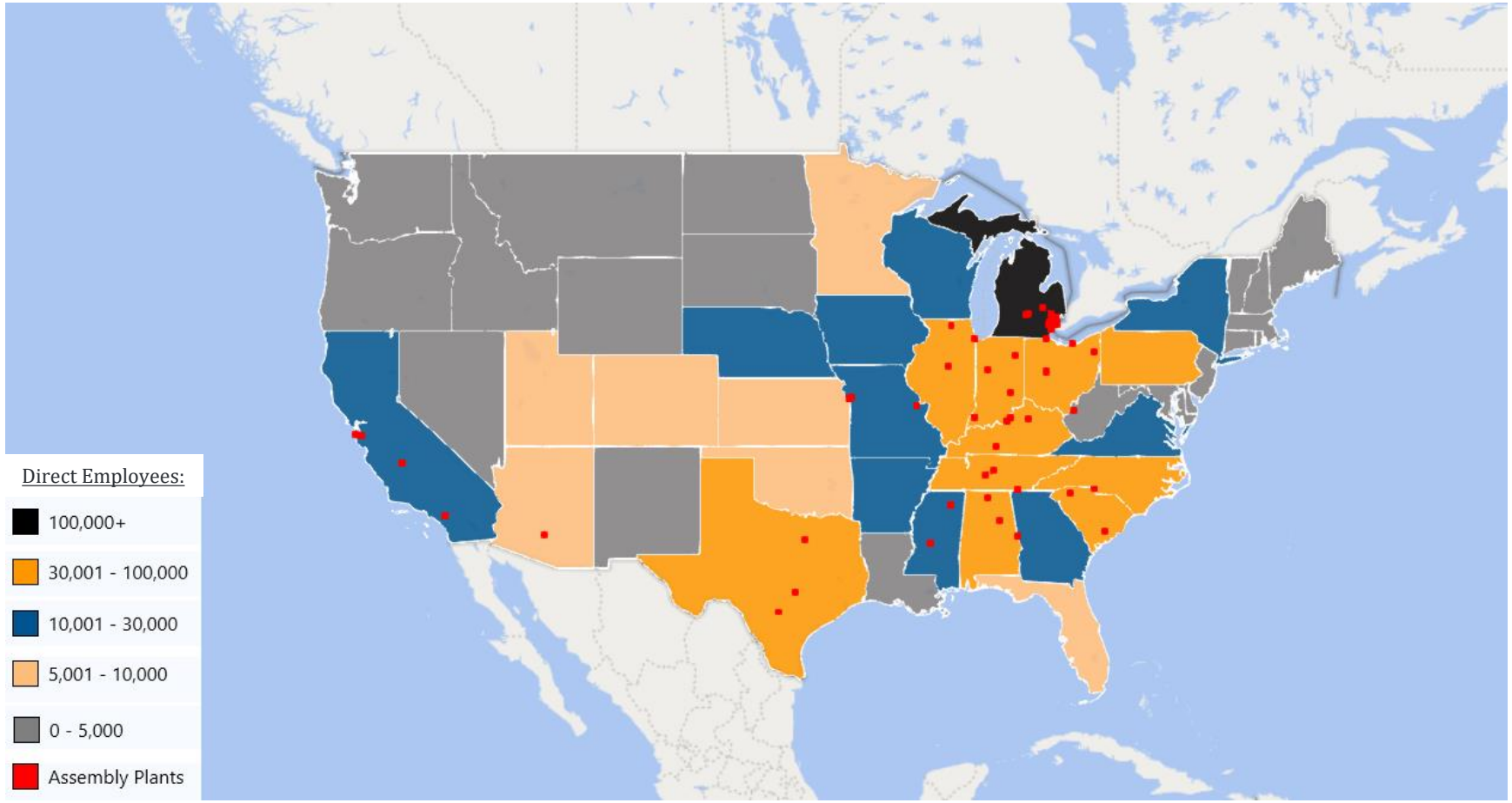

- Heavy concentration of vehicle assembly plants and overall employment primarily concentrated in the Midwest
- Top 5 states by employment include:
  - *Michigan*
  - *Ohio*
  - *Indiana*
  - *Tennessee*
  - *Kentucky*

Source: MEMA 2020 Report and Martec analysis.

***NOTE: Direct employment is based employees directly involved with vehicle assembly and manufacturing components.*

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Powertrain Plant Locations and Direct Employment Data

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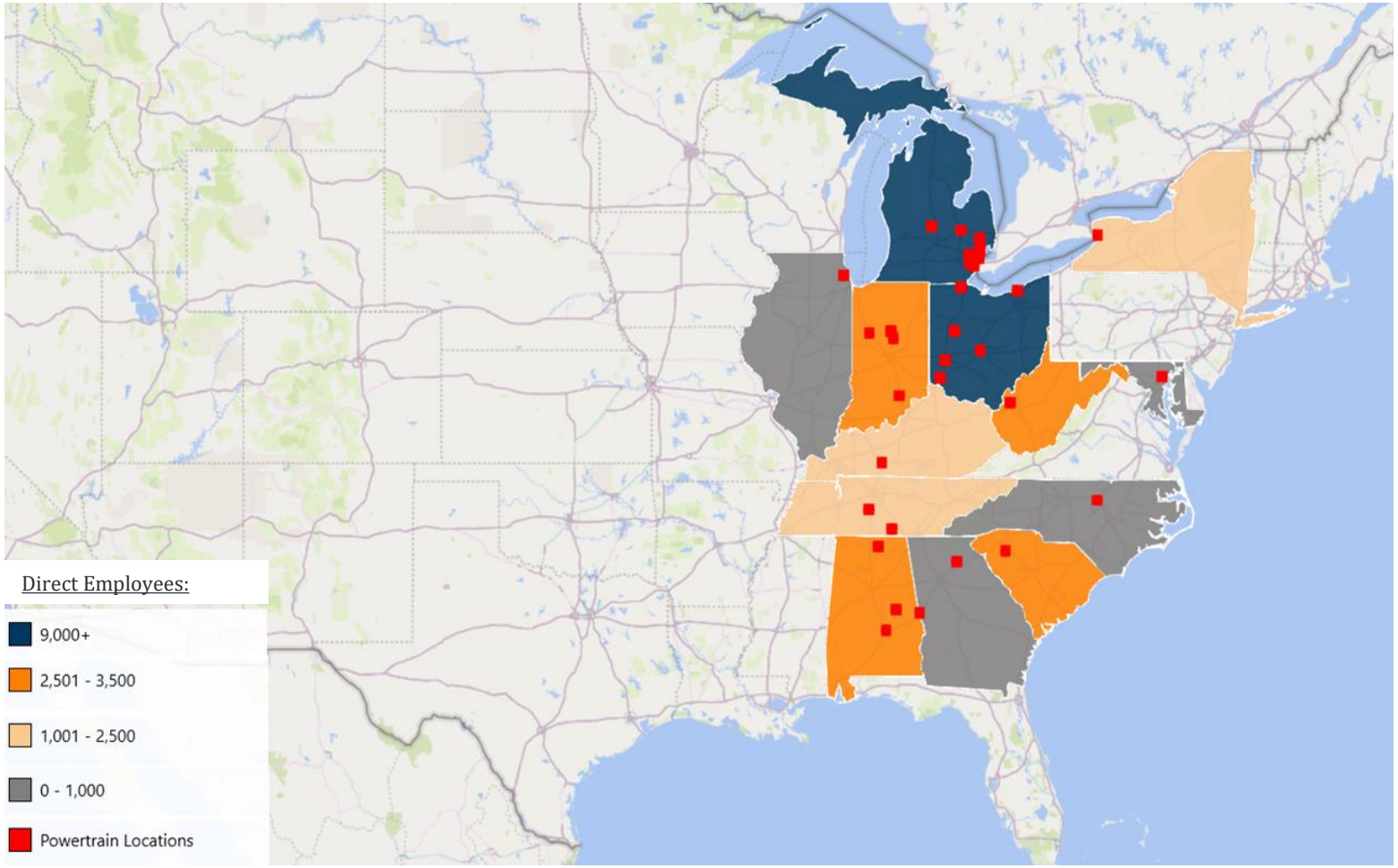

- ~39,000 direct powertrain employees exist in the US
- Midwest represents the bulk of powertrain employees at ~60%
  - *28 plants in MI, OH, IN and IL combined representing ~23,000 direct employees*
- Powertrain plants and employees in the Midwest will be the most vulnerable if future battery & e-motor plants continue to be located in the Southeast, Southwest and West coast regions

Source: MEMA 2020 Report and Martec analysis.

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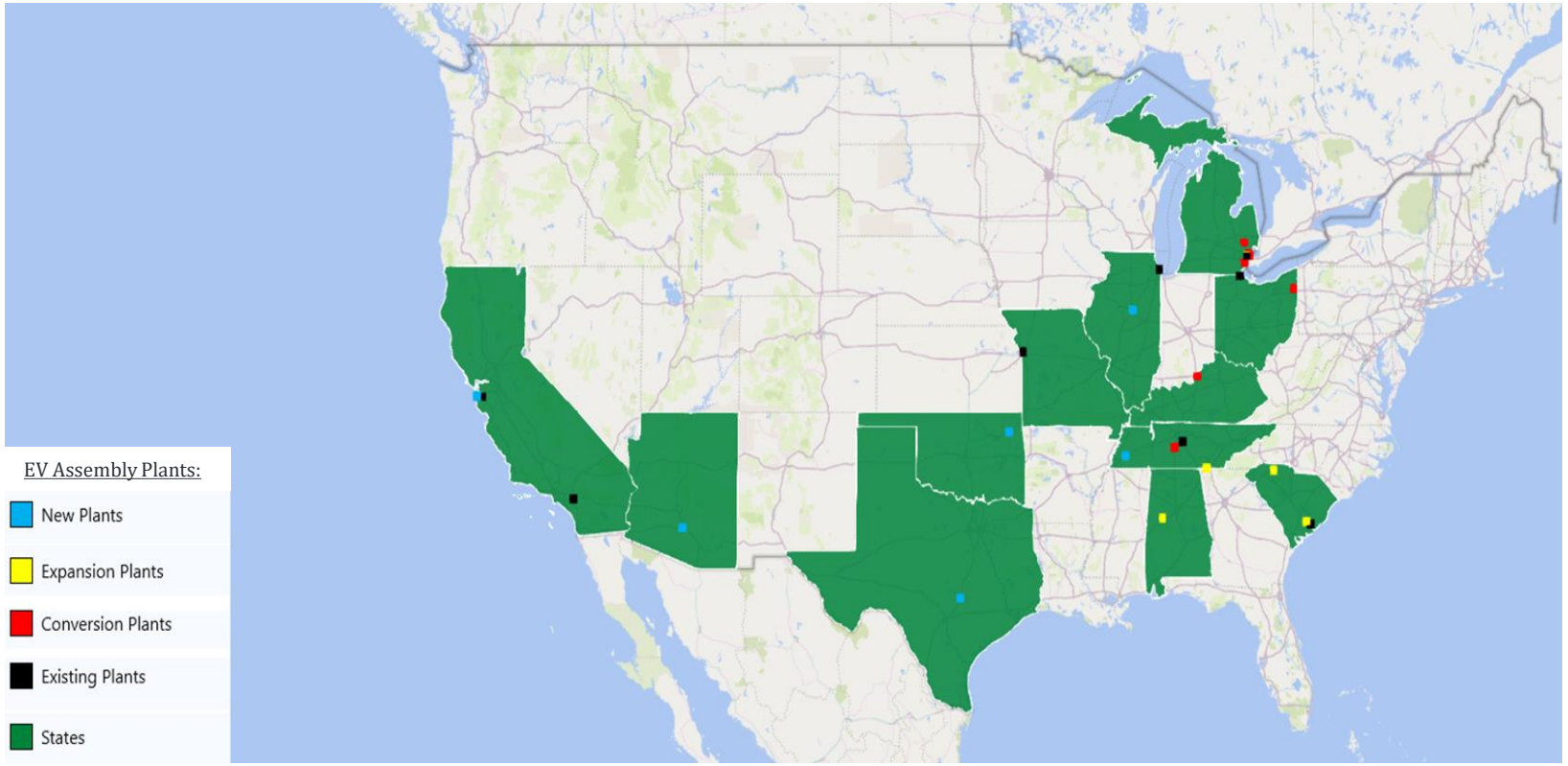
U.S. EV Current and Planned Vehicle Assembly Plants

20 new, upgraded or plant expansions are expected to come online between 2021 – 2025.



- Vehicle OEMs are approaching future EV assembly from 3 different scenarios:
  - ***New*** *= Construct brand new plants producing 100% EVs*
  - ***Conversion*** *= Converting existing ICEV plants to EV (most will be 100% dedicated)*
  - ***Expansion*** *= Expand existing ICEV locations with new EV plant*
- 20 new EV plants have been announced or are being constructed and will be operating by 2025 in U.S.
  - ***Midwest*** *= 9 plants (45%)*
  - ***South/Southeast*** *= 7 plants (35%)*
  - ***Southwest*** *= 2 plants (10%)*
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- Existing plants produce BEV or PHEV/HEV with ICEV

Source: ICCT and Martec.

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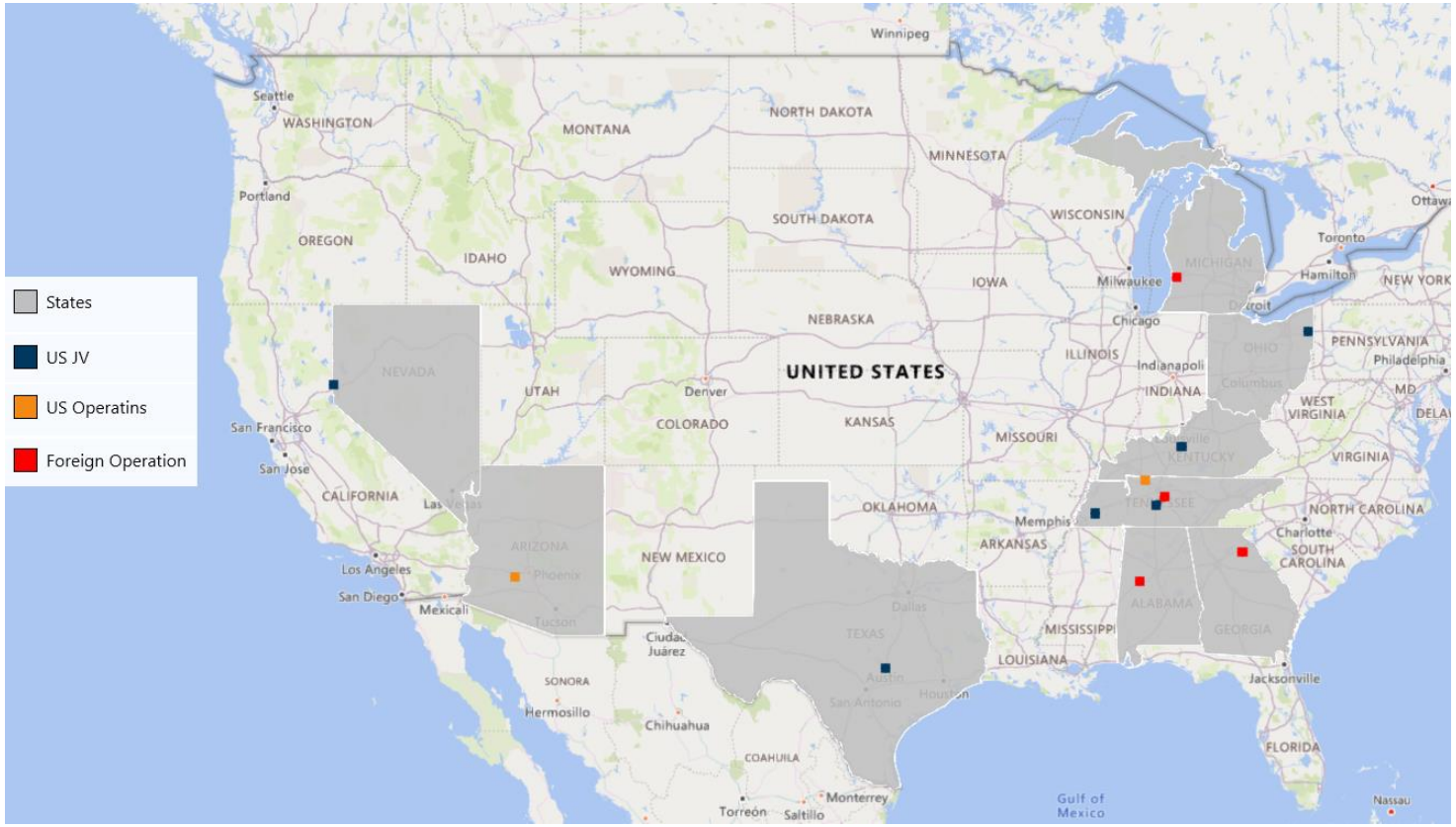
Existing vs. Announced Future BEV Battery Plants in U.S.

12 new US battery plants are under construction or have been announced*



- Almost all new battery plants being constructed or announced will be in the South or Southwest regions
  - *GM/LG Lordstown, OH plant is the only exception and is expected to start production in 2022/2023*
- All 10 new plants are planned to be operating by 2025
  - *Investment's total >$21B and represent >26,000 jobs based on announcements at capacity***
- Traditional ICEV powertrain plants are heavily located in the Midwest
  - *This will result in a shift of employment on a regional basis*

EV battery locations in the chart above excludes companies and plants that are R&D/pilot lines, focused on non-automotive/commercial applications or have no existing contracts with automotive companies in place.

Source: CIC energiGUNE and Martec research & analysis.
**Note: Plant locations for Stellantis (2) and Toyota have not yet been announced.*

***NOTE: Some of Tesla battery plant employment will be for non-automotive battery applications.*

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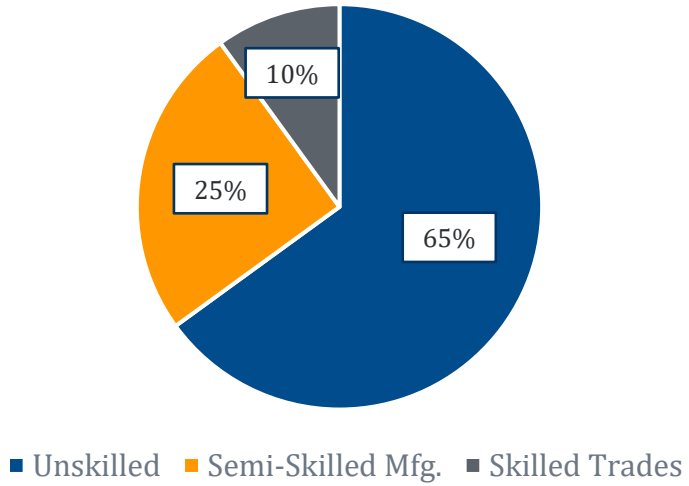
ICEV Powertrain Labor vs. BEV Battery Labor

BEVs will utilize a greater degree of unskilled labor due to less components

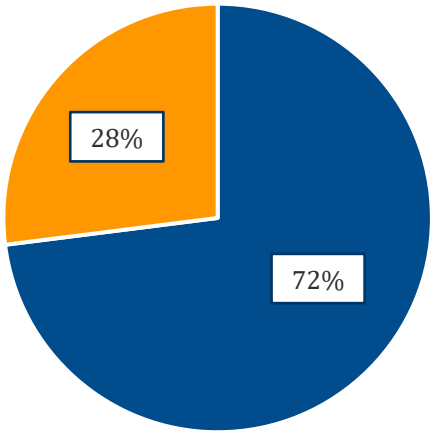
ICEV Labor Category	ICEV Powertrain Classifications	Low to High Hourly Base Wage Rate + Shift Differential*	Approximate Average Base Wage rate + Shift Differential*
Unskilled	Assembly, QC, Material handling / GSE	~$27 - $35/hr.	~$31/hr.
Semi-Skilled Mfg.	Machinists	~$31 - $36/hr.	~$33/HR.
Skilled Trades	Machine Repair, Millwright, Welder, Pipefitter, Tool & Die, Electricians	~$32 - $41/HR.	~$37/HR.

BEV Labor Category	BEV Battery Cell & Pack Classifications	Low to High Hourly Base Wage Rate	Approximate Average Base Wage rate
Unskilled	Assembly / Production associate, QC associate, Visual response technicians, Rework technicians, Material handling	~$16 - $25/hr.	~$21/hr.
Semi-Skilled/ Skilled Trades	Industrial maintenance mechanic (IMM) / repair, Metrology technician, Robotic programmers, Welder, Tool & Die, Electricians	~$26 - $40+/hr.	~$32/hr.

ICEV Powertrain Labor
Unskilled vs. Skilled*



BEV Battery Pack Labor
Unskilled vs. Skilled**



Source: Combination of Martec primary research and The White House Report: Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth June-2021.

**Note: Hourly wages are based on represented powertrain facilities including base wage + avg. shift premiums & team leader hourly bonus rate.*

***Note: Typical Battery cell/pack manufacturing can vary from 25% - 33% skilled mfg./trades vs. unskilled labor.*

****Note: Excludes fringe benefit costs. Figures are based on hourly compensation.*

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Potential Auto Service Jobs Lost Under Biden 50% Scenario

Number of Jobs Vulnerable on Service Side of Market

- Martec has identified the following amount of potential job losses under Biden's 50% scenario due to reduced service from BEVs and displacement of ICE vehicles

Repair Shop Type	Number of U.S. Shops in 2020	Total Number of Workers	Potential 2030 Jobs Lost or Vulnerable	% Change by 2030
Oil Change	8,480	50,800	~6,300	(10% - 15%)
Exhaust Systems/ Mufflers	6,502	19,300	~1,000	(5%)
Transmission Repair	9,663	33,800	~1,700	(5%)
Auto Dealerships (Basic Svc.)	16,623	253,000*	~50,600**	(20%) vulnerable
Total	41,268	356,900	~59,700	(17%)

Labor Intensity Impact Assessment

LABOR FINDINGS TO-DATE: OE MANUFACTURERS

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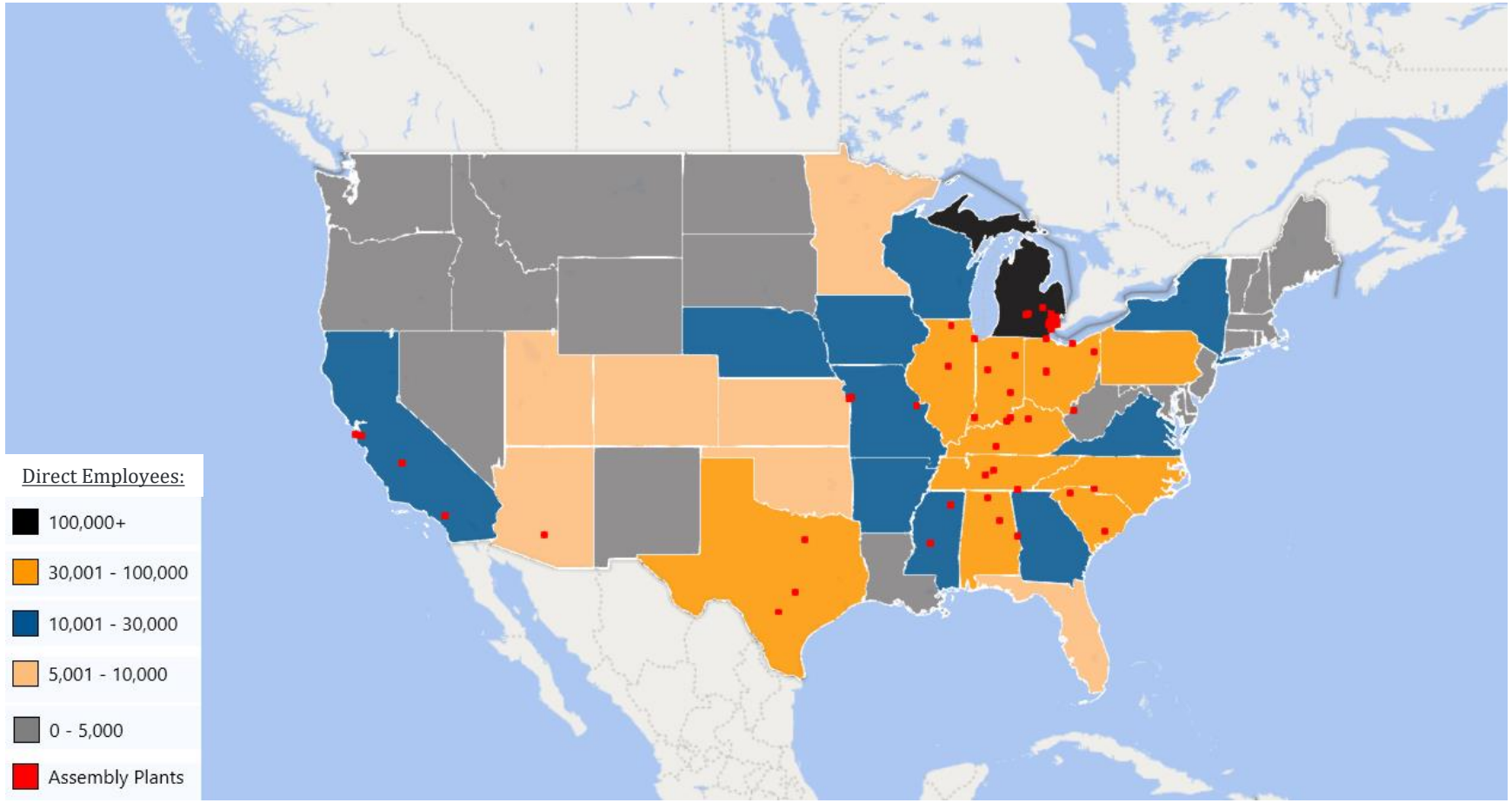

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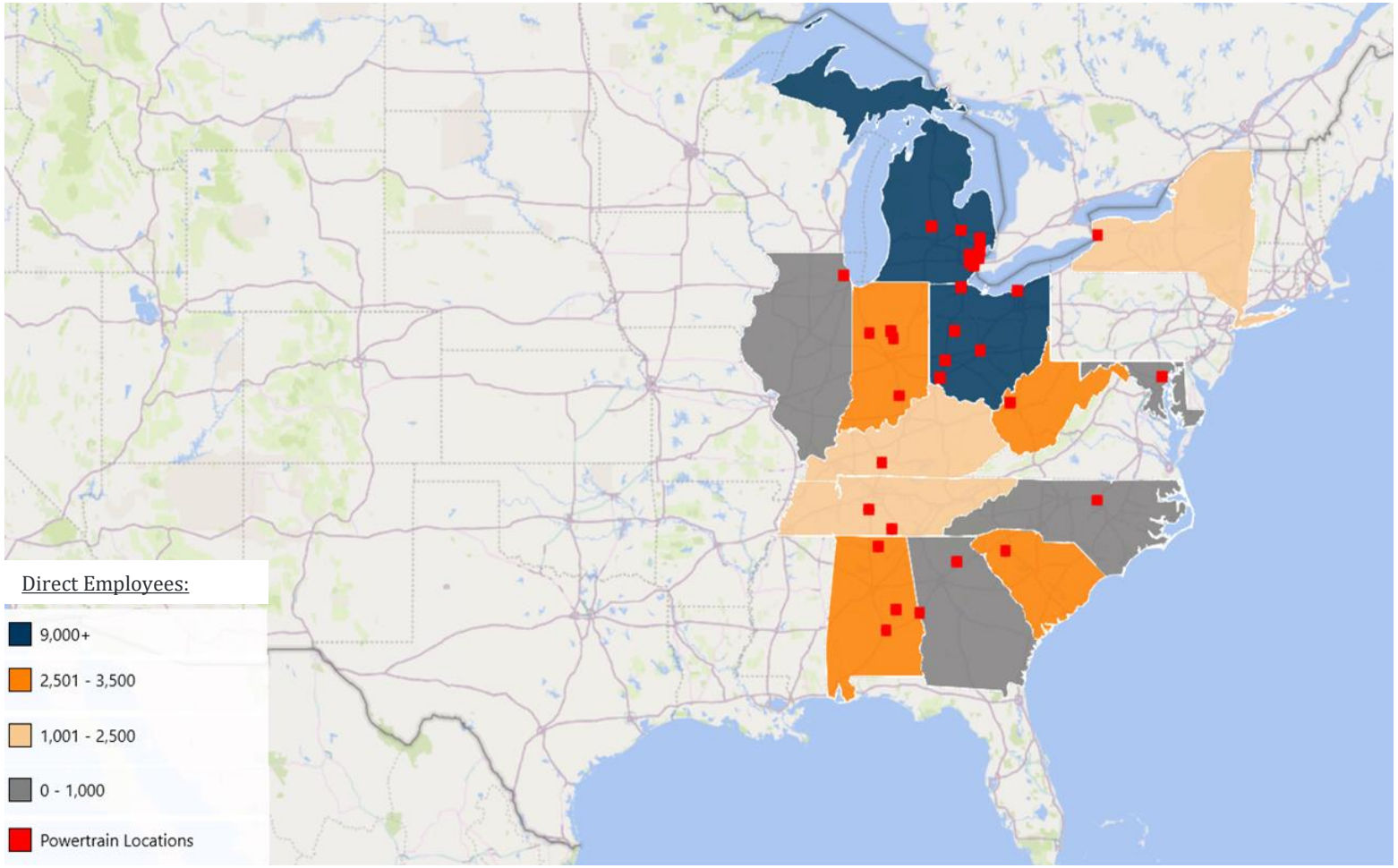

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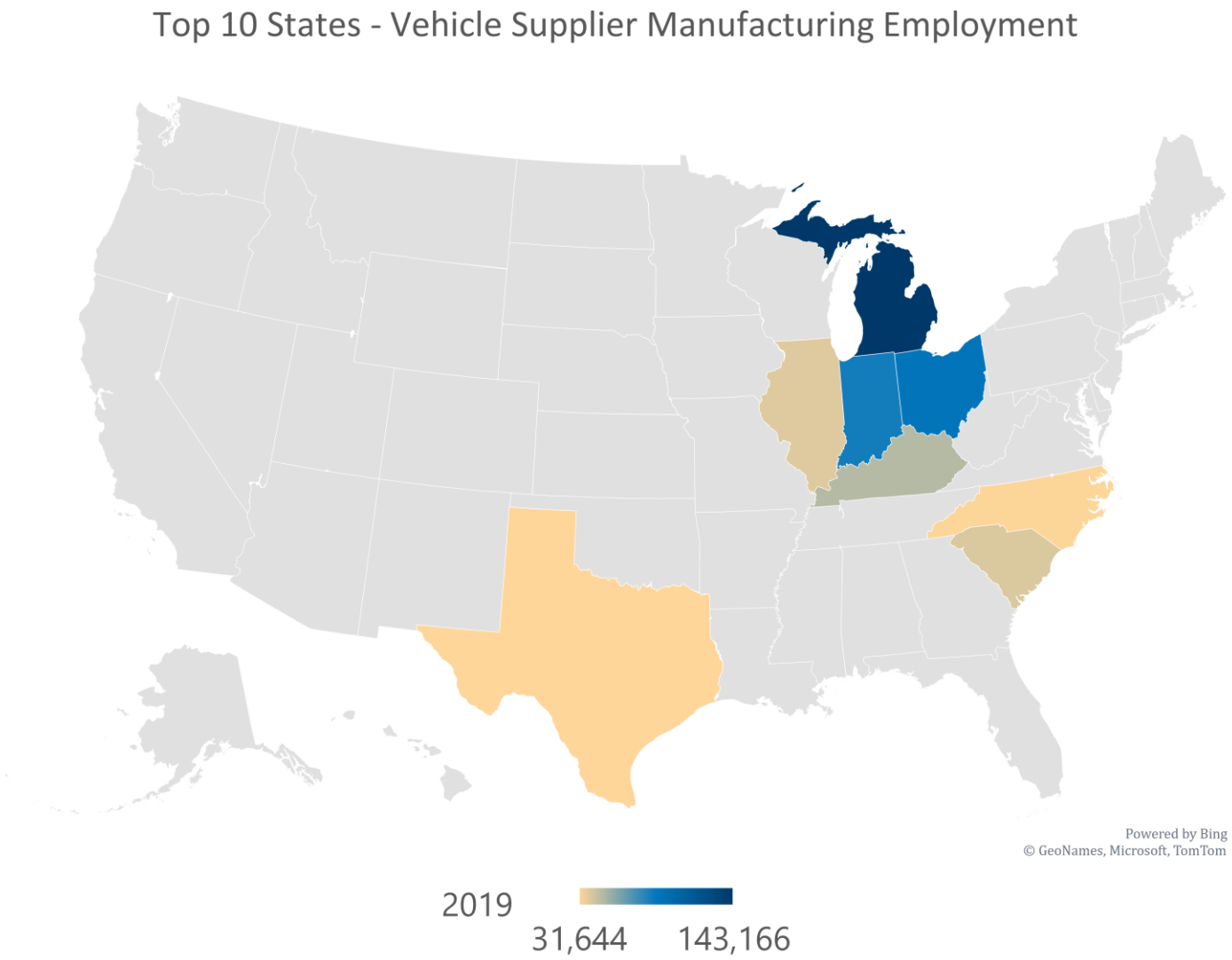
Employment Based on Vehicle Supplier Manufacturing

Based on the total automotive manufacturing industry



- Regarding all sectors of manufacturing, vehicle supplier manufacturing is the largest subset within the total manufacturing industry
- Vehicle Supplier Manufacturing industry saw an 8.1% change in employment growth from 2015 to 2019 (or 2%/yr.)
  - *Employment figures are representative of LD auto, MD/HD commercial vehicles and component manufacturing combined*
  - *Employment growth primarily driven by continued high production rates between 2015 - 2019*
- Michigan, Ohio and Indiana are the Top 3 states for automotive vehicle supplier manufacturing

Source: MEMA 2020 Report and Martec analysis.

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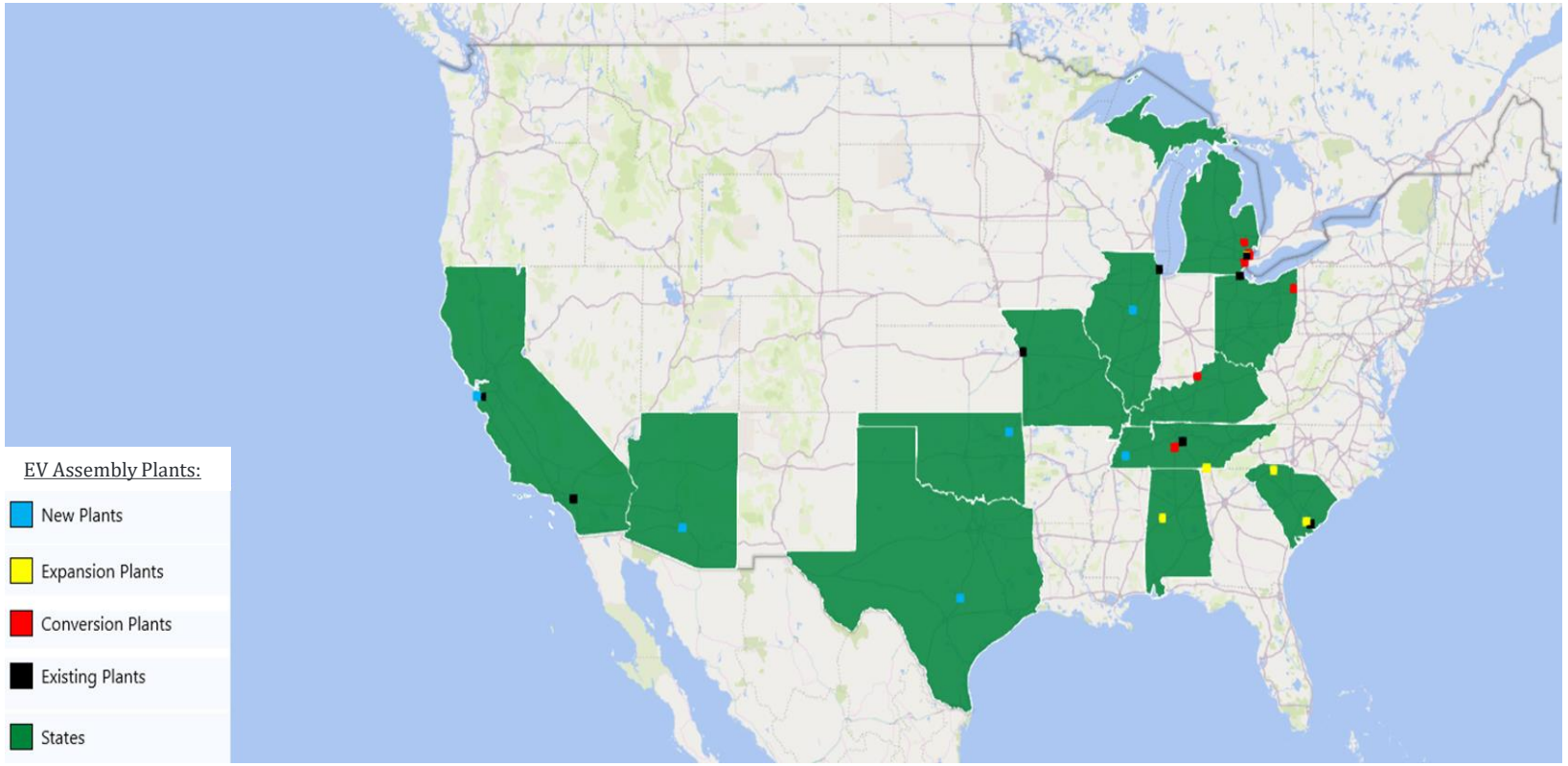

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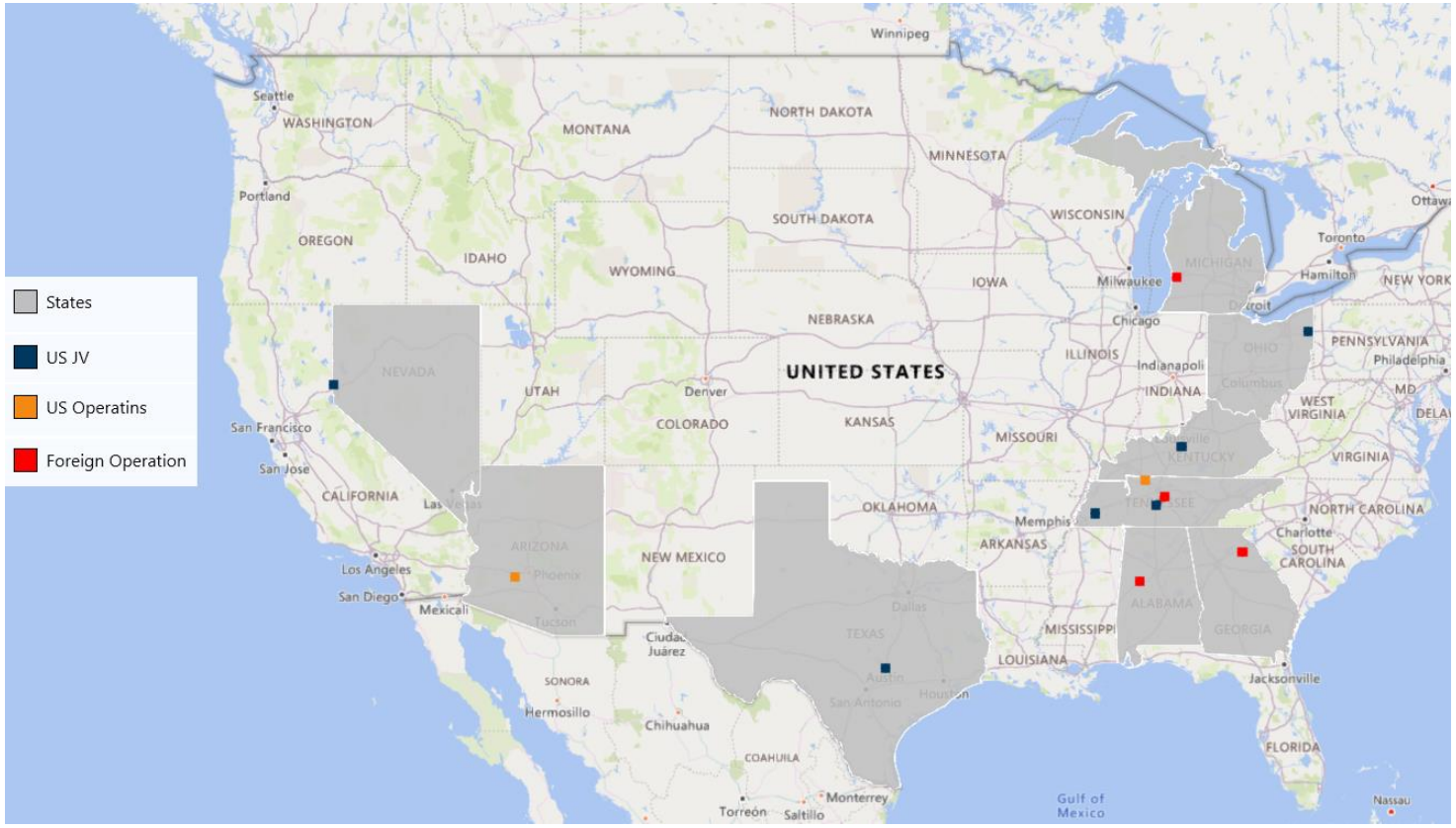

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**Note: Plant locations for Stellantis (2) and Toyota have not yet been announced.*

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U.S. BEV Battery Production Plants Detail

Partner	OEM	State	Investment	GWH Capacity	Opening Year	Job Capacity	Plant Type
Current							
Panasonic	Tesla	Nevada	$1,200,000,000	35	2017	7000	Battery
AESC	Nissan	Tennessee	$1,700,000,000	4.4	2012	300	Vehicle & Battery
LG	GM	Michigan	$303,000,000	5	2013	450	Battery
New							
SKI	Ford	Tennessee	$5,600,000,000	43	2025	6000	Vehicle & Battery
		Kentucky	$2,900,000,000	43	2025	2500	Battery
			$2,900,000,000	43	2026	2500	Battery
		Georgia	$1,300,000,000	10	2022	1300	Battery
			$1,300,000,000	12	2022	1300	Battery
None announced	Mercedes Benz	Alabama	$1,000,000,000	Not Announced	2022	600	Vehicle & Battery
LG	GM	Tennessee	$2,300,000,000	35	2025	1300	Battery
		Ohio	$2,300,000,000	30	2023	1100	Battery
Panasonic	Tesla	Texas	$1,000,000,000	90	2022	NA	Vehicle & Battery
Kore Power	Not Announced	Arizona	$500,000,000	12	2023	3000	Battery
Microvast	Not Announced	Tennessee	$220,000,000	2	2023	287	Battery
LG	Stellantis	Not Announced	Not Disclosed	40	2024	NA	Battery
Samsung		Not Announced	Not Disclosed	40	2025	NA	Battery
Toyota Tsusho	Toyota	Not Announced	$1,290,000,000***	NA	2025	1750	Battery

**Note: Does not include testing or R&D facilities.*
***Note: Only light duty on road vehicles.*
****Note: An additional $2.1B is expected to invested by 2030, details were not available.*

U.S. BEV Battery Production Plants Detail *(continued)*

Multiple future BEV battery plants and their locations are still under consideration

- **Rivian:**
  - *Rivian has been looking at sites in Atlanta, GA; Michigan, Arizona and Texas for a new EV vehicle and battery plant*
    - Expectations are Rivian will choose near the Atlanta, GA area

- **General Motors:**
  - *GM is keeping Michigan in strong consideration for at least one of two yet to be announced battery plants*
  - *GM owns a plot of land in Delta Township, MI near its Cadillac plants in the Lansing area*

- **Stellantis:**
  - *No location announced for two new battery plants with Samsung SDI and LG*

- **Toyota:**
  - *No location mentioned for $1.29 Billion battery plant, but strong speculation is in Texas*

Economic Impact Job Classifications

MEMA breaks down auto employment into 3 main categories

1
Direct Effects

Direct OEM employment:

- This analysis uses the employment at the LD car makers facilities focused on the production of vehicles and powertrain products

2
Indirect Effects

Indirect employment:

- These jobs are supporting the production of the vehicle and include primarily parts suppliers but also system integrators and subassembly manufacturers

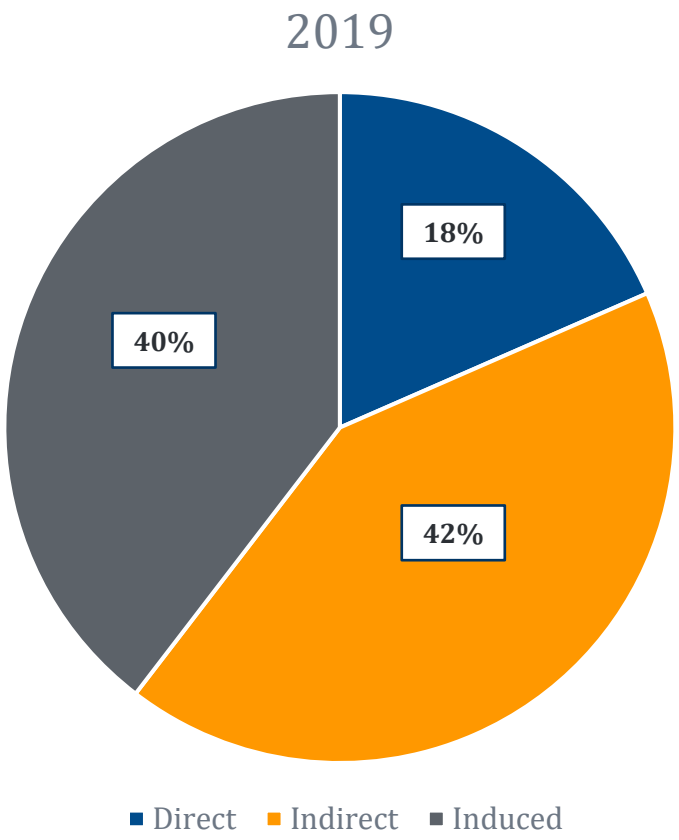
3
Induced Effects

Induced employment:

- These are the jobs that are impacted by the spending effect of both the direct and indirect employment

Economic Job Classifications – Light-Duty Auto OE

Direct, Indirect & Induced Labor Classifications Breakdown



Total U.S. LD Auto Vehicle OE Employment = ~2.97M

Source: MEMA 2020 Report.

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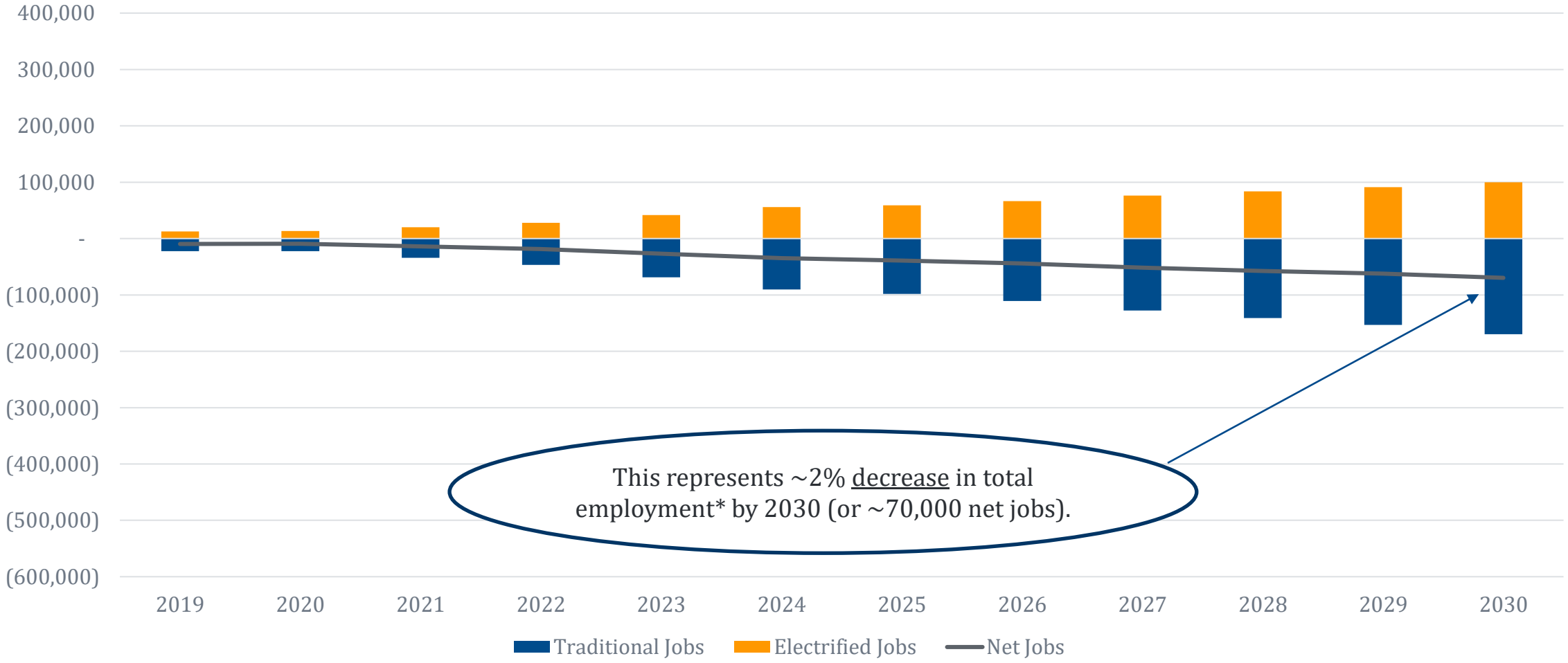

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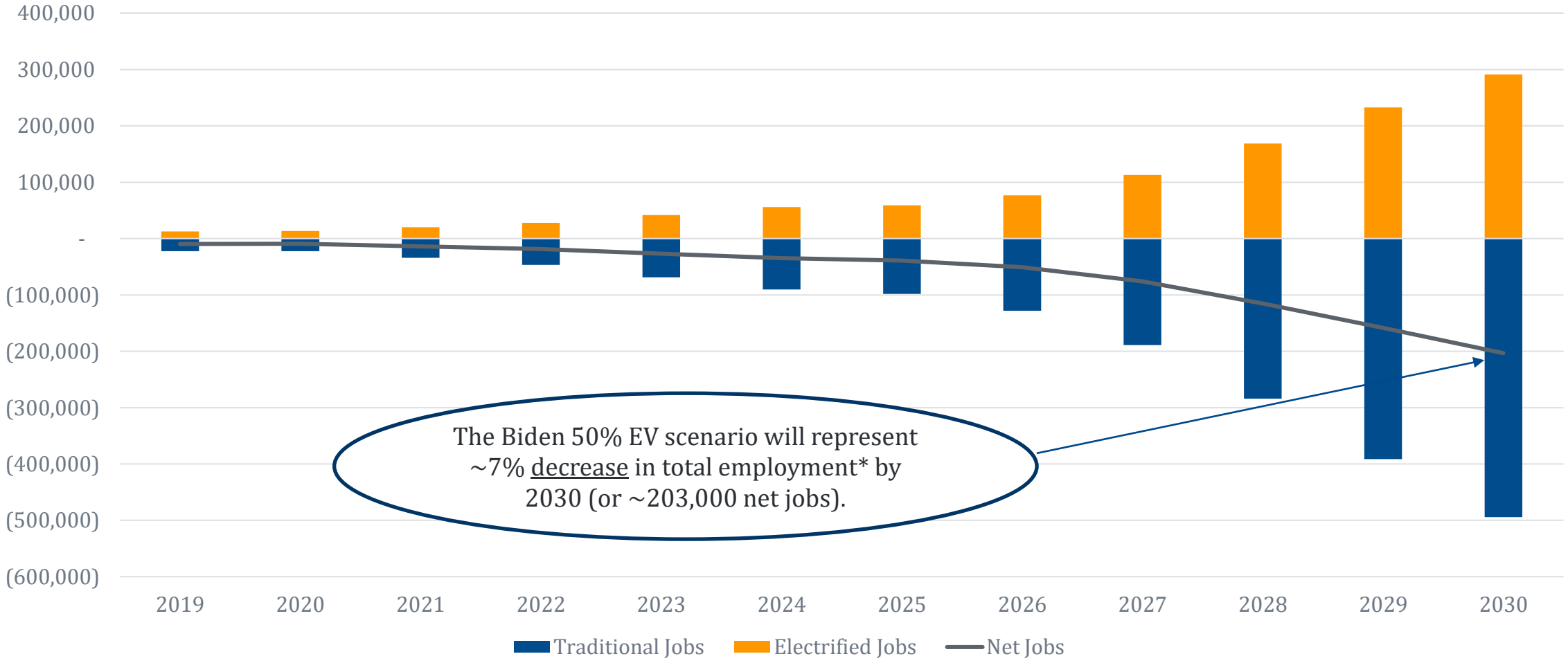
U.S. Electrification Impact

U.S. Only Biden 50% EV Introduction Scenario



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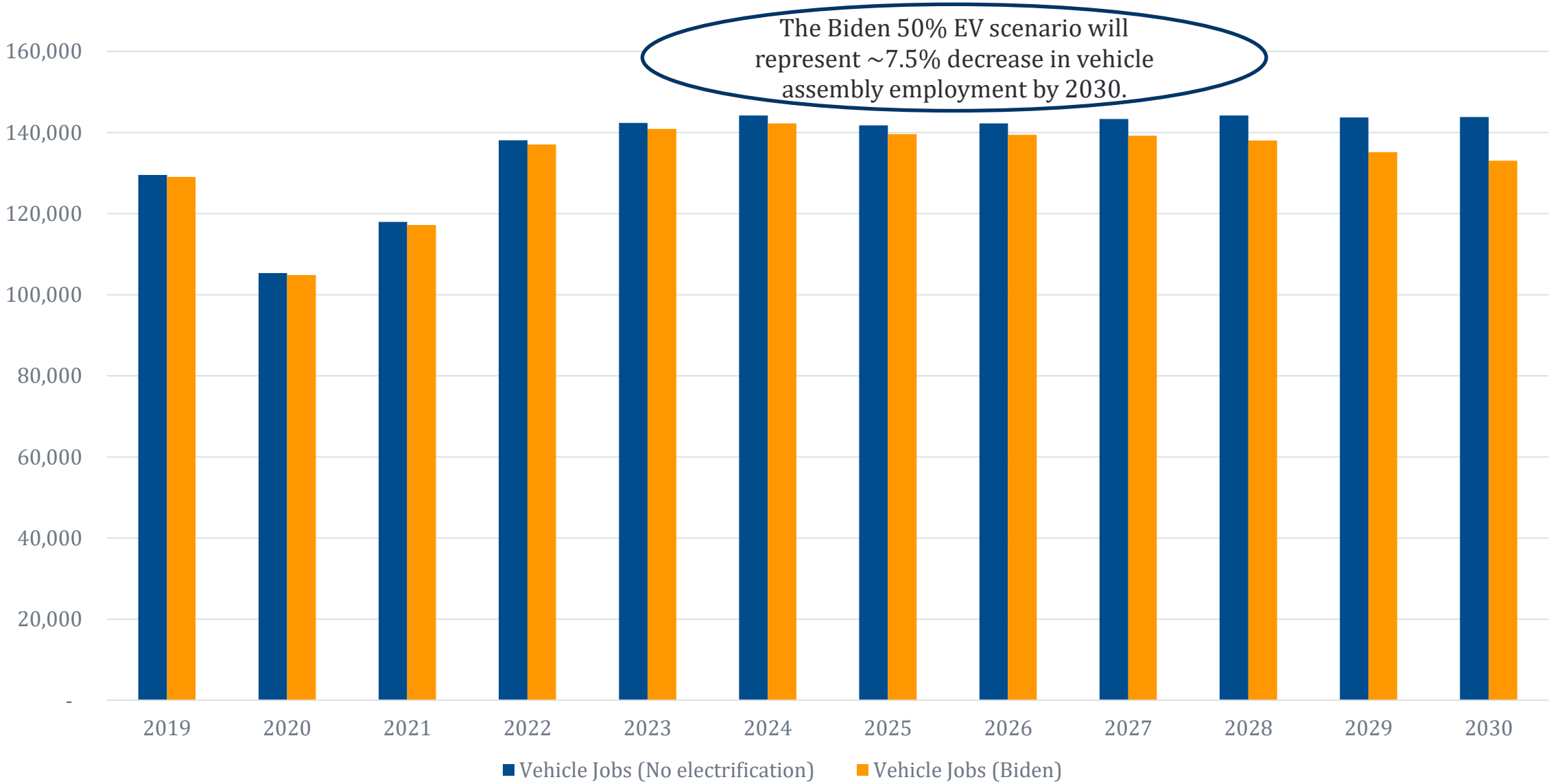
U.S. Electrification Impact

U.S. Only Biden 50% EV Introduction Scenario – OE Vehicle Assembly Direct Employment



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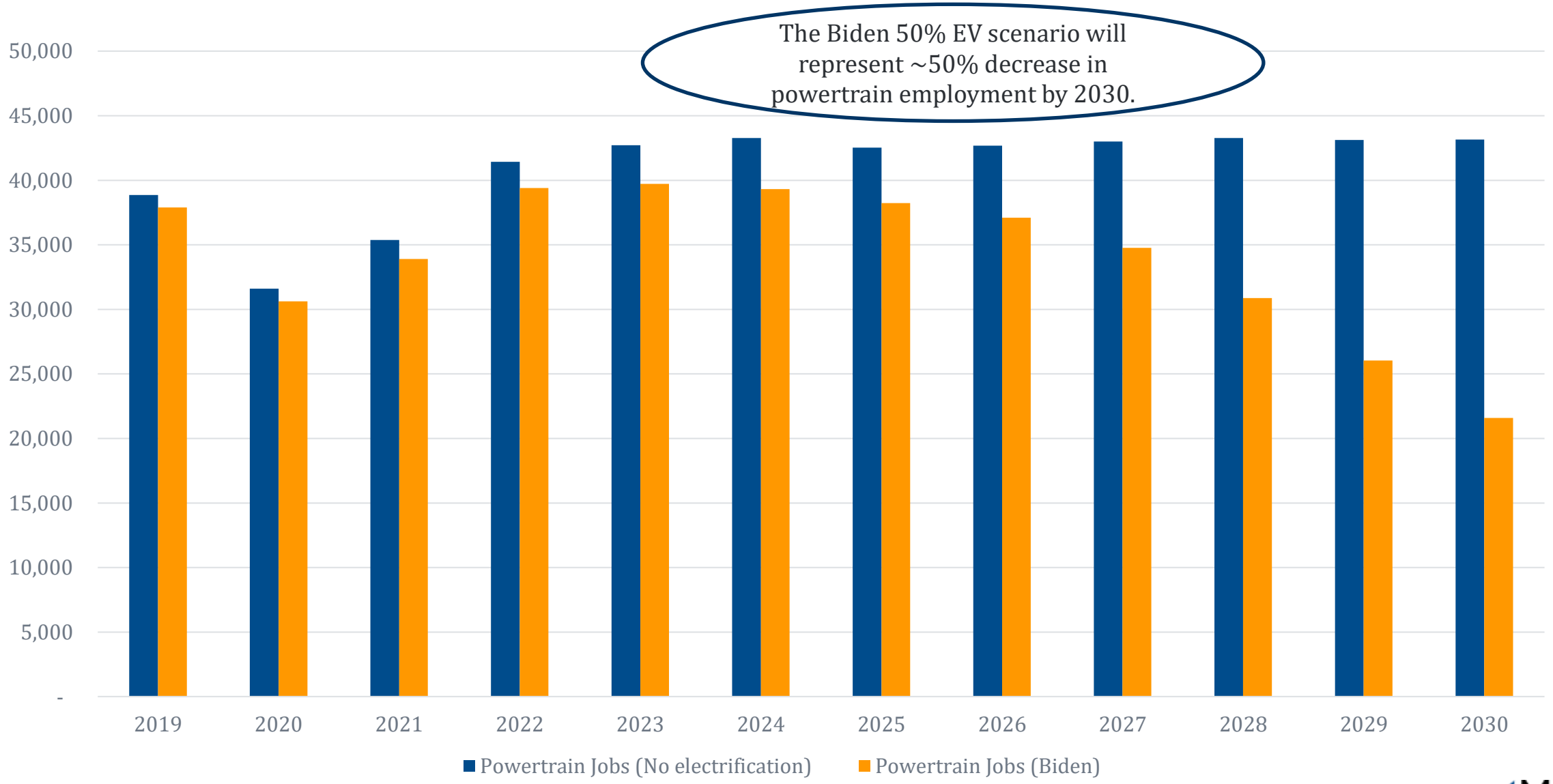
U.S. Electrification Impact

U.S. Only Biden 50% EV Introduction Scenario – ICE Powertrain OE Assembly Direct Employment



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U.S. Labor Impact Summary Analysis

Key Takeaways

- The labor impact to traditional jobs versus manufacturing an electric vehicle under the proposed 50% EV production requirement by 2030 is <u>significant</u>
  - *The removal of the ICE powertrains and the reduced vehicle assembly labor represent a loss of about 30,000 direct jobs at the OEMs*
    - These losses impact the supplier and supporting jobs by another 400,000 - 450,000 jobs (-17%)

- The new jobs created in the battery cell, pack, and motor production locations will increase overall labor demand (direct, indirect and induced jobs) by 250,000 – 300,000 (+10%) by 2030
  - *Impacts to the job markets are not distributed equally across the country*
  - *New battery plants starting to come online in the South, old powertrain plants closing in the North*

- The net impact of electrification is a reduction in the automotive and induced labor force by ~200,000 (-7%) jobs by 2030 if the markets reach the administration's goal of 50% EV production

Labor Intensity Impact Assessment

BEV VS. ICEV COMPONENTS AND IMPORT VS. DOMESTIC CONTENT

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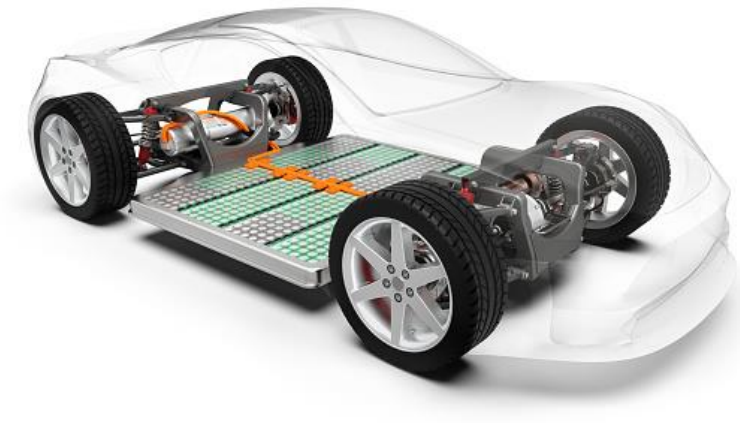
BEV vs. ICE Vehicle Components Comparison

BEVs have significantly less components than ICEVs resulting in a lower degree of hours to assemble.*

BEV Vehicle Powertrain

~200 Components



- = Does not have
+ = Has
+/- = May or may not depending on design

+	Electric Motors	–
+	Large Battery Pack(s)	–
+	Charging Converter/Inverter	–
+	High Voltage Wiring	–
+	Electric Thermal Management	–
+	Battery Mgmt. Sys. Controller	–
+	Single Ratio Transmission	–
+/-	Driveshaft	+
+/-	Axle	+
+/-	Differentials	+
–	Multi-Gear Transmission	+
–	Combustion Engine	+
–	Fuel System	+
–	Exhaust System	+
–	Alternator & Starter	+

ICE Vehicle Powertrain

~1,400 components

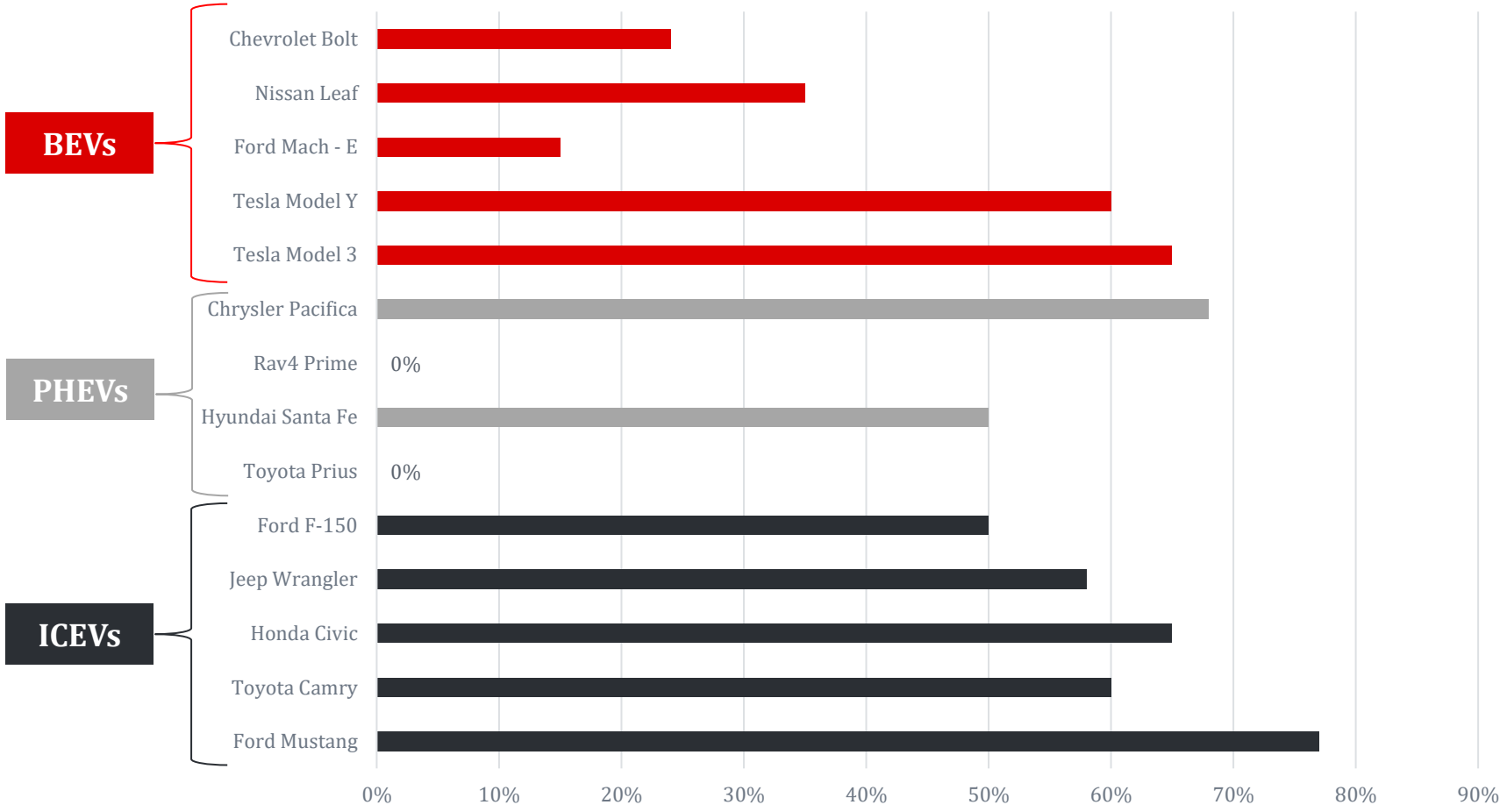
Image Source: istock

**Note: Subject matter experts indicated a 10% - 30% reduction in labor hours for final vehicle assembly.*

Component Supply Domestic vs. Import

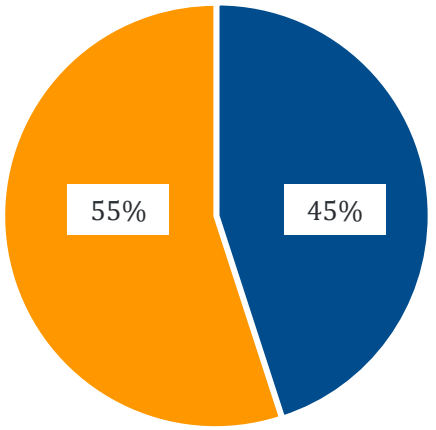
BEVs on average have a higher degree of imported parts than ICEVs. This is expected to shift over time as BEVs grow in the USA

Examples of % of Components Sourced from USA & Canada vs. Imported

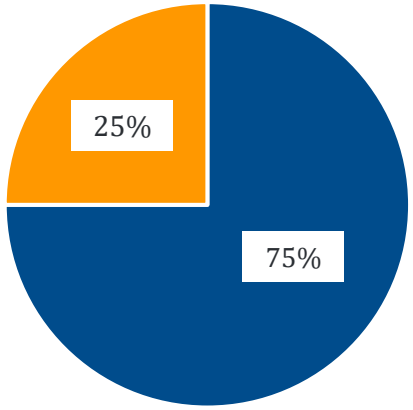


Source: NHTSA AALA 2021. Examples are based on 2021MY.

BEV Avg. Domestic vs. Import*



ICEV Avg. Domestic vs. Import*



Domestic Components Foreign Components

Source: EPI "The stakes for workers in how policymakers manage the coming shift to all-electric vehicles" and Martec research & analysis.

Labor Intensity Impact Assessment

LABOR FINDINGS TO-DATE: IMPACT ON AUTO OE SECTOR

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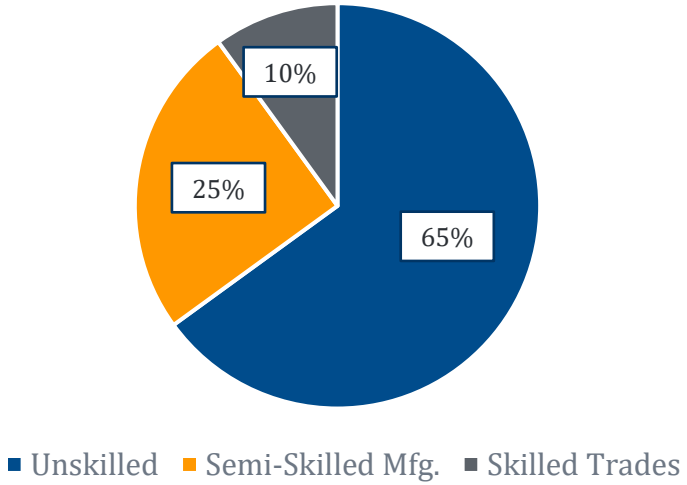
ICEV Powertrain Labor vs. BEV Battery Labor

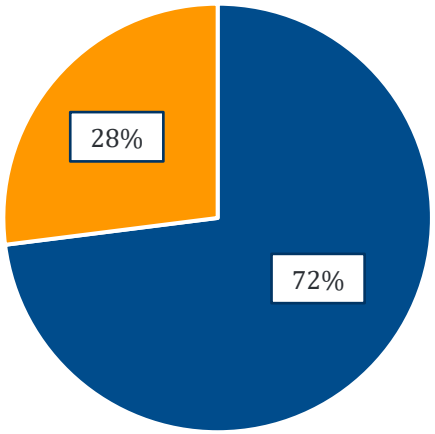
BEVs will utilize a greater degree of unskilled labor due to less components

ICEV Labor Category	ICEV Powertrain Classifications	Low to High Hourly Base Wage Rate + Shift Differential*	Approximate Average Base Wage rate + Shift Differential*
Unskilled	Assembly, QC, Material handling / GSE	~$27 - $35/hr.	~$31/hr.
Semi-Skilled Mfg.	Machinists	~$31 - $36/hr.	~$33/HR.
Skilled Trades	Machine Repair, Millwright, Welder, Pipefitter, Tool & Die, Electricians	~$32 - $41/HR.	~$37/HR.
BEV Labor Category	**BEV Battery Cell & Pack Classifications**	**Low to High Hourly Base Wage Rate**	**Approximate Average Base Wage rate**
Unskilled	Assembly / Production associate, QC associate, Visual response technicians, Rework technicians, Material handling	~$16 - $25/hr.	~$21/hr.
Semi-Skilled/ Skilled Trades	Industrial maintenance mechanic (IMM) / repair, Metrology technician, Robotic programmers, Welder, Tool & Die, Electricians	~$26 - $40+/hr.	~$32/hr.

ICEV Powertrain Labor
Unskilled vs. Skilled*



BEV Battery Pack Labor
Unskilled vs. Skilled**



Source: Combination of Martec primary research and The White House Report: Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth June-2021.

**Note: Hourly wages are based on represented powertrain facilities including base wage + avg. shift premiums & team leader hourly bonus rate.*

***Note: Typical Battery cell/pack manufacturing can vary from 25% - 33% skilled mfg./trades vs. unskilled labor.*

****Note: Excludes fringe benefit costs. Figures are based on hourly compensation.*

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Labor Intensity Impact Assessment

LABOR FINDINGS TO-DATE: IMPACT ON SERVICE SECTOR

Martec

Impact of Vehicle Maintenance

BEVs have significantly less components than ICEVs resulting in a lower degree of vehicle service

Service Item	Service Impact
Engine Oil Chang	–
Oil Filter Change	–
Engine Air Filter	–
Spark Plug Change	–
Oxygen Sensor	–
Exhaust System/Muffler Replacement	–
Timing Belt Change	–
Accessory Drive Belt	–
Fuel Filter Change	–
Transmission Servicing	–
Engine/Radiator Coolant	–
Multi-Point Inspection	0
Cabin Air Filter	0
Headlight Bulbs	0
Starter Battery Change	0
HVAC Service	0
Shocks & Struts	0
Wiper Blades	0
Brake Fluid	0
Brake Pads/Rotors/Calipers	E (Elongated)
Tire Rotation	0
Tire Replacement	+ (More Frequent)
EV Battery Coolant	+ (New)

- Due to the reduction of components and fluids a variety of service items on an ICE vehicle are eliminated compared to a BEV
  - *These service items are identified with a negative ("-") sign and highlighted in red*
  - *This will have an impact over time in certain segments of the auto repair market and shops*
- Many service items will not be impacted at all by conversion to BEVs and will maintain the same service intervals as ICEVs
  - *These service items are identified with a neutral ("0") sign and highlighted in grey*
- Some service items will be elongated as the wear & tear will be reduced, thus increasing the life of the component
  - *These service items are identified with a neutral ("E") sign and highlighted in orange*
  - *Brake pad/rotor/caliper replacement will be extended from 40k - 60k to 75k – 150k+ miles*
- Some items will be either more frequent or will be new to the automotive service repair channel
  - *BEVs tend to be 20-25% heavier resulting in early wear on tires*
  - *EV battery coolant replacement is still evolving as a new svc.*

Typical Service Schedules by Vehicle Type

Service	Service Interval (mi)			
	ICEV	HEV	PHEV	BEV
Engine Oil*	7,500	7,500	9,000	
Oil Filter*	7,500	7,500	9,000	
Tire Rotation	7,500	7,500	7,500	7,500
Wiper Blades	15,000	15,000	15,000	15,000
Cabin Air Filter	20,000	20,000	20,000	20,000
Multi-Point Inspection	20,000	20,000	20,000	20,000
Engine Air Filter*	30,000	66,667	83,333	
Brake Fluid	37,500	37,500	37,500	37,500
Tires Replaced	50,000	50,000	50,000	50,000
Brake Pads*	50,000	66,667	75,000	75,000
Starter Battery	50,000	50,000	50,000	50,000
Spark Plugs*	60,000	120,000	120,000	
Oxygen Sensor*	80,000	80,000	80,000	
Headlight Bulbs	80,000	80,000	80,000	80,000
Transmission Service*	90,000	110,000	110,000	
Timing Belt*	90,000	110,000	110,000	
Accessory Drive Belt*	90,000	110,000	110,000	
HVAC Service	100,000	100,000	100,000	100,000
Brake Rotors*	100,000	125,000	150,000	150,000
Shocks and Struts	100,000	100,000	100,000	100,000
Engine Coolant*	125,000	125,000	125,000	
EV Battery Coolant*		125,000	125,000	125,000
Fuel Filter*	150,000	150,000	200,000	
Brake Calipers*	150,000	187,500	225,000	225,000
Total Cost per Mile				

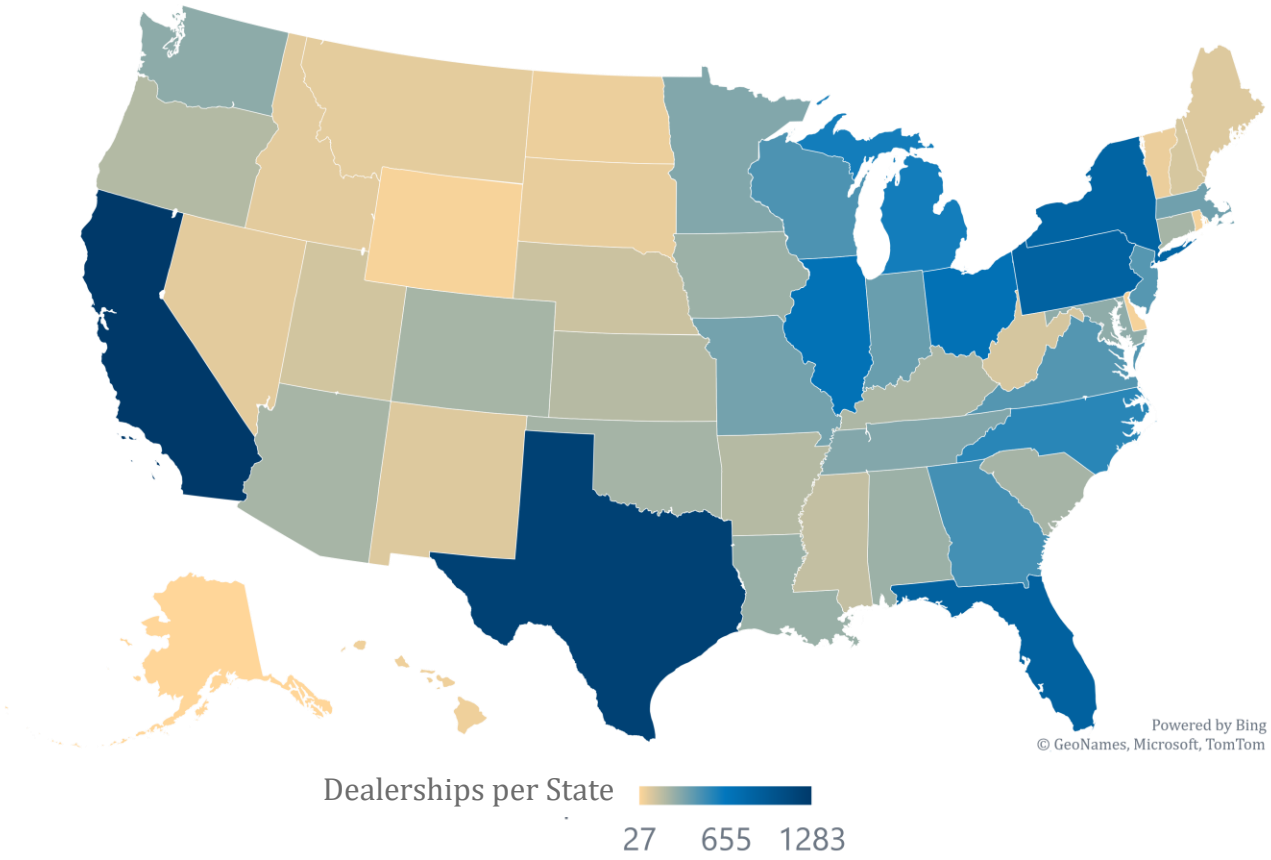
* Service intervals that vary by powertrain

Source: US Department of Energy 2021 "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains"

- U.S. Department of Energy analyzed a variety of common service items comparing changes in intervals and cost
  - *DOE evaluated all four major vehicle powertrain configurations comparing ICEVs to differences with HEVs, PHEVs and BEVs*
- Martec analyzed the impact on a select group of service shops where labor could be impacted the most whether on a negative or a positive basis
  - *Martec focused its research efforts on shop types where certain services tend to be more concentrated, these include the following:*
    - Oil change shops
    - Exhaust system repair / Muffler shops
    - Transmission repair
    - Tire repair/replacement
- Some service items are done by general automotive repair shops who conduct a variety of these auto repairs
  - *>153,000 general auto service shops exist in the U.S.*
  - *Brake repair & replacement is primarily done by these types of shops*

Light-Duty Automotive Dealership Locations Overview

U.S. LD Auto Dealerships by State - 2020



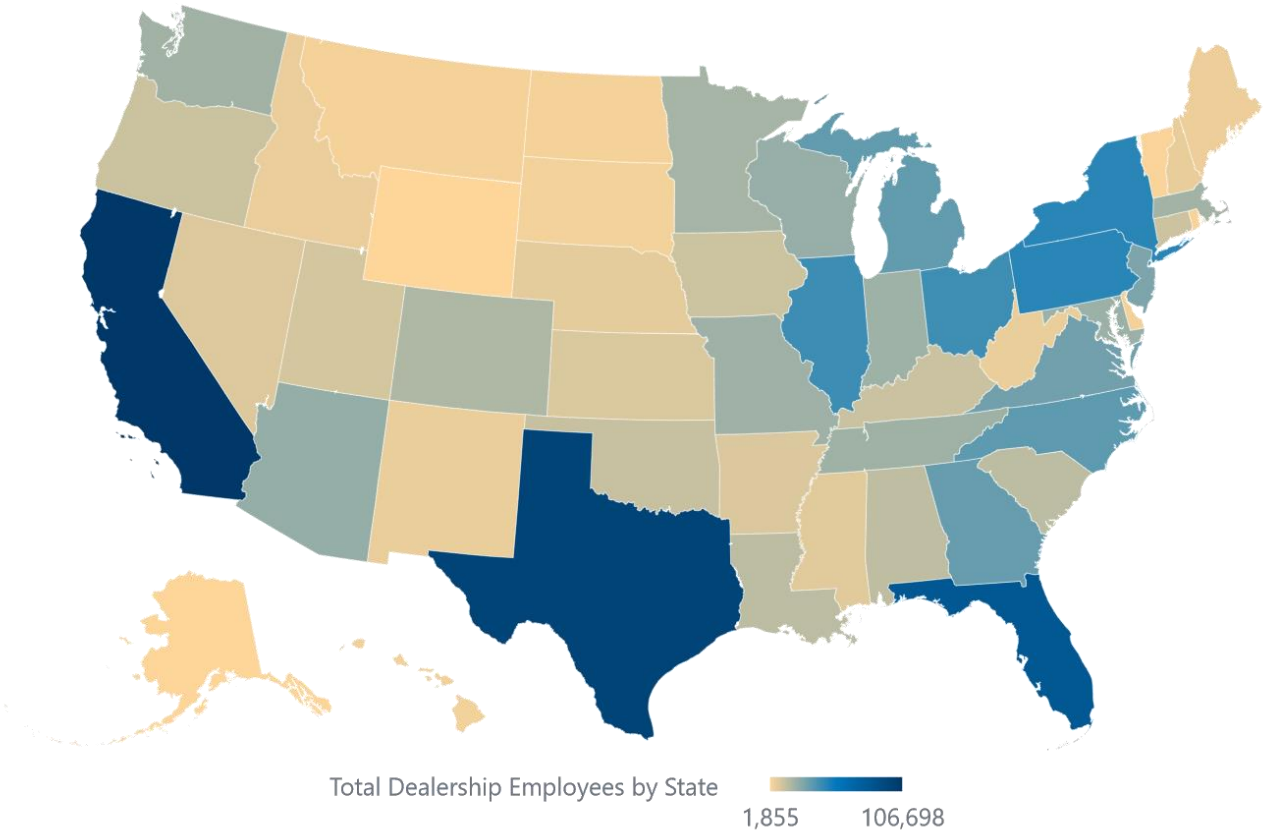
- Number of car dealerships in the US in 2020 = 16,623
  - *Top 5 states represent 31% of new car dealerships:*
    - CA = 1,283 locations
    - TX = 1,203 locations
    - FL = 878 locations
    - PA = 863 locations
    - NY = 848 locations
- Number of repair orders written in 2020 = 265.1M
  - *~36.7M (or 14%) of repair orders were express services which is predominantly oil/ fluid changes*
  - *Express services have become an increasing part of car dealership business in order to increase traffic into the dealership*
- Service & Parts totaled ~$111.2B in revenue in 2020 for car dealers
  - *Svc. & Parts tends to be a major contributor to the profitability of a dealership*

SOURCE: 2020 NADA Report

Note: Excludes used car only dealers.

Light-Duty Automotive Dealership Labor Overview

U.S. LD Auto Dealership Labor by State - 2020



C Level technicians are most vulnerable in the future due to least trained to service high-voltage EVs; higher technical levels & safety training required for EVs. Feedback that lower levels of service will gradually phase out as BEVs displace ICEVs in VIO.

- Total number of car dealership employees in the US in 2020 = 1,077,900
  - *National avg. ~64 total employees per dealership*
  - *~25% of dealership workforce are repair technicians*
    - ~253,012 service repair technicians nationally; down from 267k in 2019 primarily due to COVID
    - ~15 - 16 Technicians on average per dealership
- Repair technicians typically breakdown into 3 main categories:
  - *A Level (~25%): Highly skilled, major repairs with engine & transmissions including repairs on EVs*
  - *B Level (~50%): Conduct most standard repairs and will handle major repairs as needed*
  - *C Level (~25%): Entry level repair, oil/fluid/filter changes and car prep*
    - Perceived as most vulnerable as BEVs grow
    - ~75,000 U.S. employees
- Currently #1 concern is not BEV growth but availability of qualified technicians due labor shortage
  - *Dealerships avg. 1 to 2-week backlog*

SOURCE: 2020 NADA Report and primary interviews conducted by Martec.

Note: Excludes used car only dealers.

Martec

Impact of BEVs on New Car Dealership Labor - Preliminary

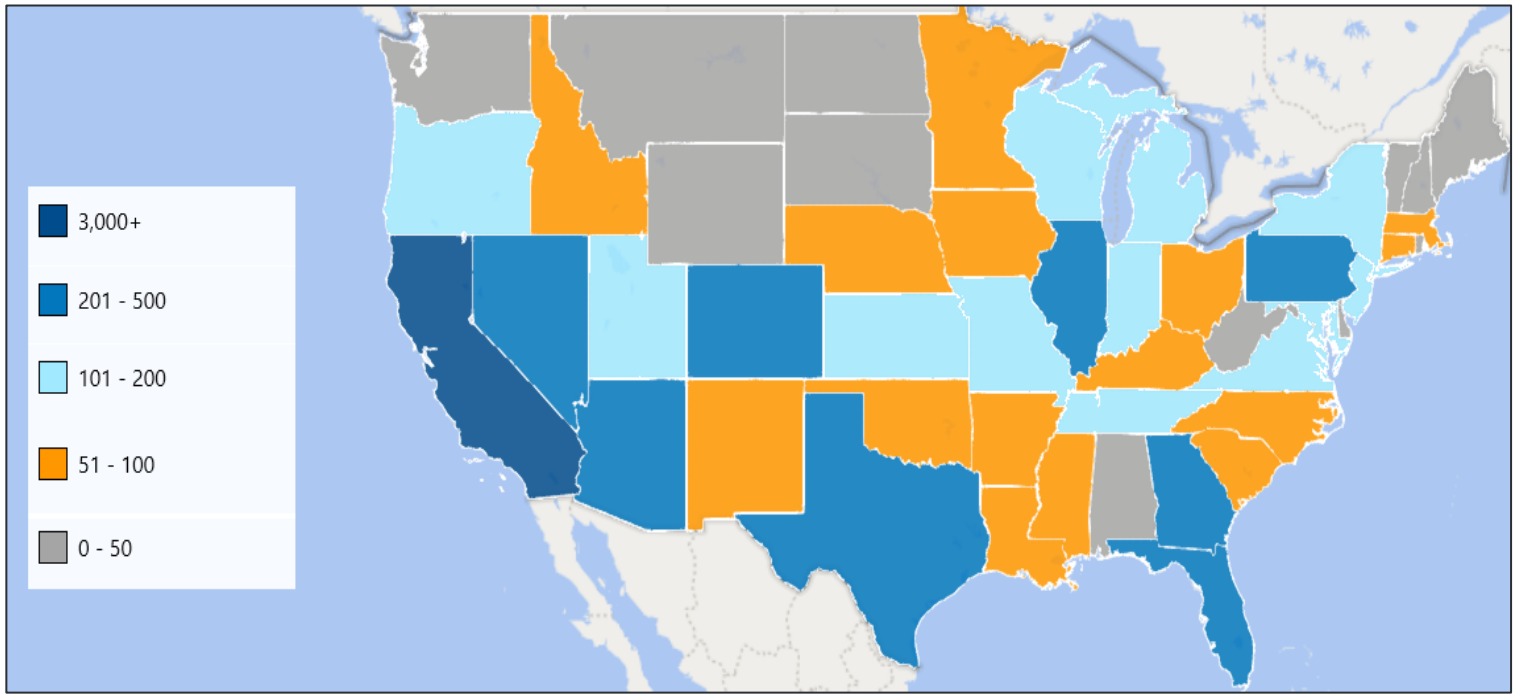
Initial feedback from new car dealerships

Impact on the dealership business & labor from growth of BEVs has been on the radar for a couple years.

- Dealerships have mocked up financial proformas to gauge potential impact
  - *Initial beliefs are ~10% - 30% of service reduction could take place*
  - *Reduction in maintenance will take some time up to 10 years or beyond before any significant impact is realized*
- Many dealerships see major obstacles that still need to be overcome
  - *Charging infrastructure not in place*
    - Utility grid is not ready
  - *Significant upgrades in home charging required*
    - ~80% - 85% of charging today is done at home
  - *Skeptical that full spectrum of consumers are ready to switch to BEVs*
  - *Chip shortage & supply-chain issues will continue to take time and similar possibilities occurring with more advanced BEVs in the future*
- Initial impact will be regional before impacting US as a whole
  - *States that are pushing faster growth or tend to prefer electrified vehicles will be impacted first*
    - Dealerships on West coast states (i.e., CA, WA and OR), CO and Northeast states will likely be impacted sooner than rest of nation
- Mechanical parts will still exist (i.e., brakes, tires, etc.) and will still be required
  - *New maintenance will need to be done such as battery coolant changes and diagnostic checks for PM*
- Overall, the initial belief is the impact will be minor to start and will likely be 2030 before BEV volumes take hold on affecting the service side of the market

Oil Change Shops by State

Number of Shops by State



- Number of quick-change oil shops in USA = ~8,480
  - ➢ *<u>Top 5 Oil Change Shop States:</u>*
    - California
    - Texas
    - Pennsylvania
    - Florida
    - Illinois

- Martec is also tracking general repair shops which represent >153,000 shops across the US that would also provide oil changes as part of their service
  - ➢ *Impact of BEV growth may also be felt in the general repair shops but due to variety of repairs conducted by this segment interviews to-date believe the impact will take beyond a decade to be visible to this segment*

SOURCES: Combination of SafeGraph, NOLN, IBIS, Statista and Martec primary research and analysis.

Oil Change Shops Employment by State

Number of Employees by State

- Total Number of employees at oil change shops in USA = ~50,800
  - *Feedback on labor impact could be 10% - 15% at most by 2030 and up to 30% by 2040**
    - *Could leave up to ~5,000 – 7,500 employees at oil change shops vulnerable if BEVs were to grow substantially*

- Typical Total Number of Employees Range (low to high) = 2 – 10

- Avg. Number of Employees = 5 – 7
  - *Minimum required to efficiently operate a quick-change oil repair shop is ~2 – 3 technicians*
  - *In upwards of 50% of technicians can be part-time employees*

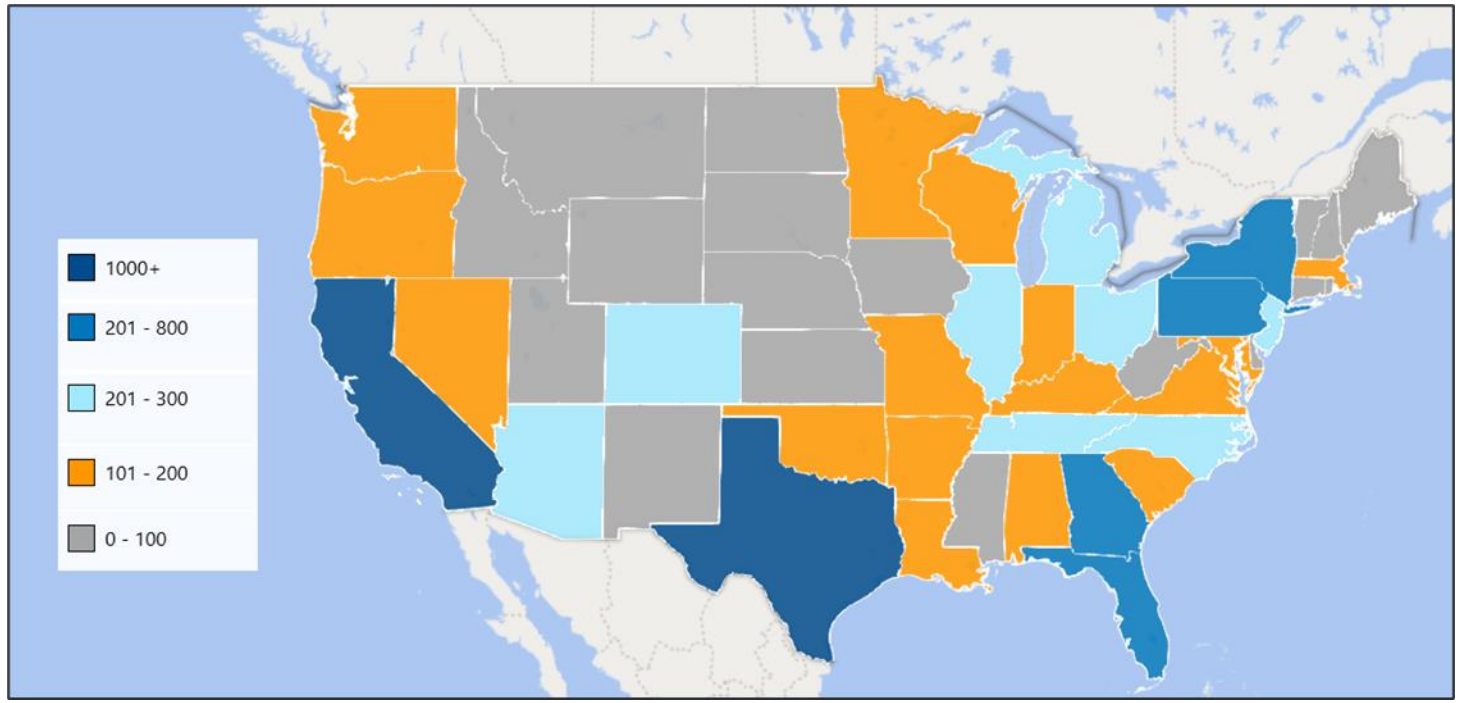
- <u>Top 5 Greatest Challenges for Shops:</u>
  - *#1 Labor availability / Quality of available labor (education)*
  - *#2 Cost of Goods/Margins*
  - *#3 Extended service intervals*
  - *#4 Electrification of vehicles*
  - *#5 Market saturation*

SOURCES: Combination of SafeGraph, NOLN, IBIS, Statista and Martec primary research & analysis.

**Note: Martec conducted primary interviews with oil change shop owners & managers, as well as industry associations and subject matter experts.*

Transmission Repair Shops by State

Number of Shops by State



- Number of transmission repair shops in USA = ~9,663
  - *Top 5 Transmission Repair Shop States:*
    - California
    - Texas
    - Florida
    - New York
    - Georgia
- These tend to be dedicated shops, but some may offer additional repair services as part of their business

SOURCES: Combination of SafeGraph IBIS, Statista and Martec primary research & analysis.

Transmission Repair Shops Employment by State

Number of Employees by State

- Total number of employees at transmission repair shops in USA = ~25,000 – 30,000
  - *Initial feedback on labor impact could be negligible to 10% at most by 2030*
    - *Transmission shop owners & managers were not confident that a significant impact would happen within this decade*
      - Most indicated that a visible impact wouldn't occur until ~2035 as more BEVs likely will be in the VIO
      - Most new car sales will have powertrain items service through the dealer for the first 5 – 7 years
      - Major ICE powertrain work tends to occur with vehicles between 7 – 12 years of age
    - *Could leave up to ~1,000 – 1,500 employees at oil change shops vulnerable if BEVs were to grow substantially*

- Typical Total Number of Employees Range (low to high) = 2 – 8

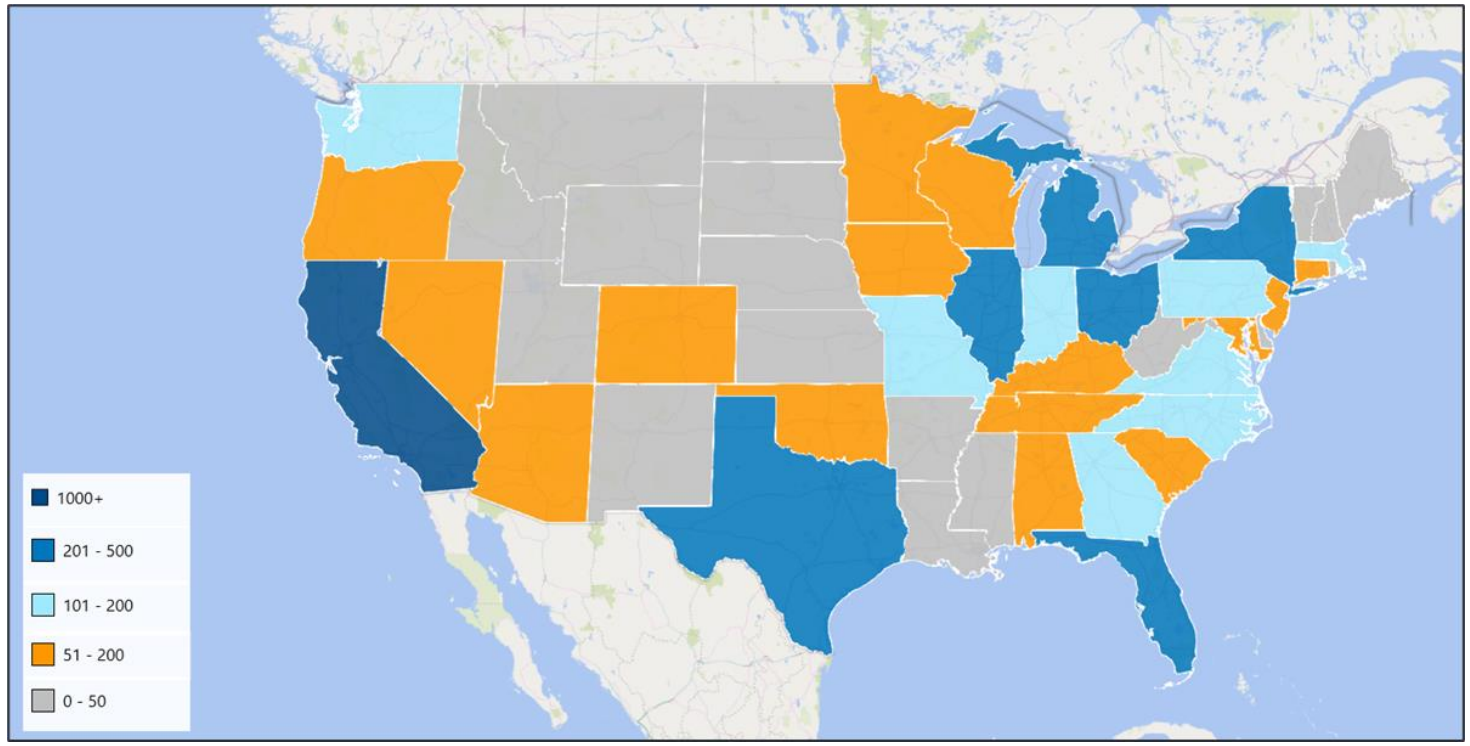
- Avg. Number of Employees = 3 - 4
  - *Minimum required to efficiently operate a quick-change oil repair shop is ~2 technicians*

- Wage rates for transmission technicians tend to be higher due to it being a specialty higher skilled type repair position
  - *Hourly wage rates low to high = $22 - $40+/hr.*
  - *Avg. hourly wage rate = $29/hr. (will vary by region and population density level)*

SOURCES: Martec primary research & analysis.

Exhaust System / Muffler Repair Shops by State

Number of Shops by State



- Number of exhaust system repair / muffler shops in USA = ~6,502
  - *Top 5 Exhaust System Repair Shop States:*
    - California
    - Texas
    - Illinois
    - Ohio
    - Florida
- These tend to be dedicated shops, but some may offer additional repair services
- Greatest Challenges for Exhaust Shops:
  - *#1 Labor availability and keep labor*
  - *#2 Exhaust systems do not wear out like they use to as many utilize stainless-steel*
    - Has become more common to see exhaust repair due to rear collisions than wear & tear
    - Hangers and fasteners for exhaust system will tend to rust or wear out before major components

SOURCES: Combination of NAICS Association and Martec primary research & analysis.

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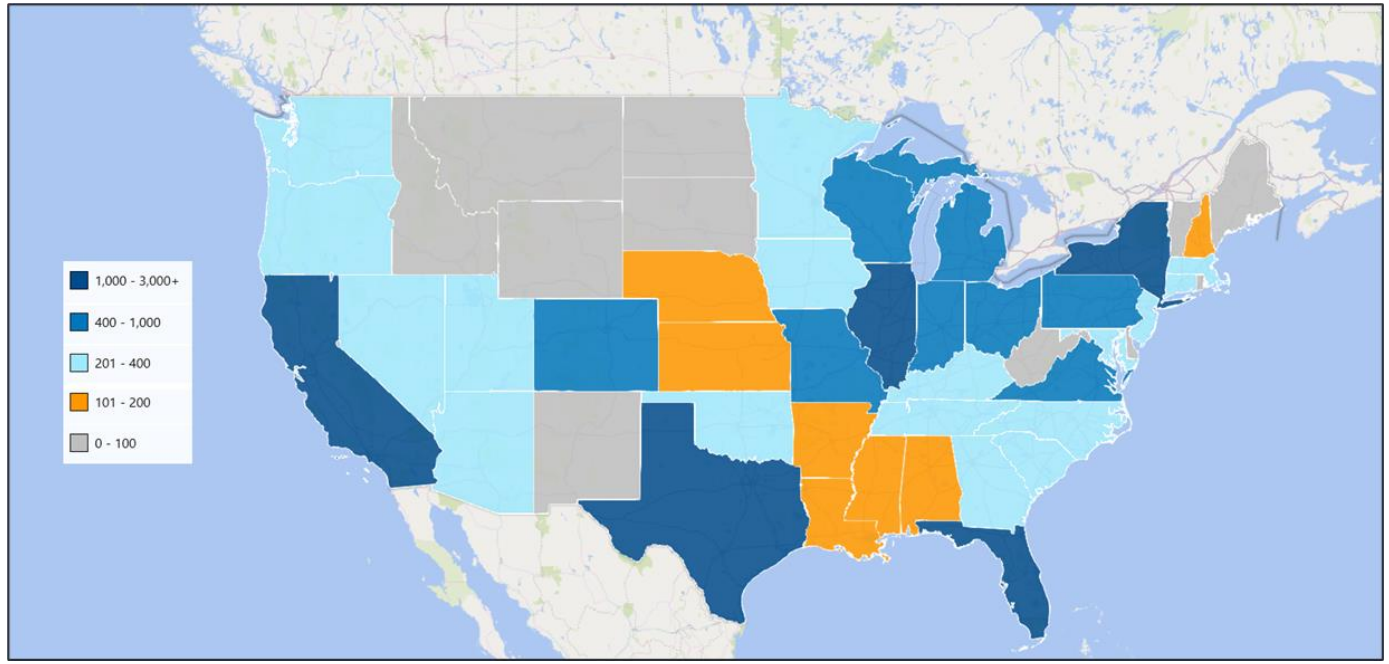
Exhaust System / Muffler Repair Shops Employment by State

Number of Employees by State



- Total Number of employees at exhaust system repair shops in USA = ~19,300
  - *Feedback on labor impact could be up to 5% by 2030*
    - *Could leave up to ~600 – 1,000 employees at exhaust system repair shops vulnerable*
- Typical Total Number of Employees Range (low to high) = 2 – 6
- Avg. Number of Employees = ~3
- Exhaust repair shops also tend to conduct emissions testing for certification as required by 30 states in the U.S.
  - *Many see this as a lost offering in their portfolio over time but do not see a significant impact to employment until beyond 2030*
  - *States like CA, CO and NY will likely feel impact first due to being more pro-EV*
  - *CA largest state with most vehicles and requires emissions testing*
- Wage rate range (low to high) = $15 - $30/hr.
  - *Avg. wage rate = ~$21/hr.*

SOURCES: Combination of SafeGraph, NOLN, IBIS, Statista and Martec primary research & analysis.

Tire Dealer & Repair Shops

Number of Shops in U.S.

- Number of tire dealers & repair/replacement shops in USA = ~33,762 (Martec working on state-by-state coverage)
- Total industry employment = ~185,600 (preliminary)
- Avg. employment per shop = ~5 - 6
- Wage rate for repair technicians (low to high) = ~$12 - $25/hr.
  - *Avg. wage rate = ~$17 - $18/hr.*

- <u>Current trends in tire repair market with growth of BEVs:</u>
  - *Many experts are predicting a significant growth or boom to the tire repair/replacement market as current trends are BEVs tend to be ~15% - 20% heavier causing early wear & tear on tires*
  - *Some respondents indicated tire manufacturers such as Continental, Pirelli and Bridgestone have started to recently introduce a higher-load tire with an HL designation*
    - Tires are designed with additional ply-layers and stiffer walls to handle heavier loads (similar to run-flats)
  - *Majority of tires for ICEVs last between 40k – 60k miles*
    - Initial feedback that XL rated tires are lasting ~30k – 40k miles for BEVs (~20% - 30% faster than ICEVs)
    - Introduction should offset a good portion of this early wear & tear but will come with a stiffer ride in the vehicle
    - Consumers want longer wearing tread; tire OEMs will continue to make modifications with new designs, materials & composites to increase tire life

SOURCES: IBIS World and Martec primary research & analysis.

Note: Martec continues to investigate if there will be a positive impact to employment by tire dealers & repair shops.

Key Service/Repair Sectors

Which auto service/repair sectors labor is the most vulnerable from BEV growth

Based on primary interviews conducted to-date, the following auto repair/service sectors were mentioned as the most vulnerable in loss of business and labor as BEVs grow:

- Oil change shops
- Exhaust system / Muffler shops
- Transmission repair shops
- Emission testing / certification shops
  - *Currently 34 US states require emission testing for vehicles*
  - *Expectation that these facilities or offerings at shops will experience a reduction in volume and labor over time*
- Automotive new car dealers
  - *A portion of labor/workforce may be impacted due to the reduction of certain services done on an ICE vehicle (i.e., oil & fluid changes)*
  - *Opportunities should exist to train a portion of workforce for electrified vehicles*
- Auto parts stores
  - *Will be impacted as belief that DIY market will decline to DIFM due to increased complexity of vehicles and high voltages making it more difficult for a consumer to work on BEVs*
- Brake repair shops
  - *Lower degree of wear & tear on brakes as BEVs and smarter electrified vehicles should help extend brake life*

Labor Intensity Impact Assessment

FINDINGS TO-DATE:
GLOBAL & DOMESTIC BEV INVESTMENTS

Martec

Overview of Electric Vehicle Announcements - Preliminary

Global & US Announcements by Major North American Vehicle Manufacturer

Vehicle OEM	EV Supply Announcements	Investment(s) in the US	Investment Outside the US

gm	• 1M global annual EV sales by 2025
	  ➢ *Pre-COVID GM produced ~8M – 10M vehicles per year*
	• 30 electric models globally by 2025, with 20 available in North America
	• Plan to offer 100% BEVs by 2035
	  ➢ *Cadillac 100% BEV by 2030, representing ~0.4M+ of vehicles*
	• Carbon neutral target by 2040
	• Plans to expand Chinese and North American EV manufacturing capability to 50% of total footprint
		• $35B global total investment by 2025
		  ➢ *$4.5B (13%) to upgrade plants for EV production*
		  – ~$2.2B Hamtramck, MI plant
		  – ~$2B Spring Hill, TN plant
		  – ~$750M Orion, MI plant
		  ➢ *$4.6B (13% battery manufacturing investment out of $35B globally by 2025*
		• 40% models offered will be BEV (2025)
			• JV with China's highest volume BEV in 2020 Wuling MINI
			• (9) EV models in China by 2020
			• 40% of new model launches will be BEV in China by 2025
			• Revamped plants in Shanghai, Wuhan and Liuzhou for BEVs
			• $1B in BEV manufacturing complex in Mexico

Ford	• 40% of global sales electric by 2030
	• 100% models in Europe plug-in electric by 2026 (PHEV & BEV)
	• All-electric in Europe by 2030
	• Plans to be carbon neutral by 2050
		• $1.7B (6%) to upgrade plants for EV production
		• $525M investment to train service technicians
		• $11.4B+ investment by Ford & SKI JV for (3) battery plants, truck plant, supplier park & recycling center in KY (2) and TN (2)
		  ➢ *Ford ~$7.0B investment*
		  ➢ *SKI (supplier) $4.4B investment*
			• $30B by 2025 globally for EV production
			• $420M+ in Mustang Mach-E production in Mexico
			• $1.5B investment to retool in Canadian plants
			• $1B investment in German electric vehicle plant

Sources: ICCT, Reuters, Bloomberg, Forbes and research by Martec.

Overview of Electric Vehicle Announcements *(continued)*

Global & US Announcements by Major North American Vehicle Manufacturer

Vehicle OEM	EV Supply Announcements	Investment(s) in the US	Investment Outside the US
STELLANTIS	• 70% of European sales electrified by 2030 • 40% of US sales electrified by 2030 ➢ *Jeep line product will have EV option by 2025* • Will offer 55 electrified models (PHEV & BEV) by 2025 (US & Europe markets)	• 40 GWh plant announced (10/2021) with partner LG by 2024 • 40 GWh battery plant announced (10/2021) with partner Samsung SDI ➢ *Starting capacity 23 GWh by 2025*	• Plans to invest $35.5B by 2025 in electrified vehicles (BEV & PHEVs)
VOLKSWAGEN GROUP	• Expected EV sales through 2028 by key region: ➢ *China ~60%* ➢ *Europe 26%* ➢ *North America ~11%* • >40% of VW Group's global sales to be BEV by 2030 (70% in Europe; 50% in US) • Almost 100% of VW Group's sales by 2040 • Carbon neutral by 2050	• $800M expansion for EV production in Chattanooga, TN plant	• Plan $86B investment globally from 2021 – 2025 (50% of total investments) • $29B planned for future battery plants • $17B investment in China by 2025 • ~$3B investment for BEV Anting & Foshan, China plants • ~$1.65B for BEV plants in Zwickau & Emden, Germany plants

Sources: ICCT, Reuters, Bloomberg, Forbes and research by Martec.

Overview of Electric Vehicle Announcements *(continued)*

Global & US Announcements by Major North American Vehicle Manufacturer

Vehicle OEM	EV Supply Announcements	Investment(s) in the US	Investment Outside the US
HYUNDAI / KIA	• Hyundai: ➢ *13% by 2025 (0.6M vehicles)* • Kia: ➢ *17% by 2026 (0.5M vehicles)* ➢ *27% by 2030*	• $7.4B US investment by 2025 • Hyundai will expand Alabama plant • Kia will expand Georgia plant	• $16B globally through 2025 (Hyundai) • $25B through 2025 (Kia) • Hyundai targeting 23 BEV models and 6 PHEV models by 2025 • Kia targeting 11 electrified models by 2026
TOYOTA	• 70 electrified models by 2025 ➢ *15 models will be BEVs* • First target for BEVs is China then Japan, India, US and Europe • Targeting 8M electrified vehicles by 2030 • Carbon neutral by 2050	• ~$800M investment in further electrification in Princeton, IN plant (likely mix of BEV and PHEV) • $1.29B Battery plant announced (10/2021); will eventually employ 1,750 workers by end of decade ➢ *Part of $3.4B investment in U.S. battery production by 2031* ➢ *Potential locations near MO, TX, IN, KY or AL*	• ~$13.7B globally in EV batteries supply-chain and R&D investment by 2030 • $1.2B investment in Tianjin, China EV plant with FAW • New JV with BYD for EVs in China
HONDA	• Targeting 100% EV globally by 2040 ➢ *100% electrified by 2025 in Europe* ➢ *Two-thirds electrified globally by 2030* • Further behind most vehicle OEMs • Plans to be carbon neutral by 2050	• Current plans only show 2 models by 2024 based on using GM's Ultium EV platform • Investment plans N/A	• $430M facility in China • $300M for battery plants supply-chain

Sources: ICCT, Reuters, Bloomberg, Forbes and research by Martec.

Overview of Electric Vehicle Announcements *(continued)*

Global & US Announcements by Major North American Vehicle Manufacturer

Vehicle OEM	EV Supply Announcements	Investment(s) in the US	Investment Outside the US
TESLA	• 1M vehicles (100% BEV) by 2022 • Targeting 20M vehicles globally by 2030 (BEV) • 6 all electric models	• $1B factory in Texas	• $5B in Shanghai, China plant • $4.4B in Berlin, Germany plant
RIVIAN	• 400,000 Vehicle target set for 2025 (100% BEV) • Six all electric models by 2025	• $750M plant in Illinois	• Plans to launch sales in Canada 2021, Europe in 2022
LUCID	• 380,000 vehicle target (100% BEV) by 2022	• $700M Plant in Arizona	• Currently accepting pre orders in Europe

Sources: ICCT, Reuters, Bloomberg, Forbes and research by Martec.

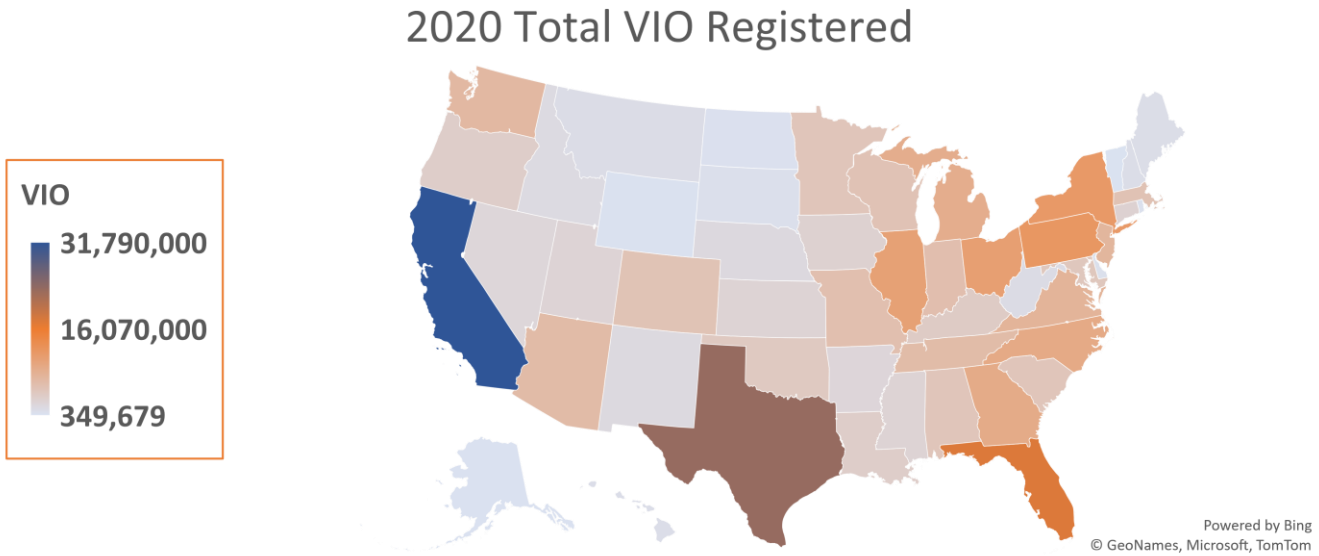
Labor Intensity Impact Assessment

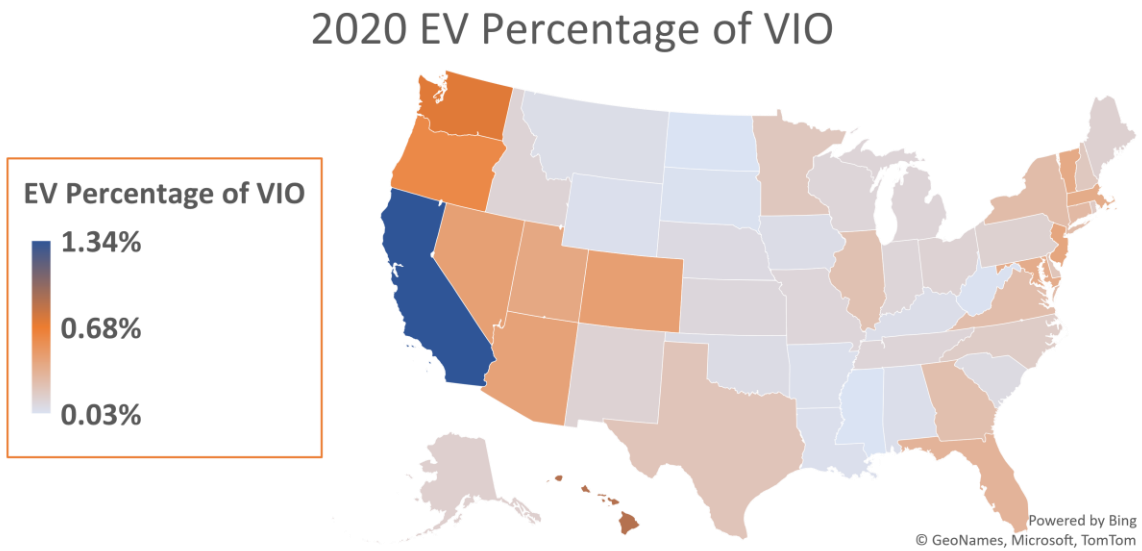
ADDITIONAL INFORMATION

Martec

Total VIO Registrations in U.S. vs. EVs

Which auto service/repair sectors labor is the most vulnerable from BEV growth





There are ~281M Light-Duty vehicles-in-operation (VIO) registered in the U.S. in 2020.

- *EVs account for <0.5% of the U.S. VIO in 2020*

California, Texas and Florida combined represent ~26% of the total VIO.

- *California alone represents 42% of EV registrations nationally*

West coast states will continue to adopt EVs faster than the rest of the nation resulting in those states LD automotive service labor force being impacted faster than other areas.

- *Martec continues to analyze this and its impact by the different service areas*

Martec

Next steps and timing

PATH FORWARD

Path Forward

Martec will continue to research all objectives in the labor intensity market assessment

- Discuss report findings
- Discuss questions from API team
- Discuss report format
- Discuss potential future questions or formats to help support API team
- Discuss next meeting update

Thank you for this opportunity.

We look forward to working with you to create solutions that will guide your success.

Keith Miller

248.327.8038

keith.miller@martecgroup.com

https://www.martecgroup.com/

Martec