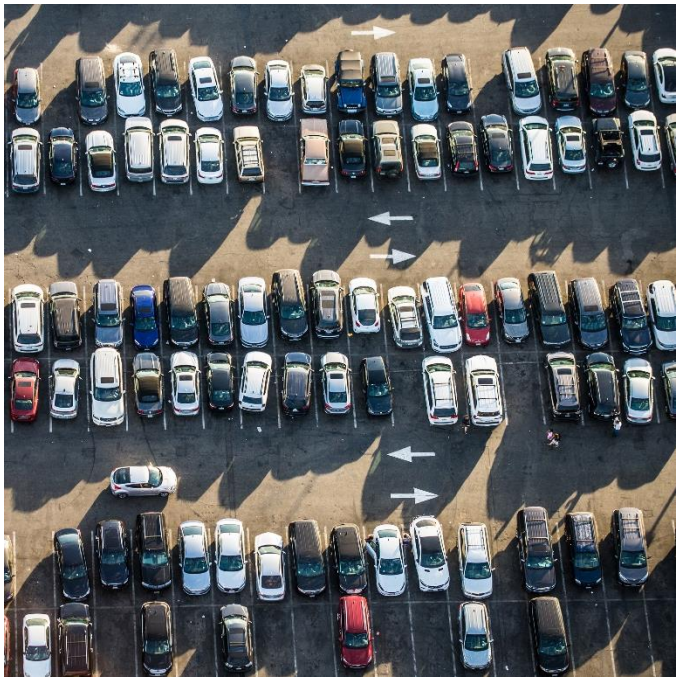
Electric Vehicle Market Status - Update

Manufacturer Commitments to Future Electric Mobility in the U.S. and Worldwide



MJB & A
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Contents

Acknowledgements

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

This report was developed by M.J. Bradley & Associates for the Environmental Defense Fund (EDF).

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MJB&A, an ERM Group company, provides strategic consulting services to address energy and environmental issues for the private, public, and non-profit sectors. MJB&A creates value and addresses risks with a comprehensive approach to strategy and implementation, ensuring clients have timely access to information and the tools to use it to their advantage. Our approach fuses private sector strategy with public policy in air quality, energy, climate change, environmental markets, energy efficiency, renewable energy, transportation, and advanced technologies. Our international client base includes electric and natural gas utilities, major transportation fleet operators, investors, clean technology firms, environmental groups and government agencies. Our seasoned team brings a multi-sector perspective, informed expertise, and creative solutions to each client, capitalizing on extensive experience in energy markets, environmental policy, law, engineering, economics and business. For more information we encourage you to visit our website, www.mjbradley.com.

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Notable Updates Since the January 2021 Report

- On March 31, 2021, President Biden released "The American Jobs Plan," proposing a more than $2 trillion investment to "rebuild and reimagine a new economy." The plan calls on Congress to invest $621 billion in transportation infrastructure and resilience, including a $174 billion investment to "win the EV market."
- President Biden issued three executive orders on revision of the federal vehicle emissions standards, integration of ZEVs into the federal fleet, and a review of and recommendations to address battery supply chain risks.
- Virginia became the thirteenth state and the first in the South to adopt California's low-emissions vehicle (LEV) and zero-emissions vehicle (ZEV) standards.
- After announcing it would commit $22 billion to electrification – nearly twice its previous commitment – and $7 billion to autonomous vehicles through 2025, Ford said that its entire European passenger vehicle line would be ZEV capable, BEV, or PHEV by mid-2026 moving to all-electric by 2030. For commercial vehicles, Ford said they would also be ZEV capable, BEV, or PHEV by 2024, and is expecting two-thirds of sales to be BEV or PHEV by 2030.
- In announcing plans to achieve carbon neutrality by 2040, GM set a goal aspiring to eliminate tailpipe emissions from new light-duty vehicles by 2035. By the end of 2025, GM plans to offer 30 BEV models globally, and BEVs will make up 40 percent of U.S. models.
- Volvo announced it would be a fully electric car company by 2030 by only selling BEVs and phasing out any car in its global portfolio with an internal combustion engine, including hybrids: "There is no long-term future for cars with an internal combustion engine. We are firmly committed to becoming an electric-only car maker and the transition should happen by 2030," said Henrik Green, chief technology officer, of the announcement. On the medium- and heavy-duty side, Volvo Group announced Volvo Energy (formerly a subset of Volvo Trucks) would be responsible for electrification matters like management of batteries over their life-cycle (i.e., second life) and charging infrastructure.
- The Alliance for Automotive Innovation said "the U.S. auto industry is aligned with the Biden Administration's goals to achieve net-zero carbon transportation and an accelerated shift to electric-drive vehicles, and is committed to working with the administration on a revised national program that includes California, brings all automakers under a unified set of common requirements and ensures a level, competitive playing field." One month later, the Alliance sent a joint letter with the United Autoworkers International Union (UAW) and the Motor & Equipment Manufacturers Association (MEMA) to President Biden stating that "the road leads to an increasingly electrified future," and the groups would commit to collaborating with the Administration on crafting and implementing a comprehensive plan that focusses on three key areas: consumers; infrastructure; and innovation, manufacturing, and supply chain.
- Manufacturers have announced nine new models for sale in the next three years, and GM announced Chevy will produce an electric Silverado pickup at its Factory ZERO Detroit plant.
- Manufacturers announced investments in light-duty factories in Tennessee; medium- and heavy-duty factories in Colorado, Indiana, and North Carolina; and battery factories in Georgia, Massachusetts, Michigan, Ohio, and Tennessee, including LG Energy Solutions' announcement that by the end of 2025, the company will invest more than $4.5 billion in its U.S. business to further expand its battery production capacity, potentially adding 10,000 additional jobs. Additionally, LG Chem and SK Innovation, two of the world's largest battery manufacturers, reached a trade deal that will allow the construction of SK Innovation's $2.6 billion Georgia manufacturing plant to move forward.
- Major electrification commitments include the Montgomery County Public Schools district, one of the largest in the country with more than 200 schools that serve 160,000 students, commitment to electrify its 1,400 school buses and FedEx announcing that its entire parcel pickup and delivery fleet will be zero–emission electric vehicles by 2040.
- As 2020 concluded, EV sales are estimated to have reached 2.5-3 million globally. Despite the pandemic, sales of EVs grew year over year from 2019 to 2020 in many places around the world while car sales shrank overall. Global EV sales increased 46 percent with EV sales in the U.S. growing four percent while overall car sales decreased 15 percent. In Europe EV sales increased 135 percent compared to a 24 percent decline in the overall car market.

Executive Summary

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

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

Transportation is currently the United States' largest source of greenhouse gas (GHG) emissions, and transportation-sector electrification is widely recognized as one of the best strategies for significantly reducing these emissions. The data summarized here support the conclusion that the automotive industry has embraced the vision of electrified mobility and that the EV market is on the cusp of a period of significant growth. Numerous manufacturers have publicly signaled their commitment to a future of electric vehicles. For example, Volvo's chief technology officer said that "there is no long-term future for cars with an internal combustion engine. [Volvo is] firmly committed to becoming an electric-only car maker and the transition should happen by 2030" after announcing they would only sell electric vehicles by 2030.[1] General Motors' (GM) CEO Mary Barra said that "at GM, we believe that after one of the most difficult years in recent history, this moment will prove to be an inflection point, the moment when our world's reliance on gas and diesel-powered vehicles will begin transitioning to an all-electric future;" the company then announced later that month that it aspires to eliminate tailpipe emissions from new light-duty vehicles by 2035.[2] Volkswagen (VW) echoed GM's sentiment, stating that "2020 marked a turning point in customer sentiment" after VW's electric sales tripled last year.[3] On a collective front, the Alliance for Automotive Innovation, the main trade group representing the U.S. auto industry, announced that "the U.S. auto industry is aligned with the Biden Administration's goals to achieve net-zero carbon transportation and an accelerated shift to electric-drive vehicles, and is committed to working with the administration on a revised national program that includes California, brings all automakers under a unified set of common requirements and ensures a level, competitive playing field."[4] One month later, the Alliance sent a joint letter with the United Autoworkers International Union (UAW) and the Motor & Equipment Manufacturers Association (MEMA) to President Biden stating that "the road leads to an increasingly electrified future," and the groups would commit to collaborating with the Administration on crafting and implementing a comprehensive plan that focusses on three key areas: consumers; infrastructure; and innovation, manufacturing, and supply chain.[5]

Beyond manufacturer statements, the National Academies of Sciences, Engineering, and Medicine declared that "the period from 2025-2035 could bring the most fundamental transformation in the 100-plus year history of the automobile" as battery costs fall and EVs reach price parity with internal combustion engine vehicles, leading them to become the "dominant type of new vehicles sold by 2035."[6]

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

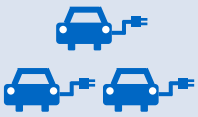
* Updates released August 2019, September 2020, and January 2021.

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

Manufacturer Commitments

Carmakers worldwide will spend more than $268 billion through 2030 developing new electrified passenger vehicle models. Nine manufacturers have already announced plans to spend over $22 billion to open new or renovated plants in the U.S. to build EVs in five different states. These plants will directly employ nearly 24,000 workers and contribute to additional job creation for suppliers and local businesses. Most recently, Ford announced $22 billion in planned investments in electrification through 2025 – nearly twice its previous commitment. As 70 percent of plug-in EVs driven on U.S. roads in 2019 were assembled domestically, these manufacturing plant investments highlight continued cultivation of a strong EV workforce and robust market. The domestic battery supply chain is also growing rapidly with nearly $12 billion announced to date across at least five states that could support 15,000 employees.

Automakers will spend **$268 billion** worldwide on light-duty vehicle **electrification through 2030** with over **$22 billion on domestic manufacturing**



Model Availability

Between 2021 and 2023, the number of battery electric (BEV) and plug-in hybrid (PHEV) passenger vehicle models available to U.S. consumers will increase from 64 to 82.* The range of vehicle types available will also increase to include sport utility vehicles (SUV), cross-overs, and pick-up trucks. 2020 brought improvements in EV range, with the median EPA estimated range exceeding 250 miles for MY2020 EVs and the introduction of the first EV to achieve a range of more than 400 miles; the Cadillac Lyric and Lucid Motors Air have received attention as models that tout 300 and 517 miles of expected EPA-rated range, respectively.

64 EV models in 2021 → **82** EV models in 2023

$

Affordability

In 2021 there will be at least four EV models available for under $30,000 (MSRP) with a driving range of up to 250 miles. There will be even more models with a net cost of under $30,000 when current federal, state, and local incentives are factored in.

EV Sales Projections

Major auto manufacturers are embracing electrification, as evidenced by the increased number and variety of electrified models offered, as well as commitments to brand electrification and sales targets. For example, Volvo anticipates BEVs will make up half of its sales in 2025 (the other half hybrid vehicles) and will move to exclusively sell EVs by 2030. Honda is aiming for two-thirds of its sales to be electrified globally and all sales in Europe by 2025. GM is aspiring to eliminate tailpipe emissions from new light-duty vehicles by 2035. Ford said that its entire European passenger vehicle line would be ZEV capable, BEV, or PHEV by mid-2026 moving to all-electric by 2030.

Volvo anticipates battery electric vehicles will make up **half its sales by 2025**

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

Charging Station Investment

In addition to expanding their portfolios to include a greater range of electric and electrified models, manufacturers like Nissan and Volvo have acquired stakes in companies that specialize in charging and battery technology while Audi, Ford, Mercedes-Benz, and Volkswagen have announced they will each invest billions of dollars in electrification strategies. Manufacturers are increasingly exploring how to expand the charging network for their drivers, demonstrated through the EVgo and GM partnership to install 2,700 new fast charge plugs by 2025 and Rivian's Adventure Network of 3,500 fast chargers for Rivian drivers and 10,000 public level 2 chargers for all drivers.

GM and **EVgo** are partnering to bring **2,700 new fast charge plugs** by 2025

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. By establishing unique, EV-dedicated brands, automakers are sending a clear signal that EVs will make up a larger share of their portfolio and reducing emissions will be a focus going forward. EV-only brands like Rivian and Lordstown are gaining momentum, and Tesla has dominated U.S. EV sales to date. On the medium- and heavy-duty side, Volvo Group announced Volvo Energy, formerly a subsect of Volvo Trucks, would be responsible for matters related to electrification, such as life cycle battery management and charging infrastructure.

Fleet Electrification

Electrification of medium- and heavy-duty commercial fleet vehicles is gaining traction, in part due to fleet electrification targets by major companies. For example, FedEx committing that its entire global parcel pickup and delivery fleet will be zero–emission EVs by 2040. These commitments send market signals that large entities are seeking electric alternatives for their fleets as components of their sustainability initiatives. These companies are planning to convert a range of light-, medium- and heavy-duty vehicle types to EVs, including delivery vans, commuter buses, transit buses, garbage trucks, and more. Today (2021), there are 48 medium-duty electrified models, 29 heavy-duty models, and 40 bus models offered across a range of vehicle vocations, and this number will continue to grow in coming years. Coupled with private sector commitments, states are signaling their interest in medium- and heavy-duty electrification through policies such as California's Advanced Clean Truck Regulation as well as multi-state collaborations like the fifteen jurisdiction Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding.

Declining Battery Costs

The cost of battery packs has fallen dramatically, from over $1,000/kilowatt-hour (kWh) in 2010 to approximately $137/kWh in 2020. Most analysts project that battery pack prices will continue to fall, reaching $100/kWh between 2023 and 2025 and $61-72/kWh by 2030. Auto manufacturers have endorsed these projections.

Battery pack prices could fall to **$100/kWh by the mid-2020s**

Price Parity

Many industry experts believe that passenger 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. While some industry experts believe price parity for BEVs with smaller battery packs has already been realized, most believe wide-spread price parity will happen around 2025.

EV life-time cost parity with internal combustion engine vehicles will occur in 2025 or earlier due to falling battery prices

Effects of COVID-19

The effects of the COVID-19 pandemic persist into 2021. As the global economy ground to a halt in the spring of 2020, many automakers that had anticipated near-term launches of new electric models – including Rivian (R1S and R1T), GM (Hummer), Byton (M-Byte and K-Byte), and Workhorse (W-15) – revised their timelines, halted operations, and furloughed workers. However, as the year progressed, automakers like Chevrolet and Audi saw increases in EV sales: in 2020, Chevy Bolt sales increased 26 percent and Audi e-tron sales increased 34 percent compared to 2019. Although manufacturers like Nissan and Hyundai have both seen overall declines in total vehicle sales in the U.S., Nissan had its best Q4 since 2016 for sales of the all-electric Leaf.

As 2020 concluded, EV sales are estimated to have reached between 2.5 and 3 million globally. Despite the pandemic, sales of EVs grew year over year from 2019 to 2020 in many places around the world while car sales shrank overall. Global EV sales increased 46 percent, with EV sales in the U.S. growing four percent while overall car sales decreased 15 percent. In Europe, EV sales increased 135 percent compared to a 24 percent decline in the overall car market.

Drivers of Global EV Growth – Global Goals to Accelerate Sales

Around the world, countries 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. European countries are leading this movement with Denmark, Ireland, France, the Netherlands, Norway, and the U.K. aiming to only sell ZEVs in the coming years (Figure 1[7]). As 2018 concluded, Norway made history as the first country where EVs made up half of all passenger vehicle sales in a year (continuing to climb to 54 percent in 2020), thanks to a host of incentives: no import tax, no sales tax, no vehicle registration fees, free access to toll roads, and free parking in some city areas.[8] In addition to Norway's EV integration model, the European Union (E.U.) as a whole adopted more stringent fuel standards for cars and light vans for 2020 and beyond: as part of a clean mobility package, the standard will require emissions in 2030 to be 37.5 percent lower for new cars and 31 percent lower for new vans compared to 2021 levels.[9] To capitalize on the momentum of standards for light-duty vehicles, the European Parliament and the European Council then turned their attention to setting the first-ever E.U. standards to reduce pollution from trucks.[10] A Denmark-led coalition of 11 E.U. member states, however, believes the bloc can – and must – go further, calling for a collective target to solely sell clean vehicles by 2040.[11] In November 2020, U.K. Prime Minister Boris Johnson announced a "Ten Point Plan for a Green Industrial Revolution for 250,000 Jobs," consisting of a variety of clean energy technology targets, one of which would be to only sell ZEVs by 2035.[12]

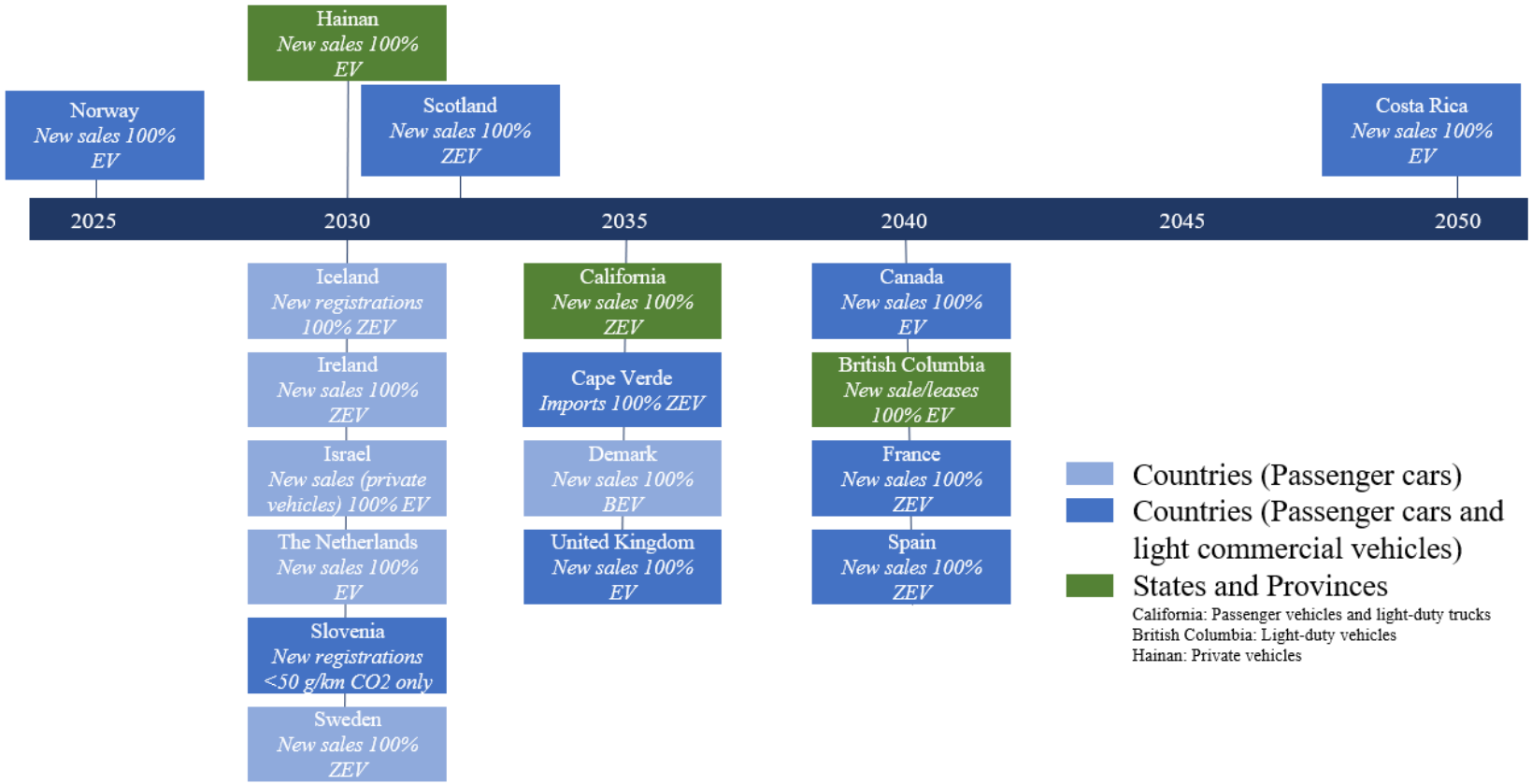
While Europe may lead in the sheer number of country commitments, India and China's targets could have the most substantial impacts: if the two countries meet their targets to only sell ZEVs by 2030 and 2040, respectively, around 3.3. billion people, or 43 percent of the world's population, would be live in countries that rely exclusively on the sale of new ZEVs after 2040.[13] To prepare for this goal, China aims to sell 7 million "new-energy vehicles" annually by 2025, amounting to approximately 20 percent of its total auto market.[14] Additionally, in October 2020 China outlined a plan that by 2035, all new cars sold will be "eco-friendly": 50 percent will need to be BEV, PHEV, or fuel cell, and 50 percent will be hybrids.[15]

In 2020, two U.S. states committed to ensuring that 100 percent of new vehicles sold are zero-emitting by 2035. First, in September, California Governor Gavin Newsom issued an executive order that set a goal that 100 percent of in-state sales of new passenger cars and trucks be zero-emission by 2035, directing the Air Resources Board to develop and propose regulations consistent with meeting that goal.[16] Further cementing this commitment, Governor Newsom's proposed 2021 budget includes $1.5 billion – of $4.5 billion total – for ZEVs and supporting infrastructure.[17] Then, days before the end of the year, Governor Charlie Baker committed Massachusetts to the same target, affirmed in the Clean Energy and Climate Plan for 2030: "[California's Advanced Clean Cars II (ACC II)] will require ZEV sales to ramp up to 100 percent of new LDV sales by 2035. Once finalized, MassDEP will adopt and implement these new ACC II regulations" (*see the* Policy Drivers of U.S. Electric Vehicle Growth *section for greater detail on ACC II).*[18] New York and New Jersey are both considering a similar path as well but have not yet taken legislative action.[19]

Globally, many cities are pledging deep decarbonization efforts as well. The mayors of the Climate Mayors Electric Vehicle Purchasing Collaborative – a pledge signed by more than 225 cities and counties across the U.S. that focuses on public fleet electrification – announced they would collectively buy more than 3,800 EVs before the end of 2021 for local government fleets; Los Angeles Mayor Eric Garcetti said of the initiative, "by pooling our purchasing power, Climate Mayors are sending a powerful message to the global car market: if you build electric vehicles, we will buy them."[20] Another coalition, the C40 Fossil Fuel Streets Declaration, commits the 35 signatories to replacing their cities' fossil fuel transit buses with electric alternatives by 2025 and to achieving zero-emissions in designated areas by 2030.[21] Major international cities are going one step further by committing to ban diesel vehicles: Rome by 2024 (in the city center); Athens, Madrid, Mexico City, and Paris following the year after; and Brussels and Amsterdam by 2030.[22] 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. As indicated by recent commitments to shift to lower emitting vehicles, a

growing list of countries and cities are anticipating and encouraging a future supported by electrified transportation.

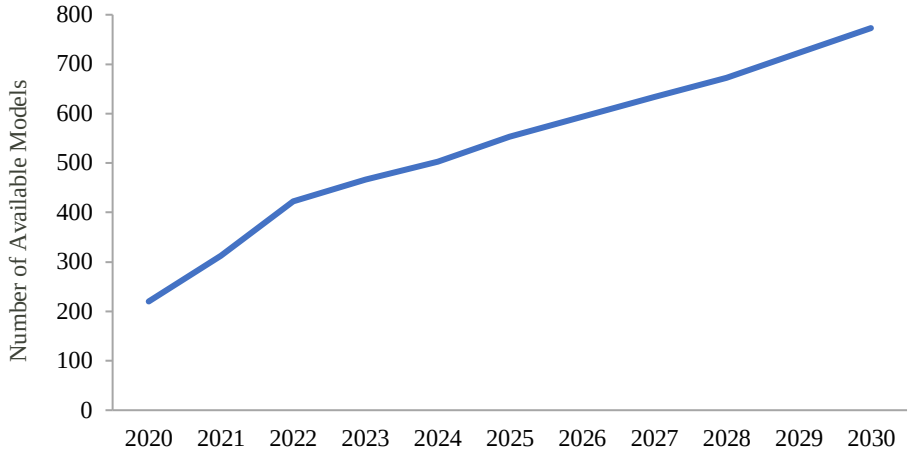
Figure 1 Timeline of Global Targets to Achieve All-ZEV Sales



Targets reflect those that are accompanied by official policy document, like Climate Change Action plans and executive orders. Discussions of targets that have not yet been accompanied by policy documents or legislation (e.g., Egypt, Germany, Portugal, New Jersey, New York, Sri Lanka, Taiwan) are not included. If a country has set multiple targets, the greatest scope is included (e.g., the U.K. and Denmark's goals include a separate timeline for diesel and gasoline vehicles [2030] and hybrid vehicles [2035]).

To meet these needs, auto manufacturers have announced plans to substantially increase availability of future EV models worldwide. As Figure 2 shows, auto makers have announced plans to offer more than 770 EV models world-wide by 2030, more than three times the number of models currently available.

Figure 2 Global Automaker Electric Vehicle Model Commitments



See Figure 1 in Appendix for announcements used. Brand announcements considered include Audi, Bentley, BMW, Daimler, FCA, Ford, GM, Hyundai, Kia, Mercedes, Nissan, Toyota, and VW.

Policy Drivers of U.S. Electric Vehicle Growth

As countries around the world individually and collectively encourage the shift to EVs, the ZEV Alliance states are leading the transition within the United States. 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.[23] These eight states – along with New Jersey and Maine, who joined in 2018 and 2019, respectively – collaborated to produce the *ZEV Task Force Multi-State ZEV Action Plan 2018-2021* and also founded the International ZEV Alliance, a global initiative between 16 North American and European national and subnational governments to accelerate the global transition to ZEVs.[24] 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."[25]

Following the successful collaboration in 2013 that brought forth the LD ZEV MOU, fifteen states and the District of Columbia turned their attention to medium- and heavy-duty (M/HD) vehicles, signing a M/HD ZEV MOU in July 2020 with the goal of ensuring that 100 percent of all new M/HD vehicle sales in their jurisdictions be ZEVs by 2050, with an interim target of 30 percent by 2030.[26] This commitment will help develop standards and regulations, deploy infrastructure, and drive investment in the sector. A few weeks prior to announcing participation in the multi-state collaborative, California adopted the Advanced Clean Trucks (ACT) Regulation, "the first ever in the world effort to mandate the construction and deployment of zero-emission vehicles in the heavy-duty sector"; under this regulation, by 2045 every new truck sold in California will be zero-emission.[27] To inform ongoing development of M/HD vehicle regulation, incentives, and programs across the state, the ACT's Large Entity Reporting Rule requires that large fleets owners and government agencies provide detailed data on their fleet composition and activity in 2021 (one-time requirement). Finally, the ACT will be paired with the ZEV Fleet Rule, which will provide regulation of public and private fleets, new mobility fleets, large employer fleets, rental fleets, and delivery fleets and will be developed in 2022. Both rules will take effect in 2024.

All the ZEV Alliance states have adopted the new car GHG emission standards enacted by the California Air Resource Board (ARB) in lieu of federal standards enacted by the Environmental Protection Agency (EPA). These states have also adopted ARB's ZEV standard, which requires that ZEVs must make up a certain percentage of each manufacturer's annual new car sales in each state. Initially the ZEV standard included a "travel provision" that allowed automakers to receive credits in all other ZEV states for vehicles sold in California. This encouraged auto manufacturers to target EV sales to California. In 2018, ARB removed the travel provision, which could lead to increased model availability and sales throughout the ZEV Alliance states. According to an analysis by the International Council on Clean Transportation, "states that adopt California's Zero Emission Vehicle regulation catalyze the market, spurring automaker marketing and expanded model availability."[28] This is reflected in the fact that the 12 states[*] that have adopted the ZEV regulation were collectively responsible for over 64 percent of BEV and PHEV light-duty vehicle sales between 2011 and 2020.[29] In March 2021, Virginia became the thirteenth state to adopt the ZEV regulation.

States continue to take steps to reduce transportation emissions, which surpassed emissions from the electric power sector in 2017 to now contribute the largest share of total economy-wide CO_2 emissions for the first time since the late 1970s.[30] One such regional strategy is being undertaken by the Transportation and Climate Initiative (TCI). Formed in 2010, TCI is a regional collaboration between 12 Northeast and Mid-Atlantic states and the District of Columbia that seeks to improve transportation, develop the clean energy economy, and reduce carbon emissions from the transportation sector. In December 2018, 10 of the 13 jurisdictions

[*] The 12 ZEV states are California, Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Vermont and Washington in addition to Washington D.C.

announced their intent to design a regional "cap-and-invest" policy that would raise funds for investing in clean transportation by imposing a fee on the GHG emissions associated with on-road motor fuels. In the final MOU released in December 2020, Connecticut, the District of Columbia, Massachusetts, and Rhode Island resolved to establish a multijurisdictional cap-and-invest program designed to ensure reductions in CO_2 emissions from the transportation sector, commencing as early as January 1, 2023.[31] The program will require "State Fuel Suppliers" to hold allowances to cover reported CO_2 emissions. At the same time that the MOU was released, eight additional states that have participated in the TCI process committed to continued collaboration with the four core signatory states, including working to help develop a model rule and other clean transportation and emission reduction program elements that could be implemented within each jurisdiction.[32]

Simultaneously, California is moving forward with its Advanced Clean Cars II (ACC II) regulations. The Air Resources Board adopted the Low-Emissions Vehicle III regulation for criteria and GHG emissions as well as the above-discussed ZEV standard in 2012 to control emission from passenger vehicles.[33] The three regulations, collectively referred to as the ACC regulation, aim to reduce smog-forming pollution that contributes to air pollution, reduce GHG emissions, and increase the market share of ZEVs. ACC II will aim to increase stringency, better align standards with real-world reductions (e.g., better control of engine start emissions that can exceed lab test emissions), and improve the ZEV experience for consumers (e.g., standardizing fast charging ports).[34] ARB staff presented an analysis and potential regulation modification in May and September of 2020, ultimately expecting to release the ACC II proposed regulation in the spring of 2021 in preparation for the December 2021 Board hearing.

At the federal level, there are multiple proposed bills that would aim to expand funding for EVs and electric vehicle infrastructure. The 2021 appropriations law, which was signed by President Trump on December 27, 2020, authorizes funding and programs to further support transportation development, including:

- Department of Transportation's (DOT) sustainable transportation research program: $2.6 billion over three years for a reauthorization of the program, which would be directed toward RD&D and commercial application activities within the Offices of Hydrogen and Fuel Cell Technologies, Vehicle Technologies, and Bioenergy Technologies;
- Surface Transportation Block Grant Program: $647.5 million for charging infrastructure along corridor-ready or corridor-pending alternative fuel corridors;
- Clean Transit Buses: $125 million for the low or no emission grant program; and
- Alternative Fuel Refueling Property Credit: extended through 2021, the tax credit provides $30,000 for businesses and $1,000 for residential properties to install alternative fuel facilities, including EV charging stations.[35]

Since taking office, President Biden has issued several executive orders that include provisions to strengthen the ZEV ecosystem:

- *Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*: On his first day in office, President Biden ordered EPA to consider revising or rescinding the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program by April 2021 as well as the SAFE Vehicles Rule for MY 2021-2026 Passenger Cars and Light Trucks by July 2021 and a recalculation of social cost of GHGs, establishing an Interagency Working Group to do so. This executive order also called for the review and revision of the federal GHG emission standards for light-duty vehicles. The Office of Management and Budget (OMB) is currently reviewing a proposal submitted on March 24, 2021 by DOT and the National Highway Traffic Safety Administration titled, "Corporate Average Fuel Economy (CAFE) Preemption," Revising SAFE 1.
- *Executive Order on Tackling the Climate Crisis at Home and Abroad:* Directs Federal (which includes 645,000 cars and trucks), State, local, and Tribal agencies to procure carbon-free electricity

and clean, zero-emission vehicles. Procurement standards specify that vehicles should be made by union workers from at least 50 percent American-made materials.

- *Executive Order on America's Supply Chains:* As China controls nearly 70 percent of the global EV battery manufacturing capacity compared to North America's 10 percent, the order directs the Department of Energy to submit a report identifying risks in the supply chain for high-capacity batteries, including EV batteries, and policy recommendations to address these risks.[36]

On March 31, 2021, President Biden also released "The American Jobs Plan," proposing a more than $2 trillion investment to "rebuild and reimagine a new economy." The plan calls on Congress to invest $621 billion in transportation infrastructure and resilience, including a $174 billion investment to "win the EV market." Specifically, the plan proposes:

- $100 billion for point-of-sale rebates and tax incentives for drivers;
- $15 billion for grant and incentive programs for state and local governments and the private sector for building out a 500,000 station national charging network;
- $25 billion to meet a goal to replace 50,000 diesel transit vehicles and $20 billion to electrify at least 20 percent of the nation's school bus fleet through EPA's "Clean Buses for Kids" program;
- $14 billion for other tax incentives to spur domestic supply chains, retool factories, and support American workers for both battery and EV production; and
- Federal procurement policies that electrify the federal fleet, including the U.S. Postal Service.

With regard to R&D, the plan calls for $35 billion for climate technologies. For federal procurement, the plan calls for $46 billion tied to clean manufacturing, including EVs and charging stations. For all procurement and investment components, President Biden emphasizes they will be tied to American companies and workers.[37]

In last few months several business coalitions have launched to promote EVs, including the Zero Emission Transportation Association (ZETA), Electrification Coalition Business Council (ECBC), and the CHARGE Coalition.

ZETA: Formed at the end of 2020, ZETA released a federal roadmap to achieve 100 percent EV sales by 2030, which consists of 34 policy proposals across six pillars: (1) accelerating light-duty EV consumer adoption through a range of incentives, including extending $7,500 tax credit cap and converting it to a point of sale rebate; (2) accelerating M/HD vehicle electrification, with a particular focus on buses, service, and delivery vehicles; (3) investing $30 billion in a national charging initiative; (4) re-establishing the U.S. as a manufacturing front-runner in production and innovation; (5) setting strong vehicle performance and emissions standards; and (6) positioning the federal government as a leader through its own fleet electrification.[38]

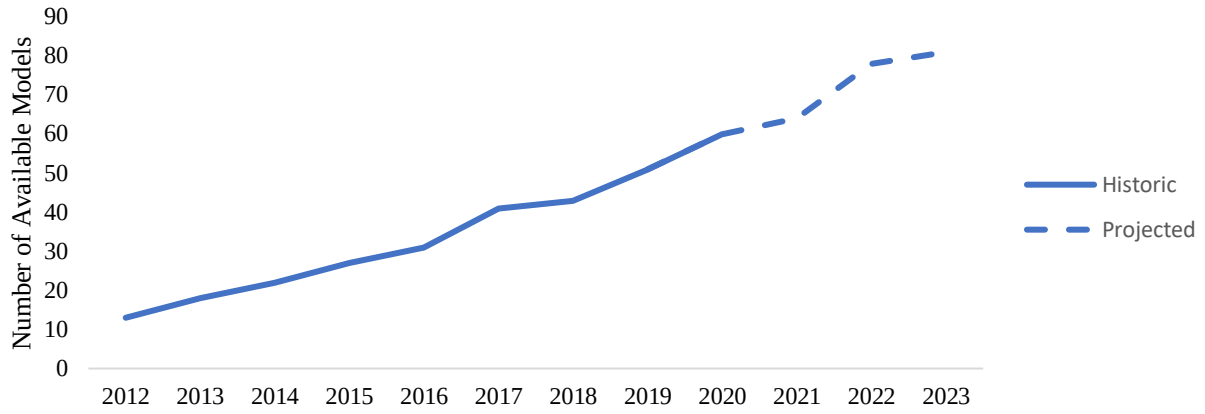
ECBC: Launching in early 2021, ECBC is a branch of the Electrification Coalition, a non-profit that aims to accelerate the transition to EVs to improve national and economic security given the U.S.'s heavy dependence on an "unstable oil market."[39] ZETA consists of 40 companies that are part of the broader ZEV ecosystem (e.g., utilities, charging network providers, EV supply chain companies, and EV-specific manufacturers like Lucid and Tesla) while ECBC's 13 members include auto manufacturers, like Ford, GM, Kia, and Volvo.

CHARGE Coalition: Launching in March 2021, the CHARGE Coalition is made up of 45 transportation, industry, environmental, labor, health, equity, and civic organizations that support the holistic and equitable transition to 100 percent zero-emission mobility. The coalition sent the Biden Administration a blueprint for EV deployment centered on three principles: public transit, electric vehicle infrastructure, and M/HD vehicles.[40]

Manufacturer Commitments

In 2012 there were 13 BEV and PHEV models available in the U.S. The number of electrified models available in the U.S. is projected to reach 64 by the end of 2021 and 82 by the end of 2023 (Figure 3).*

Figure 3 Total Light-Duty Vehicle PHEV and BEV U.S. Models Available by Year



Source: 2012-2019, https://insideevs.com/monthly-plug-in-sales-scorecard/, 2021-2022 models listed in the Appendix and previous MJB&A EV Market Reports.

Based on these firm model announcements to date, as well as longer-term commitments and investment plans, many manufacturers have taken stances in support of an EV future:

$

Investment

In total, carmakers worldwide will spend more than $268 billion through 2030 developing new electric models.† For example, since the last update, Ford announced it would double its electrification investment to $22 billion by 2025[41] 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.[42]

Automakers will spend **$268 billion**[4] worldwide on light-duty vehicle **electrification through 2030**

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

† $268 billion corresponds to the announcements listed in Figure 1 in the Appendix: BMW, Daimler, FCA, Ford, GM, Hyundai, Lucid, Tesla, Toyota, VW, and Volvo. Investments by Audi, Bentley, and Porsche were not included as they are subsidiaries of VW Group as with Mercedes-Benz of Daimler. Other estimates – covering additional manufacturers – include $250 billion by 2023 and $300 billion by 2030. See https://www.autosinnovate.org/posts/press-release/statement-on-greenhouse-gas-emissions and https://www.alixpartners.com/media-center/press-releases/pile-up-awaits-auto-industry-investments-electric-autonomous-future-balloon/.

Manufacturing

General Motors announced it would invest $2.2 billion – its largest investment in a manufacturing facility to date – to repurpose the Detroit Factory ZERO assembly center as its "flagship assembly plant in [its] journey to an all-electric future."[43]

Fiat Chrysler will invest $4.5 billion in five of its existing Michigan plants in addition to building a new assembly plant in Detroit, which will both continue to produce existing ICE models as well as enable electrification of new Jeep models.[44]

(See the Job Creation *section for additional manufacturing commitments)*

As **70 percent of plug-in EVs** driven on U.S. roads in 2019 were **assembled domestically**, these manufacturing plant investments highlight continued **cultivation of a strong EV workforce** and robust market.[45]

Manufacturer Commitments

BMW Chairman Harald Krüger anticipates a bright future for the brand's EV line up: "by 2021, we will have doubled our sales of electrified vehicles compared with 2019…we will offer 25 electrified vehicles already in 2023 – two years earlier than originally planned. We expect to see a steep growth curve towards 2025."[46]

Ford has created Team Edison, a dedicated global EV organization "focused on bringing to market profitable, exciting [EVs] and ownership experiences." Ford has stated a goal of having sixteen BEVs in their portfolio by 2022 and has announced plans to convert two of its North American plants to build plug-in models. In 2021, Ford increased its planned investment in EVs and autonomous vehicles from $11 billion to $29 billion through 2025.[47]

GM has positioned Cadillac to be its lead EV brand going forward, highlighting the BEV3 platform and declaring that "our commitment to an all-electric, zero-emissions future is unwavering."[48] Its Factory ZERO renovations will reposition the facility for greater EV production as GM aims to have 30 BEV models by 2025.

Hyundai Motor Group has declared it hopes to become "one of the world's top three EV manufacturers by 2025" through a dedicated EV brand IONIQ.[49]

Daimler aims to have a carbon-neutral passenger vehicle fleet by 2039, which will be driven by the introduction of "an entire generation of electric Mercedes models," which will be entirely electrified by 2022.[50]

Fiat-Chrysler has committed to producing more than 30 electrified models by 2022, 10 of which will be plug-in Jeeps and four will be all electric Jeeps.[51]

Porsche pledged that by 2022 the company will be investing more than six billion euros in electric mobility and by 2025, 50 percent of all new Porsche vehicles could have an electric drive system."[52]

VW hopes to produce 26 million EVs over the next decade, an increase from its previous goal of 22 million. VW's CEO announced, "our future electric cars will be the new trademark of Volkswagen."[53]

Outside of the U.S. market, PSA Groupe – the parent company of France's two major automakers Peugeot and Citroen – will electrify 80 percent of its models by 2023.[54]

Trucking

PACCAR's Kenworth and Peterbilt divisions are partnering with Dana for electric truck powertrain development. Kenworth has already developed a prototype Class 6 medium-duty electric truck and has plans to produce up to 100 of them in 2020.[55]

In October 2019 Navistar launched their NEXT eMobility solutions business unit to focus on electrification solutions in truck and school bus markets. The company has already developed a prototype electric school bus and an electric medium-duty truck.[56]

After receiving nearly $45 million in grant funding from the California Air Resources Board, Volvo launched Volvo LIGHTS, a three-year demonstration project to test the ability for heavy-duty, battery electric trucks and equipment to reliably move freight between ports and warehouses in Southern California.[57] The initiative focuses on providing a range of vehicle, charging, and workforce development innovations. The focus includes new lithium-ion battery chemistries that increase energy density by more than 20 percent and prevent premature degradation to reduce cost, as well as multiple truck configurations with all-electric ranges of up to 250 miles.

General Motors launched a new business unit, BrightDrop, in January 2021 that will focus on electric first-to-last-mile products, software, and services.[58] The brand will release two models in 2021: the EP1 and the EV600. FedEx was part of an initial pilot utilizing the EP1 and will be the first customer for the EV600.

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.[59]

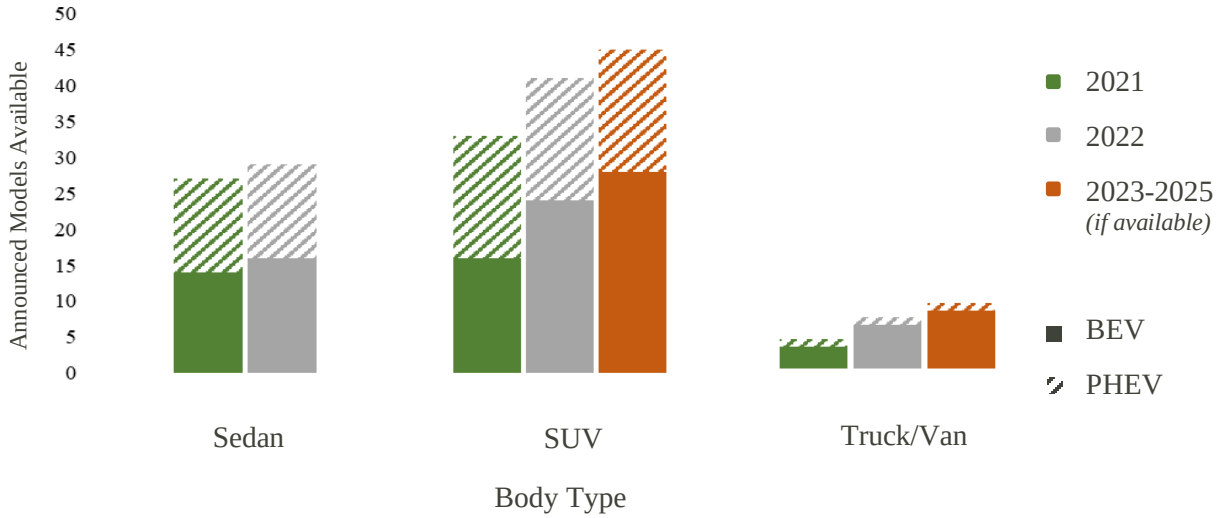
Companies like Volvo and Freightliner have begun taking order on electric models like the Mack refuse truck or the eCascadia and eM2 trucks, respectively.

Daimler Trucks has a goal of selling CO_2-neutral commercial vehicles across all of their markets, including North America, by 2039. In North America, Daimler's Freightliner division has developed electric versions of their popular Cascadia Class 8 tractor, M2 Class 6 medium-duty chassis, and MT50 medium-duty step van. Since 2018, a 30-vehicle Freightliner Electric Innovation Fleet has been operating at customer sites, accumulating over 100,000 miles of real-world operation. In March 2020, Freightliner announced it would expand this fleet by deploying eight more EVs with at least 14 different customers over the next 22 months, who collectively operate more than 150,000 Class 6 -8 vehicles.[60] In November 2020, the 30-vehicle fleet of BEV Freightliner eCascadias and 8 eM2s that make up the Freightliner Electric Innovation Fleet and the Freightliner CX Fleet, respectively, surpassed 500,000 miles of real-world use.[61]

Figure 4 summarizes projected U.S. BEV and PHEV model availability over the next three model years (a list of models considered can be found in the Appendix as well as timelines of various manufacturer commitments, model introductions, and EV sales forecasts[62]). 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 have been formally pushed to 2021, others remain uncertain. The disruption of supply chains and the shift in consumer spending patterns is affecting the auto industry as a whole – not only EV offerings – leading many brands to delay model launches and less-

profitable updates until 2021 or 2022 *(see* Sales Forecast *for greater detail on the effect of COVID-19 on EV sales).*[63]

Figure 4 Cumulative Announced U.S. Light-Duty BEV and PHEV Models 2021-2025 by Body Type



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

According to the Department of Energy (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.[64] A separate DOE analysis found that the estimated annual fuel costs for MY2021 BEV vehicles are the lowest of all available technologies, ranging from a low of $500 to a high of $850 per year, followed by PHEVs ($600-$2,400); gasoline vehicles had the widest range between $1,050 and $4,900.[65]

Job Creation

The EV industry employed nearly 131,575 individuals across the U.S. in 2020 – defying overall energy sector job loss patterns caused by the COVID-19 pandemic with employment growing more than six percent, the biggest increase of any clean energy category according to E2's *Clean Jobs America* report – with jobs surpassing 273,000 when also including jobs associated with hybrid, natural gas, hydrogen, and fuel cell vehicles.[66] California, Michigan, and Texas are the top three states supplying these clean vehicle jobs, in order. These jobs contributed to 42 states and the District of Columbia employing more clean energy than fossil fuel workers in 2019. In expanding BEV and PHEV offerings, auto makers understand the economic impact they can have through enhanced production capacity.

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

Light-Duty Vehicles

Assembly Plant Production

Ford plans to invest more than $1.45 billion in Michigan production, which could result in approximately 3,000 new jobs. This includes 900 jobs through a $900 million expansion at its Flat Rock plant as well as those created by a $700 million investment at the Rouge Complex for production of the electric F-150.[67]

In Michigan **GM** will invest $2.2 billion at Factory ZERO in Detroit to produce vehicles like the all-electric Silverado pickup and $300 million in its Orion Township plant, amounting to 2,200 and 400 new jobs, respectively.[68] GM also received a $35 million job training assistance grant from Tennessee to retain and train 2,000 employees.[69] Beyond manufacturing, GM will offer 3,000 positions for software development.[70]

In November 2019, **VW** started the expansion of its Chattanooga, Tennessee, assembly plant, which aims to add 1,000 jobs that will support its new EV line-up.[71]

Mercedes-Benz has committed $1 billion to a plant in Tuscaloosa, Alabama, to set up production of EVs in the U.S. and expects this will create 600 new jobs.[72]

Fiat Chrysler will invest $4.5 billion in five of its existing Michigan plants, which could create nearly 6,500 jobs.[73]

Lucid Motors completed the first phase of its $700 million investment for its Arizona factory and will resume construction in early 2021.[74]

According to a May 2018 IHS Markit report, **Tesla's** operations have supported over 51,000 jobs in California (20,189 directly, 31,424 indirectly through local supply chain purchases and employee consumer activity).[75]

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.[76]

Emerging EV-only manufacturers like **Mullen Technologies** are announcing investments in places like Tennessee, a $336 million announcement that could create over 425 jobs.[77]

Medium- and Heavy-Duty Vehicles

Assembly Plant Production

Navistar is investing $250 million in a San Antonio plant that will produce both diesel and electric trucks, through which it expects to support 600 new jobs. It also announced a new facility outside of Detroit that will employ 50 eMobility specialists.[78]

U.K.-based Arrival, specializing in delivery vans, will establish its first U.S. Microfactory in York County, South Carolina. The $46 million investment is expected to create 240 new jobs. Five months later, Arrival announced it would also establish a Microfactory in Charlotte, North Carolina, bringing 250 additional jobs to the region. [79]

Daimler Trucks North America expects to start production of the eCascadia and eM2 trucks in Portland, Oregon, in 2021 after announcing plans in 2019 to convert the plant to produce electric Freightliners.[80]

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.[81]

Tesla selected Austin, Texas, as the site of its next Gigafactory, where it will invest $1 billion to produce a range of EVs, including the Tesla Semi Truck – an effort that will be supported by 5,000 new jobs.[82]

Ford will hire 150 workers in Missouri to build the E-Transit van.[83]

Lightning eMotors is expanding its Loveland, Colorado plant after production ramped up by more than 600 percent in the summer and fall of 2020.[84]

Electric Last Mile Solutions is planning to build an electric light-duty vehicle in Mishawaka, Indiana. The company plans to have 100 employees by the end of 2021 and up to 900 by 2025.[85]

Mercedes will bring the next generation of eSprinter vans to the United States through a nearly $60 million investment in South Carolina.[86]

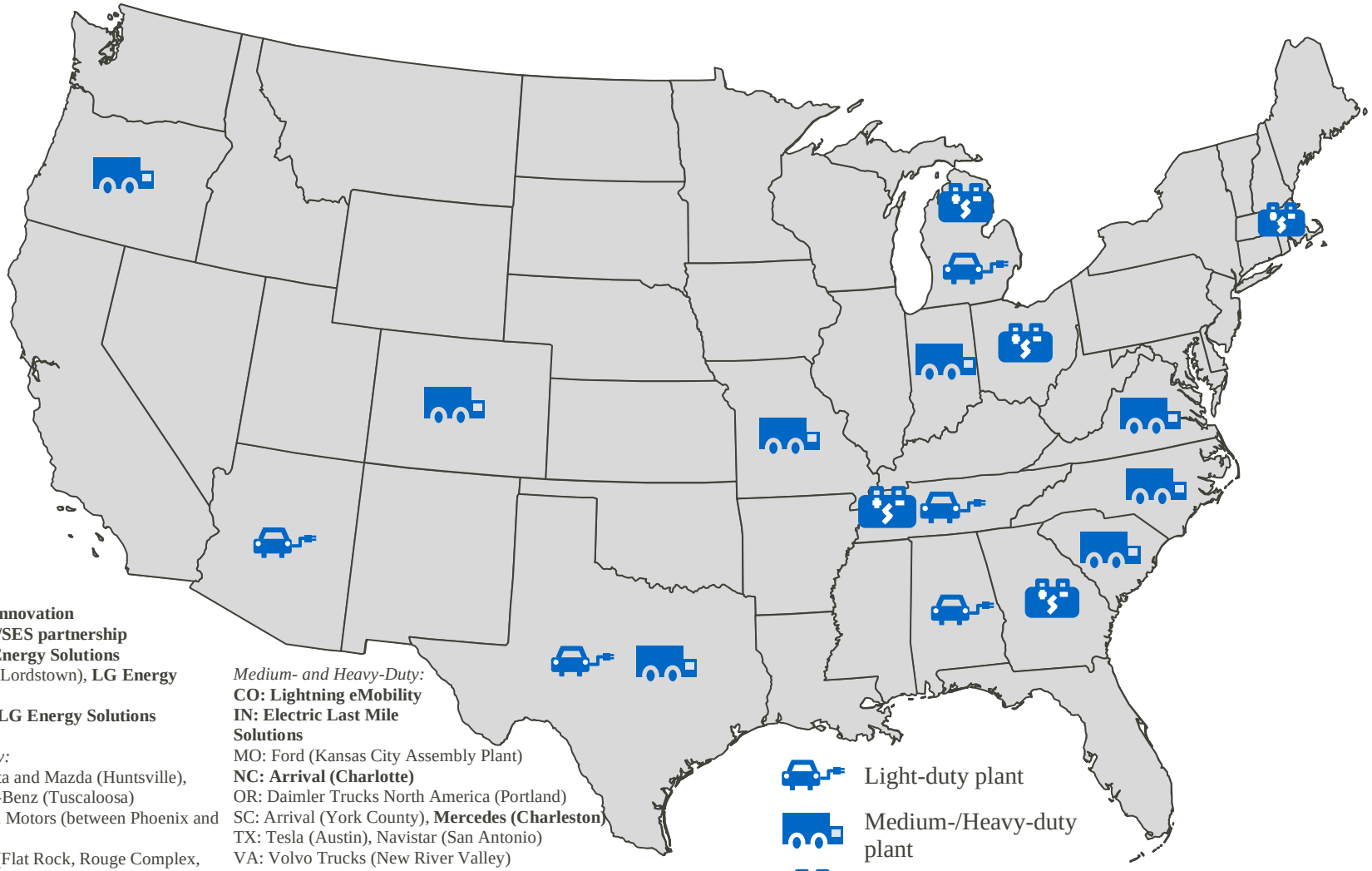
Battery Production

GM is committing to two $2.3 billion investements through a joint venture with LG Energy Solutions to produce its Ultium battery at plants in northeastern Ohio and Tennessee – a partnership that could bring over 1,100 and 1,300 jobs to each state, respectively. GM is also partnering with SES to build a manufacturing protoship line in Massachusetts.[87]

LG Energy Solution announced that by the end of 2025, the company will invest more than $4.5 billion in its U.S. business to further expand its battery production capacity, potentially adding 10,000 additional jobs in Ohio and Michigan.[88]

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.[89]

Figure 5 Announced Electric Vehicle Manufacturing Plant Expansions and Future Plans*



Batteries:
GA: SK Innovation
MA: GM/SES partnership
MI: LG Energy Solutions
OH: GM (Lordstown), **LG Energy Solutions**
TN: GM/LG Energy Solutions

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

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

Bolded indicates new addition since last update

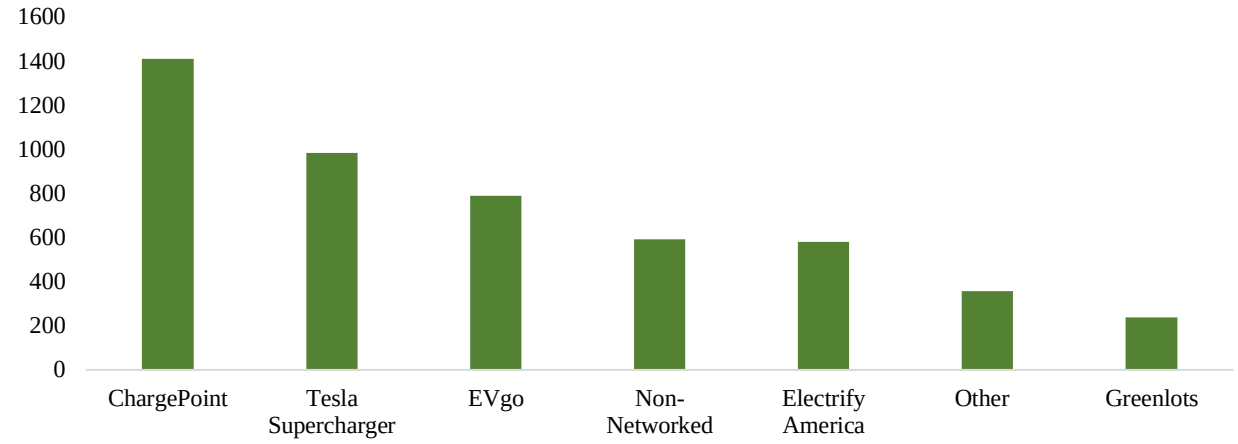
Map is forward looking, does not include existing plants like Tesla's Fremont, California plant or Rivian's Normal Plant in Illinois

Charging Network Investments

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

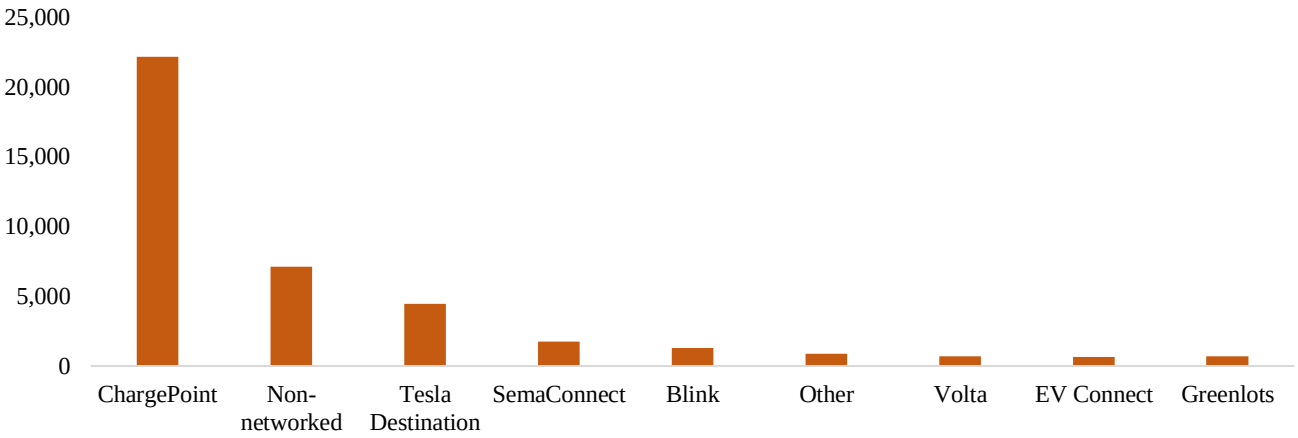
Today, five networks make up over 80 percent of Direct Current Fast Chargers (DCFC) nationally (Figure 6) while one company – ChargePoint – dominates the public Level 2 market (Figure 7).

Figure 6 Number of Direct Current Fast Charging Stations by Network



"Other" includes Francis, Blink, Webasto, EV Connect, among others. Source: Alternative Fuels Data Center, April 1, 2021, https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC&country=US&ev_levels=dc_fast

Figure 7 Number of Public Level 2 Charging Stations by Network



"Other" includes EVgo, FLO, Electrify America, OpConnect, GE WattStation, Webasto, among others. Source: Alternative Fuels Data Center, April 1, 2021, https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC&country=US&ev_levels=dc_fast

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

- Marry Barra, the Chairman and CEO of GM, said "we are moving quickly to bring new EVs to market that customers will love. We know how important the charging ecosystem is for drivers, one that includes access to convenient and reliable public fast charging" when announcing GM and EVgo's partnership to bring 2,700 new fast charge plugs to drivers over the next five years.[90]
- Porsche is offering owners of its first EV model, the Taycan, three years of free charging through a partnership with Electrify America – total investment will reach $70 million to install chargers at the automaker's 191 U.S. dealerships.[91]
- Rivian will build out the Rivian Adventure Network with dozens of chargers available by biking and hiking trails and destination spots. While the 3,500 DCFCs will be exclusively accessible to Rivian drivers, the 10,000 L2s will be accessible to all EV drivers.[92]

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

Major oil and gas companies are also exploring investments to adapt to an electric future. According to Shell's New Energies Executive Vice President, Shell's acquisition of Greenlots, an EV charging company, "is a step towards making EV charging more accessible and more attractive to utilities, businesses, and communities."[93] Chevron also made headlines as the first major oil and gas company in the U.S. to announce that it will offer a dozen EV charging plugs at five of its gas stations in California.[94]

Commercial Fleet Electrification Commitments

While cars and light-duty trucks account for the majority share of transportation GHG emissions, M/HD vehicles are responsible for nearly a quarter, with this percentage projected to increase in the future.[95]

Full-sized (40-ft.) electric transit buses have been commercially available in North America for 10 years, and their use has been steadily growing; as of early 2020, approximately 180 U.S. transit agencies are operating a total of more than 850 electric transit buses, with more than 1,000 additional electric buses on order for delivery in the next two years. This is almost three percent of the national transit bus fleet.[96] This is the only M/HD vehicle segment with significant EV penetration to-date.

A few years ago, the only large EVs commercially available in the U.S were transit buses. Today (2021), there are 44 medium-duty electrified models, 24 heavy-duty models, and over 40 bus models offered for sale, across a range of vehicle vocations, and this number will continue to grow in coming years (*see* Appendix *for greater detail*). ZEV alternatives for various vehicles classes are becoming increasingly viable: a recent working study conducted by Lawrence Berkeley National Laboratory and the University of California, Los Angeles, found that – assuming 375-mile range and current battery pack prices – an electric long-haul truck has a 13 percent per mile lower total cost of ownership, with a net savings of $200,000 over the lifetime of the electric truck. [97]

Companies that operate large fleets are taking note: Amazon has ordered 100,000 electric delivery vans from Rivian; FedEx ordered 500 electric trucks from BrightDrop as part of its 2040 goal to have a fully ZEV parcel delivery fleet globally; UPS and DHL ordered 950 electric trucks and 63 delivery vans, respectively, from Workhorse; and Walmart and PepsiCo – both companies that have pledged to strive for zero and net-zero emissions, respectively, by 2040 – are looking to Tesla for its electric semi-truck plans.[98]

With these commitments, the number of electric trucks in use could skyrocket in the near-future from 2,000 in 2019 to 54,000 by 2025.[99] These investments will continue to grow thanks to corporate fleet electrification commitments (Table 1).[100] For example, EV100 is a global initiative bringing together 82 companies committed to accelerating the EV transition and making electric transport the new normal by 2030. Commitments cover a broad range of vehicles from delivery vehicles to commuter buses to garbage trucks. Policy levers will also be a major catalyst: California anticipates there will be about 300,000 zero-emission M/HD trucks across the state by 2035 due in part to the sales component of the ACT regulation (*described in the* Policy Drivers *section).*[101]

Major Orders		
PepsiCo ordered 100 electric semi-trucks from Tesla	DHL ordered 63 electric delivery vans from Workhorse	FedEx ordered 500 electric delivery trucks from BrightDrop
UPS ordered 950 electric trucks from Workhorse and 10,000 vehicles from Arrival	Walmart ordered 45 semi-trucks from Tesla	Amazon ordered 100,000 electric delivery vans from Rivian

Recent Orders Since Last Report Update[102]		
On top of nearly 6,300 Workhorse and Tesla vehicles ordered in the last six months, Pride Group ordered 100 all-electric trucks from Lion	The Montgomery County Public Schools district will order 326 electric school buses from Thomas Built Buses	Fluid Truck ordered 40 electric trucks from Lightning eMotors that will support IKEA last-mile deliveries in New York City
The Los Angeles Unified School District Schools ordered 10 electric school buses from Lion		Merchants Fleet will order 12,600 light commercial vehicles from GM's BrightDrop

Table 1 Sample of Fleet Electrification Commitments

Sector	Company	Electric Fleet Plans
Retail	Ikea Group*	2020: Electrify deliveries in Amsterdam, Los Angeles, New York, Paris, and Shanghai (25% 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)
	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: • 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
Transportation	Lyft**	2026: 100% new vehicles for Express Drive (driver rental program) are electric 2030: 100% EVs on platform
	King County Metro (WA)	2030: 100% zero-emissions fleet
	Lime*	2030: 100% conversion of operations fleet
	Uber**	2030: 100% of rides take place in EVs in U.S., Canadian, and European cities 2040: 100% of rides take place in ZEVs, on public transit or with micromobility
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
Biotech	Genentech	2030: 100% electrification of sales fleet (1,300 vehicles) and commuter buses
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 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)

*Member companies of EV100, through which 102 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.

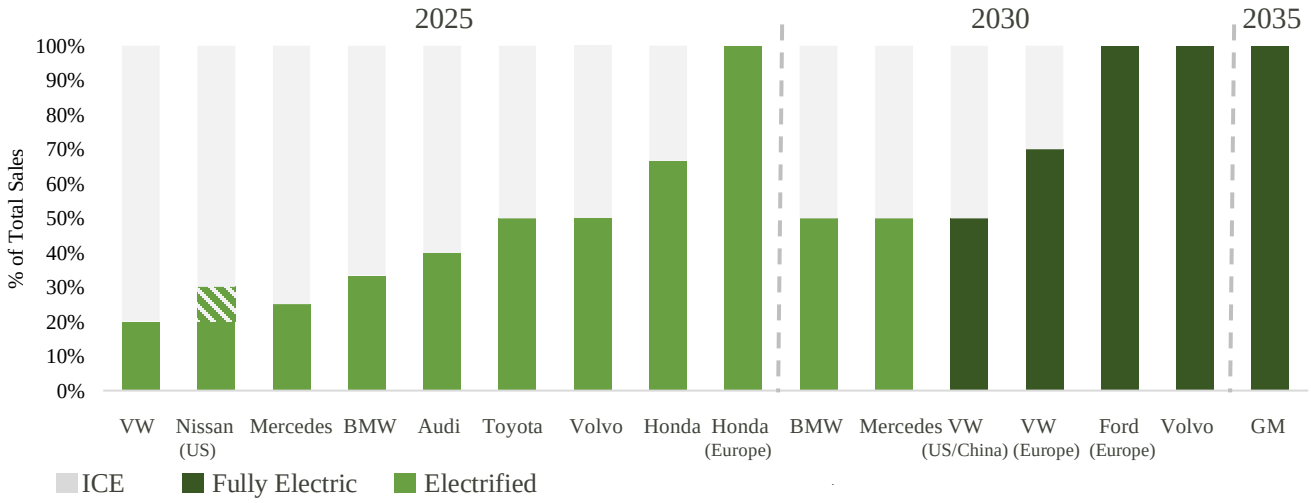
Sales Forecast

According to analysts, global EV sales could rise from 2.1 million units in 2019 to 26 million in 2030 and 54 million in 2040.[103] U.S. EV sales accelerated in recent years, rising 26 percent in 2017 compared to 2016. The following year, sales grew 81 percent – amounting to over 361,000 EVs sold in 2018 – then contracted slightly to 325,000 in 2019.[104]

While Tesla's three models and the Toyota Prius Prime were responsible for most of the increase in EV sales in 2018 and 2019 in the U.S., many of the top manufacturers are projecting that EVs will account for a significant share of their total sales by 2025, as illustrated in Figure 8.[105] Audi, BMW, Honda, Mercedes, Toyota, VW, and Volvo have all set global targets and announced projections for 2025, while Nissan has announced expectations specifically for U.S. sales. By 2035, GM has set an aspirational target to eliminate tailpipe emissions from new LDVs. The first few months of 2021 took announcements from projections and aspirational targets to commitments to only sell ZEVs. In 2018, Volvo set a target for BEVs to make up 50 percent of sales in 2025. After announcing its new strategic vision in March 2021, Volvo will still strive for its 2025 goal (with hybrids making up the other half of sales) but by 2030, will become a fully electric car company globally: "by [2030, Volvo] intends to only sell fully electric cars and phase out any car in its global portfolio with an internal combustion engine, including hybrids."[106] Ford announced a similar vision for its European passenger vehicle offerings.[107] The International Council on Clean Transportation (ICCT) estimates that auto manufacturers are collectively targeting global production of 13 million EVs annually by 2025.[108]

Taking these goals into account, industry experts believe the portion of EVs comprising total sales will climb substantially in the coming decades. Morgan Stanley predicts that annual EV sales could surpass ICE vehicle sales by 2035, "with legacy original equipment manufacturers supplying 90 percent of EV cars in the future."[109] By 2050, IHS Markit believes the EV share could climb to 60 to 80 percent of sales, which would be a dramatic market transformation over the next thirty years considering EVs comprised 2.2 percent of new car sales in 2020.[110]

Figure 8 Global* Sales Forecast by Manufacturer



**Unless otherwise indicated*
The hatched line represents a range given by the manufacturer (e.g., Nissan expects that electrified models will make up 20 to 30 percent of sales). Electrified definitions: BMW models will have electrified drive trains (BEV or PHEV), Nissan models will either be pure electric models or e-POWER powertrain models, and Audi does not define electrified. Nissan has set a goal for its U.S. sales. Honda announced in March 2019 its ambition of making one hundred percent of its European sales electrified, building upon the brand's 2017 goal of electrifying two-thirds of global sales.

One policy change that could have a substantial impact on U.S. EV sales would be more stringent federal new car GHG standards. If the incoming Biden administration adopts protective long-term vehicle standards – EV sales could climb from two percent of U.S. vehicle sales in 2019 to 25 percent by 2026 (or 4 million EV sales annually), according to BloombergNEF.[111]

Effect of COVID-19

Due to the COVID-19 pandemic, U.S. vehicle sales declined 12 percent in the first quarter of 2020 compared to Q1 2019. As the year progressed things got worse, with a 33 percent year-on-year decline in Q2, followed by a slight rebound in Q3, with U.S. sales seven percent lower than 2019 Q3 sales. Sales of EVs, however, have been less volatile this year. Despite an 18 percent reduction in overall vehicle sales through the first three quarters of 2020 compared to 2019, Tesla sales rose 65 percent compared to the same period the year before. Other automakers, including Chevrolet and Audi, have also seen increases in EV sales this year: in 2020, Chevy Bolt sales increased 26 percent and Audi e-tron sales 34 percent. Manufacturers like Nissan and Hyundai have both seen overall declines in total vehicle sales, though Nissan had its best Q4 since 2016 for the all-electric Leaf. After seeing sales of EVs triple last year, the CEO of VW said "2020 marked a turning point in the customer sentiment."[112] The Chevy Bolt EV had its best first-quarter retail sales ever, up 60 percent compared to Q1 2020.[113] Though Tesla still dominates the EV market, legacy auto manufacturers are making headway as EVs gain broader public appeal and model availability grows.[114]

Looking ahead, EV interest has been promising as consumers look towards 2021 model releases. The 2022 GMC Hummer EV sold out pre-orders in 10 minutes.[115] Ford announced it would boost production of the all-electric F-150 by 50 percent compared to original plans due to "strong early interest."[116]

Projected long-term effects of the COVID-19 pandemic on vehicle sales – both ICE and EV – vary across industry expert opinions. Early analyst reports projected that EV sales globally would fall in 2020 relative to 2019 – by between 18 and 43 percent – due to the global recession, supply chain disruptions, and changes in consumer behavior, only regaining momentum by the mid- to late-2020s as prices fall, charging becomes more abundant, and auto makers offer greater variety.[117] As noted above, as the pandemic has progressed, however, auto sales industry-wide began to rebound despite months of production shut downs, with the International Energy Agency (IEA) claiming that although total global passenger car sales are set to decline 15 percent for 2020, "electric car sales are expected to fare better than the overall passenger car market, with EV sales this year to broadly match the 2.1 million sold in 2019." [118] As 2020 concluded, global EV sales are estimated to have reached between 2.5 and 3 million globally. Despite the pandemic, sales of EVs grew year over year fromm 2019 to 2020 in many places around the world while car sales shrank overall. Global EV sales increased 46 percent with EV sales in the U.S. growing four percent (all but 10 states saw EV growth compared to 2019) while overall car sales decreased 15 percent. In Europe EV sales increased 135 percent compared to 24 percent decline in the overall car market.[119] Morgan Stanley believes this trend will carry over into 2021, projecting that global EV sales could grow 50 percent or more compared to a projected two to five percent increase for ICE vehicle sales while IHS Markit predicts the number will be closer to 70 percent growth this year.[120]

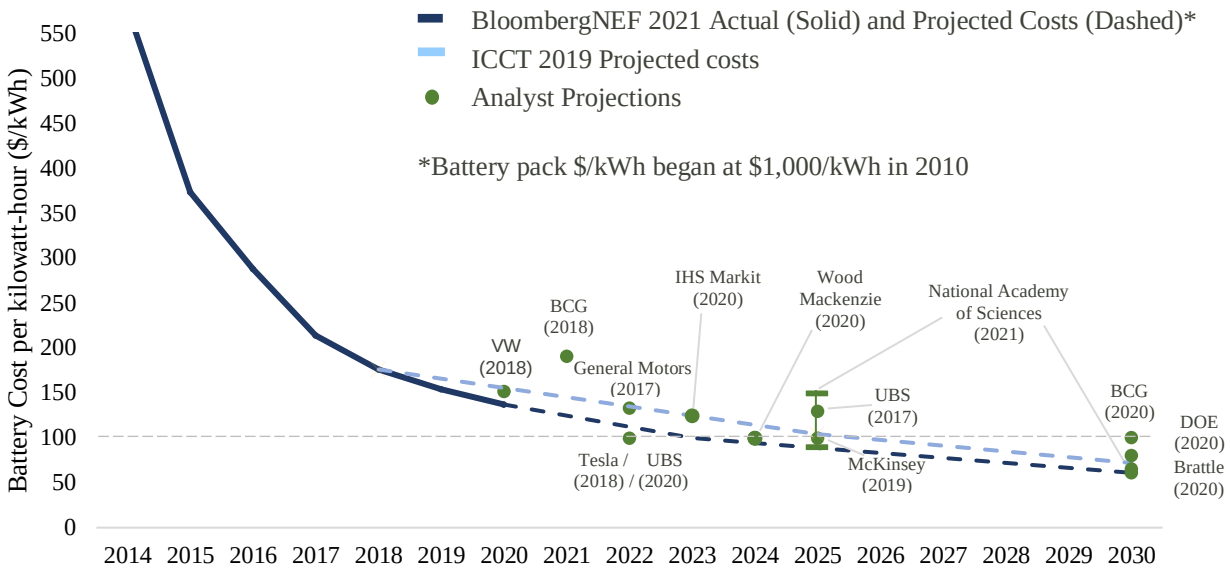
Sales rebounds will also depend on government actions: in the U.K., new gasoline and diesel vehicle registrations were down around 90 percent in May 2020 compared to the previous year while BEV registrations were up 21.5 percent, a trend that may have been influenced by a tax break for corporate buyers that began the month prior.[121] Similarly, Germany doubled its EV incentive as part of its COVID-19 stimulus plan, with combined incentives totaling €9,000 for new vehicles costing less than €45,000. President Biden's "American Jobs Plan" includes a host of EV provisions, including purchase incentives, to "win the EV market."

Battery Pack Cost Projections and EV Price Parity

For EVs to become cost competitive with ICE vehicles (without considering tax or other incentives or emissions externalities), virtually all analysts agree that battery pack prices must continue to drop from $137/kWh in 2020 to around $100/kWh.* When battery prices cross this threshold, EVs will achieve price parity on a total cost of ownership basis.

As illustrated in Figure 9[122] and Figure 10[123], most analysts agree that price parity between EVs and ICE vehicles will occur sometime between 2023 and 2025. Working in parallel with the price parity projections for batteries, Volvo expects its margins on electric cars to match those of vehicles with combustion engines by 2025.[124] With the advent of price parity on the horizon, some analysts expect the sales of conventional gas cars to peak in 2030 and decline thereafter.[125]

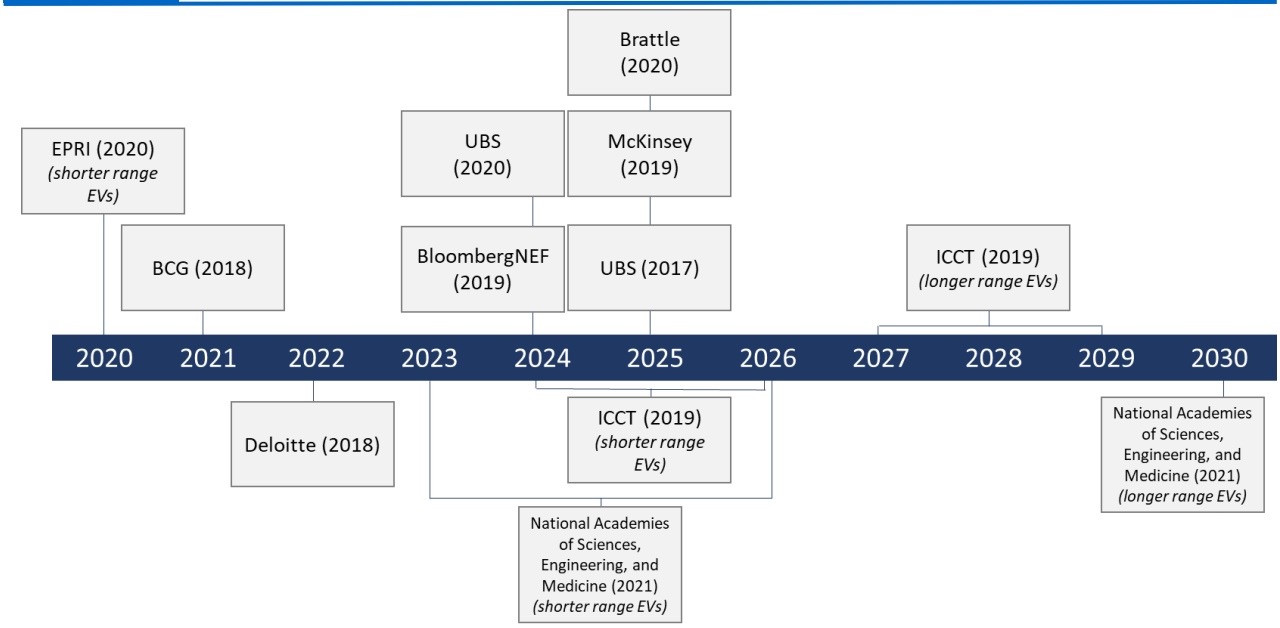
Figure 9 Actual and Projected Battery Pack Costs



Cost projection shown are for battery packs. Several of the listed sources estimated battery cell costs; for these estimates the value shown includes a 25 percent mark-up to estimate pack costs.

* BloombergNEF estimates 2020 battery pack prices at $137/kWh but estimates vary: EPRI estimates that the current cost is between $120 and $200/kWh; the Electrification Coalition estimates current costs are around $150/kWh.

Figure 10 Industry Expert Price Parity Timeline – Based on Total Cost of Ownership



Continued improvements in batteries are key to achieving ICE cost parity via reductions in upfront purchase cost, increased EV range, and increased battery life. Most analysts believe that price parity will be achieved at some point in the mid-2020s. The Electric Power Research Institute (EPRI), however, believes that BEVs with smaller battery packs (i.e., 40 kWh packs compared to 80 kWh packs), already achieved initial cost parity in 2020. While most EVs are still more expensive to purchase, they are already providing significant fuel cost savings: as highlighted by a recent National Renewable Energy Laboratory (NREL) and Idaho National Laboratory (INL) study, EVs could save drivers as much as $14,500 in fuel costs over 15 years compared to ICE vehicles.[126]

Advancements in solid-state batteries could be revolutionary. 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. QuantumScape, which received a $200 million investment from VW in June 2020, is developing high-energy density solid-state batteries that could enable up to 80 percent longer range than today's lithium-ion batteries, reach 80 percent charging capacity in 15 minutes, and effectively operate at -30 degrees Celsius – a game changer for cold weather drivers.[128]

Today, the U.S. ranks sixth globally for the lithium-ion supply chain after China, Japan, South Korea, Canada, and Germany but could rise to third place by 2025.[*] According to the U.S. State Deparment, over 80 percent of the global supply chain of rare earth elements (important components of lithium-ion batteries and other EV componnets) is controlled by China, and BloombergNEF has found that China holds 77 percent of the world's battery cell manufacturing capacity and 60 percent of the world's component manufacturing. [129] 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.

[*] Ranking according to BloombergNEF, which has ranked countries across five key themes related to the supply chain: raw materials, cell and component manufacturing, environment, RII (regulations, innovation, and infrastructure), and end demand (across electric vehicles and stationary storage). The rise to third is dependent on whether the U.S. increases its investment in raw materials and promotes EV adoption.

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

GM is investing $2.3 billion into a joint venture with LG Chemical to produce its Ultium battery at a plant in northeastern Ohio and is exploring options for a second location. GM estimates that the pack will cost 60 percent less than today's packs with twice the energy density and predicts it will allow for a maximum range of 450 miles.[130] GM is also developing a next-generation, one million mile battery – compared to current batteries that are projected to last 100,000-200,000 miles.[131]

Tesla is simultaniously developing its own million mile battery, which could come early 2021; exploring improvements in energy density for next-generation batteries through partnerships with Panasonic; and testing alternative chemistries to lithium-ion batteries with researchers at Dalhousie University.[132] During its 2020 Battery Day Event, Tesla announced it will be manufacturing "tabless" battereis that will be six times more powerful and increase range by 16 percent.[133]

Mercedes-Benz has forged research partnerships with CATL in China, particularly on its cell-to-pack design, and with Hydro-Quebec's Center for Excellence in Transportation Electrification and Energy Storage in Canada to develop solid-state battery technologies.[134] According to Hydro-Quebec, solid-state lithium metal batteries could mark a new era in EV battery development as they have "a very high energy density, are long lasting, and very light [and are] considered to be a safer alternative to regular lithium-ion batteries."[135]

On Volkswagen's first Power Day, the company presented its technology roadmap for batteries and charging through 2030. They expect the new unified cell to reduce battery costs by up to 50 percent in the entry-level segment and by up to 30 percent in the volume-level segment. Volkswagen announced it would establish six gigafactories in Europe by the end of the decade ammounting to 240 GWh of production capacity.[136]

BMW announced researchers are working "intensively" to build a prototype of a solid-state battery car – compared to the liquid electrolyte system used for lithium-ion batteries today – before 2025, a development that would improve performance and safety.[137]

Beyond automaker involvement, research insitutions like Georgia Tech, ETH Zürich, and Oak Ridge National Laboratory are collaborating on solutions that would increase energy density without reducing the battery liftetime through structures created during charge-discharge cycles.[138] 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.[139] 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-hearting structure that regulates system temperature, and bring the retail price of EVs down to $25,000.[140]

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Appendix – Manufacturer Commitments & Announced BEV and PHEV Models for Light-Duty Vehicles

Figure 1A Manufacturer Commitments: Model Announcements, Investments, and Sales Forecasts

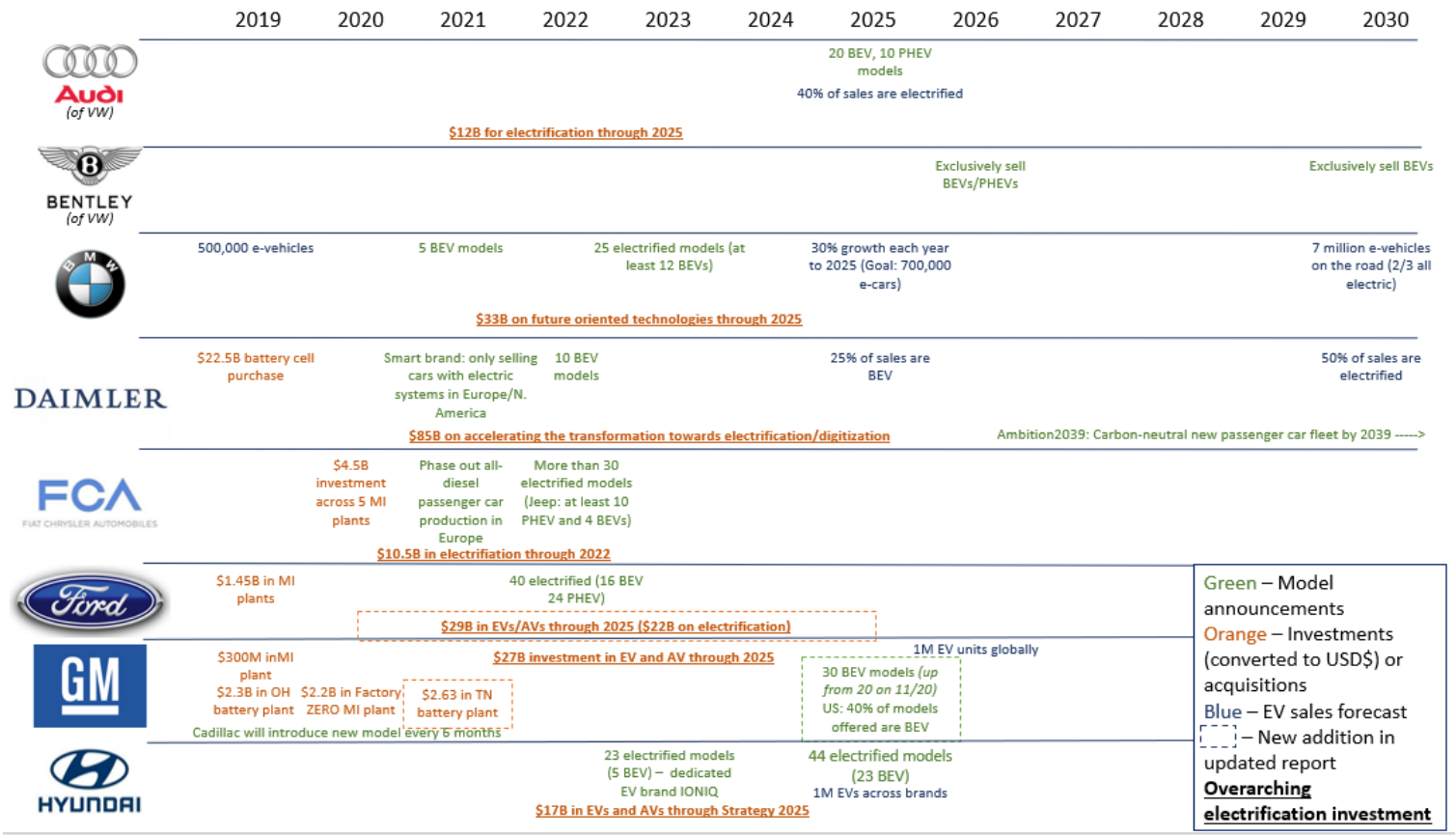

Figure 1A (cont.) Manufacturer Commitments: Model Announcements, Investments, and Sales Forecasts

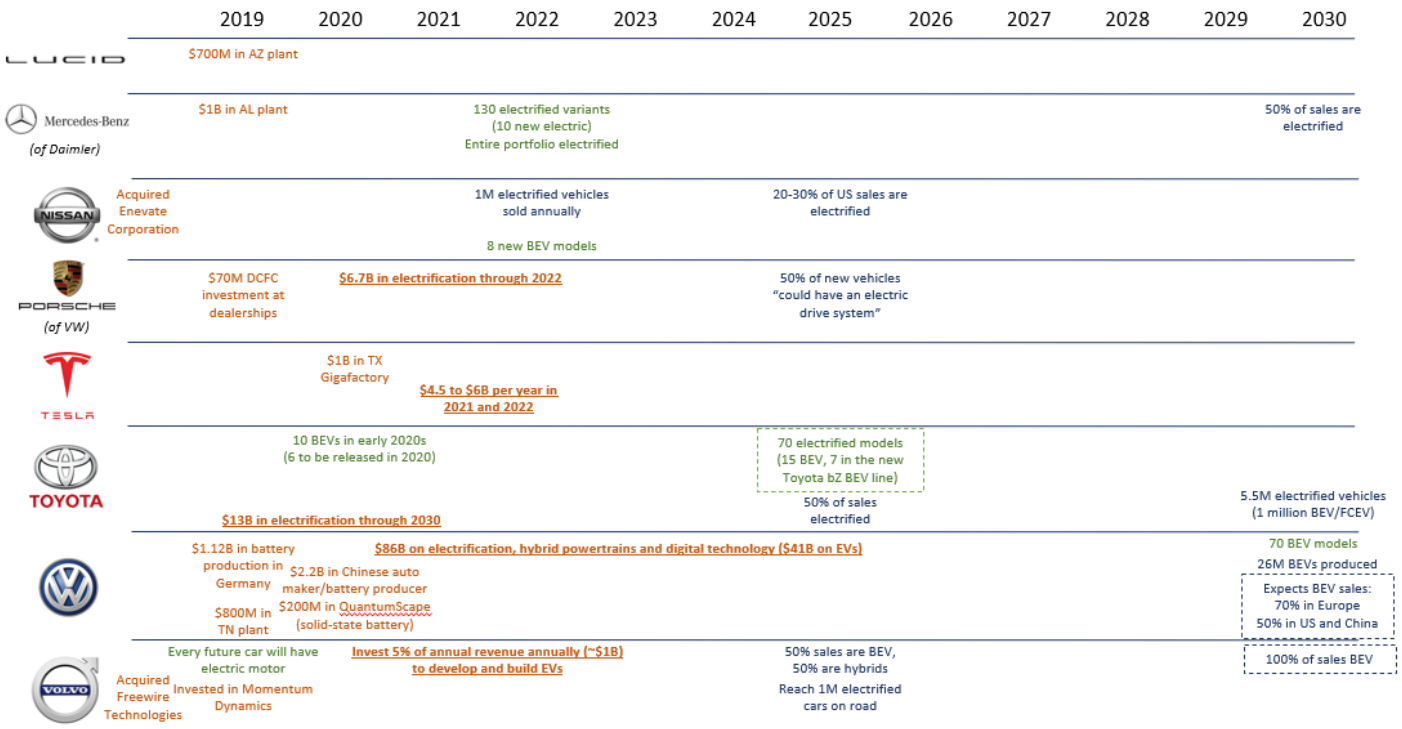

Table 1A Manufacturer Targets: Reduction in Lifecycle CO_2 Emissions from New Cars Sold

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

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

Model Announcements – Light-Duty Vehicles

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

Battery Electric Vehicles

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Atlis Motor Vehicles	**Truck/Van**	**XT**	**2022**	**125**	**300**	**$45,000**
Alpha Motor	**Truck/Van**	**Wolf**	**2023**		**250**	**$46,000**
Audi	SUV	e-tron	2021	95	222	$65,900
Audi	**Hatchback**	**e-tron GT**	**2021**	**93**	**298**	**$99,900**
BMW	Hatchback	i3	2021	42.2	153	$44,450
BMW	Hatchback	i4	2021	80	270	
BMW	SUV	Vision iX	2022		300	
BYD	SUV	e6	2021	80	250	$35,000
Cadillac	SUV	LYRIQ	2022	19	300	$60,000
Cannoo	**Truck/Van**	**MPDV1**	**2023**	**40-80**	**130-230**	
Chevrolet	Hatchback	Bolt	2021	66	259	$31,995
Chevrolet	SUV	Bolt EUV	2021	65	250	$33,995
Fisker	SUV	Ocean	2022		250	$37,499
Ford	SUV	Mustang Mach-e	2021	68	230	$42,895
Ford	Truck/Van	F 150	2022			
GMC	Truck/Van	Hummer SUT	2021		350	
Hyundai	Hatchback	IONIQ Electric	2021	38.3	170	$33,045
Hyundai	SUV	Kona Electric	2021	64	258	$37,190
Hyundai	SUV	Ioniq 5	2021	58-72.6	295	
Hyundai	Hatchback	Ioniq 6	2022			
Hyundai	SUV	Ioniq 7	2024			
Jaguar	SUV	I-Pace	2021	90	234	$69,850
Jaguar	Hatchback	XJ	2021		300	
Kandi	Hatchback	K27	2021		59	$17,499
Kandi	Hatchback	K23	2021		113	$27,499
Kia	**Hatchback**	**EV6 GT**	**2021**	**77.4**	**316**	
Kia	SUV	Niro	2021	64	239	$39,090
Lordstown Motors	Truck/Van	Endurance	2021		250	$52,500
Lucid Motors	Hatchback	Air	2022		517	$69,900
Lucid Motors	SUV	Project Gravity	2023			

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Mercedes Benz	SUV	EQC	2021	80	200	$68,895
Mercedes Benz	SUV	EQS	2022			
Mercedes Benz	SUV	EQE	2022			
MINI	Hatchback	Mini Cooper SE Electric	2021	32	110	$29,900
Mullen	**SUV**	**MPDV1**	**2023**	**40-80**	**130-230**	
Nissan	Hatchback	Leaf	2021	40	226	$24,100
Nissan	SUV	Ariya	2021	63	300	40,000
Polestar	Hatchback	Polestar 2	2021	78	233	$59,990
Porsche	SUV	Macan	2022			
Rivian	Truck/Van	R1T	2021	105	300	$67,500
Rivian	SUV	R1S	2021	105	300	$70,000
Tesla	Hatchback	Model 3	2021	54	263	$37,990
Tesla	SUV	Model Y	2021	75	244	$41,990
Tesla	Hatchback	Model S	2021		402	$69,420
Tesla	SUV	Model X	2021	100	371	$79,990
Tesla	Truck/Van	Cybertruck	2022		250	$39,990
Toyota	**SUV**	**bZ4X**	**2022**			
Volkswagen	SUV	I.D. 4	2021	48	250	$39,995
Volkswagen	SUV	I.D. Buzz	2022	111	270	
Volvo	SUV	XC40 Recharge	2021	75	200	$53,990
Volvo	**SUV**	**C40 Recharge**	**2021**	**75**	**210**	**$55,000**
Volvo	SUV	XC 90	2022			
Volvo	SUV	XC100	2023			$85,000

Plug-In Hybrid Electric Vehicles

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Audi	SUV	Q5	2021	14.1	20	$43,300
Audi	Hatchback	A7	2021		24	$74,900
Audi	Hatchback	A8	2021		17	$86,500
BMW	Hatchback	330e	2021	12	22	$44,550
BMW	SUV	X3	2021	12	17	$49,600
BMW	Hatchback	530e	2021	12	21	$57,200
BMW	SUV	X5	2021	24	30	$65,400
BMW	Hatchback	745e	2021	12	17	$95,900
Chrysler	Truck/Van	Pacifica Hybrid	2021	16	32	$39,995

Manufacturer	Vehicle Type	Model Name	Planned Availability	Battery Size (kWh)	Range (mi)	Cost
Ford	SUV	Escape	2021	14.4	37	$33,000
Ford	Hatchback	Fusion Energi	2021	9	26	$37,500
Honda	Hatchback	Clarity	2021	17	48	$33,400
Hyundai	Hatchback	IONIQ Plug-In Hybrid	2021	8.9	29	$26,500
Hyundai	Hatchback	Sonata	2021	9.8	28	$33,400
Hyundai	SUV	Tucson	2021	7.2	32	$26,135
Hyundai	SUV	Santa Fe	2021	12.4	30	$35,000
Jeep	SUV	Wrangler 4xe	2021		21	$47,995
Kia	SUV	Niro	2021	8.9	26	$29,490
Land Rover	SUV	Range Rover Sport	2021	13.1	19	$83,000
Lincoln	**SUV**	**Corsair Grant Touring**	**2021**	**14.4**	**25**	**$51, 225**
Lincoln	SUV	Aviator	2021		21	$69,740
MINI	Hatchback	MINI Countryman	2021	7.6	17	$41,500
Mitsubishi	SUV	Outlander	2021	12	22	$36,295
Porsche	SUV	Cayenne	2021	14	13	$81,800
Subaru	SUV	Crosstrek	2021	8.8	17	$35,145
Toyota	Hatchback	Prius Prime	2021	8.8	25	$28,220
Toyota	SUV	RAV4 Prime	2021		42	$38,100
Volvo	Hatchback	S60	2021	10.4	22	$47,650
Volvo	SUV	XC60 Recharge	2021	10.4	19	$53,500
Volvo	Hatchback	S90	2021	10.4	21	$60,050
Volvo	SUV	XC90 Recharge	2021	10.4	18	$63,450

Unconfirmed Models and Soft Announcements

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

Manufacturer	Vehicle Type	EV Type	Model Name	Planned Availability
Audi	SUV	BEV	Q4 e-tron	Unconfirmed for U.S. – concept
Bentley		PHEV		Two to be released in 2021
Bentley		BEV		2025
BMW	SUV Hatchback	BEV	X1 5-series	Announced will offer electrified versions, did not confirm specs or other information
Byton	Hatchback SUV	BEV	K-Byte M-Byte	Unclear due to COVID and unconfirmed for U.S.
Cadillac	**Hatchback**	**BEV**	**Celestiq**	**Unconfirmed date**
Ford	**SUV**	**BEV**		**Two crossovers for 2023**
GM	**Truck/Van**	**BEV**	**Silverado**	**Announced April 2021 with 400 miles range – release date not announced**
Honda		BEV	Fit/Jazz	
Honda	**SUV**	**BEV**		**Two to be released in 2024**
Jeep	SUV	PHEV	Renegade Compass	Unconfirmed for U.S.
Kia	SUV	BEV	Stonic	
Mercedes Benz		PHEV	*Unconfirmed for U.S.:* GLBe A250e	Announced 10 new electric models by 2022
Mercedes Benz		BEV	*Unconfirmed for U.S.:* EQA (2021) EQB (2021)	Announced 10 new electric models by 2022
Toyota	3 SUVs* (*one would be a Subaru collaboration)* 2 Trucks/ Vans* 1 Hatchback*	BEV	*Unnamed*	Announced June 2019 for 2020-2025 **2 SUVs to be announced in 2021**
Toyota		**PHEV**		**One to be introduced in 2021**
VW		**BEV**		**Project Trinity to potentially be launched 2026**
Workhorse^	Truck/Van	PHEV	W-15	Production on hold as of March 2020

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

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

Price ($)

Range (Miles)	0-30,000	30,000-40,000	40,000 – 70,000	70,000+
0-150	Kandi K27 Kandi K23 Mini Cooper SE			
150-250	Nissan Leaf	Huyundai IONIQ Kia Niro EV Chevrolet Bolt EUV BYD e6 Volkswagen I.D. 4 Fisker Ocean Tesla Cybertruck	BMW i3 Jaguar I-Pace Volvo XC 40 Volvo Polestar 2 Audi e-tron Mercedes EQC Tesla Model Y Ford Mach-e Lordstown Endurance Volvo C40 Recharge	
250+		Chevrolet Bolt Hyundai Kona Tesla Model 3	Nissan Ariya Rivian R1T Tesla Model S Cadillac LYRIQ Lucid Air Atlis XT	Tesla Model X Rivian R1S Hummer SUV Audi e-tron GT

Model Announcements – Medium- and Heavy-Duty Vehicles

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

Medium-Duty Vehicles

Manufacturer	Model	Weight Class	Availability	Battery (kWh)	Range (mi)
Electric Last Mile Services	**Elms EV Urban Delivery Van**	**Class 1**	**2021**		**150**
Arrival	**The Arrival Van**	**Class 2b-3**	**2022**	**44-133**	**112-211**
Atlis Motor Vehicles	**XP Platform (Chassis)**	**Class 2b-3**	**2022**		
Bollinger	B2 Chass-e Cab	Class 2b-3	2022	105, 140	200
Bollinger	**Chass-E (Chassis)**	**Class 2b-3**	**2022**	**105, 140**	**200**
CityFreighter	CF1	Class 2b-3	2022		
EVT Motors	Urban Truck	Class 2b-3	2021	92.5	173
EVT Motors	Van	Class 2b-3	2021	106.2	109-173
Ford	E-Transit	Class 2b-3	2021	43-86	60-126
General Motors (BrightDrop)	EV600	Class 2b-3	2021		250
Lightning eMotors	Transit Cargo Van	Class 2b-3	2021	86, 105	140, 170
Rivian	Cargo Van	Class 2b-3	2021 (Amazon Only)		
SEA Electric	Ford Transit EV	Class 2b-3	2021	88	190
Workhorse	C 650	Class 2b-3	2021	35, 70	100, 160
Workhorse	C 1000	Class 2b-3	2021	35, 70	100, 160
Canoo	MPDV2	Class 4	2022		
Dana Nordesa	W4	Class 4	2021	80, 160	75, 150
Dana Nordesa	T4	Class 4	2021	80, 160	75, 150
Greenpower	**EV Star Cargo+**	**Class 4**	**2021**	**118**	**150**
Greenpower	**EV Star Cargo**	**Class 4**	**2021**	**118**	**150**
Greenpower	EV Star CC	Class 4	2021	118	150
Lightning eMotors	E-450 Cutaway	Class 4	2021	86, 129	80,120
Motiv	Epic E450	Class 4	2021	127	105
Pheonix Motors	Zeus 500	Class 4	2021	70-150	80, 115, 150
SEA Electric	Isuzu NPR	Class 4	2021	100	170
BYD	6F	Class 5-6	2021	221	125
BYD	6R	Class 5-6	2021		85
BYD	6D	Class 5-6	2021	221	120
Chanje	V8100	Class 5-6	2021	100	150
Daimler	Freightliner MT50e (Chassis)	Class 5-6	2021	226	125

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

Heavy-Duty Vehicles

Manufacturer	Model	Weight Class	Availability	Battery (kWh)	Range (mi)
BYD	8R	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**	
Enride	**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	
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		
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**		

Manufacturer	Model	Weight Class	Availability	Battery (kWh)	Range (mi)
Kenworth	T680E	Class 7-8 Tractor	2021		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		
Kalmer	Ottawa T2E Electric Terminal Tractor	Terminal Tractor	2021		
Lonestar	Lonestar SV Reman Electric Terminal Tractor	Terminal Tractor	2021		
Orange EV	T-Series	Terminal Tractor	2021		
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
Motor Coach Industries (NFI Group)	J4500e CHARGE	Coach	2021		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
Daimler	The Saf-T-Liner® eC2 Jouley	School	2021	220	135
Greenpower	The BEAST	School	2021	193.5	150
Lion Electric	LionA	School	2021	80, 160	75, 150
Lion Electric	LionC	School	2021	210	100, 125, 155
Lion Electric	LionD	School	2021	210	100, 125, 155
Motiv	Epic F59	School	2021	127	105
Navistar	IC Bus CE Series Electric	School	2021	105-315	70-200
Pheonix Motors	Zeus 600 School Bus	School	2021	70, 105, 140	80, 115, 150
Greenpower	**EV Star**	**Shuttle**	**2021**	**118**	**150**
Greenpower	**EV Star+**	**Shuttle**	**2021**	**118**	**150**
Greenpower	AV Star	Shuttle	2021	118	150
Lightning eMotors	Transit Passenger Van	Shuttle	2021	86, 105	140, 170

Manufacturer	Model	Category	Availability	Battery (kWh)	Range (mi)
Lightning eMotors	E-450 Shuttle	Shuttle	2021	86, 129	80, 120
Lightning eMotors	F-550	Shuttle	2021	122	100
Lion Electric	LionM	Shuttle	2021	160	75, 150
Motiv	Epic E450	Shuttle	2021	127	105
Optimal EV	S1LF	Shuttle	2021		200
Pheonix Motors	Zeus 400 Shuttle Bus	Shuttle	2021	70, 105, 140	80, 115, 150
SEA Electric	E4B Commuter Bus	Shuttle	2021	88	186
Zenith Motors	Electric Shuttle	Shuttle	2021		90,110
Arrival	**The Arrival Bus**	**Transit**	**2023**		
BYD	Transit Bus K7 - 30'/K9 -S 35'/ K9 - 40'/K11 - 60'	Transit	2021	215, 266, 352, 446	137, 145/215, 156, 220
BYD	Double Decker C8MS - 35' / C8MS - 45'	Transit	2021	113, 446	170, 230
Gillig	Battery Electric Bus (40')	Transit	2021	148-444	150, 210
Greenpower	EV 250 (30')	Transit	2021	210	175
Greenpower	EV 350 (40')	Transit	2021	430	200
Greenpower	EV 550 (45' Double Decker)	Transit	2021	478	175
Hyundai	Battery Elec City	Transit	2021	256	130
Lightning eMotors	**Electric Zero Emission City Transit Bus Repower**	**Transit**	**2021**	**320**	**140, 200**
New Flyer	Xcelsior CHARGE 35', 40', and 60'	Transit	2021	350, 440, 525	179, 220 / 174, 213, 251 / 153
New Flyer	**Xcelsior AV**	**Transit**	**2021**	**Can integrate Xcelsior CHARGE platform**	
Proterra	ZX5 40' and 60'	Transit	2021	450, 675	240, 329
Volvo Group	Nova Bus LFSe/LFSe+	Transit	2021	564	75, 292
BYD	Coach Bus C6M - 23'/C8M - 35'/ C9M - 40'/C10M - 45'	Coach	2021	121, 313, 352, 446	124, 200, 230
Motor Coach Industries (NFI Group)	J4500e CHARGE	Coach	2021		230

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

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