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Electric Vehicle Market Update

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



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Glossary

ACC: Advanced Clean Cars regulation

ACT: Advanced Clean Trucks regulation

ACF: Advanced Clean Fleets regulation

AFDC: Alternative Fuels Data Center

BEV: Battery electric vehicle

CARB: California Air Resources Board

CO₂: Carbon dioxide

COP: Conference of the Parties

DCFC: Direct current fast charging

DOE: Department of Energy

DOT: Department of Transportation

DPA: Defense Production Act

EPA: Environmental Protection Agency

EV: Electric vehicle

EVSE: Electric Vehicle Supply Equipment

FTA: Federal Transit Administration

FY: Fiscal Year

GHG: Greenhouse gas

ICE: Internal combustion engine

IJA: Infrastructure Investment and Jobs Act

IRA: Inflation Reduction 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

NACFE: North American Council for Freight Efficiency

NESCAUM: Northeast States for Coordinated Air Use Management

NOx: Nitrogen oxides

NREL: National Renewable Energy Laboratory

PHEV: Plug-in hybrid electric vehicle

SSB: Solid-state battery

SUV: Sport utility vehicle

TCD: Total Cost of Driving

TCI: Transportation and Climate Initiative

TCO: Total Cost of Ownership

US FHWA: United States Federal Highway Administration

ZET: Zero Emission Truck

ZEV: Zero-emission vehicle

Electric Vehicle Market Update

Lead Authors – Version Seven: Rachel MacIntosh, Sophie Tolomiczenko and Grace Van Horn

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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 supply chain impacts on EV sales.

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

For questions or comments, please contact:

Grace Van Horn
Principal Consultant
ERM
grace.vanhorn@erm.com

This report is available at www.erm.com.

Notable Updates

August 2022 saw the passage and finalization of two of the most significant and historic policy actions supporting vehicle electrification in the U.S.:

- On August 16, 2022, President Biden signed the Inflation Reduction Act (IRA) of 2022, which provides \$369 billion in Energy Security and Climate Change investments to help achieve a 40 percent nation-wide reduction of carbon emissions by 2030. The IRA offers consumers \$7,500 in tax credits for new light-duty electric vehicles (EVs) and \$4,000 for used EVs, and up to \$40,000 for the purchase of a commercial vehicle. In addition, billions will be provided in grants and tax incentives for additional vehicle purchase programs and to spur zero-emission vehicle (ZEV) manufacturing. The Act has the potential to further accelerate the adoption of electric light-duty vehicles and provide a significant down payment on medium- and heavy-duty trucks and bus electrification.
- On August 25, 2022, the California Air Resources Board (CARB) approved the Advanced Clean Cars II (ACC II) standards, which will accelerate the transition to light-duty EVs through both increased stringency of requirements and associated actions to support wide-scale adoption and use. By 2035, all new passenger cars, trucks, and SUVs sold in California will be zero-emitting; the 17 states currently implementing Advanced Clean Cars—as well as others—may also choose to adopt these updated standards. Oregon and Washington have already announced plans to adopt ACC II within the year. CARB estimates that ACC II will create at least \$12 billion in public health benefits. A number of automakers, including Ford, GM, Honda, Stellantis, and Toyota issued statements in support of the ACC II standards.

More EVs are on the road and available than ever before:

- Globally, 2021 ended with over 16.5 million light-duty EVs on the road, a record high. In the first quarter of 2022, global light-duty EV sales rose strongly with 2 million vehicles sold, up 75 percent from the first quarter of 2021. Global medium- and heavy-duty (M/HD) EV sales doubled over 2020 volumes with over 14,200 units sold, representing 0.3 percent of all global M/HD vehicle sales in 2021.

- The number of light-duty electrified models available in the U.S. is projected to reach 187 by the end of 2025.
- Global model availability for zero-emission trucks and buses will increase nearly 26 percent from 2020 to 2023, from 433 models to 544 models.

The Federal government has taken additional key actions to advance EVs:

- On June 6, 2022, President Biden invoked the Defense Production Act (DPA) which provides U.S. Department of Energy (DOE) the authority to accelerate the domestic production of five key energy technologies in an effort to lower energy costs for the public.
- On June 9, 2022, U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) announced a notice of proposed rulemaking regarding the minimum standards for the National Electric Vehicle Infrastructure (NEVI) formula program that would set new standards and requirements for the installation, operation, interoperability, network connectivity, and maintenance of EV charging infrastructure. On September 14, 2022, the Biden Administration announced that 35 NEVI plans from States, the District of Columbia, and Puerto Rico have been approved by the FHWA, releasing more than \$900 million in NEVI funding that will build out EV chargers across 53,000 miles of U.S. highways.
- Federal agencies continue to implement the Infrastructure Investment and Jobs Act. In May 2022, the Environmental Protection Agency (EPA) issued its first round of funding of \$500 million for the Clean School Bus program, overseen by EPA; the agency accepted applications through mid-August 2022.
- On September 15, 2022, DOE, DOT and EPA, and U.S. Department of Housing and Urban Development (HUD), signed a memorandum of understanding (MOU) to draft a cross-agency transportation decarbonization strategy to guide future policy, research, development, demonstration and deployment in the public and private sectors.

States are also continuing to lead in additional EV policy and planning:

- On July 27, 2022, the Northeast States for Coordinated Air Use Management (NESCAUM) and the signatories of the Multi-State Medium- and Heavy-duty ZEV MOU released their Action Plan. The plan includes over 65 recommendations and strategies for policymakers to ensure a rapid adoption process for electric trucks and buses.
- In May 2022, New Mexico announced it had adopted California's Advanced Clean Car I standards, becoming effective for model year 2026.
- In April 2022, New York Governor Kathy Hochul agreed to a \$220 billion state budget that includes a plan to allocate funding to put about 50,000 electric school buses on the road by 2035. Per direction of the State Senate, the New York State Energy Research and Development Authority (NYSERDA) is required to provide technical assistance to the school districts.

Supply chain disruptions have affected EV and battery pricing:

- Analysts have revised their battery pack price projections expecting prices to rise slightly or stay constant until at least 2024, potentially pushing EV price parity back somewhat. Analysts cite higher raw material prices and ongoing geopolitical conflicts for these price increases. BloombergNEF's 2021 annual battery price survey predicts a \$3 price increase in 2022 to \$135/kWh, the first time battery pack prices have risen since 2010. These analyses do not consider IRA funding, which may help to more rapidly drive down prices.
- Roush Industries found a trend of decreasing upfront costs for M/HD fleet electrification compared to M/HD ICE vehicles, with electrification costs projected to drop 26 percent to 30 percent by 2024 and 42 percent to 44 percent by 2027. When considering IRA funding, Roush found the purchase price of many M/HD segments (including refuse trucks, shuttle buses and delivery trucks) will be the same or less than diesel versions as early as 2023.

Auto manufacturers continue expanding EV sales targets and making investments in EVs and batteries:

- 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.
- Ford announced that it will invest \$3.7 billion in its Michigan, Ohio, and Missouri factories to produce both electric and ICE vehicles. Ford will invest \$100 million to upgrade its Kansas City Assembly Plant that builds its E-Transit vans. The company announced that it has lined up enough batteries to reach its short-term goal of producing 600,000 EVs by 2023 and has secured enough batteries to reach about 70 percent of its long-term goal of producing 2 million EVs by 2026.
- GM announced that it is investing \$2 billion into two plants in Canada with the Canadian Government contributing \$259 million. The first will be an all-electric assembly plant located in CAMI Assembly in Ingersoll, Ontario. The second plant will be a production expansion of the Oshawa Assembly plant in Ontario to add a third shift. The company has also announced that it will invest another \$81 million to build the Cadillac Celestiq at GM's Warren Technical Center in Michigan. Additionally, GM will invest \$491 million to upgrade its EV assembly plant in Marion, Indiana.
- Hyundai, in agreement with the State of Georgia, announced that it will invest \$5.54 billion to build its first EV and battery dedicated manufacturing plants in Bryan County. The company also announced that it will invest \$300 million in its Alabama factory to produce the Genesis G70 and the Santa Fe plug-in hybrid.
- Nissan announced that it expects to invest \$17.6 billion over the next five years.
- Rivian, in agreement with the State of Georgia, announced that it has secured \$1.5 billion in public funding and will invest an additional \$5 billion to build a large EV factory east of Atlanta.
- VinFast, in partnership with the State of North Carolina, has received \$1.2 billion and will invest an additional \$4 billion into its first electric vehicle manufacturing and battery production facility in the U.S.
- GM entered a purchase agreement with Hertz for 175,000 EVs, including GM's Chevrolet, Buick, GMC, Cadillac and BrightDrop EVs, which are scheduled to be delivered over the next five years.

Executive Summary

This paper is the seventh version of 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. This version of the report is released as monumental changes are occurring in the EV space. President Biden signed the Inflation Reduction Act (IRA) of 2022, which through the provision of billions in grants and purchase credits for a variety of light-, medium-, and heavy-duty EVs, has the potential to further accelerate the adoption of light-duty EVs and provide a significant down payment on medium- and heavy-duty trucks and bus electrification. Analyses of the IRA forecast that the legislation will cut greenhouse gas (GHG) emissions down to 40 percent below 2005 levels in 2030. These GHG emission reductions will be achieved by making historic climate and clean energy investments totaling \$369 billion, representing the single biggest climate investment in U.S. history. At the state level, the California Air Resources Board (CARB) has approved the Advanced Clean Cars II update, which will accelerate the transition to light-duty EVs through both increased stringency of requirements and associated actions to support wide-scale adoption and use; by 2035 all new passenger cars, trucks, and SUVs sold will be zero emission vehicles (ZEVs).

* Updates released August 2019, September 2020, January 2021, April 2021, and April 2022.

EV projections for the next 5 to 10 years

8 key factors drive the projections for EV penetration.



To match this demand, automakers and battery manufacturers worldwide will spend more than \$626 billion through 2030 developing light-, medium-, and heavy-duty EVs. These manufacturer commitments reflect heightened efforts to address the major causes of climate change by governments world-wide, including the adoption of more stringent vehicle emission standards and EV sales targets, as well as rapidly improving economics and consumer options. 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.”¹

While previous versions of this report focused heavily on light-duty electric vehicles (LD EVs), this version also provides an in-depth discussion on medium- and heavy-duty electric vehicles (M/HD EVs). Key topics addressed include drivers of U.S. and global EV growth, policy drivers of U.S. EV growth, vehicle price parity: vehicle and battery pack cost projections, model availability and manufacturer commitments, commercial fleet electrification commitments, investments and domestic job creation, and charging network investments. The report also addresses the impact of supply chain disruptions on EV sales due to, among other things, the COVID-19 pandemic and geopolitical uncertainty.

Major findings of this report include:



Manufacturer Investments and Job Creation

Automakers and battery manufacturers worldwide will spend more than \$626 billion through 2030 developing light-, medium-, and heavy-duty electric vehicles. This would be a projected increase of more than \$111 billion in spending from the sixth EV Market Report's projection (April 2022), a 21 percent increase in spending. In the first nine months of 2022, over fifteen automakers and battery manufacturers have announced new or additional U.S.-based investments, with a combined total of over \$51 billion, to open new or renovate existing EV manufacturing, assembly, and battery production plants across twelve states. These recent investment announcements will directly employ over 41,000 workers, including over 22,500 light-duty workers, over 3,100 medium- and heavy-duty workers, and over 15,270 battery production workers once these facilities begin production. Additionally, these manufacturer investments will have an added benefit of creating additional indirect job growth for surrounding businesses. These investment announcements were made prior to the passage of the IRA, which provides further substantial funding measures for EV manufacturing and job support.



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 overall, reaching \$100/kWh between 2023 and 2025 and \$61-72/kWh by 2030. Auto manufacturers have previously endorsed these projections. However, due to ongoing supply chain disruptions, in 2022, battery pack prices rose slightly for the first time since 2010. However, it is likely that the IRA, which provides up to \$45/kWh battery cell credit and provides significant incentives for increasing EV manufacturing, could help lower the cost of battery packs in the future.



Price Parity

Many industry experts believe that light-duty EVs will reach cost parity with 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. Most industry experts 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.



Supply Chain Impacts

Projected long-term effects of the COVID-19 pandemic and ongoing geopolitical conflicts 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 late 2022 or 2023.

Prices of key minerals and metals, like lithium, cobalt, nickel, copper, and aluminum that are required components for EV batteries increased in 2021 and have continued to increase well into 2022. While the cost of these materials essential for lithium-ion batteries accounted for less than five percent of battery pack costs in the middle of the last decade, this share has risen to over 20 percent in recent years. The price of lithium and cobalt more than doubled in 2021, with lithium increasing two and a half times since the start of 2022. Due to geopolitical conflicts like the Russian invasion of Ukraine and supply being cut in China, lithium-ion battery pack prices may continue to rise, though, as noted above, there are strong incentives in the IRA that will help drive down costs.



Model Availability

By 2025, there will be approximately 187 battery electric (BEV) and plug-in hybrid (PHEV) light-duty vehicle models available to U.S. consumers, an expected increase of 78 models from the previous version of this report's 109 models. The selection of vehicle types available will also increase to include a much broader selection of sport utility vehicles (SUV), crossovers, and pick-up trucks. In 2021, the median EPA estimated range of LD EVs exceeded 230 miles for vehicles of that model year and the first EV to achieve a range of more than 400 miles was introduced; while the maximum range for any EV offered in MY2021 was 405 miles, there are already EV models offered for MY2022 achieving a maximum range of more than 500 miles, including Lucid Motors Air models, which tout 516 miles of expected EPA-rated range. Significant growth has also been seen in the M/HD space. In 2019, there were only 20 models of Class 2b-8 zero-emission trucks (ZETs) available for purchase in the U.S.; now, there are more than 136 models available. The number of ZETs and bus models available in the global market is projected to increase 26 percent from 2020 through 2023.



Affordability

As of 2022, there will be 15 LD EV models available for under \$40,000 manufacturer's suggested retail price (MSRP) with a driving range of over 100 miles. There will be 10 models with a net cost of under \$30,000, assuming they can take advantage of the newly expanded federal incentives. Of note, the Chevrolet Equinox, available in 2024, is estimated to be priced at \$30,000 with a range of 300 miles. In addition to these declining upfront purchase prices, many analyses conclude EVs will provide substantial consumer savings in avoided fuel costs. For instance, recent studies (before 2022 inflation and gas prices) found that an LD EV buyer could save over \$5,000 in avoided fuel costs over the life of the vehicle, while the owner of an electric medium-duty box truck could save \$6,269 in avoided fuel cost over the lifetime of the vehicle.



EV Manufacturer Commitments and Sales Targets

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, Ford said that its entire European LDV line will 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. Similarly, GM set a goal to produce one million EVs in North America by 2025 and plans to exclusively sell EVs by 2035. Additionally, Honda aims for two-thirds of its sales to be electrified globally and all sales in Europe by 2025; and 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.



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 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 also gaining momentum, and Tesla has continued to dominate U.S. EV sales to date. On the medium- and heavy-duty side, Volvo Group announced Volvo Energy, formerly a subset of Volvo Trucks, would be responsible for matters related to electrification, such as life cycle battery management and charging infrastructure.



Fleet Electrification

Electrification of M/HD commercial fleet vehicles is gaining traction, in part due to fleet electrification targets by major companies. For example, Hertz, in addition to its existing purchase agreements with Tesla for 100,000 Tesla model 3s and Polestar for 65,000 Polestar 2 models, signed a deal with GM to purchase 175,000 EVs and Walmart has ordered 4,500 all-electric last-mile delivery vehicles from Canoo. These commitments send market signals that established companies are seeking electric alternatives for their fleets as components of their sustainability initiatives. These companies are planning to convert a range of LD and M/HD vehicle types to EVs, including delivery vans, commuter buses, transit buses, garbage trucks, and more.



Charging Station Investments

In addition to expanding their portfolios to include a greater range of electric and electrified models, auto manufacturers like Nissan and Volvo have acquired stakes in companies that specialize in charging and battery technology. 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 EV drivers. Recently, Volvo Trucks North America announced plans to develop a publicly accessible electric M/HD charging network that will connect several California cities.²

Global EV Growth as Critical Context

While this report in many ways focuses 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).³ Global light-duty EV sales reached a new record in 2021, growing 103 percent since 2015, to nearly 6.6 million units, effectively curbing nearly 1.5 million barrels of oil a day—about 3.3 percent of global oil demand.⁴ In 2021, Europe and China were responsible for 85 percent of global EV sales with the U.S. in third accounting for 10 percent of global sales.⁵ BloombergNEF estimates that China and Europe will account for almost 80 percent of EV sales by 2025, with the U.S. representing almost 15 percent of market sales by 2025.⁶ As of March 2022, Norway continues to lead EV market share, with a 86.1 percent BEVs and a 5.8 percent PHEVs share.⁷ In the first six months of 2022, Europe's share of new registrations of battery-electric light-duty vehicles rose around a third more than in the same period last year, totaling nearly 650,000 units, while fossil-fuel powered cars' market share declined.⁸

In July 2021, the European Commission unveiled its "Fit for 55" package proposal which aims at revising current E.U. emission legislation.⁹ The package proposes more stringent fuel economy standards to cut emissions by 55 percent by 2030, 100 percent by 2035 and proposes to ensure all new vehicles sold by 2035 are zero-emitting.¹⁰ These signals of national ambition are 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 June 2, 2022, the European transport ministers adopted a general approach for three legislative proposals of the Fit for 55 package concerning alternative fuel infrastructure. The general approach contains the fundamental aspects of the European Commission proposal, such as requirements for building out the Trans-European Transport (TEN-T) network for light-, medium-, and heavy-duty vehicles by 2030. It also amends some of the Commission proposal like developing EV corridors by 2025 and then covering all TEN-T roads by 2030, leeway for the adoption of the total power of electric recharging pools and ensuring that charging is a user-friendly experience.¹¹

On June 29, 2022, the European Union (EU) settled on proposed laws that will require all new light-duty vehicles be ZEVs from 2035 onward, and proposes a 59 billion euro fund to protect lower-income citizens from carbon dioxide costs, to be paid out from 2027 to 2032.¹² The 27 member countries also agreed on a proposal to allow the EU carbon market to impose carbon dioxide costs on polluting fuels that are used in the transportation and building sectors, beginning in 2027. Lastly, member countries agreed on core elements of a proposal from the Commission that would reinforce the market (including shipping) to cut emissions 61 percent by 2030 from 1990 levels.¹³ The Council's agreement on the proposed laws will form their position in upcoming negotiations with the European Parliament on the final laws.¹⁴ The European Parliament has already backed the 2035 car target, making it likely that the proposed law will become EU law.¹⁵

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."¹⁶

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 for trucks and buses. Fifteen countries signed the MOU with an interim goal for zero-emission new M/HDV sales of 30 percent by 2030 and 100 percent by 2040. Subnational governments such as Quebec, Canada and Telangana, India, and top manufacturers and fleets like DHL, Heineken, and BYD have also signed the MOU.¹⁷

Lastly, in collaboration with the U.S. State Department'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 for at least one of the four sectors: steel, trucking, shipping, and aviation.¹⁸ One year later and the First Movers Coalition has nine government partners[†] and 55 members with recent additions including Delta Airlines and A.P Moller Maersk.

[†] Nine Government Partners Include: Denmark, India, Italy, Japan, Norway, Singapore, Sweden, the United Kingdom, and the U.S.

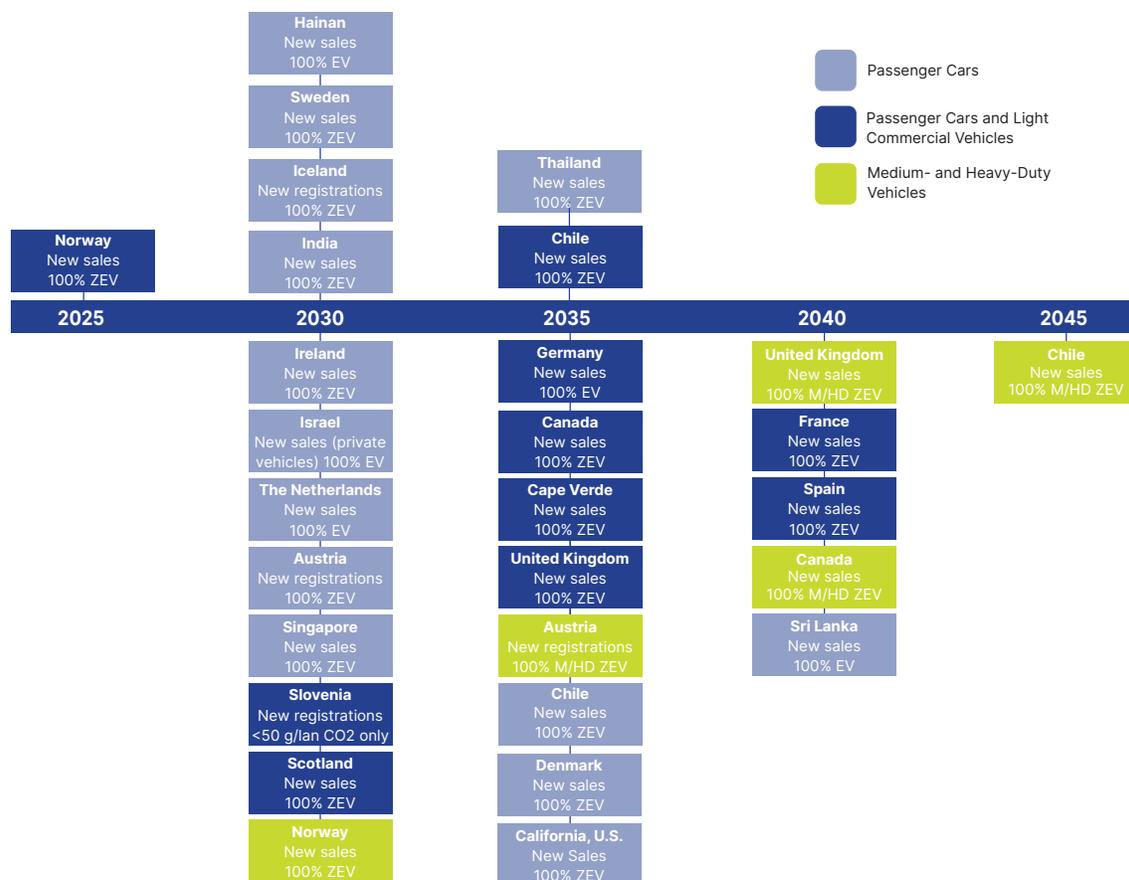
While Europe may lead in the sheer number of country commitments, India's and China's targets could have substantial impacts: if the two countries meet their targets to only sell ZEVs by 2030 and 2040, respectively, around 3.3 billion people, 43 percent of the world's population, would be living in countries that rely exclusively on the sale of new ZEVs after 2040.¹⁹ China aims to sell seven million "new-energy vehicles" annually by 2025, amounting to approximately 20 percent of its total auto market.²⁰ With sales of EVs already approaching 18 percent, that goal is within reach, according to the China Association of Automobile Manufacturers.²¹ Additionally, the China Association of Automobile Manufacturers estimates that EV sales in China will reach five million by the end of this year.²² 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.²³

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., representing over 74 million Americans, that focuses on public fleet electrification—announced intentions to collectively buy more than 3,800

EVs 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."²⁴ Another coalition, the C40 Fossil Fuel Streets Declaration, is a network of mayors from 100 world-leading cities that collaborate on the actions that are needed to tackle the climate crisis. 36 signatories from the coalition have committed to replacing their cities' fossil fuel transit buses with electric alternatives by 2025 and to achieving zero-emissions in designated areas by 2030.²⁵

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 the year after; and Brussels, Amsterdam, and Milan by 2030.²⁶ 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 2050.²⁷ As indicated by recent commitments to shift to lower emitting vehicles, a growing list of countries 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

Monumental changes are occurring in the EV policy space. At the state level, the California Air Resources Board (CARB) approved the Advanced Clean Cars II update, which will accelerate the transition to light-duty EVs through both increased stringency of requirements and associated actions to support wide-scale adoption and use. By 2035, all new passenger cars, trucks, and SUVs sold in California — along with other states that chose to adopt the California standards — will be ZEVs. In early August, President Biden signed the Inflation Reduction Act (IRA) of 2022, which through the provision of billions in grants and purchase credits for a variety of light-, medium-, and heavy-duty EVs, has the potential to further accelerate adoption of electric light-duty vehicles and provide a significant down payment on medium- and heavy-duty trucks and bus electrification. This follows close on the heels of the Infrastructure Investment and Jobs Act, which directed well over \$15 billion in incentives, grants and R&D programs toward EV purchases, EV infrastructure, and EV and battery manufacturing and development.

As compared to other countries where the central governments are pushing for the shift to EVs, in the U.S., states have long been the leaders in policies to drive EV adoption. However, recently the federal government has also directed increasing focus to electrifying the transportation sector as a key strategy for lowering economy-wide emissions.

State Action

For light-duty vehicles, a key policy is the development and adoption of the California Clean Cars I (ACC I) regulation, 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 pollutant and GHG emissions, and a ZEV standard that requires that ZEVs make up a certain percentage of each manufacturer's annual new car sales in the state.²⁸ Under the federal Clean Air Act, California has the authority to set more protective standards while other states may adopt those standards in lieu of federal standards enacted by the Environmental Protection Agency (EPA). In total, 17 states

accounting for more than 35 percent of national LDV sales have adopted the ZEV regulation. In 2021, Minnesota, Nevada, and Virginia joined the ZEV program,²⁹ in early 2022, Delaware adopted California ZEV standards (effective beginning in model year 2027) and in May 2022, New Mexico announced that it had adopted the ZEV standards becoming effective for model year 2026.³⁰ Pennsylvania has currently adopted LEV standards and is in the process of drafting ZEV standards.

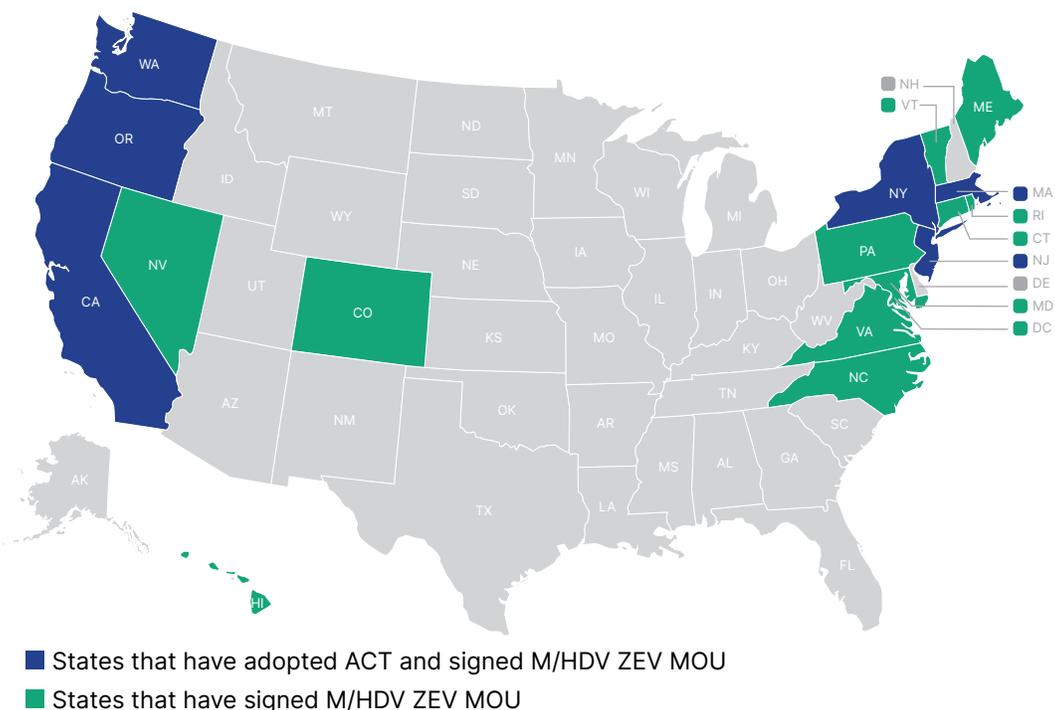
On August 25, 2022, CARB voted unanimously to adopt the historic Advanced Clean Cars II regulation (ACC II).³¹ The regulation rapidly scales down light-duty passenger car, truck and SUV emissions starting with the 2026 model year through 2035, ultimately requiring 100 percent of new vehicle sales to be ZEV by 2035. The regulation will substantially reduce air pollutants that threaten public health and cause climate change. CARB estimates that ACC II will provide the public with at least \$12 billion in public health benefits by reducing premature deaths, hospitalizations, and lost workdays due to air pollution exposure.³² In addition, the ZEV assurance measures included in the rule, which include proposals to set minimum warranty and durability requirements, increase serviceability, and facilitate charging and battery labeling, will help ensure all consumers can successfully replace their fossil fuel-powered vehicles with new or used vehicles that meet their needs for transportation and protect the emission benefits of the program. These benefits will extend beyond California: the 17 states that have adopted all or in part the LEV and ZEV regulations will account for more than 35 percent of the new light-duty vehicle sales across the U.S. Each state must now determine if it will adopt the new ACC II rules; Oregon and Washington have already announced plans to adopt ACC II within the year. This rule now aligns with California Governor Gavin Newsom's September 2021 Executive Order N-79-20 that set a goal that 100 percent of in-state sales of new light-duty passenger cars and trucks be zero-emission vehicles by 2035.³³ Ford stated that, "The CARB Advanced Clean Cars II rule is a landmark standard that will define clean transportation and set an example for the United States,"³⁴ while GM noted "General Motors and California have a shared vision of an all-electric future, eliminating tailpipe emissions from new light-duty vehicles by 2035."³⁵

States may pair the ACT with the Advanced Clean Fleets (ACF) Rule, which requires manufacturers to sell 100 percent zero emission Class 2b through 8 vehicles by 2040. The ACF includes in-use requirements for public, large, and drayage fleets starting in 2024 with the vehicle types that are easiest to electrify and increasing to include 100 percent of all vehicle types by 2039. Additionally, in 2020, California adopted the Low NOx Heavy-Duty Omnibus Regulation, which will cut nitrogen oxides (NOx) emissions from heavy-duty trucks by roughly 75 percent below current standards beginning in 2024 and 90 percent in 2027.⁴¹ The regulation requires manufacturers to comply with stricter NOx emissions standards, new engine testing procedures, and other emissions-related requirements.⁴² Both the ACT and the heavy-duty NOx rule are finalized, and the ACF is expected to be finalized by the end of this year. These three rules will take effect starting in 2024. It is important to note that these rules are all supported by California's Transportation Electrification Framework, a state initiative to support electric transportation, 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.⁴³ In late December of 2021, New Jersey, New York, and Washington all adopted the ACT rule and more states are considering adoption this year.^{44,45}

In addition to adopting the ACT rule, in April 2022, New York's Governor Hochul agreed to a \$220 billion state budget that includes a plan to allocate funding to put about 50,000 electric school buses on the road by 2035. Per direction of the State Senate, NYSERDA is required to provide technical assistance to the school districts.⁴⁶

Figure 3. States Adopting California's Advanced Clean Trucks Regulation Or M/HD ZEV Programs



Regional Action and Collaboration

States have also worked together to increase transportation electrification through collective action. One key form of collaboration is the creation of a memorandum of understanding which allows 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 2025.⁴⁷ These eight states—along with New Jersey and Maine, who joined in 2018 and 2019, respectively—collaborated to produce the ZEV Task Force’s Multi-State ZEV Action Plan 2018-2021 and 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.⁴⁸ 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.”⁴⁹

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 Multi-State 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 2030.⁵⁰ In 2021, Virginia became the sixteenth signatory and the Province of Quebec became the 17th signatory of the Multi-State MHD ZEV MOU.⁵¹ Most recently, Nevada has become the 18th signatory to join the MOU.; U.S. signatories now represent 43 percent of nationwide population, almost half of the economy, and 36 percent of the nation’s M/HD vehicles.^{52,53} On July 27, 2022, the Northeast States for Coordinated Air Use Management (NESCAUM) and the signatories of the Multi-State MHD ZEV MOU released the Multi-State MHD ZEV MOU Action Plan.⁵⁴ The plan includes over 65 recommendations and strategies for policymakers to ensure a rapid adoption process for electric trucks and buses. A few recommendations and strategies include vehicle sales and purchase requirements (e.g., the ACT Rule), vehicle and infrastructure purchase incentives, utility investments in charging infrastructure, financing mechanisms, workforce development programs, and the deployment of public charging communities within and along travel corridors.⁵⁵

‡ 15 states include California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington.

State governments have also formed region-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.⁵⁶ 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 cooperate 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.⁵⁷

The Vehicle to Everything (V2X) Memorandum of Understanding, signed April 2022, will join new resources from DOE and signatories[§] to research the technical and economic feasibility of bi-directional charging into energy infrastructure and will build out cybersecurity. Through the EVs@scale lab consortium, DOE and six DOE national laboratories will conduct high-risk, high-reward research and development in the challenges and barriers to Vehicle Grid Integration (VGI). Some challenges and barriers include smart charge management, high power charging and facilities, dynamic wireless charging, codes and standards, and cyber physical security.⁵⁸ (For more information on bi-directional charging, see “Battery Pack Supply Chain” below.)

In May 2022, formed by a group of automakers, battery manufacturers, and lithium producers, the Coalition for American Battery Independence (CABI) aims to advocate for federal policies that support the U.S.-based processing and production of batteries and their components, starting with mineral procurement. Members of CABI include Ford, GM, Tesla, Panasonic of North America, and the Zero Emission Transportation Association.⁵⁹

§ Signatories include DOE’s Offices of Vehicle Technologies, Electricity, Technology Transitions, and Cybersecurity, Energy Security, and Emergency Response, The California Energy Commission, The California Public Utilities Commission, The City of Lancaster and City of Lancaster Community Choice Aggregator, The City of Los Angeles, Fermata Energy, First Student, Ford Motor Company, General Motors LLC, International Brotherhood of Electrical Workers—Chapter 11, Lion Electric Inc., Los Angeles Department of Water and Power, Lucid Group, Inc. (Lucid Motors), the National Electrical Contractors Association—Los Angeles, Nissan, Nuvve Holding Corp., Pacific Gas and Electric Company, Rhombus, Sacramento Municipal Utility District, San Diego Gas & Electric, Southern California Edison, and Zeem Solutions.

Federal Action

At the federal level, there are multiple legislative and regulatory actions that aim to accelerate EV adoption. Since taking office, President Biden has issued key executive orders that include provisions to support and strengthen the ZEV ecosystem and provide a foundation to many legislative and regulatory actions:

- On August 5, 2021, President Biden signed Executive Order 14037 Strengthening American Leadership in Clean Cars and Trucks. This order sets a goal for 50 percent of all new passenger cars and light-duty trucks sold in 2030 be ZEVs. EPA is directed to establish new multi-pollutant emission standards for light-, medium-, and heavy-duty for model year 2027 and later; establish new NOx 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.⁶⁰
- On December 8, 2021, President Biden signed Executive Order 14057 Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability which 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.⁶¹

On August 16, 2022, President Biden signed the Inflation Reduction Act of 2022 (IRA) into law.⁶² The Act "...make[s] a historic down payment of deficit reduction to fight inflation, invest in domestic energy production and manufacturing, and reduce carbon emissions by roughly 40 percent by 2030."⁶³ The IRA will invest about \$369 billion in Energy Security and Climate Change programs over 10 years, the single biggest climate investment in U.S. history. This includes significant investment to significantly accelerate electrification of light-, medium- and heavy-duty vehicles across the country. This includes significant investment to rapidly accelerate electrification of light-, medium- and heavy-duty vehicles across the country. Specifically, the IRA will:

- Provide low- and middle-income individuals with a \$4,000 tax credit to buy used clean vehicles and up to \$7,500 tax credit for the purchase of new clean vehicles that meet certain MSRP caps and domestic content and critical mineral requirements.^{64,65}
- Provide a tax credit for commercial ZEVs up to \$40,000, a heavy-duty charging infrastructure tax credit of \$30,000 per property changed to \$100,000 per item.
- Issue \$60 million in grants to reduce diesel-related transportation emission in disadvantaged communities.
- Distribute \$500 million to accelerate domestic manufacturing of clean energy technologies and components, \$2 billion for auto manufacturing facility conversion, and \$20 billion in loans to build out the domestic clean vehicle manufacturing network.



Table 1 contains an overview of key grant programs and tax credits applicable ZEVs.

Table 1. Key Investments from the Inflation Reduction Act of 2022

Title	Description	Funding Allocation / Estimated Tax Credits Over 10 Years
Clean Vehicle Credit	<ul style="list-style-type: none"> Extend the \$7,500 consumer tax credit available to buy a new clean vehicle under certain price limits and subject to income limitations of the filer. There is no longer a limit on per-manufacturer credits. The vehicle battery must meet critical mineral or battery component sourcing requirements that increase over time; if the vehicle meets one but not both of these of these requirements, the credit is reduced by 50 percent (\$3,750). Clean vehicles must be assembled in the U.S. After 2023, a clean vehicle may not contain any battery components which were manufactured by a foreign entity of concern, and after 2024 critical minerals may not be. sourced from a foreign entity of concern. 	\$7.5 billion
Credit for Previously Owned Clean Vehicles	<ul style="list-style-type: none"> Establish a new \$4,000 consumer tax credit available to buy a used clean vehicle or up to 30 percent of the sale price; credit is subject to income limitations of the filer. Vehicles must meet the vehicle battery and critical mineral requirements outlined above, may not exceed a price of \$25,000, and be at least 2 years old. 	\$1.3 billion
Qualified Commercial Clean Vehicles	<ul style="list-style-type: none"> Establish a new 15 percent tax credit for vehicles that are qualified as a “commercial clean vehicle” and 30 percent credit for vehicles not powered by a gasoline or diesel internal combustion engine. Credit cannot exceed \$40,000 (if the vehicle weighs less than 14,000 pounds, the tax credit cannot exceed \$7,500). 	\$3.6 billion
Extension of the Advanced Energy Project Credit	<ul style="list-style-type: none"> Establish a program to consider and award certifications for qualified investments and eligible credits to qualifying advanced energy project sponsors, including charging infrastructure. 	\$6.2 billion

Title	Description	Funding Allocation / Estimated Tax Credits Over 10 Years
Alternative Fuel Refueling Property Credit	<ul style="list-style-type: none"> Amend the tax credit for 30 percent, up to \$100,000, of the cost of any qualified alternative fuel vehicle refueling property such as electricity (including bidirectional charging), hydrogen, any fuel at least 85 percent of the volume of ethanol, natural gas, compressed or liquified natural gas, and liquefied petroleum natural gas, and any mixture of two or more of biodiesel, diesel fuel or kerosene. Not applicable for locations used as the taxpayer's principal residence. 	\$1.7 billion
Advanced Technology Vehicle Manufacturing	<ul style="list-style-type: none"> Provide direct loans for reequipping, expanding, or establishing a manufacturing facility in the U.S. to produce or for engineering integration of advanced technology vehicles that emit low or zero emissions. 	\$3 billion
Domestic Manufacturing Conversion Grants	<ul style="list-style-type: none"> Provide grants for domestic production of efficient hybrid, plug-in electric hybrid, plug-in electric drive, or hydrogen fuel cell electric vehicle. Recipient must provide at least 50 percent of the total cost of the project. 	\$2 billion
Clean Heavy-Duty Vehicles	<ul style="list-style-type: none"> Establish a program to award grants, rebates, or contracts to recipients for up to 100 percent of costs related to: <ul style="list-style-type: none"> The incremental cost of replacing a non-ZEV with a ZEV; Purchasing, installing, operating, and maintaining charging and or fueling infrastructure; Workforce development and training to support maintenance, charging, fueling and operations of ZEVs; or Planning and technical activities to support the adoption and deployment of ZEVs. 	\$1 billion

Title	Description	Funding Allocation / Estimated Tax Credits Over 10 Years
Diesel Emissions Reductions	<ul style="list-style-type: none"> Provide grants, rebates, and loans to identify and reduce diesel emissions resulting from goods movement facilities and vehicles servicing goods movement facilities in low-income and disadvantaged communities. 	\$60 million
Greenhouse Gas Reduction Fund	<ul style="list-style-type: none"> Award grants, loans, and other financial and technical assistance to low-income and disadvantaged communities to deploy or benefit from zero-emission technologies. 	\$27.9 billion
Funding to reduce air pollution at schools	<ul style="list-style-type: none"> Award grants for activities to monitor and reduce GHG emissions and other air pollutants at schools in low-income and disadvantaged communities. 	\$50 million
Funding to Reduce Air Pollution at Ports	<ul style="list-style-type: none"> Award grants and rebates to purchase or install zero-emission port equipment or technology, to conduct planning or permitting in connection with the purchase or installation of zero-emission port equipment, and develop qualified climate action plans. 	\$3 billion

Overall, the IRA includes grants and credits that will lower the purchase price of both LD and M/HD ZEVs and likely increase their rate of adoption. In an analysis done by ERM for the Environmental Defense Fund (EDF), ERM found that the grants alone could increase the number of ZEV sales by over 74,000 vehicles between 2023 and 2031. Additionally, ERM found that the purchase price for a wide range of commercial ZEVs will reach parity with comparable diesel or gas vehicles at least 5 years and as much as 12 years earlier than would occur without the credit, and as early as 2023 for many ZEVs.⁶⁶ (See Vehicle Price Parity: Medium- and Heavy-Duty EVs for more information).

The IRA follows behind the \$1.2 trillion Infrastructure Investment and Jobs Act (IIJA) signed into law by President Biden on November 15, 2021.⁶⁷ 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 Infrastructure 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 to school systems that have matching funds to deploy for ZEV school buses; it accepted applications through mid-August 2022.⁶⁸

On June 9, 2022, DOT's Federal Highway Administration (FHWA) announced a notice of proposed rulemaking regarding the minimum standards for the National Electric Vehicle Infrastructure (NEVI) formula program.⁶⁹ This proposed rule would set new standards and requirements for the installation, operation, interoperability, network connectivity, and maintenance of EV charging infrastructure; traffic control devices or on-premise signage acquired, installed, or operated in conjunction with EV charging infrastructure; data and its format and schedule for submission; and information on publicly available EV charger locations, pricing, real-time availability, and accessibility through accessible applications. On September 14, 2022, the Biden Administration announced that 35 plans from States, the District of Columbia, and Puerto Rico⁷⁰ have been approved by the FHWA, releasing more than \$900 million in NEVI funding that will build out EV chargers across 53,000 miles of U.S. highways.^{70 71}

⁷⁰ 35 approved plans include Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Puerto Rico, Rhode Island, South Dakota, Tennessee, Utah, Washington, and Wisconsin.

Table 2. Sample of the Infrastructure Investment and Jobs Act Programs

Title	Description	Funding Allocation	Implementation Progress
Clean School Bus Program	Provides funding for state and local governments, eligible contractors, and nonprofit school transportation associations to adopt low-carbon and zero-emission school buses.	\$5 billion	Applications for the Clean School Bus Program were due to EPA prior to August 19, 2022. EPA will review applications and begin the selection process and notify applicants of their selection status in October 2022.
National Electric Vehicle Formula Program	Establishes a program that provides funds to states 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	FWHA announced a Notice of Proposed Rulemaking (NRPM) regarding the minimum standards for the NEVI Formula Program, which was open for public comment(s) until August 22, 2022. 35 NEVI plans from States, the District of Columbia, and Puerto Rico have been approved as of September 2022.
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; Individual grants awarded up to \$15 million at 80% federal share, and up to 1% can be used to provide technical assistance to eligible entities, 5% can be used on educational and community engagement activities.	FWHA released a memorandum announcing the 2022 Round 6 Designated Alternative Fuels Corridors. Guidelines are being developed, and FWHA will establish a grant program by November 15 th , 2022.
Reductions of Truck Emissions at Port Facilities	Establishes a program to reduce truck idling at port facilities including to study port electrification, emerging technologies and fund projects that reduce port-related emissions.	\$50 million for each FY2022-FY2026	Program implementation yet to be announced.

Title	Description	Funding Allocation	Implementation Progress
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	On March 14 th , 2022, FTA announced approximately \$409.3 million in grants to 70 projects in 39 states to improve the safety and reliability of America's bus systems.
Advanced Technology Vehicles Manufacturing Program (ATVM)	Expands the ATVM program within the Department of Energy's Loan Program Office to include medium and heavy-duty vehicles and off-road vehicles, including maritime technology.	Provides additional funds to this existing program and expands the eligibility of ATVM to include medium- and heavy-duty vehicles, trains, aircraft, maritime vessels, and hyperloop technology.	
Battery Processing and Manufacturing	Provides funds to expand the processing and manufacturing of advanced batteries, including for EVs and the electric grid, in the U.S. These funds are deployed into various grants for demonstration projects, construction of facilities and retooling/retrofitting/ expanding facilities for battery manufacturing and recycling.	Program grants: \$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 R&D, \$50 million for State and Local Programs and \$15 million for Collection System for Batteries	On May 2 nd , 2022, DOE released an FOA entitled "Bipartisan Infrastructure Law Battery Materials Processing and Battery Manufacturing Funding Opportunity Announcement". Applications were due by July 7 th , 2022.

Title	Description	Funding Allocation	Implementation Progress
Electric Drive Vehicle Battery Recycling and Second-Life Application Program	Provides research, development and demonstration funds for electric vehicle battery recycling and second-life applications for vehicle batteries.	\$200 million distributed over FY2022-2026	On May 2 nd , 2022, DOE released an FOA entitled “Bipartisan Infrastructure Law–Electric Drive Vehicle Battery Recycling and Second-Life Applications.” Concept Paper submissions were due on May 31 st , 2022, and full applications submissions were due on July 19 th , 2022.
Consideration of Measures to Promote Greater Electrification of the Transportation Sector	Amends section 111 of the Public Utility Regulatory Policies Act of 1978 to add an electric vehicle charging program requiring states to promote affordable and equitable electric vehicle charging, improve the customer experience with charging, accelerate third-party investment in charging, and allow utilities to recover marginal costs of delivering electricity to electric vehicle charging infrastructure.	N/A	Applicable for/to multiple programs.
Deployment of Technologies to Enhance Grid Flexibility	Amends the Energy Independence and Security Act of 2007 to include Smart Grid investments that provide demand flexibility and to help quickly rebalance the electrical system, facilitate the aggregation or integration of distributed energy resources, and more.	\$3 billion for FY2022, to remain available through September 30, 2026	On July 6 th , 2022, DOE issued a FOA and opened the application period for States, Tribal nations, and territories to apply for the formula grants to improve the resilience of the electric grid. Applications are due prior to September 30 th , 2022.

*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.

On the regulatory front, EPA and DOT have taken numerous actions since 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; and EPA is currently reviewing separate waiver requests for California's ACT and NOx Omnibus rules. DOT also officially repealed the prior Administration's regulation that would have preempted states from taking this action.^{72,73} 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 2026.⁷⁴ 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 next four years, sales of ZEVs and near-ZEVs will increase market share from about 7 percent in MY 2023 to about 17 percent in MY 2026.⁷⁵

Though there have been legal challenges filed against this rule, the Alliance for Auto Innovators, who represents automakers that produce almost 99 percent of new LDVs sold in the U.S., has intervened in litigation to defend these standards. In addition, in September 2022, GM and EDF announced a set of recommendations that seek to accelerate a zero-emissions, all-electric future for passenger vehicles in MY2027 and beyond. The recommendations were jointly developed by GM and EDF to support the next tier of EPA clean car standards. The outlined principles focus on:

1. A pathway to eliminating tailpipe emissions from new light-duty vehicles by 2035.
2. Providing certainty for automakers and communities.
3. Seeking performance-based and multi-pollutant standards reflecting EPA's long-standing approach to vehicle emission standards.
4. Supporting underserved and socially vulnerable communities.
5. Offering a compliance pathway that supports accelerated EV adoption.
6. Encouraging coordination between EPA and DOT.⁷⁶

Relatedly, on May 2, 2022, the National Highway Traffic Safety Administration finalized its 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 eight percent year over year for each model year 2024 through 2026.⁷⁷

Regarding heavy-duty vehicles, 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 2027.⁷⁸ Separately, 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 FY 2022 under the Low-No Emission Grant Program are approximately \$1.1 billion and \$375 million for the Grants for Buses and Bus Facilities Program.⁷⁹ 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.⁸⁰

On June 6, 2022, President Biden invoked the Defense Production Act (DPA) which provides DOE the authority to accelerate the domestic production of five key energy technologies:

- Electrolyzers, fuel cells, and platinum group metals,
- Solar panels,
- Transformers and electric grid components,
- Heat pumps, and
- Insulation.

Title III of DPA provides financial assistances such as loans, loan guarantees, purchases, and purchase commitments to help improve, expand, and maintain domestic production capabilities.⁸¹ It is estimated that as the transition to a clean energy economy continues, global demand for these technologies is set to increase by 400 percent to 600 percent over the next few decades.⁸² Invoking the DPA is a part of the Administration's plan to lower energy costs for the public.

On September 15, 2022, DOE, DOT, EPA, and HUD signed a MOU to establish a joint executive-level team to coordinate strategies to decarbonize the transportation sector. The MOU states that the agencies will work with key transportation and energy stakeholders from across the private sector to draft a transportation decarbonization strategy, which will guide future policy, research, development, demonstration, and deployment.⁸³

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

Vehicle Price Parity: Vehicle and Battery Pack Cost Projections

Policy drivers have historically been one of the key factors leading to increased electric vehicle adoption. However, economics will increasingly play a large factor in consumer adoption. Electric vehicles can provide significant consumer benefits, with lower total cost of ownership for many vehicle types fast approaching.

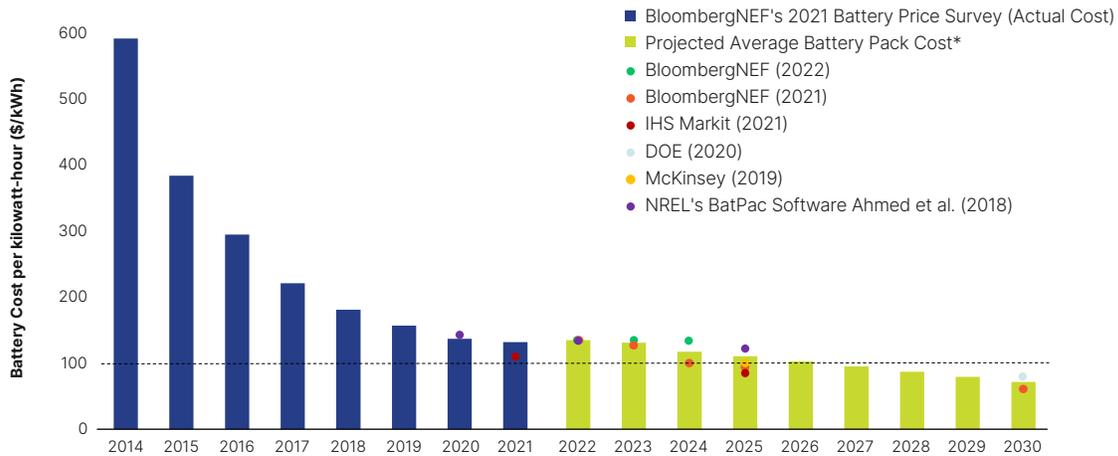
When exploring price parity, there are two considerations. The first is purchase price or “out-the-door” price parity of a vehicle—the total cash price that the buyer will pay for an electric vehicle compared to a comparable gasoline or diesel vehicle. Purchase price includes the original listing price and additional fees such as destination fees, extended warranty fees, dealer service and handling fees, and processing fees. The second is total cost of ownership which considers all financial aspects of vehicle ownership including, but not limited to, vehicle purchase price, fuel or energy costs, fueling or charging infrastructure costs, maintenance costs, and other situational costs like vehicle mid-life refresh costs. This is because of the cost savings due to operation (electricity is cheaper than gasoline) and maintenance (EVs have reduced maintenance schedules), EVs are likely to reach total cost of ownership price parity with conventional vehicles before purchase price parity is achieved.

One key factor driving price parity is the cost of batteries, which can comprise more than 30 percent of the total cost of manufacturing an EV. For light-, medium-, and heavy-duty 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. The Electric Power Research Institute (EPRI) and DOE estimate that at \$80/kWh, EVs with 60 kWh battery packs would achieve initial cost parity with ICE vehicles.⁸⁴ Technological developments, such as solid-state batteries (SSB), may also help drive future battery cost reductions; for example, Nissan believes that the solid-state battery can reduce costs to \$65/kWh by 2028 (see sidebar below for more details).

However, due to growing battery supply chain disruptions from higher raw material prices, many analysts have revised their battery pack price projections, such that prices will either rise slightly or stay constant until at least 2024 (see Figure 4). Predating the passage of the Inflation Reduction Act, BloombergNEF’s 2021 annual battery price survey predicts a \$3 price increase in 2022 to \$135/kWh (reflected in Figure 4), the first-time battery pack prices have risen since 2010.^{85,86} IHS Markit predicts that surging raw material prices would put further EV battery pack price declines on hold until 2024.⁸⁷ This analysis also predicts that the average 2022 EV battery pack prices will be five percent higher than in 2021.⁸⁸ Other analysts such as E Source, a battery solutions firm, estimate battery cell prices will continue to surge by 22 percent between 2023 through 2026, peaking at \$138/kWh, before declining again in 2031 to reach \$90/kWh.⁸⁹ These estimates do not take into account the investment under the IRA, which through direct credits and manufacturing investments and incentives, have the potential to dramatically shift the supply chain and assembly process for batteries (see Policy Drivers, above). For example, the IRA provides a \$35/kWh battery cell credit with an additional \$10/kWh credit for battery modules produced in the U.S that could help lower the costs of battery packs in the future.

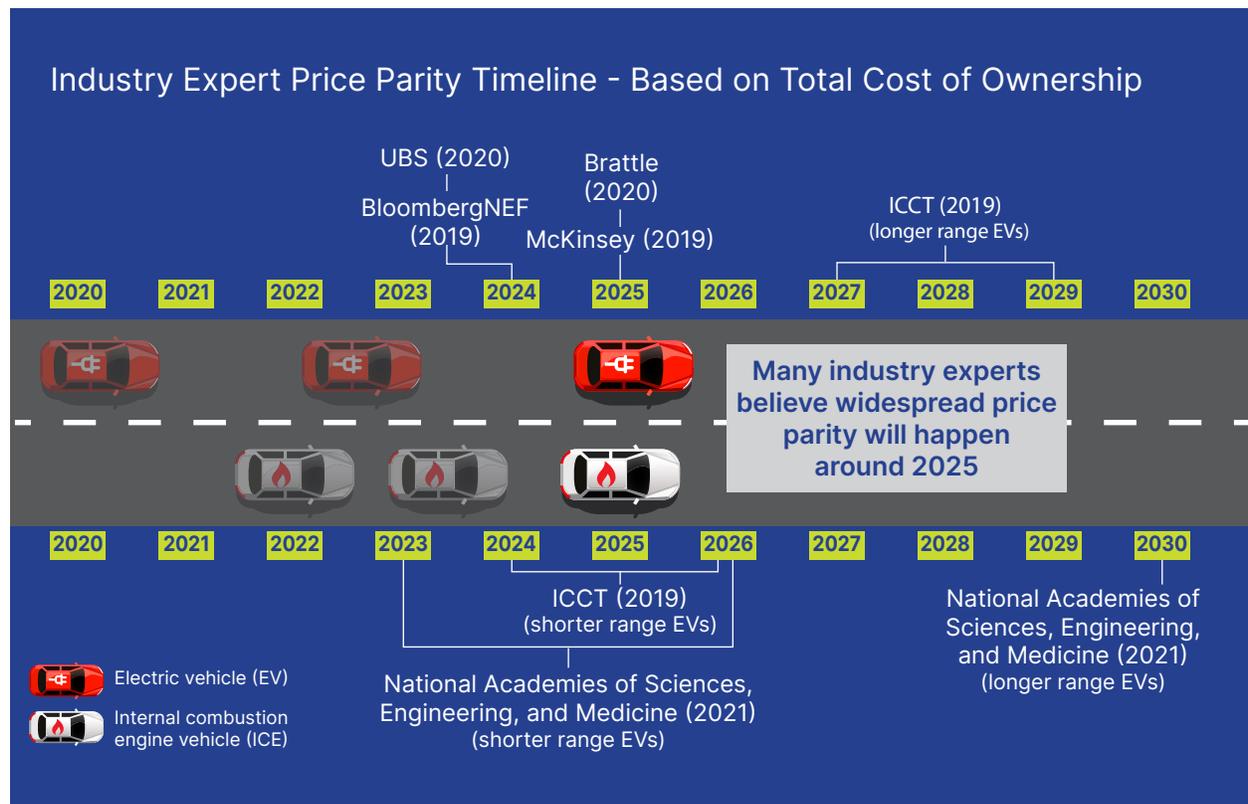
Figure 4. Actual and Projected Battery Pack Costs



Aggregated median battery pack cost based on projected battery price costs of literature review presented sources.

Light-Duty EVs

As illustrated below, most analysts agree that price parity between light-duty EVs and ICE vehicles will occur sometime between 2023 and 2025.⁹⁰ BloombergNEF's 2022 EV Outlook expects price parity between LD EVs and ICE vehicles to now be reached in 2026, as opposed 2023 (see Battery Back Production and Supply Chain for more information.)



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 EPRI believes that passenger 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. The study concluded that passenger EVs could save drivers as much as \$14,500 in fuel costs over 15 years compared to ICE vehicles.⁹¹ An EDF analysis, using DOE'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 ICE vehicle counterpart.⁹²

†† 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.



Medium- and Heavy-Duty EVs

As for M/HD vehicles, a study conducted by Roush Industries for EDF found that, when considering existing fleets with infrastructure (excluding chargers) that is already owned by the fleet operator, by 2027 many electric freight trucks and buses will be less expensive to purchase and operate than their ICE counterparts.⁹³ The report analyzes total cost of ownership (TCO) on all financial aspects of ownership like vehicle purchase price, fuel and or energy cost, fueling and or charging infrastructure cost, maintenance costs, and vehicle mid-life refresh cost, if applicable.⁹⁴ However, social and environmental costs such as pollution and climate benefits were not considered.

Roush found that there is a general trend of decreasing upfront costs for fleet electrification compared to ICE vehicles, with electrification costs projected to drop 26 percent to 30 percent by 2024 and 42 percent to 44 percent by 2027 for the vehicle classes analyzed.⁹⁵ EV costs are largely driven down by battery price, with a predicted price drop from \$123/kWh in 2021 to \$68/kWh by 2027. In addition, maintenance costs and energy costs significantly lower the TCO of EVs relative to their ICE counterparts.⁹⁶ Taking these price indicators into account, the report found that when looking at TCO per mile for each vehicle class analyzed, in 2027, EVs cost less to operate than their ICE counterparts over vehicle lifetime.

The Roush report's findings have been echoed in other 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. NREL states that BEVs will become cost competitive for almost all light-medium and medium trucks before 2030 with short haul heavy-duty trucks by 2035.⁹⁷ The report also found that electric buses are already cost-competitive, in certain instances, with a total cost of driving (TCD) well below that of diesel counterparts by 2032.⁹⁸ Overall the report finds that ZEVs can reach TCD parity (without incentives) with diesel counterparts by 2035 for all M/HD vehicles. CALSTART states that by 2030, all battery-electric M/HD vehicles in California will have a lower TCO (without incentives) than diesel counterparts, driven primarily because the continued decrease in battery price and operational costs relative to the high cost of diesel fuel.⁹⁹

An ERM analysis utilizing Roush Industries' ZEV prices found that IRA grants and tax credits could fund the purchase of 98,000 M/HD ZEVs between 2023 and 2031.¹⁰⁰ In addition, when using CARB's vehicle pricing estimates and applying IRA tax incentives, purchase price parity for all M/HD vehicles is reached by 2031, with 9 of the 24 vehicle segments reaching parity by 2027 and two by 2023.

Figure 5. Total Cost of Ownership per Mile for M/HD Vehicles (Vehicles Purchased in 2027)¹⁰¹



ZEV alternatives for various vehicle 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.¹⁰²

A North American Council for Freight Efficiency analysis, using March 2021 average U.S. prices of diesel and electricity, compared the fuel cost between a diesel and electric medium-duty box truck. This study concluded that consumers who own an electric box truck will save \$6,269 in avoided fuel cost over the lifetime of the vehicle.¹⁰³

Battery Pack Production and Supply Chain

Supply chain disruptions, material shortages, and high costs are putting pressure on the auto market.

COVID-19 has had global economic ramifications 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 2022, others remain uncertain. The disruption of supply chains and the shift in consumer spending patterns affects the auto industry as a whole—not only EV offerings—leading many brands to delay model launches and less-profitable updates until later in 2022 or 2023. 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 and even into 2023.

Prices of key minerals and metals, like lithium, cobalt, nickel, copper, and aluminum that are required components for battery manufacturing, increased in 2021 with this price trend predicted to continue through 2022. In recent research from IEA, cathode materials (lithium, nickel, cobalt, and manganese), essential for lithium-ion batteries, accounted for less than five percent of battery pack costs in the middle of the last decade. However, this share has risen to over 20 percent in recent years. The price of lithium and cobalt more than doubled in 2021, with lithium increasing two and a half times since the start of 2022.¹⁰⁴

IEA also expects that with ongoing geopolitical conflicts like the Russian invasion of Ukraine and supply being cut in China, lithium-ion battery pack prices will continue to rise. Russia is a major producer of minerals like aluminum, accounting for nearly six percent of global production, ten percent of nickel, and two percent for Class 1 nickel, the only grade used in lithium-ion batteries. According to IEA, on March 8, 2022, nickel prices soared from \$25,000 per metric ton to over \$100,000 per metric ton which caused the London Metal Exchange to suspend the trading of nickel for a week.^{105,106}

Today, the U.S. ranks second globally for the lithium-ion supply chain after China and will likely remain so through 2026.¹⁰⁷ According to the U.S. State Department, over 80 percent of the global supply chain of rare earth elements (important components of lithium-ion batteries and other EV components) is controlled by China, and BloombergNEF found that China holds 77 percent of the world's battery cell manufacturing capacity and 60 percent of the world's component manufacturing.¹⁰⁸ 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.

In June 2021, in an effort to bolster domestic battery production, DOE released the National Blueprint for Lithium Batteries which aims to guide investments and developments in the domestic lithium-battery manufacturing value chain.¹⁰⁹ The document identifies five goals to establish a domestic supply chain that will help the U.S. meet its goal of establishing a secure battery materials and technology supply chain, and support long-term U.S. economic competitiveness and equitable job creation by 2030. The five goals are to:

1. secure access to raw and refined materials and discover alternatives for critical minerals in commercial and defense applications
2. support growth in U.S.-based material-processing to meet battery demand;
3. stimulate the U.S. electrode, cell, and pack manufacturing sectors;
4. enable end-of-life reuse and critical mineral recycling at scale in the U.S.; and
5. maintain and advance U.S. leadership in battery technology by supporting R&D, STEM education, and workforce development.

Furthermore, increasing domestic production and manufacturing of batteries could help control environmental impacts. For example, a 2018 analysis found that batteries produced in the U.S. create 65 percent less GHG emissions than those produced elsewhere.¹¹⁰ The U.S., like other more developed economies such as those in the European Union, also typically enforces stricter environmental and labor standards, which can improve overall environmental outcomes.¹¹¹ There are some efforts to improve environmental performance of international production as well (see sidebar).

The Responsible Mineral Initiative strives to evolve business practices that better support responsible global mineral sourcing and production with emphasis on high-risk conflict-affected areas and provides its more than 400 members with resources to improve their regulatory compliance and align with international standards while supporting industry and stakeholder expectations. The Initiative offers four program areas focusing on Responsible Minerals Assurance Process (RMAP), a Conflict Minerals Reporting Template (CMRT), due diligence guidance, and stakeholder engagement.

In February 2022, the Biden Administration announced plans to direct \$3.16 billion through the following programs: Battery Materials Processing Grants, Battery Manufacturing and Recycling Grants, and Electric Drive Vehicle Battery Recycling and Second-Life Applications Program, appropriated by IJA. These programs direct funding toward domestic battery materials refining and production plants, battery cell and pack manufacturing facilities, and battery recycling facilities.¹¹² This announcement comes one year after President Biden signed Executive Order 14017, America's Supply Chains, which directed DOE to submit a report identifying risks in the supply chain for high-capacity batteries, including EV batteries, and policy recommendations to address these risks.¹¹³ In addition, DOE's Loan Programs Office (LPO) offers loans through the Advanced Technology Vehicles Manufacturing (ATVM) program to support U.S. manufacturing of light-duty EVs, EV components, and materials that improve fuel economy.¹¹⁴ Recently, DOE's LPO announced a conditional commitment with Ultium Cells LLC, GM and LG Energy Solutions' joint venture, for a \$2.5 billion dollar loan to help finance the construction of new lithium-ion battery cell manufacturing facilities in Ohio, Tennessee, and Michigan.¹¹⁵ This will be LPO's first loan that is exclusively for a battery cell manufacturing project under ATVM. Additionally, on August 9, 2022, President Biden signed the CHIPS (Creating Helpful Incentives to Produce Semiconductors for America) Act of 2022.¹¹⁶ The Act provides \$52.7 billion in subsidies for U.S. semiconductor manufacturers to strengthen the domestic chip supply chain for chip components critical across a variety of technology, including EVs.¹¹⁷

More recently, on August 16, 2022, President Biden signed the Inflation Reduction Act of 2022 (IRA) into law, setting the stage for an approximately \$369 billion investment in Energy Security and Climate Change programs over 10 years, the single biggest climate investment in U.S. history.¹¹⁸ Among its programs, IRA will distribute \$500 million to accelerate domestic manufacturing of clean energy technologies and components, \$2 billion for auto manufacturing facility conversion, and \$20 billion in loans to build out the domestic clean vehicle manufacturing network. Furthermore, receipt of the expanded tax credit for EVs is now contingent on vehicles' batteries having been assembled and increasingly sourced in North America and sourcing an increasing percentage of critical minerals either domestically or from a free trade partner (and explicitly barring any procurement from certain countries such as China and Russia). These incentives and funding opportunities will expand and strengthen the battery manufacturing supply chain.

U.S. automakers have begun transitioning away from China-supplied rare earth metals.¹¹⁹ For example, Ford announced its deal with Lake Resources, an Australian company, to offtake approximately 25,000 tonnes of lithium per year from Lake Resources' Argentinian Kachi Project.¹²⁰ The companies will work to develop a Clean Lithium Supply chain to meet global environmental demands. Lake Resources' Chairman Stu Crow said that "increasing customer and consumer scrutiny around lithium production's environmental and ethical credentials drives our focus on sustainable extraction" and the company "...is committed to integrating sustainable development practices through [their] operations, minimizing [their] environmental footprint, and contributing to a clean energy future." Accordingly, Ford recently announced that it added a second battery type to its lineup, lithium iron phosphate (LFP). While the company will initially source the LFP batteries from China's Contemporary Amperex Technology Company (CATL), Ford indicated that it plans to open a 40-GWh LFP battery cell factory in North America by 2026.¹²¹ LFP batteries are estimated to cost at least 30 percent less than batteries made with nickel and cobalt as iron and phosphorous are abundant, but they also hold 30 percent less energy than their nickel and cobalt counterparts.¹²²

GM followed with an announcement that it signed a deal with Swiss miner Glencore PLC, to source cobalt from its Murrin operation in Australia.¹²³ Both GM and Glencore are members of the Responsible Mineral Initiative (RMI), and Glencore's Murrin operations is conformant with the OECD-aligned Responsible Minerals Assurance Process. In an effort to achieve its goal of producing one million EVs annually by 2025, GM prepaid Livent Corp. \$198 million for a guaranteed six-year supply of lithium.¹²⁴ In total, according to DOE's 2021 estimate and additional 2022 automaker and battery manufacturers' announcements, there will be 16 new EV battery manufacturing plants coming online in the U.S. by 2025.¹²⁵ These "gigafactories" will be instrumental in ushering a new era of domestic battery production across the U.S..

Emerging Technologies and 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 report, the SSB market is expected to grow to \$8 billion by 2031.¹²⁶ Additionally, according to BloombergNEF, solid-state cells produced at scale could be manufactured at 40 percent of the cost of current lithium-ion batteries.¹²⁷ Progress is dependent on developing supply chains for solid electrolytes. A recent study from Minviro for Transportation & Environment (T&E) found that SSBs have the potential to reduce the carbon footprint of an electric vehicle's battery by almost 40 percent compared to liquid lithium-ion batteries, when utilizing the most sustainable products, and reduce the electric vehicle's carbon footprint by 24 percent.¹²⁸

QuantumScape, which received a \$200 million investment from VW in June 2020, is developing high-energy density SSBs 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.¹²⁹ The company announced in March 2022 that it signed with a fourth automaker to test its offerings; though it did not disclose the name of the auto manufacturer, it stated that it is a Top 10 automaker by global revenue.¹³⁰ QuantumScape indicated that this new collaboration has been brought forth after the automaker tested the Company's SSBs in its own labs. One of the other three automakers is Volkswagen, a Top 10 global manufacturer, and an international luxury automotive company. In its Q2 2022 report, QuantumScape announced that they successfully developed a 24-layer prototype cell that has endured over 600 cycles of charging, with improvements to its manufacturing process expected to improve performance further.¹³¹

To rival QuantumScape, **Solid Power**, a Colorado-based battery start-up backed by Ford and BMW, started its pilot production of its SSB cells. The company states that its battery cells will provide EV owners a longer range and a shorter recharging time at a lower cost. Solid Power believes that its batteries "...can be produced using the tooling and processes

already in place in current factories making lithium-ion battery cells."¹³² The company expects to begin shipment of the SSB to BMW and Ford for prototype testing by the end of 2022, with real-world use expected in 2024.

BMW announced researchers are working "intensively" to build a prototype of a SSB car before 2025, a development that would improve performance and safety.¹³³

Nissan plans to bring laminated SSBs to market by 2028. The materials, design, and manufacturing for SSBs will be studied, and data gathered will be used for a pilot production line at the Yokohama Plant starting in 2024, with the plan for scaled in-house manufacturing by 2028. Nissan believes that the SSB can reduce EV battery pack costs to \$75/kWh in 2028 and to \$65/kWh thereafter.¹³⁴

Beyond automaker involvement, research institutions like Georgia Tech, ETH Zürich, and Oak Ridge National Laboratory are collaborating on solutions that would increase energy density without reducing the battery lifetime through structures created during charge-discharge cycles.¹³⁵ 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.¹³⁶ 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 \$25,000.¹³⁷

Bidirectional charging, more commonly known as two-way charging, utilizes an advanced battery that allows EVs to receive energy or a charge from EVSE equipment and provide energy or discharge to an external load when paired with similarly capable EVSE infrastructure.¹³⁸ This technology can provide back-up energy to buildings, known as vehicle to building (V2B) charging; to microgrids, known as vehicle to grid (V2G) charging; or to other distributed energy resources. Bidirectional EVs can be used for demand response and resiliency providing decarbonized emergency generation, participating in demand response or time-of-use (TOU) arbitrage during peak energy loads.

Currently, it is projected that an EV battery pack's useful life will last between 10 to 20 years.¹³⁹ However, declining battery capacity differs based on customer use and needs. Auto manufacturers are beginning to invest in battery recycling or upcycling technology so when an EV battery pack's useful life comes to an end and is no longer sufficient to power a vehicle, it can still be utilized for other needs. Manufacturers like Nissan are investing in second-life projects that utilize battery packs once used in vehicles to be converted into energy storage systems to stabilize the grid or power homes and buildings. Other manufacturers like Ford and Volvo are investing in battery recycling that aims to reduce the cost of EV batteries and offset the environmental and social costs of critical minerals and metals mining.

Redwood Materials, Inc. is a Nevada-based lithium-ion battery recycling startup that collects, refurbishes, and recycles EV batteries and battery materials. Redwood has a string of partnerships with several battery suppliers and automakers including Proterra, Ford, Volvo, Panasonic, Toyota, and most recently, VW Group.¹⁴⁰ Redwood aims to create a circular supply chain for EV batteries within the U.S. that will eventually reduce the cost of EV batteries and offset the need for mining critical minerals and metals.

Outside of U.S. borders, **Nissan** and **Enel** have partnered to launch the "Second Life" project that utilizes used Nissan electric vehicle batteries at a standard power plant in Melilla, Spain, to enhance grid stability.¹⁴¹ Melilla is an autonomous city of Spain with a population of 90,000, located in Northern Africa and is isolated from the national distribution grid. Currently, the back-up generator for the Melilla facility is composed of 48 used Nissan LEAF batteries and 30 new ones. The Nissan batteries provide around 4 MW and can produce up to 1.7 MWh of energy if the power plant disconnects from the system; the storage facility can provide energy to the grid for 15 minutes, which is enough time to reset the system and restart the power supply at the power plant.

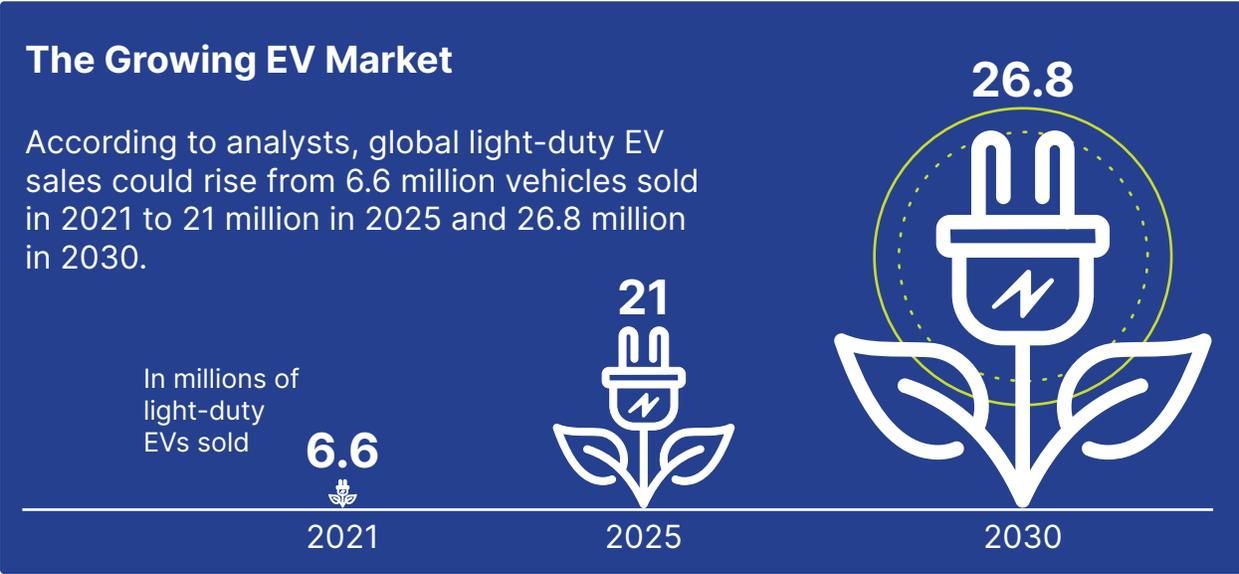
Connected Energy is an international second-life battery storage company that provides commercial scale stationary energy storage systems. Connected Energy secured an additional \$18 million from five new major investors, Caterpillar Venture Capital Inc., the Hinduja Group, Mercuria, OurCrowd, and Volvo Energy, who are joining existing investors ENGIE New Ventures, Macquarie, and the Low Carbon Innovation Fund.¹⁴² The company plans to use the investment to scale up its technology and operations to develop its first in-house large-scale M-STOR system, planned to be between 20 MW and 40 MW. Connected Energy has 16 operational systems across Europe and the United Kingdom that help balance energy behind the grid, including a partnership with Groupe Renault who provides Kangoo Z.E. vehicle model batteries to a Connected Energy's E-STOR project that has a combined energy storage capacity of 720 kWh and delivers 1.2 MWh of power.¹⁴³

To push forward battery innovation and drive further reduction in cost, automakers have announced a host of research and production partnerships. For more information, see section "Investments and Domestic Job Creation" below.

Model Availability and Manufacturer Commitments

In 2021, worldwide EV sales reached 6.6 million per the International Energy Agency’s Global EV Outlook 2022 report.¹⁴⁴ In total, the year 2021 ended with over 16.5 million light-duty EVs on the road, a record high.¹⁴⁵ Global LD EV sales rose strongly in the first quarter of 2022 with two million vehicles sold, up 75 percent from the first quarter of 2021.¹⁴⁶ According to BloombergNEF’s 2022 Long-Term Electric Vehicle Outlook, global light-duty EV sales are set to grow rapidly in the next few years, rising from 6.6 million sold in 2021 to 21 million in 2025;¹⁴⁷ and according to an S&P Global Platts Analytics’ report, global LD EV sales are projected to reach 26.8 million in 2030.¹⁴⁸ Additionally, BloombergNEF estimates that global on-road light-duty

EVs are expected to hit 77 million by 2025 and 229 million by 2030.¹⁴⁹ In the M/HD market, global M/HD EVs doubled over 2020 volumes with 14,200 units sold, representing 0.3 percent of all global M/HD vehicle sales in 2021.¹⁵⁰ A study from the North American Council for Freight Efficiency and RMI shows that more than half of America’s commercial M/HD vehicles, as well as all vans and step vans in the U.S. and Canada are currently electrifiable.¹⁵¹ This study conservatively estimates that electrification of the 4.2 million active Class 3, 4, 5, and 6 vans and step vans in the U.S. and Canada could reduce more than 43 million MT CO₂e emissions annually, the equivalent of nearly five billion gallons of diesel a year.¹⁵²



Model Availability

In the U.S., 2021 saw the addition of about 630,000 new light-duty EVs—more than 2019 and 2020 EV sales combined—bringing the total of on-road light-duty EVs to about two million.¹⁵³ Bank of America analysts see the year 2022 as a “major year of commercialization” for the EV market, projecting that the U.S. EV market will grow from six percent of new sales this year (2022) to 16 percent in 2024.¹⁵⁴ In 2021, the International Council on Clean Transportation (ICCT) estimated that auto manufacturers are collectively targeting a global production of 68 million EVs annually by 2025; U.S.-manufactured EVs accounting for only ten percent of global production with China and Europe combined representing roughly 40 percent of global production.¹⁵⁵

EV demand has been growing immensely as consumers look towards 2022 and 2023 models and later releases. In January and February of 2022, Consumer Reports (CR) surveyed Americans on their thoughts about BEVs and low carbon fuels.¹⁵⁶ The survey found that 71 percent of Americans surveyed expressed some level of interest in buying or leasing a BEV with 14 percent indicating that they would “definitely” buy or lease today, 22 percent would “seriously consider”, and 35 percent said they “might” consider. Digging further, the survey found that 33 percent of Americans say that it is the fact that it costs less to charge an EV than it does to refuel an ICE vehicle that would make them consider purchasing an EV; 31 percent indicated that the lower lifetime costs would affect their decision, and 28 percent cited lower maintenance costs. When asked what posed barriers to EV adoption, 61 percent said charging logistics, 55 percent said vehicle range, and 52 percent said costs associated with buying, owning, and maintaining an EV. However, the survey then found that almost half of Americans are unaware of the incentives that are available to them when purchasing an EV.

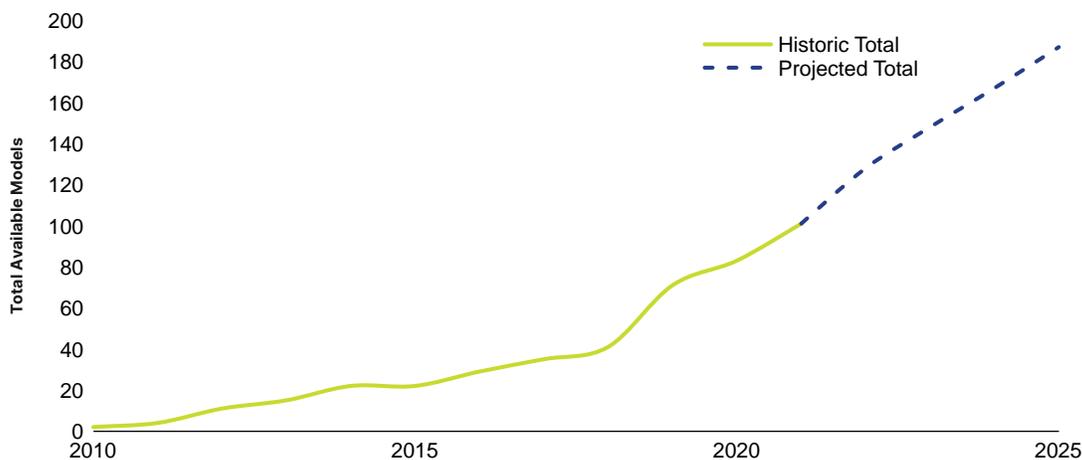
Taking the survey’s finding into consideration, and assuming access to the newly expanded federal incentives, there will be ten EV models available with a net cost of under \$30,000 by the end of 2022. Additionally, as of 2022, there will be 15 LDV models available for under \$40,000 manufacturer’s suggested retail price (MSRP) with a driving range of over 100 miles. In addition to these declining upfront purchase prices, many analyses conclude that EVs will provide substantial consumer savings in avoided fuel costs. For instance, recent studies (before 2022 inflation and gas prices) found that an LD EV buyer could save over \$5,000 in avoided fuel costs over the life of the vehicle.

The consumer demand for EVs can be exemplified through vehicle reservations. For example, the 2022 GMC Hummer EV sold out pre-orders in 10 minutes,¹⁵⁷ reaching over 90,000 reservations¹⁵⁸; 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;^{159,160} the 2023 Chevrolet Silverado saw more than 110,000 at the start of 2022 and has since reached 150,000 reservations as of late July,^{161,162,163} Cadillac plans to open more reservation slots for its 2023 LYRIQ model after the first round of reservations filled in over 10 minutes;¹⁶⁴ and Fisker announced the Ocean SUV has more than 40,000 reservations.¹⁶⁵

Based on announcements by major auto manufacturers, the number of electrified models available in the U.S. is projected to reach 187 by the end of 2025 (Figure 6), with over 85 new models slated to launch in model years 2022-2025.[‡]

‡ Vehicles included in this figure accounts for confirmed and aspirational electrified model availability targets that are available or will become available in the U.S. with MSRPs 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, and the Leaf and Leaf e-Plus were counted as a single vehicle.

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



More Models, More Miles

The number of electrified light-duty models available in the U.S. is projected to increase to 187 models available by 2025.



2022 average range = 234 miles

An ever-increasing number of models are now above the

300
mile range

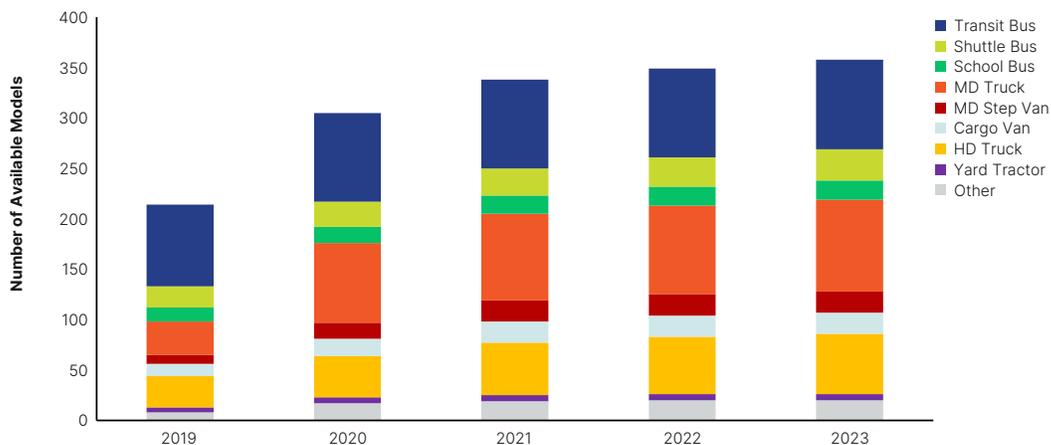


In the medium- and heavy-duty market, model availability is also rapidly increasing. In 2019, there were only 20 models of Class 2b-8 zero-emission trucks (ZETs) available for purchase in the U.S.^{§§166} CALSTART estimated that in the U.S. market, as of March 2022, there were 136 M/HD ZETs available for purchase across 41 different manufacturers.¹⁶⁷ Global model availability for ZETs and buses will increase nearly 26 percent from 2020 to 2023, from 433 models to 544 models.¹⁶⁸ The study found that, globally, the strongest growth from 2020 to the end of 2022 in model availability will be seen in the zero-emission school buses

and medium-duty step van market segments at 143 percent and 120 percent growth, respectively. Heavy-duty trucks have grown more than 50 percent to a total of 61 models from 2020 to 2022. However, CALSTART estimates that zero-emission transit buses have the largest selection of model availability at 262 different models on the market, with most of these models seen in China. Range for these ZETs are improving and according to manufacturer data, via CALSTART, medium-duty ZETs, medium-duty step vans, and cargo vans have median ranges of 153 miles, 133 miles, and 146 miles, respectively.

§§ Note that this includes only trucks and not all M/HD vehicles, such as shuttle buses or yard tractors.

Figure 7. Total Medium- and Heavy-Duty Vehicle U.S. Models Available by Year¹⁶⁹



Light-duty Vehicle Manufacturer Commitments

The majority of light-duty vehicle manufacturers have committed to greatly increasing ZEV sales over the coming years, and many automakers are working toward a full ZEV fleet within the next decade. See below for key manufacturer commitments (see, also, the Investments and Job Creation section for recent model announcements).

- **Alpha Romeo** announced that it will provide a fully electric fleet by 2027, the first of Stellantis' 14 brands to stop manufacturing of ICE vehicles.¹⁷⁰ The automaker will expand its fleet to encompass five electric models.¹⁷¹
- **BMW** expects fully electric vehicles to make up 50 percent of the company's global sales earlier than its initial 2030 target.¹⁷² In 2022, including pre-production vehicles, BMW will have 15 fully electric models in production; 90 percent of its current market segments. BMW also expects its MINI brand to be fully electric by the early 2030s.¹⁷³ The automaker expects to sell over 2 million fully electric vehicles by the end of 2025 and 10 million fully electric vehicles by 2030. This goal will primarily be fulfilled with what is currently available in its fleet as it aims to bring new models to the market starting in 2025.¹⁷⁴
- **Buick**, a GM brand, pledged to make all new vehicles electric by 2030. After Cadillac, Buick becomes the second GM brand with a 2030 deadline to release only electric vehicles. Buick's first electric model is its North American Electra EV series and is set for release in 2024.¹⁷⁵
- **Mercedes-Benz** announced that all newly launched vehicle platforms will be electric-only from 2025 onward and is preparing for new cars to be electric-only by the end of the decade, where market conditions allow.¹⁷⁶ Additionally, Mercedes-Benz aims to have a carbon-neutral passenger vehicle fleet by 2039. The automaker expects to halve CO₂ emissions by 2030.¹⁷⁷
- **Ford** expects 50 percent of its global vehicle volume, and 100 percent of its European volume, to be fully electric by 2030.^{178,179} The automaker has created Team Edison, a dedicated global EV organization "focused on bringing to market profitable, exciting [EVs] and ownership experiences." 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.¹⁸⁰ By 2023, Ford expects to become the second highest producer of electric vehicles, behind Tesla.¹⁸¹ Additionally, Ford set a global target of producing more than 2 million EVs per year by 2026.¹⁸²
- **GM** has a goal to have 30 BEV models by 2025, with 20 models available in North America, and to only sell ZEVs by 2035.¹⁸³ Additionally, GM plans to run its U.S. operations on renewable energy within the next four years and become carbon neutral in its global products and operations by 2040.^{184,185} The automaker 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."¹⁸⁶ Its Factory ZERO renovations will reposition the facility for greater EV production as it aims to reach a capacity of one million electric units annually in North America by 2025.¹⁸⁷
- **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 2035.¹⁸⁸ The automaker aims to launch 30 new electric vehicle models, including two SUVs and a mini car, by 2030 and produce more than 2 million EVs per year.¹⁸⁹
- **Hyundai** has committed to carbon neutrality by 2045.¹⁹⁰ Hyundai is targeting 1.87 million BEVs sold annually by 2030 with the help of 17 new BEV models; 11 for Hyundai and 6 for Genesis. Additionally, all new Genesis vehicles will be electric starting in 2025, with the goal of being a 100 percent ZEV brand by 2030 and carbon-neutral by 2035.¹⁹¹
- **Kia** aims to sell 1.2 million BEVs worldwide by 2030. The company is targeting to introduce 14 new BEV models by 2027 and launching at least 2 BEV models every year.¹⁹²
- **Nissan** aims to have 23 electrified models available worldwide, including 15 fully electric models, and 40 percent of vehicles sold in the U.S. to be electrified by 2030. The company is also considering a third U.S. EV manufacturing facility.¹⁹³ Additionally, Nissan has a goal to be carbon-neutral across the life cycle of all its vehicles by 2050.¹⁹⁴

- **Porsche** set a goal for 50 percent of its sales to be electric in 2025, and 80 percent by 2030.¹⁹⁵ By the end of 2022, Porsche will have invested more than six billion euros in electric mobility.¹⁹⁶
- **Stellantis** aims for 100 percent of sales in Europe and 50 percent of sales in the U.S. to be BEVs by the end of this decade.¹⁹⁷ Additionally, the company plans to offer more than 75 BEV models and reach global annual BEV sales of 5 million vehicles by 2030. In the North American market, Stellantis has committed to 96 percent of its nameplates (Jeep, Ram, Dodge, Fiat etc.) to have electrified options for all models by 2025, and fully battery-electric options by 2030.¹⁹⁸ The Chrysler brand has announced plans to shift to an all-electric fleet by 2028.¹⁹⁹
- **Subaru** aims to have 40 percent of new global car sales be electric by 2030, with 100 percent of vehicles equipped with electrification technology in the first half of the 2030s.²⁰⁰
- **Toyota** aims to sell 3.5 million BEVs per year by 2030. The company plans to offer around 70 electrified models globally by 2025 and 30 BEV models across the Toyota and Lexus brands by 2030.²⁰¹
- **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 55 percent for all-electric vehicles by introducing more than 25 new BEV models by 2030.²⁰² By 2030, VW will launch around 70 fully electric models, and around 60 hybrid models. By 2040, nearly all new VW vehicles in major markets will be zero-emission. The entire VW fleet will be carbon neutral by 2050.²⁰³
- **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 2025.²⁰⁴

Figure 8. Global Sales Goals by Manufacturer

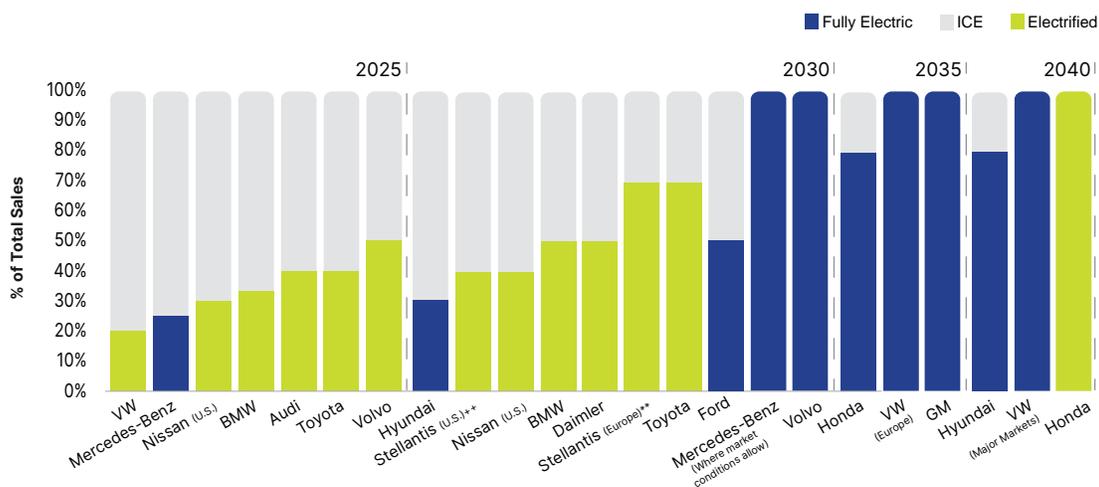
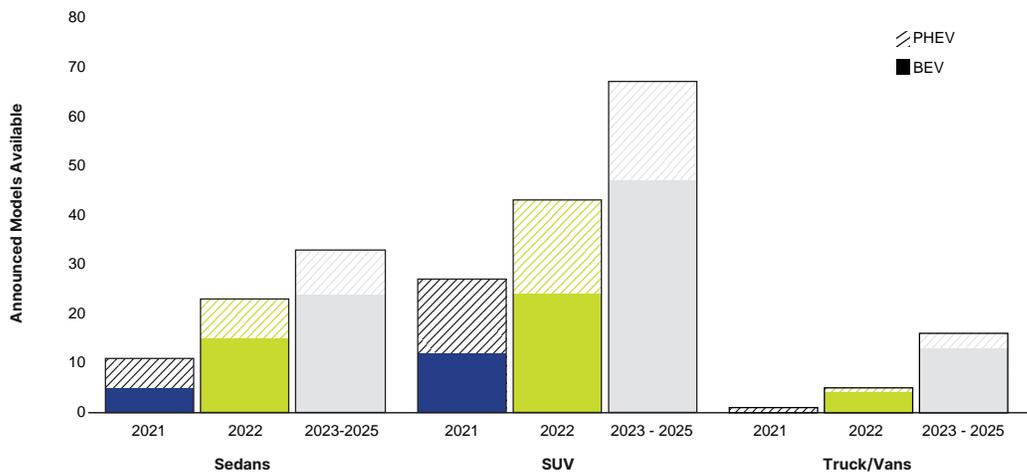


Figure 9 summarizes projected U.S. BEV and PHEV model availability from the previous year and over the next three model years according to officially released automaker announcements. Figure 9 does not take into account unconfirmed or aspirational electrified model availability targets set by automakers (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). 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.²⁰⁵ 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.²⁰⁶ The EPA estimated maximum range experienced a slight improvement over the 2020 model's 402-mile range, rising to 405 miles.²⁰⁷

Figure 9. Cumulative Announced U.S. Light-Duty BEV and PHEV Models by Body Type



Medium- and Heavy-Duty Vehicle Manufacturer Commitments

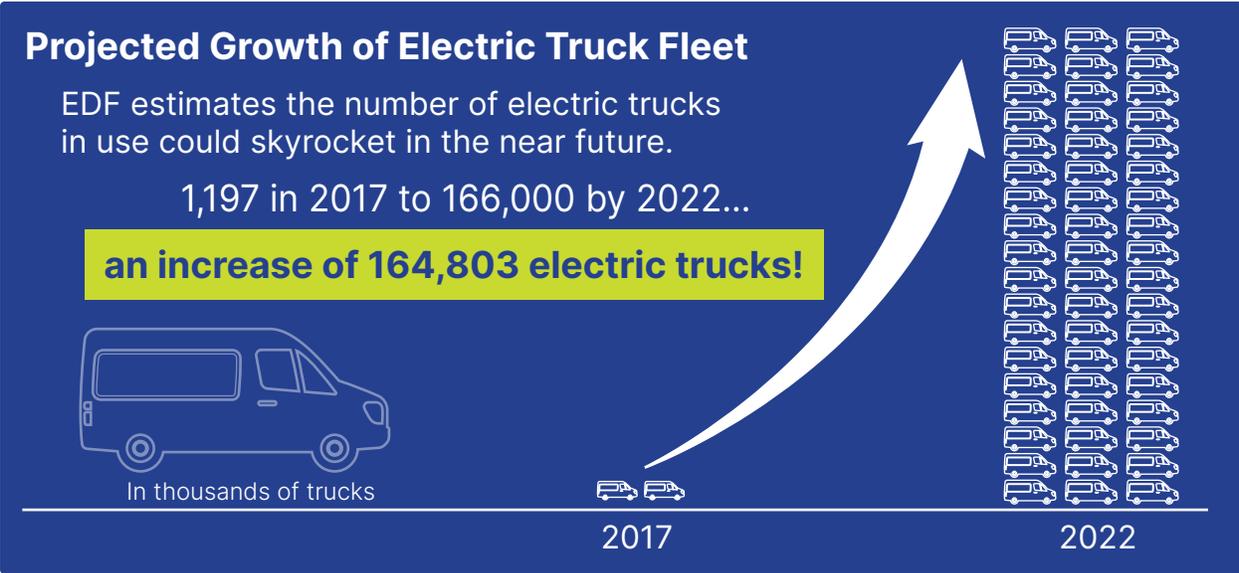
- Daimler Trucks** has a goal of selling CO₂-neutral vehicles in Europe, Japan, and North America and CO₂-neutral production at all of their plants by 2039. In North America, Daimler's Freightliner division has developed electric versions of their popular Cascadia Class 8 tractor, M2 Class 6 medium-duty chassis, and MT50 medium-duty step van. In January 2022, Daimler Trucks North America announced that its Freightliner battery electric Innovation and Customer Experience (CX) Fleets surpassed 1 million real world miles from fleets operating across the West Coast and Canada. The company deployed more than 40 batteries electric eCascadias and eM2s rotating between their almost 50 customers in the U.S. and Canada.²⁰⁸
- 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.²⁰⁹
- General Motors' BrightDrop** brand signed its second agreement with FedEx in January 2022 to supply the company with priority production of 2,000 electric 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.²¹⁰ In April 2022, BrightDrop announced that it is renaming its EV410 and EV600 electric delivery vans to Zevo 400 and Zevo 600 stating that the rebranding more closely aligns with the company's mission and purpose to decarbonize last-mile deliveries.²¹¹
- Traton SE**, the parent company of Navistar, announced that it has a goal to have half of all trucks sold zero-emitting by 2030.²¹²
- Volvo Trucks** set a global target that 50 percent of all truck sales will be electric by 2030.²¹³ In 2021 Volvo Trucks took orders, including letters of intent to buy, for more than 1,100 electric trucks in over 20 countries.²¹⁴

Commercial Fleet Electrification Commitments

A few years ago, the commercial fleet EV market in the U.S. was dominated by transit buses. However, the demand from medium- and heavy-duty fleet operators to pursue other electric vehicle options has grown in recent years. In addition, light-duty vehicle manufacturers like Ford, Tesla, and Polestar have begun to partner with light-duty commercial fleet operators to meet the growing demand for these electrified vehicles.

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). Companies that operate large fleets are taking note; see major orders updates below. 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.”²¹⁵

Across the industry, the number of zero-emission truck and bus deployments and orders are skyrocketing from 1,197 vehicles in 2017 to a projected 166,000 vehicles by the end of 2022.^{216,217} As of March 2022, 1,895 Class 2b through Class 3 ZEVs had been deployed in the U.S. since January of 2017.²¹⁸ These investments will continue to grow thanks to corporate fleet electrification commitments (see box on page 39 and Table 3, below). For example, the 82 companies that are part of the global initiative EV100 have committed to accelerating the EV transition and making electric transport the new normal by 2030. Commitments cover a broad range of vehicles from delivery vans 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 ACT regulation sales mandate (described in the Policy Drivers of U.S. Electric Vehicle Growth section).



Major Orders Since Last Report Update

- **DHL** ordered 44 Volvo electric trucks for its European operations comprising of the Volvo FL, a 16-ton truck with a battery capacity between 100 kWh and 300 kWh, the Volvo FE which is a little bigger than the FL, and the Volvo FM, a 44-ton GCW truck with a battery pack between 180 kWh and 540 kWh.²¹⁹
- **Maersk** has ordered 110 Volo VNR electric Class 8 trucks for its North American fleet, increasing the company's electric fleet to 126 trucks with the expectation that 450 electric trucks will be deployed in 2022-2023.²²⁰
- **Merchants Fleet** ordered 58 electric step vans from Xos, Inc., which will be delivered during the second quarter of 2022.²²¹
- **Penske** ordered 750 Ford E-Transit vans for its rental fleet.²²²
- **Sysco Corporation**, the leading global foodservice distribution company, ordered 800 electric Freightliner eCascadia Class 8 tractors from Daimler Trucks, to be delivered by 2026.²²³
- **United Rentals** ordered 500 F-150 Lightnings and 30 E-Transits vans from Ford with delivery beginning in late 2022.²²⁴
- **USPS** announced that it will buy at least 25,000 (40 percent) all-electric NGDV models from Oshkosh Defense, upping its prior commitment to buy at least 10,019 EVs (20 percent) from their original 50,000-unit order. USPS also announced that it plans to buy more than 34,500 commercially available trucks, including as many BEVs that are commercially available and consistent with the delivery profile.²²⁵
- **Hertz** signed a deal with Polestar ordering 65,000 Polestar 2 EVs over the next five years with first availability in North America and Australia by late 2022.²²⁶ Additionally, in September 2022, Hertz announced its plans to order up to 175,000 GM electric vehicles, including GM's Chevrolet, Buick, GMC, Cadillac and BrightDrop EVs, over the next five years.²²⁷
- **Walmart** ordered 4,500 all-electric last-mile delivery vehicles from Canoo.²²⁸
- **WattEV** has purchased 50 Volvo VNR Electric heavy-duty truck to distribute to carriers in California as part of its Truck-as-a-Service (TaaS) mode.²²⁹



Business Coalitions

In addition to individual business, a robust array of coalitions is now adding information, insight, and advocacy to promote EVs, especially across fleets. 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 focused on accelerating the electric vehicle transition for companies in North America. CEVA has 32 members, and The Climate Group (EV100) is an engagement partner that helps members reach their goals and commitments.²³⁰

CHARGE Coalition: Launched in March 2021, the CHARGE Coalition is made up of 52 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.²³¹

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."²³² ECBC's 28 members include auto manufacturers like Ford, GM, Kia, Rivian, Proterra and Volvo.

NEHC: First formed in March 2021 and greatly expanded in July 2021, the National Electric Highway Coalitions consists of more than 60 investor-owned and municipal electric companies and electric cooperatives that span across 48 states and the District of Columbia. Members are committed to providing EV fast charging stations that will allow the public to drive EVs along major U.S. travel corridors by the end of 2023.²³³

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).²³⁴ ZETA has released a federal roadmap to achieve 100 percent EV sales by 2030, which consists of 34 policy proposals across six pillars.



Table 3. Sample of Fleet Electrification Commitments

Sector	Company	Electric Fleet Plans Implementation Progress
Retail	Ikea Group*	2020: Electrify deliveries in Amsterdam, Los Angeles, New York, Paris, and Shanghai (25% global of deliveries) 2025: 100% 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% fleet electrification
	Unilever	2030: 100% fleet electrification (11,000 vehicles)
	LG Energy Solutions	2030: 100% 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% 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: <ul style="list-style-type: none"> Xcel Energy: 2023: 100% electric sedan portion of fleet; 2030: 100% electric light-duty fleet; 30% M/HD vehicles Consumers Energy: 2025: Buy or lease 100% of EVs for fleet Southern California Edison: 2030: 100% electric passenger car and small-to-midsize SUV, 30% medium-duty vehicles and pickup trucks, 8% heavy-duty trucks, 60% forklifts
	National Grid	2030: 100% electric fleet (5,700 vehicles)
	Public Service Co.	2022: 10% electric fleet minimum 2030: 50% electric fleet 2045: 100% electric fleet
Transportation	Lyft**	2026: 100% new vehicles for Express Drive (driver rental program) are electric
	King County Metro (WA)	2030: 100% EVs on platform
	Lime*	2030: 100% zero-emissions fleet
	Uber**	2030: 100% conversion of operations fleet
	Alto	2030: 100% of rides take place in EVs in U.S., Canadian, and European cities

Sector	Company	Electric Fleet Plans Implementation Progress
Delivery	DHL	2025: 70% of first- and last-mile delivery services with clean transport modes 2050: Reduce logistics-related emissions to zero
	FedEx	2025: 50% of Express global parcel pickup and delivery (PUD) fleet purchases electric 2030: 100% PUD fleet purchases electric 2040: 100% ZEV PUD fleet
	Maersk	2040: Enterprise-wide carbon neutral operations
Biotech	AstraZeneca	2025: 100% fleet electrification (16,000 vehicles)
	Genentech	2030: 100% electrification of sales fleet (1,300 vehicles) and commuter buses
	Biogen	2030: 100% 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% Electric School bus fleet 2040: 100% electric MTA bus fleet
	New Jersey	2024: At least 10% of new bus purchases will be zero emission buses 2026: At least 50% of new bus purchases will be zero emissions buses 2032: 100% of new bus purchases will be zero emissions buses
	Los Angeles, California	2028: 100% ZEV vehicle conversions “where technically feasible” (2028: taxi fleet, school buses; 2035: urban delivery vehicles) 2035: 100% electrification of sanitation fleet through LA Department of Sanitation Commitment
	Houston, Texas	2030: 100% EV non-emergency, light-duty municipal fleet
	Chicago, Illinois	2040: 100% 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% of new vehicle sales to be electric (43,000 vehicles) 2030: 80% of new vehicle sales to be electric (166,000 vehicles)

Investments and Domestic Job Creation

In total, automakers and battery manufacturers worldwide will spend more than \$626 billion through 2030 developing light-, medium-, and heavy-duty electric vehicles. This would be a projected increase of more than \$111 billion in spending from the sixth EV Market Report's projection (April 2022), a 21 percent increase in spending. In the first nine months of 2022, over fifteen automakers and battery manufacturers have announced new or additional U.S.-based investments, with a combined total of over \$51 billion, to open new or renovate existing EV manufacturing, assembly, and battery production plants across twelve states. These recent investment announcements will directly employ over 41,000 workers, including over 22,500 light-duty workers, over 3,100 medium- and heavy-duty workers, and over 15,200 battery production workers once these facilities begin production. For example, GM announced that it will invest \$7 billion in four Michigan facilities that will result in over 7,000 jobs. Additionally, Hyundai, in agreement with the State of Georgia, announced that it will build its first EV and battery manufacturing plants in Bryan County, GA, investing \$5.54 billion. 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.²³⁵

Domestic Job Impacts

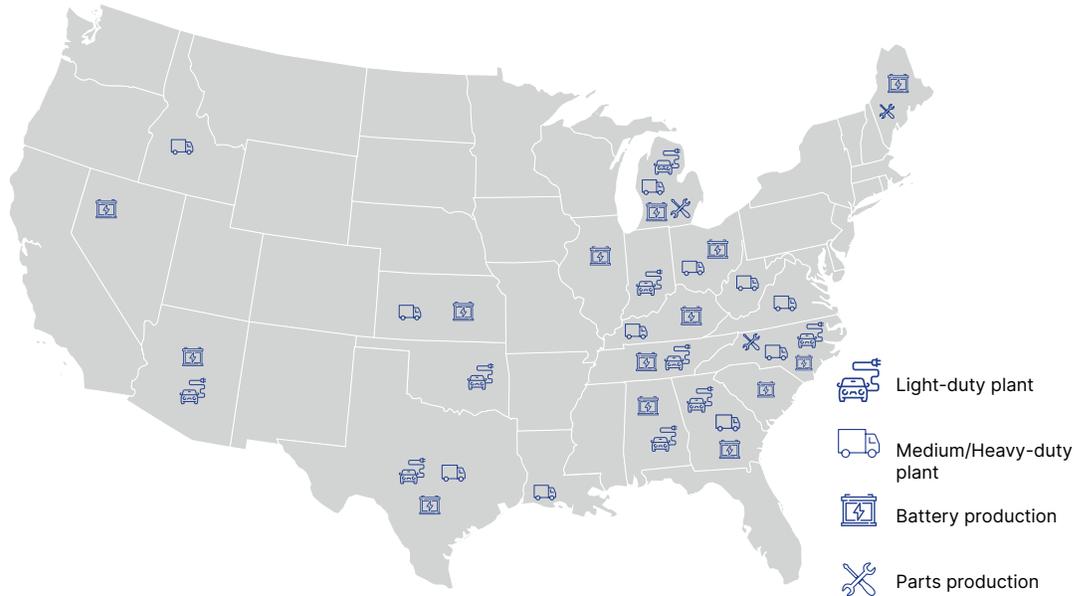
According to DOE's United States Energy and Employment Report 2022, in 2021, the U.S. electric vehicle jobs section grew by 21,961 jobs, a 26 percent employment growth rate.²³⁶ In comparison, electric vehicle jobs grew only 8 percent (6,000 jobs) in the prior year.²³⁷ Defying overall energy sector job loss patterns, jobs in electric vehicles, plug-in hybrid vehicles, and hybrid vehicles were the only sub-categorical energy sector jobs that rose in numbers from 2019 to 2021 and did not decrease from 2019 to 2020.

California, Michigan, and Texas are states with the highest number of clean vehicle jobs, though every state benefits from the growing investment in clean and electric transportation. Even states without policies supporting EV adoption have seen an increase in jobs due to battery and vehicle manufacturing. Appendix D contains a full listing of these commitments by state. Figure 10 depicts the recently announced electric vehicle manufacturing plant expansions and future plans across the U.S.



Recent policy action, discussed in more detail in “Policy Drivers of U.S. Electric Vehicle Growth” above, has been focused on job creation, including billions of dollars in investments for clean energy including significantly increased purchase incentives for U.S.-made electric vehicles.

Figure 10. Announced Electric Vehicle Manufacturing Plant Expansions and Future Plans



Batteries:

- AL: Mercedes Benz (Tuscaloosa)**
- AZ: Lucid Motors, **LG Energy Solutions**
- GA: SK innovation, **Hyundai (Bryan County)**
Rivian (Atlanta)
- IL: Rivian
- KS: Panasonic**
- KY: Ford/SK Innovation, **Ascend Elements**
- Envision Automotive Energy Supply Corp.**
- MA: GM/SES Partnership
- MI: LG Energy Solutions, Ford, GM (Detroit-Hamtramck, Orion, Wallace)
- NC: Toyota**
- NV: Redwood Materials, Inc. (Reno)**
- OH: GM (Lordstown), LG Energy, **SemCorp**
- SC: ABB E-mobility (Columbia)**
- 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), **Hyundai (Montgomery)**
- GA: Hyundai (Bryan County), Rivian (Atlanta)**
- IN: Toyota (Princeton), **Stellantis (Kokomo), GM (Marion)**
- MI: Ford (Flat Rock, Rouge Complex, Dearborn), GM (Orion Township, Detroit Factory ZERO), Fiat Chrysler (across five plants), Nissan (Canton)
- Stellantis (Dundee)**
- NC: VinFast**
- OK: Canoo (Tulsa)**
- TN: VW (Chattanooga), GM (Spring Hill), Mullen Technologies, Ford/SK Innovations (Stanton)
- Nissan (Smyrna)
- TX: Tesla (Austin, Travis County)

Parts:

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

Medium-and Heavy Duty:

- CO: Lightning eMobility
- GA: Blue Bird and Lightning eMotors (Fort Valley)**
- IL: Lion Electric (Joliet)
- IN: Electric Last Mile Solutions (Mishawaka)
- MI: Navistar (Detroit)
- MO: Ford (Kansas City)
- NC: Arrival (Charlotte), **Thomas Built Buses (High Point)**
- OR: Daimler Trucks North America (Portland)
- SC: Arrival (York County), Volvo (Ridgeville), Mercedes, **GreenPower Motor Company (Charleston)**
- 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

Auto manufacturers are also working to advance the electric vehicle workforce. In 2018, Tesla launched a program called Tesla START, a 12-week training program with community colleges to train people to become Tesla service technicians.²³⁸ Recently, Tesla announced its plans to expand the program through its partnership with Lincoln Educational Service Corporation, a company with technical schools across the U.S., to train the next generation of electric vehicle technicians.

In the Medium- and Heavy-Duty vehicle industry, Volvo Trucks North America announced on May 25, 2022 plans to open a new facility in Tinley Park, Illinois, to expand access to battery-electric truck training in the central U.S.²³⁹ The courses offered will focus on Volvo VNR Electric Trucks and offer proper training on best practices when servicing high-voltage electric drivetrains and components. Like Tesla and Volvo Trucks, Ford has begun its own training program, as shown in the case study below.

CASE STUDY:

Ford's Light Truck Electrification: Economic & Jobs Impact Study and Corporate Job Development Efforts

A study exploring the job impacts of electric Ford F-150 Lightning production highlighted the potential impact that electric vehicle manufacturing and supply chain development could have on the U.S. economy and job market.²⁴⁰ Using the IMPLAN input-output economic model, the analysis found that:

- A single direct job associated with the production of the 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 44,000 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.

With the launch of the electric F-series, as well as other electric models, Ford Motor Company and Ford and Lincoln dealers are partnering with select community colleges and technical schools across the U.S. to deploy the Automotive Student Service Education Training (ASSET) program, one of three post-secondary Ford-sponsored automotive training programs through New Ford Tech, which aims to support and grow a collection of qualified Ford automotive repair technicians.²⁴¹ The ASSET program will provide Ford and Lincoln dealerships with technicians trained with Ford service technologies, diagnostic, and repair methods. This program will begin to integrate a Ford EV curriculum that includes courses on High Voltage Systems Safety, Hybrid Vehicle and Battery Electric Components and Operation, instructor-led Hybrid and Electric Vehicle Operation and Diagnosis, and an introduction to High Voltage Battery Service. The company has recently partnered with Pima Community College in Tucson, AZ, Wake Technical College in Raleigh, NC, and Gwinnet Technical College in Lawrenceville, GA to offer the ASSET program and has provided more than 25 PHEV and or BEV vehicles to offer hands on training.

In over two years, an ASSET student can earn up to 100 percent of Ford's Service Technician Specialty Training (STST) credentials, earn an associate degree in Automotive Technology, and have one year of work experience at a participating dealership. The program has 13 possible certifications including Ford's High Voltage System Certification. More than 12,000 students have participated in the ASSET program and more than 1,800 dealerships are participating sponsors.



Light-Duty Vehicles: Investment and Jobs Announcements

Canoo, a California EV startup, will build a new EV factory outside of Tulsa, Oklahoma, opening in 2024 and expected to create “more than 2,000 jobs.”²⁴² The company broke ground on the factory in the fourth quarter of 2021.²⁴³

Ford announced that it will spend \$3.7 billion to invest in its Michigan, Ohio, and Missouri factories to produce both EVs and ICE vehicles.²⁴⁴ In Michigan, the automaker will speed up production of the new F-150 Lightning at the Rouge EV facility to produce 150,000 units a year. This \$2 billion investment, though also accounting for ICE vehicle improvements, will add nearly 3,200 jobs. In Ohio, Ford will invest \$1.5 billion to refurbish its Ohio Assembly Plant to make an unannounced electric commercial vehicle starting in 2025, adding 1,800 new jobs. Lastly, in Kansas City, Missouri, Ford will dedicate \$95 million and 1,100 jobs to add a third shift to build its Transit van, both BEV and ICE.²⁴⁵ In 2022, Ford increased its planned investment in EVs and autonomous vehicles from \$11 billion to over \$50 billion through 2026.

GM plans on increasing its initial investment of \$2.2 billion for its Michigan facilities to \$7 billion.²⁴⁶ 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. This investment will result in over 7,000 jobs across all assembly facilities.^{247,248,249} GM also received a \$35 million job training assistance grant from Tennessee to retain and train 2,000 employees.²⁵⁰ Beyond manufacturing, GM plans on hiring 8,000 positions for software development.²⁵¹ The company has also announced that it will invest another \$81 million to build the Cadillac Celestiq at GM's Warren Technical Center in Michigan.²⁵² Production is set to begin in late 2023 with a low production volume of 400 units a year; this will be the first vehicle model built at the Warren Tech Center. Additionally, GM will invest \$491 million to upgrade its EV assembly plant in Marion, Indiana.²⁵³

GM announced that it is investing \$2 billion into two plants in Canada with the Canadian Government contributing \$259 million.²⁵⁴ The first plant will be an all-electric assembly plant located in CAMI Assembly in Ingersoll, Ontario that will build electric commercial vans. In 2021, GM announced that it would invest \$799 million to convert CAMI to produce the Zevo 600, formerly named EV600.²⁵⁵ The second plant will be a production expansion of the Oshawa Assembly plant in Ontario to add a third shift, creating 2,600 jobs. Currently the Oshawa Assembly plant only produces light-duty and heavy-duty gasoline-powered trucks but Scott Bell, GM's vice president of Chevrolet hopes to produce an EV in Oshawa to align with GM's goal to offer an all-electric lineup by 2035.

Honda will invest \$63 billion on EV research and development over the next 10 years.²⁵⁶



Light-Duty Vehicles: Investment and Jobs Announcements

Hyundai, in agreement with the State of Georgia, announced that it will build its first EV and battery dedicated manufacturing plants in Bryan County. The company will invest \$5.54 billion, breaking ground in 2023 with expected production to begin in 2025.²⁵⁷ The factory will supply almost 8,100 jobs and produce roughly 300,000 units annually by utilizing AI technology and data in all processes of production. The battery manufacturing facility will establish a partnership with details to come.²⁵⁸ Lastly, the company will invest \$300 million and add 200 jobs to its Alabama factory to produce the Genesis G70 and the Santa Fe plug-in hybrid.²⁵⁹

Nissan is expected to invest \$17.6 billion through 2025 to speed up its transition toward electrification.²⁶⁰ The automaker is considering building a new manufacturing plant in the U.S. to keep up with demand for EVs and could add several thousand jobs.²⁶¹

Rivian, in agreement with the State of Georgia, announced that it has secured \$1.5 billion in public funding to build a large EV factory east of Atlanta. The automaker will spend \$5 billion to build the facility that will produce 400,000 light-duty trucks and SUVs a year and create 7,500 jobs. Expected production is set to begin sometime mid-decade.²⁶²

Stellantis 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. The company announced that it will invest \$99 million into three component plants in North America to manufacture hybrid engines.²⁶³ Of that, Stellantis will invest \$83 million into its Dundee, Michigan Engine Complex where production is expected to begin in 2025.

VW announced that it will invest \$7.1 billion in its product line-up, R&D capabilities, and manufacturing capabilities in North America over the next five years. The company hopes to start the production of the I.D.Buzz in either the U.S. or Mexico.²⁶⁴

VinFast, a Vietnamese automaker, announced that it will invest \$4 billion into its first electric vehicle manufacturing and battery production facility in the U.S. The plant will employ 7,500 people and produce an initial projected capacity of 150,000 EVs a year.²⁶⁵ Production is set to begin in 2024.²⁶⁶ In partnership with the State of North Carolina, VinFast has received \$1.2 billion to invest in their new EV and battery manufacturing plant.²⁶⁷



Medium- and Heavy-Duty Vehicles: Investment and Jobs Announcements

U.K.-based **Arrival**, specializing in delivery vans, announced plans to establish a Microfactory in Charlotte, North Carolina, bringing 250 jobs to the region. The plant is scheduled to begin production in 2023.²⁶⁸

Blue Bird and Lightning eMotors, a Colorado-based manufacturer, plan to launch production of a Class 5-6 EV chassis, including last-mile delivery step vans, motorhomes, and other specialty vehicles, in late 2023 at its manufacturing facility in Fort Valley, Georgia.²⁶⁹

Daimler Trucks North America expects to start production of the eCascadia and eM2 trucks in Portland, Oregon in late 2022 after announcing plans in 2019 to convert the plant to produce electric Freightliners.²⁷⁰

Ford invested \$100 million to upgrade its Kansas City Assembly Plant and hired 150 new employees to build electric vans.²⁷¹ In early 2022, Ford began shipping out its 2022 E-Transit van, the electric version of the popular Ford Transit cargo van.²⁷²

GreenPower Motor Company, in agreement with the State of West Virginia, announced that it will lease/purchase a 9.5-acre manufacturing facility in South Charleston that will initially add 200 jobs and eventually add 900 new jobs once the facility reaches full production capacity within two years. Production on the all-electric school buses is set to begin August 2022.²⁷³

In January 2022, **Kenworth** unveiled an electric version of its T680E semi-truck (Class 8).²⁷⁴ The semi-truck is designed for pickup and delivery applications, regional hauling and is available as a day cab tractor or straight truck. It is the company's first Class 8 battery-electric truck, which Kenworth states can be fully charged in three hours.²⁷⁵



Medium- and Heavy-Duty Vehicles: Investment and Jobs Announcements

Lion Electric invested \$70 million in 2021 for a new manufacturing plant that will create 750 jobs over the next three years.²⁷⁶ The company began work in early 2022 on a new factory in Joliet, 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.²⁷⁷

Mercedes will bring the next generation of eSprinter vans to the U.S. through a nearly \$60 million investment in North Charleston, South Carolina.²⁷⁸ Navistar invested \$250 million in a San Antonio plant that will produce both diesel and electric trucks, through which it expects to support more than 600 new jobs.²⁷⁹ It also announced a new facility outside of Detroit that will employ 50 eMobility specialists.²⁸⁰

Orange EV, a leading manufacturer of heavy-duty industrial zero-emission vehicles, announced that it has secured \$35 million in institutional funding from S2G Ventures and CCI. This funding will allow the manufacturer to meet increased demand, deliver vehicles to new markets, and develop new technologies for the Class 8 commercial vehicle segment.²⁸¹

Thomas Built Buses will add 280 jobs to a second shift at its Saf-T-Liner C2 Plant in High Point, North Carolina working exclusively with the Saf-T-Liner C2 school bus and the Saf-T-Liner C2 Jouley electric school bus.²⁸²

Traton SE, who acquired Scania and Man brands in 2021, has announced that it will invest \$2.9 billion by 2026 on developing and refining alternative drivetrains. Additionally, in late 2021, Traton signed a joint venture agreement with Daimler Trucks and the Volvo Group to spend €500 million (~\$554 million) to build a European network of at least 1,700 public chargers for battery-electric heavy-duty trucks and buses.²⁸³

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.²⁸⁴



Electric Vehicle Battery Production Announcements

Ascend Elements announced that it plans to invest \$1 billion to build a battery production facility in southwestern Kentucky and is expected to produce enough lithium-ion cathode materials for up to 250,000 electric vehicles.²⁸⁵ Battery production is scheduled to begin in 2023 and to create up to 400 new jobs.

Envision Automotive Energy Supply Corp. (AESC), a Japan-based company will invest \$2 billion to build a 3 million square-foot battery technology plant in the Kentucky Transpark and create 2,000 new jobs. The factory is expected to produce batteries for 300,000 vehicles annually once it becomes fully operational in 2027.²⁸⁶

Ford announced that it has lined up enough batteries to reach its short-term goal of producing 600,000 electric vehicles by 2023 and has secured enough batteries to reach about 70 percent of its long-term goal of producing 2 million electric vehicles by 2026.²⁸⁷ The automaker is investing \$50 million in a startup EV battery recycling company, Redwood Materials, that is able to recover 95 percent of precious metals.

GM will be opening the Wallace Battery Cell Innovation Center in Warren, Michigan 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.²⁸⁸ Additionally, GM and LG Energy Solutions' joint venture is expected to open 3 Ultium Cell battery manufacturing facilities in Warren Ohio, Spring Hill Tennessee, and Lansing, Michigan by 2024. The Ultium Cells facility located in Warren, Ohio has announced that battery cell production will begin in this month, August 2022, employing 700 workers.²⁸⁹ The \$2.3 billion Spring Hill, Tennessee facility is expected to create 1,300 jobs and production is set to begin in late 2023.²⁹⁰ Lastly, the \$2.6 billion Lansing, Michigan plant is expected to create more than 1,700 new Ultium Cells jobs once completed in 2024.²⁹¹ On July 25, 2022, GM and LG Energy Solutions secured a \$2.5 billion loan from the U.S. Energy Department to finance the construction of the three Ultium Cells manufacturing facilities.²⁹²

Honda and **LG Energy Solutions** announced a new joint-venture and plans to invest \$4.4 billion to establish a new EV battery plant in the U.S. The plant is expected to reach an annual production capacity of 40 GWh. Although the location of the plant has yet to be determined, the joint-venture aims to begin construction on the facility in early 2023, with mass production of EV batteries stated to begin by the end of 2025.²⁹³

LG Energy Solutions announced that it will invest \$1.4 billion to build a battery manufacturing factory with a production capacity of 11 GWh in Arizona by 2024, making it the first factory in the U.S. to build cylindrical cells, commonly used in Tesla and Lucid vehicles. The company says that there is potential to add further production capacity in the future determined by demand for the cylindrical batteries.²⁹⁴



Electric Vehicle Battery Production Announcements

Mercedes-Benz has spent \$1 billion to open a new battery manufacturing plant in Tuscaloosa, Alabama. The plant will create 600 new jobs and will supply lithium-ion batteries for the EQS and EQE SUV models.²⁹⁵

Panasonic plans to build a \$4 billion EV battery plant in De Soto, Kansas—a project that is expected to result in 4,000 direct new jobs.²⁹⁶

Redwood Materials, Inc. announced that it plans to spend \$3.5 billion on a battery-factory plant outside of Reno, Nevada. The plant is expected to be one of the first facilities in the U.S. that will produce key materials for EV batteries. Construction of the plant is expected to last 10 years and will provide more than 1,500 full-time jobs in that time frame. The plant will aid Redwoods in their vision of building a closed-loop battery ecosystem aimed at cutting dependence on imported materials while simultaneously lowering EV costs.²⁹⁷

Piedmont Lithium, a North Carolina-based company, will invest \$582 million to build a lithium hydroxide processing, refining, and manufacturing facility in Etowah, Tennessee. This facility is slated to be the largest lithium hydroxide, processing facility constructed in the United States, producing a key component in the manufacturing of EV batteries. The facility will start production in 2025, and will result in 120 EV battery manufacturing jobs.²⁹⁸

Rivian Automotive plans to build a \$5 billion battery and assembly plant east of Atlanta, Georgia, that is projected to employ as many as 10,000 workers.²⁹⁹

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.³⁰⁰

Semcorp, a Shanghai-based EV battery component producer, announced that it will invest \$916 million in a battery manufacturing plant in Sidney, Ohio to produce separator film for lithium-ion batteries. The plant will employ nearly 1,200 people.³⁰¹

Sparkz, an energy startup, plans to build an EV battery plant in Taylor County, West Virginia. The plant will employ 350 workers. The plant will produce EV batteries for off-road and commercial vehicle markets with a primary focus on mining, farming, and delivery vehicles.” (citation: Nolting, Mike. “Sparkz bringing battery manufacturing facility to Taylor County.”³⁰²



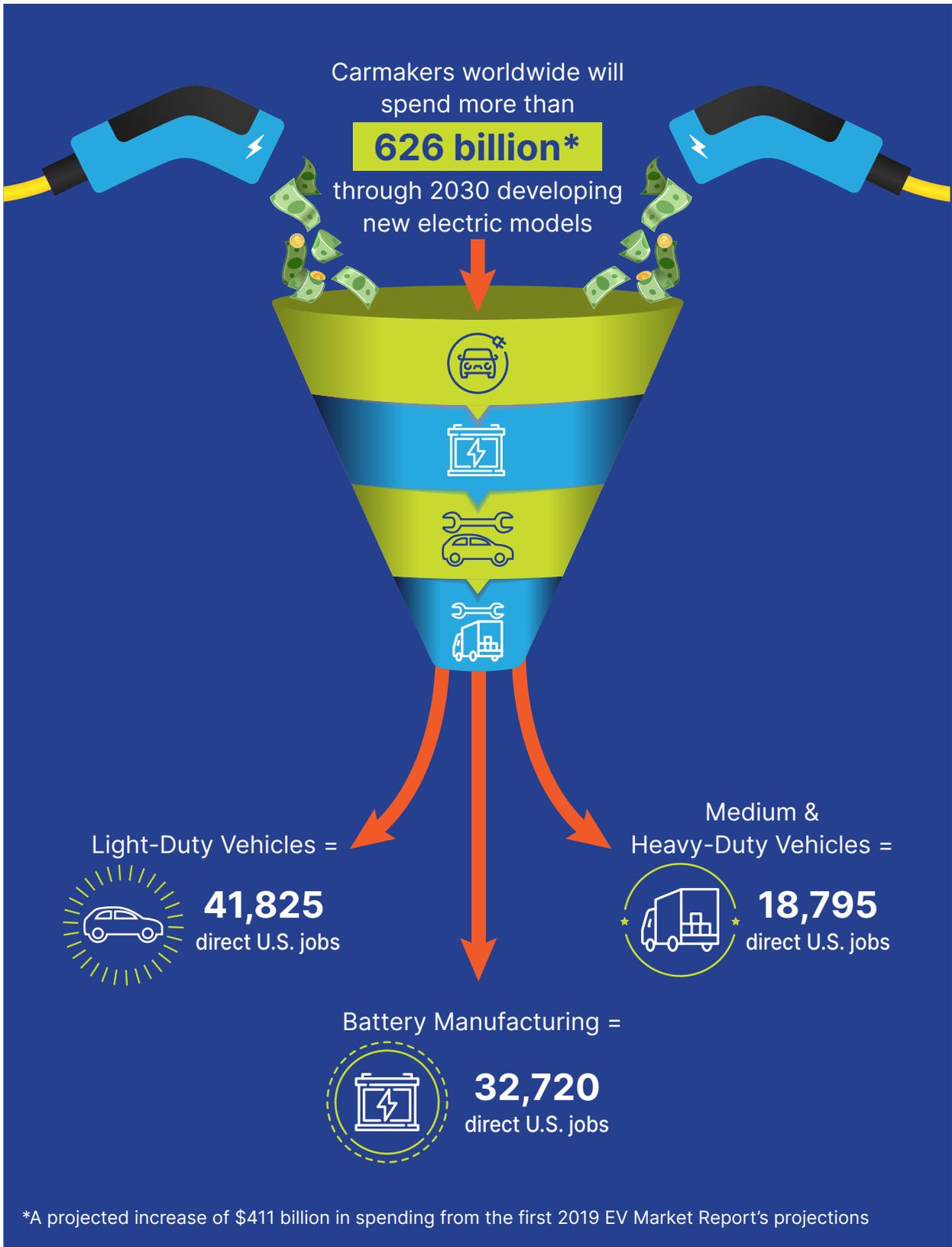
Electric Vehicle Battery Production Announcements

Stellantis has paired with LG Energy Solution to formulate a joint venture to produce battery cells and modules for North America. The new plant, located in Windsor, Ontario, will employ about 2,500 people producing over 500,000 vehicles per year. The two companies plan to spend \$4.1 billion to build the plant and is expected to open early 2024. The factory will aim to have an annual production capacity of 40 GWh. Stellantis has announced that its current factory in Windsor that produces strictly minivans will now begin to produce an electric vehicle.³⁰³ Stellantis and Samsung SDI announced a joint venture to invest over \$2.5 billion for a lithium-ion battery production plant in Kokomo, Indiana with an annual production capacity of 23 GWh, aiming to increase to 33 GWh in the next few years. The plant is set to add 1,400 new jobs and production is targeted for 2025.³⁰⁴

Subaru is investing \$1.9 billion on electric vehicle battery capacity over the next 5 years.³⁰⁵

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 2025.³⁰⁶ In an agreement with Panasonic, the two companies will purchase lithium from Ioneer Ltd's Rhyolite Ridge mining projects in Esmeralda County, Nevada.³⁰⁷ Over the agreement's 5 years, Ioneer will supply Prime Planet Energy Solutions (PPES), formed by Toyota and Panasonic in 2020, with 4,000 tonnes of lithium carbonate annually. The agreement commits PPES to utilize the lithium to build EV battery parts in the U.S. for its market. Currently PPES is based in Japan and is considering building a battery manufacturing plant in western North Carolina. Additionally, **Toyota** will invest an additional \$2.5 billion into its newest battery manufacturing facility located in North Carolina. This investment adds capacity to support BEV battery production and adds 350 jobs to the facility. The facility is expected to begin production in 2025.³⁰⁸

VinFast, a Vietnamese automaker, announced that it will invest \$4 billion into its first electric vehicle manufacturing and battery production facility in the U.S. The plant will employ 7,500 people and produce more than 250,000 vehicles a year. Production is set to begin in 2024.³⁰⁹



Charging Network Investments

Creating an accessible public charging network will be essential to achieving wide-spread EV adoption. For light-duty vehicles, this will be critical for reducing range anxiety for long trips and for expanding the population of drivers who can comfortably own EVs. For medium- and heavy-duty vehicles, while much of charging is expected to be private and depot-based, investing in publicly accessible charging will be critical for electrifying certain use cases, such as long-haul trucking. Automakers, private charging companies, and states and local governments are all making investments to build out this system.

Light-Duty Vehicles

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.

As of July 2022, there were approximately 6,358 Direct Current Fast Chargers (DCFC) stations (24,695 EVSE ports) and approximately 43,609 Level 2 (L2) stations (96,631 EVSE ports) in the U.S.³¹⁰ Today, five networks make up over 84 percent of DCFCs nationally (Figure 11), while one company— ChargePoint —dominates the public L2 market with 26,239 stations (Figure 12).

Figure 11. Number of DCFC Stations by Network in the U.S.

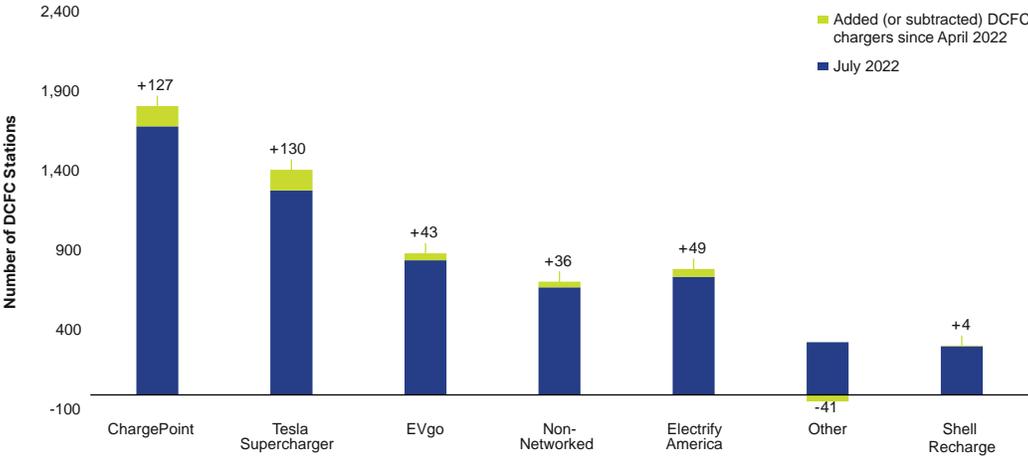
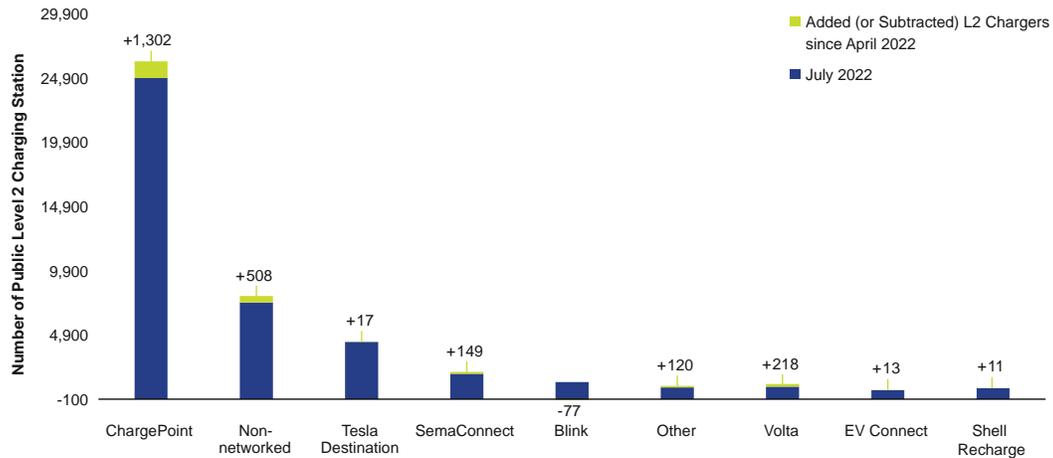


Figure 12. Number of Public Level 2 Charging Station by Network in the U.S.



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 updates since the last version of this report include:

- Rivian started building out the Rivian Adventure Network with dozens of chargers available by biking and hiking trails and destination spots. In late June 2022, Rivian deployed its first three DC fast charging sites in California and Colorado for its R1T electric pickup truck.³¹¹ 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.
- Electrify America and Genesis have partnered to offer owners of the new 2023 Genesis GV60 three years of free 30-minute charging. GV60 owners will have access via Electrify America’s mobile app to its roughly 800 charging stations and nearly 3,500 individual L2 and DCFC chargers. This is Electrify America’s thirteenth partnership.³¹²
- Electrify America announced that it has raised \$450 million for its charging network. The company announced that Siemens invested a “low triple-digit” amount giving the Company a seat on Electrify America’s board.³¹³
- FLO, a Canadian EV charging company, announced that it will open its first U.S. manufacturing plant outside of Detroit, Michigan in 2023. FLO plans to spend \$3 million and add 57 workers in 2023 and gradually expand to 277 employees by 2028. This plant is a crucial part of FLO’s goal to make and deploy more than 250,000 chargers in the U.S. market by 2028.³¹⁴
- GM is partnering with EVgo and Pilot Co. to bring 2,000 DCFCs to highway corridors across the U.S. at as many as 500 Pilot and Flying J gas stations starting later this year.³¹⁵ The chargers will bear Pilot’s name and be sub-branded with GM’s name while EVgo will engineer and operate the charging stalls. The partnership announced that it plans to identify federal, state, and local funding to install the stations.
- The Joint Office of Energy and Transportation announced that it will award \$1.5 million to National Association of State Energy Office (NASEO) and the American Association of State Highway and Transportation Officials (AASHTO) to develop and deploy a national EV charging network.³¹⁶

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, such as Shell, Chevron, TotalEnergies, ExxonMobil, and BP.³¹⁷ In 2021, Shell's public charging network, Shell ReCharge, announced its plans to install 500,000 publicly accessible chargers across the globe by 2025.³¹⁸

The Status of Charging Stations

Between January 2021 and 2022, there has been a 20% increase of public 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.

Medium- and Heavy-Duty Vehicles

Due to the use cases and patterns for many medium- and heavy-duty vehicles, it is expected that the majority of charging needs can be met by private, depot-based charging. For example, NREL calculates that 87 percent of U.S. medium- and heavy-duty fleet's primary operating range is less than 200 miles, and that 70 percent operate primarily within 100 miles.³¹⁹ EDF has noted that "[t]he vehicles that are most ready for electrification in the 2027-2029 timeframe are those that rely on depot charging... These vehicles include delivery vans, transit buses, box trucks, refuse haulers and last-mile-delivery trucks among other market segments."³²⁰

However, there are likely to be public charging needs for longer-range trips, both as a "safety net" for local use cases and to support long-haul applications, including around 10 percent of heavy-duty trucks in the U.S. that have a primary operating range of 500 miles or more.³²¹ While some smaller medium-duty vehicles may be able to rely on the light-duty charging network, larger vehicles will need significantly different site configurations and a mix of high-powered and ultra-high-powered charging ports to support long-haul trucks.³²² According to an analysis conducted by ICF, today's average Class 8 electric truck would consume approximately 660 kWh of electricity a day. Even if overnight charging is feasible, charging power needed would significantly exceed the charging capacities at existing light-duty stations.³²³

Analysis by Atlas Public Policy suggests that the U.S. will need to commit between \$100 billion and \$166 billion in charging infrastructure investments this decade to support an acceleration in electric truck adoption. The wide range in the findings reflects uncertainty in utilization rates for on-road charging and the required amount of on-road versus depot charging.³²⁴ ICCT estimates 2 million overnight private chargers (e.g., depot) are needed for 2.4 million U.S. ZEV tractors by 2050 (around 77 percent of all chargers). These investments will likely be needed by 2030 to support an increase in electric long-haul trucks through 2035 due to long project and utility lead times for high-powered sites. Targeting high-traffic corridors first and serving multiple vehicle types at each site can increase utilization of on-road charging and significantly reduce needed investments.³²⁵

To date, there have been limited investments in public medium- and heavy-duty charging. One of the most advanced initiatives is the West Coast Clean Transit Corridor Initiative, an ongoing, collaborative effort among 16 utilities to support the development of electric vehicle charging facilities along I-5, from San Diego to British Columbia, for heavy- and medium-duty freight haulers and delivery trucks. Following an initial June 2020 report outlining conceptual charging sites,³²⁶ the West Coast utilities are conducting grid readiness assessments in preparation for infrastructure installations and upgrades that will support vehicle charging capacities of at least 3.5 megawatts with potential for further upgrades to create even higher-power sites.³²⁷

As M/HD manufacturers prepare to bring more electrified models to market, they are also recognizing the need for a robust, well-developed charging ecosystem. Notable updates since the last version of this report include:

- **Traton SE** signed a joint venture agreement with Daimler Trucks and the Volvo Group to spend €500 million (~\$495 million) to build a European network of at least 1,700 public chargers for battery-electric heavy-duty trucks and buses.³²⁸
- **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.³²⁹
- **Volvo Trucks North America**, in partnership with Volvo Financial Services, Volvo Technology of America, Shell Recharge Solutions, TEC Equipment, Affinity Truck Center, and Western Truck Center, announced plans to develop a publicly accessible electric M/HD charging network that will connect several California cities.³³⁰ The Electrified Charging Corridor Project was awarded \$2 million from the California Energy Commission under the BESTFIT Innovative Charging Solutions program to help address the key barriers to associated to long-range electric M/HD deployment and adoption. The project will install several high-powered charging stations by 2023 at existing Volvo Trucks' dealerships.
- **ABB E-mobility**, a global EV charging infrastructure manufacturer, announced that it will spend \$4 million to open an EV charger factory in Columbia, South Carolina. The facility is expected to produce up to 10,000 EV chargers per year, with voltages ranging from 20 kW to 180 kW, and are intended for public use, school buses, and commercial fleets.³³¹



Conclusion

The next five to ten years could be the most significant years in the history of the auto industry as the globe transitions to zero-emission vehicles. Implementation of monumental policy developments, such as the Advanced Clean Cars II update, the Advanced Clean Trucks rule, and the passage of the historic Infrastructure Investment and Jobs Act and Inflation Reduction Act, will continue to make transportation electrification more affordable and accessible to the consumer. Automakers and battery manufacturers worldwide will spend more than \$626 billion through 2030 developing light-duty and medium- and heavy-duty electric vehicles. As advancements in electric vehicle technology continues, electric vehicles are expected to reach cost parity with internal combustion engine vehicles when battery pack prices fall below \$100/kWh.

By 2025, it is estimated that there will be approximately 187 battery electric (BEV) and plug-in hybrid (PHEV) passenger vehicle models available to U.S. consumers. 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.

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. The adoption of Advanced Clean Cars II will drive toward 100 percent ZEV sales by 2035 across states that will adopt the standards, providing an estimated \$12 billion in public health benefits. The historic adoption of the Inflation Reduction Act of 2022 will invest about \$369 billion in Energy Security and Climate Change programs over 10 years, the single biggest climate investment in U.S. history. These policy commitments will work hand in hand with manufacturer efforts to push ZEVs further into the mainstream, providing massive benefits to drivers and society at large.

Appendix A: Manufacturer Commitments for Light-Duty Vehicles

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
LUCID	\$700M in AZ plant											
Mercedes-Benz (of Daimler)	\$1B in AL plant			130 electrified variants (10 new electric) Entire portfolio electrified			\$47B in electrification through 2030					100% of sales are electrified
Nissan	Acquired Enevate Corporation			1M electrified vehicles sold annually 8 new BEV models			20-30% of U.S. sales are electrified \$23B in electrification through 2027					40% of sales are electrified
(of VW)	\$70M DCFC investment at dealerships		\$6.7B in electrification through 2022				50% of new vehicles "could have an electric drive system"					80% of sales are electrified
Tesla	\$1B in TX Gigafactory		\$4.5B to \$6B per year in 2021 and 2022									
Toyota		10 BEVs in early 2020s (6 to be released in 2020)					40% of sales electrified					5.5M electrified vehicles (1M ZEVs)
Volkswagen	\$1.12B in battery production in Germany \$800M in TN plant	\$2.2B in Chinese auto maker/battery production plant \$200M in QuantumScape (solid-state battery)					\$70B on electrification through 2030	70 electrified models (15 BEVs, 7 in the new Toyota bZ BEV line)				20M BEVs produced 70 BEV models Expects BEV sales: 70% in Europe 50% in U.S. and China
Volvo	Acquired Freewire Technologies	Every future car will have an electric motor	Invest 5% of annual revenue (~1B) to develop and build EVs				50% sales are BEV, 50% are hybrids Reach 1M electrified cars on road					100% of sales BEV
Audi (of VW)							20 BEV, 10 PHEV models 40% of sales are electrified					
Bentley (of VW)							Exclusively sell BEVs/PHEVs					Exclusively sell BEVs
BMW	500,000 e-vehicles		5 BEV models \$36M in battery start-up with U.K. Government		25 electrified models (at least 12 BEVs)		\$33B on future oriented technologies through 2025	30% growth each year to 2025 (Goal: 700,000 e-cars)				7 million e-vehicles on the road (2/3 all electric)
DAIMLER	\$22.5B battery cell purchase	Smart brand: only selling cars with electric systems in Europe/N. America		10 BEV models			25% of sales are BEV					50% of sales are electrified Ambition2039: Carbon-neutral new passenger car fleet by 2039 →
STELLANTIS	\$4.5B investment across 5 MI plants	More than 30 electrified models (Jeep: at least 10 PHEV and 4 BEVs)					\$35.5B on electrification through 2025					70% of European and 40% of U.S. Sales are LEV
Ford	\$1.45B in MI plants	\$11.4B in battery investment with SK Innovation		40 electrified (16 BEV 24 PHEV)			\$22B on electrification through 2025					Transition to electric-only product line-up between 2025—2030 50% of global sales are BEV by 2030
GM	\$300M in MI plant \$2.3B in OH \$2.2B in Factory battery plant Cadillac will introduce a new model every 6 months		\$2.6B in TN battery plant				\$35B on investment in EV and AV through 2025	1M EV units globally				
Hyundai					23 electrified models (5 BEV) - dedicated EV brand IONIQ		\$17B in EVs and AVs through Strategy 2025 \$7.4B in U.S. Manufacturing by 2025	44 electrified models (23 BEV)				1M EVs across brands

Green Model announcements
Orange Investments (converted to USD\$) or acquisitions
Blue EV sales forecast
 [] New addition in updated report
Overarching electrification investment

Table 1A: Manufacturer Targets: Reduction in Lifecycle CO₂ Emissions From New Cars Sold

Manufacturer	Overarching Goal	Targeted Reduction in Lifecycle CO ₂ Emissions from New Cars Sold			
		2025	2030	2035	2040
BMW	Business ambition for 1.5°		33% or more		
Daimler	Scope 3 SBTi: 42% reduction by 2030			2039: carbon-neutral	
Ford	Carbon neutral by 2050				
General Motors	Carbon neutral by 2040		2035: eliminate tailpipe emissions		
Honda	Business ambition for 1.5°		30%	50%	
Toyota	Business ambition for 1.5°	30% or more	35% or more		90% or more
Volkswagen Group	Carbon neutral by 2050	30% or more	Reduce to 74g CO ₂ /km		
Volvo	Carbon neutral by 2040	40% or more			

Appendix B: Model Announcements – LDV

BEV Announcements

Bolded entries are new updates since last version

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Acura	SUV	ADX	2024			\$55,000
Alpha Motor	Truck/Van	Wolf	2023		250	\$46,000
Atlis Motor Vehicles	Truck/Van	XT	2023	125	300	\$45,000
Audi	Luxury Sedan	A6 e-tron	2023		400	
Audi	Luxury SUV	e-tron	2022	95	226	\$66,800
Audi	Luxury SUV	e-tron S	2022	95	208	\$85,200
Audi	Luxury SUV	Q4 e-tron	2022	82	241	\$49,900
BMW	Luxury Sedan	i4	2022	81	301	\$55,900
BMW	Luxury SUV	iX	2022	111.5	324	\$83,200
Buick	Sedan	Electra	2025			\$50,000
BYD	Luxury SUV	e6	2022	80	250	\$35,000
BYTON	Sedan	M-Byte	2022	72	224	\$45,000
Cadillac	Luxury Sedan	Celestiq	2025			
Cadillac	Luxury SUV	LYRIQ	2023	19	312	\$62,990
Canoo	Truck/Van	Lifestyle Vehicle	2022	80	250	\$34,750
Canoo	Truck/Van	MPDV1	2023	40-80	130-230	\$33,000
Canoo	Truck/Van	Pickup	2023		200	
Chevrolet	SUV	Blazer	2023			
Chevrolet	Sedan	Bolt	2022	66	259	\$31,500
Chevrolet	SUV	Bolt EUV	2022	65	247	\$33,500
Chevrolet	SUV	Equinox	2023		300	\$30,000
Chevrolet	Truck/Van	Silverado	2023		400	\$39,900
Dodge	Sedan	eMuscle	2024			
Fisker	Luxury SUV	Ocean	2022		250	\$37,499
Fisker	SUV	Pear	2024		250	\$29,990
Ford	Truck/Van	F-150 Lightning	2022	98	230	\$39,974
Ford	SUV	Mustang Mach-e	2022	68	224	\$43,895
Genesis	Luxury SUV	GV60	2022	77.4	248	\$58,890

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Genesis	Luxury SUV	Electrified GV70	2023			\$50,000
Genesis	Luxury Sedan	G80	2023		310	\$48,745
GMC	Truck/Van	Hummer EV Pickup or SUV EV2	2024		250	\$84,650
GMC	Truck/Van	Hummer EV Pickup or SUV EV2X	2023		300	\$94,650
GMC	Truck/Van	Sierra Denali	2023			
Hyundai	SUV	Ioniq 5	2022	77.4	303	\$39,950
Hyundai	Sedan	Ioniq 6	2023	53		\$45,000
Hyundai	SUV	Kona Electric	2022	64	258	\$34,000
Indi	Hatchback	One	2023	75	230	\$45,000
Jaguar	Luxury SUV	I-Pace	2022	90	234	\$71,300
Jeep	SUV	Wrangler	2024			\$50,000
Jeep	SUV	Recon	2024			
Jeep	SUV	Wagoneer S	2024		400	
Kandi	Sedan	K23	2022	18	80	\$22,499
Kandi	Sedan	K27	2022	18	116	\$11,999
Kandi	Truck/Van	K32	2022	20.7	60	\$30,499
Karma	Luxury Sedan	GSe-6	2022	110	300	\$79,900
Kia	Sedan	EV6	2022	77.4	339	\$33,900
Kia	SUV	EV9	2023			
Kia	SUV	Niro EV	2022	64	293	\$39,990
Lexus	Luxury SUV	RZ 450e	2023		225	\$55,000
Lordstown Motors	Truck/Van	Endurance	2023		250	\$52,500
Lucid Motors	Luxury Sedan	Air	2022		406	\$87,400
Mazda	SUV	MX-30 EV	2022	33.5	100	\$33,470
Mercedes Benz	Luxury SUV	EQB	2022			
Mercedes Benz	Luxury SUV	EQC	2022		200	\$68,895
Mercedes Benz	Luxury SUV	EQE	2023			\$85,000
Mercedes Benz	Luxury SUV	EQS	2023			
MINI	Sedan	Mini Cooper SE Electric	2022	32	110	\$34,225

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Mullen	SUV	Mullen Five	2023	95	325	\$55,000
Nissan	SUV	Ariya	2022	63	304	\$45,950
Nissan	Sedan	Leaf	2022	40	226	\$27,800
Polestar	Luxury Sedan	Polestar 2	2022	78	270	\$40,900
Polestar	Luxury SUV	Polestar 3	2022			
Porsche	Luxury SUV	Macan	2024			\$80,000
Porsche	Luxury Sedan	Taycan Cross Turismo	2022	93.4	215	\$95,050
Porsche	Luxury Sedan	Taycan	2022	79.2	282	\$86,700
Ram	Truck/Van	1500	2024			
Rivian	Truck/Van	R1T	2023	105	314	\$67,500
Rivian	SUV	R1S	2023	105	316	\$72,500
Subaru	SUV	Solterra	2023		220	\$44,995
Tesla	Luxury Sedan	Model 3	2022	54	267	\$46,990
Tesla	Truck/Van	Cybertruck	2022		250	\$39,990
Tesla	Luxury Sedan	Roadster	2023		620	
Tesla	Luxury SUV	Model Y	2022	75	318	\$65,990
Toyota	SUV	bZ4X	2023	71.4	252	\$42,000
Vinfast	SUV	VF8	2022		292	\$40,700
Vinfast	SUV	VF9	2022		369	\$55,500
Volkswagen	SUV	I.D. 4	2022	48	275	\$41,230
Volkswagen	SUV	I.D. Buzz	2024	111	270	
Volkswagen	Sedan	ID.Space Vizzion	2022			
Volvo	Luxury SUV	C40 Recharge	2022	75	226	\$55,300
Volvo	Luxury SUV	XC40 Recharge	2022	75	223	\$53,550
Volvo	Luxury SUV	XC60	2024			
Volvo	Luxury SUV	XC 90	2022			
Volvo	Luxury SUV	XC100	2023			\$85,000

PHEV Announcements

Bolded entries are new updates since last version

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Alpha Romeo	Luxury SUV	Tonale	2023	15.5	30	\$38,000
Audi	Luxury SUV	Q5	2022	17.9	20	\$55,400
Audi	Luxury Sedan	A7	2022	17.9	26	\$75,900
BMW	Luxury Sedan	330e	2022	12	21	\$43,300
BMW	Luxury Sedan	530e	2022	12	21	\$55,550
BMW	Luxury SUV	X5 xDrive45e	2022	24	31	\$65,700
Chrysler	Truck/Van	Pacifica Hybrid	2022	16	32	\$46,978
Ford	SUV	Escape	2022	14.4	37	\$35,455
Hyundai	SUV	Tucson	2022	7.2	33	\$35,400
Hyundai	SUV	Santa Fe	2022	12.4	30	\$40,000
Jeep	SUV	Grand Cherokee 4xe	2022		25	\$60,695
Jeep	SUV	Wrangler 4xe	2022		21	\$54,595
Karma	Luxury Sedan	GS-6	2022		80	\$93,000
Kia	SUV	Niro	2022	8.9	26	\$29,590
Kia	SUV	Sorento	2022	13.8	32	\$45,190
Land Rover	Luxury SUV	Range Rover Sport	2022	13.1	48	\$83,000
Lexus	Luxury SUV	NXh+	2022	40	37	\$57,255
Lincoln	Luxury SUV	Corsair Grand Touring	2022	14.4	28	\$51,810
Lincoln	Luxury SUV	Aviator Grand Touring	2022		21	\$69,740
Mitsubishi	SUV	Outlander	2022	12	22	\$36,995
Porsche	Luxury SUV	Cayenne	2022	14	17	\$86,500
Subaru	SUV	Crosstrek	2022	8.8	17	\$36,845
Toyota	Sedan	Prius Prime	2022	8.8	25	\$28,670
Toyota	SUV	RAV4 Prime	2022		42	\$40,300
Volvo	Luxury Sedan	V60 Recharge	2022	10.4	41	\$70,550
Volvo	Luxury Sedan	S60 Recharge	2022	10.4	41	\$51,250
Volvo	Luxury SUV	XC60 Recharge	2022	10.4	35	\$57,200
Volvo	Luxury Sedan	S90 Recharge	2022	10.4	38	\$70,500
Volvo	Luxury SUV	XC90 Recharge	2022	10.4	32	\$71,900

Unconfirmed or Soft Model Announcements

Manufacturer	Vehicle Type	EV Type	Model Name	Planned Availability
Alpha Motor	Sedan	BEV	Jax Saga Estate Saga Ace Coupe	
	Truck/Van		Wolf +Super Wolf	
Alpha Romeo		BEV and PHEV	Giulia or Stelvio One large flagship model	2025 One large flagship model in 2027
Bentley	SUV	PHEV	Bentayga Hybrid Flying Spur Hybrid	2021
Bentley		BEV		2025
BMW	SUV Sedan	BEV	X1 5-series	Announced will offer electrified versions, did not confirm specs or other information
BYTON	Sedan	BEV	K-Byte	Unclear due to COVID and unconfirmed for U.S.
Chrysler	Sedan	BEV	Airflow	2025
Ford	SUV	BEV	Explorer	2023
Honda		BEV	Fit/Jazz	
Honda	SUV	BEV	Prologue	2024
Hyundai	SUV	BEV	Ioniq 7	2024
Jeep	SUV	PHEV	Renegade Compass	Unconfirmed for U.S.
		BEV	Wrangler	2023
Kia	SUV	BEV	Stonic EV9	Unconfirmed for US 2023
Lucid Motors	Luxury SUV	BEV	Project Gravity	2024

Manufacturer	Vehicle Type	EV Type	Model Name	Planned Availability
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)	Announced 10 new electric models by 2022
Mullen	SUV	BEV	Ottava	2024
Polestar	SUV Sedan	BEV	Polestar 4 Polestar 5	2023 2024
Toyota	3 SUVs* (one would be a Subaru collaboration) 2 Trucks/ Vans*1 Sedan*	BEV	Unnamed	Announced June 2019 for 2020-2025 2 SUVs to be announced in 2021
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.

Figure 2A: Price-Range Matrix: BEV Models Available in 2022

Bolded entries are new updates since last version.

		Price (\$)			
		0–30,000	30,000–40,000	40,000–70,000	70,000+
Range (Miles)	0–150	Kandi K27 Kandi K23	Kandi K32 Mazda MX-30 MINI Cooper SE		
	150–250	Nissan LEAF	BYD e6 Canoo Lifestyle Vehicle Chevrolet Bolt EUV Ford F-150 Lightning Fisker Ocean Tesla Cybertruck	Audi e-tron Audi Q4 Byton M-Byte Ford Mach-e Genesis GV60 Mercedes EQC Volvo C40 Recharge Volvo XC 40 Recharge	Audi e-tron S Jaguar I-Pace Porsche Taycan Cross Turismo
	250+		Hyundai Kona Electric Chevrolet Bolt Hyundai Ioniq 5 Kia Niro	BMW i4 Nissan Ariya Polestar 2 Tesla Model 3 Tesla Model Y Vinfast VF8 Vinfast VF9 Volkswagen I.D. 4	BMW iX Karma GSe-6 Lucid Motors Air

Appendix C: Model Announcements – Medium- and Heavy-Duty Vehicles

Medium-Duty Vehicles

Bolded entries are new updates since last version

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	Range (mi)
Electric Last Mile Services	Elms Urban Utility	Class 1	Cargo Van	2022		
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

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	Range (mi)
Utilimaster	Reach EV	Class 3	Step Van			
Utilimaster	Velocity M3	Class 3	Cargo Van		120	75
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
Centro 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
Chanje	V8100	Class 5-6	Cargo Van	2021	100	150
Daimler	Freightliner MT50e (Chassis)	Class 5-6	Box Truck	2021	226	125

Manufacturer	Model	Weight Class	Vehicle Type	Availability	Battery (kWh)	Range (mi)
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
Phoenix 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
Lightning eMotors	Transit Passenger Van	Shuttle	2021	86, 105	140, 170
Lightning eMotors	E-450 Shuttle	Shuttle	2021	86, 129	80, 120

Manufacturer	Model	Category	Availability	Battery (kWh)	Range (mi)
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
Phoenix 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

M/HDV 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 ZEV Investments and Jobs by State ”

Bolded entries are new updates since last version.

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.
	Hyundai	Hyundai announced it will begin building the Electrified Genesis GV70 and the hybrid version of the Santa Fe at its Montgomery, Alabama plant—investing \$300 million and create 200 new jobs.
Arizona	Atlis Motor Vehicles	Atlis launched 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.
	LG Energy Solutions	LG Energy Solutions announced that it will invest \$1.4 billion to build a battery manufacturing factory with a production capacity of 11 GWh in Arizona by 2024, making it the first factory in the U.S. to build cylindrical cells, commonly used in Tesla and Lucid vehicles.
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.

State	Company	ZEV Investment and Jobs
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.
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.
	Hyundai	In agreement with the State of Georgia, announced that it will build its first EV and battery dedicated manufacturing plants in Bryan County, GA. The company will invest \$5.54 billion, breaking ground in 2023 with expected production to begin in 2025. The factory will supply almost 8,100 jobs and produce roughly 300,000 units annually utilizing AI technology and data in all processes of production.
	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. In agreement with the State of Georgia, Rivian has received \$1.5 billion in public funding,
	Blue Bird	Announced a plan to launch production of Blue Bird's Class 5-6 EV chassis in late 2023 at its manufacturing facility in Fort Valley, Georgia.
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.

State	Company	ZEV Investment and Jobs
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.
		Stellantis and Samsung SDI announced a joint venture to invest over \$2.5 billion for a lithium-ion battery production plant in Kokomo, Indiana with an annual production capacity of 23 GWh, aiming to increase to 33 GWh in the next few years. The plant is set to add 1,400 new jobs and production is targeted for 2025.
Toyota Motor	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.	
Kansas	Panasonic	Plans to build a \$4 billion EV battery plant in Kansas—a project that is expected to result in 4,000 direct new jobs.
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 Lincoln vehicles.
	Envision Automotive Energy Supply Corp. (AESC)	Will invest \$2 billion to build a 3 million square-foot battery technology plant in the Kentucky Transpark and create 2,000 new jobs. The factory is expected to produce batteries for 300,000 vehicles annually once it becomes fully operational in 2027.
	Ascend Elements	Ascend Elements, a U.S. company, announced its plans to invest up to one billion dollars in a factory to produce sustainable battery materials for electric vehicles. Production is scheduled to start at the end of 2023 and add up to 400 jobs. The plant is expected to produce enough lithium-ion cathode materials for up to 250,000 electric 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.

State	Company	ZEV Investment and Jobs
Maryland	Greenland Technologies	Greenland Technologies, a technology developer and manufacturer of electric industrial vehicles and drivetrain systems for material handling machineries a vehicles, has announced that it will open a 50,000 square-foot manufacturing facility in Baltimore County, Maryland to support its increasing demand for its line of electrical industrial vehicles.
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	FLO	FLO will invest \$3 million in a new EV charger manufacturing facility in Auburn Hills, MI. This is the company's first U.S. manufacturing facility and it expected to create 133 jobs with production to begin in 2023.
	Ford	In Michigan , the automaker will speed up production of the new F-150 Lightning at the Rouge EV facility to now produce 150,000 units a year. This \$2 billion investment, though also accounted for ICE vehicle improvements, will add nearly 3,200 jobs.
	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. GM announced that it plans to invest another \$81 million to build the Cadillac Celestiq at GM's Warren Technical Center in Michigan.
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 \$95 million in its Kansas City, Missouri Assembly Plant to add a third shift to produce the E-Transit vans, adding 1,100 jobs.
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.
	Redwood Materials	Announced that it plans to spend \$3.5 billion on a battery-factory plant outside of Reno, Nevada. The plant is expected to be one of the first facilities in the U.S. that will produce key ingredients for EV batteries. Construction of the plant is expected to last 10 years and will provide more than 1,500 full-time jobs in that time frame.
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 Automotive	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.
	VinFast	VinFast, a Vietnamese automaker, announced that it will invest \$4 billion in a new EV and battery manufacturing plant in Chatham County, North Carolina. The facility will employ 7,500 people and produce more than 250,000 vehicles a year. Production is expected to begin in 2024. In partnership with the State of North Carolina, VinFast has received \$1.2 billion to invest in their new EV and battery manufacturing plant.
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.
	Ford	In Ohio, Ford will invest \$1.5 billion to refurbish its Ohio Assembly Plant to make an unannounced electric commercial vehicle starting in 2025, adding 1,800 new jobs.
	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.
	Semcorp	Semcorp announced that it will invest \$916 million into a manufacturing plant in Sidney, Ohio that will employ nearly 1,200 peoples. Semcorp is a Shanghai-based producer of EV battery components, and this factory will make separator film for lithium-ion batteries.

State	Company	ZEV Investment and Jobs
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 Kising said that there is \$15 billion of electric auto manufacturing investment in the pipeline looking at Oklahoma.
	Oklahoma Governor'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.
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 Australian-based charging station manufacturer.

State	Company	ZEV Investment and Jobs
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.
	Octopus Energy U.S.	In July 2022, Octopus Energy U.S. announced plans to launch Octopus Electric Vehicles (OEV), a new business venture that aims to accelerate accessibility and adoption of EVs and smart charging.
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.
West Virginia	GreenPower Motor Company	In agreement with the State of West Virginia, announced that it will lease/ purchase a 9.5-acre manufacturing facility in South Charleston that will initially add 200 jobs and eventually add 900 new jobs once the facility reaches full production capacity within the next 2 years. Production on the all-electric school buses is set to begin August 2022.

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