


BENEFITS OF TRANSPORTATION ELECTRIFICATION IN A POST PANDEMIC WORLD

Quantifying the Potential Economic, Public Health, and Climate Benefits of Transportation Electrification and Assessing the Road Ahead

By Conner Smith, Nick Nigro, and Nicole Lepre

JUNE 2021

ATLAS PUBLIC POLICY
WASHINGTON, DC USA

ALLIANCE FOR TRANSPORTATION ELECTRIFICATION (ATE)
SEATTLE, WA

EXECUTIVE SUMMARY

The first three months of 2021 saw early actions from the Biden Administration and strong commitments to transportation electrification made by automakers, utilities, and other key players in the United States electric vehicle (EV) market. This activity has increased the number and breadth of pathways that policymakers can pursue to accelerate the shift towards transportation electrification and capture more of the billions of dollars in investments committed to the technology worldwide. The first paper in this series highlighted the public health, economic, and environmental costs associated with the COVID-19 pandemic and severe 2020 wildfire season. Underserved communities have borne a disproportionate amount of the economic and public health impacts due to long-term overexposure to dirty air, increased occupational hazards through greater exposure to the virus, and disproportionate levels of unemployment.

Now is the time for bold action at the federal and state levels to put the United States in a position of leadership in transportation electrification. This paper outlines three key opportunities for the country to achieve success and rapidly decarbonize the transportation sector:

Take Decisive Action at Federal Level.
The Biden Administration's American Jobs Plan could inject $174 billion into transportation electrification in the United States [1]. This includes $15 billion for EV charging, which would fill a portion of the investment in charging needed to facilitate 100 percent zero emission U.S. passenger car sales by 2035. Estimates on investments needed range from $87 to $110 billion through 2030 [2, 3]. The plan would also provide critical support to an industry looking to expand domestic EV manufacturing, battery development, and other component production. This support is essential to help ensure that the country remains competitive in the global EV market and that investment and jobs are not lost to China and the European Union.

Expand State Policy Frameworks.
For the last several years, states have been leading the policy development and public funding for transportation electrification. More than $2.4 billion has been committed to EVs and EV charging around the country through April 2021. Continuing and strengthening support from state governments and utilities will be essential to achieve widespread transportation electrification. Expanding multi-state and multi-utility partnerships, such as the Transportation and Climate Initiative Program and Regional Electric Vehicle West initiative, will be critical to growing transportation electrification nationwide. Moreover, many states have an opportunity to increase funding support for transportation electrification by dedicating remaining Volkswagen Settlement funding to EVs and EV charging and implementing policies requiring utilities to develop EV programs [4].

Prioritize Underserved Communities.
Major investments in EV and charging deployment, with a focus on underserved communities, can improve economic and public health outcomes for communities disproportionately impacted by COVID-19 and other historical injustices. Utilities have taken significant actions toward ensuring the benefits of transportation electrification are shared equitably, with more than 23 percent of the $3 billion in all-time approved investment in EV programs designated to these communities [5]. A coordinated, national approach to embracing transportation electrification is also a critical way for the United States to deliver far-reaching emissions reductions and make meaningful progress on air quality, especially in underserved communities, and on the fight against climate change.

INTRODUCTION

After years of inaction at the federal level, transportation electrification may receive a significant infusion of federal support through the comprehensive infrastructure and climate plans proposed by the Biden administration [6, 7]. The roughly $2 trillion proposed infrastructure package, the American Jobs Plan, will focus on providing targeted funding to help individuals, transit agencies, and companies invest in clean technology and drive job creation in the United States. If passed by Congress, this would amount to about one percent of GDP per year for the next eight years, which is an historic and massive investment of public funds. At least $174 billion of the plan is targeted specifically for transportation electrification. As a whole, the American Jobs Plan could add three million jobs to the U.S. economy through 2030 and result in a sizeable reduction in greenhouse gas emissions [8]. Analysis by Rhodium Group on similar clean transportation and clean energy investments under the proposed Growing Renewable Energy and Efficiency Now (GREEN) Act[1] finds investments similar to those in the American Jobs Plan could reduce greenhouse gas emissions by 19 percent compared to 2005 levels by 2030 [9].

Part of the heightened emphasis on electric vehicle (EV) investment comes from directives to buy American-made products to stimulate the economy and support domestic jobs. The pandemic has put a renewed focus on the impact of the transportation sector on air quality and greenhouse gas emissions. During this period, there has been a 15 percent drop in transportation emissions and 10 percent drop in emissions across all sectors in 2020, when social distancing resulted in a significant decline in travel of all forms. Rhodium Group, the organization behind these emissions estimates, cautions that these reductions are likely temporary "without meaningful structural changes in the carbon intensity of the U.S. economy" [10]. However, the reductions demonstrate the potential for transformational investments in transportation electrification to achieve lasting emissions reductions.

The pandemic also highlighted the need to direct economic and environmental benefits from the recovery efforts towards underserved communities. Communities of color continue to face persistently higher unemployment levels compared to white communities [11]. In addition to inequitable economic outcomes, these communities have historically borne the brunt of exposure to emissions from vehicles, ports, power plants, refineries, and other leading sources of criteria air pollution due to racially discriminatory housing policy [11]. Increasing concentration of criteria pollutants associated with combustion, like fine particulate matter ($PM_{2.5}$), by one additional unit was found to increase the risk of COVID-19 mortality by eight percent [12]. The first paper in this series, *Air Quality, Climate Change, and COVID-19*, described in greater detail the disproportionate impacts of the pandemic amid existing economic, public health, and environmental inequalities.

Early activity in transportation electrification in 2021 has generated considerable interest in the public sphere around the economic and environmental opportunities of a major shift towards EVs. In addition to spurring new domestic manufacturing employment and investment in some regions, EVs offer the opportunity to realize long-term emissions reductions. While the private sector is accelerating investments in EV market, infusions from federal and state governments are likely still needed to accelerate the deployment of EVs and the necessary charging infrastructure to support electrification across all sectors and weight classes. Additionally, public support is needed to support domestic efforts around batteries, supply chains, and materials. Moreover, utility investments in EV programs and

[1] The GREEN Act was first introduced in June 2020 by Rep. Mike Thompson and was later reintroduced under House Bill 848 in February 2021 and referred to the House Ways and Means Committee [127].

infrastructure will continue to provide a significant and sustained source of funding through the investment of ratepayer dollars.

The Biden Administration's focus on investment in domestic manufacturing and increasing American competitiveness in clean energy and transportation could make EVs an important part of the economic recovery from the pandemic in the United States. The focus on EVs in the American Jobs Plan could mark an era of EV market expansion throughout North America whose automobile and supply chain industries are tightly integrated. Moreover, such investments, if properly made and implemented, could start to close the competitive gap in both technology and production with China and the European Union.

The escalating costs of COVID-19 as well as the widespread damages from climate disasters like wildfires outlined in part one of this series have increased the urgency around achieving significant emissions reductions in part through rapid transportation electrification. This paper describes how leadership from the federal government combined with action at the state level could invigorate the American EV sector and deliver considerable climate and air quality benefits, especially to the low-income communities and communities of color experiencing worse impacts from the pandemic, while laying a strong foundation for economic recovery and job creation in domestic supply chains.

ECONOMIC BENEFITS FROM TRANSPORTATION ELECTRIFICATION

New investments in transportation electrification can create jobs across occupations and regions and contribute to GDP while simultaneously decreasing pollution. Moreover, electrification can help drivers save money over the lifetime of their vehicle by replacing gasoline and diesel with electricity which, on average, is cheaper [13, 14]. Recent polling finds that 70 percent of voters support federal spending to advance transportation electrification, 71 percent of voters – including more than 50 percent of Republican voters – support the goal of achieving a 100 percent clean economy by 2050, and 66 percent of voters support a multi-trillion-dollar federal economic stimulus that prioritizes clean energy and transportation infrastructure investments [15].

Significant momentum in transportation electrification already exists globally with an increasing amount of investment committed by automakers and manufacturers to expand electrification efforts. Without robust transportation electrification policies and programs, the United States risks losing EV investment and jobs to China and the European Union. While the United States saw a three percent decline in EV sales between 2019 and 2020, the global EV market grew by 39 percent [16]. This was driven by China and Europe, the latter of which saw EV sales surge 170 percent in 2020 [17].

European market growth is being driven by strong public policy including generous passenger vehicle incentives, emissions standards, and public funding for vehicle manufacturing and charging deployment. This robust policy framework was created to facilitate the EU's commitment to deploy 30 million EVs through 2030 [18, 19]. There has also been a flurry of manufacturing investment on the continent with European giant Volkswagen leading all automakers in terms of global investment committed to transportation electrification. The Biden Administration's American Jobs Plan and increasing electrification commitments from automakers and other stakeholders could rapidly transform the clean energy and transportation sectors in the United States and help ensure that the United States benefits from transportation electrification through new domestic jobs. The 2035 Report produced by the Goldman School of Public Policy at the University of California at Berkeley and Energy Innovation found that despite a direct job loss in the auto sector (e.g., vehicle manufacturing) through 2035, a rapid shift to clean energy and transportation will produce two million net new jobs, including jobs in the electric power sector along with indirect and induced jobs [3].

EMPLOYMENT AND INVESTMENT IN MANUFACTURING

Most automakers and manufacturers have made a decisive shift towards transportation electrification. Accelerating rapidly since the beginning of 2018, private companies have committed almost $500 billion to EV investment around the world [20]. America's largest automaker, General Motors, aspires to only sell electric vehicles by 2035 [21]. The United States, which has a large auto manufacturing jobs base, is well positioned to capitalize on this investment surge and transition existing auto manufacturing jobs to EV production and potentially grow jobs in new areas, like battery assembly and manufacturing.

The automotive sector has long been a critical source of employment and other economic activity in the United States, creating a strong foundation to support the burgeoning transportation electrification market. In January 2020, before the onset of the pandemic, the U.S. auto sector employed 976,000 people directly in manufacturing and an additional two million people in the retail trade, including auto dealerships [22]. The combined 2.85 million people employed in the auto sector as of January 2021 represent two percent of the 160 million people in the civilian labor force [23]. According to the Alliance for Automotive Innovation, the auto industry supports more than 10.3 million jobs including both direct and indirect employment. By this measure, the employment tied to the sector represents eight percent of private sector employment [24]. The Alliance estimates that the auto sector contributes roughly 3.5 percent of the total U.S. Gross Domestic Product.

The auto sector and the U.S. manufacturing sector suffered job loss as a result of production shutdowns and flagging consumer demand throughout the pandemic. Auto manufacturing employment dropped seven percent and retail employment fell five percent between January 2020 and January 2021 [23]. According to BW Research, the clean vehicles subsector employed more than 260,000 people directly before the onset of the pandemic. At least 12 percent of these jobs had been lost through December 2020 due to extended production shutdowns and lower consumer demand for new cars [25].

The U.S. auto sector has been adding back manufacturing jobs since reaching a pandemic-induced 10-year low of only 626,000 employed in April 2020. More than 900,000 people were working in U.S. auto manufacturing as of March 2021, still nine percent lower than pre-pandemic levels [26]. Recent announcements from leading American automakers indicate that an increasing share of jobs will be positioned to support the rollout of electrification strategies. Table 1 highlights major announcements from manufacturers in the United States on potential new employment in EV manufacturing.

Growth in the transportation electrification sector in the United States over the last decade has increased the contribution of EVs to employment and economic growth in the United States. At least 35,000 people currently are or are expected to be employed directly in EV-specific manufacturing positions at 32 facilities across 13 states. This is roughly 3.6 percent of the overall auto sector manufacturing employment, greater than the market share of EVs, which constituted two percent of all light-duty vehicle sales in 2020 [13]. These facilities have generated more than $27 billion in local investment in the cities and states where they are located [13]. The net effect on jobs from a complete transition to electric transportation will vary greatly worldwide depending on jobs in vehicle and supply chain manufacturing, onshoring battery production and other key material processing, vehicle maintenance and repair, energy generation, and more (see Box 1).

The EV-related facility-level employment and investment numbers reflect only a portion of the investment automakers have committed to furthering transportation electrification in the United States. Automakers and manufacturers operating in the United States have committed approximately $100 billion to EV

programs, roughly a fifth of the total global investment. Figure 1 shows the five manufacturers with the largest private investment commitments to electrification in the United States, totaling $80 billion [20].

TABLE 1: TOP 10 ANNOUNCED U.S. PASSENGER EV MANUFACTURING COMMITMENTS

Automaker	Facility	State	EV Investment (Billion $)	New EV Employment	Production Start Year
Tesla	Fremont Factory	CA	$4.1	10,000	2012
Tesla	Reno Gigafactory	NV	$4.5	7,000	2017
Tesla	Gigafactory 5	TX	$1.1	5,000	2022
General Motors	Detroit-Hamtramck	MI	$2.2	2,200	2021
Nissan	Smyrna Factory	TN	$1.7	1,300	2012
General Motors	Spring Hill Factory	TN	$2.3	1,300	2022
General Motors	Lordstown Joint Venture	OH	$2.3	1,100	2020
Volkswagen	Chattanooga Plant	TN	$0.8	1,000	2022
Rivian	Normal Plant	IL	$1.0	1,000	2021
Ford	Flat Rock Assembly	MI	$8.5	900	2020
Total			$26.9	36,400	

This table lists the top 10 U.S. EV manufacturing commitments made by automakers and includes both existing and planned EV-specific jobs at each facility. Seven of the 10 have EV production start dates in 2020 or later. These numbers are drawn from public press releases and may not reflect the total amount of investment and employment related to EV production at these facilities.

Source: Atlas EV Hub [13]

While the Biden Administration's commitments to support domestic manufacturing and supply chains could help boost automaker confidence in the growth potential of the U.S. EV market, individual state labor, tax, policy, and regulatory environments will also influence where investments are made. Large commitments made to electrification by General Motors and Ford in the latter half of 2020 that are currently assumed to support the domestic EV market may be spent elsewhere if the market conditions in the United States are less favorable to EVs. The EV industry is international in nature and intensely competitive both among the manufacturers and among the countries, states, and local jurisdictions looking to attract such investments. Ford announced in February 2021 that it would invest $1 billion to build out EV manufacturing capabilities in Germany [27]. Tesla is also gearing up to launch production at its newest Gigafactory in Berlin in 2021 [28]. Box 2 highlights the most significant recent developments from major American automakers.

Direct manufacturing investments at specific U.S. facilities do not capture employment throughout the EV supply chain. In states like Texas and Pennsylvania, which do not host any existing EV plants, transportation electrification supply chains could support thousands of jobs. In Texas, more than 5,000

new jobs could be created from Tesla's new factory outside of Austin. Research suggests existing jobs in the Lone Star state could also transition to EV manufacturing if automakers like General Motors and Toyota decide to move upcoming EV production to facilities currently located in Texas [30, 31].

Box 1: EV Job Projections in the 2035 Report

In April 2021, Energy Innovation and the University of California Berkeley's Goldman School of Public Policy released a study called the 2035 Report [3]. The key findings of the report are as follows:

- 100 percent passenger vehicle, bus, and truck electrification is technologically and economically feasible by 2035.
- Light-duty and heavy-duty electric vehicles cost less than counterpart conventional vehicles on a total cost of ownership basis by 2025 and reach upfront price parity in the mid- to late-2020s and mid- to late-2030s, respectively.
- Combined with 90 percent renewable electricity generation nationwide, complete transportation electrification could lead to a 45 percent economy-wide reduction in greenhouse gas emissions by 2030 relative to 2005 levels.
- More than two million net jobs (direct, indirect, and induced) could be created by 2035 across the transportation, energy, and fuel sectors.
- High levels of EV deployment are contingent upon the adoption of a collection of supportive policies at both the state and federal level.

Net job creation figures are dependent on what the report calls the "DRIVE Clean" policy scenario. The 2035 report and analysis from Bloomberg New Energy Finance (BNEF) predicts that automakers will focus their EV efforts in the global markets where governments offer the strongest public policy support for the technology [29]. Under the DRIVE Clean framework, the United States would have to implement a suite of policies including tougher vehicle standards, a national 100 percent EV sales targets, and expanded tax credit and rebate programs at the state and federal levels across all vehicle classes.

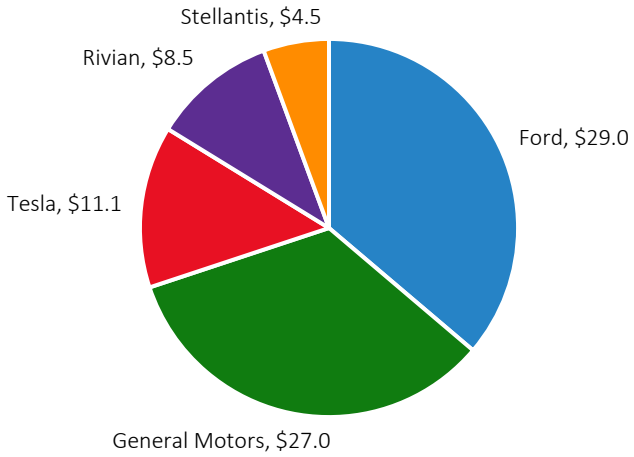
The report relies on Energy Innovation's Energy Policy Simulator (EPS) to project job growth potential. Under the DRIVE Clean Scenario, the EPS estimates that direct job creation will outpace direct job loss, leading to a net gain of more than 400,000 direct jobs across the electricity, fuel, and auto sectors. Roughly 470,000 direct jobs are expected to be lost in the auto sector primarily through the supply chain as a result of the more limited maintenance needs associated with EVs compared to conventional vehicles. The EPS does not account for the positive impact that "Made in America" policies can have in encouraging a greater share of EV supply chain industry development in the United States could have on domestic jobs. The report notes that the United States is currently behind leading EV markets in the European Union and China in terms of battery and supply chain manufacturing.

Not included in the employment numbers mentioned in Table 1 is the growing presence of medium- and heavy-duty vehicle manufacturing from Arrival, Proterra, Freightliner Trucks, Thomas Built Buses, Volvo Trucks, and New Flyer [14].[2] While some of these manufacturers make both electric and conventional buses and trucks and often do not directly report jobs or investment specific to EV production, increasing electrification of the medium- and heavy-duty sector would likely require the creation of jobs or shift of existing jobs to facilitate growing demand for electric vans, trucks, and buses. In North Carolina, which is

[2] In February 2021, Daimler (the parent company of Freightliner Trucks and Thomas Built Buses) announced it would divide its passenger car operation from the trucks and buses arm of the company [128].

home to headquarters and manufacturing facilities for Arrival, Volvo, and Daimler, clean vehicles and energy jobs are growing 50 percent faster than the labor market as a whole [32, 33].

FIGURE 1: FIVE LARGEST EV INVESTMENT COMMITMENTS FOR U.S.-BASEDAUTOMAKERS (BILLION $)



This represents the sum of all publicly announced investment commitments to EV strategies by automakers based in the United States. Without supportive federal and state policies, a greater portion of these investments could be made outside of the United States. Not all investment in EVs is discernible from public reports.

Source: Atlas EV Hub [20]

While the net impact on jobs from a transition to EVs will not be clear for some time, transportation electrification will create new jobs in EV charging and battery manufacturing. Several charging providers were included on the list of 25 companies contributing to the $37 billion in private investment announcements made in 2020 [20]. ChargePoint, which accounts for 47 percent of all charging ports installed in the United States, raised $493 million in a merger with Switchback Energy Acquisition Corp in September 2020 [37]. EVgo, a charging provider focused on fast charging stations, merged with the Climate Change Crisis Real Impact I Acquisition Corporation in January 2021 and raised $575 million in proceeds [38]. These two deals boosted the total investment by charging companies to $3.7 billion, with $2 billion to date coming from Electrify America, a provider established under the terms of the Volkswagen Settlement [20].

Expansion in domestic battery production also has potential to support many new jobs in the United States. In December 2019, a joint venture between General Motors and LG Chem announced plans to establish a battery cell assembly plant in Lordstown, Ohio, that could support more than 1,100 new jobs [39]. The automaker announced plans for a second $2.3 billion battery plant through this partnership to be located in Tennessee alongside an existing vehicle manufacturing plant in April 2021 [40]. In addition, SK Innovation, a large battery manufacturer, is planning to invest $2.6 billion in a battery plant in Georgia

that could employ as many as 2,600 people [41].[3] In May 2021, the manufacturer announced plans to team up with Ford on a new joint venture to produce batteries at two undisclosed domestic facilities by 2025 [42]. Tesla is also gearing up to produce its batteries in house at scale for the first time as opposed to not relying heavily on Panasonic for large-scale battery production. The automaker unveiled its battery cells in September 2020, which it plans to use in the upcoming Tesla Semi freight truck that is scheduled to go into production in Austin, Texas some time in 2022 due to a battery shortage that has pushed back deliveries initially planned for the fourth quarter of 2021 [43, 44].

Box 2: American Automakers Expanding EV Programs in 2021

In the first three months of 2021, automakers and manufacturers have made $27 billion of new pledges to invest in EV and EV charging programs in the United States, roughly 70 percent of the total committed in 2020 [20].

General Motors: In January 2021, the automaker became the first of the Detroit Three—including General Motors, Ford, and Stellantis (formerly Fiat-Chrysler)—to pledge to electrify all sales across their brands globally by 2035 [21]. The January announcement also included promises to reach carbon neutrality by 2040, a target only previously set by foreign automakers including Volkswagen, Daimler, Volvo, and Nissan. The automaker is gearing up to release its first EVs on their Ultium battery platform in partnership with LG Chem later in 2021 [34].

Ford: In February 2021, Ford increased their investment commitment in electric and autonomous vehicles by $18 billion and announced a target to electrify all sales in the European market by 2030 [35]. The total $29 billion now pledged slightly edges out GM's $27 billion commitment. The restriction of Ford's commitment to the European market reflects the risk of the United States losing out to other markets with stronger policy support. In April 2021, Ford also announced plans to begin manufacturing their own batteries domestically at a new facility in Michigan as soon as 2025 [36].

Besides automakers and manufacturers, electric utilities are accelerating their programs and activities to spur EV adoption and help build out foundational electric infrastructure for charging stations across all use cases. Utility investment worth more than $1.2 billion were approved in 2020, three times higher than the investment approved in 2019 [5]. These investments will go towards projects such as the construction of new infrastructure to support EV charging and will therefore support jobs such as construction jobs. Xcel Energy, one of the top ten utilities in the country in terms of total EV investment, has seen success in rolling out comprehensive EV programs in several states in their service territory. In addition to the $26.5 million approved in Minnesota already, Xcel was approved to invest $110 million in their transportation electrification plan in Colorado in January 2021 [5].

At the federal level, the U.S. Department of Energy (DOE)'s Energy Storage Grand Challenge aims to accelerate the commercialization of next generation energy storage technologies manufactured in the United States. It supports research and development while providing funding to reduce the time required

[3] Notably, in a February decision, the U.S. international Trade Commission sided with allegations made by LG Chem that SK Innovation stole trade secrets and placed a 10-year import ban on SK Innovation after four-year and two-year grace periods in which the company can supply batteries to Ford, and Volkswagen, respectively. The companies reached a $1.8 billion settlement in April 2021 that resolved the dispute and cleared the way for SK Innovation to continue their investment plans [120, 126].

to bring new technologies to market. BNEF estimates that average battery pack prices fell by 89 percent between 2010 and 2020 [45]. The DOE program's Roadmap, released in December 2020, outlines targets to reduce storage costs by 90 percent from 2020 levels through 2030 [46]. The DOE Vehicle Technologies Office aims for battery pack costs to reach $60 per kilowatt-hour (kWh), more than a 40 percent reduction from levels seen in 2020. This new cost threshold is also being targeted by Tesla and Volkswagen as both automakers continue to strive towards cheaper, in-house battery production [47].

EV MARKET GROWTH AND TRENDS

The U.S. EV market in the last six months has been considerably stronger than during the same six months in the previous year, exhibiting resiliency during the pandemic and outpacing year-over-year conventional vehicles sales in 2020. U.S. passenger EV sales declined by three percent while the auto sector overall fell by 15.6 percent [13]. So far in 2021, EV sales have set monthly records in both January and February, with sales in February up 100 percent compared to 2020 levels. Of particular note is Tesla's declining market share with the entry of new models. Roughly 37 new EVs are expected to enter the market by the end of 2021, with some already being introduced, including the Ford Mustang Mach-E, the Volkswagen ID.4, Audi Q5 plug-in, and Volvo XC40 Recharge [13].[4] Tesla remains the U.S. market leader, accounting for 62 percent of the total U.S. passenger EV sales in 2020 and 51 percent in February 2021. Figure 2 shows the difference in monthly EV sales growth between January 2020 and February 2021 with and without Tesla.

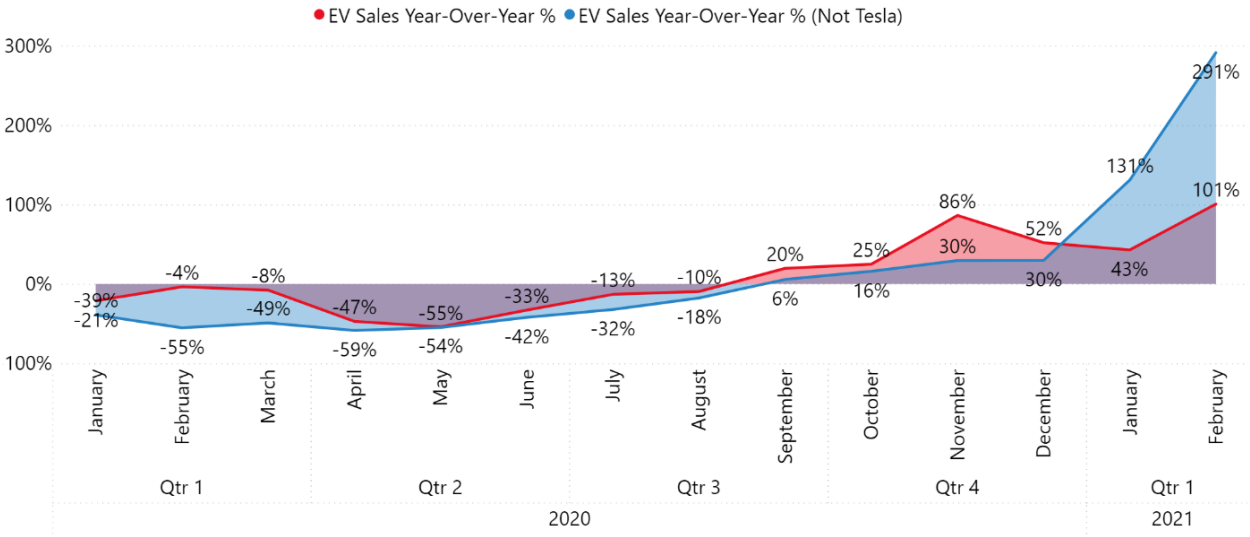
Looking ahead, BNEF's 2020 Electric Vehicle Outlook projects that the global EV fleet will grow by 14 times through 2040 and passenger EV market share in the United States could reach 60 percent of new vehicle sales [48]. To get there, the United States will likely need substantive new policies and investments in order to see the type of growth currently taking place in Europe. European EV sales were up by 170 percent in 2020 over 2019 while overall auto sales dropped by 24 percent [17]. Europe's lead in transportation electrification can be at least partially attributed to strong regional policy commitments and the dedication of pandemic recovery funds to climate investments. More than one million EVs were sold across Europe in 2020 and the European Union is seeking to rapidly accelerate the transition and deploy 30 million EVs by 2030 [18]. The plan includes significant government support for transportation electrification as a vehicle for COVID-19 economic recovery and an essential action to achieve the Union's climate goal of carbon neutrality by 2050. This activity helped Europe catch up to China, the global leader in EV sales in 2020. China and Europe both saw total sales volume reach roughly 1.3 million EVs, four times the number of U.S. sales [16].

As the EV market grows, the number and type of used vehicles available to consumers will also grow. Among consumers who own and operate a personal vehicle, roughly 70 percent purchased a used vehicle based on 2019 market data [49, 50]. Meanwhile, new vehicle prices across fuel types rose six percent between January and December 2020, reaching an all-time new vehicle average transaction price (ATP) high of $40,000 [51]. Analysts link this new car price increase to more limited supply due to production delays, essential component shortages, income loss, lack of low-interest credit availability, and shifting travel preferences due to the pandemic [52, 53, 54, 55, 56]. This ramp up in new vehicle prices led to an even larger increase in demand for used vehicles with the ATP for used vehicles reaching $23,000, a 14 percent year-over-year increase [56].

[4] Anticipated EV models expected to enter the market in 2021 but not yet available as of May include the Rivian R1T/R1S, Chevrolet Bolt EUV, GMC Hummer SUT, Cadillac Lyriq, Audi Q4 e-tron, Mercedes EQS,

EVs will likely be an increasingly attractive option in the used segment because of the low operating costs, an important factor for consumers purchasing a used vehicle. The introduction of new EVs including the Chevy Bolt EUV, Ford F-150 Lightning, and Volkswagen ID.4 that are priced below the new vehicle ATP of $40,000 will increase the number of affordable options available to buyers when these vehicles enter the used market. State policy, like Oregon's EV rebate program, provides a boost to the used market by expanding eligibility to used vehicles and offering larger rebates for income-qualified buyers [57]. Expanding rebate programs to specifically target low-income buyers will help ensure that EV market growth is reaching the used vehicle customer base while also achieving emissions reductions by getting older conventional cars off the road [58].

FIGURE 2: YEAR-OVER-YEAR EV SALES GROWTH



Without Tesla, the year-over-year U.S. EV sales growth is lower in the first eight months in 2020. Including Tesla, 2020 U.S. EV sales were down three percent for the whole year. This falls to 22 percent when Tesla is excluded.

Source Atlas EV Hub [13]

While U.S. EV sales were slowed by the pandemic, charging deployment in 2020 was almost double the number of stations reportedly installed in 2019. New investments and reverse merger deals from charging service providers helped drive investment commitments in electrification strategies from private companies operating in the United States compared to 2019 [20].

Declining battery prices and greater model availability are also driving global expansion in the medium- and heavy-duty vehicle segment. This progress is expected to continue, with BNEF projecting the EV share of new vehicle sales for transit buses, medium-duty commercial vehicles, and heavy-duty commercial vehicles to reach 75 percent, 20 percent, and 10 percent through 2040, respectively [29]. Federal support for electric transit buses through the Low or No-Emission Program has been a key source of support driving the commercialization of this technology. The program has awarded more than $485 million to deployment of electric buses since 2013 and the number of electric transit buses deployed in the United States grew by 24 percent between 2019 and 2020 [59]. While school bus deployment has lagged behind transit buses, state government funding through the Volkswagen Settlement and other programs increased from $23 million in 2018 to $250 million through December 2020 [60]. In the truck market,

private companies are rapidly increasing the number of models available across all use cases. Technology advancements coupled with regulatory efforts are expected to allow electric trucks to overtake the sales of diesel trucks in the North American market by 2040 [61].

ELECTRICAL GRID, ENVIRONMENTAL, AND PUBLIC HEALTH BENEFITS FROM TRANSPORTATION ELECTRIFICATION

Electrifying transportation would have a significant impact on electricity demand, emissions, and public health in the United States. BNEF projects EV market share will reach as high as 60 percent by 2040 [29]. A separate analysis from Bloomberg estimates that electrifying all vehicles and accelerating the shift to renewable electricity would lead to a 30 percent reduction in U.S. greenhouse gas emissions compared to 2019 and effectively cut out 13 percent of primary energy consumption by improving overall system efficiency and reducing wasted energy inputs for electricity generation that are lost as heat [62].

The potential climate and public health benefits from EVs are increasing over time as the electricity generation fuel mix adds renewables and removes fossil fuels. This section explores the energy planning, climate, and public health benefits of EVs as they relate to the power grid and energy consumption.

ELECTRICAL GRID BENEFITS AND EQUITY PRIORITIES

Recent events, including the wildfires in the western United States and the power outages in Texas, have highlighted the importance of investing in an increasingly resilient and modern electrical grid. Wildfires and the conditions that cause them, including high winds, heat waves, and dry lightning, have led to sweeping emergency electricity service shutoffs across the western United States; in some cases, utilities have been held liable for the onset of catastrophic fires resulting from grid equipment.

The causes of the electricity curtailments and extended power outages in Texas (as well as adjacent states) are still being investigated but were likely caused by a number of factors, including unprecedented frigid weather, lack of winterization of key parts of power generators, market design, and governance and regulatory issues. While multiple interventions are likely necessary to address the full suite of causes of the crisis that played out in Texas, transportation electrification may be one tool that utilities can leverage to deliver grid operational benefits through vehicle-grid integration (VGI) strategies [63].[5]

In addition to helping create grid resiliency, VGI can facilitate more efficient use of existing grid infrastructure, which can put downward pressure of electricity rates. Three methods used to achieve VGI include EV charging rates that encourage charging through reduced rates during off-peak hours, managed charging programs[6], and using EV batteries to supply energy to the grid through bidirectional power flow, known as vehicle-to-grid (V2G).

[5] VGI is defined in the California Legislature as any initiative to "shift the time, charging level, or location where grid-connected electric vehicles charge or discharge, in a manner that optimizes plug-in electric vehicle interaction with the electrical grid and provides net benefits to ratepayers" [121].

[6] Smart charging is active control of unidirectional power flow from the grid to the vehicle, where vehicle charging is controlled by grid operators, aggregators, automakers, or other entities utilizing managed/smart charging technology depending on grid conditions.

Throughout 2020, approved utility investment in transportation electrification increased three times over the amount approved in 2019. Through February 2021, almost $3 billion in utility EV programs have been approved and nearly $2.3 billion of those approved programs include elements to promote VGI, such as requiring charging technology to be capable of "smart" charging or requiring participation in an EV rate the encouraged off-peak charging [5]. Even partial participation in VGI mechanisms can lead to significant savings for utilities. An analysis from Synapse Energy Economics in June 2020 found that between 2012 and 2019, EV charging rates in the Southern California Edison and Pacific Gas & Electric service territories – the two service territories with the highest rates of EV adoption in the United States – helped facilitate $800 million in revenue above costs [64].

California utilities, responsible for half of the nation's utility EV investment to date, are also leading on VGI efforts. A February 2021 report from the California Public Utilities Commission (CPUC) found that considerable investment in transportation electrification across the state's three investor-owned utilities have not had an impact on rates to date. The February costs and affordability report found that "a well-managed effort to move customers to all electric homes and electric vehicles could result in over a $100 a month reduction in overall energy bills [65]."

Equity has emerged as a core priority in utility transportation electrification programs. The February CPUC report warned that low-income customers could be left out of grid modernization and electrification initiatives in the absence of subsidies and low-cost financing options for both vehicles and infrastructure. As of February 2021, at least $700 million, or 23 percent of all approved potential utility EV investment, could directly support EV and charging rollout in underserved communities [5]. A July 2020 decision in New York authorized $701 million in make-ready investment spread across six of the state's seven investor-owned utilities, 20 percent of which is allocated to underserved communities [66]. The program includes $85 million in prizes or competitive grants from the New York State Energy Research and Development Authority (NYSERDA) for innovative projects, including bus and truck electrification in environmental justice communities throughout the state [67].

Utilities in states with rapidly growing EV markets, including Colorado and Virginia, are targeting electrification of medium- and heavy-duty vehicles to enhance grid resilience and reduce emissions from vehicles operating in underserved communities. Xcel Energy's $110 million Transportation Electrification Plan for Colorado includes a 15 percent investment commitment to underserved communities and will provide EV rebates directly to income-qualified customers and pilots exploring V2G with school buses [68]. In Virginia, Dominion is taking a similar approach and has committed to partner with the state as it rolls out Volkswagen Settlement funds to electrify all school buses in the state over the next few decades [63].

ENVIRONMENTAL AND PUBLIC HEALTH BENEFITS FROM TRANSPORTATION ELECTRIFICATION

Reducing emissions from transportation is one of many necessary actions to meet climate change targets both globally and nationally. The Greenlining Institute, a leading environmental justice group, highlights transportation electrification as a key part of a strategy to advance both climate and health justice in the United States [69]. Meeting the targets set in the Paris Agreement to keep global temperature increase below two degrees Celsius will require the United States to achieve economy-wide emissions reductions between 26 and 28 percent below 2005 levels by 2025 [70]. The transportation sector accounts for 28 percent of U.S. greenhouse gas emissions and decarbonization can be a major contributor to achieving climate goals [71]. Reaching an 80 percent U.S. carbon reduction by midcentury would require near-100

percent renewable energy electricity generation and the electrification of between 67 and 84 percent of all vehicle travel [72].

In addition to being a necessary part of effective climate change mitigation, transportation electrification also has an essential role to play in delivering widespread air quality benefits across the nation. According to the U.S. Environmental Protection Agency (EPA), transportation accounts for 55 percent of all nitrogen oxide (NO_x) emissions, a leading contributor to ground-level smog in cities across the country [73]. The Centers for Disease Control and Prevention (CDC) estimates these emissions could lead to between 1,000 and 4,300 additional premature deaths annually by 2050 unless action is taken. The annual health costs associated with current levels of criteria air pollution are estimated at $6.5 billion [74].

Reducing criteria air pollution from all sources is essential to promote public health, especially for underserved communities that face a disproportionate share of the emissions burden from both the power and transportation sector. In particular, emissions from medium- and heavy-duty vehicles both on the road and at ports and industrial sites are concentrated in these communities due to decades of racially discriminatory environmental and housing policies [11]. A study conducted in California showed that Latinx communities face 15 percent higher than average exposure to dangerous criteria pollutants like fine particulate matter ($PM_{2.5}$) and Black communities have an 18 percent higher exposure rate. White communities have an exposure rate 17 percent below the California average [75].

According to the CDC, the concentration of many criteria air pollutants will increase with climate change as climate-driven extreme weather events like wildfires contribute significantly to concentrations of $PM_{2.5}$ and PM_{10} [11]. Underserved communities, including Latinx farmworkers and houseless populations, predominantly people of color, are also facing greater health risks associated with wildfire smoke than white communities. In response to these inequalities, California, the state hit hardest by the 2020 wildfire season, established the Listos California initiative to provide state grants to promote emergency preparedness specifically in disadvantaged communities [76].

Other states heavily impacted by the 2020 fire season, like Washington, are taking the initiative to implement comprehensive plans to combat the increasing severity of wildfires driven by climate change. In April 2021, the legislature passed House Bill 1168, bipartisan legislation that allocated $125 billion every two years for the next eight years to invest in community resilience and wildfire preparedness and prevention [77]. In the same session, the legislature also passed a bill implementing a clean fuel standard program in the state to reduce transportation emissions statewide and help address the root causes of climate change [78].

Transportation electrification is being including in parts of the pandemic and climate response efforts being developed across the country. In California, public officials and stakeholders have convened the Strategic Growth Council to coordinate investments worth almost $900 million directly supporting underserved communities in their response to public health and climate change challenges [79]. In February 2021, the council launched the Partners Advancing Climate Equity to increase support for local and regional climate action led by underserved communities [80].

This type of integrated policy effort will be necessary for communities across the country to respond to and mitigate climate change. Recent research published in the scientific journal Nature estimates that country-level emission reductions targets from the Paris Agreement will have to be 80 percent more ambitious in order to prevent global temperature increase beyond the established thresholds [81]. The

United States could position itself to achieve climate targets and enhance environmental justice with rapid transportation electrification. The following section outlines policies and pathways that are being taken throughout the country to accelerate this transition.

TRANSPORTATION ELECTRIFICATION POLICY PATHWAYS ALONG THE ROAD TO RECOVERY

According to the United Nations Environmental Program (UNEP), only 18 percent of pandemic relief funds and 2.5 percent of total spending worldwide have been directed towards sustainability initiatives [82]. A majority of this investment falls in Europe. While none of the $4.8 trillion approved Coronavirus relief spending in the United States through March 2021 included a focus on medium- and long-term economic stimulus measures like transportation electrification or clean energy, the Biden Administration has made investment targets for both a clear priority of its $2 trillion infrastructure package under the American Jobs Plan [85, 86, 87, 83].

The United States will have to take clear action on energy and transportation decarbonization to meet the Biden Administration's climate goals. On April 22, 2021, the Biden Administration announced targets to reduce U.S. greenhouse gas emissions by between 50 and 52 percent from 2005 levels by 2030 [83]. This new target supersedes the commitments made through the Paris Agreement and sets a clear directive for both the federal government and state governors, legislatures, and public agencies around the country to take steps to reduce emissions.

Research from Energy Innovation in early 2021 estimates the cost of delayed action in decarbonizing the U.S. economy to be considerable. They estimate that beginning to enact policies to promote a large-scale clean energy and transportation transition in 2030 as opposed to 2021 causes the costs associated with the transition to be 75 percent higher [84]. Specifically, beginning to act in 2030 would cost $8 trillion compared to $4.5 trillion if action begins in 2021. These cost increases are a result of a shortened timeline to phase out conventional vehicles and fossil fuel power plants and still meet Paris Agreement climate targets.

A 2020 study from Princeton University identified several low-cost pathways for the United States to reach net-zero greenhouse gas emissions by 2050. The analysis projects only a three percent net increase in energy costs for aggressive decarbonization compared to the business as usual approach through 2030 [85].

Table 2 highlights key actions policymakers can take to progress transportation electrification in 2021.

TABLE 2: NEAR TERM TRANSPORTATION ELECTRIFICATION POLICY OPPORTUNITIES

Policy Action (Jurisdiction)	Description
Enact the American Jobs Plan (Federal)	Proposed in March 2021, the plan could bring $174 billion in funding for transportation electrification initiatives including federal EV rebates, school and transit bus funding, and charging infrastructure investment.
Continue and Expand State Incentive Programs	13 states and the District of Columbia have some form of active passenger EV rebate or tax credit program in place. Another 24 states have programs supporting charging infrastructure while only seven have programs targeted at medium- and heavy-duty vehicles. Continuing and strengthening these existing programs and adding new programs in other states would have a significant impact on EV adoption and help ensure the market develops more evenly nationwide. New incentive programs are particularly important in states that adopt California's Zero Emissions Vehicle (ZEV) program for passenger vehicles and/or the Advanced Clean Truck rule for medium- and heavy-duty vehicles.
Strengthen Federal Vehicle Standards (Federal)	The Biden Administration has signaled intentions to restore stronger vehicle standards initially implemented under the Obama Administration. The standards were weakened by the Trump Administration in March 2020. Analysts say standards will need to be more aggressive than Obama-era rules to enable rapid EV adoption.
Implement EV Sales Targets and Related Regulations (Federal, State)	13 states have adopted the California ZEV Program targeting light-duty electrification. California, Washington, and Massachusetts have set conditional targets to electrify all passenger vehicle sales by 2035. ZEV states account for 67 percent of all passenger EV sales between January 2019 and February 2021. In addition, fifteen states have adopted targets to electrify all bus and truck sales by 2050. California has gone further than this standard and implemented the Advanced Clean Truck rule, requiring by 2035 zero-emission truck/chassis sales be 55 percent for Class 2b-3, 75 percent for Class 4-8, and 40 percent for truck tractors [86]. Increasing adoption of these regulations could lead to large regional gains in EV rollout if paired with other supportive policies, such as EV rebate programs.
Increase Multi-State Program Adoption (State)	Several multi-state policy frameworks, including the Transportation and Climate Initiative Program and Regional Electric Vehicle West initiative, have increased coordination around and funding available for EVs and EV charging in participating states. Utilities in the Midwest, Southeast, and West Coast are leading efforts to create multi-state charging corridors and networks, as well.
Dedicate Remaining Volkswagen Settlement Funding to EVs (State)	At least 65 percent of Volkswagen Settlement funds remain unspent throughout the country. States with remaining reserves can follow the lead of Colorado, New Jersey, and Virginia in dedicating all remaining funding to EVs and EV charging. This one-time funding source can help increase demand for medium- and heavy-duty EVs in nascent markets.
Implement Utility and Statewide Transportation Electrification Plans (State)	Policymakers can collaborate with electric utilities and other stakeholders to set deployment targets and increase EV investment. States like Colorado, which required utility transportation electrification plans through legislation, are seeing large increases in proposed utility investment. Coalescing around statewide deployment targets can inform plans and determine how much investment is needed.

FEDERAL ACTION ON TRANSPORTATION ELECTRIFICATION

The federal government has provided key support for transportation electrification since the mass market began in 2010 through vehicle and charging tax incentives, research and development investments, and technology deployment programs. Box 3 highlights federal support for transportation electrification.

Large infusions of federal funding will be necessary to fill charging gaps, even in the nation's leading EV markets, for the country to achieve widespread EV adoption this decade. In California, which accounts for a third of the nation's charging stations and almost half of all EV sales, public charging infrastructure will need to grow by more than four times to serve estimated EV adoption levels by 2025 [87].

Following the enactment of the America Rescue Plan in March 2021, the Biden Administration turned its focus to sweeping infrastructure and jobs legislation [94]. The Biden Administration's American Jobs Plan proposes levels of federal funding for clean energy and transportation that far exceed anything the U.S. government has done before, including the American Recovery and Reinvestment Act of 2009 (ARRA). The Biden Administration's plan, formally announced on March 31, 2021, establishes a pathway to deliver on campaign promises to create one million auto sector jobs, deploy 500,000 charging stations, electrify public transit across the country, and reach 100 percent carbon-free electrical power by 2035. These investments are also aimed at supporting the Administration's ambitious goal of achieving a 52 percent reduction in greenhouse gas emissions from 2005 levels by 2030 [95].

Biden's $2 trillion plan allocates $174 billion to a variety of transportation electrification initiatives, including point-of-sale EV rebates to consumers, electrification of 20 percent of the nation's school bus fleet, the replacement of diesel transit vehicles with electric models, tax incentives for medium- and heavy-duty trucks, and $15 billion in tax and funding programs for charging infrastructure (see Figure 3). The plan sets bold targets to ensure 40 percent of all climate and clean technology investments are designated to support underserved communities [1].

Research from Atlas Public Policy shows that investments from the American Jobs Plan would be a sizeable start but not sufficient to support 100 percent passenger EV sales by 2035, a goal targeted by California, Massachusetts, New York, and other states making aggressive EV adoption goals. [4]. Studies estimate that between $87 and $110 billion of investments will be needed for charging infrastructure by 2030, including up to $39 billion in public charging to set the country on a path to support 100 percent EV sales by 2035 [2, 3].[7] Figure 3 shows the main EV elements of the American Jobs Plan by investment category.

The Biden Administration is also attempting to demonstrate leadership by pursuing federal fleet electrification. In March, President Biden announced a goal to electrify the entire 645,000-vehicle federal fleet, roughly a third of which are U.S. Postal Service (USPS) vehicles [97]. Box 4 highlights some of the challenges with electrifying the Postal Service. In addition to potential difficulties with USPS, the federal fleet contains many thousands of tactical and niche vehicles used by the Department of Defense and Homeland Security. Despite these hurdles, electrification of the federal fleet would provide significant demand for EV manufacturers, spurring further innovation in the transportation electrification market and helping to make EVs more accessible to the public. The electrification of the federal fleet would be a move consistent with the federal government's long history of investing in innovative technologies.

[7] The Atlas Public Policy study estimates that public charging costs increase from $39 to $52 billion when 150-kilowatt charging equipment is used instead of equipment capable of 350-kilowatt charging.

Box 3: Federal Funding for Transportation Electrification

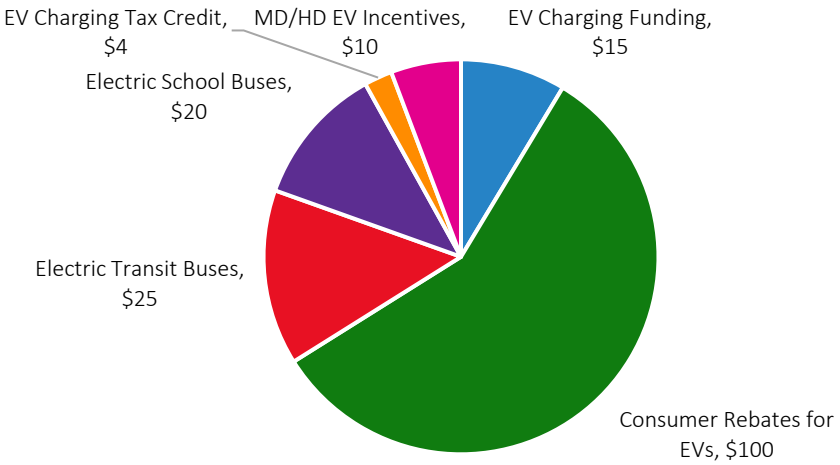
American Recovery and Reinvestment Act (ARRA) of 2009: The ARRA led to the allocation of more than $18 billion to clean transportation projects [88]. This included $400 million in grant funding for alternative fuel technologies including EV and EV charging deployment administered by Clean Cities Coalitions around the country at a time when the U.S. EV market was nascent [89]. The charging service provider, ChargePoint, accounted for 70 percent of U.S. charging ports at the beginning of 2013 and completed the execution of their 4,600 charging station deployment through a $15 million grant from the ARRA that same year [90]. ChargePoint remains the largest charging service provider in the United States with 46 percent of the national networked charging ports. They were the first charging company in the United States to go public in September 2020 at a $2.4 billion valuation [91].

Federal Low or No Emission Bus (Low-No) Grant program: Since 2015, the Federal Highway Administration has awarded more than $450 million to support transit bus electrification in 46 states. This represents 60 percent of all recorded public funding for this technology [60]. This investment has provided critical support to the electric transit bus industry with deployments almost doubling nationwide since 2018 [59].

Alternative Fuel Vehicle Refueling Property Credit: This tax credit is for up to 30 percent of the cost of charging equipment up to $30,000. The credit has expired and been renewed multiple times, and is currently set to expire at the end of 2021 [92]. The credit has cost $560 million between 2012 and the 2018 tax year [93].

Plug-in Electric Vehicle Credit: This tax credit, which ranges from $2,500 to $7,500 depending on the vehicle battery size, is available for the first 200,000 EV sales for each auto manufacturer. General Motors and Tesla have already exceeded this cap with others likely to follow in the near future. The credit has cost $2.32 billion between the 2012 and the 2018 tax year [93].

FIGURE 3: EV FUNDING IN THE AMERICAN JOBS PLAN (BILLION $)

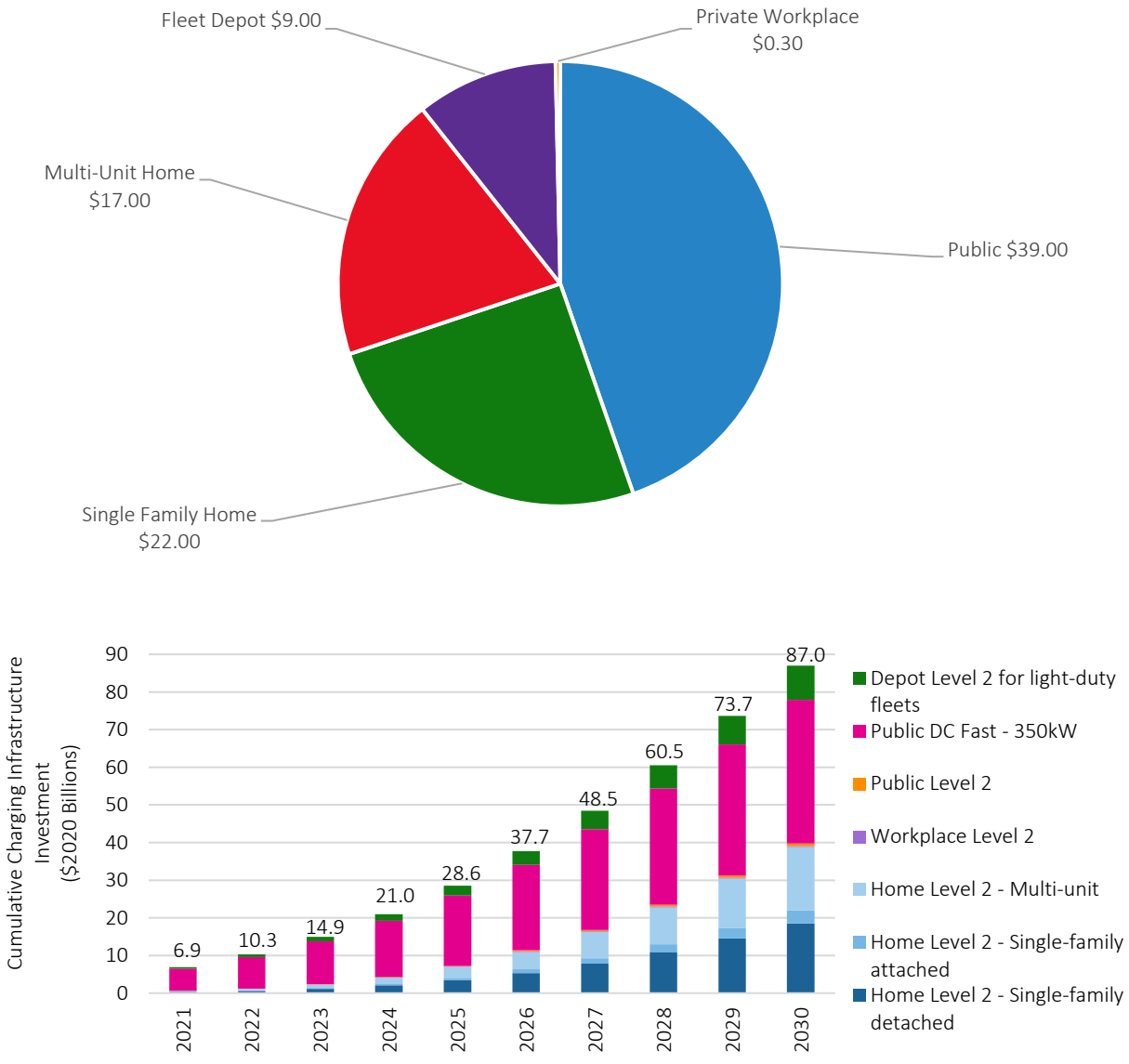


This chart breaks down the elements within the Biden Administration's proposed $174 billion in transportation electrification funding.

Source: [96]

The Biden Administration's plans to make major investments in transportation electrification build off ongoing bipartisan momentum for EV charging and vehicle incentives. Senator Shelley Moore Capito (R-WV), the leading Republican on the Environment and Public Works Committee, has indicated support for including EV charging tax credits in infrastructure plans [98]. Figure 4 shows the breakdown of total and annual investment needs by charging location based on an Atlas Public Policy study from April 2021.

FIGURE 4: CHARGING INVESTMENT (BILLION $) NEED BY LOCATION AND OVER TIME



These charts break down the $87 billion in investment needed to expand charging infrastructure by the location of the needed charging ports. Annual investment needed increases steadily through 2030.

Source: Atlas Public Policy [2]

Box 4: Challenges with Electrifying the U.S. Postal Service

In late February 2021, the USPS awarded a contract to Oshkosh Defense to design, develop, and deliver the Next Generation Delivery Vehicle to replace its aging fleet. Notably, only 10 percent of the new vehicles are currently planned to be electric, falling short of the 100 percent goal established in Biden's Executive Order and receiving heavy criticism from clean energy advocates and some lawmakers. The pathway to electrify the USPS more quickly is not straightforward, as the agency is a semi-independent federal agency not subject to the direct control of the President [100]. The EV company Workhorse was among the leading contenders for the contract that lost out to Oshkosh, which has admitted to having limited EV manufacturing experience [101]. Several Democratic representatives have issued a resolution calling for a hold on the contract while officials investigate stock trading that occurred as the decision to award the multi-billion contract to Oshkosh was imminent [102]. Legislation has been introduced to provide $6 billion to push USPS to electrify all of its fleet vehicles by 2040 [103].

As for vehicle incentives, a bipartisan group of Senators introduced the America's Transportation Infrastructure Act of 2019 after Tesla and General Motors crossed the threshold of EV sales where the federal EV tax credit is phased out. The act sought to extend the federal EV tax credit for automakers from 200,000 to 600,000, where EVs sold between 200,000 and 600,000 would receive a credit worth up to $7,000 [99].

In the current session of Congress, House Democrats reintroduced the Growing Renewable Energy and Efficiency Now (GREEN) Act to extend the EV tax credit and offer new incentives for renewable energy and energy efficiency investments [104, 105]. Independent analysis from the Rhodium Group found that the legislation's provisions could reduce U.S. greenhouse gas emissions to 19 percent below 2005 levels by 2030 [9]. The assessment predicts that tax credit expansion could increase EV market share of all light-duty vehicle sales from under three percent in 2020 to 38 percent by 2030. The GREEN act's potential to garner bipartisan support is in its focus on expanding tax credits with clear benefits to clean energy and transportation manufacturers operating in the United States. If enacted, it would also extend tax credits to manufacturers of medium- and heavy-duty EVs nationwide [106].

OPPORTUNITIES AT THE STATE LEVEL

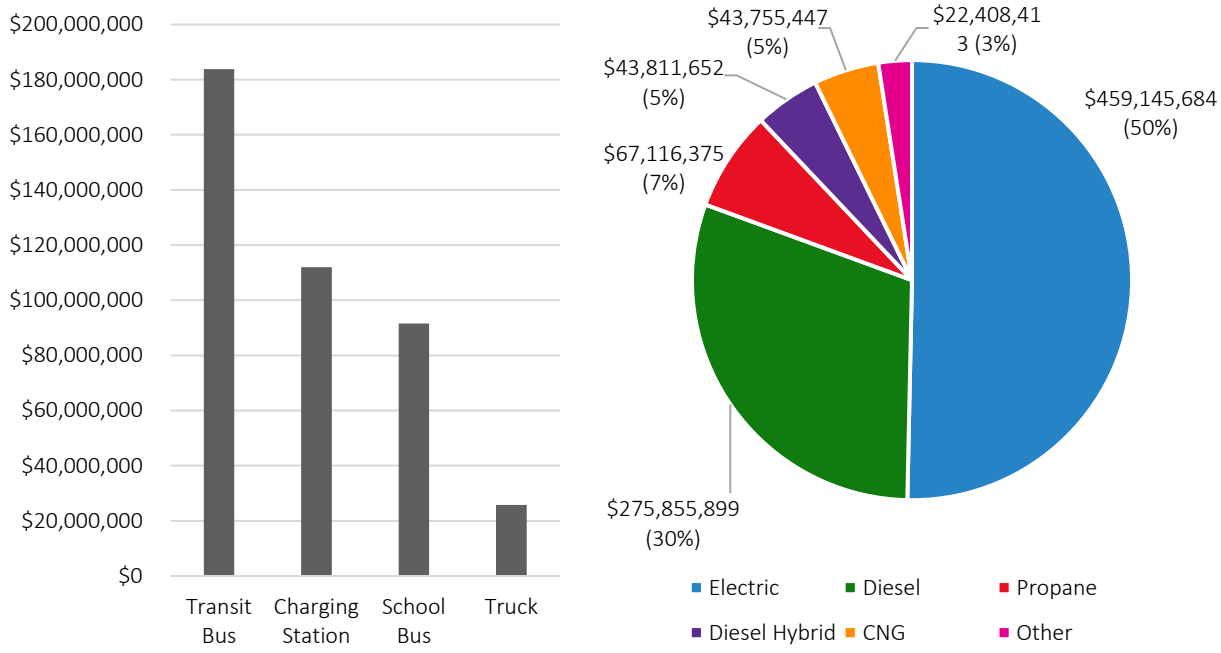
Many states have shown leadership in transportation electrification over the past decade through the efforts of their legislatures, public utility commissions, energy offices, environmental agencies, transportation departments, and others. While federal policy will be essential to achieve substantial transportation electrification, support at the state-level will continue to be essential. This support includes maintaining existing state EV incentive programs to supplement new incentives that could come at the federal level by enacting of the American Jobs Plan. States could also follow the lead of Oregon, which strengthened its EV rebate program in May 2021 for low-income and rural households and in communities of color [4].

In addition to establishing incentive programs for consumers, states are increasingly looking to lead by example through the electrification of their fleets. These efforts have the dual benefit of sending a strong market signal that government is behind EV technology and potentially saving the state considerable money in fleet operating expenditures. In Washington state, Atlas Public Policy led a comprehensive

analysis of fleet electrification for all publicly-owned vehicles in Washington and found that the state could cost effectively electrify nearly all fleet vehicles by 2035, with electrification of many thousands of vehicles being practical on or before 2025. The study estimated that reduced operating costs from EV use could lead to more than $3 billion in cumulative savings from 100 percent fleet electrification in Washington in 2035 [107].

States are also prioritizing the use of existing funding sources, like the Volkswagen Settlement, for EVs. Colorado, Virginia, New Jersey, and Illinois are among the states that have committed to using all of their remaining Settlement funds for transportation electrification or have chosen to awarded 100 percent of prior funding rounds to transportation electrification. As of April 2021, 65 percent of the $2.8 billion allocated to the states in 2017 has not yet been awarded. At least $459 million, almost half of the total $913 million in awards, has gone to medium- and heavy-duty EVs and light-duty charging infrastructure. Figure 5 summarizes the awards made so far by fuel type and highlights EV awards by vehicle use case.

FIGURE 5: VOLKSWAGEN SETTLEMENT AWARDS BY FUEL TYPE AND EV AWARDS BY VEHICLE USE CASE THROUGH APRIL 2021



These charts show the breakdown of VW Settlement awards by fuel type and EV awards by use case. At least 65 percent of remaining funds are unspent and most is eligible to go towards EV and EV charging deployment.

Source: Atlas EV Hub [60]

Multi-state partnerships have also emerged as a constructive way for leading states to advance EVs. Participation in these initiatives by Republican and Democratic-led states are continuing to experience the positive impacts of increasing EV adoption and investment. [108]. Three states in California's ZEV program—Massachusetts, Maryland, and Vermont—are led by Republican governors and are also among the 15 states that adopted the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum

of Understanding (ZEV Bus and Truck MOU) setting targets to reach 100 percent ZEV bus and truck sales by 2050 [109, 110]. Table 3 shows the leading states for EV deployment per capita and several other policy and transportation electrification investment statistics. However, targets alone will not drive widespread EV adoption. Table 3 below shows that eight out of the top 10 states for EV deployment per person have active EV tax credits or rebates.

Regional initiatives, like the Transportation and Climate Initiative (TCI) can help coordinate public, private, and utility action and generate positive attention on local markets. Across the 11 TCI states, passenger EV sales grew by more than 13 percent between 2019 and 2020 while the national market shrank by three percent [13]. Most recently the TCI states began a new effort referred to as the TCI Program (TCI-P). The program, which would collect emissions "allowance" payments from major oil and gas suppliers in participating states to invest in transportation electrification and other emissions-saving technologies, has been adopted by Connecticut, Massachusetts, Rhode Island, and Washington, DC. Across these jurisdictions, TCI-P investments could help reduce greenhouse gas emissions by 26 percent by 2032 [111]. Notably, the policy design process was altered in 2020 to put a greater emphasis on underserved communities at the behest of stakeholders in states that have yet to adopt the program; these revisions led to a requirement that 35 percent of funds invested through the TCI-P be invested in underserved communities to promote environmental justice. The stakeholder engagement process is ongoing and the remaining eight states[8] participating in the TCI-P process have expressed intentions to move forward [112].

Electric utilities in several regions are also emerging as a convener of regional activity. Across California, Oregon, and Washington, utilities have finalized plans in the West Coast Clean Transit Corridor Initiative to develop 27 fast charging sites along Interstate-5 to primarily serve medium- and heavy-duty freight vehicles [113]. This network builds on the previous work of the West Coast Electric Highway that was initiated by state Governors and transportation departments in the last decade. A similar multi-state effort continues to unfold in the Rocky Mountain region under the Regional Electric Vehicle Plan for the West (REV West). The initiative, which was formalized in 2019, has facilitated the deployment of more than 100 fast charging stations along corridors throughout the region as of the December 2020 progress report [114].

A utility partnership of a comparable scope across the Southeast, Gulf Coast, and Midwest was announced in March 2021. Six of the nation's largest utilities, AEP, Duke Energy, Dominion Energy, Southern Company, Entergy, and the Tennessee Valley Authority, are partnering to electrify major interstates and corridors across 16 states [115]. This builds off earlier efforts led by Ameren in Missouri and CMS Energy in Michigan to form the Midwest EV Charging Corridor stretching from Michigan to Texas [116].

Individual states will likely continue to have the most control over how their EV markets fare in the near term. Since the mass market inception for EVs in 2010, state policy has been a key driver behind EV adoption and charging deployment. In 2020, New Jersey emerged as a policy leader with the legislature passing S 2252 ("the PIV Act") to set the stage for utility planning and investments in EV infrastructure along with a strong role for charging service providers. The law included a $5,000 EV rebate,[9] and goals to

[8] State participating in the TCI-P process that have not adopted the program include Delaware, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Vermont, and Virginia.

[9] The Charge Up New Jersey Program completed its first disbursement of roughly $30 million in December 2020 and is set to resume offering point of sale rebates for EV purchases in the Summer of 2021 [129].

deploy 400 DC fast and 1,000 Level 2 public charging stations by 2025 and electrify all state public and transit fleet vehicles by 2040 [117]. Public Service Electric and Gas Company and Atlantic City Electric have since filed for and received approvals from the Board of Public Utilities after it published policy guidance. New Jersey has also established a state-run EV rebate program, and recently started a rulemaking to adopt the Advance Clean Trucks rule for medium- and heavy-duty EVs. While there are many factors influencing EV adoption, these policies likely helped New Jersey lead the nation in year-over-year EV sales growth with a 40 percent increase between 2019 and 2020. Conversely, the expiration of a $5,000 tax credit program in Georgia in 2015 was likely one of several factors contributing to a 65 percent decline in EV sales between 2015 and 2016 [14]. As of March 2021, 13 states and the District of Columbia had active EV tax credit or rebate programs. Eleven of these states have also adopted the ZEV Program [110].

TABLE 3: TOP 10 STATES FOR EV DEPLOYMENT PER CAPITA

State*^	EV Sales per 1,000 People	L2 Ports per 1,000 People (rank)	Approved Utility Investment ($ million, rank)	Public Funding for EVs ($ million, rank)	State EV Incentive
California*^	20.39	0.81 (2nd)	$1,500 (1st)	$1,000 (1st)	Active
Hawaii^	11.05	0.50 (5th)	$2.3 (21st)	$10.7 (33rd)	No
Washington*^	9.29	0.44 (7th)	$25.9 (9th)	$61.9 (4th)	Active
Oregon*^	8.81	0.44 (8th)	$18.4 (12th)	$16.5 (22nd)	Active
Vermont*^	8.68	1.08 (1st)	$0	$5.7 (44th)	Active
Colorado*^	6.88	0.55 (3rd)	$110.2 (4th)	$39.1 (8th)	Active
New Jersey*^	5.86	0.15 (27th)	$225.9 (3rd)	$122.7 (3rd)	Active
Massachusetts*^	5.79	0.52 (4th)	$75.3 (5th)	$35 (9th)	Active
Maryland*^	5.39	0.41 (10th)	$52.2 (6th)	$39.9 (7th)	Expired
Connecticut*^	5.05	0.28 (17th)	$0	$12.4 (30th)	Active

This table summarizes EV adoption and charging deployment in leading states. Nearly all leading states have had or continue to have an EV incentive. Public funding includes the Volkswagen Settlement, the federal Low-No program, and other federal and state programs.

**State has adopted the ZEV Program*

^State has adopted zero emission bus and truck MOU

Source: Atlas EV Hub [13]

In Colorado, dedicated public funding and new utility programs have yielded significant results. EV sales in Colorado grew more than 320 percent between 2015 and 2020 compared to 160 percent nationally. Legislation enacted and executive orders issued in 2019 set requirements for utilities to file transportation electrification plans and determined that all of the state's Volkswagen Settlement funding would go

towards EVs and EV charging deployment [118]. In January 2021, Xcel Energy was approved to invest $110 million through the utility's transportation electrification plan. Colorado is now the state with the fourth-highest total approved utility investment in EVs [5].

As states look to recover from COVID-19 and other challenges from 2020, some have looked to clean energy and transportation electrification to rebuild in a stronger position. California, which accounts for 46 percent of the nation's all-time EV sales, has led on incorporating EV investment into its pandemic recovery plans with a $1.5 billion carve-out for transportation electrification in the wider $4.5 billion Equitable Recovery for California's Businesses and Jobs plan [119]. Policy decisions like these will carry an even greater weight as automakers, utilities, and federal agencies look to market leaders to determine where to target investments. The following section highlights the near-term opportunities and challenges on the road ahead in a year that could prove to be a turning point in transportation electrification globally.

POLICY RECOMMENDATIONS

The surge in interest in EV policy coupled with widespread state action, utility support, and private investment in transportation electrification could help make EVs a central part of the economic recovery in the United States. New jobs in clean energy and transportation continue to outpace conventional energy and transportation job growth and are an opportunity to support domestic manufacturing and supply chains at a time when recovering from persistent high levels of unemployment is paramount [3].

Now is the time for bold action by both the federal government and the states to put the United States in a position of leadership in transportation electrification.

The United States should make significant federal investments in vehicle incentives, infrastructure deployment, technology demonstration and R&D, battery manufacturing, and supply chains to position itself to as a global leader in transportation electrification.

Policy leadership like the American Jobs Plan is necessary if the United States is to compete with China and Europe for the billions of dollars that will be invested by the private sector in transportation electrification this decade. In addition, these actions are needed to meet the climate goals laid out by the Biden Administration and in the Paris Agreement.

The Biden Administration is betting on job growth in the clean transportation and energy subsectors with the private companies increasing investment and electrification commitments. With the country's largest automaker, General Motors, setting a goal to electrify all new sales by 2035, EV manufacturing investment from established automakers is on the rise. EV investment commitments from companies operating in the United States more than doubled between 2019 and 2020, and as of March 2021, $105 billion in potential domestic investment has been committed by automakers, startups, and charging service providers [20]. Investment in specific facilities numbers almost $27 billion, supporting at least 36,000 direct manufacturing jobs [13]. This includes a growing effort to manufacture batteries domestically, a move that could bring down costs for automakers as they roll out new EVs.

States should continue to pursue and expand constructive policy and regulatory measures to accelerate market transformation in transportation.

Market-enabling state policies and programs will remain an important driver of EV adoption and charging deployment throughout this decade. Governors, state legislatures, utilities, utility commissions, and public agencies will help determine whether transportation electrification and climate investments spur an economic recovery throughout the nation. While no single blueprint exists for EV policy in a diverse nation like the United States, best practices have emerged: an upfront vehicle and charger incentive, a regulatory environment that encourages zero emission technology, a robust role for the electric utility to support infrastructure buildout, and measures to ensure the benefits of transportation electrification are experienced equitably.

Comprehensive policy frameworks are coming into focus in leading EV markets like Colorado, New Jersey, and Oregon. Multi-state efforts around EV charging will also be critical in the near term as more vehicle use cases become viable in the light-, medium, and heavy-duty vehicle classes.

The federal government and states should ensure actions on transportation electrification provide the benefits of electrification equitably.

Job creation from a clean energy and transportation electrification transition is expected to be substantial, with direct job creation outpacing direct job loss and more than 400,000 net jobs being created by 2035 [3]. Workforce development and transportation electrification investment in underserved communities can provide critical support to ensure these benefits accrue in communities of color, which have faced higher levels of unemployment throughout the pandemic [11].

It will also be essential to ensure air quality and associated health benefits of transportation electrification are targeted toward underserved communities who are disproportionately burdened by pollution. . Substantial electrification efforts should consider vehicles, especially medium- and heavy- duty vehicles, with emissions that disproportionately affect the air quality and health of underserved communities, due to decades of racially discriminatory environmental and housing policies [11].

Targeting underserved communities with transportation electrification investments is an important priority to ensure that the benefits of electrification are experienced by all of society. Utilities in many states, such as California, Colorado, New Jersey, New York, Washington, and many others, can provide an example of best practices for ensuring charging station deployment reaches communities of color and other groups not always served by the private market. More than 23 percent of all approved utility investment has been allocated to underserved communities and both federal and state transportation electrification programs are taking environmental justice seriously.

This decade will be pivotal in determining which nations will receive significant investments and related jobs in transportation electrification. The United States is well positioned to take a leadership role in this market but must take concerted action now in order to win the future. This is an opportunity for governments, the private sector, utilities, and advocates to realize the benefits of transportation electrification by working together to make major strides and set the country on a path toward rapid and widespread transportation electrification. Substantial investments in EVs and charging deployment, with a focus on underserved areas, has the potential to make meaningful improvements in economic and public health outcomes for communities who have suffered disproportionately from COVID-19 and other historical injustices. A coordinated, national approach to embracing transportation electrification is a critical part delivering far-reaching emissions reductions in the United States and making meaningful progress in the fight against climate change.

REFERENCES

[1] Biden White House, "FACT SHEET: The American Jobs Plan," March 2021. [Online]. Available: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/. [Accessed April 2021].

[2] Atlas Public Policy, "How much should the U.S. invest in public EV charging? $39 Billion," April 2021. [Online]. Available: https://atlaspolicy.com/press-release/how-much-should-the-u-s-invest-in-public-ev-charging-39-billion/. [Accessed April 2021].

[3] Energy Innovation, "2035 Report," April 2021. [Online]. Available: http://www.2035report.com/transportation/wp-content/uploads/2020/05/2035Report2.0-1.pdf. [Accessed April 2021].

[4] Atlas EV Hub, "State Policy Dashboard," April 2021. [Online]. Available: https://www.atlasevhub.com/materials/state-policy-dashboard/. [Accessed April 2021].

[5] Atlas EV Hub, "Electric Utility Filings Dashboard," February 2021. [Online]. Available: https://www.atlasevhub.com/materials/electric-utility-filings/. [Accessed February 2021].

[6] New York Times Staff, "Biden, Emphasizing Job Creation, Signs Sweeping Climate Actions," January 2021. [Online]. Available: https://www.nytimes.com/2021/01/27/climate/biden-climate-executive-orders.html. [Accessed February 2021].

[7] Biden White House, "President Biden Announces American Rescue Plan," Janaury 2021. [Online]. Available: https://www.whitehouse.gov/briefing-room/legislation/2021/01/20/president-biden-announces-american-rescue-plan/. [Accessed February 2021].

[8] Moody's Analytics, "The Macroeconomic Consequences of," April 2021. [Online]. Available: https://www.economy.com/getlocal?q=C228A0FF-2701-47B2-ADE0-D158B5866251&app=download. [Accessed April 2021].

[9] Rhodium Group, "An Assessment of the GREEN Act: Implications for Emissions and Clean Energy Deployment," December 2019. [Online]. Available: `https://rhg.com/research/an-assessment-of-the-green-act/. [Accessed March 2021].

[10] Rhodium Group, "Preliminary US Greenhouse Gas Emissions Estimates for 2020," January 2021. [Online]. Available: https://rhg.com/research/preliminary-us-emissions-2020/. [Accessed January 2021].

[11] Atlas Public Policy, Alliance for Transportation Electrification, "Air Quality, Climate Change, and COVID-19," March 2021. [Online]. Available: https://atlaspolicy.com/rand/air-quality-climate-change-and-covid-19/. [Accessed March 2021].

[12] Harvard T.H. Chan School of Public Health, "Air pollution linked with higher COVID-19 death rates," April 2020. [Online]. Available: https://www.hsph.harvard.edu/news/hsph-in-the-news/air-pollution-linked-with-higher-covid-19-death-rates/. [Accessed April 2021].

[13] Atlas EV Hub, "Automakers Dashboard," February 2021. [Online]. Available: https://www.atlasevhub.com/materials/automakers-dashboard/. [Accessed February 2021].

[14] Atlas Public Policy, "Transportation Electrification in the Southeast," October 2020. [Online]. Available: https://atlaspolicy.com/wp-content/uploads/2020/10/Transportation-Electrification-in-the-Southeast.pdf. [Accessed December 2020].

[15] ClimateNexus, "Going Clean...Making Green...for Everyone in Between," November 2020. [Online].

[16] Canalys, "Global electric vehicle sales up 39% in 2020 as overall car market collapses," February 2021. [Online]. Available: https://www.canalys.com/newsroom/canalys-global-electric-vehicle-sales-2020?utm_source=EV+Hub+Newsletter&utm_campaign=68a7201631-EMAIL_CAMPAIGN_2019_01_07_05_37_COPY_01&utm_medium=email&utm_term=0_173e047b1f-68a7201631-. [Accessed February 2021].

[17] Reuters Staff, "Europe sales of EVs, plug-in hybrids top 1M in 2020," February 2021. [Online]. Available: https://europe.autonews.com/automakers/europe-sales-evs-plug-hybrids-top-1m-2020. [Accessed February 2021].

[18] K. Abnet, "EU to target 30 million electric cars by 2030 - draft," December 2020. [Online]. Available: https://www.reuters.com/article/us-climate-change-eu-transport-idUSKBN28E2KM. [Accessed February 2021].

[19] International Council on Clean Transportation, "Euopean Electric Vehicle Factbook," July 2020. [Online]. Available: https://theicct.org/sites/default/files/publications/EV-EU-Factbook-2020.pdf. [Accessed April 2021].

[20] Atlas EV Hub, "Global Private Investments Dashboard," February 2021. [Online]. Available: https://www.atlasevhub.com/materials/private-investment/. [Accessed February 2021].

[21] General Motors, "General Motors, the Largest U.S. Automaker, Plans to be Carbon Neutral by 2040," January 2021. [Online]. Available: https://investor.gm.com/news-releases/news-release-details/general-motors-largest-us-automaker-plans-be-carbon-neutral-2040. [Accessed February 2021].

[22] Bureau of Labor Statistics, "Automotive Industry: Employment, Earnings, and Hours," January 2021. [Online]. Available: https://www.bls.gov/iag/tgs/iagauto.htm. [Accessed February 2021].

[23] Bureau of Labor Statistics, "The Employment Situation - January 2021," January 2021. [Online]. Available: https://www.bls.gov/news.release/pdf/empsit.pdf. [Accessed February 2021].

[24] Allaince for Automotive Innovation, "The Industry," February 2021. [Online]. Available: https://www.autosinnovate.org/initiatives/the-industry. [Accessed February 2021].

[25] BW Research, "Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, December 2020," January 2021. [Online]. Available: https://e2.org/wp-content/uploads/2021/01/Clean-Energy-Jobs-December-COVID-19-Memo-Final.pdf. [Accessed February 2021].

[26] Bureau of Labor Statistics, "The Employment Situation - March 2021," April 2021. [Online]. Available: https://www.bls.gov/news.release/archives/empsit_04022021.pdf. [Accessed April 2021].

[27] A. Frangoul, "Ford invests $1 billion in German plant, targets move to 'all-electric' passenger vehicles in Europe by 2030," February 2021. [Online]. Available: https://www.cnbc.com/2021/02/17/ford-invests-1-billion-in-german-electric-vehicle-plant.html. [Accessed April 2021].

[28] R. Schmitz, "What Will Tesla's New German Gigafactory Mean For Germany's Auto Industry?," February 2021. [Online]. Available: https://www.npr.org/2021/02/17/968312945/what-will-teslas-new-german-gigafactory-mean-for-germanys-auto-industry. [Accessed April 2021].

[29] Bloomberg New Energy Finance, "2020 EV Outlook," May 2020. [Online]. Available: https://bnef.turtl.co/story/evo-2020/page/2/2?teaser=yes. [Accessed February 2021].

[30] Texas Advanced Energy Business Alliance, "Electric Transportation Supply Chain in Texas," December 2020. [Online]. Available: https://www.texasadvancedenergy.org/news?hss_channel=lcp-2440574#EV_supply.

[31] Advanced Energy Economy, "Electric Transportation Supply Chain in Pennsylvania," May 2020. [Online]. Available: https://info.aee.net/electric-transportation-supply-chain-in-pennsylvania.

[32] Atlas Public Policy, "Transportation Electrification in North Carolina," February 2021. [Online]. Available: https://atlaspolicy.com/rand/transportation-electrification-in-north-carolina/. [Accessed February 2021].

[33] E2, "Clean Jobs North Carolina," 2020. [Online]. Available: https://e2.org/wp-content/uploads/2020/08/E2-NCSEA-Clean-Jobs-North-Carolina-2020.pdf. [Accessed April 2021].

[34] A. Hawkins, "GM unveils 'Ultium Drive' family of electric motors," September 2020. [Online]. Available: https://www.theverge.com/2020/9/16/21439374/gm-unveils-ultium-drive-family-of-electric-motors. [Accessed May 2021].

[35] Ford, "Ford Europe Goes All-In On EVs On Road To Sustainable Profitability; Cologne Site Begins $1 Billion Transformation," February 2021. [Online]. Available: https://media.ford.com/content/fordmedia/fna/us/en/news/2021/02/17/ford-europe-goes-all-in-on-evs.html. [Accessed February 2021].

[36] M. Wayland, "Ford could produce its own EV battery cells by 2025, executive says," May 2021. [Online]. Available: https://www.cnbc.com/2021/05/03/ford-could-produce-its-own-ev-battery-cells-by-2025-executive-says.html. [Accessed May 2021].

[37] B. Klayman, "Electric vehicle charging network ChargePoint to go public at $2.4 bln valuation," September 2020. [Online]. Available: https://www.reuters.com/article/chargepoint-spac-electric-idUKL2N2GK0QZ. [Accessed February 2021].

[38] M. Fox, "Climate Change SPAC soars 80% amid plans to merge with electric-vehicle charging network EVgo," January 2021. [Online]. Available: https://markets.businessinsider.com/news/stocks/climate-change-crisis-real-impact-i-spac-evgo-merger-plan-2021-1-1029994283. [Accessed February 2021].

[39] General Motors, "General Motors and LG Chem Team Up to Advance Toward an All-Electric Future, Add Jobs in Ohio," December 2019. [Online]. Available: https://investor.gm.com/news-releases/news-release-details/general-motors-and-lg-chem-team-advance-toward-all-electric. [Accessed February 2021].

[40] General Motors, "GM and LG Energy Solution Investing $2.3 Billion in 2nd Ultium Cells Manufacturing Plant in U.S.," April 2021. [Online]. Available: https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/apr/0416-ultium.html. [Accessed May 2021].

[41] Office of Governor Brian Kemp, "SK innovation to Invest Another $940 Million in Jackson County Expansion, Create 600 Jobs," June 2020. [Online]. Available: https://gov.georgia.gov/press-releases/2020-06-25/sk-innovation-invest-another-940-million-jackson-county-expansion-create. [Accessed February 2021].

[42] B. Klayman, "https://www.reuters.com/business/autos-transportation/exclusive-ford-motor-sk-innovation-announce-ev-battery-joint-venture-sources-2021-05-19/," May 2021. [Online]. Available: Ford Motor, SK Innovation to announce EV battery joint venture. [Accessed May 2021].

[43] L. Kolodny, "Tesla Semi production on hold until company can make its own batteries," January 2021. [Online]. Available: https://www.cnbc.com/2021/01/28/tesla-semi-production-on-hold-until-company-can-make-its-own-batteries.html. [Accessed February 2021].

[44] B. Schmidt, "Tesla Semi may be delayed until 2022 due to battery shortage," March 2021. [Online]. Available: https://thedriven.io/2021/03/29/tesla-semi-may-be-delayed-until-2022-due-to-battery-shortage/#:~:text=The%20launch%20of%20Tesla%20Semi%2C%20the%20fully%20electric,prioritised%20to%20get%20production%20and%20revenue%20levels%20up.. [Accessed April 2021].

[45] Bloomberg New Energy Finance, "Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh," December 2020. [Online]. Available: https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/. [Accessed February 2021].

[46] Department of Energy, "Energy Storage Grand Challenge Roadmap," December 2020. [Online]. Available: https://www.energy.gov/energy-storage-grand-challenge/downloads/energy-storage-grand-challenge-roadmap. [Accessed January 2021].

[47] S. LeVine, "The Goalposts Move: The New Lithium-Ion Standard is An Astonishing $60 per kWh," April 2021. [Online]. Available: https://themobilist.medium.com/the-goalposts-move-the-new-lithium-ion-standard-is-an-astonishing-60-per-kwh-7153fa8ec328. [Accessed May 2021].

[48] Bloomberg, "Severe Transit Cuts Would Cripple U.S. Economy, Experts Warn," 19 November 2020. [Online]. Available: https://www.bloomberg.com/news/articles/2020-11-19/-doomsday-transit-cuts-could-cripple-u-s-economy.

[49] Edmunds, "Used Vehicle Report," 2019. [Online]. Available: https://static.ed.edmunds-media.com/unversioned/img/industry-center/insights/2019-used-vehicle-report.pdf. [Accessed April 2021].

[50] M. Wayland, "US auto sales fall in 2019 but still top 17 million for fifth consecutive year," January 2020. [Online]. Available: https://www.cnbc.com/2020/01/06/us-auto-sales-down-in-2019-but-still-top-17-million.html#:~:text=New%20vehicle%20sales%20for%202019%20were%20originally%20forecast,of%20roughly%2016.7%20million%20to%2017.1%20million%20vehicles.. [Accessed April 2021].

[51] Edmunds, "New Vehicle Sales Expected to Close 2020 Stronger Than Anticipated, According to Edmunds," Dcember 2020. [Online]. Available: https://www.edmunds.com/industry/press/new-vehicle-sales-expected-to-close-2020-stronger-than-anticipated-according-to-edmunds.html. [Accessed March 2021].

[52] E. Rosenbaum, "The used car boom is one of the hottest, and trickiest, coronavirus markets for consumers," October 2020. [Online]. Available: https://www.cnbc.com/2020/10/15/used-car-boom-is-one-of-hottest-coronavirus-markets-for-consumers.html. [Accessed December 2020].

[53] N. Boudette, "Looking to Buy a Used Car in the Pandemic? So Is Everyone Else," September 2020. [Online]. Available: https://www.nytimes.com/2020/09/07/business/used-cars-pandemic.html. [Accessed January 2021].

[54] M. Wayland, "Coronavirus crippled U.S. auto sales in 2020 but it could have been far worse," January 2021. [Online]. Available: https://www.cnbc.com/2020/12/23/covid-19-crippled-us-auto-sales-in-2020-but-it-could-have-been-worse.html. [Accessed January 2021].

[55] N. Bomey, "Used car prices spiking as COVID-19 pandemic shakes up the market for new cars," August 2020. [Online]. Available: https://www.usatoday.com/story/money/cars/2020/08/05/car-prices-coronavirus-pandemic-new-trucks-suvs/3297869001/. [Accessed January 2021].

[56] Associated Press, "New or used? Either way, price hikes squeeze US auto buyers," February 2021. [Online]. Available: https://apnews.com/article/prices-inflation-coronavirus-pandemic-united-states-c6f8a2a7cf916cbda0d5f112b1260997. [Accessed March 2021].

[57] Oregon Department of Transportation, "Oregon Clean Vehicle Rebate Program," 2021. [Online]. Available: https://www.oregon.gov/deq/aq/programs/Pages/ZEV-Rebate.aspx. [Accessed April 2021].

[58] Greenlining Institute, "We Can't Afford to Let Electric Cars Become Luxury Items," March 2021. [Online]. Available: https://greenlining.org/press/2021/electric-cars-not-luxury-items/. [Accessed April 2021].

[59] CALSTART, "Zeroing in on ZEBs," December 2020. [Online]. Available: https://calstart.org/wp-content/uploads/2021/01/Zeroing_In_on_ZEBs_FINALREPORT_1262021.pdf. [Accessed April 2021].

[60] Atlas EV Hub, "Public Funding Awards Dashboard," April 2021. [Online]. Available: https://www.atlasevhub.com/materials/public-agency-requests-funding-awards/. [Accessed April 2021].

[61] International Council on Clean Transportation, "Race To Zero: How manufacturers are positioned for zero emission commercial trucks and buses in North America," December 2020. [Online]. Available: https://theicct.org/sites/default/files/publications/Canada-race-to-zero-EN-oct2020.pdf. [Accessed April 2021].

[62] Bloomberg Staff, "When the Electric Car Is King, Less Energy Is More," February 2021. [Online]. Available: https://www.bloomberg.com/graphics/2021-opinion-renewables-will-power-future-of-us-energy/. [Accessed March 2021].

[63] Atlas Public Policy, Alliance for Transportation Electrification, "Vehicle Grid Integration," October 2019. [Online]. Available: https://atlaspolicy.com/rand/vehicle-grid-integration/. [Accessed February 2021].

[64] Synapse Energy Economics, "Electric Vehicles Are Driving Electric Rates Down," June 2020. [Online]. Available: https://www.synapse-energy.com/sites/default/files/EV_Impacts_June_2020_18-122.pdf. [Accessed March 2021].

[65] California Public Utilities Commission, "Utility Costs and the Affordability of the Grid of the Future," February 2021. [Online]. Available: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Utilities_and_Industries/Energy/Reports_and_White_Papers/Feb%202021%20Utility%20Costs%20and%20Affordability%20of%20the%20Grid%20of%20the%20Future.pdf. [Accessed March 2021].

[66] Joint Utilities of New York, "EV Make-Ready Program," 2020. [Online]. Available: https://jointutilitiesofny.org/ev/make-ready. [Accessed March 2021].

[67] NYSERDA, "Governor Cuomo Announces Launch of $85 Million New York Clean Transportation Prizes Initiative," April 2021. [Online]. Available: https://www.governor.ny.gov/news/governor-cuomo-announces-launch-85-million-new-york-clean-transportation-prizes-initiative. [Accessed April 2021].

[68] R. Walton, "Colorado approves Xcel's $110M transportation electrification plan, with strong equity emphasis," January 2021. [Online]. Available: https://www.utilitydive.com/news/colorado-approves-xcels-110m-transportation-electrification-plan-with-st/593367/. [Accessed ` March 2021].

[69] Greenlining Institute, "9 Major Opportunities for Electric Buses & Trucks," April 2019. [Online]. Available: https://greenlining.org/press/2019/9-major-opportunities-electric-buses-trucks/. [Accessed March 2021].

[70] UNFCCC, "United States of America First NDC," March 2016. [Online]. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/U.S.A.%20First%20NDC%20Submission.pdf. [Accessed March 2021].

[71] U.S. Environmental Protection Agency, "Sources of Greenhouse Gas Emissions," 2021. [Online]. Available: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions. [Accessed March 2021].

[72] e. a. Abdullah Alarfaj, "Decarbonizing US passenger vehicle transport under electrification and automation uncertainty has a travel budget," September 2020. [Online]. Available: https://iopscience.iop.org/article/10.1088/1748-9326/ab7c89. [Accessed March 2021].

[73] U.S. Environemntal Protection Agency, "Smog, Soot, and Other Air Pollution from Transportation," 2021. [Online]. Available: https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution. [Accessed March 2021].

[74] Center for Disease Control, "Climate and Health," 2021. [Online]. Available: https://www.cdc.gov/climateandhealth/effects/air_pollution.htm. [Accessed March 2021].

[75] D. Reichmuth, "Air Pollution from Vehicles in California: People of Color Bear the Biggest Burden," February 2019. [Online]. Available: https://www.ef.org/2019/02/07/air-pollution-from-vehicles-in-california-people-of-color-bear-the-biggest-burden/. [Accessed March 2021].

[76] Office of Governor Gavin Newsom, "Governor Newsom Announces Launch of $50 Million “Listos California” Campaign to Help Build Community Resilience to Wildfires," August 2019. [Online]. Available: https://www.gov.ca.gov/2019/08/20/governor-newsom-announces-launch-of-50-million-listos-california-campaign-to-help-build-community-resilience-to-wildfires/. [Accessed 2021].

[77] Washington Legislature, "House Bill 1168," April 2021. [Online]. Available: https://app.leg.wa.gov/billsummary?BillNumber=1168&Year=2021&Initiative=false. [Accessed May 2021].

[78] Washignton Legislature, "House Bill 1091," April 2021. [Online]. Available: https://app.leg.wa.gov/billsummary?BillNumber=1091&Initiative=false&Year=2021. [Accessed May 2021].

[79] California Strategic Growth Council, "Vision," 2021. [Online]. Available: https://www.sgc.ca.gov/vision/. [Accessed March 2021].

[80] Greenlining Institute, "California Launches Partners Advancing Climate Equity to Aid Undererved Communities," February 2021. [Online]. Available: https://greenlining.org/press/2021/california-launches-partners-advancing-climate-equity-aid-underserved-communities/. [Accessed March 2021].

[81] e. a. Adrian Rafferty, "Country-based rate of emissions reductions should increase by 80% beyond nationally determined contributions to meet the 2 °C target," February 2021. [Online]. Available: https://www.nature.com/articles/s43247-021-00097-8. [Accessed March 2021].

[82] UNEP, "Are We Building Back Better? Evidence from 2020 and Pathways for Inclusive Green Recovery Spending," March 2021. [Online]. Available: https://wedocs.unep.org/bitstream/handle/20.500.11822/35281/AWBBB.pdf. [Accessed March 2021].

[83] A. Drago, "Biden commits the U.S. to cutting greenhouse gas emissions in half by 2030," April 2021. [Online]. Available: https://www.nytimes.com/live/2021/04/22/us/biden-earth-day-climate-

summit#biden-commits-the-us-to-cutting-greenhouse-gas-emissions-in-half-by-2030. [Accessed April 2021].

[84] Michael Coren, "Waiting 10 years to start eliminating emissions will cost the US more than $3.5 trillion," February 2021. [Online]. Available: https://qz.com/1967754/waiting-to-eliminate-emissions-will-cost-the-us-trillions/. [Accessed March 2021].

[85] Princeton University , "Andlinger Center for Energy and the Environment," December 2020. [Online]. Available: https://www.princeton.edu/news/2020/12/15/big-affordable-effort-needed-america-reach-net-zero-emissions-2050-princeton-study. [Accessed March 2021].

[86] California Air Resources Board, "Advanced Clean Trucks Fact Sheet," California Air Resources Board, 2021. [Online]. Available: https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet. [Accessed 1 June 2021].

[87] Atlas Public Policy, Alliance for Transportation Electrification, "Investment in Public EV Charging in the United States," February 2020. [Online]. Available: https://www.atlasevhub.com/resource/investment-in-public-ev-charging-in-the-united-states/. [Accessed March 2021].

[88] Obama White House, "ARRA Fact Sheet," February 2016. [Online]. Available: https://obamawhitehouse.archives.gov/the-press-office/2016/02/25/fact-sheet-recovery-act-made-largest-single-investment-clean-energy. [Accessed January 2021].

[89] U.S. Department of Energy, "American Recovery and Reinvestment Act," September 2016. [Online]. Available: https://afdc.energy.gov/files/u/publication/arra_cc_project_awards.pdf. [Accessed February 2021].

[90] ChargePoint, "ChargePoint Announces the Successful Completion of its ARRA-Funded ChargePoint America Program," June 2013. [Online]. Available: https://www.chargepoint.com/about/news/chargepoint-announces-successful-completion-its-arra-funded-chargepoint-america-program/. [Accessed February 2021].

[91] B. Klayman, "Electric vehicle charging network ChargePoint to go public at $2.4 bln valuation," September 2020. [Online]. Available: https://www.nasdaq.com/articles/electric-vehicle-charging-network-chargepoint-to-go-public-at-%242.4-bln-valuation-2020-09. [Accessed February 2021].

[92] Alternative Fuels Data Center, "Alternative Fuel Infrastructure Tax Credit," 2021. [Online]. Available: https://afdc.energy.gov/laws/10513. [Accessed April 2021].

[93] Tax Policy Center, "Credit Type and Amount," September 2020. [Online]. Available: https://www.taxpolicycenter.org/statistics/credit-type-and-amount. [Accessed April 2021].

[94] R. Beitsch, "Biden eyes infrastructure package to help economic, climate goals," December 2020. [Online]. Available: https://thehill.com/policy/transportation/528988-biden-eyes-infrastructure-package-to-help-economic-climate-goals. [Accessed March 2021].

[95] K. L. Katie Sullivan, "Biden announces US will aim to cut carbon emissions by as much as 52% by 2030 at virtual climate summit," April 2021. [Online]. Available: https://www.cnn.com/2021/04/22/politics/white-house-climate-summit/index.html. [Accessed April 2021].

[96] Reuters Staff, "Biden plan calls for $100 billion in new EV consumer rebates: email," April 2021. [Online]. Available: https://www.reuters.com/article/us-usa-autos-idUKKBN2BU3BA. [Accessed April 2021].

[97] M. Wayland, "Biden plans to replace government fleet with electric vehicles," January 2021. [Online]. Available: https://www.cnbc.com/2021/01/25/biden-plans-to-replace-government-fleet-with-electric-vehicles.html. [Accessed March 2021].

[98] R. Frazin, "Key Republican signals support for augmenting electric vehicle infrastructure," March 2021. [Online]. Available: https://thehill.com/policy/energy-environment/544963-key-republican-signals-support-for-augmenting-electric-vehicle. [Accessed March 2021].

[99] D. Shepardson, "Exclusive: U.S. bill to boost electric car tax credits could rev GM, Tesla," April 2019. [Online]. Available: https://www.reuters.com/article/us-autos-electric-taxcredit-exclusive-idUSKCN1RM1NG. [Accessed March 2021].

[100] E&E News, "Postal Service Sidetracks Biden EV Plan," February 2021. [Online]. Available: https://www.eenews.net/stories/1063725861#:~:text=The%20U.S.%20Postal%20Service%20yesterday,electrifying%20the%20federal%20vehicle%20fleet..

[101] Bloomberg.com, "Oshkosh Admitted Weakness on Evs Before Shock Postal Deal," 10 March 2021. [Online]. Available: https://www.bloomberg.com/news/articles/2021-03-10/oshkosh-admitted-weakness-on-evs-before-shock-win-in-postal-deal.

[102] N. Higgins-Dunn, "House lawmakers push Biden administration to investigate USPS contract with Oshkosh Defense," March 2021. [Online]. Available: https://www.cnbc.com/2021/03/09/house-lawmakers-push-biden-administration-to-investigate-usps-contract-with-oshkosh-.html. [Accessed March 2021].

[103] D. Shepardson, "U.S. lawmakers propose giving USPS $6 billion for electric delivery vehicles," March 2021. [Online]. Available: https://www.reuters.com/article/us-usa-postal-service-idINKBN2B01UV. [Accessed March 2021].

[104] Office of Congressman Mike Thompson, "Chairman Thompson, Ways and Means Democrats Introduce GREEN Act," February 2021. [Online]. Available: https://mikethompson.house.gov/newsroom/press-releases/chairman-thompson-ways-and-means-democrats-introduce-green-act. [Accessed March 2021].

[105] David Shepardson, "GM Says U.S. Should Extend Consumer, Investment Tax Credits to Boost Electric Vehicles," March 2021. [Online]. Available: https://www.usnews.com/news/top-news/articles/2021-03-11/gm-says-us-should-extend-consumer-investment-tax-credits-to-boost-electric-vehicles. [Accessed March 2021].

[106] Office of Representative Mike Thompson, "Growing Renewable Energy and Efficiency Now (GREEN) Act," February 2021. [Online]. Available: https://mikethompson.house.gov/sites/mikethompson.house.gov/files/GREEN%20%20Act%202021%20Topline%20Summary.pdf. [Accessed March 2021].

[107] Atlas Public Policy, "Electrification Assessment of Public Vehicles in Washington," November 2020. [Online]. Available: https://atlaspolicy.com/rand/electrification-assessment-of-public-vehicles-in-washington/. [Accessed March 2021].

[108] California Air Resources Board, "Zero-Emission Vehicle Program," 2021. [Online]. Available: https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program. [Accessed March 2021].

[109] California Air Resources Board, "Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding," July 2020. [Online]. Available: https://ww2.arb.ca.gov/sites/default/files/2020-07/Multistate-Truck-ZEV-Governors-MOU-20200714.pdf. [Accessed March 2021].

[110] Atlas EV Hub, "Laws and Regulations Dashboard," March 2021. [Online]. Available: https://www.atlasevhub.com/materials/laws-regulations-and-legislation/. [Accessed March 2021].

[111] Transportation and Climate Initiative, "Massachusetts, Connecticut, Rhode Island, D.C. are First to Launch Groundbreaking Program to Cut Transportation Pollution, Invest in Communities," December 2020. [Online]. Available: https://www.transportationandclimate.org/final-mou-122020. [Accessed March 2021].

[112] Transportation and Climate Initiative, "Next Steps for the Transportation and Climate Initiative," December 2020. [Online]. Available: https://www.transportationandclimate.org/sites/default/files/TCI%20Next%20Steps%2012.20.pdf. [Accessed March 2021].

[113] West Coast Clean Tansit Corridor Initiative, "West Coast Clean Tansit Corridor Initiative Study," June 2020. [Online]. Available: https://westcoastcleantransit.com/resources/G20-

049%20West%20Coast%20Clean%20Transit%20Corridor%20Fact%20Sheet.pdf. [Accessed March 2021].

[114] NASEO, "Regional Electric Vehicle Plan for the West 2020 Progress Report," December 2020. [Online]. Available: https://www.naseo.org/Data/Sites/1/rev-west-2020-progress-report.pdf. [Accessed May 2021].

[115] AEP, "AEP, Five Others Plan to Add EV Fast Chargers Creating Electric Highway Coalition," March 2021. [Online]. Available: https://www.aep.com/news/releases/read/6036/AEP%2C-Five-Others-Plan-to-Add-EV-Fast-Chargers-Creating-Electric-Highway-Coalition. [Accessed March 2021].

[116] Ameren Corporation, "Midwest energy companies pledge to build nation's largest interstate electric vehicle charging network, enabling clean transportation," September 2020. [Online]. Available: https://www.prnewswire.com/news-releases/midwest-energy-companies-pledge-to-build-nations-largest-interstate-electric-vehicle-charging-network-enabling-clean-transportation-301135689.html. [Accessed May 2021].

[117] K. H. Eric Miller, "One Year on: A Look at NJ's EV Progress in 2020," January 2021. [Online]. Available: https://www.nrdc.org/experts/eric-miller/one-year-look-njs-ev-progress-2020. [Accessed March 2021].

[118] Alternative Fuels Data Center, "Public Electric Utility Services Authorization," 2019. [Online]. Available: https://afdc.energy.gov/laws/12250. [Accessed April 2021].

[119] Office of Governor Gavin Newsom, "Governor Newsom to Propose $4.5 Billion for Equitable Recovery for California's Businesses and Jobs in 2021 Budget," January 2021. [Online]. Available: https://www.gov.ca.gov/2021/01/05/governor-newsom-to-propose-4-5-billion-for-equitable-recovery-for-californias-businesses-and-jobs-in-2021-budget/. [Accessed March 2021].

[120] D. Shepardson, "Ford CEO calls for settlement between LG Chem, SK Innovation," February 2021. [Online]. Available: https://www.reuters.com/article/us-lg-chem-sk-innovation-ford-motor-idUSKBN2AB2FH. [Accessed February 2021].

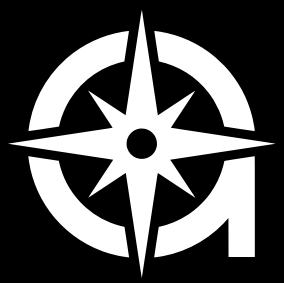
[121] California State Legislature, "SB-676 Transportation electrification: electric vehicles: grid integration," October 2019. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB676. [Accessed March 2021].

[122] W. Davis, "South Korean Electric Vehicle Battery Makers Reach $1.8B Deal To End Trade Dispute," NPR, April 2021. [Online]. Available: https://www.npr.org/2021/04/11/986234531/south-korean-electric-vehicle-battery-makers-reach-1-8b-deal-to-end-trade-disput. [Accessed April 2021].

[123] U.S. Hosue of Representatives, "House Bill 848," February 2021. [Online]. Available: https://www.congress.gov/bill/117th-congress/house-bill/848. [Accessed May 2021].

[124] Daimler, "Daimler plans separation into two pure-play companies," February 2021. [Online]. Available: https://www.daimler.com/investors/reports-news/financial-news/20210203-project-focus.html. [Accessed May 2021].

[125] New Jersey Board of Public Utilities, "NJBPU Announces Successful Conclusion of First Phase of Charge Up New Jersey Electric Vehicle Incentive Program," New Jersey Board of Public Utilities, 14 December 2020. [Online]. Available: https://www.nj.gov/bpu/newsroom/2020/approved/20201214.html. [Accessed 26 May 2021].



ATLAS
PUBLIC POLICY

WWW.ATLASPOLICY.COM