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Electric Vehicle Market Update

Manufacturer Commitments & Public Policy Initiatives Supporting Electric Mobility in the U.S. & Worldwide

Contents

Acknowledgements

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This paper summarizes the current status, and projected growth, of the U.S. electric vehicle (EV) industry over the next five to ten years. Key topics addressed include drivers of U.S. and global EV growth, auto manufacturer investments in EV development and in building a robust charging network for drivers, announced new EV model introductions, projected EV sales, projected battery pack costs and advancements, and projected date of EV "price parity" with internal combustion engine (ICE) vehicles. The report also addresses the effects of the COVID-19 pandemic on EV sales.

This report was developed by ERM for the Environmental Defense Fund (EDF).

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This report is available at www.sustainability.com.

Notable Updates Since Version Five (April 2021)

- President Biden signed the $1.2 trillion "Infrastructure Investment and Jobs Act," allowing $550 billion in new spending on investments in infrastructure upgrades, transit related activities, clean drinking water, universal high-speed internet, clean energy, transmission and power infrastructure upgrades, and climate change strategies.
- President Biden issued Executive Order on *Strengthening American Leadership in Clean Cars and Trucks,* which establishes a goal that 50 percent of new passenger vehicles sold by 2030 are zero-emitting and directs the Environmental Protection Agency (EPA) to undertake a series of rulemaking to reduce pollution from light, medium- and heavy-duty vehicles.
- President Biden issued Executive Order on *Catalyzing Clean Energy Industries and Jobs,* which sets goals for the federal government to achieve 100 percent zero-emission vehicle (ZEV) fleet acquisition by 2035, and 100 percent light-duty ZEV fleet acquisitions by 2027, among other goals.
- EPA issued more protective vehicle emission standards for greenhouse gases (GHG) as well as restored California's long-standing authority to issue its own GHG and ZEV standards. EPA also issued a proposed rule that would regulate GHG and other pollutants from medium- and heavy-duty (M/HD) vehicles.
- At COP26, several governments, key international auto manufacturers, and investors issued a joint declaration stating their intention to achieve 100 percent ZEV sales of new light duty vehicles by 2040 globally, and by 2035 in "lead markets."
- In 2021, Minnesota, Nevada, and Virginia became the 14th, 15th, and 16th states to adopt California's low-emissions vehicle (LEV) and ZEV standards. Most recently in 2022, Delaware announced that it will adopt California ZEV standards with regulations becoming effective for model year 2027 and beyond.
- General Motors (GM) announced that it will be investing $35 billion in EV production through 2025—a 75 percent increase from its initial commitment pre-pandemic. By the end of 2025, GM plans to offer 30 battery electric vehicle (BEV) models globally and aims to have more than one million units of EV capacity in North America in response to a goal of BEVs comprising 40 percent of U.S. models. Included is an investment of more than $7 billion across four Michigan manufacturing sites, the largest announced investment in GM history, creating 4,000 new jobs, thus significantly increasing domestic battery cell and electric truck manufacturing capabilities to 600,000 trucks.
- Toyota announced a $3.4 billion investment in the U.S. market focused on strengthing EV manufacturing and battery development, only a portion of its $13 billion global investment commitment. In part, Toyota will develop a $1.25 billion battery manufacturing plant in Liberty, North Carolina.
- Hyundai announced an additional investment of $16 billion to its electrification strategy adding to its original $7.4 billion commitment. The automaker plans to produce 17 new BEV models and capture seven percent of the global EV market by 2030.
- Rivian held a successful IPO, reaching a market capitalization of $100 billion.
- Ford increased its electric vehicle (EV) investment commitment to $50 billion through 2026 and expects 50 percent of its global vehicle volume to be fully electric by 2030. The manufacturer has doubled EV capacity by 2023 to 600,000 vehicles per year as F-150 Lightning reservations near 200,000 by the end of 2021 and expects to build two million EVs per year in 2026. Included is an $11.4 billion investment, in partnership with SK Innovation, in battery innovation and battery manufacturing plants in Kentucky and Tennessee; this is expected to provide 11,000 new jobs. Additionally, Ford has a set a battery pack cost goal of $80/kWh by 2030.
- Stellantis, formerly Fiat Chrysler, announced a global investment commitmtment of $35.5 billion and has committed to 96 percent of American nameplates (Jeep, Ram, Dodge, Fiat etc.) to have electrified options with all models by 2025, and fully battery-electric options by 2030. In addition, Stellantis announced a joint venture with LG Energy Solutions to construct a 40 gigawatt hour lithium-ion battery factory to break ground in the second quarter of 2022 and start production in 2024. Stellantis and Samsung SDI announced a joint venture to construct a 23 gigawatt-hour factory set to be completed in 2025.
- Nissan announced 'Ambition 2030' committing over $17 billion to fleet electrification. The manufacturer aims to have 15 fully electric vehicles on the market by 2030 and have solid state batteries in production by 2028.
- Supply chain disruptions, material shortages, and high costs are putting pressure on the auto market and analysts estimated that global automakers lost $210 billion in 2021. However, global and U.S. EV sales remained strong, up 40 percent and 4 percent year over year, respectively.
- Tesla's U.S. sales for Q3 2021 were up 104 percent compared to Q3 2019. Hertz struck a deal to buy 100,000 Model 3 vehicles by the end of 2022, making this a $4 billion investment for Hertz and increasing Tesla's market value to $1 trillion.
- Europe, for the first time, led global EV sales in 2020 with about 1.4 million registrations, a 135 percent increase, with China and the U.S. following with 1.2 million and 295,000 registrations, respectively.
- Roush Industries conducted a study that found electric medium- and heavy-duty (M/HD) vehicles to be cost competitive with diesel vehicles in nearly all vehicle segments examined at the time of purchase in 2027. Similarly, a study conducted by CALSTART indiciates that zero-emission trucks could reach cost parity by 2030 as a result of decreasing costs in key components such as batteries and motors and the expected cost increase in fuel.

Glossary

ACC: Advanced Clean Cars regulation

ACT: Advanced Clean Trucks regulation

BEV: Battery electric vehicle

CARB: California Air Resources Board

CO_2: Carbon dioxide

COP: Conference of the Parties

DCFC: Direct current fast charging

DOE: Department of Energy

DOT: Department of Transportation

EPA: Environmental Protection Agency

EV: Electric vehicle

GHG: Greenhouse gas

ICE: Internal combustion engine

IIJA: Infrastructure Investment Jobs Act

kWh: Kilowatt hour

L2: Level 2 charging

LD ZEV MOU: Light-duty zero-emission vehicle memorandum of understanding

LEV: Low-emission vehicle

LDV: Light-duty vehicle

M/HD: Medium- and heavy-duty (vehicle)

MOU: Memorandum of Understanding

MSRP: Manufacturer's suggested retail price

MY: Model year

PHEV: Plug-in hybrid vehicle

SSB: Solid-state battery

SUV: sport utility vehicle

TCI: Transportation and Climate Initiative

ZEV: Zero-emission vehicle

Executive Summary

This paper is the fifth update to an initial report released in May 2019* that summarizes the current status, and projected growth, of the U.S. electric vehicle (EV) industry over the next five to ten years. Key topics addressed include drivers of U.S. and global EV growth, auto manufacturer investments in EV development and in building a robust charging network for drivers, announced new EV model introductions, projected EV sales, projected battery pack costs and advancements, and projected date of EV "price parity" with internal combustion engine (ICE) vehicles. The report also addresses the effects of the COVID-19 pandemic on EV sales.

The data summarized here are based on formal statements and announcements by auto manufacturers, as well as analysis by the automotive press and by financial and market analysis firms that regularly cover the auto industry.

Transportation is currently the United States' largest source of greenhouse gas (GHG) emissions, and transportation-sector electrification is widely recognized as one of the best strategies for significantly reducing these emissions. The data summarized here support the conclusion that the automotive industry has embraced the vision of electrified mobility and that the EV market is on the cusp of a period of significant growth. As a result of COP26, numerous manufacturers, including General Motors (GM), Ford, Mercedes, BYD, Volvo and Jaguar Land Rover (JLR), have publicly committed to an entirely zero-emissions light-duty vehicle fleet by 2040 and 2035 in leading markets.[1] For example, Volvo's chief technology officer said that "there is no long-term future for cars with an internal combustion engine. [Volvo is] firmly committed to becoming an electric-only car maker and the transition should happen by 2030" after announcing they would only

* Updates released August 2019, September 2020, January 2021, and April 2021.

sell electric vehicles by 2030.[2] GM CEO Mary Barra said that "at GM, we believe that after one of the most difficult years in recent history, this moment will prove to be an inflection point, the moment when our world's reliance on gas and diesel-powered vehicles will begin transitioning to an all-electric future;" the company then announced later that month that it aspires to eliminate tailpipe emissions from new light-duty vehicles by 2035.[3] Volkswagen (VW) echoed GM's sentiment, stating that "2020 marked a turning point in customer sentiment" after VW's electric sales tripled last year.[4] On a collective front, the Alliance for Automotive Innovation, the main trade group representing the U.S. auto industry, announced that "the U.S. auto industry is aligned with the Biden Administration's goals to achieve net-zero carbon transportation and an accelerated shift to electric-drive vehicles, and is committed to working with the administration on a revised national program that includes California, brings all automakers under a unified set of common requirements and ensures a level, competitive playing field."[5] One month later, the Alliance sent a joint letter with the United Autoworkers International Union (UAW) and the Motor & Equipment Manufacturers Association (MEMA) to President Biden stating that "the road leads to an increasingly electrified future," and the groups would commit to collaborating with the Administration on crafting and implementing a comprehensive plan that focuses on three key areas: consumers; infrastructure; and innovation, manufacturing, and supply chain.[6]

Beyond manufacturer statements, the National Academies of Sciences, Engineering, and Medicine declared that "the period from 2025-2035 could bring the most fundamental transformation in the 100-plus year history of the automobile" as battery costs fall and EVs reach price parity with internal combustion engine vehicles, leading them to become the "dominant type of new vehicles sold by 2035."[7]

These manufacturer commitments reflect heightened efforts to address the major causes of climate change by governments world-wide, including adoption of more stringent vehicle emission standards and EV sales targets. It is likely that these government actions — and anticipation of even more stringent future standards — have been a significant driver of automaker EV commitments and investment plans, supported by dramatic reductions in the cost of batteries, which have made transportation electrification more affordable.

While this update includes a discussion of medium- and heavy-duty vehicle electrification, the primary focus covers light-duty vehicles unless otherwise noted.

Major findings of this report include:

Manufacturer Commitments

Carmakers worldwide will spend **more than $515 billion through 2030** developing new electrified passenger vehicle models.[8] This would be a projected increase of more than $300 billion in spending from the first EV market Report's projection in May 2019, more than 200 percent increase in funding. Thirteen manufacturers have already announced plans to **spend over $75 billion to open new or renovated plants in the U.S.** to build EVs in six different states. These plants will directly employ between **24,000 and 30,000 workers** and contribute to additional job creation for suppliers and local businesses. Recently, GM announced a $7 billion investment across its four Michigan manufacturing plants—which will significantly increase domestic battery cell and EV manufacturing capabilities.[9] Nissan announced a $17.6 billion investment on strengthing EV manufacturing and battery development for the next five years.[10] Ford will increase investments in electric vehicles to over $50 billion through 2026. As 74 percent of plug-in EVs driven on U.S. roads in 2020 were assembled domestically, these manufacturing plant investments highlight continued cultivation of a strong EV workforce and robust market.[11] The domestic battery supply chain is also growing rapidly with more than $14 billion announced to date across at least nine states that could support 15,000 employees.

Model Availability

By 2025, approximately **109 battery electric (BEV) and plug-in hybrid (PHEV) passenger vehicle models** will be available to U.S. consumers.* The range of vehicle types available will also increase to include sport utility vehicles (SUV), cross-overs, and pick-up trucks. The median EPA estimated range exceeded 230 miles for MY2021 EVs and the introduction of the first EV to achieve a range of more than 400 miles; the Cadillac Lyric and Lucid Motors Air have received attention as models that tout 300 and 517 miles of expected EPA-rated range, respectively.

Significant growth has also been seen in the medium and heavy duty space. In 2019, there were only 20 models of Class 2b-8 zero-emission trucks (ZETs) available for purchase in the United States;[12] now, there are more than 400. CALSTART estimates that the number of ZETs and bus models available on the market will i**ncrease 26 percent from 2020 through 2022, up to 544 total models**.[13]

Affordability

In 2022, there will be **three EV models available for under $30,000 (MSRP)** with a driving range of over 100 miles. There will be even more models with a net cost of under $30,000 when current federal, state, and local incentives are factored in. Apart from these declining upfront purchase prices, many analyses conclude EVs will save consumers substantial amounts in avoided fuel costs. For instance, an Environmental Defence Fund (EDF) analysis concludes that at current average fuel prices, an EV buyer could save over $5,000 in avoided fuel costs over the life of the vehicle.*

* Vehicles included in this figure are those that are available or expected to become available in the U.S. with an MSRP below $100,000. The number of available vehicle models will be greater when considering global EV announcements and models that cost more than $100,000.

*See EV Price Parity for more details

EV Sales Projections

Major auto manufacturers are embracing electrification, as evidenced by the increased number and variety of electrified models offered, as well as commitments to brand electrification and sales targets. For example, Volvo anticipates BEVs will make up half of its sales in 2025 (the other half hybrid vehicles) and will move to exclusively sell EVs by 2030. Honda is aiming for two-thirds of its sales to be electrified globally and all sales in Europe by 2025. At COP26 six manufacturers, including GM, Ford, Mercedes-Benz, BYD, Volvo and JLR, publicly committed to achieve an entirely zero-emissions light-duty vehicle fleet by 2040.[14] Ford said that its entire European passenger vehicle line would be ZEV capable, BEV, or PHEV by mid-2026, and expects 50 percent of its global vehicle volume to be fully electric by 2030 with an interim goal of producing two million vehicle per year in 2026.[15] Similarly, GM set a goal to have one million units of electric vehicle capacity in North America by mid-decade.

Charging Station Investment

In addition to expanding their portfolios to include a greater range of electric and electrified models, manufacturers like Nissan and Volvo have acquired stakes in companies that specialize in charging and battery technology while Audi, Ford, Mercedes-Benz, and Volkswagen have announced they will each invest billions of dollars in electrification strategies. Manufacturers are increasingly exploring how to expand the charging network for their drivers, demonstrated through GM's Ultium Charge 360 plan which aims to connect GM EV owners with over 60,000 plugs across the U.S. and Canada and Rivian's Adventure Network which aims to provide 3,500 fast chargers for Rivian drivers and 10,000 public level 2 chargers for all drivers.

EV-Specific Brand Development

Many brands are developing platforms that will exclusively cater to EVs, like GM positioning Cadillac as its lead EV brand with the BEV3 platform and Ford's Lincoln brand dedicating to an all-electric fleet by 2030. By establishing unique, EV-dedicated brands, automakers are sending a clear signal that EVs will make up a larger share of their portfolio and reducing emissions will be a focus going forward. EV-only brands like Rivian and Lucid Motors are gaining momentum, and Tesla has dominated U.S. EV sales to date. On the medium- and heavy-duty side, Volvo Group announced Volvo Energy, formerly a subsect of Volvo Trucks, would be responsible for matters related to electrification, such as life cycle battery management and charging infrastructure.

Fleet Electrification

Electrification of medium- and heavy-duty (M/HD) commercial fleet vehicles is gaining traction, in part due to fleet electrification targets by major companies. For example, FedEx has said its entire global parcel pickup and delivery fleet will be zero–emission EVs by 2040 and Amazon ordered 100,000 vehicles from Rivian. These commitments send market signals that large entities are seeking electric alternatives for their fleets as components of their sustainability initiatives. These companies are planning to convert a range of light-, M/HD vehicle types to EVs, including delivery vans, commuter buses, transit buses, garbage trucks, and more. Coupled with private sector commitments, states are signaling their interest in medium- and heavy-duty electrification through policies such as California's Advanced Clean Truck Regulation as well as multi-state collaborations like the sixteen states and 18 jurisdictions (including Washington D.C. and Quebec) Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding.

Declining Battery Costs

The cost of battery packs has fallen dramatically, from over $1,000/kilowatt-hour (kWh) in 2010 to approximately **$132/kWh in 2021**. Most analysts project that battery pack prices will continue to fall, reaching **$100/kWh between 2023 and 2025** and **$61-72/kWh by 2030**. Auto manufacturers have endorsed these projections.

Price Parity

Many industry experts believe that passenger EVs will reach cost parity with internal combustion engine (ICE) vehicles (based on total cost of ownership without considering any tax incentives) when battery pack prices fall below $100/kWh, resulting in lower up-front purchase prices. While some industry experts believe price parity for BEVs with smaller battery packs has already been realized, most believe wide-spread price parity will happen around 2025. In a recent study, Roush Industries concluded that purchase price parity for M/HD vehicles will be reached by 2027 for many vehicle segments.[16]

Effects of COVID-19

As the global economy ground to a halt in the spring of 2020, many automakers that had anticipated near-term launches of new electric models – including Rivian (R1S and R1T), GM (Hummer), Byton (M-Byte and K-Byte), and Workhorse (W-15) – revised their timelines, halted operations, and furloughed workers.

Despite the pandemic, sales of EVs grew year over year from 2019 to 2020 in many places around the world while car sales shrank overall. As 2020 concluded, global EV sales increased 40 percent (marking a return to double digit sales growth), with EV sales in the U.S. growing four percent while overall car sales decreased 15 percent.[17] In Europe, EV sales increased 135 percent compared to a 24 percent decline in the overall car market. And in 2021, global automakers sold 6.6 million EVs, more than double the 3 million sold in 2020, and triple the sales of 2019.[18]

The effects of the COVID-19 pandemic persist into 2022. Several semiconductor chip manufacturers have announced the expansion of factories to accommodate increased demand. Chip manufacturers predict that shortages are likely to continue well into 2022 though automakers differ, believing that shortages will ease in the second half of 2022.[19] Although analysts predicted a 24 percent to 26 percent decline in sales for September 2021 due to shortages, year-end sales topped 15 million vehicles, up from the 14.5 million vehicles sold in 2020.[20,21] Automakers like GM found its September 2021 sales were about 1.8 million units and reached an end of year net income record of $14.3 billion dollars—which it expects to double by 2030.[22, 23] Similarly, Tesla announced that year end 2021 production and deliveries were up 82 and 87 percent, respectively, over 2020.[24] Thanks to a $4 billion deal struck with Hertz, Tesla's end-of year 2021 market value was over $1 trillion.[25]

Projected long-term effects of the COVID-19 pandemic on vehicle sales—both ICE and EV—remain unclear. The disruption of supply chains and the shift in consumer spending patterns are leading many brands to delay model launches and less-profitable updates until 2022 or 2023.

Global EV Growth as Critical Context

While this report is in many ways focused on U.S. domestic EV trends and projections, the global market for EVs has a strong impact on U.S. sales and policy. Around the world, countries and subnational governments have announced target dates by which they would allow the sale of only zero-emission vehicles (ZEVs) to accelerate the transition to a cleaner, electrified transportation sector. The resulting technological benefits and policy frameworks will have an important impact on the U.S.—and the U.S. has an opportunity to continue action to join these leading countries.

European countries have been leading this movement with Denmark, France, Ireland, the Netherlands, Norway, and the U.K. aiming to only sell ZEVs in the coming years (Figure 1).[26] In December 2021, BEV sales in Europe and the U.K. were higher than those of diesel-powered car sales—the data indicated that 176,00 BEVs were sold as opposed to 160,000 diesel vehicles.[27] As of February 2022, Norway continues to lead EV passenger vehicle sales, with 75.6 percent BEVs and 10.5 percent PHEVs being sold.[28]

In July 2021, the E.U. unveiled its "Fit for 55" package which aims at revising current E.U. emission legislation.[29] The package proposes more stringent fuel economy standards to cut emissions by 55 percent by 2030 and 100 percent by 2035 and proposes to ensure all new vehicles sold by 2035 are zero-emitting.[30] These signals of national ambition are also being reinforced by a growing willingness to embrace regulatory standards that set meaningful timelines by which sales of all new vehicles will be zero-emitting.

On October 31, 2021, the U.N. climate conference COP26 began in Glasgow, Scotland. Here countries and subnational governments came together to tackle climate change and discuss mitigation and adaptation strategies. **At COP26, several governments, key international auto manufacturers, and investors issued a joint declaration stating their intention to achieve 100 percent ZEV sales of new light duty vehicles by 2040 globally, and by 2035 in "lead markets."** Signatories agree to work towards all sales of cars and vans being zero emissions by 2040 and no later than 2035 in leading markets.[31] Jurisdictions included the U.K, Canada, Sweden, and California, as well as important signatories from emerging markets of India and Mexico, and automakers, Ford and GM supported the declaration. However, some countries with the largest car markets—including the U.S., Germany, Japan, South Korea, and China—did not sign the pledge, nor did Toyota and Volkswagen.

Organizing bodies CALSTART and the Netherlands also introduced the first ever global agreement on zero-emission trucks and buses, the *Global Memorandum of Understanding for Zero-Emission Medium- and Heavy-Duty Vehicles*, which aims to reach net-zero carbon emissions by 2050 within the signatory countries and subnational governments. Fifteen countries signed the MOU with an interim goal of 30 percent zero-emission new vehicle sales by 2030 and 100 percent by 2040. Subnational governments such as Quebec, Canada and Telengana, Indian, and top manufacturers and fleets like DHL, Heineken, and BYD have also signed the MOU.[32]

Lastly, in collaboration with U.S. State Department's U.S. Special Presidential Envoy for Climate and the Office of Global Partnerships, the World Economic Forum, and with the U.S. Departments of Commerce and Energy, President Biden announced the launch of the First Movers Coalition. This Coalition is a platform for companies to create early markets for innovative clean energy technologies. At its launch, the Coalition had more than 25 members that have made commitments of purchasing near zero and zero-emission products, vehicles or fuels to at least one of the four sectors; steel, trucking, shipping, and aviation.[33]

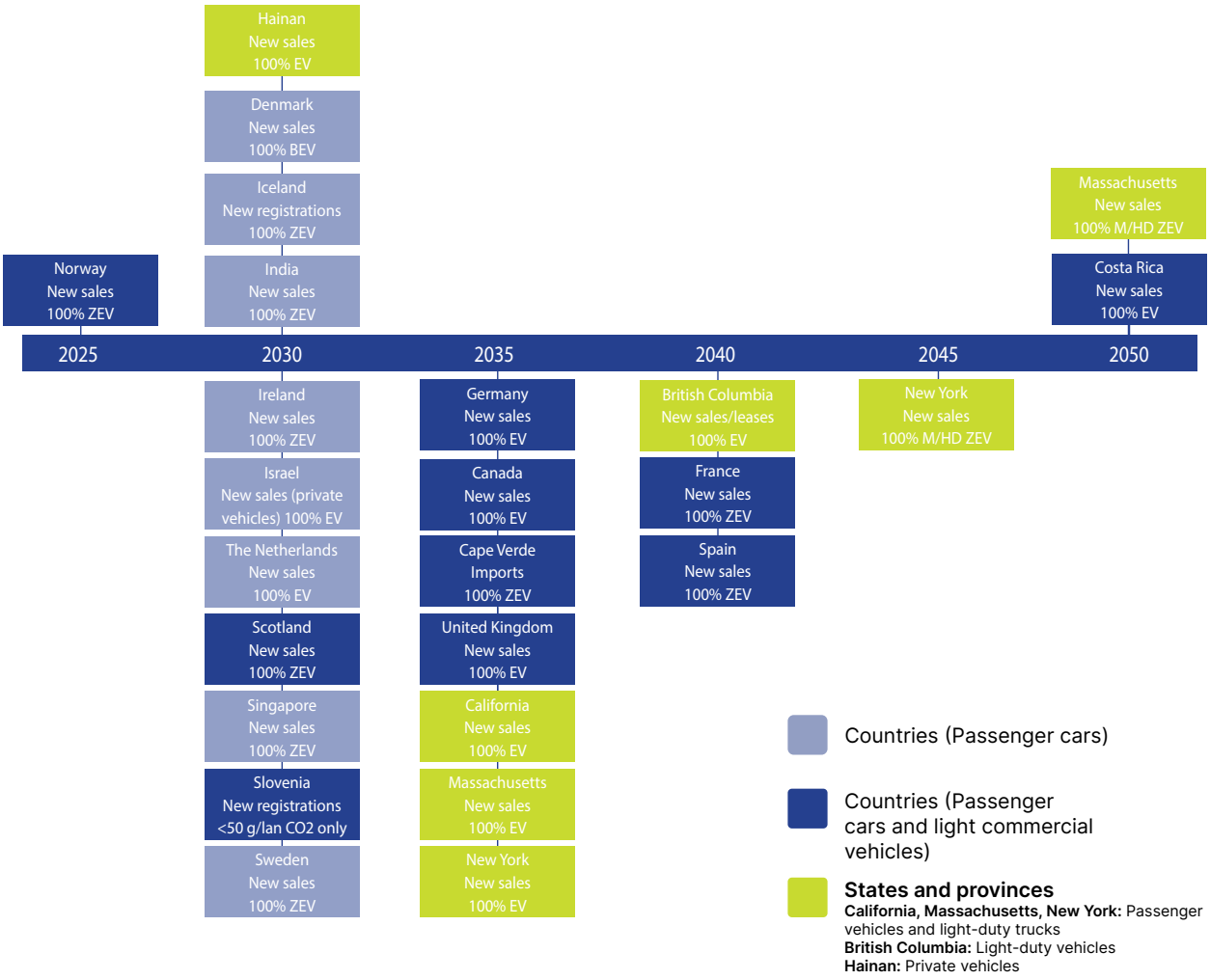
While Europe may lead in the sheer number of country commitments, India and China's targets could have substantial impacts: if the two countries meet their targets to only sell ZEVs by 2030 and 2040, respectively, around 3.3 billion people, or 43 percent of the world's population, would be live in countries that rely exclusively on the sale of new ZEVs after 2040.[34] China aims to sell 7 million "new-energy vehicles" annually by 2025, amounting to approximately 20 percent of its total auto market.[35] With sales of EVs already approaching 18 percent, that goal is within reach, according to the China Association of Automobile Manufacturers.[36] Additionally, in October 2020, China outlined a plan that by 2035, all new cars sold will be "eco-friendly": 50 percent will need to be BEV, PHEV, or fuel cell, and 50 percent will be hybrids.[37]

Globally, many cities are pledging deep decarbonization efforts as well. The Climate Mayors Electric Vehicle Purchasing Collaborative—a pledge signed by more than 470 cities and counties across the U.S. that focuses on public fleet electrification—announced intentions to

collectively buy more than 3,800 EVs before the end of 2021 for local government fleets; Los Angeles Mayor Eric Garcetti said of the initiative, "By pooling our purchasing power, Climate Mayors are sending a powerful message to the global car market: if you build electric vehicles, we will buy them."[38] Another coalition, the C40 Fossil Fuel Streets Declaration, commits the 36 signatories to replacing their cities' fossil fuel transit buses with electric alternatives by 2025 and to achieving zero-emissions in designated areas by 2030.[39]

Major international cities are going one step further by committing to eliminate diesel vehicles: Rome by 2024 (in the city center); Athens, Madrid, Mexico City, and Paris following the year after; and Brussels, Amsterdam, and Milan by 2030.[40] Los Angeles aims to increase the number of electric and zero emission vehicles operating in the city to 25 percent of all vehicles in 2025 and then to 100 percent by 2050.[41] As indicated by recent commitments to shift to lower emitting vehicles, a growing list of countries and cities are anticipating and encouraging a future supported by electrified transportation seen in Figure 1.

Figure 1.
Timeline of Global Targets to Achieve All-ZEV Sales



Policy Drivers of U.S. Electric Vehicle Growth

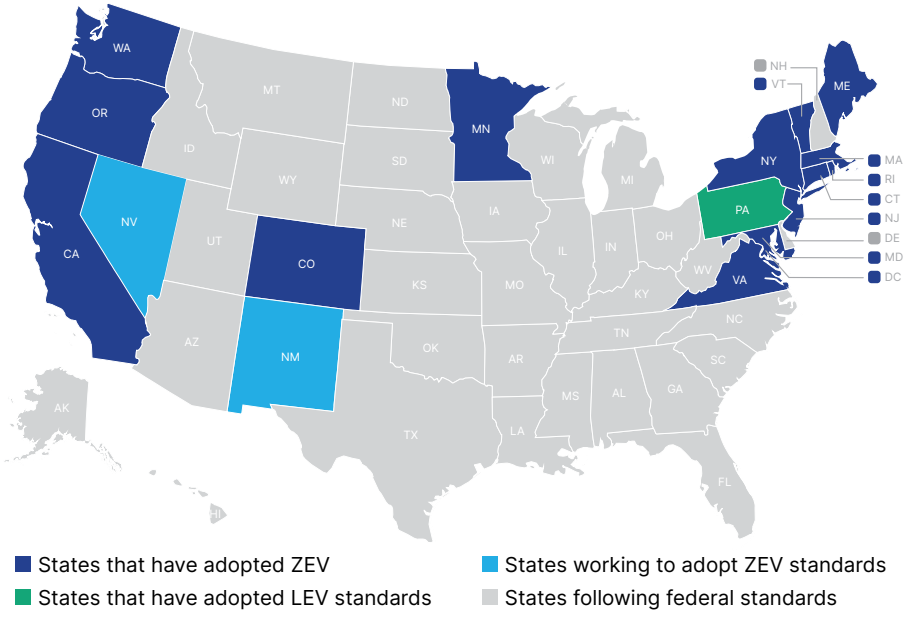
As countries around the world individually and collectively encourage the shift to EVs, in the United States, states are leading in policies to help drive adoption of electric vehicles. In addition, the federal government has directed increasing focus to electrification across the transportation sector as a key strategy for lowering economy-wide emissions.

State & Regional Action

For light duty vehicles, a key policy is the development and adoption of the California Advanced Clean Cars (ACC) regulations, which aims to reduce smog-forming pollution that contributes to air pollution, reduce GHG emissions, and increase the market share of ZEVs. The ACC includes both the Low-Emissions Vehicle (LEV) regulation for criteria and GHG emissions as well as a ZEV mandate that requires that ZEVs make up a certain percentage of each manufacturer's annual new car sales in the state.[42] Under the federal Clean Air Act, California may set its own standards while other states may adopt those standards in lieu of federal standards enacted by the Environmental Protection Agency (EPA). According to an analysis by the International Council on Clean Transportation, "states that adopt California's Zero Emission Vehicle regulation catalyze the market, spurring automaker marketing and expanded model availability."[43] In 2020, the 12 states (not including those who joined in 2021) that have adopted the ZEV regulation are collectively responsible for over two thirds of BEV and PHEV light-duty vehicle sales between 2011 and 2020.[44] In 2021, Minnesota, Nevada, and Virginia became the fourteenth, fifteenth, and sixteenth states to begin regulation to join the ZEV program.[45,46] Most recently, Delaware announced that it will adopt California ZEV standards with regulations becoming effective for model year 2027 and beyond.[47] Pennsylvania has currently adopted LEV standards and is in the process of drafting ZEV standards.[48] New Mexico is in the process of adopting ZEV regulations.[49]

The California Air Resources Board (CARB) is currently working to update the Advanced Clean Cars regulation (ACC II) to increase stringency, better align standards with real-world reductions (e.g., better control of engine start emissions that can exceed lab test emissions), and improve the ZEV experience for consumers (e.g., standardizing fast charging ports).[50] In September 2021, California Governor Gavin Newsom issued an Executive Order that set a goal that 100 percent of in-state sales of new light-duty passenger cars and trucks be zero-emission by 2035, directing CARB to develop and propose regulations consistent with meeting that goal.[51] Initial versions of the standards would ensure that at least 61 percent of new passenger cars and trucks be ZEV by 2030 on the path to meeting the 2035 goal.[52]

Figure 2.
States Adopting California's Advanced Clean Cars Regulation



CARB staff presented an analysis and potential regulation modification in May and September of 2020, as well as a series of stakeholder meetings over the course of 2021 and published draft ZEV regulations in December 2021.[53] A final rulemaking package is expected to be presented to CARB in June of 2022.[54]

In conjunction with this goal and regulatory update, California has developed a ZEV Market Development Strategy implementation framework that focuses four key elements: infrastructure as a market enabler, investing in equitable access to public charging and hydrogen fueling stations; changing behavior, making the transition as convenient as possible by bolstering technology, charging, and fueling reliability and user confidence; scale, increasing investor confidence by filling market gaps with long-term public funding; and building the EV market in California. Further cementing this commitment, Governor Newsom's 2021 budget included $1.5 billion for ZEVs and supporting infrastructure.[55] Governor Newsom's proposed 2022-2023 budget increases the 2021 budget to $10 billion dedicated to ZEVs, clean transportation and supporting infrastructure.[56]

Additional U.S. state committed to ensuring an increase of new light-duty vehicles sold are zero-emitting by 2035 include:

- In December 2020, Governor Charlie Baker comitted Massachusetts to the ACT II targets, affirmed in the Clean Energy and Climate Plan for 2030: "[California's Advanced Clean Cars II (ACC II)] will require ZEV sales to ramp up to 100 percent of new LDV sales by 2035. Once finalized, MassDEP will adopt and implement these new ACC II regulations."[57]
- In September 2021, New York Governor Kathy Hochul signed A.4302/S.2758 which sets a goal for all new passenger vehicles and off-road vehicles and equipment sold in New York State to be zero-emission vehicles by 2035.[58] Additionally, Governor Hochul's plan includes investing $1 billion to increase sales of light-duty EVs by making them more accessible to the public and making sure that there is adequate infrastructure in place to support the initiative.[59] New Jersey is considering a similar path as the New Jersey Department of Environmental Protection proposed to ensure all new vehicles are zero-emitting by 2035 in part of an official road map to bring the State's carbon dioxide emissions down by 80 percent by 2050.[60]
- In January 2022, Governor Roy Cooper signed Executive Order No. 246, which sets a goal for North Carolina to increase the total number of registered ZEVs to at least 1,250,000 and increase the sales of ZEVs to 50 percent of in-state sales by 2030.[61]

California has also led the way in policies to drive electrification of the medium- and heavy-duty (M/HD) sector. In 2020, California adopted the Advanced Clean Trucks (ACT) Regulation, "the first ever in the world effort to mandate the construction and deployment of zero-emission vehicles in the heavy-duty sector"; under this regulation, by 2045 every new truck sold in California will be zero-emission.[62] To inform ongoing development of M/HD vehicle regulation, incentives, and programs across the state, the ACT's Large Entity Reporting Rule requires that large fleets owners and government agencies provide detailed data on their fleet composition and activity in 2021 (a one-time requirement). The ACT will be paired with the Advanced Clean Fleets (ACF) Rule, which has a goal of achieving a zero-emission public bus and truck fleet in California by 2045 and significantly earlier for certain market segments like last mile delivery and drayage trucks. ACF will provide regulation of public and private fleets, new mobility fleets, large employer fleets, rental fleets, and delivery fleets and will be developed in 2022. Additionally, in 2020, California adopted the Low NOx Heavy-Duty Omnibus Regulation, which will cut NOx emissions from heavy-duty trucks by roughly 75 percent below current standards beginning in 2024 and 90 percent in 2027.[63] The Regulation will require manufacturers to comply with stricter NOx emissions standards, overhaul engine testing procedures, and other emissions-related requirements.[64] These three rules will be in full effect by 2024. It is important to note that these rules are all supported by California's Transportation Electrification Framework, a whole of state initiative to support electric transportation funding, building out of charging infrastructure, and more.

In 2021 and 2022, respectively, Oregon and Massachusetts became the first and second States outside of California to adopt both the ACT rule and the heavy-duty NOx rule.[65,66] In late December of 2021, New Jersey[67], New York[68], and Washington[69] all adopted the Advanced Clean Truck rule and Maine[70] is considering adopting the rule in 2022.

In September 2021, New York Governor Kathy Hochul signed A.4302/S.2758 which sets a goal for all new M/HD vehicles sold in New York State to be ZEVs by 2045.[71] According to Bloomberg, truck manufacturers will need to increase their zero-emission truck sales in these states to between 30 and 50 percent by 2030, and 40 and 75 percent by 2035 in order to meet the ACT targets.[72]

Regional Action & Collaboration

States have also worked together to increase transportation electrification through collective action. One key form of collaboration is the creation of memoranda of understanding

associated working groups to share best practices and collaborate on policy and market development roadmaps. In 2013, six Northeast/Mid-Atlantic states (CT, MA, MD, NY, RI, and VT) and two Pacific coast states (CA and OR) joined in a Light-Duty Zero Emission Vehicle Memorandum of Understanding (LD ZEV MOU) to enact policies that will ensure the deployment of 3.3 million light-duty ZEVs by 2025.[73] These eight states—along with New Jersey and Maine, who joined in 2018 and 2019, respectively — collaborated to produce the *ZEV Task Force Multi-State ZEV Action Plan 2018-2021* and also founded the International ZEV Alliance, a global initiative between 16 North American and European national and subnational governments to accelerate the global transition to ZEVs.[74] The Task Force underscores that in the member states, light-duty passenger vehicles are the single largest contributor to GHG emissions and a significant source of local pollutants that contribute to adverse public health effects. For that reason, "transportation electrification is essential to achieving near- and long-term state GHG reduction goals and effectively combating climate change."[75]

Following the successful collaboration in 2013 that brought forth the LD ZEV MOU, fifteen states and the District of Columbia turned their attention to M/HD vehicles, signing a M/HD ZEV MOU in July 2020 with the goal of ensuring that 100 percent of all new M/HD vehicle sales in their jurisdictions be ZEVs by 2050, with an interim target of 30 percent by 2030.[76] Additionally, on March 10, 2022, the signatories of the Multi-State MHD ZEV MOU and the Northeast States for Coordinated Air Use Management (NESCAUM) announced the public release of a draft *Multi-State MHD ZEV Action Plan*, which focuses on near-term strategies to promote the rapid, equitable, and widespread deployment of MHD ZEVs.[77]

State governments have also formed regional-specific collaborations to coordinate infrastructure and policy development. For example, the Regional Electric Vehicle West Coalition (REV West), a coalition of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, first formed in 2017, has a goal to provide a framework for creating an Intermountain West EV Corridor that will make it possible to drive an EV across major transportation corridors in the west.[78] On September 30, 2021, the states of Illinois, Indiana, Michigan, Minnesota, and Wisconsin signed a MOU establishing the Regional Electric Vehicle Midwest Coalition (REV Midwest). The coalition aims to create cohesive regional framework to accelerate the transition to electric vehicles. Through the framework, states cooperation on fleet electrification along key commercial corridors, reduce harmful emissions, improve the health of the public, and advance electric vehicle innovation. REV Midwest will focus on three key foundations; accelerate M/HD fleet electrification, promote economic growth and industry leadership, and advance equity and a clean environment throughout Midwest States.[79]

Just before President Biden signed *Executive Order on Strengthening American Leadership in Clean Cars and Trucks*, Governors from 12 states* sent a letter to President Biden urging him to move quickly towards a zero-emission transportation future. The letter lays out nine requests including setting standards to ensure all new passenger vehicles and light-duty trucks sold are zero-emission no later than 2035; setting standards to ensure all new M/HD vehicles sold are 100 percent zero-emission no later than 2045; reaffirming states have the right to follow California emission standards; ensure incentives and tax credits are beneficial to consumers and manufacturers.[80]

Federal Action

At the federal level, there are multiple legislative and regulatory actions that aim to expand the feasibility of building the EV future. Most notably, on November 15, 2021, President Biden signed into law the $1.2 trillion Infrastructure Investment and Jobs Act (IIJA). This Act passed with bi-partisan support in both the U.S. House and Senate. It provides a five-year reauthorization of the Surface Transportation Reauthorization Act, with funding for competitive grants, formula grants, set asides, and other funds for federal and state highway, bridge, rail, transit, ferries, port and airport programs, as well as funding for power grid and water infrastructure.

Among the significant new funding related to EVs, the IIJA includes $7.5 billion for grant programs administered by U.S. Department of Transportation (DOT) for EV charging infrastructure to expand Alternative Fuel Corridors and a National Electric Vehicle formula grant program at the DOT to provide additional funding to states to support EV charging infrastructure. The IIJA also provides new funding for a clean school bus programs to support zero emissions school buses, with priority given to underserved and overburdened communities, and also to school systems that have matching funds to deploy for ZEV school buses. Another DOT competitive grant program is intended to help ports reduce air emissions from idling trucks, which could include truck electrification.

The Act was passed by the U.S. Senate on August 10, 2021, the House of Representative on November 5, 2021, and signed into law by President Biden on November 15, 2021.[81] The Rhodium Group predicts that the current tax credits coupled with a build-out of EV charging infrastructure as begun with the IIJA, could result in LDV EV sales climbing as high as 52 percent in 2031.[82]

12 states include California, Connecticut, Hawaii, Maine, Massachusetts, New Jersey, New Mexico, New York, North Carolina, Oregon, Rhode Island, Washington.

Table 1.
Sample of the Infrastructure Investment and Jobs Act Programs

Title	Description	Funding Allocation
Clean School Bus Program	Provides funding for state and local governments, eligible contractors, and nonprofit school transportation associations to adopt low-carbon and zero-emissions school buses.	$5 billion
National Electric Vehicle Formula Program	Establishes a program that provides funds to states in order to strategically deploy EV charging, maintenance for the infrastructure and establish an interconnected network to facilitate data collection, access and reliability.	$5 billion for each FY2022-FY2026
Grants for Charging and Fueling Infrastructure	Establishes a grant program to deploy publicly accessible electric vehicle charging infrastructure, hydrogen fueling infrastructure, propane fueling infrastructure, and natural gas fueling infrastructure.	$2.5 billion distributed over FY2022-FY2026
Grants for Buses and Bus Facilities	Amends section 5339 of title 49 to appropriate grants for low or no emission buses and bus facilities and workforce development programs related to zero emission vehicles. This provision requires 15 percent of funding to go towards projects in rural communities.	• $206 million for each fiscal year allocated to all States and territories • $4 million allocated to each state for each fiscal year • $1 million allocated to each territory for each fiscal year
Battery Processing and Manufacturing	Provides funds to expand the processing and manufacturing of advanced batteries, including for EVs and the electric grid, in the United States. These funds are deployed into various grants for demonstration projects, construction of facilities and retooling/retrofitting/expanding facilities for battery manufacturing and recycling.	$3 billion for battery material processing, $3 billion for battery manufacturing and recycling, $10 million for Lithium-Ion Battery Recycling Prize, $60 million for Battery Recycling RD&D, $50 million for State and Local Programs and $15 million for Collection System for Batteries

In addition, the proposed Build Back Better Act would established programs, funding, and other modified provisions relating to education, labor, childcare, health care, taxes, immigration, and the environment. Specifically, the bill aims to provide funding for national electric vehicle and zero-emission medium- and heavy-duty vehicle programs such as:

- A grant and rebate program to replace Class 7 and 8 heavy-duty internal combustion engine vehicles with zero-emission vehicles, chargining infrastructure, workforce development, and planning and technical support;
- A grant and rebate program to purchase zero-emission port equipment and technology;
- A grant program to service the installation of electric vehicle supply equipment for medium- and heavy-duty vehicles in underserved communities, multi-use charging hubs, medium- and heavy-duty vehicle smart charging management, and medium- and heavy-duty battery recycling and secondary use; and
- A loan program to increase domestic manufacturing for zero-emission transportation.

This legislation reflects current Administration goals and may provide a blueprint for future congressional action to support electric vehicles.

On November 17, 2021, Chair Kathy Castor of the Select Committee on the Climate Crisis, U.S. Representative Paul Tonko, and U.S. Senators Martin Heinrich and Tina Smith announced the first ever Electrification Caucus. This bicameral caucus will advance policies to accelerate the electrification of homes, commercial buildings, and vehicles throughout the United States.[83] Issues that the caucus will discuss include:

- Consumer rebates, consumer-facing tax credits, and financing mechanisms
- Workforce training
- Justice and equity issues related to electrification
- Electric vehicle charging infrastructure
- Building codes
- Grid improvements and expanding transmission
- Upstream incentives to spur U.S. manufacturing
- Transition of electric sector to clean energy
- Incentives to encourage electrification of industrial processes and facilities

On the regulatory front, EPA has taken numerous actions in 2021 that may encourage the adoption of EVs. In March 2022, EPA reinstated California's authority to implement its own GHG emission standards and ZEV Program, allowing other states to do so as well.[84,85] DOT also officially repealed the prior Administration's regulation that would have preempted states from taking this action.[86] In addition, in December 2021, EPA finalized the "Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards" which will increase the stringency of vehicle emission standards for each model year 2023 through 2026.[87] This rule includes flexibilities to incentivize the production and sale of near-ZEV and ZEV emissions technology to reduce compliance costs and address lead time. EPA estimates that as the GHG standards become more stringent over the four year, sales of zero and near-ZEV will increase market share from about 7 percent in MY 2023 to about 17 percent in MY 2026.[88]

On March 3, 2022, EPA issued a proposed rule that aims to reduce emissions of smog- and soot-forming NOx from gasoline and diesel fueled heavy-duty vehicles and set more stringent GHG standards for certain commercial vehicle categories starting in MY 2027.[89] This proposal is complimented by *Executive Order Strengthening American Leadership in Clean Cars and Trucks* to advance the transition to a zero-emission heavy-duty vehicle fleet. Separately, the DOT unveiled on March 7, 2022, a broad national strategy to provide nearly $1.5 billion in funding for 2022 to help state and local governments purchase U.S.-built electric transit buses and low-emission models. Funding will be made available through DOT's Federal Transit Administration's (FTA) Low or No (Low-No) Emission Grant Program and the Grants for Buses and Bus Facilities Program. Monies allocated for Fiscal Year 2022 under the Low-No Emission Grant Program is approximately $1.1 billion and $375 million for the Grants for Buses and Bus Facilities Program.[90] DOT's FTA also announced that it plans to award $2.2 billion in funding, through the American Rescue Plan, to 35 transit agencies across 18 states*.[91] In addition, the National Highway Traffic Safety Administration issued proposed rule "Corporate Average Fuel Economy Standards for Model Years 2024 – 2026 Passenger Cars and Light Truck," which revises the SAFE Vehicle Rule to increase fuel economy standards by 8 percent year over year for each model year 2024 through 2026.[92]

Since taking office, President Biden has issued several executive orders that include provisions to strengthen the ZEV ecosystem and have provided a foundation for many of the legislative and regulatory actions noted above along with others:

- *Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis:* On his first day in office, President Biden ordered EPA to consider revising or rescinding the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program by April 2021 as well as the SAFE Vehicles Rule for MY 2021-2026 Passenger Cars and Light Trucks by July 2021 and a recalculation of social cost of GHGs, establishing an Interagency Working Group to do so.
- *Executive Order on America's Supply Chains:* As China controls nearly 70 percent of the global EV battery manufacturing capacity compared to North America's 10 percent, the order directs the Department of Energy to submit a report identifying risks in the supply chain for high-capacity batteries, including EV batteries, and policy recommendations to address these risks.[93]
- *Executive Order on Strengthening American Leadership in Clean Cars and Trucks:* Sets a goal of 50 percent of all new passenger cars and light trucks sold in 2030 be ZEVs. EPA is directed to establish new multi-pollutant emission standards for light-, medium-, and heavy-duty vehicles for model year 2027 and later; establish new nitrogen oxide standards for heavy-duty engines vehicles beginning model year 2027 through at least model year 2030; and establish new GHG emission standards from heavy-duty engines and vehicles beginning as soon as model year 2030 and extending into the future.[94]

*Awardees of the American Rescue Plan Additional Assistance Funding:
https://www.transit.dot.gov/funding/american-rescue-plan-arp-additional-assistance-funding

- *Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability:* Sets goals for the federal government to achieve 100 percent carbon pollution-free electricity by 2030, 100 percent ZEV acquisition by 2035, and 100 percent light-duty ZEV acquisitions by 2027, among other goals. The federal government will collaborate with American vehicle, battery, and charging equipment manufacturers and installers to transform the federal fleet.[95]

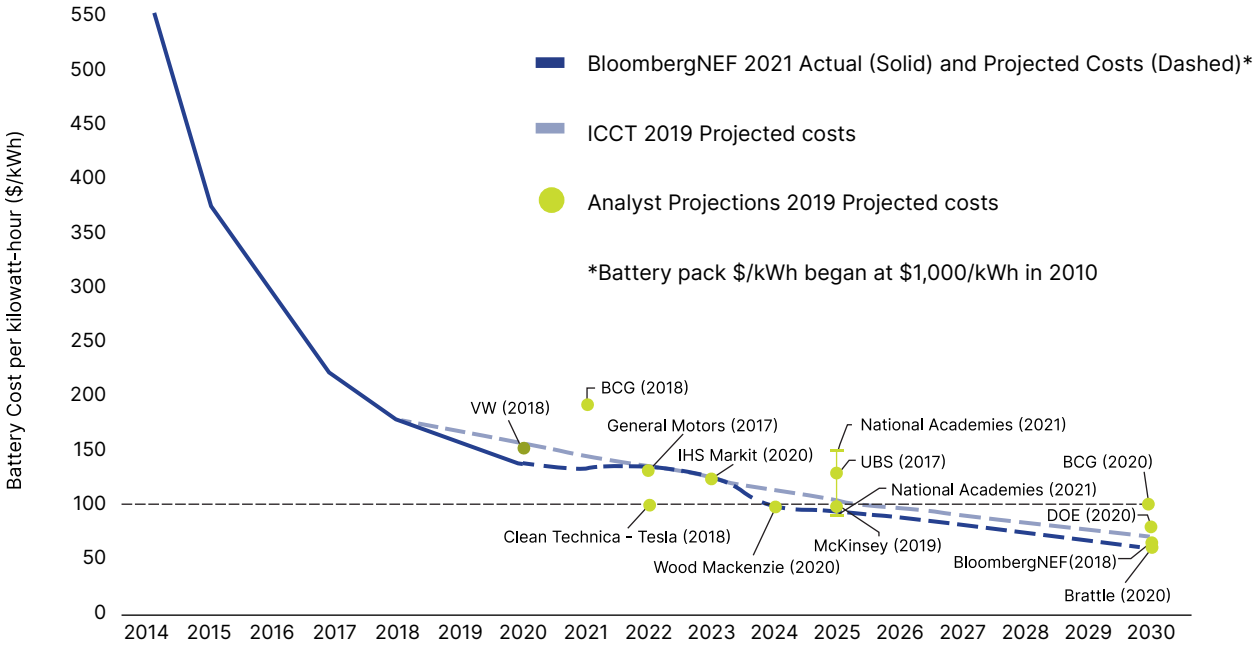
The Biden Administration also released the Electric Vehicle Charging Action Plan on December 13, 2021. The Plan sets an ambitious goal for the US aiming for 50 percent of EV sale shares by 2030 and outlines steps for federal agencies to take in supporting development and deployment of chargers across the country.[96]

Battery Pack Cost Projections & EV Price Parity

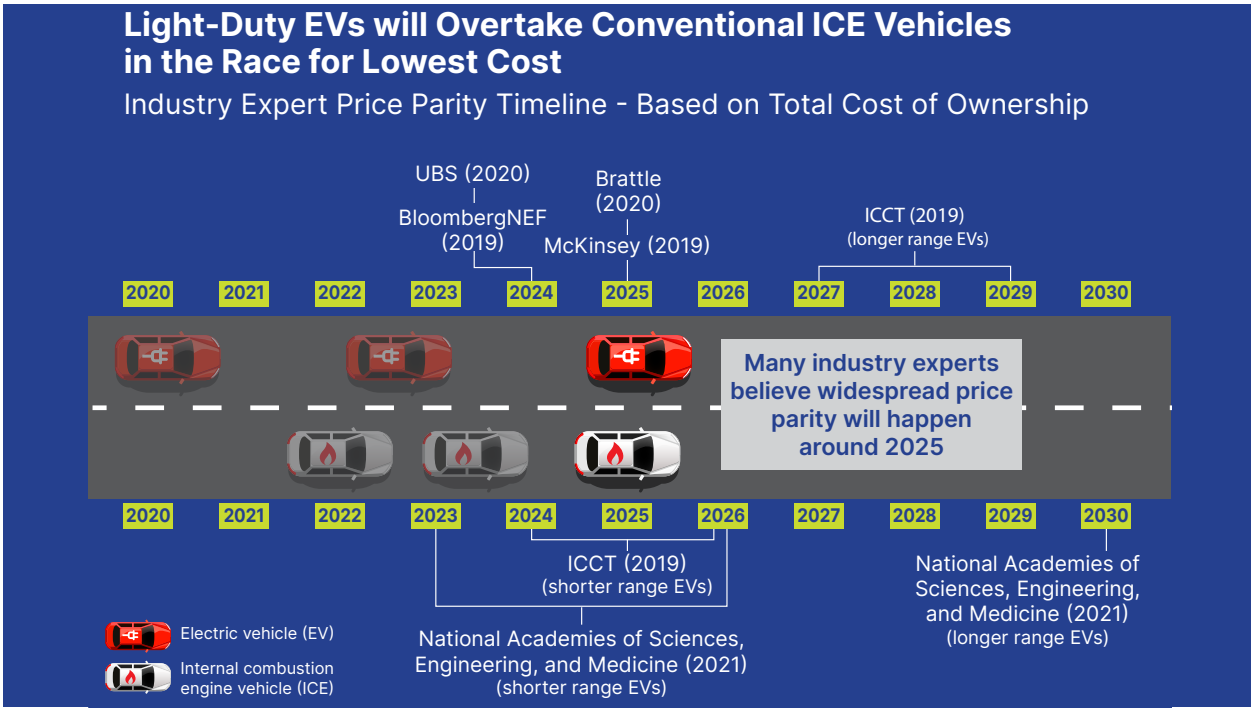
Beyond policy drivers, consumer choice and economics will strongly affect EV uptake across the U.S. while EVs already provide cost savings to drivers as compared to ICE vehicles, initial purchase price parity is a key metric in considering broader adoption of EVs. **For EVs to become cost competitive with ICE vehicles (without considering tax, other incentives, or emissions externalities), virtually all analysts agree that battery pack prices must continue to drop from $132/kWh in 2021 to around $100/kWh.*** When battery prices cross this threshold, EVs will achieve price parity on a total cost of ownership basis.

As illustrated in Figure 3, most analysts agree that price parity between EVs and ICE vehicles will occur sometime between 2023 and 2025.[97,98] EV battery prices fell 6 percent between 2020 and 2021 reaching an average price of $132 per kWh in 2021. According to BloombergNEF's 2021 annual battery price survey, due to higher raw material prices, BloombergNEF predicts a $3 price increase in 2022 to $135/kWh (reflected in Figure 3).[99] In 2020, DOE announced the goal to reduce the cost of a battery back to $80/kWh by 2030 for 300-mile range EVs in its Energy Storage Grand Challenge.[100] Additionally, BNEF predicts battery packs to be around $80/kWh in 2026 and $60/kWh in 2029.[101] Ford set a US battery pack price target of $80/kWh by 2030, and Nissan set an ambitious goal of $75/kWh by 2028.[102]

Figure 3.
Actual & Projected Battery Pack Costs



* BloombergNEF estimates 2021 battery pack prices at $132/kWh but estimates vary: EPRI estimates that the current cost is between $120 and $200/kWh; the Electrification Coalition estimates current costs are around $150/kWh.



Continued improvements in batteries are key to achieving ICE cost parity via reductions in upfront purchase cost, increased EV range, and increased battery life. The Electric Power Research Institute (EPRI) believes that BEVs with smaller battery packs (i.e., 40 kWh packs compared to 80 kWh packs), already achieved initial cost parity in 2020.

While most EVs are still more expensive upfront, they are already providing significant fuel cost savings, as highlighted by a recent National Renewable Energy Laboratory (NREL) and Idaho National Laboratory (INL) study, which concludes that EVs could save drivers as much as $14,500 in fuel costs over 15 years compared to ICE vehicles.[103] An EDF analysis, using the U.S. Department of Energy's Fuel Savings Calculator and based on March 2022 gas prices, compared the 2021 Hyundai Kona Electric with the 2021 Hyundai Kona (FWD, 2.0 L, 4cyl). This study concluded that consumers who own the Kona Electric will save $5,670 in avoided fuel cost during the lifetime of the vehicle.** Even with lower gasoline prices (in line with what was seen in March 2021), consumers who own a Kona Electric will save $5,360 in avoided fuel costs during the lifetime of the vehicle, compared to its gasoline counterpart.[104]

As for M/HD vehicles, a study conducted by Roush Industries for the Environmental Defense Fund (EDF) found that by 2027 many electric freight trucks and buses will be less expensive to purchase and operate than their ICE counterparts.[105] The study finds the general trend of decreased upfront costs for electric freight trucks and buses is largely driven by the steep decrease in battery cost.[106] The Roush report's findings have been echoed in two other recently released reports from NREL and DOE, *Decarbonizing Medium- and Heavy-Duty On-Road Vehicles: Zero-Emission Vehicles Cost Analysis*, and CALSTART's report, *Zeroing in on Zero-Emissions Trucks*, with NREL stating that with improvements in ZEV technologies and fuels, it will enable ZEVs to achieve cost parity with diesel as early as 2026 for some applications and no later than 2035 for all segments.[107,108]

Today, the U.S. ranks second globally for the lithium-ion supply chain after China, and will likely remain so through 2026.[109] According to the U.S. State Deparment, over 80 percent of the global supply chain of rare earth elements (important components of lithium-ion batteries and other EV componnets) is controlled by China, and BloombergNEF has found that China holds 77 percent of the world's battery cell manufacturing capacity and 60 percent of the world's component manufacturing.[110] As interest in fleet electrification grows globally, the U.S. could face competition or supply chain difficulties if it does not invest in domestic battery production. According to the DOE, there will be 13 new battery cell gigafactories coming online in the United States by 2025.[111] These gigafactories will be instrumental in ushering a new era of domestic battery production across the United States. Additionally, in Feburary 2022, the Biden administration announced its plans to direct $3 billion dollars appropriated in the Infrastructure Investment and Jobs Act toward funding domestic battery materials refining and production plants, battery cell and pack manufacuturing facilities, and battery recycling facilities.[112]

** Assuming residential electricity rates for charging, 10-year vehicle lifetime, 15,000 miles driven per year, and 55 percent city driving. National average gas price as of March 11, 2022. National average electricity price for residential customers as of latest EIA report for December 2021.

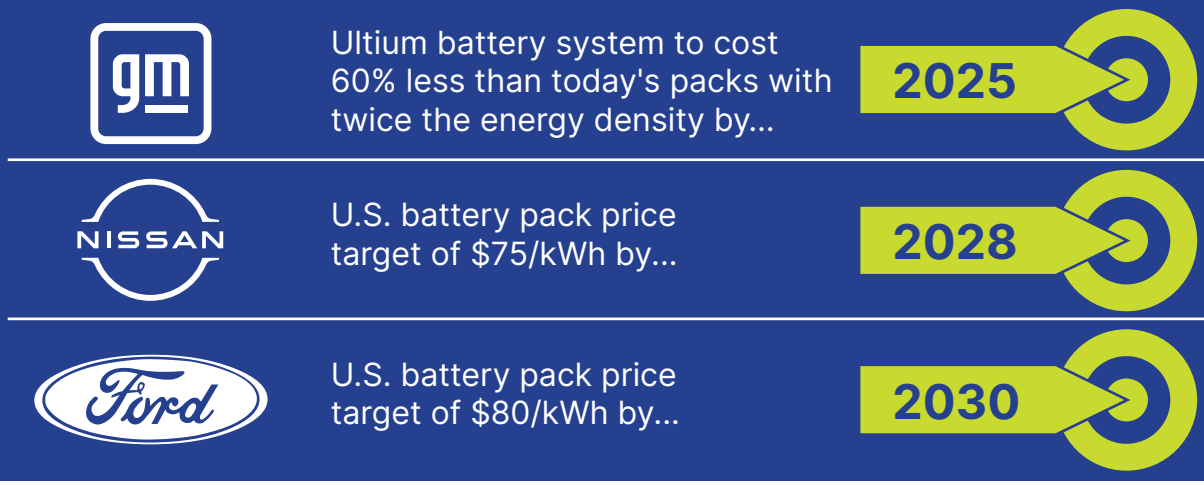
Battery Pack Advancements

Advancements in solid-state batteries (SSB) could be revolutionary, and have significant potential to drive additional battery pack cost reductions in the future. According to IDTechEx's SSB report, the SSB market is expected to grow to $8 billion by 2031.[113] Additionally, according to BloombergNEF, solid-state cells produced at scale could be manufactured at 40 percent of the cost of current lithium-ion batteries.[114] Progress is dependent on developing supply chains for solid electrolytes.

QuantumScape, which received a $200 million investment from VW in June 2020, is developing high-energy density solid-state batteries that could enable up to 80 percent longer range than today's lithium-ion batteries, reach 80 percent charging capacity in 15 minutes, and effectively operate at -30 degrees Celsius — a game changer for cold weather drivers.[115]

Beyond automaker involvement, research insitutions like Georgia Tech, ETH Zürich, and Oak Ridge National Laboratory are collaborating on solutions that would increase energy density without reducing the battery liftetime through structures created during charge-discharge cycles.[116] Researchers at the University of Michigan are experimenting with a copper metal foil for solid-state batteries, an adjustment that could cut battery pack mass in half.[117] Researchers at Pennsylvania State University announced breakthroughs in a thermally modulated lithium-ion battery they are developing that could charge in 10 minutes, even in subfreezing temperatures due to a self-heating structure that regulates system temperature, and bring the retail price of EVs down to $25,000.[118]

Manufacturer Battery Pack Goals



To push forward battery innovation, automakers have announced a host of research and production partnerships.

GM is investing $7.1 billion into a joint venture with LG Chemical to produce its Ultium battery at three North American battery cell manufacturing plants in Spring Hill and Lordstown, Ohio and in Lansing, Michigan.[119] The Lansing plant is expected to create more than 1,700 new Ultium Cells jobs once completed in 2024.[120] GM estimates that the pack will cost 60 percent less than today's packs with twice the energy density and predicts it will allow for a maximum range of 500 – 600 miles.[121] GM is also developing a next-generation, one million mile battery – compared to current batteries that are projected to last 100,000-200,000 miles.[122]

Tesla is simultaniously developing its own million mile battery; exploring improvements in energy density for next-generation batteries through partnerships with Panasonic; and testing alternative chemistries to lithium-ion batteries with researchers at Dalhousie University.[123] During its 2020 Battery Day Event, Tesla announced it will be manufacturing "tabless" batteries that will be six times more powerful and increase range by 16 percent.[124] In 2022, Panasonic announced it will invest $700 million to expand its battery factory in Japan, to make the next-generation batteries for Tesla, enough to power about 150,000 EVs.[125]

Mercedes-Benz has forged research partnerships with CATL in China, particularly on its cell-to-pack design, and with Hydro-Quebec's Center for Excellence in Transportation Electrification and Energy Storage in Canada to develop solid-state battery technologies.[126] According to Hydro-Quebec, solid-state lithium metal batteries could mark a new era in EV battery development as they have "a very high energy density, are long lasting, and very light [and are] considered to be a safer alternative to regular lithium-ion batteries."[127]

BMW announced researchers are working "intensively" to build a prototype of a solid-state battery car — compared to the liquid electrolyte system used for lithium-ion batteries today — before 2025, a development that would improve performance and safety.[128]

Nissan is investing $17.6 billion over the next five years to develop a new all solid state battery (ASSB) that will be able to be mass produced by 2028.[129]

On **Volkswagen's** first Power Day, the company presented its technology roadmap for batteries and charging through 2030. They expect the new unified cell to reduce battery costs by up to 50 percent in the entry-level segment and by up to 30 percent in the volume-level segment. Volkswagen announced it would establish six gigafactories in Europe by the end of the decade ammounting to 240 GWh of production capacity.[130]

Stellantis, formerly Fiat Chrysler, has paired with LG Chem's Energy Solution to formulate a joint venture to produce battery cells and modules for North America. The new plant is set to breakground in the second quarter of 2022 and is set to start production by the first quarter of 2024. The factory will aim to have an annual production capacity of 40 GWh.[131]

Ford is investing $5.8 billion to build BlueOval SK Battery Park, a new joint venture between Ford and SK Innovation—in Glendale, Kentucky—consisting of twin battery plants that will produce advanced lithium-ion batteries starting in 2025.[132] The Kentucky plants will create 5,000 new jobs and supply Ford's next generation electric Ford and Lincoln vehicles.

Toyota is investing $1.25 billion to develop a battery manufacturing plant in Liberty, North Carolina. The investment is a portion of their $3.4 billion US allocated investment, which is just a percentage of their $13 billion global investment. Expected to begin production in 2025, the factory will have four production lines that will produce betteries for 200,000 vehicles each with the ability to expand to six lines cumulating to over 1.2 million vehicles a year. The facility is poised to generate over 1,700 jobs.[133] Additionally, Toyota plans on debutting its solid-state battery, which is on track for commercialization by 2025, in its hybrid models first— with plans to expand use to its all-electric vehicles in the future.[134]

Charging Network Investments

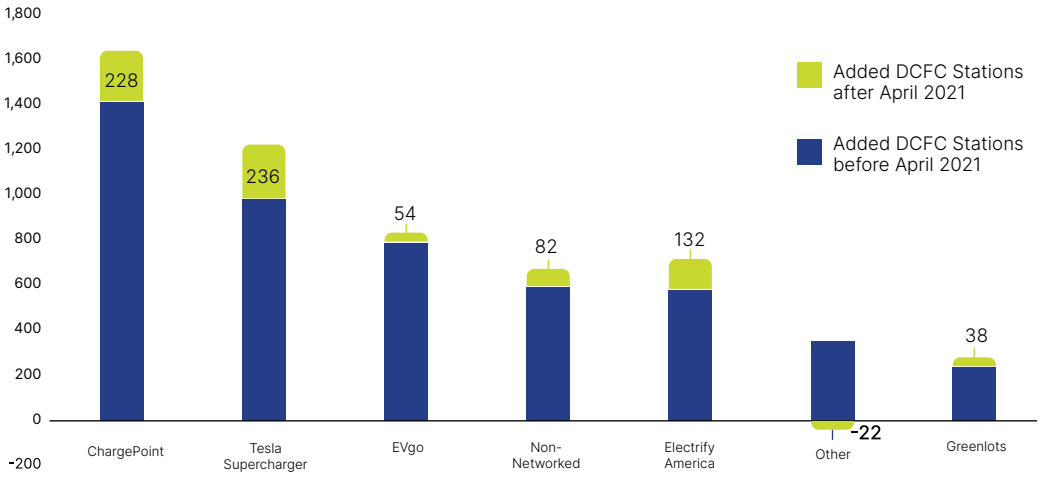
Creating an accessible public charging network will be essential to achieving wide-spread EV adoption. Although most drivers are expected to charge at home overnight due to convenience and discounted off-peak rates offered by utilities, public charging is vital for EV drivers who live in multi-unit complexes or those without a private driveway. Additionally, drivers will need charging along highways and interstates to feel confident in their ability to drive longer distances and charge along the way. Expected future battery improvements will increase EV range, thus reducing but not eliminating the need for public charging networks to support long-distance travel.

Today, five networks make up over 82 percent of Direct Current Fast Chargers (DCFC) nationally (Figure 5) while one company— ChargePoint —dominates the public Level 2 (L2) market with 24,937 stations (Figure 6).

As automakers prepare to bring more electrified models to market, they are also recognizing the need for a robust, well-developed charging ecosystem to support drivers. Notable milestones include:

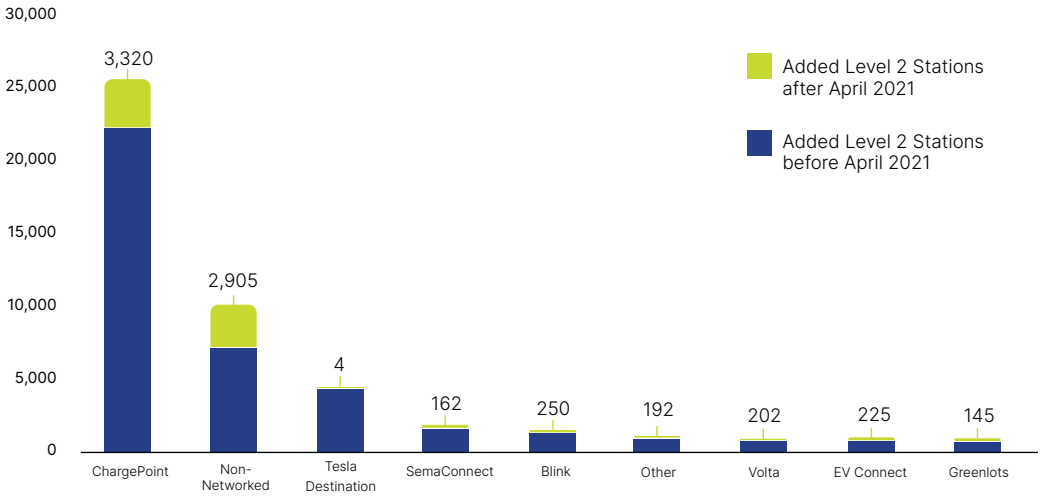
- Marry Barra, the Chairman and CEO of GM, said "we are moving quickly to bring new EVs to market that customers will love. We know how important the

Figure 4.
Number of Direct Current Fast Charging Stations by Network in the U.S.



"Other" includes Francis, Blink, Webasto, EV Connect, among others.

Figure 5.
Number of Public Level 2 Charging Stations by Network in the U.S.



"Other" includes EVgo, FLO, Electrify America, OpConnect, GE WattStation, Webasto, among others.

charging ecosystem is for drivers, one that includes access to convenient and reliable public fast charging" when announcing GM and EVgo's partnership to bring 2,700 new fast charge plugs to drivers over the next five years.[135]

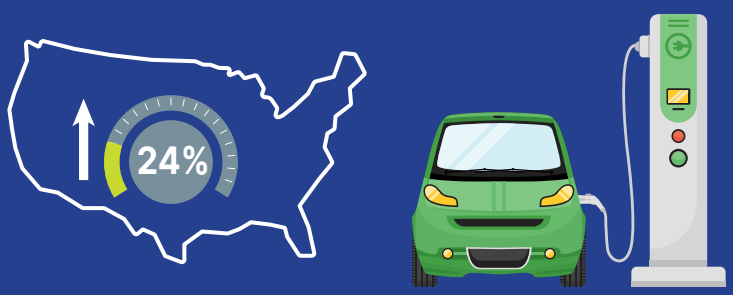
- GM has revealed the Ultium Charge 360 plan, a four-part plan to handle customer access, payment, and customer service components of EV charging at home and in public. The plan will provide GM EV owners with a mobile app that will display real-time information regarding charging locations and availability on the networks some 60,000 plugs. GM has partnered with seven third-party charging network providers (Blink Charging, ChargePoint, EV Connect, EVgo, FLO, Greenlots, and SemaConnect) throughout the U.S. and Canada to build out this network. The plan should be fully rolled out before September 2022.[136] Additionally, in January 2022, Blink announced its plans to supply L2 chargers to participating GM dealerships across the US and Canada.[137]
- Ford offers its customers access to over 16,000 public charging stations across North America through its' BlueOval Charge Network Program, including access to Electrify America's DC fast charging stations.[138]
- VW, through its' partnership with Electrify America, offers new customers three years of complementary charging at any Electrify America's DC fast and L2 charging stations starting from the date of vehicle purchase.[139]
- Rivian will build out the Rivian Adventure Network with dozens of chargers available by biking and hiking trails and destination spots. While the 3,500 DCFCs at about 600 sites through 2023 will be exclusively accessible to Rivian drivers, the 10,000 L2s will be accessible to all EV drivers.[140]
- Tesla's Supercharger network now reaches all 50 states.[141]
- Tritium, an Australian-based charging station manufacturer, announced the construction of a manufacturing facility in Lebanon, Tennessee.[142] The new facility is expected to product as many as 30,000 DCFC annually once it reaches full capacity. It is scheduled to begin operation in the third quarter of 2022 and to create more than 500 jobs in the region.

While these investments reflect automakers' understanding of the need for an expansive and reliable charging network, they are not alone in investing in widespread deployment of charging infrastructure. Utilities offer expertise, rebates, and unique charging rates while local and state governments provide funding and sometimes free or discounted charging at certain locations.

Major oil and gas companies are also exploring investments to adapt to an electric future. According to Shell's New Energies Executive Vice President, Shell's acquisition of Greenlots, an EV charging company, "is a step towards making EV charging more accessible and more attractive to utilities, businesses, and communities."[143] Chevron also made headlines as the first major oil and gas company in the U.S. to announce that it will offer a dozen EV charging plugs at five of its gas stations in California.[144]

The Status of Charging Stations

Between 2019 and 2021, there has been a 24% increase of public chargers, DCFC and Level 2 chargers installed across the United States.



Automakers have committed to growing the EV DCFC charging network by at least **6,200** stations within the next five years.

The Biden Administration has committed $7.5 billion to EV charging.

Manufacturer Commitments & Sales Forecast

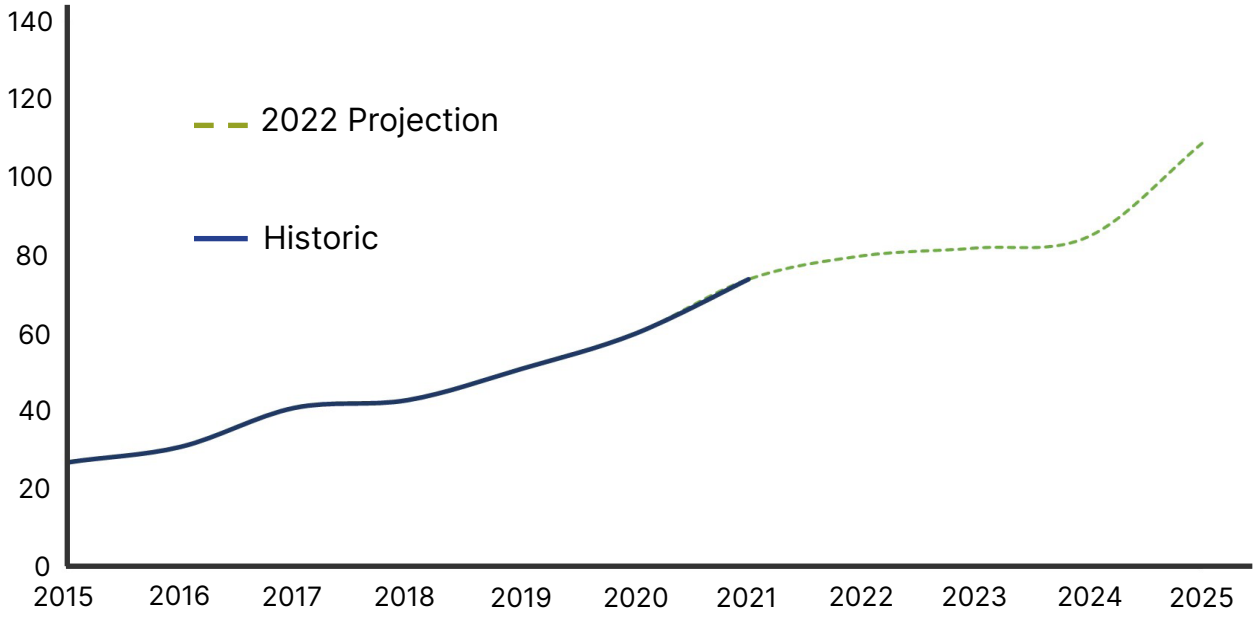
According to analysts, global light-duty EV sales reached a record high of 6.3 million units in 2021, with this number expected to rise to 26.8 million units in 2030.[145]

After seeing sales of EVs triple last year, the CEO of VW said "2020 marked a turning point in the customer sentiment."[146] Though Tesla still dominates the EV market, legacy auto manufacturers are making headway as EVs gain broader public appeal and model availability grows.[147]

According to a recent report published by BloombergNEF, global 2021 EV sales hit 6.6 million, an increase of 83 percent higher than 2020 and 168 percent increase over 2019 sales. In the United States, light-duty EVs nearly doubled from 308,000 in 2020 to 608,000 in 2021.[148,149] Bank of America analysts estimate that this trend will carry past 2022, projecting that the EV's U.S. market will grow from 6 percent of new sales this year (2022) to 16 percent in 2024.[150]

The number of electrified models available in the U.S. is projected to reach 109 by the end of 2025 (Figure 6).* Additionally, Bank of America analysts see the year 2022 as a "major year of commercialization" for the EV market—with over 85 new models slated to launch in model years 2022-2025.[151]

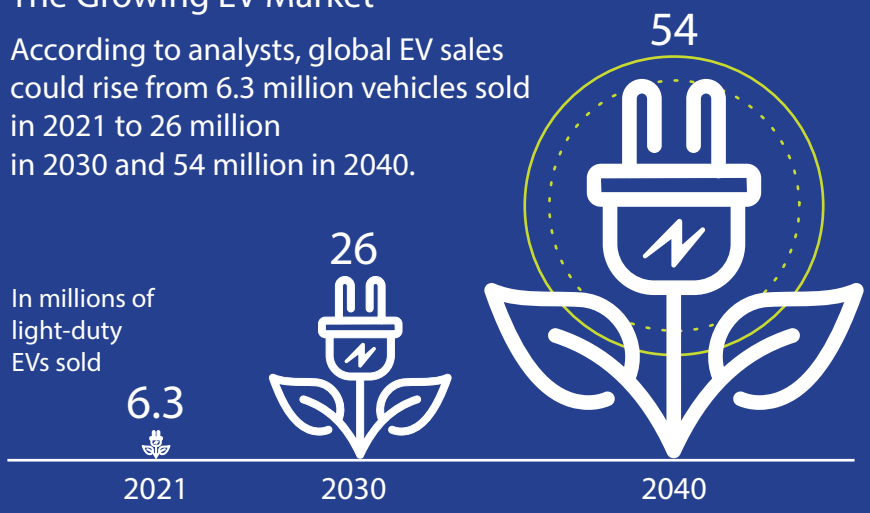
Figure 6.
Total Light-Duty Vehicle PHEV and BEV U.S. Models Available by Year



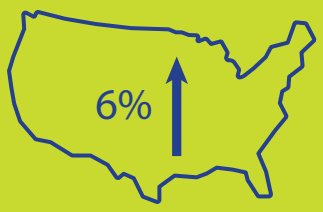
* Vehicles included in this figure are those that are available or will become available in the U.S. with MSRP below $100,000. The number of available vehicle models will be greater when considering global EV announcements and models that cost more than $100,000. Additionally, a model was only counted once although various battery sizes, ranges, and prices may be available. For example, Tesla Model S was counted once but is available in standard, long, and performance range options, same for the Leaf and Leaf e-Plus.

The Growing EV Market

According to analysts, global EV sales could rise from 6.3 million vehicles sold in 2021 to 26 million in 2030 and 54 million in 2040.



U.S. light-duty EV sales will grow from 6 percent of new sales this year (2022) to 16 percent in 2024.



$ Investment

In total, carmakers worldwide will spend more than $515 billion through 2030 developing new electric models, a projected increase of more than $300 billion in spending from a previous 2019 EV Market Report's projection*.[156] For example, since the last update, Ford announced it would increase its electrification investment to $50 billion by 2026.[157] Similarly, GM announced that it will be investing $35 billion in EV production through 2025— a 75 percent increase from its initial commitment pre-pandemic.[158] Most recently, Hyundai announced an additional investment of $16 billion in its electrification strategy.[159] Major supply chain manufacturers are increasingly announcing investment commitments as well, showcased by LG Energy Solutions recent announcement that it would invest $4.5 billion in its U.S. business to further expand its battery production capacity.[160]

Manufacturing

GM announced it will invest $7 billion— its largest investment in a manufacturing facility to date— to repurpose the Detroit Factory ZERO assembly center as its "flagship assembly plant in [its] journey to an all-electric future."[153]

Stellantis, formerly Fiat Chrysler, will invest $229 million, just a fraction of the companies $33.87 billion commitment through 2025, in three plants in Kokomo, Indiana to expedite the transition to electric vehicles.[154]

Ford, in partnership with SK Innovations, a South Korean energy company, announced it would invest $11.4 billion into building two EV manufacturing campuses, which will include three EV battery manufacturing factories and a plant for building batteries for electric pickups.[155]

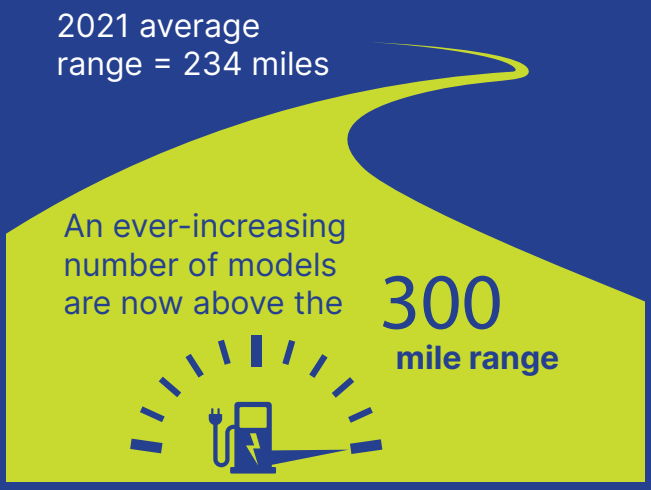
(See the Job Creation section for additional manufacturing commitments)

As 70 percent of plug-in EVs driven on U.S. roads in 2019 were assembled domestically, these manufacturing plant investments highlight continued cultivation of a strong EV workforce and robust market.[152]

* $515 billion corresponds to the announcements listed in Figure 1 in the Appendix: BMW, Daimler, FCA, Ford, GM, Hyundai, Lucid, Nissan, Tesla, Toyota, VW, and Volvo. Investments by Audi, Bentley, and Porsche were not included as they are subsidiaries of VW Group as with Mercedes-Benz of Daimler. Other estimates – covering additional manufacturers – include $250 billion by 2023 and $300 billion by 2030. See https://www.autosinnovate.org/posts/press-release/statement-on-greenhouse-gas-emissions and https://www.alixpartners.com/media-center/press-releases/pile-up-awaits-auto-industry-investments-electric-autonomous-future-balloon/.

More Models, More Miles

The number of electrified light-duty models available in the U.S. is projected to increase to 109 models available by 2025.



Manufacturer Commitments

BMW expects at least half of its car sales in 2030 to be zero emission vehicles, with 90 percent of its market categories having fully electric models available by 2023. BMW also expects its MINI brand to be fully electric by the early 2030s."[161]

Nissan will aim to have 15 fully electric models and 40 percent of vehicles sold in the US will be electrified by 2030. Nissan also expected to invest $17.6 billion over the next five years.[162]

Ford has created Team Edison, a dedicated global EV organization "focused on bringing to market profitable, exciting [EVs] and ownership experiences." In 2022, Ford increased its planned investment in EVs and autonomous vehicles from $11 billion to over $50 billion through 2026 and expects 50 percent of its global vehicle volume, and 100 percent of its European volume, to be fully electric by 2030.[163,164,165] In March 2022, Ford announced that it will be reorganizing operations into two separate units; an EV unit that will focus on rapid EV growth and accelerate production, and an ICE unit that will focus on maximizing profits.[166]

GM has positioned Cadillac to be its lead EV brand going forward, highlighting the BEV3 platform and declaring that "our commitment to an all-electric, zero-emissions future is unwavering."[167] Its Factory ZERO renovations will reposition the facility for greater EV production as it aims to reach a capacity of one million electric units in North America, aiding its goal to have 30 BEV models by 2025, with two-thirds available in North America. Additionally, GM has articulated its aspiration to make only EVs by 2035 and run its U.S. operations on renewable energy within the next four years.[168]

Hyundai Motor Group has committed to carbon neutrality by 2045.[169]Hyundai is targeting 1.87 million BEVs sold annually by 2030 with the help of 17 new BEV models; 11 for Hyundai and six for Genesis.

Honda has a goal of 100 percent ZEV sales in North America by 2040—with interim sales goals of 40 percent by 2030 and 80 percent by 2035.[170]

Daimler aims to have a carbon-neutral passenger vehicle fleet by 2039, which will be driven by the introduction of "an entire generation of electric **Mercedes** models," which will be entirely electrified by 2022.[171]

Volvo has committed to becoming a fully electric car company by 2030—with an interim goal of reaching 50 percent of global EV car sales and having one million EVs on the road by 2025.[172]

Kia aims to sell 1.2 million BEVs by 2030. The company is targeting to introduce 14 new BEV models by 2027 and launching at least 2 BEV models every year.[173]

Stellantis has committed to 96 percent of American nameplates (Jeep, Ram, Dodge, Fiat etc.) to have electrified options with all models by 2025, and fully battery-electric options by 2030.[174] The Chrysler brand has announced plans to shift to an all-electric fleet by 2028.[175]

Manufacturer Commitments

VW hopes to produce 26 million EVs over the next decade, an increase from its previous goal of 22 million. VW aims for a U.S. market share of over 50 percent for full-electric vehicles by 2030.[176] By 2040 nearly all new VW vehicles in major markets will be zero-emissions.[177] The entire VW fleet will be carbon neutral by 2050.[178]

Porsche pledged that by 2022 the company will be investing more than six billion euros in electric mobility and by 2025, 50 percent of all new Porsche vehicles will have an electric drive system, 80 percent by 2030."[179]

Outside of the U.S. market, **PSA Groupe** – the parent company of France's two major automakers Peugeot and Citroen – will electrify 80 percent of its models by 2023.[180]

Trucking

PACCAR's Kenworth and **Peterbilt** divisions are partnering with Dana for electric truck powertrain development. Kenworth has already developed a prototype Class 6 medium-duty electric truck and has plans to produce up to 100 of them in 2020.[181]

In October 2019 **Navistar** launched their NEXT eMobility solutions business unit to focus on electrification solutions in truck and school bus markets. The company has already developed a prototype electric school bus and an electric medium-duty truck.[182] In August 2021, the fully electric International eMV Series was launched with a range of 135-miles.[183] Navistar is currently developing a series of properties in San Antonio, TX that will invest more than $275 million in the company's enterprise-wide strategy for growth and innovation and support 650 local jobs.

After receiving nearly $45 million in grant funding from the California Air Resources Board, **Volvo** launched **Volvo LIGHTS**, a three-year demonstration project to test the ability for heavy-duty, battery electric trucks and equipment to reliably move freight between ports and warehouses in Southern California.[184] The initiative focuses on providing a range of vehicle, charging, and workforce development innovations. The focus includes new lithium-ion battery chemistries that increase energy density by more than 20 percent and prevent premature degradation to reduce cost, as well as multiple truck configurations with all-electric ranges of up to 250 miles.

General Motors launched a new business unit, **BrightDrop**, in January 2021 that focuses on electric first-to-last-mile products, software, and services.[185] The brand will release two models in 2021: the EP1 and the EV600. FedEx, part of an initial pilot utilizing the EP1, made its first purchasing agreement in January 2021 to acquire 500 EV600 vehicles. In 2022, FedEx signed another agreement reserving priority production for 2,000 delivery vans. BrightDrop and FedEx are working to add up to 20,000 more vehicles in the coming years. Walmart has partnered with BrightDrop, reserving 5,000 EV600 and EV410 vehicles.[186]

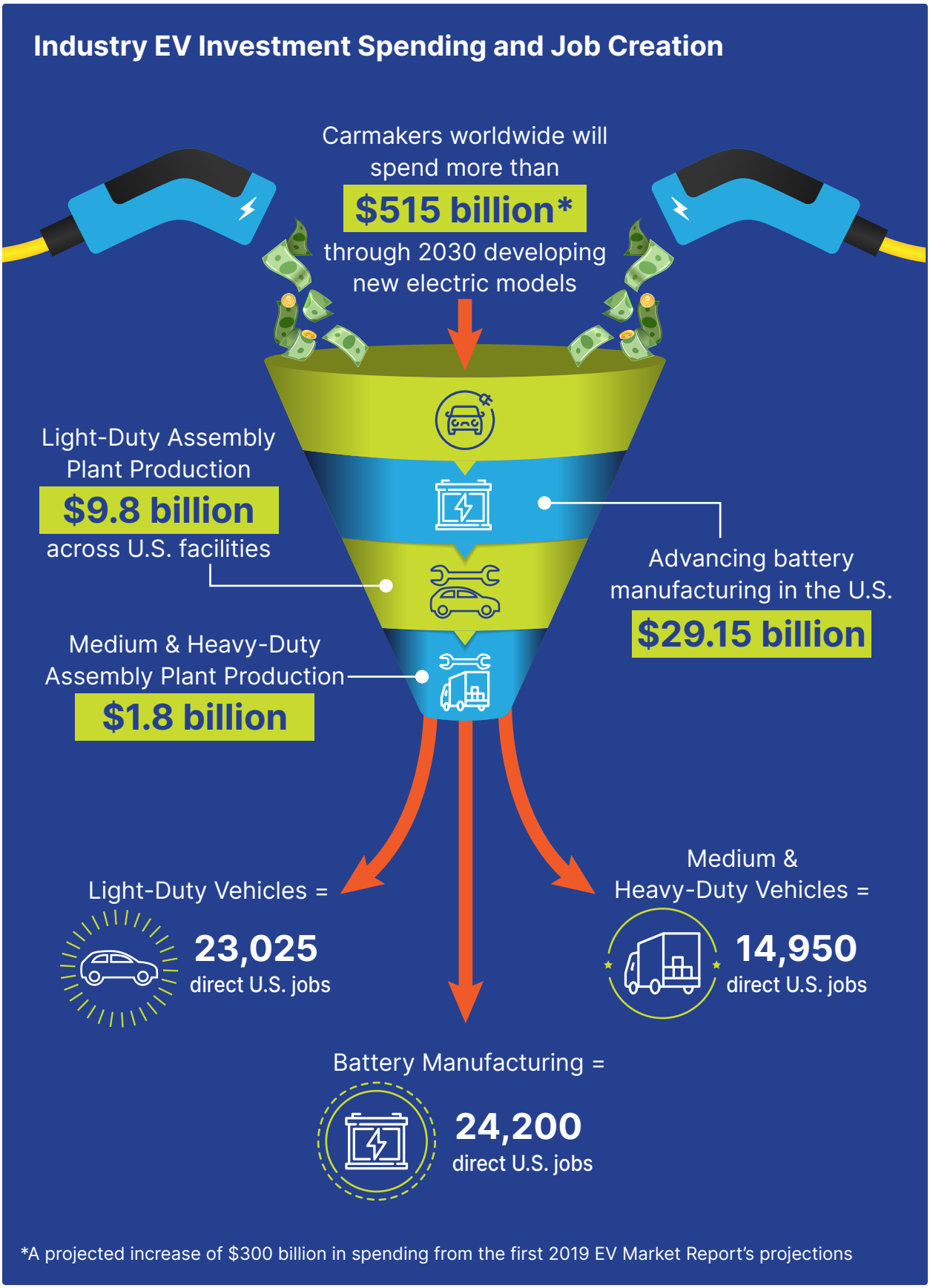
Lion Electric Company began work in early 2022 on a new factory in Jolliet, IL. This location will represent the largest dedicated production site for zero-emission medium and heavy-duty vehicles in the U.S. upon its completion, with an expected annual production capacity of up to 20,000 vehicles per year. The facility is expected to add up to 1,400 clean energy jobs in the region over the next four years.

In Europe, seven of the largest truck manufacturers— **Daimler, Scania, MAN, Volvo, DAF, IVECO, and Ford** — committed to phasing out diesel trucks by 2040, ten years earlier than initially planned.[187]

Companies like **Volvo** and **Freightliner** have begun taking orders on electric models like the Mack refuse truck or the eCascadia and eM2 trucks, respectively.

Daimler Trucks has a goal of selling CO_2-neutral commercial vehicles across all of their markets, including North America, by 2039. In North America, Daimler's Freightliner division has developed electric versions of their popular Cascadia Class 8 tractor, M2 Class 6 medium-duty chassis, and MT50 medium-duty step van. Since 2018, a 30-vehicle Freightliner Electric Innovation Fleet has been operating at customer sites, accumulating over 100,000 miles of real-world operation. In March 2020, Freightliner announced it would expand this fleet by deploying eight more EVs with at least 14 different customers over the next 22 months, who collectively operate more than 150,000 Class 6 -8 vehicles.[188] In October 2021, the 40-vehicle fleet of BEV Freightliner eCascadias and eM2s that make up the Freightliner Electric Innovation Fleet and the Freightliner CX Fleet, respectively, surpassed one million miles of real-world use.[189] In January 2022, Daimler Truck North America, in partnership with NextEra Energy Resources and BlackRock Renewable Power, will invest approximately $650 million to design, develop, install, and operate a nationwide charging network for M/HD BEV and hydrogen fuel cell trucks.[190]

Industry EV Investment Spending and Job Creation



*A projected increase of $300 billion in spending from the first 2019 EV Market Report's projections

Figure 7 summarizes projected U.S. BEV and PHEV model availability from the previous year and over the next three model years (a list of models considered can be found in the Appendix as well as timelines of various manufacturer commitments, model introductions, and EV sales forecasts).[191] According to the DOE, the median EPA estimated range for all EV models offered in the MY2020 exceeded 250 miles and also marked the first year that an EV achieved an EPA estimated maximum range of more than 400 miles.[192] The median EPA estimated range for all EV models offered in the MY2021 dropped slightly to 234 miles, due to the introduction of a wider range of models with rated ranges between 200-250 miles.[193] The EPA estimated maximum range experienced a slight improvement over the 2020 model's 402-mile range, to 405-miles.[194]

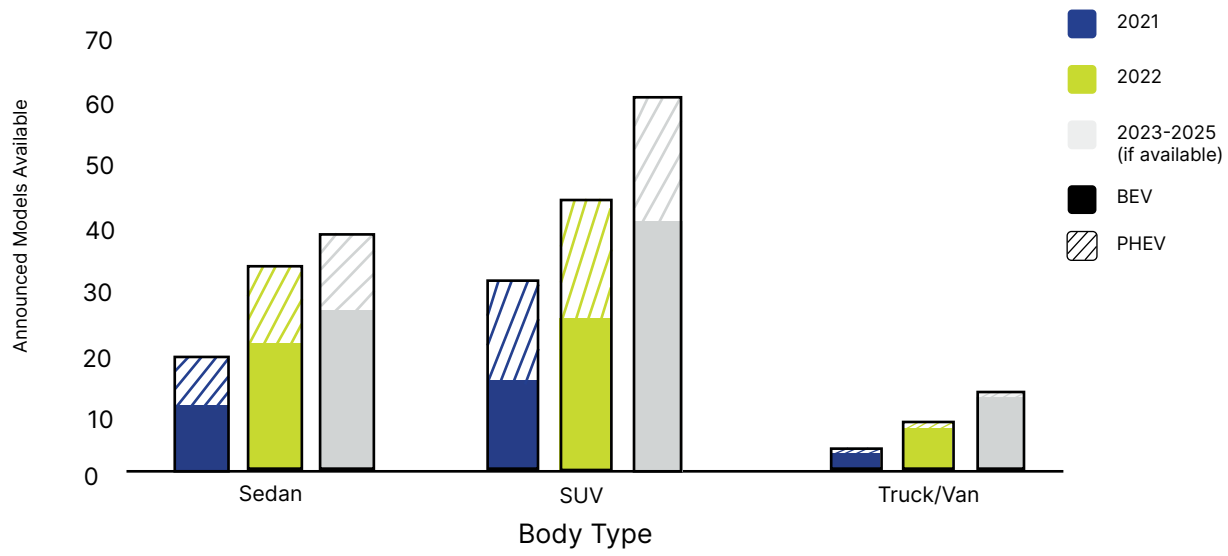
Many of the top manufacturers are projecting that EVs will account for a significant share of their total sales by 2025, as illustrated in Figure 8.[195] Audi, BMW, Ford, Mercedes, Toyota, and Volvo have all set global targets and announced projections for 2025, while Nissan has announced expectations specifically for U.S. sales. Volkswagen Group will end the sale of combustion vehicles in Europe by 2035 and expects nearly 100 percent of all new vehicles sold in major markets to be zero-emissions by 2040.[196] By 2035, GM has set a target to eliminate tailpipe emissions from new passenger vehicles. 2021 saw many significant announcements and developments:

- After announcing its new strategic vision in March 2021, Volvo will still strive for its 2025 goal (with hybrids making up the other half of sales) but, by 2030, will become a fully electric car company globally: "by [2030, Volvo] intends to only sell fully electric cars and phase out any car in its global portfolio with an internal combustion engine, including hybrids."[197]
- Ford announced a similar vision of 50 percent of sales by 2030 will be all electric.[198]
- Rivian went public in November 2021, receiving a market valuation of more than $100 billion.
- Rivian is now the U.S. second most valuable automaker ranking ahead of GM, Ford, and Lucid Group. Like many others, the automaker had trouble ramping up production due to supply-chain headaches but, its IPO raised over $12 billion which gives Rivian the funds needed to boost production of its all-electric R1T and meet its one million vehicles a year goal by the end of the decade.[199]

The International Council on Clean Transportation (ICCT) estimates that auto manufacturers are collectively targeting a global production of 68 million EVs annually by 2025; U.S.-manufactured EVs accounting for only 10 percent of global production whereas China and Europe will represent roughly 40 percent of global production.[200]

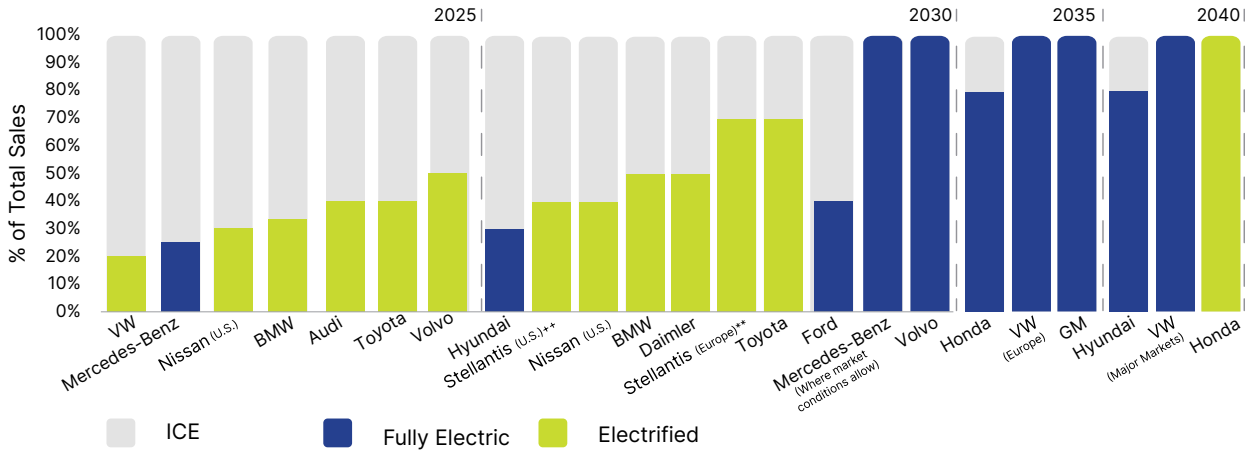
Looking ahead, EV interest has been promising as consumers look towards 2022 model and later releases. The 2022 GMC Hummer EV sold out pre-orders in 10 minutes.[201] Ford announced it will double production of the all-electric F-150 to 160,000 units annually due to "strong early interest," with reservations at the end of 2021 exceeding 200,000.[202,203] Another highly anticipated EV model is the 2023 Chevrolet Silverado. Reservations opened on January 5, 2022 and already more than 110,000 have been racked up.[204,205] Industry experts believe the portion of EVs comprising total sales will climb substantially in the coming decades.

Figure 7.
Cumulative Announced U.S. Light-Duty BEV and PHEV Models by Body Type



This figure only includes U.S. vehicles with an announced model name and model year introduction date and projected or announced purchase price less than $100,000. A complete list of models included in this graph can be found in the Appendix.

Figure 8.
Global Sales Forecast by Manufacturer



Electrified definitions: BMW models will have electrified drive trains (BEV or PHEV), Nissan models will either be pure electric models or e-POWER powertrain models, and Audi does not define electrified, and Volkswagen will have a 100 percent ZEV fleet. Nissan has set a goal for its U.S. sales. Honda announced in March 2019 its ambition of making one hundred percent of its European sales electrified, building upon the brand's 2017 goal of electrifying two-thirds of global sales.

Effect of COVID-19

COVID-19 has had global economic effects, affecting all sectors of mobility. In the spring of 2020, many automakers that had anticipated near-term launches of new electric models—including Rivian (R1S and R1T), GM (Hummer), Byton (M-Byte and K-Byte), and Workhorse (W-15)—revised their timelines, halted operations, and furloughed workers due to the COVID-19 pandemic. While some of these release dates were formally pushed to 2021, others remain uncertain. The disruption of supply chains and the shift in consumer spending patterns is affecting the auto industry as a whole—not only EV offerings—leading many brands to delay model launches and less-profitable updates until 2022 or 2023.

Projected long-term effects of the COVID-19 pandemic on vehicle sales—both ICE and EV—remain unclear, though in the short-term EV sales remained strong and far outsold ICE vehicles on a percentage basis. Though conventional and overall car registration dropped in 2020, global EV sales rose 70 percent to a record 4.6 percent market share.

As the COVID-19 pandemic continues into 2022, automakers are still bearing its costs. Supply chain disruptions, material shortages, and high costs are putting pressure on the auto market and analysts estimate that global automakers lost $210 billion in revenue in 2021.[206]

Several semiconductor chip manufacturers have announced the expansion of factories to accommodate increased demand, but predict that shortages are likely to continue well into 2022, though automakers differ, believing that shortages will ease in the second half of 2022.[207] TSMC broke ground on a $12 billion factory in Arizona in June 2021 and Intel followed closely behind, breaking ground in September 2021 of two chip factories in Arizona, a $20 billion investment.[208] Automakers, including GM, Ford and Hyundai, predict a near two-year chip constraint to ease in the second half of 2022, however, automotive chipmakers expect a recovery to take longer.[209]

Although analysts predicted a 24 to 26 percent decline in sales for September 2021 due to shortages, year-end sales topped 15 million vehicles, up from the 14.5 million vehicles sold in 2020.[210,211] Automakers like GM found its September 2021 sales were about 1.8 million units and reached an end of year net income record of $14.3 billion dollars—which it expects to double by 2030;[212,213] Similarly, Tesla has announced that year end 2021 production and deliveries were up 82 and 87 percent, respectively, over 2020.[214] Thanks to a $4 billion deal struck with Hertz, Tesla's end-of year 2021 market value was over $1 trillion.[215]

Commercial Fleet Electrification Commitments

While cars and light-duty trucks account for the majority share of transportation GHG emissions, M/HD vehicles are responsible for nearly a quarter of those emissions, with this percentage projected to increase in the future.[216]

A few years ago, the commercial EV market in the U.S. was dominated by transit buses. Full-sized (40-ft.) electric transit buses have been commercially available in North America for 10 years, and their use has been steadily growing; as of early 2020, approximately 180 U.S. transit agencies were operating a total of more than 850 electric transit buses, with more than 1,000 additional electric buses on order for delivery in the next two years. This is almost three percent of the national transit bus fleet.[217]

In 2019, there were only 20 models of Class 2b-8 zero-emission trucks (ZETs) available for purchase in the United States.[218] In 2022, CALSTART estimates that the number of ZETs and bus models available on the market will increase 26 percent from 433 models to 544 models from 2020 through 2022. CALSTART found that in 2021, medium-duty electrified vehicle models were the largest constituent of available electric M/HDV models (43 percent) and model availability will increase 48 percent through the end of 2022. Zero-emission heavy-duty truck model availability will increase 56 percent through 2022.[219] Additionally, CALSTART updated it's Zero Emissions Technology Inventory (ZETI) Tool which is an interactive online resource that provides information on commercially available zero-emission M/HDVs. ZETI now allows users to compare up to three ZEV models at once and to filter between a variety of metrics including fuel type, vehicle range, battery capacity, and when and where the ZEVs will become available.[220,221] ZEV alternatives for various vehicles classes are becoming increasingly viable: a recent working study conducted by Lawrence Berkeley National Laboratory and the University of California, Los Angeles, found that—assuming 375-mile range and current battery pack prices—an electric long-haul truck has a 13 percent per mile lower total cost of ownership, with a net savings of $200,000 over the lifetime of the electric truck.[222] A study conducted by CALSTART indicates that zero-emission trucks will reach cost parity with diesel trucks by 2030 as a result of decreasing costs in key components such as batteries and motors and the expected cost increase in fuel, while a study conducted by Roush Industries and for the Environmental Defense Fund found that many segments of electric freight trucks and buses will reach cost party at the time of purchase by 2027.[223,224]

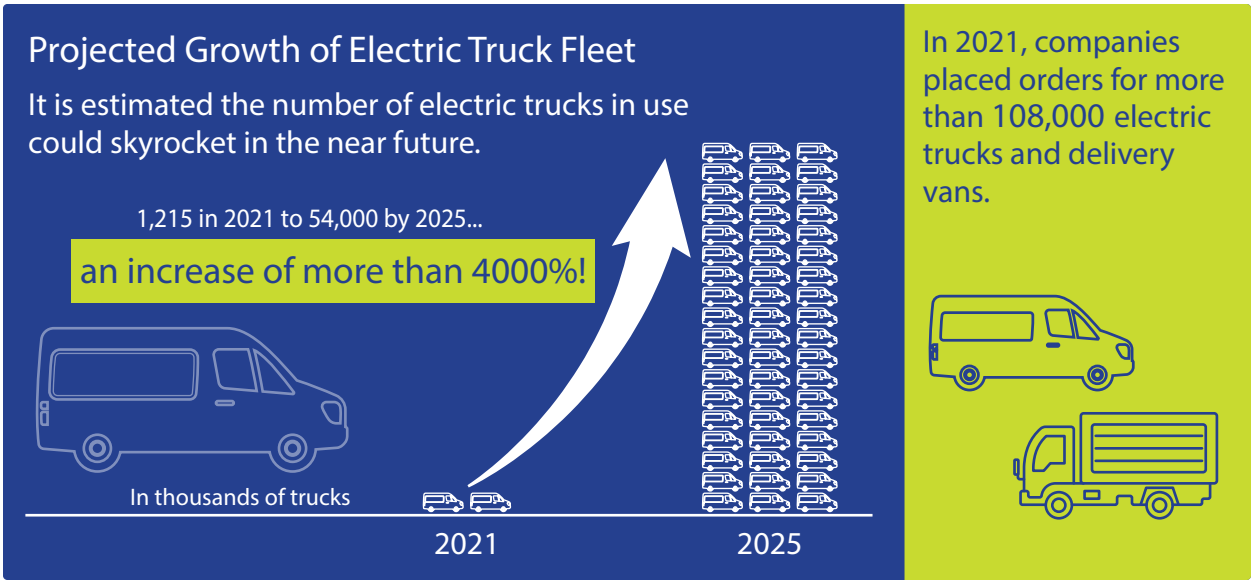
According to CALSTART, as of December 2021, 1,215 Class 2b through Class 3 ZEVs have been deployed in the United States across over 163 fleets.[225] The Environmental Defense Fund, who regularly tracks commercial fleet deployments and commitments, shows that deployments are on the rise as fleets are committing to and deploying EVs at a significant rate (see Appendix for greater detail).[226] Companies that operate large fleets are taking note: Amazon has ordered 100,000 electric delivery vans from Rivian and recently announced its' partnership with Stellantis, and its plans to be the first commercial customer of Stellantis' Ram ProMaster BEV slated for 2023;[227] FedEx ordered 2,500 electric trucks from BrightDrop as part of its 2040 goal to have a fully ZEV parcel delivery fleet globally;[228] UPS and DHL ordered 950 electric trucks and 63 delivery vans, respectively, from Workhorse; Performance Team, a Maersk Company, ordered 16 Volvo VNR Electric Class 8 trucks, and Walmart and PepsiCo – both companies that have pledged to strive for zero and net-zero emissions, respectively, by 2040 – are looking to Tesla for its electric semi-truck plans placing orders for 130 and 100 trucks, respectively*.[229] These companies have also called for greater policy commitment, stating that, "as national operators, it is important to us that policy makers work across jurisdictions – local, state, and federal – to align standards, workforce training and resources, systems, funding, and planning."[230]

Across the industry, the number of electric trucks in use could skyrocket in the near-future from 1,215 in 2021 to 54,000 by 2025.[231]

These investments will continue to grow thanks to corporate fleet electrification commitments (Table 2).[232] For example, EV100 is a global initiative bringing together 82 companies committed to accelerating the EV transition and making electric transport the new normal by 2030. Commitments cover a broad range of vehicles from delivery vehicles to commuter buses to garbage trucks. Policy levers will also be a major catalyst: California anticipates there will be about 300,000 zero-emission M/HD trucks across the state by 2035 due in part to the sales component of the ACT regulation (described in the Policy Drivers section).[233]

Companies are also making commitments to electrify their light duty fleets. Most recently, Hertz struck a deal to buy 100,000 Model 3 vehicles by the end of 2022. This investment could be worth over $4 billion.[234]

* More commercial fleet electrifications can be found via Environmental Defense Fund's Electric Fleet Deployment & Commitment List: https://docs.google.com/spreadsheets/d/1l0m2Do1mjSemrb_DT40YNGou4o2m2Ee-KLSvHC-5vAc/edit#gid=1021779951



Business Coalitions

In addition to individual business, a robust array of coalitions are now adding information, insight and advocacy to promote EVs. These coalitions of utilities, automakers, charging network providers, fleet operators, environmental and civic organizations, and others represent many of the leaders of the business and non-profit communities, and have been a critical resource in preparing for and implementing the economy-wide changes needed to facilitate the transition to an electric transportation future. A small sample of organizations includes:

ATE: The Alliance for Transportation Electrification is an umbrella organization of utilities, auto manufacturers, and other market participants. ATE supports policies that advance vehicle electrification in state rulemakings and federal legislation.

CEVA: Led by Ceres, the Corporate Electric Vehicle Alliance is a collaborative group of companies who are focused on accelerating the electric vehicle transition for companies in North America. CEVA has 28 members, and The Climate Group (EV100) is an engagement partner who helps members reach their goals and commitments.[235]

CHARGE Coalition: Launched in March 2021, the CHARGE Coalition is made up of 45 transportation, industry, environmental, labor, health, equity, and civic organizations that support the holistic and equitable transition to 100 percent zero-emission mobility. The coalition sent the Biden Administration a blueprint for EV deployment centered on three principles: public transit, electric vehicle infrastructure, and M/HD vehicles.[236]

ECBC: Launched in early 2021, ECBC is a branch of the Electrification Coalition, a non-profit that aims to accelerate the transition to EVs to improve national and economic security given the U.S.'s heavy dependence on an "unstable oil market."[237] ECBC's 24 members include auto manufacturers, like Ford, GM, Kia, and Volvo.

EHC: First formed in March 2021 and greatly expanded in July 2021, the Electric Highway Coalitions consists of 14 electric utility provider members that span across 29 states and the District of Columbia. Members are committed to enabling a long-distance travel network of DC fast charging stations to connect major highway systems.[238]

ZETA: Formed at the end of 2020, the Zero Emission Transportation Association consists of more than 50 companies that are part of the broader ZEV ecosystem (e.g., utilities, charging network providers, EV supply chain companies, and EV-specific manufacturers like Lucid and Tesla).[239] ZETA has released a federal roadmap to achieve 100 percent EV sales by 2030, which consists of 34 policy proposals across six pillars.

Major Orders Since Last Report Update[240]

DFDS ordered 125 **Volvo** FM Electric trucks.

First Student orders 260 LionC school buses from **Lion**.

AJR Trucking and MDB Transportation ordered 15 Kenworth T680E and 10 K270E trucks.

Performance Team, a Maersk Company, ordered 26 FM Electric trucks from **Volvo North America**.

New York City ordered 75 electric buses from **New Flyer of America**.

Walmart 5,000 vans from **GM's BrightDrop** and 1,100 E-Transit vans from **Ford**.

Merchants Fleet ordered a total of 5,410 vehicles from **GM's BrightDrop**.

Einride, a Swedish freight technology company operating in the U.S., ordered 200 BYD Class 8 trucks to be deployed over 2022.

FedEx ordered 2,000 electric delivery trucks from **BrightDrop**

Table 2.
Sample of Fleet Electrification Commitments

Sector	Company	Electric Fleet Plans
Retail	Ikea Group*	2020: Electrify deliveries in Amsterdam, Los Angeles, New York, Paris, and Shanghai (25 percent global of deliveries). 2025: 100 percent EV or other zero-emissions solutions for deliveries and services through suppliers.
	Amazon	2022: 10,000 electric delivery vans (short-term goal). 2030: 100,000 electric delivery vans total (long-term goal).
	Clif Bar & Company*	2030: 100 percent fleet electrification.
	Unilever	2030: 100 percent fleet electrification (11,000 vehicles).
	LG Energy Solutions	2030: 100 percent fleet electrification (380 vehicles) and install charging at all locations for staff.
	Walmart	2040: Zero emission vehicle fleet, including long-haul (6,000 trucks).
Power	Schneider Electric*	2030: 100 percent electric fleet (14,000 vehicles).
	Edison Electric Institute (EEI) Member Companies (investor-owned utilities)	2030: More than 70 percent of EEI member companies will collectively electrify more than one-third of their total fleet vehicles, including two-thirds of passenger vehicles in fleets. Examples include: • Xcel Energy: 2023: 100 percent electric sedan portion of fleet; 2030: 100percent electric light-duty fleet; 30 percent M/HD vehicles • Consumers Energy: 2025: Buy or lease 100 percent of EVs for fleet • Southern California Edison: 2030: 100 percent electric passenger car and small-to-midsize SUV, 30 percent medium-duty vehicles and pickup trucks, 8 percent heavy-duty trucks, 60 percent forklifts
	National Grid	2030: 100 percent electric fleet (5,700 vehicles).
	Public Service Co.	2022: 10 percent electric fleet minimum 2030: 50 percent electric fleet 2045: 100 percent electric fleet
Transportation	Lyft**	2026: 100 percent new vehicles for Express Drive (driver rental program) are electric. 2030: 100 percent EVs on platform.
	King County Metro (WA)	2030: 100 percent zero-emissions fleet.
	Lime*	2030: 100 percent conversion of operations fleet.
	Uber**	2030: 100 percent of rides take place in EVs in U.S., Canadian, and European cities 2040: 100 percent of rides take place in ZEVs, on public transit or with micromobility.
	Alto	2023: 100 percent all-electric fleet with services in Washington D.C., Los Angeles, Houston, Miami and Dallas.
	Port Authority of New York and New Jersey	2030: 100 percent fleet electrification (1,400 vehicles).

Sector	Company	Electric Fleet Plans
Delivery	DHL	2025: 70 percent of first- and last-mile delivery services with clean transport modes 2050: Reduce logistics-related emissions to zero
	FedEx	2025: 50 percent of Express global parcel pickup and delivery (PUD) fleet purchases electric. 2030: 100 percent PUD fleet purchases electric. 2040: 100 percent ZEV PUD fleet.
Biotech	**AstraZeneca**	2025: 100 percent fleet electrification (16,000 vehicles)
	Genentech	2030: 100 percent electrification of sales fleet (1,300 vehicles) and commuter buses
	Biogen	2030: 100 percent fleet electrification (1,600 vehicles)
Municipal	New York City, New York	2017: Only purchase PHEVs for non-emergency sedans going forward. 2025: Add 2,000 EVs to NYC sedan fleet. 2035: 100 percent Electric School bus fleet. 2040: 100 percent electric MTA bus fleet.
	New Jersey	2024: At least 10 percent of new bus purchases will be zero emission buses. 2026: At least 50 percent of new bus purchases will be zero emissions buses. 2032: 100 percent of new bus purchases will be zero emissions buses.
	Los Angeles, California	2028: 100 percent ZEV vehicle conversions "where technically feasible" (2028: taxi fleet, school buses; 2035: urban delivery vehicles). 2035: 100 percent electrification of sanitation fleet through LA Department of Sanitation Commitment.
	Houston, Texas	2030: 100 percent EV non-emergency, light-duty municipal fleet
	Chicago, Illinois	2040: 100 percent electric Chicago Transit Authority (CTA) bus fleet (1,850 buses)
	Montgomery County, Maryland	2033 (approximately 12-year process): Electrify entire school bus fleet for Montgomery County Public School district (1,400 school buses serving over 200 schools)
	Vermont	2025: 40 percent of new vehicle sales to be electric (43,000 vehicles). 2030: 80 percent of new vehicle sales to be electric (166,000 vehicles).

* Member companies of EV100, through which 121 committed member companies will electrify over 4.8 million vehicles globally
** Drivers for Lyft and Uber are contractors rather than employees, so it may be difficult to convince drivers to switch to EVs. Lyft does not intend to remove drivers from platform who do not drive electric or provide financial incentives to drivers for the transition. Instead, much of the plan revolves around exerting pressure on competitors, lawmakers, and automakers. Uber will pay BEV and hybrid drivers an incentive of $1.50 and $0.50 per trip, respectively, and GM and Renault-Nissan will offer discounts to EVs. While Uber has not explicitly stated they will not remove non-electric drivers, they may be in a similar position as Lyft. Uber recently announce it will roll out "Uber Green" in 1,400 North American cities and launch partnerships to expand EV access for its drivers.

Job Creation

The EV industry employed nearly 251,213 individuals across the U.S. in 2020 – defying overall energy sector job loss patterns caused by the COVID-19 pandemic with an employment growth rate of 3.5 percent between 2019-2020.

The biggest increase of any clean energy category according to E2's Clean Jobs America report – with jobs surpassing 273,000 when also including jobs associated with hybrid, natural gas, hydrogen, and fuel cell vehicles.[241] California, Michigan, and Texas are the top three states supplying these clean vehicle jobs, in order. These jobs contributed to 42 states and the District of Columbia employing more clean energy than fossil fuel workers in 2019. Indeed, all states benefit from the growing investment in clean and electric transportation – (see Appendix D). In expanding BEV and PHEV offerings, automakers understand the economic impact they can have through enhanced production capacity.

In March 2021, the Alliance for Automotive Innovators, the United Autoworkers International Union (UAW) and the Motor & Equipment Manufacturers Association (MEMA) sent a joint letter to President Biden stating that "the road leads to an increasingly electrified future," and the groups would commit to collaborating with the Administration on crafting and implementing a comprehensive plan that focusses on three key areas: consumers; infrastructure; and innovation, manufacturing, and supply chain. The letter called for efforts to expand and target workforce training and development programs that will upskill the existing workforce and train new workers to support both evolving workforce needs and future technology innovations.

Recent policy action, discussed in more detail under "Policy Drivers" above, has been focused on job creation, including billions of investments for clean energy including significantly increased purchase incentives for U.S.-made, union-made electric vehicles.[242]

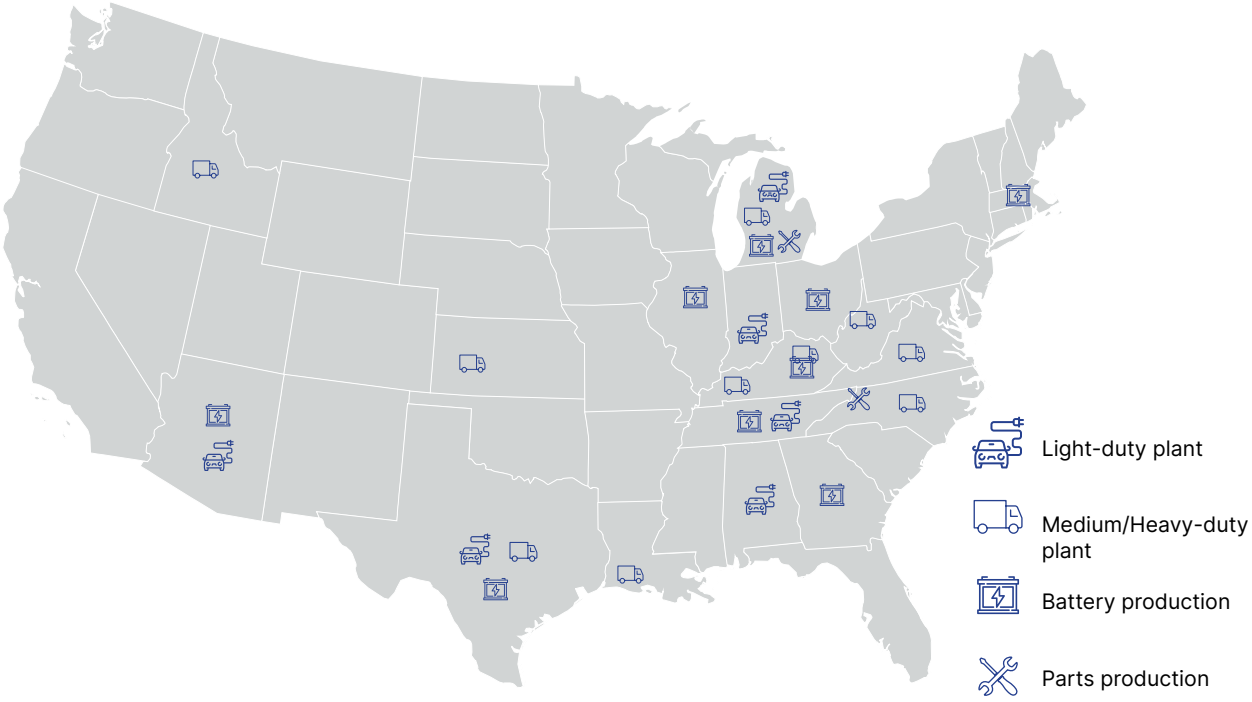
CASE STUDY

U.S. Light Truck Electrification: Economic & Jobs Impact Study

A recent study exploring the job impacts of electric Ford F-150 production highlighted the potential impact that electrical vehicle manufacturing and supply chain development could have on the U.S. economy and job market.[243] Using the IMPLAN input-output economic model, this analysis found that:

- **A single direct job associated with the production of electric F-Series vehicle could support 13 to 14 jobs in the wider U.S. economy. And every 1,000 such direct electric F-Series production-related jobs would support $1 billion in direct, indirect, and induced labor income benefits and $1.6 billion in U.S. GDP.**
- **A plant supporting 3,300 jobs could result in 44 thousand jobs in the wider economy, providing $319 million in direct income and over $3.2 billion in direct, indirect, and induced labor income benefits. These impacts could support $5.2 billion in U.S. GDP, all else being equal.**

Figure 9.
Announced Electric Vehicle Manufacturing Plant Expansions and Future Plans



Batteries
AZ: Lucid Motors
GA: SK innovation
IL: Rivian
KY: Ford/SK Innovation
MA: GM/SES Partnership
MI: LG Energy Solutions
Solutions, ford, **general motors (Detroit-Hamtramck, Orion, Wallace)**
OH: GM (Lordstown), LG Energy
TN: GM/LG Energy Solutions, Novonix/ PUREgraphite
TX: Tesla

Light-Duty:
AZ: Lucid Motors (between Phoenix and Flagstaff)
AL: Toyota and Mazda (Huntsville), Mercedes Benz (Tuscaloosa)
IN: Toyota (Princeton)
MI: Ford (Flat Rock, Rouge Complex, Dearborn), GM (Orion Township, Detroit Factory ZERO), Fiat Chrysler (across five plants)
TN: VW (Chattanooga), GM (Spring Hill), Mullen Technologies, **Ford/SK Innovations (Stanton)**
TX: Tesla (Austin, Travis County)

Parts:
KY: Bridgestone (Whitley County)
MI: Ford (Sterling Heights)

Medium-and Heavy Duty:
CO: Lightning eMobility
IL: Lion Electric (Joliet)
IN: Electric Last Mile Solutions (Mishawaka)
MI: Navistart (Detroit)
MO: Ford (Kansas City Assembly Plant)
NC: Arrival (Charlotte)
OR: Daimler Trucks North America (Portland)
SC: Arrival (York County), **Volvo (Ridgeville), Mercedes**
TX: Tesla (Austin), Navistar (San Antonio)
VA: Volvo Trucks (New River Valley)

Bolded indicates new addition since last update
Map is forward looking, does not include existing plants like Tesla's Fremont, California plant or Rivian's Normal plant in Illinois

Light-Duty Vehicles: Assembly Plant Production

Ford and **SK Innovation** are partnering to build a $5.6 billion campus, BlueOval City, in Stanton, TN that will generate 6,000 new jobs. BlueOval City will produce the electric F-150 Series, production will begin in 2025.[244]

Mercedes-Benz has committed $1 billion to a plant in Tuscaloosa, Alabama, to set up production of EVs in the U.S. and expects this will create 600 new jobs.[245]

Canoo, a California EV startup, will build a new EV factory outside of Tulsa, Oklahoma, opening in 2023 and is expected to create "more than 2,000 jobs."[246]

Electric Last Mile Solutions is planning to build an electric light-duty vehicle in Mishawaka, Indiana. The company plans to have 100 employees by the end of 2021 and up to 900 by 2025.[247]

GM plans on increasing its' initial investment of $2.2 billion for its' Michigan facilities, to a $7 billion investment.[248] This investment will go toward four manufacturing locations, including factory ZERO in Detroit to produce vehicles like the all-electric Silverado pickup and $4 billion at its Orion Township plant, a sharp increase from GM's initial $300 million investment, to build electric pickup trucks--amounting to over 7,000 jobs across all assembly facilities.[249,250,251] GM also received a $35 million job training assistance grant from Tennessee to retain and train 2,000 employees.[252] Beyond manufacturing, GM plans on hiring 8,000 positions for software development.[253]

Tesla is building a $1 billion EV manufacturing plant in Travis County, Texas, that could support 5,000 direct jobs and more than 4,000 indirect jobs due to secondary effects.[254]

In November 2019, **VW** started the expansion of its Chattanooga, Tennessee, assembly plant, which aims to add 1,000 jobs that will support its new EV line-up.[255]

Lucid Motors completed the first phase of its $700 million investment for its Arizona factory and has begun an expansion that will create 6,000 jobs.[256]

Emerging EV-only manufacturers like **Mullen Technologies** are announcing investments in places like Tennessee, a $336 million announcement that could create over 425 jobs.[257]

Medium- & Heavy-Duty Vehicles: Assembly Plant Production

Navistar is investing $275 million in a San Antonio plant that will produce both diesel and electric trucks, through which it expects to support more than 650 new jobs.[258] It also announced a new facility outside of Detroit that will employ 50 eMobility specialists.[259]

Volvo Trucks will invest $400 million over six years to upgrade its New River Valley, Virginia plant, which produces all Volvo trucks sold in North America. This could result in over 775 new jobs.[260]

U.K.-based **Arrival**, specializing in delivery vans, will establish its first U.S. Microfactory in York County, South Carolina. The $46 million investment is expected to create 240 new jobs. Five months later, Arrival announced it would also establish a Microfactory in Charlotte, North Carolina, bringing 250 additional jobs to the region.[261]

Tesla selected Austin, Texas, as the site of its next Gigafactory, where it will invest $1 billion to produce a range of EVs, including the Tesla Semi Truck — an effort that will be supported by 5,000 new jobs.[262]

Daimler Trucks North America expects to start production of the eCascadia and eM2 trucks in Portland, Oregon, in 2021 after announcing plans in 2019 to convert the plant to produce electric Freightliners.[263]

Lion Electric will invest $70 million in a new manufacturing plant that will set to create 750 jobs over the next three years.[264]

Mercedes will bring the next generation of eSprinter vans to the United States through a nearly $60 million investment in South Carolina.[265]

Ford invested $100 million to upgrade its Kansas City Assembly Plant and hired 150 new employees to build the electric van.[266] In early 2022, Ford began shipping out its' 2022 E-Transit van, the electric version of the popular Ford Transit cargo van.[267]

Electric Vehicle Battery Production

GM is partnering with SES to build a manufacturing protoship line inMichigan. GM will be opening the Wallace Battery Cell Innovation Center in Warren, MI in mid-2022. The factory will focus on battery research and development and expected to build batteries between 600 to 1200 watt-hours per liter.[268] Additionally,the GM Lansing plant is expected to create more than 1,700 new Ultium Cells jobs once completed in 2024.[269]

LG Energy Solution announced that by the end of 2025, the company will invest more than $4.5 billion in its U.S. business to further expand its battery production capacity, potentially adding 10,000 additional jobs in Ohio and Michigan.[270]

Tesla is signed a three year supply contract wih Ganfeng Lithium Co, the world's largest lithium-ion batery producer.[271]

Ford is investing $50 million in an upstart EV battery recycling company, Redwood Materials, who is able to recover 95 percent of precious metals. In partnership with **SK Innovtion**, an $5.8 billion investment plan to build a dedicated battery manufacturing site in Kentucky, BlueOval SK Battery Park. The twin battery plants will create 5,000 new jobs and is set to open in 2025.[272]

Factorial Energy has partnered with **Stellantis** and **Mercedes-Benz** to develop solid-state batteries that could deliver a 20 — 50 percent longer range per charge.[273]

SK Innovation plans to build a $2.6 billion factory outside of Atlanta, Georgia, that it expects will create at least 2,600 full time employees.[274]

Stellantis and **LG Energy Solution** announced a joint venture to construct a 40 GWh hour lithium-ion battery factory to break ground in the second quarter of 2022 and start production in 2024. Stellantis and Samsung SDI announced a joint venture to construct 23 GWh factory set to be completed in 2025.[275]

Toyota Motor North America and **Toyota Tsusho** will invest $1.29 billion until 2031 to build an automotive battery factor that will create 1,750 new jobs and start production around 2025.[276]

Rivian Automotive plans to build a $5 billion battery and assembly plant east of Altanta, Geogia, that is projected to employ as many as 10,000 workers.[277]

Appendix A. Manufacturer Commitments for Light-Duty Vehicles

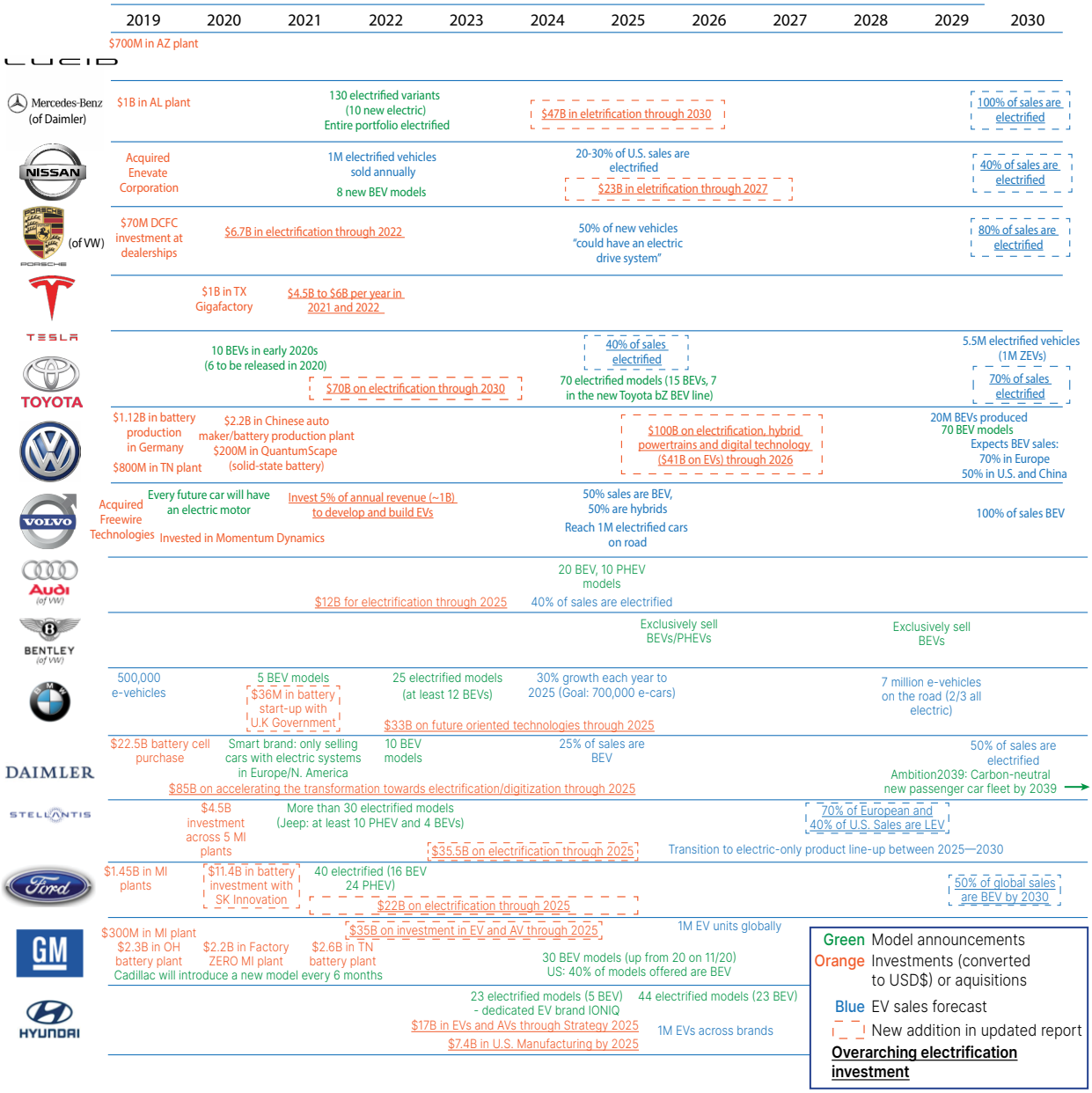


Table 1A. Manufacturer Targets:
Reduction in Lifecycle CO_2 Emissions from New Cars Sold

Manufacturer	Overarching Goal	Targeted Reduction in Lifecycle CO_2 Emissions from New Cars Sold			
		2025	2030	2040	2050
BMW	Business ambition for 1.5°		33 percent or more		
Daimler	Scope 3 SBTi: 42 percent reduction by 2030			2039: carbon-neutral	
Ford	Carbon neutral by 2050				
General Motors	Carbon neutral by 2040		2035: eliminate tailpipe emissions		
Honda			30 percent	50 percent	
Toyota		30 percent or more	35 percent or more		90 percent or more
Volkswagen Group	Carbon neutral by 2050	30 percent	Reduce to 74g CO_2/km		
Volvo	Carbon neutral by 2040	40 percent			

Note: the base year from which reduction commitments are measured varies by manufacturer (2000-2018). Most of these companies have also made commitments to reduce emissions from manufacturing (Scope 1 and 2) by similar or more aggressive levels.

Appendix B. Model Announcements – Light-Duty Vehicles

This table includes only models with an announced model name and model year introduction date for models less than $100,000. Other data is included if available; blank cells indicate that the data is not available from the manufacturer. Range is range per charge as stated by the manufacturer; for PHEVs this is electric mode range. Price is MSRP for base model, as stated by the manufacturer, and does not include any federal or state tax incentives. The term "Hatchback" is used interchangeably with "Sedan". Concept cars not included. New additions are bolded.

Battery Electric Vehicles

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Atlis Motor Vehicles	Truck/Van	XT	2022	125	300	$45,000
Alpha Motor	Truck/Van	Wolf	2023		250	$46,000
Audi	SUV	e-tron	2022	95	222	$65,900
Audi	**Hatchback**	**e-tron S**	**2022**	**95**		**$84,800**
Audi	**Hatchback**	**e-tron S Sportback**	**2022**	**95**		**$87,400**
Audi	**SUV**	**e-tron Sportback**	**2022**	**95**		**$69,100**
Audi	**SUV**	**Q4 e-tron**	**2022**	**82**		**$43,900**
Audi	**SUV**	**Q4 Sportback e-tron**	**2022**	**82**		**$52,700**
BMW	Hatchback	i3	2021	42.2	153	$44,450
BMW	**Hatchback**	**i4**	**2021**	**80**	**301**	**$56,395**
BMW	**SUV**	**iX**	**2022**	**113**	**324**	**$84,195**
BYD	SUV	e6	2021	80	250	$35,000
BYTON	**SUV**	**M.Byte**	**2022**	**71-95**	**200-240**	**$45,000**
Cadillac	SUV	LYRIQ	2022	19	300	$59,990
Canoo	Truck Van	MPDV1	2023	40-80	130-230	$33,000
Canoo	**SUV**	**Lifestyle Vehicle**	**2022**	**40, 60, 80**	**130,190, 250**	**$34,750**
Canoo	**Truck/Van**	**Pickup Truck**	**2022**		**200+**	
Chevrolet	Hatchback	Bolt	2022	66	259	$31,000
Chevrolet	SUV	Bolt EUV	2022	65	247	$33,000
Chevrolet	**SUV**	**Equinox**	**2023**			**$30,000**
Chevrolet	**SUV**	**Blazer**	**2023**			
Chevrolet	**Truck/Van**	**Silverado**	**2024**		**400**	**$39,900**
Faraday Future	**Sedan**	**FF91**	**2023**	**130**	**300**	
Fisker	SUV	Ocean	2022		250-350	$37,499

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Ford	SUV	Mustang Mach-e	2022	68	305	$42,895
Ford	Truck/Van	F-150 Lightning	2022		230 — 300 (extended-range pack)	$39,974
Genesis	**SUV**	**GV60**	**2022**	**77.4**	**270**	**$55,000**
Genesis	**Sedan**	**G80**	**2022**		**250**	**$60,000**
GMC	**Truck/Van**	**Hummer EV SUV**	**2023-2024**		**250-350**	**$79,995**
GMC	**Truck/Van**	**Hummer EV Pickup**	**2021-2024**		**250-350**	**$79,995**
Hyundai	Hatchback	IONIQ Electric	2021	38.3	170	$33,045
Hyundai	SUV	Kona Electric	2022	64	258	$34,000
Hyundai	SUV	Ioniq 5	2022	58-72.6	295	$43,650
Hyundai	Hatchback	Ioniq 6	2022			
Hyundai	SUV	Ioniq 7	2022			
Jaguar	SUV	I-Pace	2022	90	22	$69,900
Kandi	Hatchback	K23	2022	18	80	$22,499
Kandi	Hatchback	K27	2022	17.69	59	$17,499
Kia	Hatchback	EV6	2022	77.4	310	$45,000
Kia	SUV	Niro	2022	64	293	$39,990
Karma	**Sedan**	**GSe-6**	**2022**	**110**	**300**	**$79,900**
Lexus	**Sedan**	**RZ 450e**	**2023**		**250**	**$55,000**
Lordstown Motors	Truck/Van	Endurance	2022	109	250	$52,500
Lucid Motors	Hatchback	Air	2022		400+	$77,400
Lucid Motors	SUV	Project Gravity	2023			
Mazda	**SUV**	**MX-30**	**2022**	**35.5**	**100**	**$33,470**
Mercedes Benz	SUV	EQB	2022	66.5	240	$48,000
Mercedes Benz	SUV	EQC	2021	80	200	$68,895
Mercedes Benz	Sedan	EDE	2023		370	$80,000
MINI	Hatchback	Mini Cooper SE Electric	2022	32	114	$29,900
Mullen	**SUV**	**Five**	**2024**		**325**	**$55,000**
Nissan	Hatchback	Leaf	2022	40	149	$27,400
Nissan	**SUV**	**Ariya**	**2022**	**65-90**	**300**	**$40,000**

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Porsche	**Sedan**	**Taycan**	**2022**	**79.2**	**200**	**$82,700**
Porsche	**Sedan**	**Taycan Cross Turismo**	**2022**	**93.4**	**215**	**$95,050**
Rivian	Truck/Van	R1T	2022	105	314	$67,500
Rivian	SUV	R1S	2022	105	316	$70,000
Subaru	**SUV**	**Solterra**	**2023**	**71.4**	**220**	**$46,000**
Tesla	Hatchback	Model 3	2022	54	262	$41,990
Tesla	SUV	Model Y	2022	75	326	$54,990
Tesla	Hatchback	Model S	2022		405	$89,990
Tesla	SUV	Model X	2022	100	360	$99,990
Tesla	Truck/Van	Cybertruck	2023		250	$39,990
Toyota	SUV	bZ4X	2022	71.4	250	$40,000
Vinfast	**SUV**	**VF8**	**2022**		**250**	**$41,000**
Vinfast	**SUV**	**VF9**	**2022**		**320**	**$56,000**
Volkswagen	SUV	I.D. 4	2022	48	260	$39,995
Volkswagen	SUV	I.D. Buzz	2022	111	270	
Volvo	SUV	XC40 Recharge	2022	75	223	$55,300
Volvo	SUV	C40 Recharge	2022	75	200	$58,750

Plug-In Hybrid Electric Vehicles

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Audi	SUV	Q5	2022	17.9	23	$54,600
Audi	Hatchback	A7	2022	17.9	26	$75,900
Audi	Hatchback	A8	2022	14.1	17	$95,900
BMW	Hatchback	3 Series	2022	12	22	$42,950
BMW	Hatchback	5 Series	2022	12	21	$55,550
BMW	SUV	X5 Series	2022	24	30	$63,700
BMW	Hatchback	7 Series	2022	12	17	$95,900
BMW	Hatchback	i3	2022	42	126	$48,300
Chrysler	Truck/Van	Pacifica Hybrid	2022	16	32	$44,920
Ford	SUV	Escape	2021	14.4	37	$33,075
Honda	Hatchback	Clarity	2021	17	47	$33,400
Hyundai	Hatchback	IONIQ Plug-In Hybrid	2022	8.9	29	$26,800
Hyundai	SUV	Tucson	2022	7.2	33	$34,750
Hyundai	SUV	Santa Fe	2022	12.4	30	$39,350
Jeep	SUV	Wrangler 4xe	2021		21	$47,995
Jeep	**SUV**	**Grand Cherokee 4xe**	**2022**		**24**	
Karma	**Sedan**	**GS-6**	**2022**		**80**	**$93,000**
Kia	SUV	Niro	2022	8.9	26	$24,690
Kia	**SUV**	**Sorento**	**2022**	**23.8**	**32**	**$44,990**
Land Rover	SUV	Range Rover Sport	2021	13.1	19	$83,000
Lincoln	SUV	Corsair Grant Touring	2022	14.4	28	$51,485
Lincoln	SUV	Aviator Grand Touring	2022		21	$70,640
Lexus	**SUV**	**NX 450h+**	**2022**		**36**	**$55,650**
Mazda	Hatchback	MX-30 PHEV	2022			
MINI	Hatchback	MINI Countryman	2021	7.6	17	$41,500
Mitsubishi	SUV	Outlander	2022	13.8	22	$36,995
Porsche	SUV	Cayenne	2021	14	13	$83,300
Subaru	SUV	Crosstrek	2021	88	17	$35,345
Toyota	Hatchback	Prius Prime	2022	88	25	$28,220
Toyota	SUV	RAV4 Prime	2021		42	$38,350
Volvo	Hatchback	S60	2022	10.4	22	$47,650
Volvo	SUV	XC60 Recharge	2022	10.4	19	$54,250
Volvo	Hatchback	S90	2022	10.4	21	$60,050
Volvo	SUV	XC90 Recharge	2022	10.4	18	$63,800
Volvo	**Hatchback**	**V60 Recharge**	**2022**	**10.4**	**22**	**$67,300**

Unconfirmed Models & Soft Announcements

Concept cars and announcements unconfirmed by the manufacturer (i.e., models that have been discussed by automotive press, but automaker have not confirmed a launch date or details) are not included in the charts throughout the report but are included here for reference. Soft commitments from automakers have also been included when possible. The term "Hatchback" is used interchangeably with "sedan". New additions are bolded.

Manufacturer	Vehicle Type	EV Type	Model Name	Planned Availability
Bentley	**SUV**	**PHEV**	**Bentayga Hybrid** **Flying Spur Hybrid**	**2021**
Bentley		BEV		2025
BMW	SUV Hatchback	BEV	X1 5-series	Announced will offer electrified versions, did not confirm specs or other information
BYTON	Hatchback	BEV	K-Byte	Unclear due to COVID and unconfirmed for U.S.
Cadillac	**Hatchback**	**BEV**	**Celestiq**	**2025**
Chevrolet	Truck/Van	BEV	Silverado	2023 - Announced April 2021 with 400 miles range —
Chevrolet	SUV	BEV	Blazer	Spring 2023
Chevrolet	SUV	BEV	Equinox	Fall 2023
Chrysler	**Hatchback**	**BEV**	**Airflow**	**2025**
Dodge	**Sedan**	**BEV**	**eMuscle**	**2024**
Ford	SUV	BEV	Explorer	Two crossovers for 2023
Genesis	SUV	BEV	Electrified GV70	2023
GMC	Truck/Van	BEV	Sierra EV	2023
Honda		BEV	Fit/Jazz	
Honda	**SUV**	**BEV**	**Prolongue**	**2024**
Jeep	SUV	PHEV BEV	Renegade Compass Wrangler	Unconfirmed for U.S. 2023
Kia	SUV	BEV	Stonic EV9	Unconfirmed for U.S. 2023
Mercedes Benz		PHEV	Unconfirmed for U.S.: GLBe A250e	Announced 10 new electric models by 2022
Mercedes Benz		BEV	Unconfirmed for U.S.: EQA (2021) EQB (2021)	Announced 10 new electric models by 2022
Mullen	**SUV**	**BEV**	**Ottava**	**2024**
Polestar	**SUV** **Sedan**	**BEV**	**Polestar 4** **Polestar 3**	**2023** **2022**
Porsche	**SUV**	**BEV**	**Macan**	**2023**
Ram	**Truck/Van**	**BEV**	**Ram 1500**	**2024**
Tesla	**Sedan**	**BEV**	**Roadster**	**2023**
Toyota	3 SUVs* (one would be a Subaru collaboration) 2 Trucks/ Vans* 1 Hatchback*	BEV	Unnamed	Announced June 2019 for 2020-2025 2 SUVs to be announced in 2021

Manufacturer	Vehicle Type	EV Type	Model Name	Planned Availability
Toyota		PHEV		One to be introduced in 2021
VW	Sedan	BEV	ID.Space Vizzion	2022
Workhorse**	Truck/Van	PHEV	W-15	Production on hold as of March 2020

*Toyota announced six new vehicles will launch but did not provide further details.
These are speculations based on https://www.caranddriver.com/news/a27887943/toyota-ev-rollout-plans/.

**Workhorse announced a model but has not announced details or launch dates due to production delays.

Price-Range Matrix: BEV Models Available in 2022

		Price ($)			
		0-30,000	30,000-40,000	40,000 — 70,000	70,000+
Range (Miles)	0-150	Kandi K27 Kandi K23 MINI Cooper SE	**Mazda MX-30**		
	150-250	**Nissan LEAF**	**Canoo Lifestyle Vehicle** **Chevrolt Bolt EVU** Fisker Ocean Huyundai IONIQ **Kia Niro** Tesla Cybertruck	Alpha Motors Wolf BMW i3 Jaguar I-Pace Volvo XC 40 Audi e-tron Mercedes EQC Lordstown Endurance Volvo C40 Recharge	**Porsche Taycan** **Porsche Taycan** **Cross Turismo**
	250+		**Hyundai Kona Electric** **Chevrolet Bolt** **Kia Niro**	**Atlis Motors XT** **BMW i4** Cadillac LYRIQ **Hyundai Ioniq 5** **Kia EV6** Nissan Ariya **Polestar 2** Rivian R1T **Rivian R1S** Tesla Model 3 **Vinfast VF8** **Vinfast VF9**	Audi e-tron GT BMW iX Hummer SUV Hummer Pickup Karma GSe-6 Lucid Motors AirTesla Model S

Appendix C. Model Announcements – Medium- & Heavy-Duty Vehicles

This table includes only models with an announced model name and model year introduction date. Other data is included if available; blank cells indicate that the data is not available from the manufacturer. New additions are bolded.

Medium-Duty Vehicles

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	range (mi)
Electric Last Mile Services	Elms Urban Utility	Class 1	Cargo Van	2022		115-135
EVT Motors	Cutaway Van	Class 1	Cargo Van	2021	106.2	170
Arrival	The Arrival Van	Class 2b-3	Cargo Van	2022	44-133	112-211
Atlis Motor Vehicles	XP Platform (Chassis)	Class 2b-3		2022	150, 200, 250	300, 400, 500
Bollinger	B2 Chass-e Cab	Class 2b-3, 4, 5-6	Pickup Truck/ Box Truck/ Utility Truck	2022	105, 140	200
CityFreighter	CF1	Class 2b-3		2022		
Daimler	Mercedes-Benz eSprinter	Class 2b-3	Cargo Van	2023		96
EVT Motors	Urban Truck	Class 2b-3	Box Truck	2021	92.5	173
EVT Motors	Van	Class 2b-3	Cargo Van	2021	106.2	109-173
Ford	E-Transit	Class 2b-3	Cargo Van	2021	43-86	60-126
General Motors (BrightDrop)	EV600	Class 2b-3	Cargo Van	2021		250
Lightning eMotors	Transit Cargo Van	Class 2b-3	Cargo Van	2021	86, 105	140, 170
Rivian	Built for Purpose	Class 2b-3	Step Van	2021 (Amazon Only)		150
SEA Electric	Ford Transit EV	Class 2b-3		2021	88	190
Workhorse	C 1000	Class 2b-3	Cargo Van/Step Van	2021	35, 70	100, 160
Volkswagon	eTransporter	Class 2b-3	Cargo Van			82
Volkswagon	I.D. Buzz Cargo	Class 2b-3	Cargo Van		111	340
Electric Last Mile Services	Urban utility	Class 3		2022		250
Utilimaster	Reach EV	Class 3	Step Van			
Utilimaster	Velocity M3	Class 3	Cargo Van		120	75

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	range (mi)
Zenith	Cab Chassis/ Cutaway Cab	Class 3	Box Truck			10, 100, 135
Alpha Mobility	G Series Logistic Truck	Class 4	Box Truck	2021	108, 144	125
Bollinger	Chass-E	Class 4				200
Canoo	MPDV Series	Class 4	Cargo Van	2022	130-230, 90-190	40, 60, 80
Cenntro Automotive	CityPorter	Class 4	Cargo Van	2021		220
Dana Nordresa	W4	Class 4	Step Van	2021	80, 160	75, 150
Dana Nordresa	T4	Class 4	Step Van	2021	80, 160	75, 150
Greenpower	EV Star Cargo+	Class 4	Box Truck	2021	118	150
Greenpower	EV Star Cargo	Class 4	Cargo Van	2021	118	150
Greenpower	EV Star CC	Class 4	Utility Truck	2021	118	150
Lightning eMotors	E-450 Cutaway	Class 4	Box Truck	2021	86, 129	80,120
Motiv	Epic E450	Class 4	Step Van/ Box Truck	2021	127	105
Phoenix Motors	Zeus 500	Class 4	Step Van	2021	70-150	80, 115, 150
SEA Electric	Isuzu NPR	Class 4	Box Truck/ Utility Truck	2021	100	170
Zeus Electric Chassis	Electric Work Truck	Class 3-6	Utility Truck	2022	175	150
Bollinger	Chass-E	Class 5-6	Cargo Van/ Step Van/ Box Truck/ Utility Truck			200
BYD	6F	Class 5-6	Box Truck	2021	221	125
BYD	6R	Class 5-6	Refuse Truck	2021		85
BYD	6D	Class 5-6	Step Van	2021	221	120

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	range (mi)
Chanje	V8100	Class 5-6	Cargo Van	2021	100	150
Daimler	Freightliner MT50e (Chassis)	Class 5-6	Box Truck	2021	226	125
Dana Nordesa	T5	Class 5-6	Box Truck	2021	80, 160	60, 120
Dana Nordesa	T6	Class 5-6	Box Truck	2021	160	120
EVT Motors	Electric Van Cutaway	Class 5-6	Box Truck	2021	106	173
Hino	M5	Class 5-6	Box Truck	2021	138	150
Kenworth	K270E	Class 5-6	Box Truck	2021	141	100, 200
Lightning eMotors	F-59 Cargo Van and Food Truck	Class 5-6	Cargo Van/ Step Van	2021	128, 160, 192	110, 140, 170
Lightning eMotors	6500XD Cab Forward Truck	Class 5-6	Box Truck	2021	122, 153, 184	88, 110, 130
Lion Electric	Lion6	Class 5-6	Box Truck	2021	252	180
Motiv	Epic F-59	Class 5-6	Step Van	2021	127	105
Navistar	International Trucks eMV	Class 5-6	Utility Truck	2021	321	250
Peterbilt	220EV	Class 5-6	Box Truck	2021	140-348	200
Roush CleanTech	Ford F-650	Class 5-6	Utility Truck	2021	138	100
SEA Electric	Ford F-59	Class 5-6	Step Van	2021	138	200
SEA Electric	Ford F-650	Class 5-6	Utility Truck	2021	138	200
SEA Electric	Hino 195	Class 5-6	Box Truck	2021	138	200
SEA Electric	Isuzu NRR EV	Class 5-6	Box Truck	2021	138	200
SEA Electric	Isuzu NQR EV	Class 5-6	Box Truck	2021	138	200
XOS	X-Platform (Chassis)	Class 5-6	Step Van	2021		200
Zenith Motors	Electric Step-Van	Class 5-6	Step Van	2021		90
Hino	L6 and L7	Class 6-7 Tractor	Tractor Trailer	2021		

Heavy-Duty Vehicles

Manufacturer	Model	Weight Class	Availability	Battery (kWh)	Range (mi)
BYD	8R Refuse	Class 7-8 Rigid	2021		75
Daimler	Freightliner eM2	Class 7-8 Rigid	2021	325	230
Dennis Eagle	eCollect	Class 7-8 Rigid	2021	300	
Einride	Pod	Class 7-8 Rigid	2022/2023		112
Kenworth	K370E	Class 7-8 Rigid	2021	282	100, 200
Lion Electric	Lion8 Tandem	Class 7-8 Rigid	2021	336	170
Lion Electric	Lion8 Refuse	Class 7-8 Rigid	2021	336	130
Lion Electric	Lion8 Bucket	Class 7-8 Rigid	2021	336	170
Nikola	Refuse	Class 7-8 Rigid	2023		150
Peterbilt	520EV (Refuse)	Class 7-8 Rigid	2021	308-420	60-90
SEA Electric	Ford F-750	Class 7-8 Rigid	2021	138	170
SEA Electric	Isuzu FTR	Class 7-8 Rigid	2021	138	200
SEA Electric	Refuse	Class 7-8 Rigid	2021	138, 220	
Volvo	VNR Electric Straight Truck	Class 7-8 Rigid	2021	264	150
Volvo Group	Mack Trucks LR Electric	Class 7-8 Rigid	2021	150	70
BYD	8TT	Class 7-8 Tractor	2021	409	175
Daimler	Freightliner eCascadia	Class 7-8 Tractor	2022	550	250
Hino	XL Series	Class 7-8 Tractor	2022		
Kenworth	T680E	Class 7-8 Tractor	2021	120	150
Lion Electric	Lion8 Tractor	Class 7-8 Tractor	2021	588	210
Nikola	Tre	Class 7-8 Tractor	2021	750	250-300
Peterbilt	579EV	Class 7-8 Tractor	2021	264-420	110-200
Tesla	Semi	Class 7-8 Tractor	2021		300 or 500
Volvo	VNR Electric	Class 7-8 Tractor	2021	264	120
BYD	8Y	Terminal Tractor	2021	281	
Kalmer Ottawa	Ottawa T2E Electric Terminal Tractor	Terminal Tractor	2021	132	
Lonestar	Lonestar SV Reman Electric Terminal Tractor	Terminal Tractor	2021		
Orange EV	T-Series	Terminal Tractor	2021	80, 100, 160, 180	
Terberg Tractors	YT202-EV	Terminal Tractor	2021		

Buses

Manufacturer	Model	Category	Availability	Battery (kWh)	Range (mi)
BYD	Coach Bus C6M - 23′/C8M - 35′/ C9M - 40′/C10M - 45′	Coach	2021	121, 313, 352, 446	124, 200, 230
Lightning eMotors	Coach Power train Retrofit	Coach	2021	640	195
Motor Coach Industries (NFI Group)	J4500e CHARGE	Coach	2021	544	230
Motor Coach Industries (NFI Group)	D45 CRTE LE CHARGE	Coach	2021	389, 544	170, 230
Van Hool	CX45E	Coach	2021	648	310
Blue Bird	All American RE Electric	School	2021	160	120
Blue Bird	Micro Bird G5 Electric	School	2021	88	100
Blue Bird	Vision Electric	School	2021	160	120
BYD	Type D School Bus	School	2022	150	155
Daimler	The Saf-T-Liner® eC2 Jouley	School	2021	220	135
Greenpower	The BEAST	School	2021	193.5	150
Lion Electric	LionA	School	2021	80, 160	75, 150
Lion Electric	LionC	School	2021	210	100, 125, 155
Lion Electric	LionD	School	2021	210	100, 125, 155
Motiv	Epic F59	School	2021	127	105
Navistar	IC Bus CE Series Electric	School	2021	105-315	70-200
Pheonix Motors	Zeus 600 School Bus	School	2021	70, 105, 140	80, 115, 150
Greenpower	EV Star	Shuttle	2021	118	150
Greenpower	EV Star+	Shuttle	2021	118	150
Greenpower	AV Star	Shuttle	2021	118	150

Manufacturer	Model	Category	Availability	Battery (kWh)	Range (mi)
Lightning eMotors	Transit Passenger Van	Shuttle	2021	86, 105	140, 170
Lightning eMotors	E-450 Shuttle	Shuttle	2021	86, 129	80, 120
Lightning eMotors	F-550	Shuttle	2021	122	100
Lion Electric	LionM	Shuttle	2021	160	75, 150
Motiv	Epic E450	Shuttle	2021	127	105
Optimal EV	S1LF	Shuttle	2021	113	200
Pheonix Motors	Zeus 400 Shuttle Bus	Shuttle	2021	70, 105, 140	80, 115, 150
SEA Electric	E4B Commuter Bus	Shuttle	2021	88	186
Zenith Motors	Electric Shuttle	Shuttle	2021	62.5	90,110
Arrival	The Arrival Bus	Transit	2023		
BYD	Transit Bus K7 - 30'/K9 -S 35'/ K9 - 40'/K11 - 60'	Transit	2021	215, 266, 352, 446	137, 145/215, 156, 220
BYD	Double Decker C8MS - 35' / C8MS - 45'	Transit	2021	113, 446	170, 230
Gillig	Battery Electric Bus (40')	Transit	2021	148-444	150, 210
Greenpower	EV 250 (30')	Transit	2021	210	175
Greenpower	EV 350 (40')	Transit	2021	430	200
Greenpower	EV 550 (45' Double Decker)	Transit	2021	478	175
Hyundai	Battery Elec City	Transit	2021	256	130
Lightning eMotors	Electric Zero Emission City Transit Bus Repower	Transit	2021	320	140, 200
New Flyer	Xcelsior CHARGE 35', 40', and 60'	Transit	2021	350, 440, 525	179, 220 / 174, 213, 251 / 153
New Flyer	Xcelsior AV	Transit	2021	Can integrate Xcelsior CHARGE platform	
Proterra	ZX5 40' and 60'	Transit	2021	450, 675	240, 329
Volvo Group	Nova Bus LFSe/ LFSe+	Transit	2021	564	75, 292

Concept Vehicles

Manufacturer	Model	Category
Avevai	Iona Van	Class 2b-3
Avevai	Iona Truck	Class 4
Bollinger	Deliver-E	Class 4
XOS	ET-One	Class 7-8 Tractor
Neuron EV	TORQ	Class 7-8 Tractor
Hino	Hino XL Box Truck (Xos)	Class 7-8 Rigid
Letenda	Electrip	Transit Bus

Appendix D. Recent Zero Emission Vehicle Investments & Jobs by State

(April 2022)

State	Company	ZEV Investment and Jobs
Alabama	Mercedes-Benz	Committed $1 billion to expand a plant in Tuscaloosa, Alabama, to set up production of EVs and batteries in the U.S. and expects this will create 600 new jobs.
Arizona	Atlis Motor Vehicles	Atlis recently launced a $10 million crowdfunding campaign to raise capital and expand their operations. Atlis has secured $300+ million in future revenue from battery technology alone and over 24,000 contractual orders for trucks around the world. Atlis plans to use the capital to help further their plans to create a new truck called the XT that targets customers in the agriculture, construction, and utility industries. Atlis plans to hire more engineers, buy more battery testing equipment, expand sales programs, and finalize the production-level design for the XT. Atlis Motor produces electric work trucks.
	Lucid Motors	Completed the first phase of its $700 million investment for its Arizona factory and has begun an expansion that will create 6,000 jobs.
	Polestar, Rivian, Tesla	Operations in Arizona.
Arkansas	Canoo	Selected Bentonville, AR as its headquarters and will use the area as an anchor for its electric vehicle production operations and for research-and-development efforts. These and other investments will bring at least 545 high paying jobs to Benton and Washington counties in Northwest Arkansas.
	Envirotech Vehicles Inc.	Announced it will move its manufacturing operations and headquarters across the country from California to Osceola, Arkansas, adding about 800 jobs as part of an $80.7 million investment over the next five years. It will be about two years before full-scale production can begin at the Osceola facility, with the plant producing up to 2,000 vehicles a year. To do that, the company plans to invest up to another $200 million above the initial $80.7 million investment. Envirotech makes and provides all-electric, zero-emission vehicles and zero-emission drive trains for medium to heavy-duty commercial fleet vehicles. The company will place a priority on local sourcing of materials, including lithium and steel from Arkansas-based producers such as U.S. Steel.
California	Office of Governor Gavin Newsom	Governor Newsom has outlined a $10 billion package to accelerate the transition to zero-emission vehicles.
	State of California	California is home to 34 ZEV-related manufacturers and more than 360 unique ZEV-related companies – and in 2020, ZEVs became the state's number one export.

State	Company	ZEV Investment and Jobs
Colorado	BMW and Ford	Invested $130 million in Solid Power, a Colorado startup that makes solid-state battery cells for electric vehicles. Solid Power will add at least 60 jobs at its Louisville headquarters by the end of 2022, doubling its workforce.
	Lightning eMotors	Invested an additional $5 million to expand its manufacturing capacity to meet increasing demand. Currently more than 50 highly skilled technicians build and customize medium duty commercial vehicles at the company's manufacturing campus. That number is expected to more than double by the end of 2022 as the company continues to expand.
Florida	Cenntro Automotive	Selected Jacksonville for its first U.S.-based manufacturing facility. The company is investing about $25 million, and the new facility is expected to bring in 34 new jobs. Cenntro Automotive is an EV commercial vehicle company.
Georgia	SK Innovation	Plans to spend $2.6 billion to build two battery plants outside of Atlanta, Georgia, that it expects will create at least 2,600 full time employees by 2023. The first facility is set to start commercial production in early 2022 and the second plant will start production by the end of 2023.
	Rivian	Announced it will spend $5 billion to build an electric truck, SUV, and van factory east of Atlanta. It is the largest industrial announcement in Georgia history. The company projects 7,500 jobs will be created but could grow to as many as 10,000 workers, which would make it among the largest auto assembly complexes in the United States.
Illinois	Lion Electric	Announced it is investing $70 million to convert a Joliet warehouse into a factory to produce up to 20,000 electric trucks and buses a year. Lion plans to hire about 750 workers and open the plant later in 2022.
	Rivian	In 2017, Rivian bought a former Mitsubishi Motors plant in Normal, Illinois for $17 million. It has since invested an additional $1.2 billion in renovations to the plant where it expects to employ 2,500 workers and is has begun production of its R1T electric truck.
	Stellantis	Expects to convert its nearly dormant Belvidere Assembly Plant, which makes the Jeep Cherokee, into the automaker's first EV factory in the U.S. by 2024.
Indiana	Electric Last Mile Solutions	Planning to build an electric light-duty vehicle in Mishawaka, Indiana. The company plans to have 100 employees by the end of 2021 and up to 900 by 2025.
	General Motors	Planning to invest more than $50 million into one of its Indiana facilities as a part of expanding the company's electric vehicle production. The Bedford Casting Operations, south of Bloomington, will be upgraded to produce components for the engine and transmission for the Chevrolet Silverado EV that is set to debut next year.
	Stellantis	Will invest $229 million in three plants in Kokomo, Indiana to expedite the transition to electric vehicles.
	Toyota Motors	Announced the construction of a $1.3 billion automotive battery plant near one of its vehicle assembly plants in Princeton, Indiana, which is already focused on EV generation. In April, TMMI announced plans to invest $800 million to retool the manufacturing lines at the Gibson County plant to produce two electric vehicle models and add 1,400 workers. Toyota says it aims to start battery production in 2025, focusing on lithium-ion auto batteries. The new factory will eventually result in 1,750 new jobs, according to the automaker.

State	Company	ZEV Investment and Jobs
Kansas	Kansas Government	Kansas is hoping to land a $4 billion advanced manufacturing facility. Stellantis is thought to be the unknown company that is considering the state for a 3 million-square-foot, 4,000-job development.
Kentucky	Ford	Investing $5.8 billion to build BlueOval SK Battery Park, a new joint venture between Ford and SK Innovation—in Glendale, Kentucky—consisting of twin battery plants that will produce advanced lithium-ion batteries starting in 2025. The Kentucky plants will create 5,000 new jobs and supply Ford's next-generation electric Ford and Licoln vehicles.
Louisiana	Syrah Resources	Announced it is investing $176 million to expand its Syrah Technologies graphite processing facility in central Louisiana, giving the State a supply-chain foothold in the rapidly expanding market for electric vehicle components produced in the United States. Syrah Technologies is retaining 19 employees and creating 36 direct new jobs with average annual salaries of $69,000, plus benefits. Louisiana Economic Development estimates the project will result in 52 indirect jobs, for a total of 88 new jobs in Louisiana's Central Region.
Massachusetts	Factorial Energy	Raised $200 million led by Mercedes-Benz and Stellantis to accelerate commercial production and deployment of Factorial's solid-state battery technology that offers up to 50 percent greater driving range than current lithium-ion technology. Factorial Energy is based in Woburn, MA.
	General Motors	Invested $139 million in SES AI Corporation to develop a battery manufacturing prototyping line in Woburn, MA.
Michigan	General Motors	Announced an investment of more than $7 billion in four Michigan manufacturing sites, creating a total of 4,000 new jobs, and retaining 1,000 – the single largest investment announcement in GM history.
Mississippi	Nissan	Will invest $500 million to retool its U.S. assembly plant near Canton, Mississippi, to build two new electric vehicles. A top executive said the automaker is looking for a U.S. site to build a battery factory. Nissan plans to assemble electric vehicles for its Nissan and Infiniti brands in Mississippi starting in 2025.
Missouri	Ford	Plans to invest $100 million in a plant in Missouri to produce an all-electric version of its Transit van. The investment is part of Ford's more than $11.5 billion in spending on electric vehicles through 2022, including $3.2 billion set aside for several new all-electric vehicles such as the Transit van and an EV version of the F-150 pickup. The Transit EV will be produced at Ford's Kansas City Assembly Plant, where it will add 150 jobs for production of the van.
Nevada	Ford	Investing $50 million in Redwood Materials, a Nevada-based upstart electric vehicle battery recycling company founded by former Tesla executive JB Straubel.
	Nuro	Announced it will invest $40 million in a production facility in southern Nevada. Construction on the manufacturing facility is scheduled to be completed in 2022. Nuro specializes in autonomous electric vehicles.
New York	General Motors	Plans to invest $154 million in Western New York to produce electric motor components at its Lockport plant.

State	Company	ZEV Investment and Jobs
North Carolina	Arrival Automative	Will establish a High Voltage Battery Module (HVBM) assembly plant in Charlotte, adding 150 jobs and investing approximately $11.5 million. It will be Arrival's third facility in Charlotte, including its North American headquarters and its Van Microfactory.
	Toyota	Investing $1.25 billion to develop a battery manufacturing plant in Liberty, North Carolina. Expected to begin production in 2025, the facility is poised to generate over 1,750 jobs.
Ohio	Benchmarking Mineral Intelligence	In a new report, Ohio Battery Supply Chain Opportunities, Benchmark Mineral Intelligence—a leading battery industry analysis firm—concludes that Ohio is already home to several companies active in the supply chain, including BASF which produces cathode materials for lithium ion batteries in Elyria, and Dana Corporation which produces thermal management systems for Li-ion batteries. Several Ohio universities are also leaders in battery research and development, including Ohio State, Wright State, Case Western Reserve University, the University of Dayton, and the University of Akron. Additionally, Glenn Research Center manages Li-ion battery development for the International Space Station and the Air Force Research Lab at Wright Patterson Air Force Base supports research on lithium ion for military applications.
	Endera	Acquired Metro Titan, LLC, a school and shuttle bus manufacturing company. From its Ohio-based facility, Endera will manufacture electric Type A school buses, shuttle buses, and paratransit vehicles for the DOT, healthcare, airport, university, corporate, municipal, and last-mile transportation industries - all built on electrified Ford and Chevrolet chassis. Endera's employee base will double in size because of the acquisition. Endera is a vertically integrated transportation technology company specializing in all-electric commercial vehicles, charging infrastructure and software solutions.
	General Motors	Investing $2.3 billion into a joint venture with LG Chemical to build a battery cell manufacturing plant in Lordstown, Ohio. GM said it expects to put the Ultium batteries in its new Cadillac Lyriq electric car and its new electric Hummer sport utility vehicle. GM said it will hire 1,100 people at the plant.
Oklahoma	Canoo	Will build a new EV factory outside of Tulsa, Oklahoma, opening in 2023 and is expected to create more than 2,000 jobs.
	Oklahoma Department of Commerce	Oklahoma Commerce Director Brent Kisling said that there is $15 billion of electric auto manufacturing investment in the pipeline looking at Oklahoma.
	Oklahoma Governo's Office	Republican Gov. Kevin Stitt is planning to award a state-record $15 million to electric vehicle manufacturer Canoo to help support the company's planned investment of more than $560 million in new facilities in Oklahoma.
Oregon	Arcimoto	Opened a new 250,000-square-foot manufacturing facility that it says will allow it to increase production of its electric vehicles.
	Daimler Trucks North America	Spent $200 million to convert its Portland, OR plant to produce electric Freightliners, including the eCascadia and eM2 trucks. Daimler Trucks North America is the leading manufacturer of Class 8 trucks in the U.S.
Pennsylvania	Mack Trucks	Completed an $84 million overhaul of its Lehigh Valley Operations site in Lower Macungie Township, PA, including adding production of the company's Mack LR Electric model.

State	Company	ZEV Investment and Jobs
South Carolina	Arrival	Will establish its first U.S. Microfactory in York County, South Carolina. The $46 million investment is expected to create 240 new jobs. Five months later, Arrival announced it would also establish a Microfactory in Charlotte, North Carolina, bringing 250 additional jobs to the region. Arrival specializes in delivery vans.
	Mercedes-Benz	Will bring the next generation of eSprinter vans to the United States through a roughly $60 million investment in South Carolina.
	Proterra	Announced new manufacturing operations in Spartanburg County. The company's $76 million investment is expected to create more than new 200 jobs. Proterra is a leader in the design and manufacturing of zero-emission electric transit vehicles and EV technology solutions for commercial applications.
Tennessee	Ford	Announced a $5.6 billion investment to create an industrial campus northeast of Memphis that will produce a new generation of electric trucks and electric vehicle batteries. Manufacturing is expected to begin in 2025, and the company is expected to employ about 5,700 people.
	General Motors	Is spending $2 billion to transition its Spring Hill, Tennessee assembly plant to become the company's third vehicle manufacturing site to produce electric vehicles.
	Mullen Technologies	Announced a $336 million investment to set up manufacturing in Memphis, with potential to create over 425 jobs.
	Tritium	Announced the construction of a manufacturing facility in Lebanon, Tennessee. The new facility is expected to produce as many as 30,000 DC chargers annually once it reaches full capacity and create more than 500 jobs in the region. Tritium is an Anustralian-based charging station manufacturer.
Texas	Tesla	Is building a $1 billion EV manufacturing plant in Travis County, Texas, that could support 5,000 direct jobs and more than 4,000 indirect jobs due to secondary effects.
Utah	Ideanomics	Announced a $450 million deal to acquire Orem, Utah-based VIA Motors, a manufacturer of commercial EVs that include cargo vans, trucks, and buses. VIA will make commercial EVs for commercial fleets and product distributors throughout North America. Ideanomics is a financial technology firm that promotes the automotive industry's transition to electric vehicles.
	Renewable Innovations	Partnered with General Motors to create mobile power generators and place fast, mobile electric vehicle charging stations across the country. GM will supply HYDROTEC fuel cell power cubes to Renewable Innovations for the company to build mobile power generators capable of charging electric vehicles anywhere.
Virginia	Volvo Trucks	Will invest $400 million over six years to upgrade its New River Valley, Virginia plant, which produces all Volvo trucks sold in North America, including electric drivetrains. Volvo plans to create over 775 new jobs.

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