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SOUTHERN ALLIANCE FOR CLEAN ENERGY
KNOXVILLE, TN & ASHEVILLE, NC USA



TRANSPORTATION ELECTRIFICATION IN NORTH CAROLINA

| A DEEP DIVE INTO TRAVEL PATTERNS & STATISTICS ACROSS THE EV SECTOR

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CONNER SMITH, ATLAS PUBLIC POLICY

NORTH CAROLINA HIGHLIGHTS

ELECTRIC PASSENGER VEHICLES

North Carolina has the 17th largest number of passenger electric vehicles (EVs) and the seventh largest number of electric transit buses on the road in the United States.

North Carolina's EV market grew by five percent through December 2020 while the nation's shrank by three percent.



ELECTRIC BUSES AND TRUCKS

Increasing government funding can create regional demand for electric buses and trucks built by manufacturers operating in the state.

Buses and trucks contribute higher per-vehicle miles traveled across North Carolina and their emissions disproportionately impact underserved communities.

ELECTRIC TRANSPORTATION INFRASTRUCTURE

North Carolina has the eighth-highest utility investment in the country following November 2020 approvals for Duke Energy investment.

North Carolina is the ninth most populous state but ranks 37th in DC fast charging deployment per person.

The state can leverage the North Carolina ZEV Plan and \$64 million in remaining Volkswagen Settlement funds to accelerate transportation electrification.

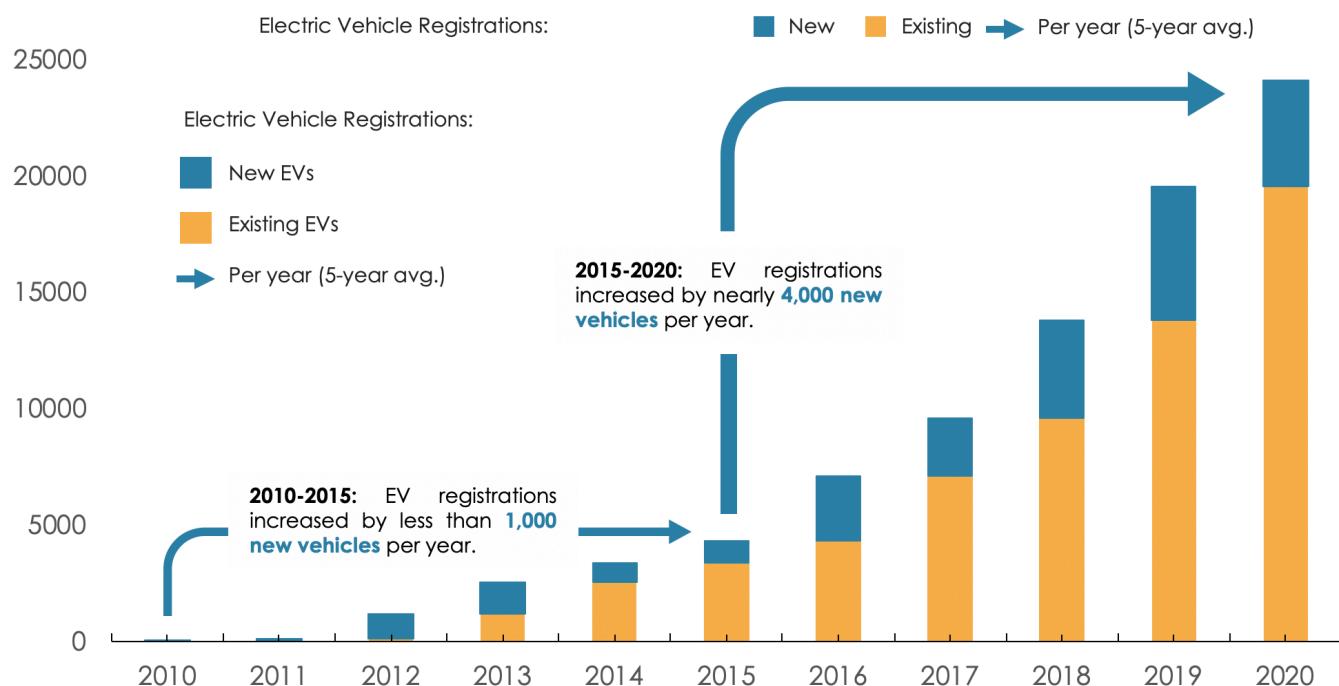


EXECUTIVE SUMMARY

NORTH CAROLINA EV MARKET OUTPACES NATIONAL TRENDS IN 2020

North Carolina is emerging as a regional hotspot for transportation electrification in the Southeast and has the 17th highest passenger electric vehicle (EV)¹ sales in the United States. Between January and December 2020, North Carolina EV sales were up five percent compared to 2019 [1]. EV sales nationwide were down three percent through December 2020 as a result of the pandemic that has reduced consumer demand and impacted production in the auto market [2]. Figure 1 shows the growth of the EV market in North Carolina between 2010 and 2020.

FIGURE 1: EV MARKET GROWTH IN NORTH CAROLINA



This chart shows the increasing number of EV registrations in North Carolina. Average annual EV registrations increased by almost four times between 2015 and 2020 compared to the previous four years.

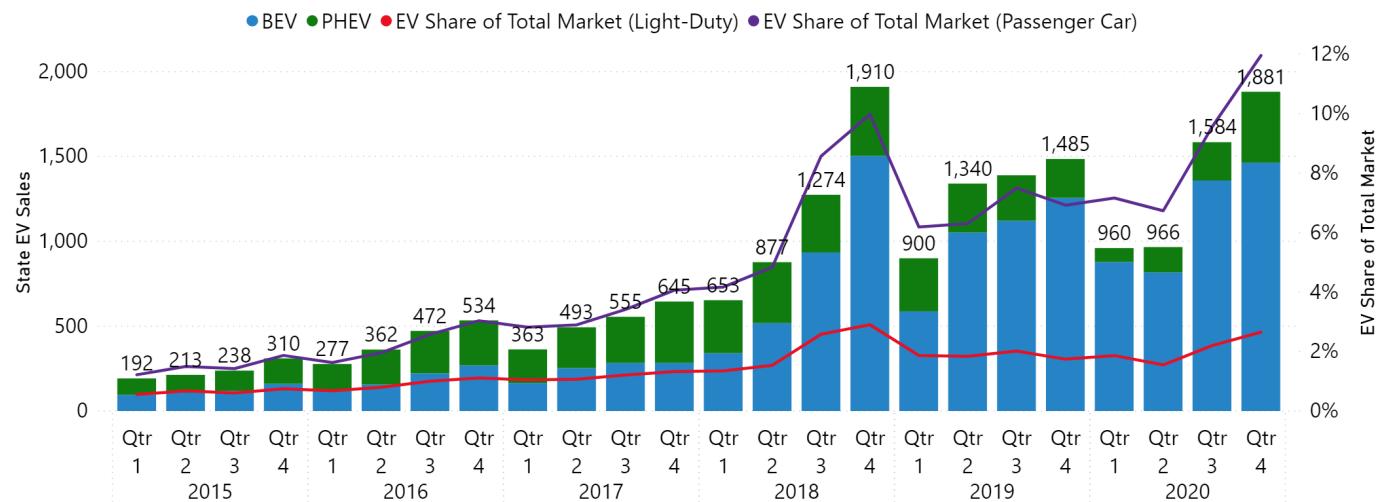
Source: Southern Alliance for Clean Energy [3]

North Carolina's EV market has been trending in a positive direction since 2015 and while sales were down three percent nationwide between 2019 and 2020, North Carolina EV sales grew by five percent. The state's EV sales also grew by eight between 2018 and 2019 while the national market shrank by 12 percent. In the third and fourth quarters of 2020, the EV share of total passenger car sales, excluding light-duty pickup trucks, reached as high as 12 percent. Figure 2 shows EV sales in North Carolina between 2015 and 2020.

¹ Both all-electric vehicles and plug-in hybrid electric vehicles are considered EVs in this brief.

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FIGURE 2: ELECTRIC VEHICLE MARKET IN NORTH CAROLINA



This chart shows the increasing number of EV sales in North Carolina. Annual EV sales increased by more than five times between 2015 and 2020. The upper (purple) line shows the North Carolina EV market share of all passenger vehicle sales while the lower (red) line shows the EV share of the entire light-duty market, which is roughly 2 percent.

Source: [Atlas EV Hub \[1\]](#)

DIVERSE STATE TASK FORCE DRIVES INITIAL NORTH CAROLINA EV MARKET GROWTH FORWARD

EV market growth in North Carolina has been driven by the efforts of a diverse group of stakeholders to advance the development of supportive policies. The first comprehensive statewide transportation electrification roadmap was organized by the NC Plug-in EV Taskforce. The group, which was launched in 2011, led the creation of the 2013 Plug-in Electric Vehicle Roadmap for North Carolina as well as local EV readiness plans for major metropolitan areas including Asheville, Charlotte, Greensboro-Winston-High Point, and Raleigh-Durham-Chapel Hill [4]. The taskforce combined the forces of stakeholders across the state including Clean Cities Coalitions, the North Carolina Department of Commerce, and a range of consulting groups, non-profit organizations, electric utilities, universities, and local governments. These early planning efforts led to the creation of Plug-In NC, a coalition of stakeholders who continue to work on state-wide EV adoption [5].

EV MARKET GROWTH FURTHER PROPELLED BY GOVERNMENT AND UTILITY ENGAGEMENT

Building off of this early momentum, Governor Roy Cooper set a number of goals for the transportation sector in the state in 2018 with the enactment of Executive Order 80, North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy. The order established greenhouse gas emissions targets, passenger EV deployment goals, and outlined a framework for statewide partnerships around charging infrastructure rollout [6]. The order outlined two clear plans in the Department of Transportation's North Carolina ZEV Plan and the Department of Administration's Motor Fleet Plan. While the former tackles broad-based support for increased EV and EV charging deployment, the latter identified strategies for the state to identify and pursue electrification of fleet vehicles [7, 8].

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This executive action has helped generate investment and engagement in transportation electrification from other stakeholders in North Carolina. In November 2020, Duke Energy was approved to invest more than \$25 million in EV programs, the state's first approval for a utility EV program [9]. The approval authorizes investment across both of Duke's subsidiaries in the state, Duke Energy Carolinas and Duke Energy Progress. The order includes support for school bus electrification that will be leveraged to support the first round of funding granted through the state's Volkswagen Settlement in July 2020. While North Carolina is behind much of the rest of the country in per person deployment of EVs and EV charging, this approval launched the state to the number seven spot in terms of total electric utility investment in transportation electrification.

SIGNIFICANT FUNDS AVAILABLE TO INCREASE EVS AND EV CHARGING

While the state is now a leader in electric utility investment, North Carolina has room to grow in the amount of funds dedicated to transportation electrification with at least \$64 million remaining from their Volkswagen Settlement Allocation. Round one included funding for DC fast charging as well as both school and transit buses and were the state's first awards through the Settlement. The awards were announced at the same time as the signing of the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (MOU) [10]. North Carolina was the only state in the Southeast region and one of only three states that are not a part of the California-led ZEV Program² to join the agreement seeking 100 percent ZEV bus and truck sales by 2050.

ELECTRIC TRANSPORATION POLICY AND INVESTMENT CREATES JOBS

North Carolina's support for transportation electrification has led to an increase in clean transportation jobs in the state, with startups and small manufacturers opening new facilities. Increasing EV plans and several major EV truck and bus manufacturers including Daimler and Volvo expanding EV operations at existing facilities in the state [11, 2]. United Kingdom-based Arrival is one of the new players setting up shop in North Carolina and contributing to the growing ecosystem of medium- and heavy-duty EV manufacturing in the region [12].

Support for domestic EV manufacturing is likely to increase with President Biden signing an executive order to strengthen "Buy American" provisions on January 25, 2021 [13]. The same day, the Biden Administration announced plans to electrify the entire federal fleet, a move that will increase demand for U.S.-made EVs in the public sector [14]. There are at least 600,000 vehicles in the federal fleet.

These executive actions are the latest moves in sweeping green infrastructure plans outlined by the Biden Administration that seeks to leverage federal funds to deploy more than 500,000 charging stations nationwide and create 1 million new jobs in the auto industry. National momentum towards transportation electrification has increased the opportunity for North Carolina to play a leading role in the regional EV market and set examples for best practices in transportation electrification on the national scale.

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² ZEV States include California, Colorado, Connecticut, Maine, Massachusetts, Maryland, New Jersey, New York, Rhode Island, Oregon, Vermont, Washington

INTRODUCTION

North Carolina is emerging as a regional hotspot for transportation electrification and is the ninth most populous state in the country with roughly 10.5 million people. The state's EV market expanded by a factor of five between 2015 and 2020, but still lags behind neighboring Georgia and Virginia in several key indicators including EV and EV charging deployment [2].

ELECTRIC TRANSPORTATION OFFERS A SOLUTION TO MULTIPLE CRISES IN NORTH CAROLINA

Electrifying transportation in North Carolina can deliver significant economic and environmental benefits while supporting the public health of vulnerable communities at a critical time in the COVID-19 pandemic. Transportation contributes the most of any sector to North Carolina's greenhouse gas emissions, accounting for 42.5 percent in 2017 [15]. On-road vehicles are also the leading source of criteria pollutants and account for 37 percent of these emissions, which are known to increase the occurrence and severity of health risks including respiratory and heart disease [16]. Electrifying on-road vehicles provides an opportunity to make large emissions reductions and reach the state's climate goals while promoting public health. Climate change is expected to place critical infrastructure at chronic risk of flooding and other extreme weather events that will strain state budgets and will impact communities throughout the state [17].

Transportation contributes the most of any sector to North Carolina's greenhouse gas emissions. Electrifying on-road vehicles provides an opportunity to make large emissions reductions and reach state climate goals while promoting public health.

HIGH DEMAND FOR EVS IN NORTH CAROLINA

Investing in transportation electrification not only provides jobs for North Carolinians, but also enhances the state's overall resiliency by transferring expenditure away from fossil fuel imports and towards in-state and regional energy production. North Carolina's EV market has already outperformed the national market throughout the pandemic, which has caused production delays and reduced consumer demand within the auto industry [18].

Through December 2020, North Carolina's EV sales grew by five percent while the national EV market was down three percent [1]. EVs are also outperforming conventional vehicle sales in North Carolina through December 2020, which were down 11 percent.



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AUTOMAKER AND MANUFACTURER COMMITMENTS HAVE POTENTIAL TO SPUR MANUFACTURING JOBS

EV market recovery has been supported by increasing commitments from automakers and manufacturers looking to expand investments in electrification. Electrification commitments in the United States worth more than \$37 billion were announced or specified between January and December 2020 [19]. This more than doubled the amount pledged in 2019. General Motors led the surge in investment in 2020, adding \$7 billion to their initial \$20 billion commitment to EV investment on November 19th [20]. These investment commitments will support more than 30 new passenger EV models that are expected to enter the U.S. vehicle market before the end of 2021 [21]. In total, more than \$77 billion is expected to be invested in the U.S. EV market across all light-, medium-, and heavy-duty vehicle segments [19].

The MOU signed by Governor Cooper in 2020 sets NC on a course to achieve 100 percent ZEV bus and truck sales by 2050.



While North Carolina does not have any major passenger manufacturing facilities, the state is home to several EV charging and medium- and heavy-duty vehicle manufacturing facilities. On the charging side, manufacturers ABB and Siemens are both active in the state. In the medium- and heavy-duty electrification sector, Daimler and Volvo Trucks both operate facilities in the state and have committed to producing electric trucks and buses in the next several years.

Daimler's subsidiaries in North Carolina include both Freightliner Trucks and Thomas Built Buses. The headquarters of Volvo Trucks and their subsidiary Mack Trucks are both located in Greensboro. The in-state market for medium- and heavy-duty EVs is set to increase with the adoption of the ZEV bus and truck MOU in July 2020. The agreement sets the state on a course to achieve 100 percent ZEV bus and truck sales by 2050, a goal that was also adopted by 14 other states and Washington DC [10].

RAPID DEPLOYMENT OF EVS AND BUILD OUT OF CHARGING CORRIDORS IS FORTHCOMING

The signing of the MOU is only one supportive policy the state has adopted to advance transportation electrification. The state released the North Carolina ZEV Plan in October 2019 outlining goals to deploy 80,000 passenger EVs throughout the state by 2025 [22]. The plan also outlined a pathway to develop EV charging along key corridors other publicly accessible locations. The statewide EV charging network is also set to receive support from electric utilities. Duke Energy was approved to invest \$25 million in several EV pilots including public charging deployment and support for electric school buses [23].

North Carolina's EV sector could see additional support as the state moves to award more of its Volkswagen Settlement allocation. In July 2020, the state made its first awards through the settlement and designated \$9.5 million in funds for EVs and EV charging [24]. Roughly \$64 million of the state's initial allocation of \$92 million remains to be awarded and could go towards transportation electrification.



Roughly \$64 million of the North Carolina's initial VW Settlement allocation of \$92 million remains to be awarded and could go towards transportation electrification.

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RELYING ON POLICY AND RESEARCH, NORTH CAROLINA CAN CHARGE FORWARD WITH ELECTRIC TRANSPORTATION

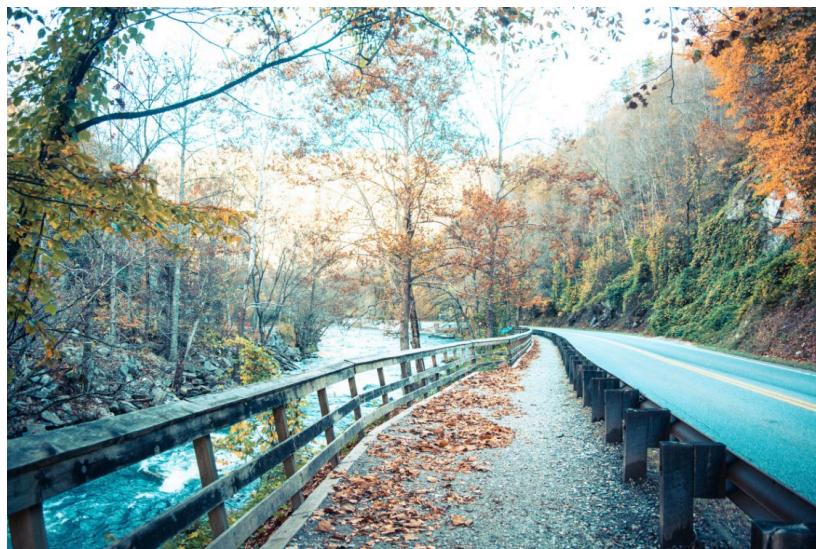
North Carolina is positioned to benefit from EVs in multiple ways and transportation electrification stakeholders can draw on existing research to help inform policy and program implementation across the state. This brief is focused on highlighting key EV indicators and current opportunities in North Carolina, drawing on examples from around the country and Atlas Public Policy's own research. Table 1 summarizes additional research available to provide a deeper understanding on ways to maximize the value proposition of rapid transportation electrification by implementing some of the policy interventions referenced in this brief.

TABLE 1: ADDITIONAL RESOURCES ON THE BENEFITS OF TRANSPORTATION ELECTRIFICATION

TITLE	AUTHOR	SCOPE
Update on electric vehicle adoption across U.S. cities	International Council on Clean Transportation	This brief provides an overview of light-duty EV and EV charging uptake across metro areas throughout the country. It also provides policy recommendations and guidance. The authors found that rebates and tax credits remain important for reducing upfront cost barriers [25].
Clean Jobs North Carolina	E2	This study conducted an analysis of all clean energy and transportation jobs in North Carolina and concluded that the green economy is employing 10 times more people than fossil fuels [11].
Transportation Electrification in the Southeast	Atlas Public Policy, Southern Alliance for Clean Energy	This study took a close look at progress towards transportation electrification in six states in the Southeast including North Carolina, Alabama, Florida, Georgia, South Carolina, and Tennessee [2].
Vehicle-Grid Integration	Atlas Public Policy, Alliance for Transportation Electrification	This brief identifies challenges and opportunities surrounding vehicle-grid integration (VGI) with a focus on how EVs can increase utilization of existing electrical grid assets and put downward pressure on rates by reducing grid operational costs [26].
High Potential Regions for Electric Truck Deployments	North American Council on Freight Efficiency	This report provides a framework for medium- and heavy-duty industry stakeholders to assess truck electrification markets in different regions. The report identifies electric truck hot spots and makes recommendations for policy support [27].
Beyond Financing: A Guide to Green Bank Design in the Southeast	Duke University, Nicholas Institute for Environmental Policy Solutions	This guide provides an overview of the structure and function of green banks and explores how such an approach could be leveraged in the Southeast to maximize limited public funds and catalyze clean energy investment [28].

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The Road to Cleaner Air	American Lung Association	This report draws on the findings of the organization's 2020 State of the Air report to provide recommendations to realize public health gains through transportation electrification [29].
Electric Vehicle Ownership Costs	Consumer Reports	This study estimates the cost saving potential of EVs compared to conventional vehicles by combining updated depreciation rates and maintenance and repair costs with real world average vehicle prices [30].
Comparison of Medium- and Heavy-Duty Technologies in California	ICF International, Inc.	This study assesses the emissions impact, total cost of ownership, and economic benefits of electrifying medium- and heavy-duty vehicles in California. It found that electric trucks are the most promising technology for the state to achieve long-term environmental and economic goals [31].
Roadmap for Electric Transportation	Regulatory Assistance Project	This resource provides a policy guide and model legislation related to transportation electrification. It is meant to guide states to implement policy that leads to economic savings, job creation, enhanced national security, and strengthened commitment to address public health and climate change [32].

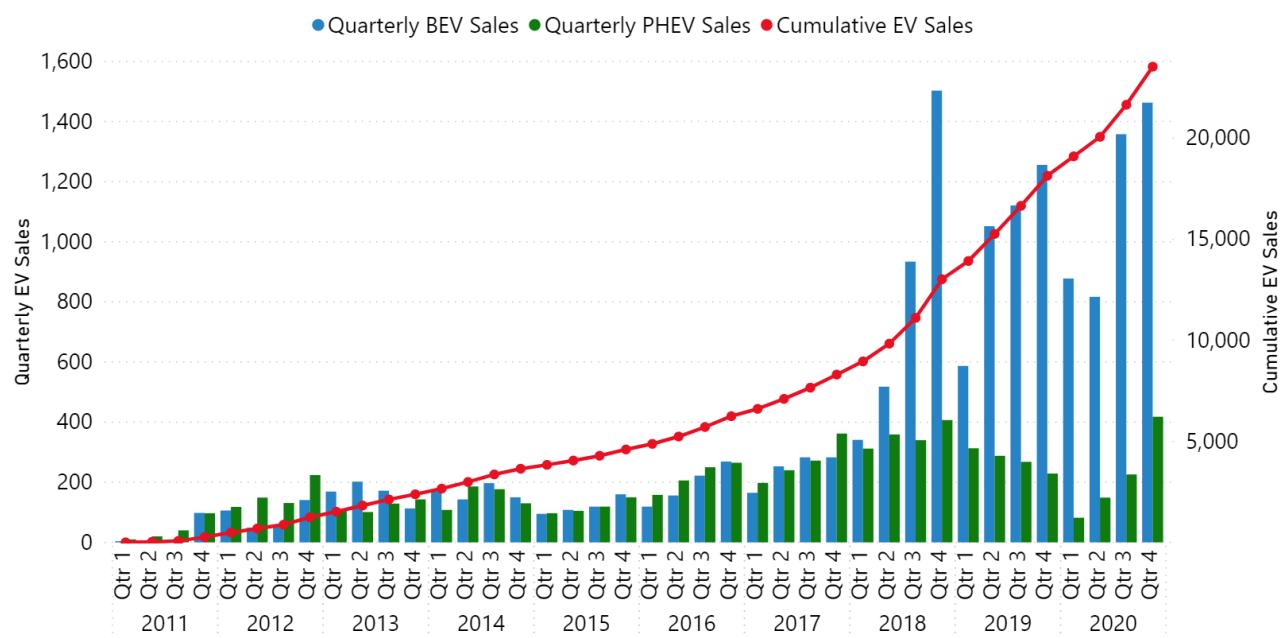


This brief, "Transportation Electrification in North Carolina", produced by Atlas Public Policy with support from the Southern Alliance for Clean Energy (SACE), provides an overview of the state of the EV market and deployment in North Carolina while also highlighting travel patterns and transit agency statistics, along with snapshots of EV policy and program examples from other states. Statewide transportation electrification roadmaps and funding available through the Volkswagen Settlement have generated momentum in North Carolina and can be harnessed to accelerate the EV market across the state and position it as a regional and national leader.

EV MARKET TRENDS IN NORTH CAROLINA

North Carolina has seen significant EV and EV charging deployment growth since the start of 2018. Annual EV sales increased by five percent between 2019 and 2020 while national sales were down by three percent. Between 2018 and 2019, passenger EV sales in the state increased by eight percent while national sales fell by 12 percent [1]. This trend of accelerating EV sales has also emerged in other states in the Southeast including Florida while national sales have fallen overall [2]. Rallying EV sales between September and December are the primary drivers for the increase in year-to-date EV sales in North Carolina. The state's EV market represents only 1.7 percent of the national total and ranks 17th out of all states in terms of total EV sales through December 2020. EVs make up 1.2 percent of the total passenger vehicle market in North Carolina in 2020. Figure 3 shows the trend in EV sales over time in North Carolina through December 2020 and Table 2 ranks the top ten states based on all-time passenger EV sales numbers through December 2020.

FIGURE 3: EV SALES IN NORTH CAROLINA THROUGH DECEMBER 2020



EV sales have been growing steadily in North Carolina and increased by five percent between 2019 and 2020. All-electric sales far outpace plug-in hybrid sales in 2020.

Source: *Atlas EV Hub* [1]

TABLE 2: TOP 10 STATES BY EV SALES THROUGH DECEMBER 2020

RANK	STATE	PASSENGER EV SALES THROUGH DEC 2020	EV SALES SHARE OF NATIONAL TOTAL	POPULATION SHARE OF NATIONAL TOTAL
1	California	767,642	46%	12%
2	Florida	78,125	4.7%	5.9%
3	New York	77,112	4.6%	6.5%
4	Washington	65,231	3.9%	2.3%
5	Texas	63,585	3.8%	8.8%
6	New Jersey	48,926	2.9%	2.7%
7	Georgia	44,269	2.6%	3.2%
8	Massachusetts	38,205	2.3%	2.1%
9	Illinois	37,343	2.2%	3.9%
10	Colorado	35,934	2.1%	1.8%
...				
17	North Carolina	23,526	1.4%	3.2%
TOP 10 TOTAL		1,256,372	75%	47%

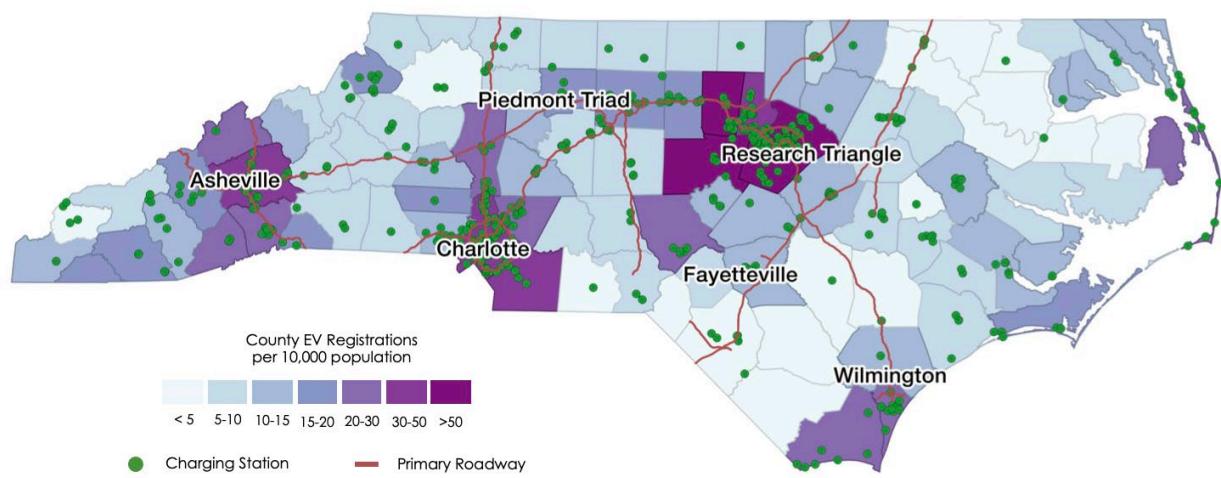
Together, the top 10 passenger EV markets in the country account for 75 percent of all passenger EV sales nationwide despite making up just 47 percent of the population.

Source: *Atlas EV Hub [1]*

Roughly 23,500 EVs have been sold in North Carolina through December 2020. This puts North Carolina behind Michigan and ahead of Ohio in terms of total EV sales. As is the case nationwide, Tesla accounts for the majority of EV sales to date in North Carolina. The Tesla Model 3 and Model Y are the first and second most popular EVs in the state with 4,665 and 1,444 vehicles sold between January 2019 and December 2020, respectively. Tesla claims 69 percent of all EV sales in the state over this same time period. Chevrolet claims seven percent of North Carolina EV sales with Nissan, Toyota, and BMW each claiming between two and four percent [1]. The North Carolina Department of Transportation also tracks EV registrations by county on a monthly basis and reported that as of December 2020, there were 24,126 EVs registered statewide [3]. Figure 4 shows the distribution of EV registrations throughout the state at the county level.

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FIGURE 4: EV REGISTRATION DISTRIBUTION BY COUNTY IN NORTH CAROLINA THROUGH DECEMBER 2020

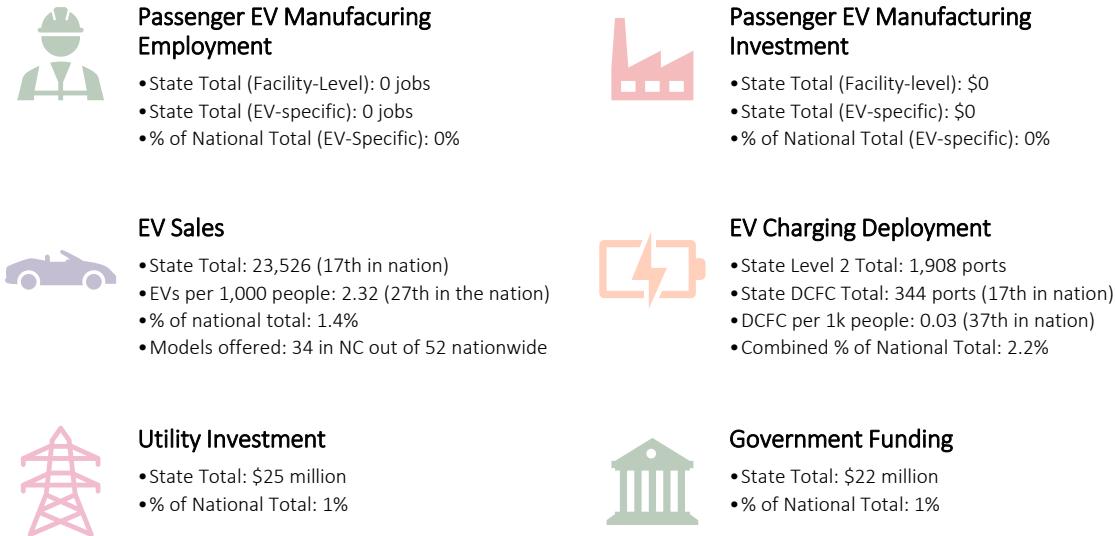


EVs are concentrated in the major population centers of the Research Triangle (Raleigh, Durham, and Chapel Hill), Charlotte, and Asheville.

Source: Southern Alliance for Clean Energy [3]

On a per person basis, North Carolina ranks 27th in EV deployment below both neighboring Georgia and Virginia, which rank 12th and 20th, respectively. The state is even further behind in DC fast charging deployment per person and ranks 37th nationally. While North Carolina is behind much of the rest of the country in per person deployment of EVs and EV charging, it has the seventh-largest amount of electric utility investment in transportation electrification. Figure 5 compares North Carolina to the nation as a whole on several key state-level EV indicators.

FIGURE 5: EV INDICATORS IN NORTH CAROLINA THROUGH DECEMBER 2020



North Carolina accounts for three percent of the national population with 10,488,084 people. North Carolina is in the bottom half of all states in terms of EV and EV charging deployment per person, but in the top half for utility and government support for EVs. The state has no reported direct investment or employment in passenger EV manufacturing, but has medium- and heavy-duty vehicle manufacturing in state. Data on medium- and heavy-duty manufacturing and employment investment is not publicly available and does not show up in these numbers.

Source: *Atlas EV Hub [1]*

At the regional level, North Carolina is behind Florida and Georgia and ahead of Alabama, Tennessee, and South Carolina in terms of EV sales. North Carolina represents 18 percent of the Southeast region's population and 14 percent of the EV sales. Roughly 17 percent of the charging stations in the Southeast are in North Carolina. The state's approved utility investment is higher than any state in the region and its government funding for transportation electrification almost matches that of Florida, the state in the Southeast with the most grant funding awarded [23, 33].

Unlike other states in the Southeast including Alabama, Tennessee, and South Carolina, North Carolina does not currently host any major passenger vehicle manufacturing facilities. However, the state leads the region in medium- and heavy-duty vehicle manufacturing. While few of these manufacturers directly report EV-specific investment or jobs at these facilities, research from E2 indicates that clean energy and transportation are key drivers of the North Carolina economy providing more than 113,000 jobs at the end of 2019 [11]. Before the pandemic, jobs in clean energy and transportation in North Carolina were growing 50 percent faster than other sectors of the labor market. Economic downturn due to COVID-19 led to a 20 percent reduction in the state's clean energy and transportation workforce. In the clean vehicles sector, the report estimates that clean transportation accounted for 7,105, or six percent of the total clean jobs in the state at the end of 2019. Between March and July 2020, the clean vehicles sector in North Carolina saw an 18 percent decline in employment [11].

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This downturn is likely short lived and medium- and heavy-duty manufacturers operating in the state continue to advance electrification plans. Daimler, which operates existing manufacturing facilities under both the Freightliner Trucks and Thomas Built Bus brands in North Carolina, has committed \$43 billion to global electrification investment and seeks to reach carbon neutrality in their passenger vehicle segment by 2039 [34, 19]. The manufacturer aims to only offer carbon-neutral commercial vehicles in North America by 2039 [35]. Thomas Built Buses, which is headquartered in High Point, made their first electric school bus deliveries to Dominion Energy in Virginia in October 2020. The buses, which were designed in collaboration with Greenville, South Carolina-based electric transit bus manufacturer Proterra, are the first in the initial wave of the utility's electric school bus vehicle-to-grid (V2G) program in their Virginia service territory. Thomas Built was selected as the sole vendor for the first 50 buses that will be deployed through the program [36]. In November 2020, the company's all-electric SAF-T-Liner C2 Jouley school bus was chosen by the state's largest business advocacy organization, NC Chamber, as the winner of the inaugural "Coolest Things Made in NC" contest [37].

In addition to school buses, Daimler manufactures trucks in North Carolina at several facilities. The manufacturer rolled out its 700,000th truck at its Mount Holly facility in November 2020 [38]. The facility, which employs 800 people, has not indicated if the upcoming Freightliner electric trucks will be manufactured in state. However, Daimler Trucks is committed to electric truck production and in 2019 converted their facility in Portland, Oregon to prepare for at least eight EV offerings over the next several years [39]. Production on the first electric models is expected to begin in Portland by early 2022. In December 2020, the manufacturer pledged to reach carbon neutrality in their manufacturing process across all North American facilities by 2025 [40]. Volvo Trucks and their subsidiary Mack Trucks, which are headquartered in Greensboro, also have plans to ramp up electrification. While it has not been announced whether any manufacturing will take place in-state, Mack announced plans to begin making electric refuse trucks in September 2020 that could be available as soon as 2021 [41]. Volvo Trucks launched their debut electric trucks in California in June 2020 [42].

Startups are also looking to North Carolina as they advance their electrification plans. United Kingdom-based Arrival announced on December 9, 2020 that they would be locating their North American headquarters in Charlotte with an investment of \$3 million to support 150 employees in the city [12]. This followed an announcement from October 2020 that the company would invest \$46 million and employ 240 people at their first American factory across the border in Rock Hill, South Carolina [43]. Arrival broke onto the scene in early 2020 when it announced an investment of \$110 million from Hyundai. Production for the company's electric transit buses and delivery vehicles is expected to begin in 2021.

Significant activity in medium- and heavy-duty manufacturing in North Carolina has occurred in parallel with the adoption of the ZEV bus and truck MOU in July 2020 [10]. The agreement established goals to reach 100 percent ZEV truck and bus sales in the state by 2050, a move that helped garner North Carolina a higher favorability for electric truck market growth potential from the North American Council for Freight Efficiency in their 2020 report compared to neighboring states [27]. North Carolina can maximize in-state investment in electric bus and truck manufacturing by designating more of the funding available through the Volkswagen Settlement and other programs to support transportation electrification. Policy and funding support for these vehicles can accelerate the in-state market for manufacturers with facilities in North Carolina and send a clear signal that the Tar Heel State is ready to lead on this front of transportation electrification.

EV CHARGING AND ELECTRIC UTILITY ENGAGEMENT

North Carolina is addressing the need for charging infrastructure to support EV deployment through both statewide infrastructure strategy and utility investment. As is the case with medium- and heavy-duty EVs, the state benefits from in-house EV charging manufacturing with both ABB and Siemens operating production and corporate facilities in North Carolina. ABB is working with researchers at North Carolina State University on a three-year initiative launched in 2018 that is designed to identify the grid upgrades and technological development needed to significantly accelerate DC fast charging throughout the state [44]. The company produces charging equipment at a facility in Mebane and is currently developing technology for publicly accessible charging solutions [45]. With thousands of employees across the state, Siemens is also a leading manufacturer of EV charging stations in the region with production facilities in Wendell, North Carolina and other operations in Georgia [46]. Nationwide, manufacturers and charging service providers have committed more than \$2.6 billion in private investment in EV charging [19].

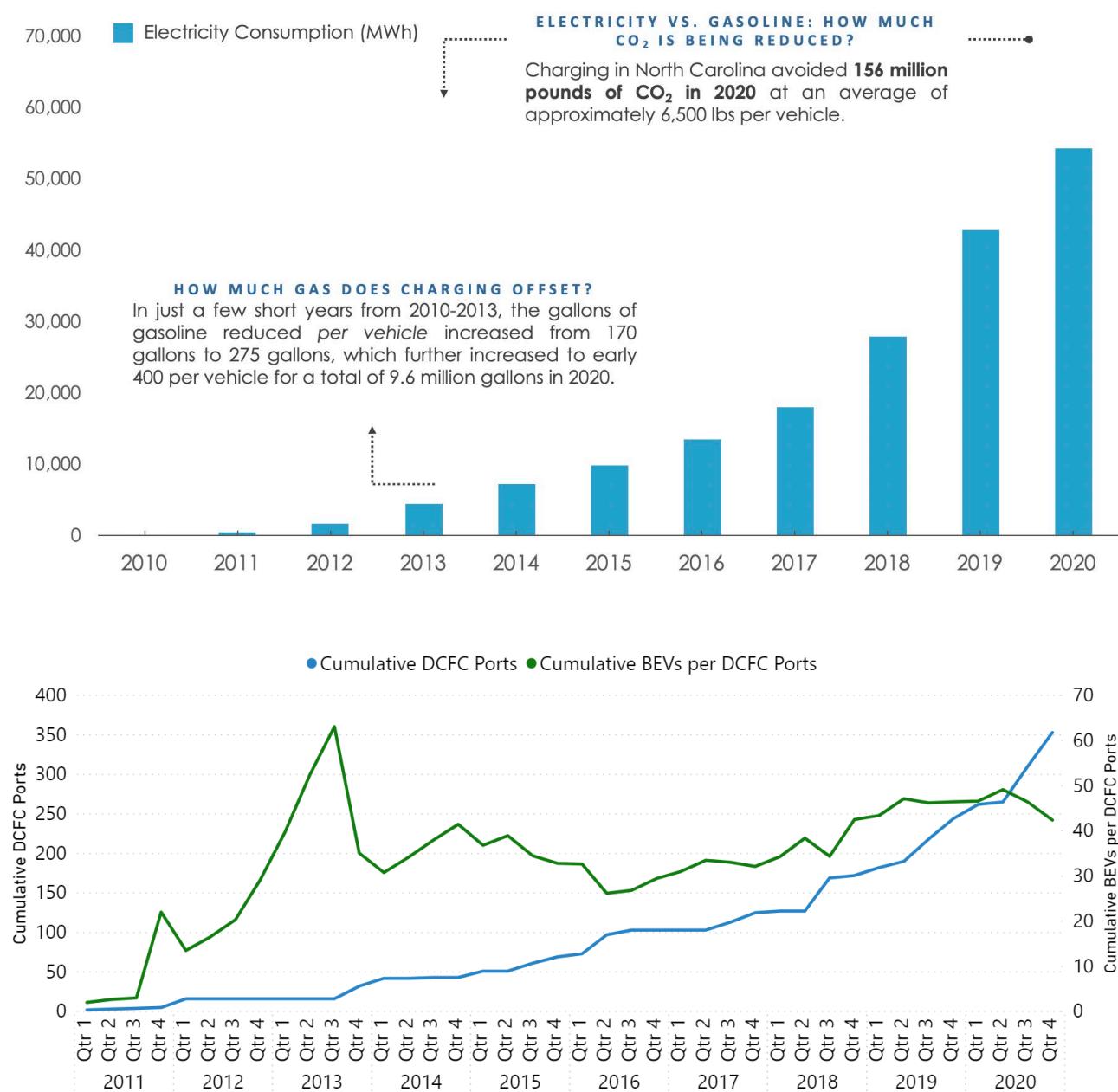
Investment in statewide EV charging networks can provide support for businesses operating in North Carolina while also preparing the state to meet rapid EV deployment goals. Demand for EV charging in North Carolina accelerated following Governor Roy Cooper's Executive Order 80: North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy issued in October 2018. The order established a goal to deploy 80,000 EVs by 2025, a four-fold increase over the total amount of EVs sold in the state through October 2020 [6]. It also required the establishment of the North Carolina ZEV Plan, which, released in 2019, outlines goals for statewide EV charging corridors co-managed by the Department of Transportation and Department of Environmental Quality.

These plans seek to rapidly expand the available EV charging infrastructure throughout the state and bring it up to the level seen in neighboring states. Through December 2020, North Carolina had deployed at least 344 DC fast charging and 1,908 Level 2 charging stations. Charging station deployment grew by 57 percent nationwide in 2020 compared to the number of ports installed at the end of 2019.³ In North Carolina, EV charging ports increased by 30 percent in 2020 compared to the end of 2019. On a per person basis, the state ranks 37th for DC fast charging deployment. This puts North Carolina behind neighboring Virginia and Georgia, which rank 14th and 26th for this metric, respectively [1]. Figure 6 shows the growth in EV charging energy consumption and deployment over time in North Carolina.

³ Estimates for the growth in charging station deployment over time do not include a large batch of ChargePoint stations that were all reportedly opened on June 12th, 2020. It is unlikely all of these stations opened on this date.

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FIGURE 6: EV CHARGING ENERGY CONSUMPTION AND DEPLOYMENT OVER TIME IN NORTH CAROLINA



These charts show increasing energy consumption from and deployment of EV charging in North Carolina over time. EV energy demand has increased more than five times since 2013. EV deployment has been increasing faster than DC fast charging deployment since 2016 on average.

Source: Southern Alliance for Clean Energy, Atlas EV Hub [47, 48, 49, 50]

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Low levels of per person charging station deployment in North Carolina relative to neighboring states could change with incoming state grants through the Volkswagen Settlement and recent approvals for electric utility EV programs. In July 2020, the state issued its first awards through the Volkswagen Settlement. In addition to providing \$6 million for electric transit and school buses, the announcement specified \$3.4 million for DC fast charging deployment on key corridors throughout the state [24]. The state also opened a \$1.15 million grant program for Level 2 charging stations on January 25, 2021 [51]. North Carolina allocated the maximum allowable 15 percent of its \$92 million total allocation to EV charging. This indicates that an additional \$9.3 million in untapped funds are currently available to expand the state's charging network.

Duke Energy, the state's largest electricity provider, is also looking to support the acceleration of EV and EV charging deployment in North Carolina. Duke has filed programs in states throughout its service territory, however, the program initially filed in North Carolina in March 2019 worth more than \$76 million was the largest one to date. The program proposed investment in an array of different projects including electric school and transit buses, fleet electrification, and public fast charging [52]. On November 24, 2020, the North Carolina Utilities Commission (NCUC) issued a partial approval of Duke's plans. The order authorized \$25 million from the initial proposal and includes \$7 million to support the purchase of and charging infrastructure needed for up to 30 electric school buses [53]. It also approved investment supporting 40 DC utility-owned fast charging stations and 240 Level 2 charging stations at public and multi-unit dwelling sites with a focus on providing charging at low-income housing sites [9]. Box 1 below highlights some of specific guidelines the NCUC issued as a part of their approval.

BOX 1: NCUC GUIDELINES FOR DUKE ENERGY ET PILOT APPROVAL

The Commission's order directs Duke to redesign denied program elements and refile them in 2021 [9]. Specifically, NCUC established the following guidelines that Duke can fulfill by convening stakeholders to gather input on how future programs can maximize the benefits of ratepayer-funded transportation electrification initiatives:

- Proper Scale and Scope: Duke should pilot smaller programs involving new technology before scaling them up.
- Rate Design: future pilot programs should include experimental EV charging rates and methods to track participation for limited subsets of pilot customers.
- Cost-Benefit Analysis: pilot programs must exhibit tangible net benefits before being scaled up.
- Leverage Other Funding: pilot programs should utilize third-party funding including from private and public sources when possible and seek program partnerships when possible.
- Make-Ready Approach: Duke should identify and execute grid infrastructure upgrades required for increased EV charging deployment.
- Objectives, Metrics, and Verification: All pilots should have clear goals so progress can be evaluated in program reports.
- Reporting and Stakeholder Engagement: Duke must consult stakeholders for all future pilots.

These guidelines provide a clear path forward for Duke as it looks to expand its EV offerings in North Carolina. Duke has already committed to establishing a series of stakeholder meetings to solicit feedback in the execution of pilots approved in this order.

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Although the approval represents only one third of the initial proposal, the modified program remains the largest yet recorded in the Southeast region. The decision positions North Carolina as the state with the eighth-highest level of approved utility investment in the country. The approval of multi-unit dwelling charging with a focus on low-income customers in the NCUC order also positions Duke Energy to join a growing number of leading electric utilities prioritizing investment in underserved communities. Through December 2020, utilities across the country had committed \$766 million, or roughly 30 percent of all-time approved investment, to transportation electrification directly benefiting underserved communities. This has become an increasing focus for utility program design in leading EV markets like California, New York, and Colorado with requirements to prioritize these groups established in both commission orders and legislation. In addition to direct support for the most vulnerable groups, utilities are increasingly viewing transportation electrification as an avenue to lower rates for all customers. By offering different types of EV rates and other VGI tools to manage the electricity demand of EV drivers, some utilities have seen significant increases in revenue above costs associated with increasing EV adoption. Box 2 below highlights some of the economic benefits experienced by electric utilities that have incorporated VGI initiatives into their programs.

BOX 2: ECONOMIC BENEFITS OF UTILITY INVESTMENT IN TRANSPORTATION ELECTRIFICATION

Utilities around the country are implementing new ways to account for increasing EV adoption and maximize the potential savings for both themselves and drivers through vehicle-grid integration (VGI). Utility operating cost savings can be achieved when EV drivers charge their vehicles at off-peak times, increasing energy sales without requiring the utility to invest in new grid infrastructure. EV charging can also provide other vehicle-grid integration (VGI) services, defined in California as, “any method of altering the time, charging level, or location at which 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.”

For utilities in at least 27 states, VGI programs have included EV-specific rate schedules to achieve EV charging demand shifts. Utilities like Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) have used time-of-use (TOU) rates, which offer reduced pricing for charging during off-peak times. Research from Synapse Energy Economics updated in June 2020 found that EVs have generated more than \$800 million in revenue above costs for the state’s two largest utilities, [54]. TOU EV rates like the ones studied in the Synapse analysis are only one form of EV rate reform options available to utilities. Con Edison in New York has implemented multiple programs to enhance VGI, including TOU rates, reduced demand charges for medium- and heavy-duty vehicles, and rebates for charging infrastructure and participation in managed charging programs [55]. Reducing these charges lowers the fuel cost for fleet managers and can increase savings potential compared to conventional vehicles, driving fleet managers to increase EV uptake [56]. This has also been applied to public DC fast charging by utilities like Florida Power and Light. The objective of these rates is to reduce the cost of supplying electricity for station hosts and improve the business case for owning and operating public fast charging [57]. Rate design is only one method utilities use to capture the benefits of VGI. Other methods include employing managed charging technology where the utility can directly control charging station consumption. EVs can also provide bi-directional power flow (V2G) where EVs act as distributed energy resources for grid operators. Utilities around the country are implementing VGI programs to maximize the cost savings potential of EVs. These savings are passed down to all utility customers in the form of lower rates and savings on the utility side [26].

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Duke is already looking to explore the potential for V2G through electric school buses supported by the November approval. This follows significant commitments to advancing this technology made by Dominion Energy in Virginia. In June 2020, the utility announced plans to deploy at least 50 electric school buses by the end of the year including a focus on exploring V2G applications [58]. As is the case with Dominion in Virginia, the NCUC has directed Duke to partner with state agencies and leverage additional funding available through the Volkswagen Settlement to advance these pilot projects. This is far from the only utility activity being pursued in North Carolina and for their part, Duke is ramping up their investment in other states in the region as well. Duke received an approval for \$8.8 million in South Carolina in September 2020 and the utility was approved in 2017 for their first EV charging program in Florida [23]. On top of the September approval in South Carolina, Duke announced a new commitment to electrify all of their light-duty fleet and half of their medium- and heavy-duty fleet vehicles by 2030 [59].

The accelerating EV market in North Carolina is also being supported by the state's electric member cooperatives and municipal utilities. Member-owned cooperatives have been expanding EV offerings to ratepayers throughout North Carolina with Roanoke Electric Cooperative launching a V2G pilot program with EV drivers in their service territory in November 2020. The pilot is designed to advance understandings of the applications of V2G technology in the state while also providing financial incentives for customers to switch to EVs [60]. Roanoke Electric is one of just several cooperatives in North Carolina working to support transportation electrification. NC Electric Cooperatives, the industry association representing all 26 member-owned utilities in the state, offers \$3,500 rebates towards the purchase of a Nissan Leaf for eligible customers. Cooperatives across the state are also responsible for expanding rural charging networks and have so far installed 31 charging stations in rural areas across North Carolina and invested more than \$1 million [61]. In addition to this, eight of North Carolina's electric cooperatives were awarded \$700,000 in Volkswagen Settlement funding to expand the co-op-owned network of electric vehicle charging stations. The co-ops will use the money to install another 10 high-speed charging stations along significant travel corridors in rural and suburban communities throughout North Carolina in the next two years [62].

Municipally-owned utilities are also working to electrify transportation across the state. Five municipal utilities were also awarded Volkswagen Settlement funding to install six fast-charging stations in five towns to help fill charging gaps along major highways [51]. ElectriCities, a not-for-profit membership organization of municipally-owned electric utilities in NC, provides matching grants for members to develop community EV plans to evaluate the potential electric load, revenue, and environmental impact of electric vehicles, assess the availability of electric vehicles locally, and present program options for the cities to market electric vehicles. In January 2021, the organization launched a grant funding program for Level 2 charging using funds from the Settlement [63]. While utility activity is accelerating in North Carolina and positioning the Tar Heel state as a regional and national leader, smaller states like Colorado continue to pull ahead. Colorado, a state with roughly half the population compared to North Carolina, has approved more than \$100 million in utility investment for transportation electrification. Almost all of this came from the approval of Xcel Energy's comprehensive transportation electrification plan on January 11, 2021 [64]. The state also ranks 11th in terms of DC fast charging deployment per person compared to North Carolina's 37th. Part of Colorado's EV success stems from its status as one of the 12 states that are a part of the California ZEV program and account for 65 percent of all U.S. passenger EV sales since the beginning of 2019. Within this group, California and New York also claim almost all of the largest utility programs in the country. Major approvals in New York and California from the second half of 2020 worth \$701 million and \$436 million, respectively, featured the make-ready model where utilities provide investment for all or a portion of the required infrastructure and upgrades up to the charging station itself. Table 3 provides information on the leading utility programs by total potential investment.

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TABLE 3: TOP 10 UTILITY PROGRAMS BY HIGHEST POTENTIAL INVESTMENT THROUGH DECEMBER 2020

UTILITY (STATE)	DOCKET	PROGRAM STATUS	DATE OF LATEST UPDATE	POTENTIAL INVESTMENT	PRIMARY FOCUS AREA
Southern California Edison (CA)	A1806015	Approved	8/27/2020	\$436 million	Make-Ready EV Charging for Residential and Non-residential Level 2 Charging
Consolidated Edison (NY)	18-E-0138	Approved	7/16/2020	\$396 million	Make-Ready EV Charging for Non-residential Level 2 Charging, Public DCFC
Southern California Edison (CA)	A1701021	Approved	5/31/2018	\$372 million	Make-Ready EV Charging for Medium- and Heavy-Duty Fleets
Public Service Electric and Gas Company (NJ)	EO18101111	Filed	9/26/2018	\$364 million	EV Charging Rebates for Residential Level 2 Charging, Public Fast Charging
Pacific Gas & Electric (CA)	A1701022	Approved	5/31/2018	\$267 million	Make-Ready EV Charging for Medium- and Heavy-Duty Fleets
National Grid (NY)	18-E-0138	Approved	7/16/2020	\$251 million	Make-Ready EV Charging for Non-residential Level 2 Charging, Public DCFC
New York State Electric & Gas Corporation (NY)	18-E-0138	Approved	7/16/2020	\$183 million	Make-Ready EV Charging for Non-residential Level 2 Charging, Public DCFC
Xcel Energy (MN)	M-20-492	Filed	6/17/2020	\$156 million	Vehicle Rebates for Transit Buses, Fleet EVs
Rochester Gas & Electric Corporation (NY)	18-E-0138	Approved	7/16/2020	\$144 million	Make-Ready EV Charging for Non-residential Level 2 Charging, Public DCFC
Central Hudson Gas & Electric (NY)	18-E-0138	Approved	7/16/2020	\$130 million	Make-Ready EV Charging for Non-residential Level 2 Charging, Public DCFC

This table shows the top utility programs in the country in terms of highest potential investment. Most of these include approvals for utilities in New York and California issued since July 2020. Make-ready investments are the leading business model and most of these programs include a focus on EV charging for non-residential and fleet vehicles.

Source: Atlas EV Hub [23]

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The approvals in both New York and California also include some of the largest ever carve-outs for underserved communities, indicating a growing role for electric utilities in serving the customer groups that private companies do not always target with their investment [65]. Language in the program design, especially in New York, points to the urgency to enhance environmental justice through utility investment. These communities bear the heaviest burden from transportation pollution and suffer the most from the emissions of medium- and heavy-duty vehicles in particular [66]. New research linking increased exposure to air pollution with higher COVID-19 mortality rates and worse health outcomes in communities of color has highlighted the need for transportation electrification as an avenue to improved health outcomes and equity [67, 68].

Pandemic relief and environmental justice will continue to remain key topics for transportation electrification investment and policy in 2021 as states look again to the federal government for leadership. Electric utilities like Xcel Energy are playing their part in major proposals outlined in Table 3 above that center their proposed investment around job creation and economic relief to combat the impacts of the pandemic in Minnesota. These are but a few of the examples North Carolina can look to as statewide EV policy is advanced and policymakers strive to meet climate and public health goals.

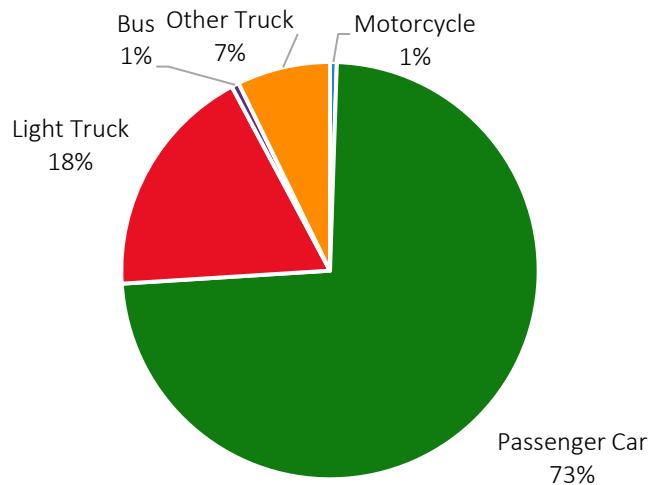
TRAVEL PATTERNS AND EMISSIONS IN NORTH CAROLINA

Air quality inequalities came into greater focus throughout 2020 due to fluctuating travel patterns and the linkages between race, air pollution, and public health exposed by the COVID-19 pandemic. Throughout the pandemic, public transit ridership saw steep declines while passenger vehicle travel made a quick recovery and returned to pre-pandemic levels by June 2020 [69]. Record-low ridership has strained budgets and transportation systems, leading to several of the nation's largest agencies to propose service cuts that largely impact underserved communities that rely on public transit [70]. Transit agencies have avoided mass layoffs and cuts for the near-term due to more than \$39 billion in federal relief funding through two rounds of pandemic relief funding in March and December [71].

Fluctuating travel patterns throughout the pandemic contributed to a 15 percent overall decline in transportation emissions in the United States in 2020 [72]. Even when accounting for this drop, transportation remains the lead sources of greenhouse emissions in the United States. While they do not directly address the ability of transportation electrification to reduce statewide emissions and mitigate climate change, the multi-stakeholder North Carolina Future Investment Resources for Sustainable Transportation (NC FIRST) Commission recognized climate change as a key vulnerability for transportation systems in the state and the need to build resilience over the next several decades [73]. In North Carolina, transportation is the leading source of greenhouse gas emissions and accounts for 42.5 percent of the state's carbon dioxide (CO₂) emissions [74]. Mirroring patterns seen throughout the United States, passenger vehicles are the primary source of transportation emissions in North Carolina and account for the majority of vehicle miles travelled (VMT). The Federal Highway Administration reports that passenger vehicle travel made up 73 percent of the total 121 billion annual vehicle miles traveled in North Carolina in 2018 [75]. The proportion increases when looking specifically at the largest metro regions in the state. In both Charlotte and Raleigh, passenger vehicles made up more than 94 percent of annual passenger miles traveled based on responses recorded in the 2017 National Household Travel Survey. Drivers across the two regions averaged roughly 12,500 annual miles driven in passenger vehicles, above the national average of 11,600 [76]. Figure 7 shows the breakdown of annual vehicle miles traveled by vehicle type in North Carolina.

TRANSPORTATION ELECTRIFICATION IN NORTH CAROLINA

FIGURE 7: ANNUAL VEHICLE MILES TRAVELED BY VEHICLE TYPE



Passenger vehicles account for the majority of annual miles traveled in North Carolina with trucks of all classes making up a majority of the remaining miles.

Source: Federal Highway Administration [75]

In addition to electrifying vehicles, reducing VMT and decarbonizing upstream electricity grid emissions are essential to maximize the environmental and public health benefits of EVs [77]. Emissions reductions from the transportation sector in 2020 are primarily derived from a reduction in travel of all types brought on by the pandemic, according to a January 2021 study from the Rhodium Group [78]. The report warns that these emissions reductions are likely temporary in the absence of “meaningful structural changes in the carbon intensity of the U.S. economy.”

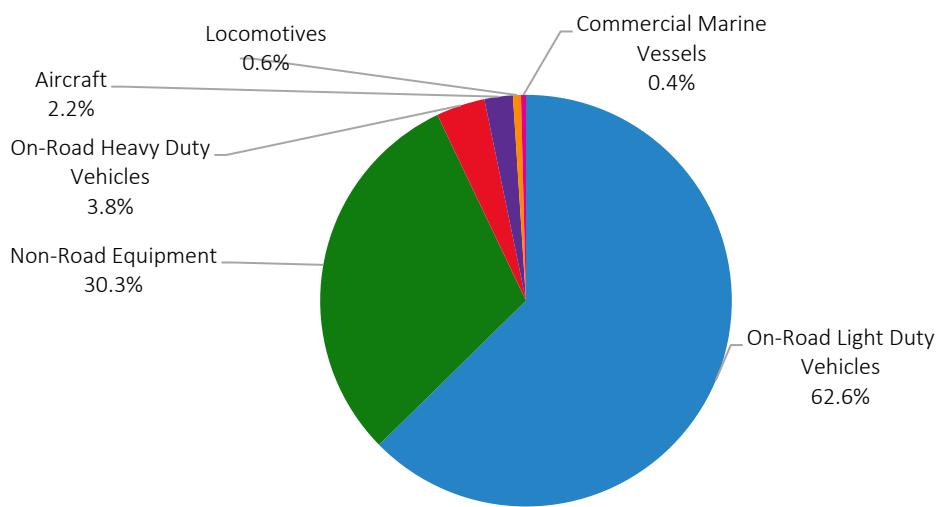
In terms of upstream emissions, utilities around the country have made some progress towards decarbonization in recent years. The Southern Alliance for Clean Energy notes that declines in the carbon intensity of the Southeastern power grid since 2007 allowed transportation to surpass electricity consumption as the leading source of regional greenhouse gas emissions in 2017 [79]. In North Carolina, the electric power sector claims 40 percent of the state’s CO₂ emissions. Despite the power grid’s contribution to the state’s emissions, driving an all-electric vehicle in North Carolina is comparable to the emissions of a conventional vehicle achieving 85 miles per gallon (mpg) according to the Union of Concerned Scientists [80]. Nationwide, the average fuel economy equivalent of driving an EV is 88 mpg.

While light-duty vehicles should be a top priority for electrification if North Carolina is to meet climate goals, medium- and heavy-duty vehicles contribute an outsized portion to criteria air pollutant emissions with considerable public health impacts [66]. These vehicles account for a disproportionate share of both vehicle miles traveled (VMT) and emissions relative to the number of vehicles on the road. Bus travel across Charlotte and Raleigh accounted for 15 million revenue miles traveled in 2018, meaning the bus was carrying passengers at the time of the trip. This means that each of the more than 320 buses operating in full service in these two cities travelled an average of more than 45,000 miles in 2018 [81]. This is more than 3.5 times the average 12,500 miles traveled by a passenger vehicle in metro North Carolina [76]. North Carolina transit bus annual VMT is almost exactly the same as the national average of 45,000 miles per year reported by the Federal Highway Administration [82].

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Trucks contribute even more to annual VMT and emissions on a per vehicle basis. Trucks average the highest amount of annual VMT of any vehicle type nationwide with more than 62,500 miles of yearly travel. The per-vehicle criteria air pollutant emissions from medium- and heavy-duty vehicles is also higher. Commercial trucks, which make up seven percent of annual VMT in North Carolina, account for 19 percent of the nitrogen oxide (NO_x) emissions in the state. Light-duty vehicles have a 91 percent share of the annual VMT and only 54 percent of the NO_x emissions. Although registration data by class is not available for North Carolina, trucks and buses account for roughly 10 percent of the on-road vehicle fleet nationwide [83]. The contribution of these vehicles to greenhouse gas emissions is also outsized with medium- and heavy-duty vehicles contributing 23 percent of the nationwide greenhouse gas emissions [84]. Figure 8 shows the breakdown of criteria air pollutant emissions by mobile source in North Carolina based on 2017 data.

FIGURE 8: CRITERIA AIR POLLUTANT EMISSIONS BY MOBILE SOURCE IN NORTH CAROLINA



Light-duty vehicles account for 63 percent of criteria air pollutants in North Carolina, leading all other sectors. Non-road equipment, such as forklifts and yard tractors, accounts for the second-largest proportion.

Source: Environmental Protection Agency [85]

The disproportionate share of criteria pollutant emissions relative to the number of vehicles on the road demonstrates a high per-vehicle emissions saving potential and public health gain associated with medium- and heavy-duty electrification compared to other vehicle classes. Electrifying trucks and buses is also a priority because underserved communities are exposed to a disproportionate share of emissions caused by these vehicles. Exposure to on-road vehicle emissions exacerbate public health issues such as asthma in underserved communities and has been shown to increase community vulnerability to COVID-19 [66]. North Carolina has already taken the lead in addressing these emissions by signing on to the ZEV truck and bus MOU and has the opportunity to follow California's Advanced Clean Trucks Rule which establishes a clear pathway for progressive electrification of different segments of the medium- and heavy-duty vehicle fleet in the state [86].

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North Carolina could also follow the example of other MOU signatories like Colorado and New York. Both states have set up ongoing funding programs for electric trucks and buses, tapping the Volkswagen Settlement and other reserves to ensure that vehicles operating in underserved communities are fast tracked for electrification [87, 88].

North Carolina's transit bus fleet is also positioned for considerable growth. As of the 2020 transit vehicle inventory from the American Public Transportation Association (APTA), there were at least 23 electric transit buses in operation throughout North Carolina [89]. This is below the 61 battery electric transit buses reported by CALSTART in the 2020 update to their "Zeroing in on ZEBs" study [90]. Even with this higher number, electric transit buses only make up only five percent of the North Carolina transit buses reported by APTA. Electric school bus and truck deployment is far lower. Fortunately, the state has several policy levers and funding resources it can draw on to speed up the transition to ZEV fleets across all vehicle classes.

POLICY OPTIONS TO ACCELERATE TRANSPORTATION ELECTRIFICATION IN NORTH CAROLINA

North Carolina has made considerable progress indicating a commitment to transportation electrification in state policy over the last several years but must do more if it wants to cement its role as a regional leader in transportation electrification. In particular, there are more opportunities for policymakers in the state to encourage collaboration between electric utilities, private companies, fleet operators, and public agencies to strengthen the EV ecosystem in North Carolina. Multilateral partnerships and networks can ensure that North Carolinians see both economic, public health, and environmental gains while positioning the state to capture the growing investment and jobs associated with clean vehicles [11]. Duke Energy is already taking a lead on the planning required to ensure that accelerated EV adoption serves as a boon for rather than hindrance to critical infrastructure such as road networks and the electrical grid. Box 3 below touches on the road network funding issue while the *EV Charging and Electric Utility Engagement* section discussed the cost savings potential associated with vehicle-grid integration.

BOX 3: ROAD NETWORK FUNDING CHALLENGES IN NORTH CAROLINA AND THE ECONOMIC OPPORTUNITY OF EVS

The average fuel economy of vehicles is slowly increasing across the nation. Between 2000 and 2017, the average fuel economy of light-duty vehicles in the United States rose from 20 to 22.4 miles per gallon and existing federal vehicle standards are expected to result in increased fuel economy in the near future [50]. This trend poses a challenge for road network funding since North Carolina, like all states, relies to some degree on motor fuel taxes to finance highways, bridges, and other essential transportation infrastructure. In 2018, these taxes accounted for 60 percent of all of North Carolina's road network revenue, the single largest source [91].

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A 2019 study from researchers at the North Carolina Clean Energy Technology Center estimates that annual fuel tax revenue losses from EVs amounted to roughly \$1.1 million. This is far less than one percent of the annual fuel tax revenue collected by the state [91]. Based on EV deployment at the time, this amounts to \$100 per vehicle. The state has sought to recover this revenue through a \$130 annual registration fee for EV drivers, leading the researchers to conclude that EV drivers in North Carolina are paying \$30 more per year than they would in gas taxes for driving a comparable conventional vehicle [92]. Similar findings are echoed by the NC FIRST Commission in its final report, which suggests increasing the annual registration fee for EVs and exploring pilot mileage-based fees as methods to account for revenue loss from transportation electrification [73].

Increased EV deployment at the 80,000-vehicle target established by Governor Cooper in Executive Order 80 would amount to a fractional loss of road network revenue even in the absence of an annual fee. As EVs and other advanced, efficient vehicles enter the market in North Carolina, the state must weigh the importance of encouraging innovation and the need to fund the road network. It is also important to note that road network funding systems built entirely on road use will suffer revenue shortfalls in years like 2020 where transportation declined. At least 29 other states have implemented annual registration fees and research from Consumer Reports in September 2019 found that at least 11 of these states were charging fees higher than a driver of a comparable conventional car would pay in gas taxes [93].

North Carolina has already laid important groundwork for rapid transportation electrification through Executive Order 80. By setting EV deployment goals and mandating a coordinated EV charging rollout between agencies, the state is ahead of others in the region who lack such plans. The Department of Transportation (DOT)'s North Carolina ZEV Plan outlines steps to realize goals to reduce greenhouse gas emissions 40 percent from 2005 levels by 2050 [8]. The plan outlines four key areas where the state can provide support for potential EV buyers: Education, Convenience, Affordability, and Policy. Under the education bucket, the DOT seeks to enhance both public knowledge of EVs as well as specific marketing strategies for dealers and fleet operators. The plan addresses the need for greater convenience by outlining priority corridors and sites for EV charging to ensure that the increasing number of EV drivers on the road are able to refuel with ease. DOT is considering implementing financial incentives for vehicles and charging to reduce the upfront cost of vehicles and improve affordability in the used market as well. Finally, DOT seeks to lead by example with policy directives requiring publicly owned vehicles to be electrified and enhancing regional collaboration around EV rollout.

In terms of regional partnerships, North Carolina could lead in generating increased collaboration between states in the Southeast. North Carolina benefits from neighbors that have already implemented some form of EV strategy in both Virginia and Tennessee. Established in 2018, Drive Electric Tennessee also seeks to enhance the rollout of EV corridors throughout the state and region [94]. Further south, Florida has also made strides in June 2020 with the enactment of the Essential State Infrastructure Bill establishing interagency partnerships to ramp up EV charging deployment [57].

Beyond this, North Carolina can look to the growing number of states on the East Coast participating in the Transportation and Climate Initiative (TCI). Virginia is the only southern state that has joined on to the TCI. Box 4 provides further context on the TCI.

BOX 4: TRANSPORTATION AND CLIMATE INITIATIVE

The Transportation and Climate initiative (TCI) seeks to implement policies to generate funding for regional clean transportation projects [95]. In December 2020, three member states including Connecticut, Massachusetts, and Rhode Island as well as Washington DC formally adopted the TCI Program which proposes to implement a “cap and invest” program [96]. Through this element, pollution is capped at a certain threshold and polluters must obtain allowances for pollution that can be auctioned to generate revenue for clean transportation investment [97]. This model follows California’s Low Carbon Fuel Standard program, which launched in 2011 and now generates more than \$2 billion in annual climate investments [98].

Outside of the states that adopted the program formally in December 2020, Delaware, Maine, Maryland, Massachusetts, New York, New Jersey, New Hampshire, Pennsylvania, Vermont, and Virginia are member states of the TCI. Some of these states have signaled openness to formally adopting the program once concerns with the initial outline, such as the lack of prioritization of environmental justice, are resolved [99].

Other states, including North Carolina have been consulted in TCI deliberations. This follows the state’s adoption of the sweeping Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (MOU) [5]. A majority of the TCI member states are also signatories on this MOU and have adopted the California-led ZEV Program. North Carolina can expand its leadership and ensure it benefits from new regional frameworks by expressing support for the TCI and goals to reduce greenhouse gas emissions that are consistent with the objectives outlined in Executive Order 80.

In addition to their membership in the TCI, Virginia passed House Bill 717 in April 2020, which established a working group to prepare the state to implement an EV rebate program [100]. The rebate program is required to go into place before the end of 2021 and would make Virginia the only state in the Southeast with such a policy in place. Nationwide, there are 15 states with active rebate or tax credits for EV purchase with a majority of programs falling in ZEV states. Colorado’s tax credit program also includes incentives for medium- and heavy-duty vehicles and offers up to \$8,000 and \$16,000 for the purchase of a medium- duty and heavy-duty electric truck, respectively.

Colorado has taken their support for medium- and heavy-duty electrification a step further and has required by executive order that all remaining Volkswagen Settlement funds go towards the procurement of ZEVs [101]. While North Carolina has made some progress in funding EVs through the settlement, only a third of the first round of awards announced in July 2020 are going to transportation electrification projects [24]. The state has \$64 million in funding remaining from their \$92 million allocation and state agencies have the power to designate which technologies are prioritized in later rounds. North Carolina can also look to Colorado’s lead to strengthen statewide EV plans. The Colorado plan has a much more aggressive EV deployment target of 940,000 EVs and 100 percent transit bus electrification by 2030.

North Carolina can also build on the momentum of Duke’s approval in November 2020 to increase the role of electric utilities in preparing the state for greater levels of transportation electrification. California is one state that has taken strides to institutionalize the role of electric utilities in the transportation electrification space. Beyond the \$1.5 billion in existing approved utility EV programs, the state passed Assembly Bill 841 in October 841. This legislation directs utilities in the state to provide the necessary make-ready investments to reduce the cost to install charging stations at sites throughout California and avoids the need for formal regulatory approval for essential grid upgrades [102]. This is particularly helpful

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for sites located at multi-unit dwellings where reduced cost of installation can encourage building owners to provide charging services. In addition to this new law, California is one of at least seven states that has existing “right to charge” regulations and building codes requiring that building owners allow residents to install charging stations on the premises themselves [103]. Enacting similar legislation could establish ongoing utility support for EV charging rollout and ensure that individuals in multi-unit residences in North Carolina are able to charge as conveniently as those in single family homes.

Another policy priority outlined in North Carolina’s is the importance of fleet electrification for both public and privately-owned vehicles in the state. As mentioned above, Duke Energy is one of the largest private fleets in the state that has committed to electrification. Public vehicles operated by the state are also targeted for electrification through the North Carolina ZEV Plan and agencies are required to prioritize EVs in new procurements. This approach has also been adapted at the municipal level with the state’s largest city, Charlotte, setting goals for a carbon neutral fleet by 2030 [104]. North Carolina already benefits from the establishment of statewide roadmaps for EV and EV charging deployment and could realize significant savings by expanding fleet electrification efforts to the state level. Fleet managers around the country are beginning to recognize the urgency and opportunity around fleet electrification according to survey responses from 91 fleet managers collected by Rocky Mountain institute and published in a January 2021 report [105]. The savings potential of fleet electrification at the state level based off a comprehensive study led by Atlas Public Policy in Washington state is outlined in Box 5 below.

BOX 5: SAVINGS POTENTIAL OF PUBLIC FLEET ELECTRIFICATION, A LOOK AT WASHINGTON STATE

The electrification of public fleet vehicles across all classes and use cases has the potential to generate significant savings for public fleets throughout the country. This was the key finding of a comprehensive analysis of all public fleet vehicles in Washington state led by Atlas Public Policy in partnership with the National Renewable Energy Laboratory and the Washington State University Energy Program. The study team found that under current market conditions, the state could cost-effectively electrify more than 1,650 vehicles immediately and achieve \$72 million in savings over the lifetime of these vehicles. Electric transit buses were particularly cost-effective to electrify given high operational savings and the availability of competitive models in that sector of the EV market.

The study also found several pathways to savings with widespread electrification by 2035. Savings potential is enhanced by the development of comprehensive roadmaps for fleet electrification that prioritize electrification of vehicles with higher savings potential in the near term. Even under the worst case estimate of technological advancement included in the analysis, more than half of all public fleet vehicles in Washington should have cost competitive EV alternatives by 2035. In this unfavorable scenario, a complete conversion of the fleet to EVs would result in savings of more than \$250 million. Savings potential associated with 100 percent electrification exploded to more than \$3.4 billion when assuming reductions in the cost of charging infrastructure and cost-saving innovations such as reduced battery costs for electric trucks.

This state-level savings potential could be even greater in North Carolina, which has a larger population and likely larger public fleet compared with Washington. In addition to this, North Carolina has already outlined a strategy for public vehicle electrification in the Motor Fleet ZEV Plan [7]. In the 2019 findings, the plan conservatively estimated a lifetime savings potential of \$3.8 million for the electrification of only 570 vehicles. Improving battery technology and reduced costs of EVs every year will only improve the cost effectiveness and savings potential of fleet electrification.

TRANSPORTATION ELECTRIFICATION IN NORTH CAROLINA

Fast-tracking EVs for public vehicle procurement will support the state's deployment goals while also ensuring new models are readily available for private fleets and individual customers as well. This is especially true in the medium- and heavy-duty vehicle segment where North Carolina could support the demand for new vehicles from manufacturers like Volvo and Daimler that operate facilities in-state. Since the beginning of 2018, North Carolina has awarded \$18.4 million for electric transit, school, and shuttle buses through both the Volkswagen Settlement and the Federal Low- and No Emission Bus Program. The state has not made any awards for electric trucks through December 2020 [33].

The presence of major manufacturers with EV commitments and the adoption of policy actions like the ZEV bus and truck MOU have led the North American Council for Freight Efficiency to deem North Carolina one of the two highest priority electric truck markets in the region along with Virginia [27]. Support for medium- and heavy-duty electrification will likely increase as the state has not made any major funding awards since signing on to the MOU in July 2020. With \$64 million in unspent Volkswagen Settlement funds remaining, North Carolina could emerge as the leading investor in electric trucks and buses if Governor Cooper or other state leaders take action and designate remaining funds to EVs in line with the goals set forth in the MOU. Policymakers in North Carolina can look to several policies across the United States that have been used to advance EVs. These are described below.

LIGHT-DUTY EV AND EV CHARGING INCENTIVES

State-administered tax credits or rebates or utility-administered rebates to reduce the upfront cost of EVs and/or charging. Vehicle rebates have been implemented in 15 states and charging rebates are active in 29. Incentives maximize driver savings with EVs and can increase spending power [32].

Example Programs	North Carolina Application
Oregon Clean Vehicle Rebate Program [106]: <ul style="list-style-type: none">• \$2,500 Standard Rebate• Doubles if driver is low-income• Applies to used vehicles	North Carolina has not implemented an incentive program for EVs. Georgia had a \$5,000 tax credit between 2013 and 2015. EV sales in Georgia fell 65% throughout 2015 when the program ended.

MEDIUM- AND HEAVY-DUTY VEHICLE AND CHARGING INCENTIVES

State or utility-administered vouchers covering the part or all of the cost differential between electric trucks and buses and conventional models. Five states have implemented these programs. EV truck deployment can lead to fleet savings and free up investment [31].

Example Programs	North Carolina Application
California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program [107]: <ul style="list-style-type: none">• 2,750 vouchers for ZEVs awarded• More than \$324 million disbursed since 2010• 57% of vehicles funded operating in underserved communities	North Carolina is already considered a favorable electric truck market and could increase deployment by implementing a voucher program. The state can leverage VW Settlement funds to launch a program.

TRANSPORTATION ELECTRIFICATION TARGETS

State- or city-level goals setting EV or EV charging deployment commitments. Targets can apply to one stakeholder (e.g., a transit agency) or create multi-stakeholder partnerships between utilities, governments, and companies. 21 states have adopted some form of targets. Executive orders and legislation can also be leveraged to require utilities or other stakeholders to create plans [32].

Example Programs	North Carolina Application
<p>Massachusetts Interim Clean Energy and Climate Plan for 2030 [108]:</p> <ul style="list-style-type: none"> • Proposed in December 2020 • 45 percent greenhouse gas emission reduction below 1990 level by 2030 • 30% ZEV bus and truck sales by 2030 • 100% ZEV light-duty sales by 2035 	<p>North Carolina has already implemented targets through Governor Cooper's Executive Order 80. The state could consider expanding these targets in light of other commitments made through the ZEV Bus and Truck MOU.</p>

ZEV PROGRAM

Twelve states led by California have implemented regulations requiring automakers to make available for sale an increasing proportion of passenger EVs relative to overall vehicle sales in a given state [109].

Example Programs	North Carolina Application
<p>Colorado Adoption of ZEV Program [110]:</p> <ul style="list-style-type: none"> • Enacted in August 2019 • Based the state's authority under Section 177 of the Clean Air Act • All model year 2022 and later vehicles sold in Colorado must meet CA standards. 	<p>North Carolina would be the first state in the Southeast to adopt these standards; most ZEV states are in the Northeast and West Coast. This foundational policy could help accelerate North Carolina's progress towards ZEV deployment goals outlined in the state's ZEV plan.</p>

MULTI-STATE COORDINATION

This typically entails formal partnership between multiple state agencies to develop multi-state transportation electrification targets or infrastructure networks.

Example Programs	North Carolina Application
<p>Regional Electric Vehicle (REV) West Plan [111]:</p> <ul style="list-style-type: none"> • A memorandum of understanding signed by AZ, CO, ID, MT, NV, NM, UT, and WY • Plan to deploy corridor EV charging stations making it possible to drive an EV through region 	<p>North Carolina benefits from existing EV and EV charging strategies in neighboring states including Tennessee and Virginia. North Carolina could partner with these states to promote regional travel, which could attract further tourism to the state and create jobs in the growing EV charging sector.</p>

TRUCK REGULATIONS

On June 25, 2020, California adopted the first-of-its kind Advanced Clean Trucks (ACT) Rule requiring all truck sales in the state to be zero emission by 2045 [112].

In July 2020, California joined 15 other states in signing the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (MOU). This establishes multi-state coordination around electric truck deployment and sets the stage for policy development similar to the ACT rule in participating states [113].

Example Programs	North Carolina Application
<p>Advanced Clean Trucks (ACT) Rule in California:</p> <ul style="list-style-type: none"> • 100% ZEV short-haul drayage trucks by 2035 • 100% ZEV last-mile delivery vans by 2040 • 100% ZEV truck sales by 2045 	<p>North Carolina has already signed onto the ZEV Bus and Truck MOU and could further establish their leadership by implementing a voucher program or adopting regulations similar to the ACT Rule. This would also support jobs and manufacturing in the state.</p>

RIGHT-TO-CHARGE AND MAKE-READY BUILDING CODES

Right-to-Charge laws refers to legislation that provides residents of properties the right to install charging infrastructure assuming the resident will cover the associated costs of the infrastructure. In some cases, these laws apply to both renters and owners. Seven states have implemented right-to-charge codes [114]. At least six states including Virginia have gone further to require that EV charging be installed at new constructions. These policies establish new building codes that can require utilities or property owners to pave the way for EV charging infrastructure installation in parking spots.

Example Programs	North Carolina Application
<p>California Make-Ready Policy Package [115, 102]:</p> <ul style="list-style-type: none"> • Requires construction of EV charging at multi-family dwellings • Allows residents of leased property to install EV charging stations at their own expense • Requires utilities to invest in make-ready infrastructure to reduce construction and installation costs 	<p>North Carolina has strong utility support for transportation electrification and directives from the utilities commission for Duke Energy to explore make-ready programs that could be enhanced by right-to-charge legislation. Any codes requiring EV charging would have to pass through the state's Building Code Council.</p>

DIRECT SALES OF PASSENGER VEHICLES

Formal legislation that allows EV manufacturers that do not have franchised dealers to sell directly to consumers [114, 116].

Example Programs	North Carolina Application
<p>Colorado Direct Sales Law [116]:</p> <ul style="list-style-type: none"> • Allows all EV manufacturers to sell directly to customers • Goes further than other states that only make this exception for Tesla 	<p>North Carolina currently only allows Tesla to sell directly to customers at a limited number of locations in the state [117]. Allowing automakers and EV startups to sell directly to consumers will increase market competition and expand the EV options North Carolinians can choose from. It also could lead to greater startup investment in the state.</p>

UTILITY INCENTIVES AND EV RATE DESIGN

Utilities around the country are designing rebate programs and offering separate EV rates to reduce the cost of charging and encourage EV uptake in their service territories. Utilities in at least 21 states have implemented time-of-use EV rates, and others including Xcel Energy and Consolidated Edison have offered comprehensive programs with multiple tools to reduce EV charging costs. Utility programs that emphasize VGI have been shown to reduce the cost of grid operation, helping to put downward pressure on electricity rates for all customers. Utilities in Oregon, California, and Minnesota have also piloted subscription-based EV rates for all classes of EVs to reduce the cost of refueling for EV owners. Lower fuel costs encourage EV adoption and lead to a greater proportion of transportation fuel consumption from in-state sources.

Example Programs	North Carolina Application
<p>Minnesota and Oregon Utility Programs:</p> <ul style="list-style-type: none"> • Xcel Energy Fleet Charging Service offers rebates for charging station installation and fleet optimization services to reduce charging costs [118]. • Portland General Electric owns and operates public fast charging stations and offers subscription-based membership to EV drivers for fixed price charging [119]. 	<p>Duke Energy and electric cooperatives in the state have already established programs to explore VGI and the Commission has directed them to explore experimental EV rates as a part of future program rollout. Duke could look to multiple examples of EV rate design and charging service programs to complement approved charging infrastructure investments.</p>

EV PLANNING FOR THE FUTURE IN NORTH CAROLINA

By prioritizing emissions reductions, public health, and economic growth in statewide plans, North Carolina is on track to lead a rising EV market in the Southeast. Research from the Environmental Defense Fund finds that North Carolina faces significant threats due to climate change. At least \$340 million worth of coastal property is already at risk of chronic flooding, a figure expected to rise to \$4 billion by 2045 [120]. Beyond property damage, heat waves and other extreme weather effects are anticipated to bring considerable public health costs, particularly impacting underserved communities. Increased support for EV adoption is recommended as one of the leading solutions to the problems facing North Carolina and can be coupled with other actions including emissions limits and utility regulatory reform to ensure the state leads on clean energy and transportation innovation.

North Carolina has begun to address the role of transportation in contributing climate change in Executive Order 80 with EV deployment levels set to achieve 40 percent reduction in greenhouse gas emissions from 2050 levels by 2030 [8]. Supporting the clean energy and transportation economy in the state can achieve these goals and deliver jobs to the region. North Carolina currently ranks in the top 10 states in the nation in terms of clean energy employment and the sector is employing more than 10 times as many people as the fossil fuel industry [11]. The state also leads the nation in clean energy jobs located in rural areas.

North Carolina is beginning to see a boost in EV-related jobs as well and according to analysis for E2, ranks 14th in the nation in clean vehicle employment. This is likely to change following recent announcements that the medium- and heavy-duty EV startup Arrival will locate their American headquarters in Charlotte [12]. The inflow of investment in manufacturing in North Carolina could create a virtuous cycle where manufacturers like Daimler, Volvo, and Proterra feed into the increase EV production supply chain in the region.

The EV market in North Carolina is only increasing and the North Carolina ZEV Plan references estimates from Bloomberg New Energy Finance to project that there could be 250,000 EVs on the road in the state by 2030. This level of growth would require a considerable but attainable acceleration from the Governor's target of 80,000 vehicles by 2025. More than 60 new EV models are expected to reach the market before the end of 2022, bringing consumers a wider range of options including the first all-electric pickup trucks [1]. This vehicle category leads in markets like North Carolina and pickup trucks accounted for five of the top 10 selling vehicles on the U.S. market in 2020 [121]. Only two of the top 10 were sedans and the entire American auto industry continues to shift towards crossover, SUV, and pickup segments.

Automakers are preparing new model offerings and investment strategies to push for recovery in 2021 after a projected sales decline of 15 percent in 2020 [122]. The U.S. EV market appears to have fared better than the conventional market with EV sales down nine percent through November 2020, the last month for which data was available [1]. Monthly EV sales for September, October, and November were higher than the numbers from 2019 and the introduction of anticipated models like the Ford Mustang Mach-E in the final month of the year bodes well for the U.S. EV market in 2021. Globally, the EV market is expected to grow by up to 50 percent in 2021 [123].

The United States can also look to the model set by Europe as an example of what is possible if pandemic relief is paired with a prioritization of investment in clean technologies [124]. In December, the European Union announced new targets to deploy 30 million EVs by 2030. There were roughly 2 million registered EVs across the EU as of December 2020 [125]. Automakers including Volkswagen, Daimler, and Renault all

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saw EV sales grow by more than 100 percent in 2020 while the European auto market shrunk by 25 percent overall [126]. Europe and China are expected to continue leading global EV market growth. Although Bloomberg New Energy Finance expects passenger EVs expected to make up 60 percent of new vehicle sales in the United States by 2040, a 30-fold increase over current levels. Electric truck sales are also expected to increase from negligible levels in 2020 to 10, 20, and 30 percent of light-, medium-, and heavy-duty new commercial vehicle sales by 2040, respectively [127].

Market growth is being driven by falling battery prices with BNEF estimating a 13 percent decline in average battery prices per kilowatt-hour between 2019 and 2020 [128]. This trend has ushered in a wave of investment in EVs in the United States with at least \$36 billion in new and specified investment commitments from automakers in 2020 [19]. This is more than double the amount that was recorded in 2019. The investment landscape looks favorable in 2021 with clear priorities around transportation electrification established by the Biden Administration [129]. North Carolina has exhibited the policy leadership required to capture more of this investment and has room to grow to ensure that the state and the Southeast region as a whole is not left behind as the U.S. EV market continues to grow in 2021.

Increased EV adoption across all vehicle classes is critical if North Carolina is to meet its transportation electrification and climate goals. On-road vehicles are the leading source of greenhouse gas and criteria pollutant emissions in the state and emissions from commercial vehicles in particular disproportionately harm marginalized communities.

North Carolina has a strong policy framework under the North Carolina ZEV Plan and the ZEV Bus and Truck MOU that it can use to spur investment in manufacturing, create clean jobs, and rapidly electrify both public and privately-owned vehicles throughout the state. It also has \$64 million in unspent Volkswagen Settlement funds that state agencies can deploy to facilitate the transition to EVs. Stakeholders in North Carolina can also draw support from electric cooperatives and utilities like Duke Energy to ensure all North Carolinians have access to affordable charging infrastructure and rates that help maximize fuel cost savings associated with driving an EV.

The urgency to invest in the clean economy has never been greater in light of the ongoing COVID-19 pandemic. The state can also leverage leadership from the Biden Administration and its clear commitment to EVs as a basis to advance policy platforms and programs within North Carolina. Doing so will ensure that the most vulnerable North Carolinians are prioritized as the state looks to grapple with the pandemic, climate change, and other factors impacting the public health and economic security of communities across the country.

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