Opportunity AV: How Many and What Types of Jobs Will Be Created by Autonomous Vehicles?

Prepared For :

CHAMBER OF PROGRESS

Prepared By:

steer

FOURTH ECONOMY
A Steer Company

About Chamber of Progress

Chamber of Progress is a tech industry coalition devoted to a progressive society, economy, workforce, and consumer climate. We back public policies that will build a fairer, more inclusive country in which all people benefit from technological leaps.

The following report on autonomous vehicles is an independent report commissioned by Chamber of Progress and developed by Steer and Fourth Economy.

About the Consultants

Working across cities, infrastructure, and transportation, Steer is a consultancy that combines commercial, economic, technical, and planning expertise to find powerful answers to our clients' complex questions. Fourth Economy is a national strategy firm focused on community and economic development. We partner with communities and organizations, public and private, who are ready for change to equip them with tools and innovative solutions to build better communities and stronger economies.

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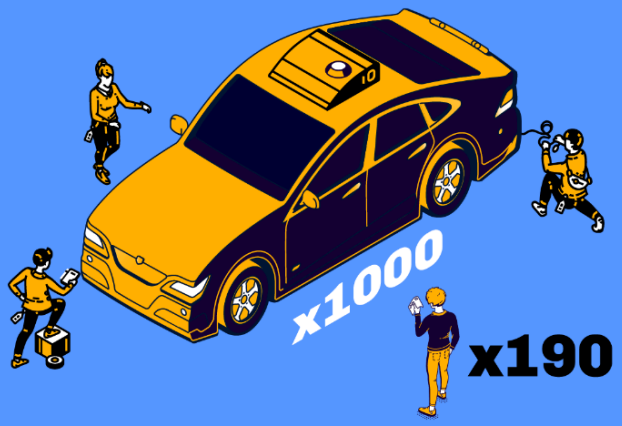
KEY FINDINGS

Based on analysis of the AV industry and inputs from industry stakeholders, we present below some key takeaways relating to AV impacts on the workforce, and recommendations that will help shape the future of the U.S. AV industry.



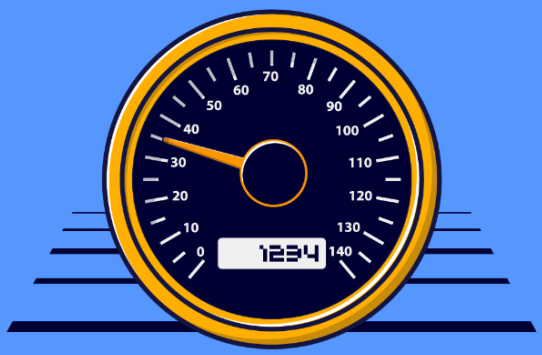
GROWING DEMAND FOR SKILLED WORKERS

Based on our analysis, for every 1,000 AVs approximately 190 jobs will be required for manufacturing and servicing of these vehicles.

EXPANDING OPPORTUNITY

82%

of AV workers make more than the U.S. median wage. Many of these high-paying jobs are accessible to workers without a college degree.



PLENTY OF ROAD AHEAD

Automation and AV adoption may drive concerns about future job losses. The impact, however, will be gradual, providing the workforce time to plan and update skills for the future as the transition unfolds, rather than occurring overnight.

DRIVING REGIONAL ECONOMIES

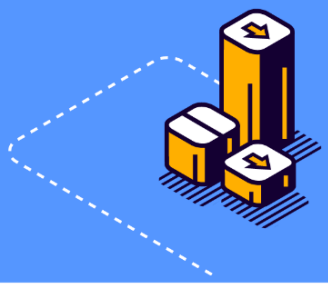
AVs can support the resiliency of the U.S. auto industry where it is strong today (MI, IN, AI, OH) and create new centers for AV-related jobs in places with strong tech sectors (MA, CO, CA).

PLANTING A FLAG

Establishing strong policy support along with growing the skills of the labor force, there is an opportunity for the U.S. to become a leading manufacturer and exporter of AVs.

ACCELERATING GROWTH

AV technology has the potential to spur growth in other industries such as off-road logistics, mining, defense, agriculture, and construction.



Key Findings

Based on analysis of the AV industry and inputs from industry stakeholders, we present below some key takeaways relating to AV impacts on the workforce, as well as recommendations that will help shape the future of the U.S. AV industry.

- **The AV industry supports workers with a range of skill levels, with many jobs accessible to workers without a college degree.** Proactive investment and policy support enable the broad deployment of AVs. This study considers the market readiness of on-road AVs to inform three potential scenarios. In a central AV fleet-size scenario, with a slow shift from traditional vehicles to AVs, there will be an estimated AV workforce of 114,000 workers to meet the production; distribution; and maintenance, upgrades, and repair needs of nearly nine million AVs produced over the next 15 years.

- **The total number of AV workers needed to develop, produce, distribute, maintain, upgrade, and repair AVs will depend on the AV fleet size.** In 15 years, future AV market size in the U.S. could range between 3.6 and 36 million vehicles, depending on the adoption rate of AVs across conservative to optimistic scenarios. That translates to an average annual production of 240,000 to 2.4 million AVs. The workforce needed to produce and maintain AVs ranges from 46,000 workers in a conservative AV fleet-size scenario to 455,000 in an optimistic AV fleet-size scenario.

- **AV industry jobs typically pay above U.S. median wage.** Our analysis suggests that 82 percent of AV workers make more than the U.S. median wage of $44,520. Many of these high-paying jobs are accessible to workers without a college degree. Of the AV workers in positions that do not typically require a bachelor's degree, 59 percent earn above the U.S. median wage. Examples of AV jobs that do not require a bachelor's degree include production and assembly line workers and service and maintenance technicians.

- **The U.S. has the potential to establish itself as a major exporter of AVs, including, but not limited to, vehicles, parts, technology, and knowledge.** The U.S. is currently a global leader in AV development and deployment. Establishing strong policy support along with growing the skills of the labor force, there is an opportunity for the U.S. to become a leading manufacturer and exporter of AVs.

- **The U.S. can build on its competitive advantage in the AV market.** Already, the United States–Mexico–Canada Agreement requires that 75 percent of a passenger vehicle's value originate in North America for it to receive duty-free treatment, and that 75 percent of "core parts," including advanced batteries, originate in North America. Furthermore, the Biden-Harris administration's CHIPS and Science Act of 2022

committed smart investment into research, science, technology, and workforce development to support the U.S. domestic manufacturing sector and ensure the country remains a leader in the manufacturing of the technology of tomorrow.[1]

- **AVs have the potential to create more high-skilled/specialized jobs in the automotive and adjacent industries.** The U.S. auto industry currently employs more than ten million people, including those who build vehicles and vehicle components at manufacturing plants throughout the country. These U.S.-based manufacturing facilities are well positioned to lead in the manufacturing of AVs and benefit from the growth and employment opportunities. Based on our analysis, for every 1,000 AVs approximately 190 jobs will be required for manufacturing and servicing of these vehicles—including 95 in Development and Production; 30 in Distribution; and 65 in Maintenance, Upgrades & Repairs.

- **AV companies are located throughout the United States and are actively hiring.** A recently released report from the Alliance for Automotive Innovation identified 84 AV companies in 30 states and 120 cities.[2] An analysis of job posting data from Lightcast™ indicates that companies are actively hiring for positions, with more than 800 job postings per month for open positions. AV companies are hiring for roles like software engineers, system engineers, manufacturing workers, vehicle technicians, and vehicle operators.[3]

- **Jobs replaced or repurposed by the AV industry will be gradual.** There is an ongoing concern about related job losses, such as those affecting taxi, for-hire, or delivery vehicle drivers. However, the impact on these jobs is expected to be very gradual as fleet automation or the transition to widespread adoption of AVs is not expected to happen overnight. This will allow the workforce to plan for and update their skills for the future. Additionally, recently published research suggests while vehicle automation may eliminate drivers, the deployment of AVs will still require human labor for many other roles, involving operation, safety, and ongoing maintenance. The report suggests that a driverless future may not be jobless.[4]

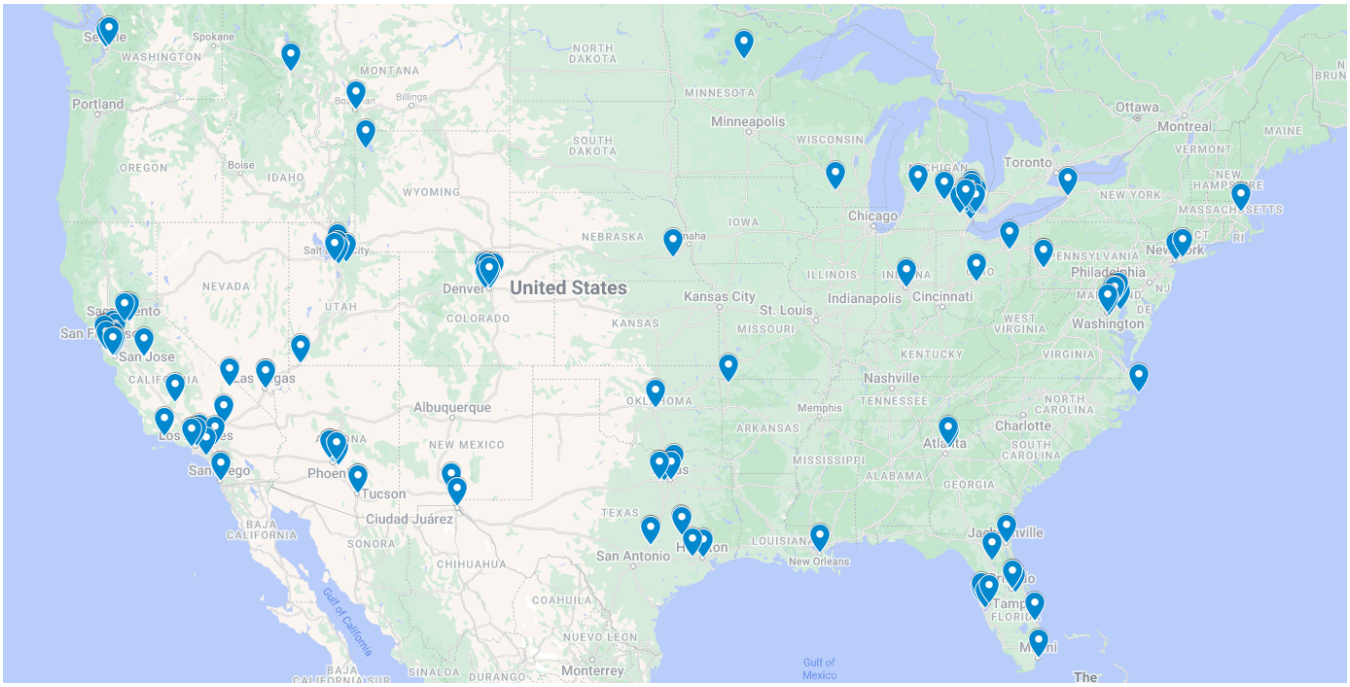
- **AVs have the potential to catalyze economic growth in adjacent industries.** The potential for the use of AVs in the U.S. is not just limited to on-demand transportation, public

[1] FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China | The White House
[2] "Ready to Launch: Autonomous Vehicles in the U.S. Tracking the Current (and Future) AV Landscape" | Alliance for Automotive Innovation, 2022
[3] Steer and Fourth Economy Analysis of Lightcast™, 2023
[4] "Systems Engineering Team Reveals How Automated Vehicles Are Transforming Labor in Taxi Services" | George Washington University School of Engineering & Applied Science

transit, and trucking. Other industries, such as off-road logistics, mining, defense, agriculture, and construction, have strong use cases to harness the benefits of AV technology.

- **AVs can support the resiliency of the U.S. auto industry.** Cities and states have an opportunity to build a skilled workforce (via education and training) to support current and future auto job opportunities. This would foster job growth both in locations with existing auto jobs (e.g., Michigan, Indiana, Alabama, Kentucky, and Ohio) and in other locations that could become new centers for AV manufacturing with established tech jobs (e.g., Massachusetts, Colorado, and California). Cities, states, and higher education partners can play an important role in upskilling, reskilling, and developing the skill sets of potential AV workers through collaboration with AV companies and research facilities. Some examples of research facilities include Ohio State University's Center for Automotive Research and the University of Michigan's Mcity, which collaborate with industry partners in Detroit and Columbus to "target resources toward the exploration and testing of advanced automotive technologies and the cultivation of a highly skilled and engaged future workforce."

Autonomous Vehicles: An Emerging Industry



Map: Location of AV Companies and On-Road AV Operations | Data Source: Alliance for Automotive Innovation, Steer and Fourth Economy Analysis

U.S. AV Companies – Current Reach and Scale

AV companies are located throughout the United States. A recently released report from the Alliance for Automotive Innovation identified 84 AV companies in 30 states and 120 cities.[5] The AV industry spans from tech startups to auto manufacturers and includes trucking, technology, ride-sharing, automotive, and transportation companies. As noted by Jeff Farrah, executive director of the Autonomous Vehicle Industry Association, the AV industry has "already created new jobs and brought new investment, tax revenue, resources, and human capital to states across the country, including Arkansas, California, Alabama, Arizona, Arkansas, Kansas, Nevada, New Mexico, Oklahoma, Pennsylvania, Michigan, Florida, Washington, Colorado, and Texas."[6] Farrah continues, "In communities across those states, the AV industry is providing opportunities for workers with a wide array of expertise and educational backgrounds, including many jobs that do not require a college degree. These jobs include auto technicians,

[5] "Ready to Launch: Autonomous Vehicles in the U.S. Tracking the Current (and Future) AV Landscape" | Alliance for Automotive Innovation, 2022

[6] "The Future of Automated Commercial Motor Vehicles: Impacts on Society, the Supply Chain, and U.S. Economic Leadership" | Written Testimony to the House of Representatives Committee on Transportation & Infrastructure, 2023

fleet managers, safety operations specialists, sensor calibrators, transportation planners, and many others to serve the growing needs of AV fleets and AV manufacturers."[7] In addition to AV companies, the AV economy also includes a series of businesses, operations that will grow and/or develop to support AV companies. Additionally, AVs have the potential to catalyze economic growth in adjacent industries. The potential for the use of AVs in the U.S. is not just limited to on-demand transportation, public transit, and trucking. Other industries, such as off-road logistics, mining, defense, agriculture, and construction, have strong use cases to harness the benefits of AV technology.

The Expanding U.S. AV Opportunity

As the AV industry continues to grow, workers across more states stand to benefit. According to the Center for Strategic and International Studies, AV companies have invested over $16 billion in the development of AV technologies, and the market is poised to reach $1 trillion in 2030 and as high as $3 trillion by 2040.[8]

AV technologies are part of the suite of autonomous, connected, electrified, and shared vehicle technologies that are sweeping the automobile industry. Taken in conjunction, these technologies will transform the auto industry and have the ability to boost technological development and economic activity across traditional manufacturing regions. Moreover, this transformation in the way that vehicles are designed, developed, and manufactured has the potential to "bridge the divide between high-tech innovation hubs and regions where manufacturing has—or had—traditionally dominated economic activity."[9]

Autonomous vehicles have the potential to bridge the divide between high-tech innovation hubs and regions where manufacturing has—or had—traditionally dominated economic activity.

To realize these opportunities and ensure continued leadership in AV development and deployment, the U.S. must get three things right: **encourage further technology development**, **increase capital investment**, and **establish a favorable regulatory framework**.[10]

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[7] "The Future of Automated Commercial Motor Vehicles: Impacts on Society, the Supply Chain, and U.S. Economic Leadership" | Written Testimony to the House of Representatives Committee on Transportation & Infrastructure, 2023

[8] Bridging the Divide: Autonomous Vehicles and the Automobile Industry | Center for Strategic and International Studies

[9] Bridging the Divide: Autonomous Vehicles and the Automobile Industry | Center for Strategic and International Studies

[10] "Economic Danger Zone: How America Competes to Win the Future Versus China" | Written Testimony to the House of Representatives Committee on Energy & Commerce, 2023

What Is the AV Market Opportunity?

The U.S. is leading in technology development and capital investment: American companies have developed the most advanced AV technology to date, and billions have been invested in innovative AV companies. Despite this lead, the U.S. is at risk of falling behind the rest of the world on AV public policy, which would harm economic competitiveness. **Policymakers must decide: Will the U.S. be a leader or a follower in the AV marketplace?**

Policymakers must decide: Will the U.S. be a leader or a follower in the AV marketplace?

Potential Future AV Scenarios

This study considers the market readiness of on-road AVs to inform three future scenarios:

CONSERVATIVE SCENARIO

Very gradual shift from traditional vehicles to AVs. Limited investment and policy support constrain the adoption of AVs.

CENTRAL SCENARIO

Slow shift from traditional vehicles to AVs. Modest investment and policy support that results in a moderate adoption of AVs.

OPTIMISTIC SCENARIO

Accelerated shift from traditional vehicles to AVs. Proactive investment and policy support enable the broad deployment of AVs.

While AV technology is proven for a range of existing and intended uses, the true market share of AVs will be controlled by technology readiness, regulatory actions, workforce availability, and consumer perception. Some AV types or use cases are likely to penetrate the market sooner than others. The generally recognized early use cases for AVs are expected to be shared-use passenger vehicles and small delivery vans utilized for commercial use typically in local settings. See the Appendix for a more detailed discussion of vehicle types and market readiness.

FUTURE AV MARKET SHARE

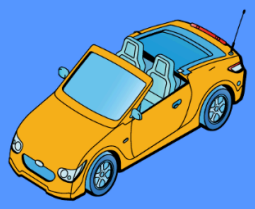
Today, there are **276 million registered vehicles in the U.S.**[11] These include taxis and for-hire vehicles, shuttles and buses, personal cars, small vans, and medium and large trucks. In 15 years, the portion of these vehicles that will be AVs could range anywhere from between 3.6 and 36 million vehicles, depending on the speed at which AVs are adopted. ⏩

AV market readiness
Low, Medium, High

Currently registered vehicles
Number of vehicles

Projected future AV market share
Number of vehicles

Personal cars



Low

200 Million

200,000 - 10 Million

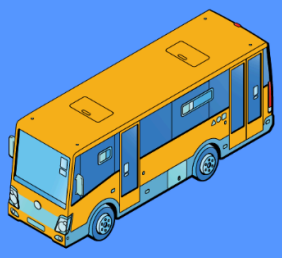
Taxis and for-hire vehicles

High

1.5 Million

75,000 - 375,000

Buses and shuttles



High

1 Million

50,000 - 250,000

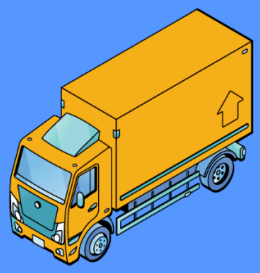
Small delivery vans

High

60 Million

3 Million - 24 Million

Medium or large delivery trucks



Medium

14 Million

75,100 - 375,000

AV Market Penetration by Market Scenario

In 15 years, future AV market size in the U.S. could range between 3.6 and 36 million vehicles, depending on the adoption rate of AVs. The scenarios we consider range from conservative (AVs account for 1.3 percent of all on-road vehicles) to optimistic (AVs account for 13 percent of all on-road vehicles), with AV adoption rate varying by vehicle type as presented in the table below:

Use cases	Current fleet size (approx.)	Potential AV fleet size by scenario (% AV)		
		Conservative	Central	Optimistic
Taxis and for-hire vehicles	1,500,000	75,000 (5%)	150,000 (10%)	375,000 (25%)
Shuttles and buses	1,000,000	50,000 (5%)	100,000 (10%)	250,000 (25%)
Small delivery vans	60,000,000	3,000,000 (5%)	6,000,000 (10%)	24,000,000 (40%)
Medium or large trucks	14,000,000	280,000 (2%)	700,000 (5%)	1,400,000 (10%)
Personal cars	200,000,000	200,000 (0.1%)	2,000,000 (1%)	10,000,000 (5%)
Total	**276,500,000**	**3,605,000 (1.3%)**	**8,950,000 (3.2%)**	**36,025,000 (13%)**

AV Market Penetration Scenarios | Data Source: Bureau of Transportation Statistics, Steer and Fourth Economy Analysis Note: Market readiness is determined based on current trials as well as complexities in regulations. It can be assumed that the transition to AVs will be very gradual and will depend on the use cases. Our assumed market share is for 15 years ahead. See the Appendix for a more detailed discussion of vehicle types and market readiness.

Annualized AV Production Estimates by Market Scenario

	Conservative	Central	Optimistic
Potential AV fleet size	**3,605,000**	**8,950,000**	**36,025,000**
Per-year AV production (Average annual production needed to create AV fleet size produced over the course of 15 years)	**240,000**	**597,000**	**2,402,000**

Annual AV Production Estimates | Data Source: Steer and Fourth Economy Analysis

Our analysis suggests that in a **central AV fleet-size scenario**—with a future 3.2 percent AV market share across vehicles—there will be nearly **nine million AVs produced over the next 15 years**. While the number of AVs produced will likely ramp up over that 15 year time period (e.g., more AVs will be produced in 2035 than in 2025), **an average of nearly 600,000 AVs would need to be produced each year to build a fleet to meet the size of the central scenario**.

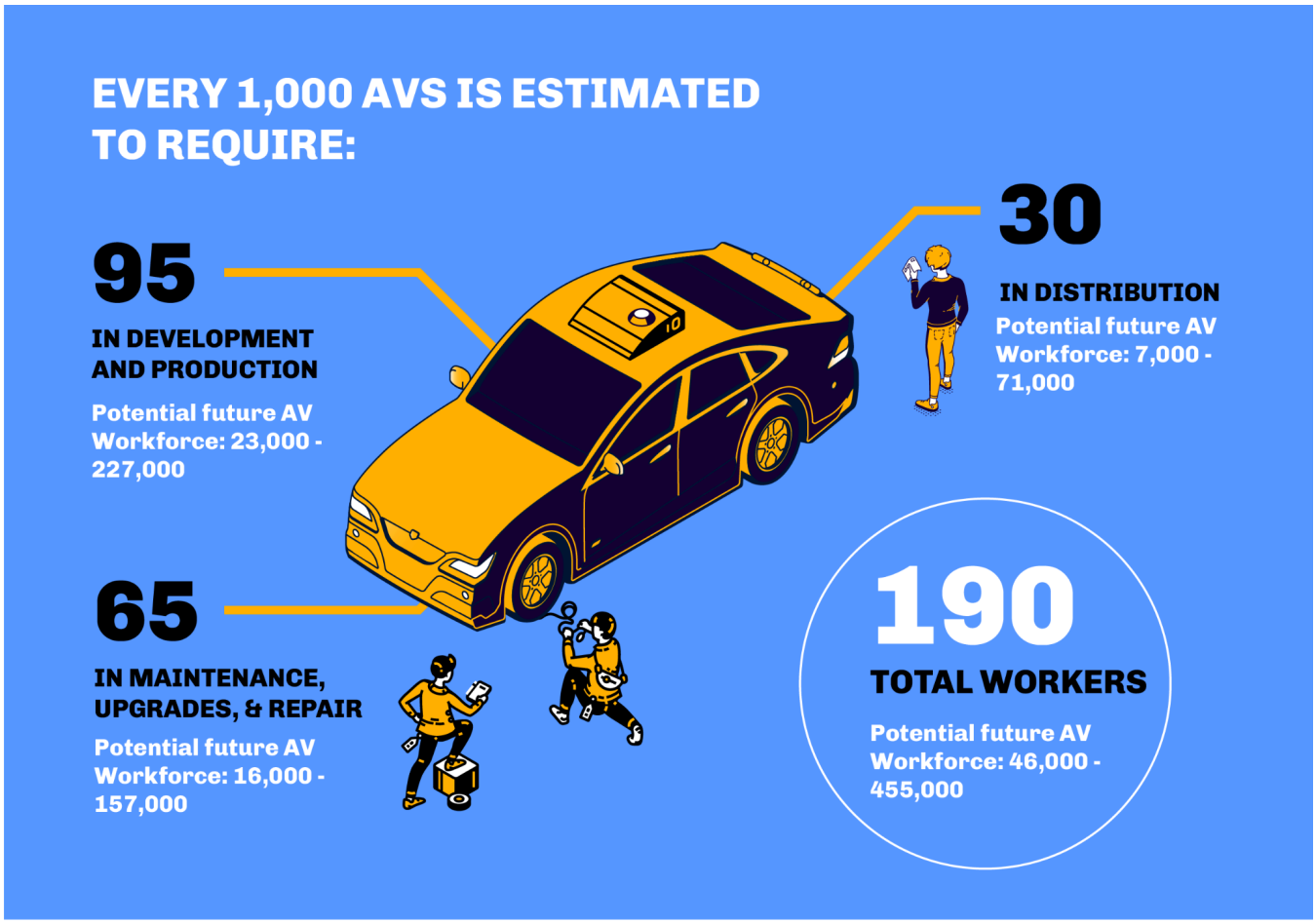
[11] Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances | Bureau of Transportation Statistics

What Will Be the AV Workforce Impact?

AV Workforce Impact

The AV industry will employ workers across roles that develop, manufacture, distribute, and service AVs. If AVs follow the same staffing patterns as other automotive manufacturing, **for every 1,000 AVs approximately 190 jobs will be required for manufacturing and servicing of these vehicles—including 95 in Development and Production; 30 in Distribution; and 65 in Maintenance, Upgrades & Repairs.**

Throughout stakeholder interviews, it has been confirmed that the need to expand on hiring all of the above roles is certain as the adoption of AVs becomes more widespread. AV companies have indicated a need to hire for roles as diverse as engineers, production workers, operations and management, sales, and field technicians.



AV Worker Impact by Scenario

The total number of AV workers needed to develop, produce, distribute, maintain, upgrade, and repair AVs will depend on the AV fleet size. In 15 years, future AV market size in the U.S. could range between 3.6 and 36 million vehicles, depending on the adoption rate of AVs across conservative to optimistic scenarios. That translates to an average annual production of 240,000 to 2.4 million AVs. The total AV worker impact across AV fleet-size scenarios is presented in the table below:

	Workers per 1,000 vehicles	Conservative	Central	Optimistic
Development and Production Design, Engineering, Testing, High-Res Mapping, Manufacturing	95	23,000	57,000	227,000
Distribution	30	7,000	18,000	71,000
Maintenance, Upgrades & Repair	65	16,000	39,000	157,000
Total	**190**	**46,000**	**114,000**	**455,000**

AV Workforce by Fleet-Size Scenario | Data Source: Steer and Fourth Economy Analysis of U.S. Department of Transportation National Transportation Statistics and Lightcast™, 2022

Many traditional auto makers already incorporate autonomous capabilities into their vehicles. To do this, the auto industry employs a workforce that includes STEM workers like engineers and software developers, production workers like assembly line workers and fabricators, and workers who distribute and service motor vehicles. As the AV industry continues to mature and have increased levels of vehicle production, it should display similar levels of staffing needs as the auto industry as a whole. Our analysis matches historic data for levels of vehicle production output from the U.S. Department of Transportation National Transportation Statistics with workforce data from the Bureau of Labor Statistics and Lightcast™ data to determine the amount of workforce required to develop, manufacture, distribute, and service motor vehicles. See the Appendix for a more detailed discussion of the workforce impact calculation.

In a **central AV fleet-size scenario**, there will be an estimated **AV workforce of 114,000 workers** to meet the production; distribution; and maintenance, upgrades, and repair needs of nearly nine million AVs produced over the next 15 years. Under this scenario, the AV workforce would include 57,000 Development and Production workers, 18,000 Distribution workers, and 39,000 Maintenance, Upgrades & Repairs workers. **Under a more optimistic scenario of AV production of 36 million vehicles produced over the next 15 years, the AV workforce impact could be as large as 455,000 workers.** Production; distribution; and maintenance, upgrades, and repair activities describe functions of AV industries. These industries employ workers with a variety of

roles, or occupations, that support various aspects of AV business operations. The next sections of this report define the interrelated field of Core AV Industries and describe Core AV Occupations corresponding to the development, manufacturing, and maintenance of AVs.

Defining Core AV Industries

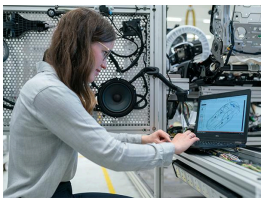
Current AV companies are concentrated within an interrelated field of Core AV Industries, each with its own function within the development, manufacturing, and maintenance of AVs. As noted by the Aspen Institute's the Future of Work Initiative, Core AV Industries include: **Development and Production** – Design, Engineering, Testing, High-Res Mapping, Manufacturing; **Distribution**; and **Maintenance, Upgrades & Repairs** industries.[12]

For the purposes of this study, Core AV Industries across development, manufacturing, and maintenance of AVs were defined by using Job Posting Analytics data from Lightcast™. Our analysis identified a list of 18 detailed industries—as defined by the North American Industry Classification System (NAICS)—that fit the skills profile for AV workers. See the Appendix for a detailed list of Core AV Industries.

[12] "Exchange: Future of Work & Mobility" | The Future of Work Initiative at the Aspen Institute, 2018

Who Are AV Workers?

AV workers hold a variety of jobs corresponding to the development, manufacturing, and maintenance of AVs. Core AV Occupations include STEM Occupations; Production Occupations; Transportation and Sales Occupations; Installation, Maintenance, and Repair Occupations; and General Business Support Occupations. Our analysis identified a list of ten occupational groups—as defined by the Standard Occupational Classification System (SOC)—for AV workers. See the Appendix for a detailed list of Core AV Occupations.

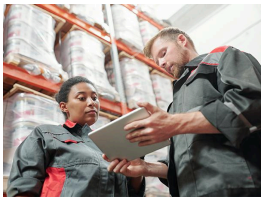


STEM Occupations

STEM Occupations—those in science, technology, engineering, or math—are particularly important for AV design, engineering, testing, and high-res mapping. Computer occupations dominate the STEM group, and their top defining skills include computer science and programming languages.

Production Occupations

Production Occupations are concentrated within AV manufacturing. These occupations include production and assembly line workers, fabricators, and machinists. Workers can often access these jobs with a high school education and on-the-job training.

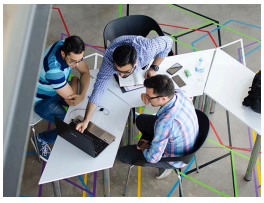


Transportation and Sales Occupations

Transportation and Sales Occupations are concentrated within distribution industries. Positions within these occupations include material movers, machine operators, and delivery drivers.

Installation, Maintenance, and Repair Occupations

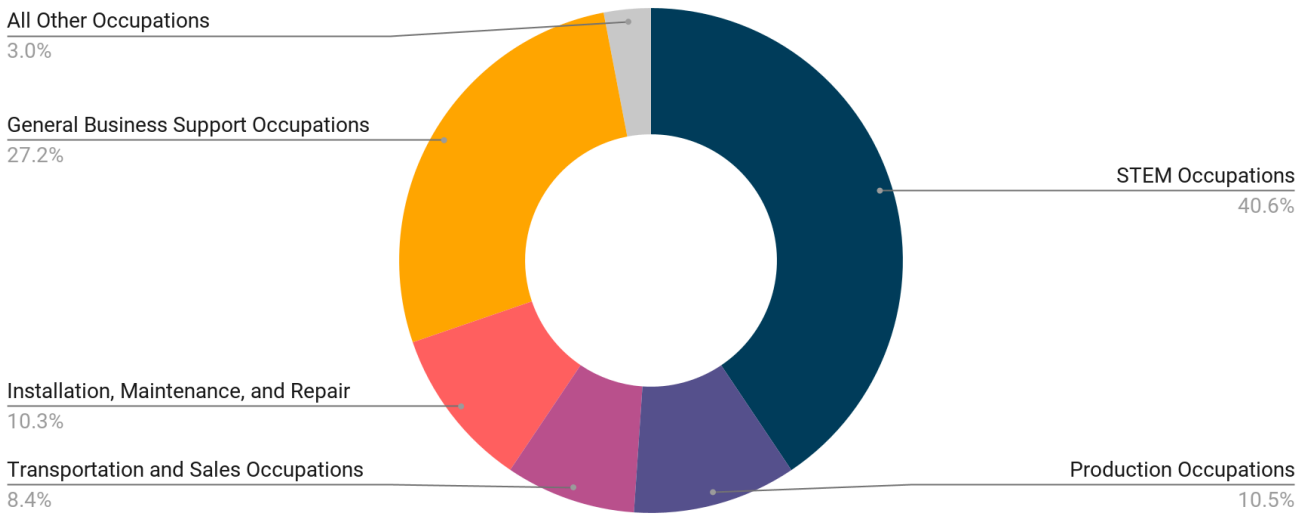
Installation, Maintenance, and Repair Occupations are concentrated within industries that perform repairs and ongoing maintenance for on-road vehicles. Workers in these roles—including service and maintenance technicians—frequently need on-the-job training and credentialing to keep up with new computerized vehicle systems.



General Business Support Occupations

General Business Support Occupations are found throughout all industries and include workers that support the business operation of companies that develop, manufacture, and maintain vehicles. These occupations include management, finance, and administrative roles.

Current Share of AV Workers by Occupation Type



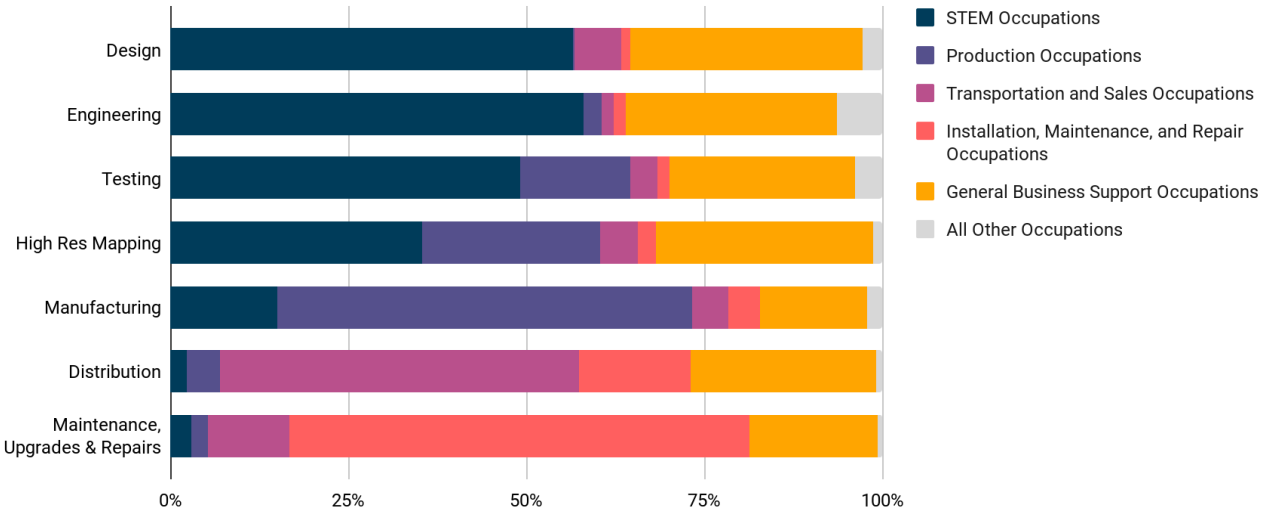
Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

The largest share of existing AV workers within Core AV Industries—accounting for more than four in ten AV workers—are employed in STEM Occupations (Computer and Mathematical Occupations; Architecture and Engineering Occupations; and Life, Physical, and Social Science Occupations). As the AV industry matures, the mix of occupations is likely to still contain high levels of STEM roles associated with design, engineering, and testing, but also likely to shift toward more production roles associated with manufacturing AVs and maintenance roles associated with maintaining a growing fleet of AVs.

Existing Core AV Occupations also include Production Occupations; Transportation and Sales Occupations; Installation, Maintenance, and Repair Occupations; and General Business Support Occupations.

While our analysis captures many Core AV Occupations, there are some workers and work roles that may not be fully captured in the data. For example, AV companies conduct software validation for a number of years, which requires both a specialist to validate the software and also requires drivers in cars in markets for a number of years. Any given point, an AV company could employ 8-10 people as drivers in each market. Roadside assistance is another example; an AV tow truck could have up to 2 people in it at a given time. AVs will also have an unseen component of business operations and support roles that require human labor like security, janitors to clean depots and cars, technical operators who check the sensors.

Current Concentration of Occupations within Core AV Industries



Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

Current Core AV Occupations are spread throughout current Core AV Industries, with some occupations concentrated within specific industries.

- **STEM Occupations** are concentrated in Design, Engineering, Testing, and High-Res Mapping Industries. STEM Occupations are also present in Manufacturing Industries.
- **Production Occupations** are concentrated in Manufacturing Industries. Production Occupations are also present in Testing and High-Res Mapping Industries.
- **Transportation and Sales Occupations** are concentrated in Distribution Industries. Transportation and Sales Occupations are also present in the Maintenance, Upgrades & Repairs Industries.
- **Installation, Maintenance, and Repair Occupations** are concentrated in Maintenance, Upgrades & Repairs Industries. Installation, Maintenance, and Repair Occupations are also present in Distribution Industries.
- **General Business Support Occupations** are present throughout Core AV Industries.

Wages, Typical Entry-Level Education, and Typical On-the-Job Training for AV Workers

Occupational Group	Typical Wages	Typical Entry-Level Education	Typical On-the-Job Training
STEM Occupations	$80,000 to $127,000	Bachelor's degree or higher or skills-based credential	None
Production Occupations	$38,000 to $45,000	High school diploma or equivalent	Moderate-term on-the-job training
Transportation and Sales Occupations	$36,000 to $63,000	High school diploma or equivalent or no formal educational credential	Short-term or moderate-term on-the-job training
Installation, Maintenance, and Repair Occupations	$45,000 to $58,000	Postsecondary nondegree award	Short-term on-the-job training
General Business Support Occupations	$66,000 to $97,000	Bachelor's degree or higher or high school diploma or equivalent	None or short-term on-the-job training

Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

Note: Typical wages reported as the median annual wage for workers earning between the 25th and 75th percentiles within the occupation group, meaning that half of workers within the occupational group earn within this wage range.

AV jobs are high paying: 82 percent of AV workers make more than the U.S. median wage of $44,520. Many of these high-paying jobs are accessible to workers without a college degree. Of the AV workers in positions that do not typically require a bachelor's degree, 59 percent earn above the U.S. median wage.

Workers filling roles within the AV industry have a range of typical entry-level education and on-the-job training requirements, depending on the occupation they hold. Workers within STEM Occupations will require the most attention from higher education institutions that offer undergraduate and graduate degrees in engineering and computer science to tailor degree programs. Additionally, skill-based credentials specific to autonomous technologies will be essential to building the AV workforce. Production Occupations and Installation, Maintenance,

and Repair Occupations will require the most attention within workforce development—in terms of building credentials, upskilling, and on-the-job training for the AV workforce.

- **STEM Occupations** typically require a bachelor's degree or higher (81 percent) and no on-the-job training (96 percent). STEM jobs are high-paying, with typical wages ranging from $80,000 to $127,000. Strong partnerships with higher education institutions are needed to bolster the AV STEM workforce. While bachelor's degrees have historically been required for STEM positions, increasingly more STEM workers are being employed by companies that prioritize skills over degrees within technology occupations. Accenture and IBM are among the companies implementing skills-based hiring strategies. A recent analysis of over 51 million job postings by the Burning Glass Institute found that employers are reducing degree requirements for a variety of roles, and that across all U.S. industries, "an additional 1.4 million jobs could open to workers without college degrees over the next five years."[13]

- **Production Occupations** typically require a high school diploma or equivalent (98 percent) and moderate-term on-the-job training (89 percent). These occupations typically earn $38,000 to $45,000. Production workers increasingly work with technology to complete tasks across assembly, fabrication, machining, or other manufacturing processes.

- **Transportation and Sales Occupations** typically require a high school diploma or equivalent or no formal educational credential (88 percent) and short-term or moderate-term on-the-job training (90 percent). These workers typically earn $36,000 to $63,000.

- **Installation, Maintenance, and Repair Occupations** typically require a postsecondary nondegree award (56 percent) and short-term on-the-job training (60 percent). These workers typically earn $45,000 to $58,000. Service and maintenance technicians frequently need on-the-job training and credentialing to keep up with new computerized vehicle systems.

- **General Business Support Occupations** typically require a bachelor's degree or higher (72 percent) and no or short-term on-the-job training (90 percent). These business support occupations can pay good wages, with workers typically earning between $66,000 and $97,000. As the AV industry grows, workers in these occupations may come from businesses or industries outside of the AV industry and will most likely be able to transfer their skills to the AV industry with minimal retraining needed.

[13] "How the Shift to Skills-Based Hiring Holds the Keys to Growing the U.S. Workforce at a Time of Talent Shortage" | Harvard Business Review and Emsi Burning Glass

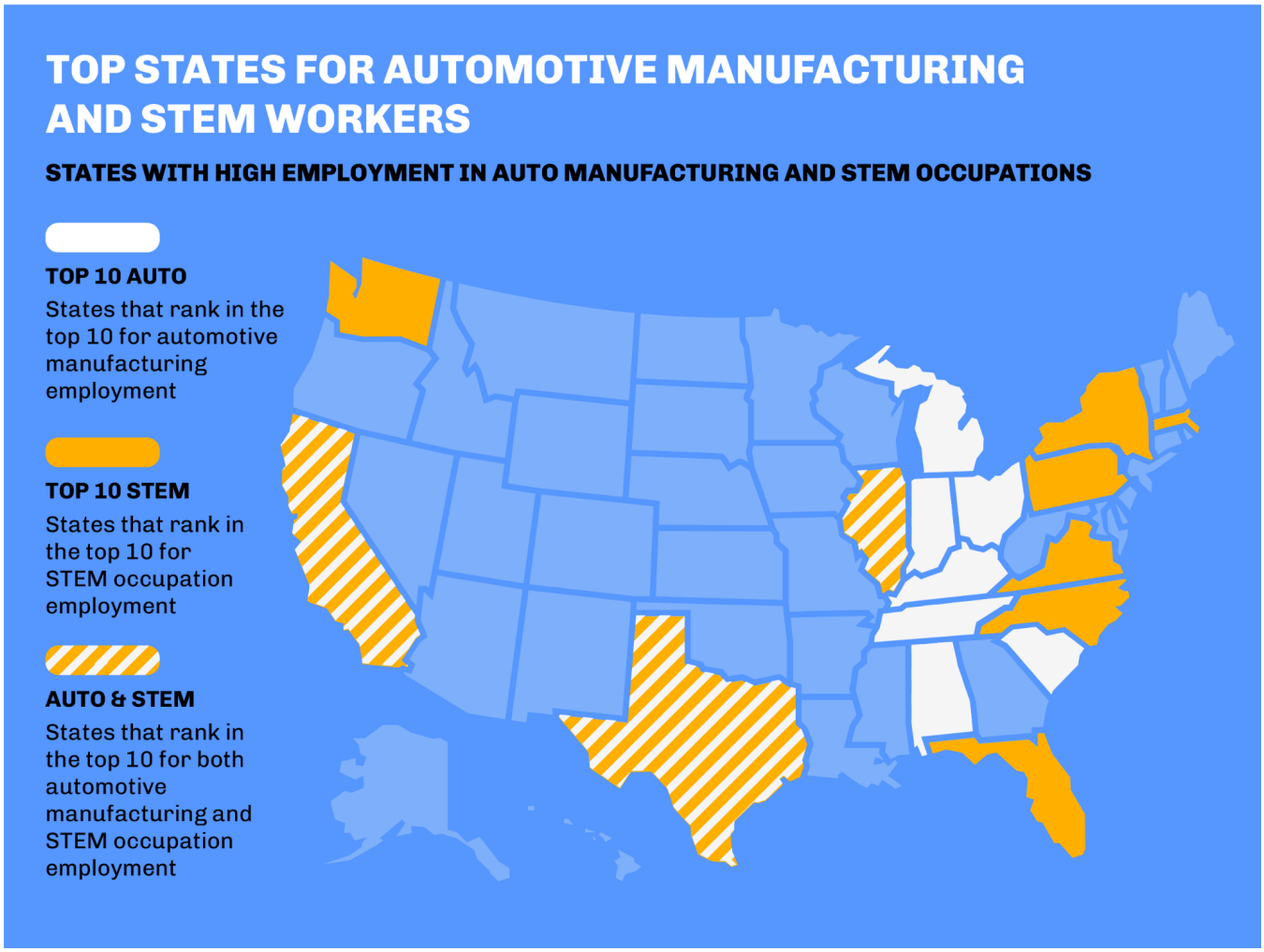
Which States Are Well Positioned to Benefit from the Growing AV Workforce?

As the AV industry continues to grow, many states stand to benefit. States that have a high presence of skilled workers across automotive manufacturing and STEM Occupations, as well as those who make investments in workforce development initiatives for AV workers, could reap the most economic benefits.

Top States for Automotive Manufacturing and STEM Workers

The presence of an existing workforce within automotive manufacturing and STEM Occupations is one sign of potential AV readiness. Many states have a high concentration of automotive manufacturing or STEM workers, and are well positioned to benefit from the emergence of the AV market.

In this section, we look at specialization—by both employment and concentration of workers—for the workforce across automotive manufacturing and STEM Occupations. Additionally, we offer examples of partnerships between AV companies and higher education institutions that prepare the workforce for the jobs of the future. Workforce development initiatives paired with existing workforce strengths can ensure that the U.S. has the workforce to compete in the global AV market.



The presence of an existing workforce within automotive manufacturing and STEM occupations is one sign of potential AV readiness. Many states are well positioned to benefit from the emergence of the AV market because of the high number of automotive and STEM workers.

Top States for Automotive Manufacturing Employment

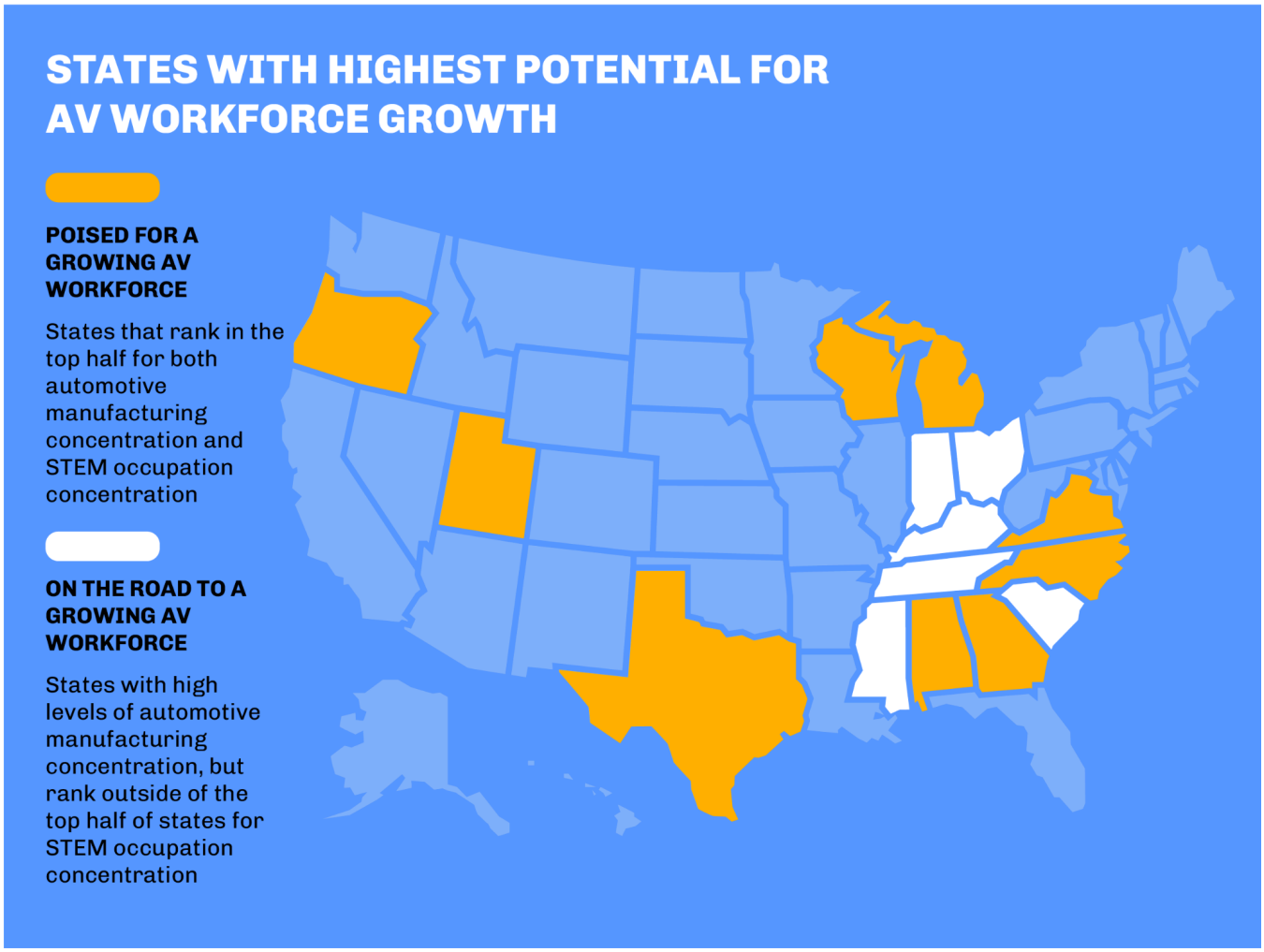
- Michigan, Indiana, Ohio, Tennessee, Kentucky, Alabama, and South Carolina rank in the top 10 for automotive manufacturing employment.

Top States for STEM Occupations Employment

- New York, Florida, Virginia, Pennsylvania, Washington, Massachusetts, and North Carolina rank in the top 10 for STEM occupation employment.

Top States for Automotive Manufacturing and STEM Occupations Employment

- California, Texas, and Illinois rank in the top 10 for automotive and STEM employment.



Industry specialization can also be determined by industry concentration. Industry concentration is the share of workers within the industry relative to the overall workforce.

Poised for a Growing AV Workforce

- Alabama, Georgia, Michigan, North Carolina, Oregon, Texas, Utah, Virginia, and Wisconsin rank in the top half for both automotive manufacturing concentration and STEM occupation concentration.

On the Road to a Growing AV Workforce

- Indiana, Kentucky, Mississippi, Ohio, South Carolina, and Tennessee all have high levels of automotive manufacturing concentration, but rank outside of the top half of states for STEM occupation concentration. These states have a strong automotive industry, but may need to bolster their STEM workforce to access the full benefit of the emerging AV industry.

Top States for Existing Automotive Manufacturing

The presence of an existing workforce within automotive manufacturing is one sign of potential AV readiness. Many states have a high concentration of automotive manufacturing, and are well positioned to benefit from the emergence of the AV market.

According to the Bureau of Labor Statistics, the automotive manufacturing industry includes the following industries by NAICS definition:[14]

- 3361: Motor Vehicles Manufacturing
- 3362: Motor Vehicle Bodies and Trailer
- 3363: Motor Vehicle Parts Manufacturing

Industry specialization can be determined by both overall industry employment (number of workers employed in the industry) and industry concentration (share of workers within the industry relative to the overall workforce).

One measure of industry concentration is the location quotient. A location quotient is a way of quantifying how concentrated a particular industry is in a state as compared to the U.S. as a whole. It can reveal what makes a particular state unique in comparison to the national average. Industry location quotients are calculated by comparing the industry's share of state employment with its share of national employment.

[14] Automotive Industry | Bureau of Labor Statistics

Automotive Manufacturing Employment

	State	Auto Mfg. Employment, 2022
1	Michigan	177,138
2	Indiana	128,921
3	Ohio	96,360
4	Tennessee	65,315
5	Kentucky	59,912
6	California	50,928
7	Alabama	49,743
8	Texas	46,881
9	Illinois	39,725
10	South Carolina	37,201
11	Georgia	27,753
12	Missouri	24,447
13	North Carolina	24,149
14	Wisconsin	17,783
15	Pennsylvania	16,398
16	Mississippi	14,180
17	Virginia	12,748
18	Iowa	10,588
19	New York	10,505
20	Florida	7,981
21	Arizona	7,700
22	Arkansas	7,265
23	Nebraska	6,152
24	Oklahoma	5,978
25	Utah	5,778

Automotive Manufacturing Employment and Industry Concentration | Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

Automotive Industry Concentration (Location Quotient)

	State	Industry Concentration (LQ), 2022
1	Indiana	6.2
2	Michigan	6.2
3	Kentucky	4.7
4	Alabama	3.7
5	Tennessee	3.1
6	Ohio	2.7
7	South Carolina	2.6
8	Mississippi	1.9
9	Missouri	1.3
10	South Dakota	1.2
11	Iowa	1.0
12	Illinois	1.0
13	Nebraska	0.9
14	Wisconsin	0.9
15	Georgia	0.9
16	Arkansas	0.9
17	North Carolina	0.8
18	West Virginia	0.8
19	Kansas	0.6
20	Oklahoma	0.6
21	Texas	0.5
22	Utah	0.5
23	Virginia	0.5
24	Idaho	0.5
25	Oregon	0.4

Automotive Manufacturing Employment and Industry Concentration | Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

Top States for STEM Workers

The presence of an existing workforce within STEM Occupations is one sign of potential AV readiness. Many states have a high concentration of STEM workers, and are well positioned to benefit from the emergence of the AV market.

According to the Bureau of Labor Statistics, STEM Occupations include by SOC definition:[15]

- 15-0000: Computer and Mathematical Occupations
- 17-0000: Architecture and Engineering Occupations
- 19-0000: Life, Physical, and Social Science Occupations

Specialization can be determined by both overall occupational employment (number of workers employed in the occupations) and occupational concentration (share of workers within the occupations relative to the overall workforce).

Once again, we will use location quotient analysis to illustrate how states compare relative to workers in the AV-related sector. Occupational location quotients are calculated by comparing the occupations' share of state employment with its share of national employment.

[15] STEM Occupations | Bureau of Labor Statistics

STEM Occupations Employment

	State	STEM Employment, 2022
1	California	1,233,919
2	Texas	778,229
3	New York	461,844
4	Florida	449,168
5	Virginia	352,358
6	Pennsylvania	327,748
7	Washington	325,532
8	Illinois	309,061
9	Massachusetts	288,894
10	North Carolina	286,240
11	Ohio	285,916
12	Michigan	281,345
13	Georgia	267,464
14	New Jersey	257,827
15	Colorado	239,204
16	Maryland	238,859
17	Arizona	188,046
18	Minnesota	182,007
19	Wisconsin	158,669
20	Missouri	147,247
21	Tennessee	143,794
22	Indiana	135,692
23	Oregon	129,277
24	Utah	115,068
25	Alabama	113,482

STEM Employment and Occupational Concentration | Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

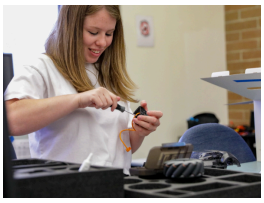
STEM Occupations Concentration (Location Quotient)

	State	Occupational Concentration (LQ), 2022
1	Washington	1.6
2	Maryland	1.5
3	Virginia	1.5
4	Colorado	1.4
5	Massachusetts	1.3
6	Utah	1.2
7	California	1.2
8	New Hampshire	1.1
9	Oregon	1.1
10	New Mexico	1.1
11	Michigan	1.1
12	Delaware	1.1
13	Minnesota	1.1
14	New Jersey	1.0
15	Alaska	1.0
16	Arizona	1.0
17	North Carolina	1.0
18	Rhode Island	1.0
19	Texas	1.0
20	Connecticut	1.0
21	Georgia	1.0
22	Alabama	0.9
23	Pennsylvania	0.9
24	Wisconsin	0.9
25	Vermont	0.9

STEM Employment and Occupational Concentration | Data Source: Steer and Fourth Economy Analysis of Lightcast™, 2022

Promising Practices for AV Workforce Development

AV companies are partnering with higher education institutions to create workforce development initiatives that prepare people for the jobs of the future. These workforce development initiatives not only advance AV technology deployment but also prepare the U.S. workforce to compete globally.



Service Engineer Technicians

In Pennsylvania, Aurora partnered with Pittsburgh Technical College to create and launch a new associate degree program that trains autonomous service engineer technicians to maintain and customize robotic or autonomous systems.[16]

Autonomous Fleet Technicians

In Texas, Nuro developed a certification program with San Jacinto College for autonomous fleet technicians. The program includes access to paid internships and part-time work opportunities, as well as a pathway for full-time jobs with benefits postgraduation.[17]

Advanced Manufacturing

In California, Cruise was a seed funder for Humanmade, a nonprofit organization offering advanced manufacturing job training programs for underserved communities, including skills training, education, access to advanced tools and machinery, and interview workshops.[18]

[16] Associate of Science: Robotics & Autonomous Engineering Technology | Pittsburgh Technical College
[17] San Jacinto College and Nuro Announce First AV Technician Certificate Program in Texas | San Jacinto College
[18] Advanced Manufacturing Workforce Development Programs | Humanmade

Conclusion and Recommendations

To realize the benefits of the AV industry and the potential to create jobs for workers with a range of skill levels, the following recommendations should be considered.

- **Establish a supportive federal regulatory environment.** While the U.S. is currently a global leader in the AV industry, as the technology begins to commercialize and is more widely deployed, it is crucial that there is a supportive national regulatory environment. In the absence of federal AV legislation, individual states are developing their own AV legislation. This would create a patchwork approach regarding the deployment and operation of AVs across states. Congress, the U.S. Department of Transportation, and the private sector should work together to establish an appropriate national policy framework that supports AV growth, encouraging all states to implement consistent frameworks for AV operation to reinforce the U.S. as a world leader in this space.

- **Develop international collaboration to set AV regulations.** Diverging regulatory approaches in these areas in foreign markets would limit opportunities for U.S. AV exports and therefore potential U.S. employment in the sector. A coordinated approach to AV safety and operating regulations is necessary for the United States to lead in the global AV industry, as it is not the only country crafting AV regulations. Foreign governments currently use trade agreements to cement recognition of vehicle standards among partners—a tactic that U.S. automakers claim limits export opportunities. By acting as a first mover and striking a cooperative stance, the United States has the opportunity to engage with global automakers and trading partners to develop common standards, minimize the barriers to exporting AV systems and vehicles, and maximize the potential for U.S. employment in the sector.

- **Encourage state-sponsored skills development programs to prepare the workforce for the jobs of the future.** This could include leading on initiatives related to job growth, such as training, reskilling, certification, safety, and facilitating cross-border collaboration. This may include working in collaboration with colleges and universities to develop tailored programs for skills required in the AV sector.

- **Ensure that Infrastructure Investment and Jobs Act funding expenditures support the embedding of digital infrastructure in the physical infrastructure.** Infrastructure, embedded with real-time monitoring and control systems, can provide the basis for connected vehicles to provide safety and congestion reduction benefits. Current investments being made can have multidecade-long life cycles, which makes it imperative to align investments to the AV possibilities ahead.

- **Consider AVs when planning, developing, or investing in electric vehicle infrastructure.** All AVs are expected to be electric vehicles (EVs). The future need for charging by AVs should be considered when developing or investing into EV charging infrastructure technologies to make sure that the infrastructure remains relevant and provides sufficient speed and power for maximum utilization of AVs and minimal charging.

- **Support ongoing AV innovation through federal investments in Tech Hubs, NSF Engines, and similar initiatives.** The U.S. Economic Development Administration manages the Tech Hubs Program to "strengthen U.S. economic and national security with investments in regions across the country with assets and resources with the potential to become globally competitive in the technologies and industries of the future."[19] In October 2023, the Biden administration announced the designation of 31 inaugural Tech Hubs across the US.[20] The National Science Foundation launched the Regional Innovation Engines (Engines) in May 2023 with the focus of "seeding the future for communities to grow their regional economies through research and partnerships."[21] Both initiatives included just one award that highlights AV development with the Tulsa Hub for Equitable & Trustworthy Autonomy, led by Tulsa Innovation Labs, and Advancing Autonomous Systems Technologies in the Northern Front (North Dakota, South Dakota, Montana, Idaho), led by the University of North Dakota. Further promotion of AV innovation as a desirable focus area in these programs would support sector growth.

[19] Economic Development Administration Regional Technology and Innovation Hubs (Tech Hubs) | EDA
[20] FACT SHEET: Biden-Harris Administration Announces 31 Regional Tech Hubs to Spur American Innovation, Strengthen Manufacturing, and Create Good-Paying Jobs in Every Region of the Country | White House
[21] Portfolio - Regional Innovation Engines | NSF - National Science Foundation

Appendix

This analysis was conducted in the fall of 2023 and utilized data that was available at that time. As with any analysis of an emerging industry, assumptions and market conditions can rapidly change. Therefore, the analysis should not be taken as a guarantee of any future performance.

Scope of the Study

SAE International defines six levels of automation in driving, where levels 0–3 represent assisted driving with some autonomous features, but predominantly require a driver to monitor the road conditions and therefore be present in the vehicle to take control as required. Levels 4–5 of driving automation are typically termed as "driverless" vehicles, which are capable of fully monitoring the road conditions and do not require a driver to be present in the vehicle.

A level 4 vehicle can operate on its own under certain operating conditions specific to a geography, landscape, weather, and traffic conditions, while a level 5 vehicle can operate at any and all conditions.[22]

Vehicle Types and Market Readiness

For the purposes of this study, on-road passenger and freight autonomous vehicles (AVs) with the autonomy of level 4 and above are considered. This includes autonomous cars, vans, taxis, and for-hire vehicles; smaller shuttles and buses; and delivery vans and trucks. This study excludes other types of AVs, such as autonomous bots, drones, flying cars or taxis, and autonomous rail.

According to the Autonomous Vehicle Industry Association (AVIA), collectively, AVs have driven over 44 million miles on public roads across the U.S. (not including testing facilities or tracks) as of 2023.[23] This suggests that AVs are not just an experimental concept but likely to be a reality sooner or later. A key requirement is to strengthen the regulatory landscape to facilitate AV testing. As it stands today, the federal government oversees vehicle design, safety, and performance, while states govern driver's licensing, insurance, and liability. Cities, meanwhile, control the local rules of the road. As of 2022, 40 states and Washington, DC, have passed laws allowing AV testing and/or deployment on public roads, while ten states have no AV-related statutes.[24]

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[22] Levels of Driving Automation | SAE
[23] AVIA Data Shows 44 Million+ Autonomous Miles Driven and Outstanding Safety Record | Autonomous Vehicle Industry Association
[24] States Lead the Way on Autonomous Vehicle Regulation as Federal Law Looms on the Horizon | Morgan Lewis

This study focuses on five use cases of on-road AVs including taxis and for-hire vehicles, shuttles or buses, small delivery vans, medium and large trucks, and personal cars. The likely rate of adoption of these AV use cases in the next 15 years has been estimated based on the current industry intelligence.

Taxis and For-Hire Vehicles

Today, the most developed form of autonomous passenger vehicles includes AV ride-hailing, where a vehicle known as a robotaxi drives itself to pick up and drop off passengers to a predetermined location. This use case offers users a flexibility to make a point-to-point journey without the burden of owning and maintaining a vehicle. This also offers efficient use of vehicles, compared to private ownership where vehicles are utilized less than 5 percent of the time.[25]

Several trials have been conducted in the U.S. since the early 2010s to test safe operations of these vehicles on public roads. In August 2022, robotaxi operators won approval from California regulators to operate commercial service 24/7.[26] As of 2023, the public[27] can hail a robotaxi in Phoenix and San Francisco, with plans to launch robotaxis in Austin, and they are being piloted in over ten states across the U.S.[28]

Having driven millions of test miles, the robotaxi operators such as Waymo and Cruise are now looking to fully commercialize the service within a zone or a city area. This is a positive step toward confirming feasibility of the concept. If regulatory barriers are addressed, this AV use case showcases high market readiness compared to other use cases.

Shuttles or Buses

Autonomous shuttles or buses typically operate on a fixed or semifixed route during a fixed time of the day, picking and dropping off passengers at predetermined stops, similar to traditional or on-demand buses within a zone or city area. Operationally, they are less complicated than robotaxis, where vehicles are required to navigate through and make stops at any part of the operational area. This use case has the potential to fill in the gaps in public transport provision or privately run shuttle services (e.g., airport shuttles).

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[25] "Cars Are Parked 95% of the Time." Let's Check! | Reinventing Parking
[26] Waymo's Robotaxis Are Now Available to Tens of Thousands of People across All of San Francisco | The Verge
[27] Please note: in some cases, the public needs to register themselves with the operator, and they are put on a waiting list before being given access to hail a ride with AVs.
[28] Robotaxis Hit the Accelerator in Growing List of Cities Nationwide | Axios

Michigan-based autonomous shuttle operator May Mobility has agreed to deals with a few local jurisdictions to operate commercial shuttle services in cities like Ann Arbor, Michigan; Arlington, Texas; Grand Rapids, Minnesota; and a few more.[29] This is a popular use case, albeit in a trial setting, across Europe and Asia as well, with operators such as ZF and Navya offering a full suite of services from feasibility analysis of a site to deployment to operations and maintenance support.

In consideration of a relatively simpler operating model and regulatory landscape similar to robotaxis, this use case has a high market readiness. Subject to suitable regulatory support, it can be deployed at scale if sufficient investment is in place.

Small Delivery Vans

The concept of autonomous delivery vans aims to reduce vehicle miles traveled by individuals to conduct daily errands, such as buying groceries or smaller essential items, through an autonomous on-demand delivery service. This can help tackle congestion and transport-related emission issues while also freeing up people's time.

Nuro, a U.S.-based door-to-door small autonomous delivery service provider, acquired the first license to operate a fleet of vehicles in California in 2019. Since then, they have deployed autonomous delivery vans in California, Texas, and Arizona for pilot programs delivering food and goods for Walmart, Uber Eats, Domino's, and more.

This use case is not subject to the same regulatory approvals as for passenger services as they do not need to meet additional passenger safety requirements of the National Highway Traffic Safety Administration as they do not carry a person within the vehicle. Nonetheless, the safety of other road users and other AV regulatory restrictions in terms of trials and operations still need to be ensured. Overall, this use case offers the highest level of market readiness with an opportunity to scale up rapidly.

Medium and Large Trucks

The future of trucking can be improved through deployment of autonomous trucks. With no human driver, these vehicles can be on the road for longer periods and also, with features like platooning,[30] can improve fuel efficiency and road safety. This can help with tackling the truck driver employment shortages. This use case also has the potential to reduce overall trucking

[29] Our Locations | May Mobility

[30] *Platooning* refers to a scenario where a line of trucks synchronized together can follow each other at close distances, improving gas mileage.

costs, according to TuSimple, a U.S.-based autonomous trucking company. The efficiency in operations and elimination of human drivers may result in up to a 40 percent reduction in trucking costs.[31]

TuSimple conducted the first AV truck trial in December 2021 between Tucson and Phoenix, Arizona, covering a distance of 80 miles on public highways without a driver being present. Since then, they have been conducting trials in China and Japan too.[32] Aurora Innovation, Inc., another U.S.-based company, has been developing self-driving trucks and conducting pilots in Texas, albeit with a human driver being present. They have plans to launch a commercial service in 2024.

The technology and regulatory challenges for this use case are more complicated than the previous use cases, which are mostly operated in smaller areas, typically within a city boundary. The AV trucks need to be able to operate in most weather conditions, with fog or snow, and there have been limited pilots in these settings. Also, these vehicles would require consistent high-quality infrastructure support, such as high-speed internet throughout the route (for remote monitoring and V2X connectivity) and EV charging facilities to support top-up charging on long-distance journeys. These are not yet sufficiently developed. And finally, to ensure efficient rollout, autonomous trucks would also require consistent national or at least multistate legislation around AVs, which may take longer to realize. Considering all these factors together, the market readiness of autonomous trucks is low to medium.

Personal Cars

Personal AVs could be desirable because of the convenience they can offer to users. However, AVs are likely to remain considerably expensive compared to traditional cars, which will limit the adoption of AVs in the personal car segment in the short term. Fully autonomous features will most likely only be available within the large-vehicles segment offered by premium OEMs who cater to customers who are insensitive to price.

Private ownership of AVs also has the potential to significantly increase car use if price is not a barrier, particularly among people who currently do not hold a driver's license or do not have the capability to drive. This may worsen congestion and add to parking-related issues across major U.S. cities. Furthermore, additional liability related to complexities and legal challenges may be prohibitive to the legalization of personal ownership of AVs. Therefore, the market readiness for full AV-capable personal cars in the next 15 years is expected to be low.

[31] Driverless Trucks and Robot Deliveries Promise Fewer Traffic Jams than Robotaxis | NBC Bay Area
[32] TuSimple Conducts Autonomous Trucking Trials in China | Forbes

Methodology

- **AV Market Scenario and AV Market Penetration** - Market readiness is determined based on current trials as well as complexities in regulations. It can be assumed that the transition to AVs will be very gradual and will depend on the use cases. Our assumed market share is for 15 years ahead. Our market scenarios are informed by vehicle types and market readiness as described in detail above.

- **Workforce Impact Calculation** - AVs were assumed to follow the same staffing patterns as other automotive manufacturing. Across the U.S. automotive industry from 2017 to 2021, there were 95 vehicle production workers for every 1,000 vehicles produced. Likewise, distribution roles added another 30 workers, and maintenance, upgrades, and repairs 65 workers, for every 1,000 vehicles. During that time period, according to U.S. Department of Transportation National Transportation Statistics Data, there were an average of 10,268,834 passenger cars and commercial vehicles produced. The workforce needed to develop, manufacture, distribute, and service those vehicles included an average of: 972,553 Development and Production workers (NAICS 3361: Motor Vehicle Manufacturing, 3362: Motor Vehicle Body and Trailer Manufacturing, 3363: Motor Vehicle Parts Manufacturing); 303,005 Distribution workers (NAICS 423110: Automobile and Other Motor Vehicle Merchant Wholesalers, 423120: Motor Vehicle Supplies and New Parts Merchant Wholesalers); and 671,382 Maintenance, Upgrades & Repair workers (NAICS 811111: General Automotive Repair, 811114: Specialized Automotive Repair, 811210: Electronic and Precision Equipment Repair and Maintenance).

- **Defining Core AV Industries** - For the purposes of this study, Core AV Industries across development, manufacturing, and maintenance of AVs were defined by using Job Postings Analytics data from Lightcast™. Our analysis identified a list of 18 detailed industries—as defined by the North American Industry Classification System—that fit the skills profile for AV workers. For the job posting analytics, we selected a skill for the query: Autonomous Vehicles, which is a specialized skill. We also selected the United States for the region. The time frame for our job posting analysis was August 2022 to September 2023.

- **Defining Core AV Occupations** - Our analysis identified a list of ten occupational groups—as defined by the Standard Occupational Classification System—for AV workers. Workers within the ten occupational groups containing Core AV Occupations make up 97 percent of the current employment levels within Core AV Industries.

Core AV Industries

Design

- 541512: Computer Systems Design Services
- 541511: Custom Computer Programming Services

Engineering

- 541330: Engineering Services

Testing

- 541380: Testing Laboratories and Services

High-Res Mapping

- 334511: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
- 334515: Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals

Manufacturing

- 336110: Automobile and Light Duty Motor Vehicle Manufacturing
- 336120: Heavy Duty Truck Manufacturing
- 334413: Semiconductor and Related Device Manufacturing
- 334419: Other Electronic Component Manufacturing
- 335999: All Other Miscellaneous Electrical Equipment and Component Manufacturing
- 336320: Motor Vehicle Electrical and Electronic Equipment Manufacturing
- 336390: Other Motor Vehicle Parts Manufacturing

Distribution

- 423110: Automobile and Other Motor Vehicle Merchant Wholesalers
- 423120: Motor Vehicle Supplies and New Parts Merchant Wholesalers

Maintenance, Upgrades & Repairs

- 811111: General Automotive Repair
- 811114: Specialized Automotive Repair
- 811210: Electronic and Precision Equipment Repair and Maintenance

Core AV Occupations

STEM Occupations

- 15-0000: Computer and Mathematical Occupations
- 17-0000: Architecture and Engineering Occupations
- 19-0000: Life, Physical, and Social Science Occupations

Production Occupations

- 51-0000: Production Occupations

Transportation and Sales Occupations

- 53-0000: Transportation and Material Moving Occupations
- 41-0000: Sales and Related Occupations

Installation, Maintenance, and Repair Occupations

- 49-0000: Installation, Maintenance, and Repair Occupations

General Business Support Occupations

- 11-0000: Management Occupations
- 13-0000: Business and Financial Operations Occupations
- 43-0000: Office and Administrative Support Occupations

Data Sources

- Alliance for Automotive Innovation AV Company Location Data, 2023
- U.S. Department of Transportation National Transportation Statistics Data, 2017–21
- Lightcast™ Jobs Posting Analytics with Autonomous Vehicles Specialized Skill, 2023
- Lightcast™ Staffing Patterns Data, 2022
- Lightcast™ Industry Map Data, 2022
- Lightcast™ Occupation Map Data, 2022
- Lightcast™ Occupation Table Data, 2022