Transportation Electrification Study

November 2019

Raleigh

Study prepared for the City of Raleigh by:

Electrification Coalition

Brightfield

greenlots
A Member of the Shell Group

ROSS STRATEGIC

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Executive Summary

Many cities around the country have undertaken actions and policies to support transportation electrification to improve air quality, reduce greenhouse gas emissions, support residents that choose to drive electric vehicles (EVs), enhance equitable access to clean mobility, and promote economic development. This study recommends efforts the City of Raleigh can undertake to advance transportation electrification both in its own operations and in the community more broadly.

This study was prepared by a consulting team under contract to the City of Raleigh, drawing on lessons and practices from around the country and informed by a series of engagements with City of Raleigh managers and staff. First, the consulting team met with the City of Raleigh project team to outline key steps in the project and develop a detailed project plan. This was followed by an information collection phase during which the consulting team met with City staff from multiple departments that are involved (or will become involved) in transportation electrification. This was accomplished through a series of interviews to collect information about current City-owned EV infrastructure, current and projected demand for transportation electrification, public-private partnerships, regional plans that may influence decisions and direction, and ideas about new EV infrastructure charging sites, investments, programs, and incentives. The consulting team produced a synthesis memo of information from this initial outreach (which included conversations with other interested regional stakeholders). The consulting team also developed a demand assessment memo (Attachment 2) with information on current and projected future demand for EV charging, recommendations for infrastructure placement, and an inventory of EV market predictors in Raleigh. The next phase of the project centered on an in-person meeting that covered key topics identified through the interviews and demand assessment memo. The consulting team compiled a presentation, delivered information, and answered questions about transportation electrification through a series of in-person discussions. The consultants developed additional research and education materials on key electrification topics to discuss during a third meeting with the City project team. During this meeting the consultants and City project team discussed prioritization and decision-making for key aspects of transportation electrification actions and strategies. This study is the culmination of these efforts and products.

This Executive Summary describes recommended strategies and actions the City of Raleigh can undertake to advance transportation electrification in the areas of: **City of Raleigh Municipal Fleet, Charging Infrastructure, Equity and Access, Equitable Economic Development and Public Engagement,** and **Implementation Roles and Responsibilities**. These recommended strategies and actions are listed below. A handshake icon identifies which of these should be undertaken with external stakeholder collaboration through public-private partnerships or partnerships that may not include the City. The consulting team believes that the City of Raleigh should go into this work optimistic and inspired about the many ways that transportation electrification can help Raleigh remain truly world-class and the place that an increasing number of people choose to work, invest, and live.

City of Raleigh Municipal Fleet

Strategy / Action	Description
1.1 STRATEGY	Develop municipal fleet targets and timelines for replacing a majority of the light-duty municipal fleet with electric vehicles by a reasonable but aggressive date based on expected light-duty fleet turnover.
1.2 ACTION	Based on existing telematics, begin replacing the City of Raleigh's light duty fleet with highway-speed EVs when the use case aligns with the performance of EVs on the market.
1.3 ACTION	Install required charging infrastructure to meet existing municipal fleet electrification needs and create an infrastructure strategy to support fleet electrification growth.
1.4 ACTION	Develop and implement a strategic approach to municipal fleet telematics to make informed fleet conversion decisions.
1.5 STRATEGY	Develop a municipal fleet conversion strategy that builds on lessons from initial efforts to bring fleet conversion to scale.
1.6 ACTION	Explore vehicle lease-to-own programs that may de-risk technology investment and enable the City to capture the value of tax credits to reduce overall capital investment.
1.7 STRATEGY	Develop an internal City strategy to require City staff to choose motor pool electric vehicles instead of gas cars whenever applicable.
1.8 ACTION	Conduct internal City education and training on EV driving and charging.
1.9 STRATEGY	Recognizing the City's plans to convert 75% of its transit fleet to compressed natural gas from wastewater methane capture, develop a strategy to replace the remainder of the transit fleet with alternative fuels, including electric buses, on a reasonable but aggressive timeline based on expected fleet turnover and expansion.
1.10 ACTION	Leverage potential funding, such as Volkswagen Settlement Funds, future Federal Transit Administration bus electrification funds, and possible Duke Energy rebates to purchase an initial number of electric buses and charging infrastructure. 
1.11 ACTION	Equip City departments with electric mowers and other equipment where noise is of concern. Explore partnership with North Carolina State University's Grounds Management to quantify the direct and indirect benefits to converting lawn mowing equipment to electric to support future Raleigh investment. 
1.12 ACTION	Expand research and piloting of hybrid bucket trucks in the City's fleet.

Charging Infrastructure

Strategy / Action	Description
2.1 STRATEGY	Advance EV-readiness in new and existing private commercial and multi-family buildings by: • 2.1A: Exploring incentives and education to encourage developers of all new commercial and multi-family parking lots or structures to dedicate a certain percentage of spaces as EV-ready and that all new development of residential homes be equipped with the infrastructure needed to install EV charging stations, such as conduit, wiring, and electrical capacity. • 2.1B: Streamlining and simplifying the permitting process for commercial property owners who wish to install charging infrastructure on existing commercial or multi-family properties.
2.2 ACTION	Lead by example by making all new and upgraded City buildings EV-ready. Require that all new City buildings and large renovations of existing buildings equip 20% of parking spaces with the infrastructure needed to install EV charging stations.
2.3 ACTION	Ensure all City EV charging hardware and software investments are interoperable and support the functions needed to effectively manage a network of chargers and provide information for future data-driven decisions about electrification of vehicles and equipment.
2.4 ACTION	Based on an evaluation of current and likely future use, replace existing City-owned Level-2 public charging stations with Open Charge Point Protocol (OCPP)-compliant networked Level-2 chargers operated on a single best-in-class EV charging network management software platform and add new Level-2 chargers in locations of currently recognized need.
2.5 ACTION	Encourage EV adoption and clean mobility through EV charging at City-owned park-and-ride facilities where feasible and integrate with zero-emission shuttles from park-and-ride lots to downtown.
2.6 STRATEGY	To position Raleigh to be aligned with the growing EV market, create an EV-ready strategy that identifies locations for future charging stations. As funds become available to support additional City-owned stations, this strategy will enable the capturing and execution of funds.
2.7 ACTION	Maximize opportunities to integrate EV charging with Smart Cities technologies and services.
2.8 ACTION	Build strategic partnerships with nearby municipalities, NGOs, and electric utilities to connect Raleigh's transportation electrification infrastructure strategies to regional resilience efforts. Focus on building the capacity of individuals, communities, institutions, businesses, and systems in Raleigh to adapt to chronic stresses and acute shocks. 
2.9 ACTION	Advance workplace charging through collaborative efforts with large employers that leverage recognition, branding, and competition. 
2.10 ACTION	Explore partnerships with industry, utility, and rideshare companies to create DC fast charging "hubs" of multiple chargers. The hubs should provide rapid charging to a variety of transportation uses, including private EVs, ridesharing, transportation network company vehicles, and delivery vehicles and could be located to encourage connectivity to other forms of mobility, including transit. 

Equity and Access

Strategy / Action	Description
3.1 ACTION	Partner with public health researchers and organizations to better understand the localized air quality issues impacting citizens and specific transportation options that can improve health in these areas.
3.2 ACTION	Explore opportunities to build partnerships with Wake County and other strategic stakeholders to advance equity and access benefits derived from vehicle electrification.
3.3 ACTION	Work with transportation network companies to increase equity, access, and opportunity for low-income residents to participate in the lower-cost and higher-margin electric rideshare economy.
3.4 STRATEGY	Help ensure that residents without access to off-street charging can charge an EV by: • 3.4A: Creating a right-of-way ordinance to allow curbside charging. • 3.4B: Encouraging charging in multi-family building parking facilities.
3.5 STRATEGY	Work with others to create an EV charging station installation handicap parking standard.

Equitable Economic Development and Public Engagement

Strategy / Action	Description
4.1 ACTION	Engage in strategic partnerships to advance workforce development initiatives related to transportation electrification.
4.2 ACTION	Engage regional businesses and entrepreneurs in the transportation electrification sector to identify demonstration and collaboration opportunities to advance electrification.
4.3 ACTION	Integrate information into economic development marketing campaigns that showcases Raleigh's innovative electric mobility solutions to reinforce Raleigh's position as an international leader in technology innovation and support business recruitment efforts.
4.4 ACTION	Create a public education and awareness campaign to increase the community's understanding of the broad benefits of transportation electrification, dispel myths, incorporate outcomes of funding opportunities such as the Volkswagen Settlement, and communicate Raleigh's transportation electrification implementation objectives.
4.5 ACTION	Begin building relationships with rideshare companies and other partners to explore ways to encourage electrification of transportation network company fleets (e.g., taxis, Uber, and Lyft).

Implementation Roles and Responsibilities

Strategy / Action	Description
5.1 ACTION	Include transportation electrification as an initiative within the City of Raleigh's Strategic Plan. Identify connections between the specific recommended actions and strategies in this study with the Key Focus Area sections of the Strategic Plan.
5.2 ACTION	Establish an internal Initiative Team with representation from across City departments and external stakeholders to undertake the implementation activities identified in the study, coordinate implementation efforts across departments, and monitor and report on implementation progress. As part of this work, craft a longer-term approach for managing transportation electrification and mobility as a program. The Office of Sustainability could serve as the convener of the team, and the different initiatives and actions should be led by the designated department leads and supporting departments.
5.3 ACTION	As implementation proceeds beyond an initial set of near-term activities, evaluate the need for additional staffing to oversee transportation electrification and mobility efforts.
5.4 ACTION	Proactively build transportation electrification investments into the City's operating budget and Capital Improvement Program based on funding availability.

Conclusion

By undertaking the strategies and actions recommended in this study, the City of Raleigh can send an important signal about its forward-thinking approach to transportation electrification within the broader context of economic development, equity, service to residents, environmental stewardship, and prudent use of public resources. The study finds that City of Raleigh has many opportunities to be a leader through its own actions, strategies, and investments (e.g., electrification of City-owned and operated vehicles) and by partnering with the private sector to develop EV infrastructure that meets projected demand. Equity is a vitally important topic for the City of Raleigh, and applying an equity lens to transportation electrification is another area in which City of Raleigh can demonstrate leadership. Communicating the value of transportation electrification to the public will be crucial to success.

Implementing the strategies and actions recommended in this document will involve (and even require) learning and adaptation over time as City leadership, managers, and staff develop insights from early steps but also as the reality of what is possible unfolds through changes in technology, policy, and the expectations of residents. Working on transportation electrification may require City personnel to work together in new ways, but it can draw on the deep expertise and capacity within City government by engaging teams across departments. The City can help ensure effective implementation by engaging a cross-departmental Initiative Team with clear internal leadership and by budgeting and investing to support the recommendations in this study. The process of developing this transportation electrification study has allowed the City of Raleigh to systematically consider the issues involved in becoming a leading clean transportation community and establish detailed implementation steps with assigned roles and responsibilities.

Introduction

This study recommends strategies and actions the City of Raleigh can undertake to accelerate transportation electrification in support of the City's vision to *pursue a world-class quality of life by actively collaborating with our community towards a fulfilling and inspired future for all.* The study was developed by a consulting team of Ross Strategic, Brightfield Transportation Solutions, Electrification Coalition, and Greenlots in collaboration with City of Raleigh managers and staff through a series of engagements to increase understanding of transportation electrification and identify a proposed direction for the City.

City of Raleigh has been involved in previous efforts related to transportation electrification. This includes participation in Project Get Ready, a Rocky Mountain Institute program to launch the installation of electric vehicle (EV) charging stations across the country. Project Get Ready helped coordinate efforts to overcome perceived barriers related to technology, consumer demand, infrastructure, and incentives. The City of Raleigh's Fuel and Fleet Transformation Plan, completed in 2015, evaluated petroleum-reduction initiatives and identified additional cost-effective strategies for transitioning Raleigh's fleet to an even greater use of alternative fuels and advanced transportation technologies. Raleigh was an early adopter of EV technology and has made progress adopting cleaner transportation solutions. However, the EV infrastructure that Raleigh first installed is now at the end of its useful life, and much more has been learned about the market since that time. City of Raleigh considers this study as an opportunity to learn more about this evolving market and associated best practices to help better plan for future needs of the City and community.

Transportation electrification connects to many aspects of the community. It includes investments in infrastructure to support residents that choose to drive EVs, but it is also about cleaner air, equitable access to clean mobility, economic development, fostering a culture of innovation, and efficient government. Because of this broad connectivity, transportation electrification can be a valuable opportunity to advance many of the City of Raleigh's goals and objectives. These goals and objectives are outlined in guiding documents such as the City of Raleigh Strategic Plan and 2030 Comprehensive Plan. The City's Strategic Plan is a three- to five-year plan that focuses on near term initiatives and actions, while the 2030 Comprehensive Plan facilitates long term best practices. Additional guiding documents include the Roadmap to Raleigh's Energy Future: Climate Energy Action Plan, Fuel and Fleet Transportation Plan, and elements of the ongoing work to develop strategies and engage community stakeholders for the Community-wide Climate Action Plan. Transportation electrification aligns closely with these city-wide guiding documents, which provide guidance to City staff on City Council priorities in the short and long term: the 2030 Comprehensive Plan provides long term planning guidance while the Strategic Plan provides short term actions in three- to five-year cycles. See the next section, "Strategic Vision and Alignment" for information on alignment with these city-wide guiding documents.

The mission of the City of Raleigh is to "build a stable platform of evolving services for our community through which we champion positive and sustainable growth and realize visionary ideas for all, with the vision of pursuing a world-class quality of life by actively collaborating with the community towards a fulfilling and inspired future for all." To achieve this, the City can

chart a future strategic direction for transportation electrification that draws on models and best practices from around the country and a clear understanding of Raleigh's unique characteristics and opportunities. Raleigh can be a regional and national leader in accelerating the transition to electric vehicles through a mix of investments, strategies, programs, and partnerships.

In addition to supporting City of Raleigh's Strategic Plan, transportation electrification provides an important contribution to the community-wide goal to reduce greenhouse gas emissions 80% by 2050. A nearer-term marker on the way to this ambitious goal is the State of North Carolina's goal, embodied in Executive Order 80, to have 80,000 EVs on the road by 2025 and reduce North Carolina's greenhouse gas emissions 40% by 2025. Raleigh is well-positioned to lead North Carolina cities in helping achieve this State goal. While these 2050 and 2025 goals guide the aspirations for this work, Raleigh is early in the process. The City can learn much from near-term steps undertaken in the next one to two years to guide what follows. In the planning process—and reflected in this study—the consulting team has worked with the City to identify potential near-term actions that can increase understanding within the City and community, establish processes for internal collaboration and external engagement, and generate information to drive future data-driven decisions. These near-term actions may occupy much of the City's attention on transportation electrification in the next year and set the City up over the next three years for deeper investment and integration of transportation electrification. As the City undertakes this work, transportation electrification technology, markets, and policies are changing rapidly and creating new opportunities for improving services, creating opportunities for the community, reducing impacts on the environment, and being prudent stewards of the public's resources.

A set of key principles guide the recommendations in this document:

- **Align** with City of Raleigh's Strategic Plan, 2030 Comprehensive Plan, future Community-wide Climate Action Plan, and other guiding documents and plans and strive to leverage existing priorities and resources.
- **Support** City of Raleigh's vision to pursue a world-class quality of life by actively collaborating with the community towards a fulfilling and inspired future for all.
- **Demonstrate** data-driven decision making and forward-leaning leadership.
- **Employ** business models that ensure fiscal responsibility.
- **Benchmark** against best practices from leading municipalities.

As the City undertakes this work, it should seek out opportunities to leverage federal and state resources, private investment, and a range of partnerships. However, the City's objectives shouldn't be dependent on these opportunities. The incentive flows into transportation electrification—such as federal tax credits, Federal Transit Administration Low or No Emissions Transit Bus Funding, and Volkswagen settlement resources—while much publicized, are not likely to have a sizable financial impact at-scale for the City's broad objectives. There is intense competition for these limited amounts of resources. The City shouldn't wait for them or make its planning dependent on them, but it should keep current on all available funding mechanisms, be engaged where there are opportunities for influence, and be ready when opportunities arise.

The planning that produced this document began in late 2018 and involved an iterative process over the course of several months. Given the cross-departmental nature of transportation planning and implementation, a Steering Committee comprised of key staff from across City departments (including Sustainability, Transportation, Information Technology, Engineering Services, Budget & Management Services, and the City Manager's Office) provided oversight and advising throughout the planning process. Three meetings were held to engage City staff:

- Meeting 1 (January 2019): Through individual interviews and group discussions, City of Raleigh staff representing a range of City departments with a role in shaping the City's transportation electrification work shared their aspirations for transportation electrification, questions, and information about current efforts. External stakeholders, such as North Carolina State University (academic sector), North Carolina Department of Environmental Quality (state agency), Duke Energy (utility sector), and Triangle J Council of Governments (local government coalition) also provided input on

City of Raleigh's role and opportunities for transportation electrification. This initial engagement resulted in a foundation of information and broad list of suggested principles to underpin transportation electrification work.

- Meeting 2 (March 2019): City staff and management participated in educational sessions related to electrification of municipal fleets, charging infrastructure and policy, equity and access, equitable economic development and public engagement. For each education session, participants were engaged in key questions to focus and refine the City's potential strategic options and direction. Based on these discussions (and information from interviews and discussions from Meeting 1), the project team provided initial recommendations for transportation electrification strategies and actions for the City of Raleigh in a briefing memo.
- Meeting 3 (May 2019): The Steering Committee and other key City of Raleigh personnel discussed and affirmed specific recommended actions and strategies from the briefing memo to inform this study. Specific areas of focus for this meeting included electrification of the City fleets, charging technology hardware and software, internal planning and budgeting, and roles and responsibilities for implementation among City Departments.

The next sections of this study describe the contribution of transportation electrification to the City's vision, Strategic Plan, and 2030 Comprehensive Plan followed by a description of key characteristics of the community that create the context for this work. The study is then structured around five key topic areas: **Municipal Fleets, Charging Infrastructure, Equity and Access, Equitable Economic Development and Public Engagement,** and **Implementation Roles and Responsibilities**. Within each topic area, the document describes strategies that can be developed and actions that can be undertaken by the City of Raleigh to accelerate transportation electrification in pursuit of its mission and vision. This study also highlights near-term actions that the City of Raleigh can achieve more readily and quickly; these can serve as "quick wins" in the transportation electrification process.

As the City evaluates how to support the transition to transportation electrification, it should recognize that the private sector has an important role to play. Several recommendations involve public-private partnerships or other types of collaboration—for example with large organizations with large workforces that may benefit from workplace charging for EVs. In the sections that follow, a handshake icon identifies strategies and actions that should be undertaken with external stakeholder collaboration through public-private partnerships, or through partnerships that may not include the City.

Strategic Vision and Alignment

Local government plays an important role in leading the way on climate mitigation, sustainability, and equity—and transportation electrification can contribute to all three. At the same time, city governments should validate proposed new activities or modifications to existing practices through a solid business case, including demonstrated community benefits that provide a strong return on investment. These values of innovation and responsibility are embedded within the City of Raleigh's Strategic Plan and 2030 Comprehensive Plan, which provide the context for the City of Raleigh's transportation electrification efforts as outlined below.

Transportation electrification can contribute to Raleigh's strategic plan and vision in key areas outlined below.

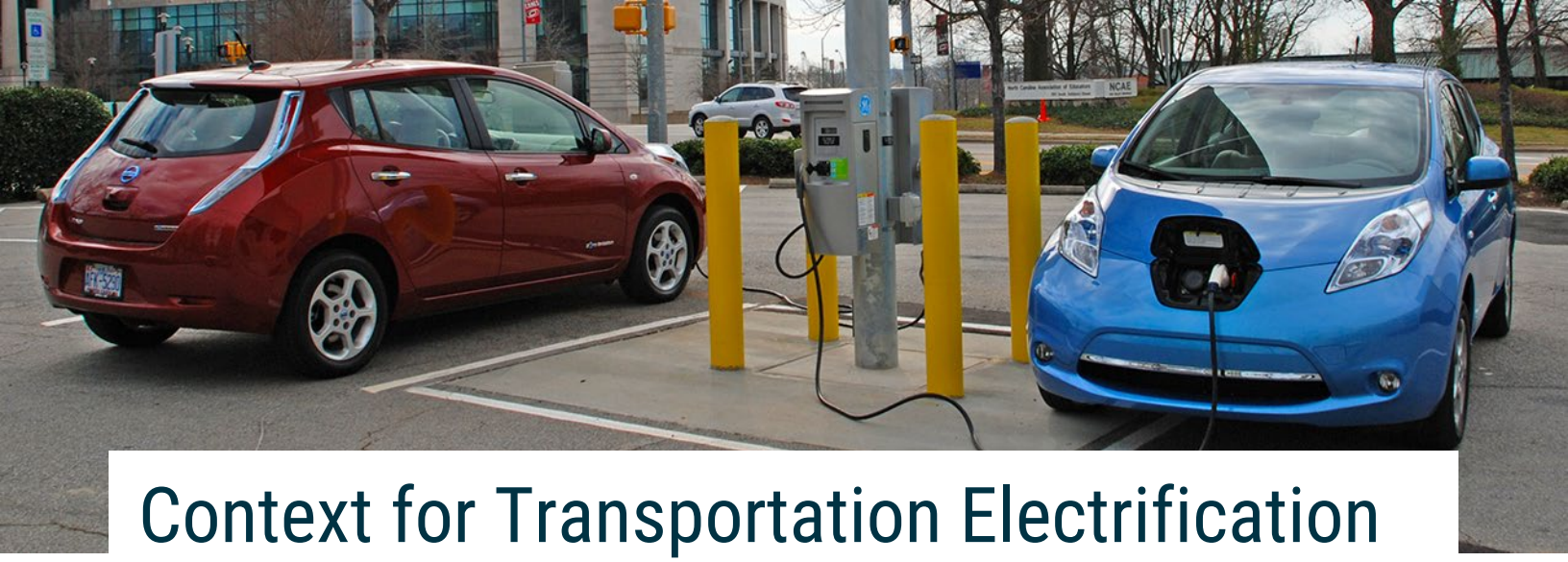
City of Raleigh's Strategic Plan Element	Connection to Transportation Electrification
Growth & Natural Resources *Objective 3:* Optimize public infrastructure projects to address community resiliency, sustainability, and efficiency.	This objective is the key strategic driver for transportation electrification and rationale for budgetary expenditures based on a broad range of fiscal and quality of life benefits valued by City of Raleigh.
Transportation & Transit *Objective 2:* Enhance the safety, maintenance, convenience, and appearance of the transportation network in order to give more people more choices.	This objective is connected to lower total cost of ownership benefits of electrified transit and expansion of clean mobility choices for residents, including for low-income populations.
Transportation & Transit *Objective 3:* Connect the City's transportation network to the region through partnerships.	This objective is connected to regional transit authorities and possible related funding opportunities for electric buses.
Transportation & Transit *Objective 4:* Establish Raleigh as the leader in transportation innovation.	This objective provides strategic direction to be ambitious about transportation electrification broadly, including fleets, transit, school buses, and private vehicles, given the strong regional presence of technology innovation companies and associated dynamic workforce.
Economic Development & Innovation *Objective 1:* Identify and enhance workforce development partnerships and efforts and actively serve as a conduit to residents, businesses, and resource partners to attract, retain, and engage a talented workforce of various ages, skill sets, and backgrounds to support a diverse and growing economy.	This objective highlights the intersection of transportation electrification with attracting and retaining businesses and employees; it reflects the desire for many skilled employees to have access to transportation electrification and have the city embrace innovative and climate-responsive technologies.

City of Raleigh's Strategic Plan Element	Connection to Transportation Electrification
Economic Development & Innovation *Objective 2:* Cultivate an innovative and entrepreneurial culture based on shared strategic goals.	This objective anticipates the opportunity for public-public and public-private partnerships to support electric vehicle infrastructure deployment, mobility partnerships with rideshare companies, public health research, and equity and access collaboration.
Economic Development & Innovation *Objective 4:* Maintain and develop amenities and infrastructure specifically attractive to economic development.	This objective provides the strategic rationale for investments and partnerships to support electric vehicle charging infrastructure deployment, especially in the downtown core.
Safe, Vibrant Healthy Communities Promote a clean, engaged community environment where people feel safe and enjoy access to community amenities that support a high quality of life.	This aspiration reinforces the connection to City of Raleigh's interest in promoting equity across programs, and to providing safe and healthy services including infrastructure.

In addition to supporting the City of Raleigh's Strategic Plan, transportation electrification helps advance the City's 2030 Comprehensive Plan. The 2030 Comprehensive Plan contains six themes that reinforce the City's vision and overall goals. Three of these themes connect with transportation electrification: Growth Management, Coordinating Land Use and Transportation, and Greenprint Raleigh – Sustainable Development. There are also specific elements of the 2030 Comprehensive Plan with connections to transportation electrification under Section C.1 Energy Security and Climate Change Preparedness. These are listed in the table below.

City of Raleigh's 2030 Comprehensive Plan Element
Policy EP 1.1: Greenhouse Gas Reduction. Promote best practices for reducing greenhouse gas emissions.
Policy EP 1.2: Vehicle Electrification. Promote the electrification of transportation, both public and private.
Policy EP 1.3: Total Cost of Ownership Analysis. Use Total Cost of Ownership (TCO), life-cycle analysis, and/or payback analysis on all energy saving proposals.
Policy EP 1.9: Sustainable Public Realm. Incorporate sustainable technology and materials into public realm projects.
Policy EP 1.12: Air Quality Improvements. Reduce the number of air quality days categorized as 'unhealthy' or 'hazardous,' based on the Air Quality Index readings provided by the North Carolina Department of Environment and Natural Resources, Division of Air Quality.
Policy EP 1.13: Evaluating Development Impacts on Air Quality. Evaluate potential air emissions from new and expanded development, including transportation improvements and municipal facilities, to ensure that measures are taken to mitigate any possible adverse impacts.
Action EP 1.12: Charging Stations. When viable, install charging stations for electric automobiles in public parking lots and garages.
Policy PU 6.1: Energy and Telecommunications Planning. Work with regional and private organizations to plan for adequate future energy and telecommunications facilities and service delivery.

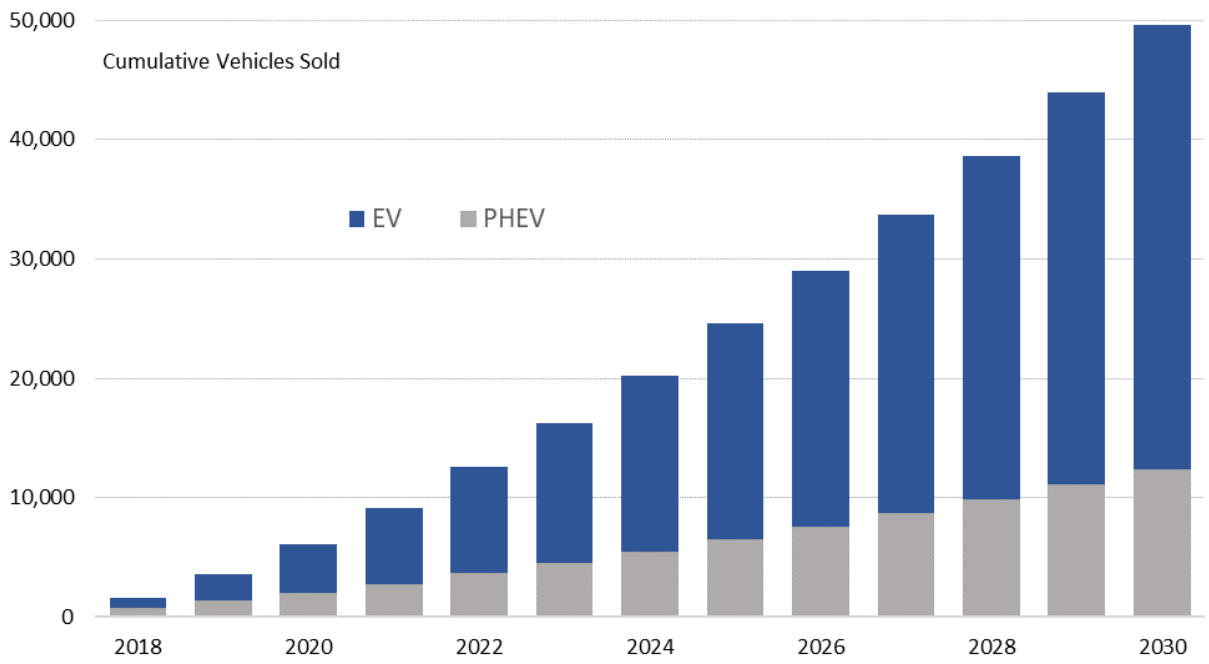
City of Raleigh's 2030 Comprehensive Plan Element
Policy PU 6.2: Alternative Energy Sources. Foster alternative energy sources within the region and state to mitigate rising energy costs and associated environmental impacts.
Policy PU 6.3: Visual Impacts of Utility Infrastructure. Consider ways to affect the placement and appearance of utility infrastructure—including substations, transmission towers and lines, and switching boxes—to minimize visual disruption and negative effects on quality of life, and to enhance streetscapes in pedestrian-oriented districts.
Action PU 6.3: Coordination with Utilities. Convene regular meetings with utility companies to compare growth projections and to discuss other long-range planning issues.



Context for Transportation Electrification

There are over 1.1 million electric vehicles (EVs) currently on U.S. roads. By 2025, 11% of new car sales and 5% of all vehicles on the road are expected to be EVs. By 2040, EVs are expected to grow to 55% of new car sales and comprise 33% of vehicles on the road nationwide. Over the next several decades, the Raleigh region's economic capacity and increasing population will continue to build interest in EV adoption. As illustrated in the table below, nearly 50,000 EVs powered entirely by an electric battery or Plug-in Hybrid Electric Vehicles (PHEVs) powered partially by an electric battery are expected on the road in Wake County by 2030 (based on cumulative vehicles sold over time); an increasing share of these vehicles over time will be battery-only EVs.[1]

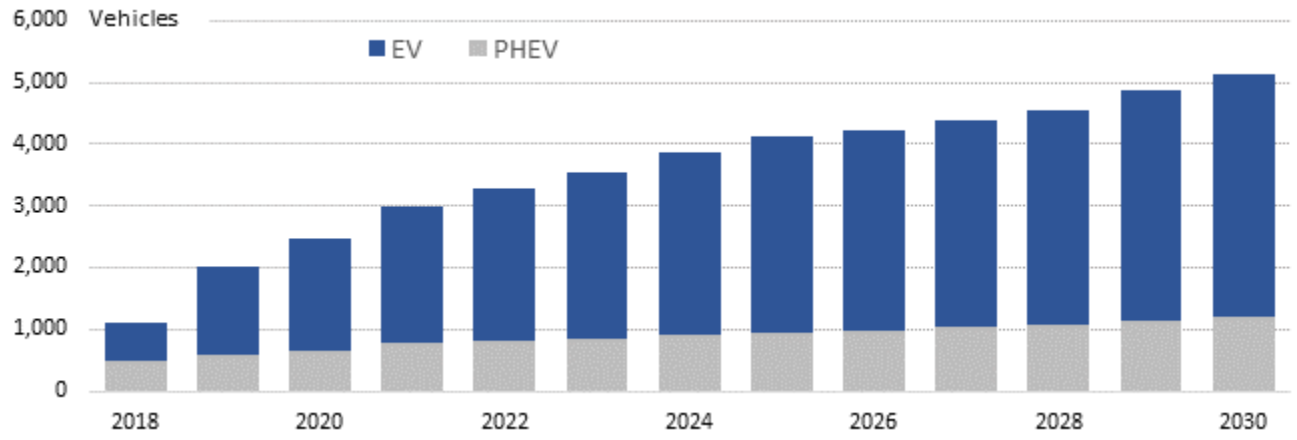
Wake County Projected EV Stock Based on Cumulative Vehicles Sold



Source: Electrification Coalition analysis based on data from the Energy Information Agency and U.S. Department of Energy.

[1] Electrification Coalition, "Raleigh Electric Vehicle Charging Infrastructure Demand Assessment," March 2019. Included as attachment to this study.

Wake County Projected New EV Sales (Annual)



Source: Electrification Coalition analysis based on data from the Energy Information Agency and U.S. Department of Energy.

Demographics

Raleigh's demographic profile suggests that there may be a strong current market for EVs among well-educated and higher income residents, but it also emphasizes the importance of market trends that are making EVs more affordable for residents of lower income. More than 1 million people now reside in Wake County, up from just below 270,000 in 1975. Although population growth has slowed in recent years, Wake County's population is expected to increase to approximately 1.5 million residents in 2035, a 36% increase from 2017 levels.[2] This growth is fueled, in part, by Raleigh's central location in North Carolina and status as an innovation hub. High-tech startups and businesses concentrate around reputable research and academic institutions to reduce geographic barriers and improve collaboration. Consequently, Raleigh's labor force has been transformed over the last several decades. Nearly 20% of the City's workforce is employed in highly skilled sectors, including science, education, and health services. According to the U.S. Census Bureau's *American Community Survey*, approximately half of Raleigh residents have earned at least a bachelor's degree.[3] The City and its constituent Durham-Chapel Hill metropolitan statistical area rank among the most well-educated regions in the country.

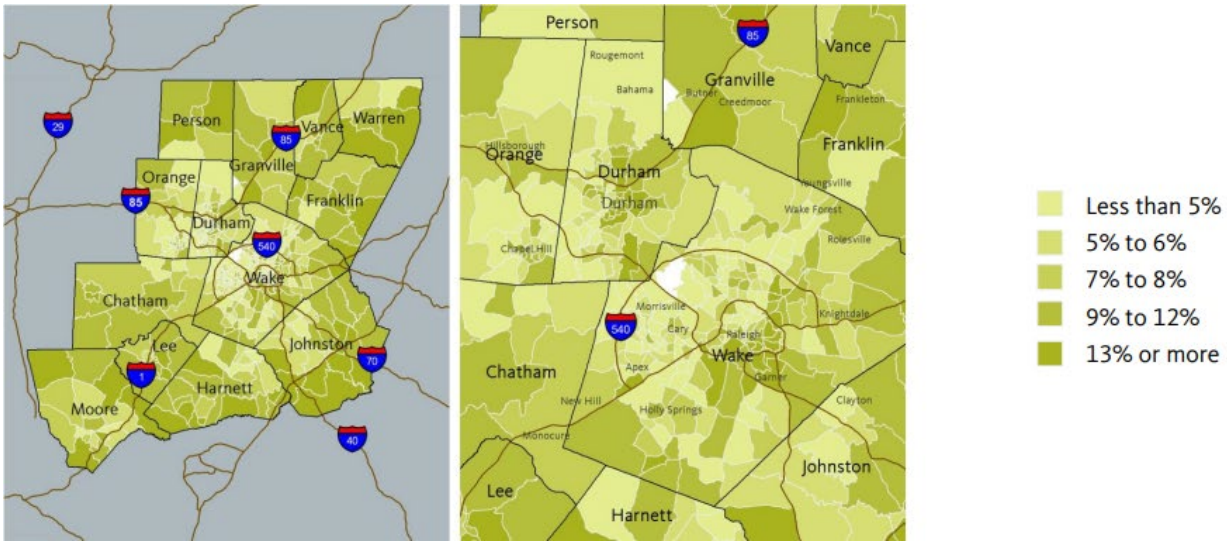
In Wake County, the concentration of skill and talent supports a median household income of $73,577, approximately 28% above the national average.[4] Compared to the state, Raleigh's unemployment rate is also low at 3.3% and has tracked below the U.S. national average for the past several years. Through 2026, North Carolina's Department of Commerce anticipates the state's labor market will add 389,000 new jobs.[5]

While the community should continue to support the growth and opportunities in the region, it is important to recognize that this isn't the reality for everyone and not everyone has the same access to resource. For example, while Raleigh and the region have high employment opportunities, not everyone has the same access to employment. As the graphic below illustrates, there are

[2] Analysis based on data from the U.S. Census Bureau and the North Carolina State Demographer; and State of North Carolina, Budget and Management Office, "County/State Population Projections."
[3] Electrification Coalition analysis based on data from the U.S. Census Bureau. Note that the proportion of Raleigh residents holding a bachelor's degree has risen roughly 4 percentage points over the seven years, from 46.6 percent to 50.8 percent. This proportion is approximately on par with educational attainment in Wake County.
[4] Department of City Planning, City of Raleigh, North Carolina, 2017 Data Book, September 2018; and Electrification Coalition analysis based on data from the U.S. Census Bureau American Community Survey 2017 for Wake County.
[5] North Carolina Department of Commerce, Press Release, North Carolina Employment Projections to 2026, October 10, 2018.

pockets of employment throughout Wake County as through other counties in the state.[6] Given these types of disparities, the city should approach its work on transportation electrification with an equity lens to address different needs of different people in the community.

Unemployment Rate by Census Tract, 2012



Source: Equitable Growth Profile of the Research Triangle Region

[6] See: PolicyLink and the Program for Environmental and Regional Equity (PERE), Equitable Growth Profile of the Research Triangle Region: https://www.policylink.org/sites/default/files/Triangle_J_Profile_Final_31March2015.pdf.

What Do We Know About the Changing Market of EV Drivers and Providing Access for All Raleigh Residents?

Much of the research on the characteristics of EV drivers comes from the trade press and is intended to inform manufacturers, dealers, and others about market trends. Clean Technica, for example, conducts an annual survey of EV drivers about their interests, needs, and concerns—as well as their demographics. Complementing industry-wide analysis are deeper market research studies into specific vehicle manufacturers, such as Tesla, which has traditionally aimed for higher income markets.

However, this market research offers only a snapshot in time in a fast-developing market. As more EV models become available, battery range increases, and costs come down, the demographics of EV owners are likely to change significantly. Over the next several decades, the region's population and economic growth will likely continue to drive increasing consumer demand for EVs, especially as the price of the standard lithium-ion battery pack declines and EVs become affordable to new segments of the consumer market. For reference, battery packs cost approximately $400 per kilowatt hour just five years ago. Today, those costs have declined to around $175 per kilowatt hour and continue to fall as automakers boost EV research and development spending.

While Raleigh's economic growth provides significant opportunity for the community, like all cities that are growing across the country, the City recognizes a need to ensure that all residents have access to resources and a high quality of life. Raleigh's overall demographic characteristics of higher incomes, education, and home ownership suggest a strong current demand for EVs, and as the city plans for the future development of electrification of transportation, there is opportunity to ensure that all residents have access to this growing market.

According to an Equitable Growth Profile study done on the Research Triangle Region of which Raleigh is the largest municipality, "While the Research Triangle is experiencing renewed growth, prosperity is not distributed evenly in the region. Many rural and inner-city areas suffer from a lack of car access and limited transportation choices…. Poverty is also highest in major cities and on the outer northeast edges of the region. And while rent burden (households spending 30 percent or more of income on rent) is persistent throughout the region, it is more prevalent in these same areas. Not coincidentally, communities of color are highly concentrated in these same outer fringes and inner boroughs."

The Equitable Growth Profile provides strategies for spurring more equitable growth in the region. These include, *Growing good jobs and creating pathways into them for workers facing barriers to employment*, and *Building communities of opportunity throughout the region*. As Raleigh's economy continues to develop, the growth of the EV market can provide opportunities for all residents. This Electrification of Transportation study, in particularly identified in the Equity & Access and the Equitable Economic Development sections, provide potential strategies and actions around providing economic opportunities and access in the emerging transportation electrification market.

Sources:

- Clean Technica 2017 survey results: https://www.carmax.com/articles/hybrid-electric-2017-survey-results
- Clean Technica EV surveys: https://cleantechnica.com/2019/05/12/ev-drivers-who-are-you-why-are-you-whats-next/
- Hedges & Company market research on Tesla demographics: https://hedgescompany.com/blog/2018/11/tesla-owner-demographics/
- Equitable Growth Profile of the Research Triangle Region: https://dornsife.usc.edu/assets/sites/242/docs/EquityProfile_ResearchTriangle_Summary.pdf

Built Environment

A large proportion of Raleigh's housing is single-family owner-occupied units.[7] Like most cities with a growing number of EVs, an increasing share of owners prefer to power up at home rather than rely on public charging. Areas where there are higher proportions of multi-unit dwellings and older construction homes may not support as large a share of home charging units because of constraints on whether shared parking in multi-unit dwellings can be used for dedicated EV charging or constraints on electrical infrastructure in older homes and buildings. Drivers may require more dedicated public charging access in these areas or increased private investment spurred by public policies.

Due to the Southern United States' high population growth rates, the U.S. Census Bureau's American Housing Survey shows a large proportion of the region's housing units are new construction (generally built after the year 2000). An analysis by the University of North Carolina's Carolina Population Center confirms that 2000 to 2010 was the peak decade for most home construction in Raleigh.[8] For at-home charging of EVs, this means that many of the city's suburban homes were built to comply with recent energy and building codes and have modern electrical systems that can easily support charger installation. The South leads the nation with over 38% owner-occupied homes, enabling many owners to install equipment without hinderance or delay.[9] The region's warmer climate means there are fewer garages or carports for vehicle chargers, which is neither helpful nor a hindrance to maintaining at-home EV charging equipment with standard weatherproofing.

As the City of Raleigh's population continues to grow, the number of single occupancy homes will also increase, encouraged by the metropolitan region's comparatively low population density. Therefore, in areas outside of Raleigh's downtown, the installation of public charging units will be necessary but not critical for the development of the overall market. In and around downtown Raleigh, meanwhile, a higher proportion of multi-unit family dwellings will require dedicated access to public charging infrastructure to support higher urban traffic flows and a denser concentration of resident populations.

Like many urban centers, Raleigh's downtown integrates residential and commercial properties into its urban core. As a result, the City has a vibrant nightlife, for example containing the highest concentration of live music venues and craft breweries in the state.[10] These attractions, as well as public places like schools and libraries that are highly trafficked, are key locations for charging infrastructure for residents with EVs to charge their vehicles while in the city.

As the City considers rezoning applications that will increase Raleigh's density, especially to the south and west of downtown, it will be increasingly important to evaluate public charging needs of a growing EV market (see related discussion in the "Charging Infrastructure" section of this study). On a population density basis, Raleigh has room to accommodate these demands. Compared to metropolitan communities of a similar size, Raleigh's density rivals that of Atlanta, which is about 20,000 residents larger by population and approximately 370 persons less dense per square mile.[11] Atlanta has already had a positive experience with EVs. In 2014, it propelled the State of Georgia to an EV market share of 1.9% of light-duty vehicle sales, which was the highest share of any state at the time. (This rate of EV adoption was largely due to a state tax credit that provided a financial purchase incentive for electric vehicle consumers).[12]

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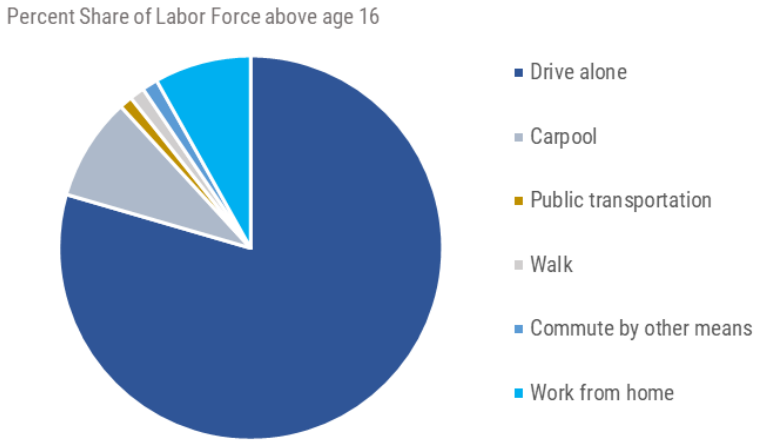
[7] Electrification Coalition, "Raleigh Electric Vehicle Charging Infrastructure Demand Assessment," March 2019. Included as attachment to this study.
[8] Rebecca Tippett, "Peak construction: When did NC housing stock grow the most?" UNC Carolina Population Center, February 24, 2014.
[9] Electrification Coalition analysis based on data from the U.S. Census Bureau 2017 National Housing Survey and Oak Ridge National Laboratory.
[10] VisitRaleigh.com, Facts About Raleigh, N.C., n.d. Many of these businesses are likely to attract EV enthusiasts and potential EV drivers. This was the Electrification Coalition's experience operating an accelerator community in Northern Colorado. See, e.g., Electrification Coalition, *Drive Electric Northern Colorado Case Study,* 2016.
[11] Electrification Coalition analysis based on data from the 2017 U.S. Census estimate.
[12] Keybridge LLC, "Impact of Eliminating the Zero-Emissions Vehicle Tax Credit on the Georgia State Economy," February 18, 2015.

Travel Patterns

Planning and density matter to charger utilization in terms of the built environment, but so do commuting patterns. Despite significant investments in GoRaleigh, the North Carolina State University Wolfline, and other public transportation options, Raleigh is predominantly a car-oriented city. According to surveys administered by the U.S. Census Bureau, the average Raleigh household owns 1.74 motor vehicles, which is nearly the same as the national average (1.8) but higher than transportation electrification leaders like Seattle, WA (1.39) and Columbus, OH (1.55), suggesting that **conversion of personal vehicles to electric is a particularly important strategy for reducing transportation-related emissions for Raleigh**, similar to areas around Los Angeles where some ring cities have an average of over two vehicles per household. Only 6% of households in Raleigh do not own a car compared to 8.7% nationally.[13] In 2017, these rates supported total vehicle registrations nearing 800,000 in the city, a rate that has grown around 2.8% annually on average since 2013.[14]

Statewide increases in population and car ownership help drive increases in vehicle miles traveled. North Carolina motorists drove 11.5 billion miles in 2017, an increase of about 3.6% annually between 2013 and 2017. Buses and transportation network companies can help alleviate some passenger trips, but nationally, it is light-duty vehicles that account for the largest share of vehicle miles traveled. According to the U.S. Census Bureau's 2017 American Community Survey, only 20% of Wake County residents walk, carpool, use public transportation, or commute by other means (see figure).[15] **The majority—eight in ten (80%) of the 420,000 people employed in Wake County's labor force—commute to work alone in a single occupancy vehicle**. This is higher than the national average of 76% and significantly higher than the New York metro area (around 50%), San Francisco (57%), and Boston, Washington, D.C., and Seattle (all around 66%) as well as Chicago (70%); the percent of commuters that drive to work in more compact cities like Boulder, Ann Arbor, and Iowa City also falls below the national average.[16] **For the majority of Raleigh commuters, converting to an electric vehicle is the primary means of shifting to a clean transportation option.**

Wake County Commuting Preferences 2017



Source: EC analysis based on data from the U.S. Census Bureau.

[13] Governing.com, *Vehicle Ownership in U.S. Cities,* 2016 based on data from the U.S. Census Bureau American Community Survey.
[14] Wake County Government, *Data Dashboard,* 2017 based on data from the North Carolina Department of Transportation.
[15] Electrification Coalition analysis based on data from the U.S. Census Bureau's American Community Survey 2017.
[16] Richard Florida, "The Great Divide in How Americans Commute to Work," CityLab, https://www.citylab.com/transportation/2019/01/commuting-to-work-data-car-public-transit-bike/580507/

As Raleigh has continued to grow, commute times have increased to 25 minutes on average. Alongside increases in population, urban density, and vehicle miles traveled, longer commute times may imply longer waits, greater travel distances, and/or higher traffic volumes. **Longer commute times spent traveling at lower speeds or idling increase transportation-related emissions for fossil fuel vehicles but not electric vehicles, which don't emit pollution when idling (or traveling at any speed).**

Why doesn't this study talk about other transportation options like electric bikes and scooters?

Providing a range of alternative transportation options is very important for increasing mobility and reducing environmental degradation. The City of Raleigh is already pursuing and focusing on reducing vehicle miles traveled through a range of bicycle, pedestrian, and other mobility strategies. Because Raleigh remains a highly car-dependent area and transportation electrification requires significant coordination and investment, this study focuses on getting people into cleaner vehicle options as one of many paths to a cleaner transportation future for Raleigh.

Public Charging Needs

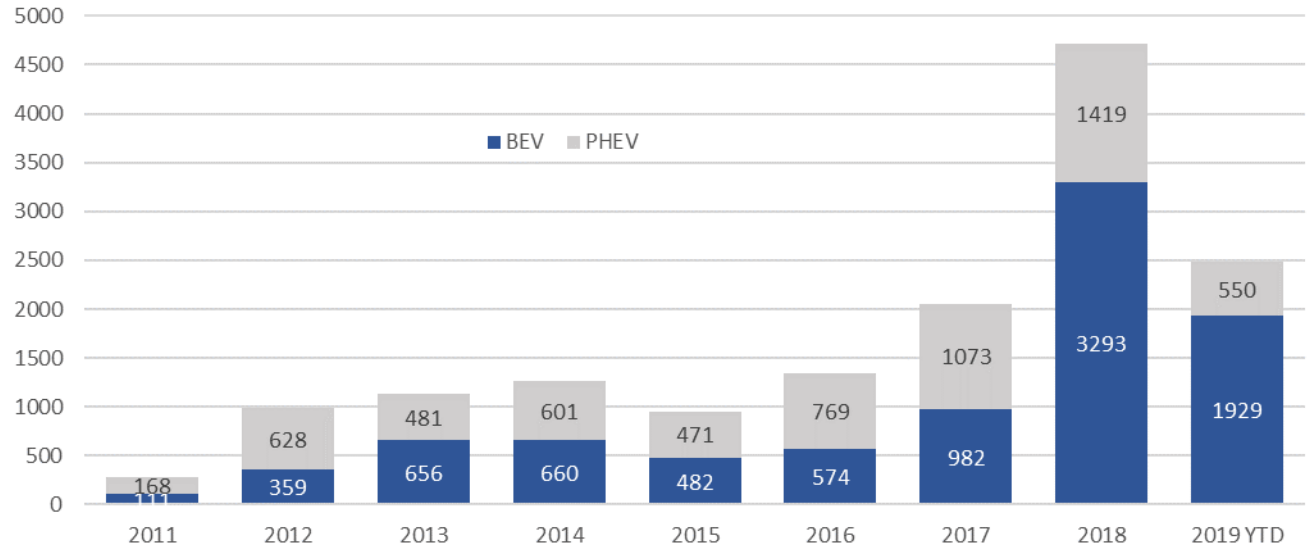
Many Level 2 charging stations are currently available to Raleigh EV drivers. Alternative Fuels Data Center (AFDC) has logged 60 public charging stations in Raleigh, more than three-quarters of which are at Levels 1 and 2 (see page 25 for information on types of chargers).[17] Nearly nine out of every ten chargers are accessible 24 hours per day. Raleigh's downtown zip code of 27601 hosts 10 publicly-accessible Level 2 charging stations, the city's highest concentration. This is followed by 9 stations within the city's southwestern 27606 zip code and 8 within its northwestern 27607 zip code.[18] Two zip codes (27613 and 27529) have no publicly-available Level 2 charging stations.[19] Statewide, AFDC says North Carolina has 560 public charging stations, of which Raleigh accounts for 11% of the total. Combined, the cities of Raleigh, Durham, Chapel Hill, and Cary represent over 25% of North Carolina's public EV charging infrastructure.

These stations serve the region's growing EV market. Since 2011, North Carolina's total EV stock has grown to nearly 10,400 vehicles, approximately 51% of which are battery electric vehicles (BEVs) that use only a battery for power as compared to a plug-in hybrid electric vehicle (PHEV) that can use a small internal combustion engine as well as a battery.[20] Wake County accounts for just over 1,600 (16%) of the state's EVs.

As further described in the "Charging Infrastructure" section, the Raleigh area will need additional charging to keep pace with the growing market for EVs. The City can support community members choosing EVs and reducing transportation-related emissions through investments, policies, and partnerships that expand access to charging.

[17] Electrification Coalition analysis based on data from AFDC.
[18] Electrification Coalition analysis based on data from AFDC and UnitedStatesZipCodes.org.
[19] Three additional zip codes (27614, 27608, 27605) have only one charger each. As the City undertakes the recommended actions in the section "Equity and Access" it should engage community groups to determine if there are unmet needs for charging in these areas with few or no publicly accessible chargers.
[20] Electrification Coalition analysis based on data from the Alliance of Auto Manufacturers' U.S. Light-Duty Advanced Technology Vehicle Sales Dashboard.

North Carolina EV Sales, 2011–19 (year to date)



Without a more favorable suite of state and municipal EV adoption incentives, it is unlikely that North Carolina's EV adoption rate will exceed the nation's as a proportion of new light duty vehicle sales. North Carolina's commitment at the state level to get 80,000 new electric vehicles on the road is a promising sign, but purchase incentives are not yet state policy. In 2018, EVs represented only 1% of North Carolina's new light-duty vehicle sales (+0.5% from 2017). Nationally, EVs are now above 2% of light-duty sales.[21]

Across the many characteristics described above, Raleigh and the broader Wake County area are ready for future EV adoption. The workforce's strong technology focus and an influx of new residents will bring many EV enthusiasts to Raleigh and fuel demand for new charging infrastructure. However, this concentration of enthusiasts is not enough for the market to develop on its own. Dedicated plans and supportive policy can complement important consumer education campaigns to help increase adoption beyond early adopters and enthusiasts and broaden equitable access to the benefits of transportation electrification.

The remainder of this study provides recommendations on how the City of Raleigh can accelerate the transition to electric vehicles and reap the benefits of transportation electrification. These recommendations are either identified as "actions" that city government can undertake now without additional city policy or "strategies" that would require new policy or plans to be developed. A handshake icon identifies which of these strategies and actions should be undertaken with external stakeholder collaboration through public-private partnerships or partnerships that may not include the City. For several recommendations, the study identifies near-term actions that the City can take to begin implementation.

[21] Electrification Coalition analysis based on data from the Alliance of Auto Manufacturers, IHS Markit Inc, and BEA.

City of Raleigh Municipal Fleet

Overview

Electrifying the City of Raleigh's municipal fleet is a publicly visible commitment to sustainability and climate goals that show the City is leading by example. Passenger electric vehicles (EVs) are usually more cost-effective when total costs of ownership over the life of the vehicle are considered because of lower costs for electricity versus gasoline and lower maintenance costs, which offset the higher initial cost of the vehicle and charging infrastructure. The favorable return on investment is optimized when vehicles are highly utilized and have predictable, return-to-base routes that allow charging at night.

Vehicles that have the highest return on investment for converting to an EV are those with high annual vehicle miles traveled, daily routes of less than 200 miles, return to a central parking facility, and the ability for uninterrupted overnight charging. A handful of characteristics associated with fleets make it easier for them to overcome barriers to adoption, as described below.

Total Cost of Ownership Approach	•Fleet managers rank total cost of ownership as the most significant factor in acquisition decisions
Route Predictability	•Predictability lowers infrastructure investment and concern about charging access
High Utilization Rates	• High mileage per vehicle increases return on investment and lowers average cost per mile
Use of Central Parking Facilities	•Central facilities lower infrastructure investment via economies of scale in installation
Importance of Maintenance Costs	•Lower maintenance costs of new technology lead to substantial cost savings
Lower Fuel Prices	•Electricity is less expensive to power a vehicle per mile than petroleum
Return on Investment	•In the right applications, EVs will generate a strong return on investment during their useful life
Sustainability Initiatives	•EVs contribute to sustainability initiatives around reduced GHG emissions and/or petroleum use

In the near-term, the City can pursue value and opportunity from electrification of high-utilization fleets of passenger cars. Some departments operate heavy duty vehicles or other specialized equipment for which an electric replacement either does not exist or is relatively new to the market (with associated cost margins and unproven technology). The City can begin replacing these types of vehicles with EVs when the use case aligns with the performance of EVs on the market.

1.1 STRATEGY: **Develop municipal fleet targets and timelines for replacing a majority of the light-duty municipal fleet with electric vehicles by a reasonable but aggressive date based on expected light-duty fleet turnover.**

Undertaking the near-term actions in this study can provide the experience and data over the next few years to set ambitious targets and timelines for overall fleet electrification. The rationale for converting the City of Raleigh's fleets to electric vehicles and committing to an ambitious target can be based on the direct financial benefits of EVs as well as benefits that are very real but more difficult to put in dollar terms, such as social benefits related to health and quality of life. The suite of benefits includes:

- Lower total cost of ownership driven by lower fuel and maintenance costs
- Less price volatility of electricity vs. gasoline meaning greater predictability of future costs
- Reduced greenhouse gas emissions in alignment with the City's climate goals
- Improved air quality, especially in low-income neighborhoods near traffic corridors
- Improved clean mobility opportunities (e.g., for clean transit)
- Jobs and economic development
- Responsiveness and customer service to residents choosing an EV

Examples of City Fleet Targets

Fleet electrification targets set by Mayors and City Councils provide a goal and authorizing environment for city departments to procure electric vehicles. For example, the City of Charlotte, North Carolina is striving for a 100% zero-carbon fleet by 2030. Other examples from around the country include:

- Asheville, NC: 25% of transit fleet to be electric by the end of 2019
- Austin, TX: 330 EVs by 2025
- Columbus, OH: 200 EVs in light duty fleet by 2020
- Los Angeles, CA and Seattle, WA: Electrify 100% of bus transit fleet
- New York City: 20% of fleet to be electric by 2025 and all-electric bus system by 2040

1.2 ACTION: **Based on existing telematics, begin replacing the City of Raleigh's light duty fleet with highway speed EVs when the use case aligns with the performance of EVs on the market.**

Near-Term Actions

- Replace five aging Motor Pool vehicles with EVs
- Add low-speed neighborhood electric vehicles (35 mph maximum) to Parking Services' fleet and equip them with license plate reading technology to support downtown parking management

A key near-term opportunity for the City is electrification of aging vehicles in the Motor Pool. These vehicles have many users, which will provide broad exposure to EVs. Telematics data confirms that these vehicles are highly utilized during the day. They return to central parking facilities at night, allowing for overnight charging. A second near-term opportunity is adding additional low-speed neighborhood electric vehicles (35mph maximum) to Parking Services' fleet and equipping them with license plate reading technology (light-dependent resistor sensors) to support downtown parking management.

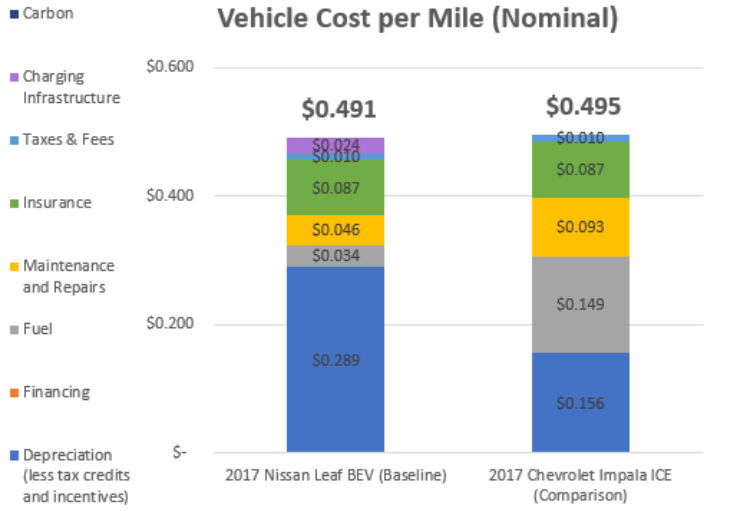
Tools for Comparing Electric Vehicles to Internal Combustion Vehicles

There are a variety of no-cost tools available for comparing EVs with equivalent internal combustion engine vehicles to support fleet replacement decisions. They include:

- Alternative Fuels Data Center Vehicle Cost Calculator: afdc.energy.gov/calc/
- fueleconomy.gov: www.fueleconomy.gov
- Atlas EV Hub Fleet Procurement Analysis Tool: www.atlasevhub.com/materials/fleet-procurement-analysis-tool/

These tools allow fleet owners and managers to customize cost and emissions comparisons between vehicles based on factors such as:

- Make, model, and year of vehicle
- Gas and electricity prices
- Vehicle miles traveled
- Procurement options (e.g., cash, loan, or lease)
- Charging technology and tax credits
- Tax incentives and other policies



Source: Atlas EV Hub Fleet Procurement Analysis Tool; uses $0.104 $/kWh and $2.89/gallon for comparison

1.3 ACTION: **Install required charging infrastructure to meet existing municipal fleet electrification needs and create an infrastructure strategy to support fleet electrification growth.**

Initial City fleet charging infrastructure investments should focus on planned near-term EV fleet conversions (see Action 1.2). As the longer-term goals for fleet EV conversion are developed, they should be accompanied by a fleet charging infrastructure strategy that reflects where electric fleet vehicles are likely to be parked and what charging infrastructure will best serve the various use cases of those vehicles to ensure that there is good location and technology fit between the vehicles and chargers. The strategy should describe what component of City government will own the equipment and who will cover the costs. Chargers should include Level 2 and Direct Current (DC) fast chargers as required for buses and other specific use cases (see the Charging Infrastructure section for a description of charging infrastructure options). All fleet chargers should operate on the same Open Charge Point Protocol (OCPP)-compliant network (see call-out box below for more detail on key protocols).

Hardware and Software Protocols for Interoperability

Interoperability allows digital devices and systems to communicate with each other to accomplish complex tasks together. This back-and-forth communication occurs nearly instantaneously and seamlessly in the background, allowing users to be productive without thinking about the enabling technology. Interoperability is one of the fundamental building blocks of our digital world. It is enabled by communication standards known as protocols, and two of these protocols are vital for transportation electrification.

Open Charge Point Protocol (OCPP) is an internationally recognized open application protocol that allows EV charging stations and central management systems from different vendors to communicate with each other. OCPP acts as the intermediary between the charging station and the back end or network management software. If charging stations are OCPP-compliant, they can easily connect to an OCPP-compliant back-end network.

Open Automated Demand Response enables a networked charging system to interact with a utility's systems for managing the electricity grid. This allows utilities, cities, and residents to partner on programs such as utility demand response, which times charging to correspond to lower times of electricity demand, reducing costs for EV owners and utility customers.

1.4 ACTION: **Develop and implement a strategic approach to municipal fleet telematics to make informed fleet conversion decisions.**

Near-Term Action

- Extend telematics data collection to the entire City fleet and make fleet vehicle data analysis available throughout City government to support departments' fleet vehicle replacement decisions

Understanding the use of vehicles is critical for understanding the potential value of converting to EVs, both in terms of the total cost of ownership and to ensure a good fit with drivers' needs. To support data-driven decisions about future fleet conversions, the City should work to invest in additional telematics and ensure that data analysis is available widely throughout the organization to support those making fleet decisions.

1.5 STRATEGY: **Develop a municipal fleet conversion strategy that builds on lessons from initial efforts to bring fleet conversion to scale.**

Based on fleet telematics data, assessment tools, and experience from initial fleet conversion, the City can establish a fleet conversion strategy that identifies the most viable opportunities for fleet conversion over the lifetime of the city's current fleet vehicles and maps onto the City's approach for assessing vehicle replacement cycles. Aligning EV conversion with the City's established replacement process means that it will likely be an incremental process rather than a department-by-department replacement of all fleet vehicles. The strategy can leverage a fleet assessment process (see call-out box below) that integrates an analysis of fleet rightsizing as well as internal budgeting and operational practices. Beyond the Motor Pool, other high-utilization City fleet vehicles that should be evaluated for near-term opportunities for EV replacement include high-utilization vehicles such as those used by Development Services and non-pursuit Police Department vehicles.

Near-Term Actions

- Integrate EV analysis into City's "right-sizing" effort
- Identify highest viability opportunities for fleet vehicle conversion
- Begin a scoping effort for a fleet vehicle conversion strategy and financing model

Fleet Assessment Process

The City is undertaking a process to assess fleet vehicles, which creates opportunities for assessing fleets for EV suitability and potentially creating new processes and mechanisms related to budgeting and capital expenditures. Through this process, the City could:

- Assess opportunities for right-sizing vehicle fleets, such as alternatives for under-utilized vehicles
- Develop EV procurement processes and standard procedures
- Identify approaches for internal funding of the transition to EVs
- Develop an approach for managing fuel-related fleet surcharges as vehicles transition to EVs

As part of this work, Raleigh could be a leading innovator in approaches for internal funding of the transition to EVs. The City could consider assessing a range of options for valuing the many benefits of EVs and reflecting that value in procurement decisions and processes. This might include:

- Adjusting internal vehicle use fees and accounting to monetize EV vehicle savings over time and incentivize EV use
- Right-sizing under-utilized fleets and investing savings in EVs
- An internal carbon tax on fleet vehicles

1.6 ACTION: **Explore vehicle lease-to-own programs that may de-risk technology investment and enable the City to capture the value of tax credits to reduce overall capital investment.**

Federal EV tax credits of $7,500 per vehicle have been vital for increasing broad market demand for passenger vehicles. These incentives are not available to city agencies. However, new business models have emerged for leasing vehicles or contracting for fleet services that help cities capture the value of the tax credit. The City of Raleigh can assess opportunities to utilize these types of opportunities as well as bulk purchasing opportunities that continue to emerge and other opportunities for reducing the up-front cost of EVs and thereby improving return on investment.

1.7 STRATEGY: **Develop an internal City strategy to require City staff to choose motor pool electric vehicles instead of gas cars whenever applicable.**

Near-Term Actions

- Cultivate City leadership and management support to direct city employees to use an EV from the motor pool and convert City fleet vehicles to EVs whenever possible
- Create EV default settings for motor pool reservations and require a justification to use non-EVs
- Look for opportunities for employees to access ride share vehicles for personal use

Procuring EVs and charging equipment is only part of the process of reducing the environmental impact of City fleets. The EVs also need to be used. In fact, EVs become more and more cost-effective compared to internal combustion vehicles the more they are used because much of the cost savings comes from the lower cost of fuel and maintenance, which are tied directly to the number of miles traveled. Once drivers try an EV, they are often hooked by its performance (which is the reason ride-and-drives are popular among dealers, manufacturers, and advocates).

A State Model for Prioritizing EV Procurement and Use

In October 2018, North Carolina Governor Roy Cooper signed Executive Order 80 which committed the State to address climate change and transition to a clean energy economy, including setting an example for public agencies to commit to electric vehicle fleets. Among other commitments in the Executive Order, Governor Cooper directed State cabinet agencies to "prioritize [zero emission vehicles (ZEVs)] in the purchase or lease of new vehicles and… use ZEVs for agency business travel when feasible." The North Carolina Department of Administration (ncadmin.nc.gov/) was also instructed to develop a plan "that identifies the types of trips for which a ZEV is feasible, recommends infrastructure necessary to support ZEV use, develops procurement options and strategies to increase the purchase and utilization of ZEVs, and addresses other key topics." The City of Raleigh can look to this type of example for its own internal strategy for EV procurement and use.

1.8 ACTION: **Conduct internal City education and training on EV driving and charging.**

Near-Term Action

- Develop an internal communications strategy to build EV literacy among city staff, including education on the City's strategy and actions, driving events for staff, and understanding of EV performance and benefits

To get over initial familiarity barriers and make sure EVs are used, the City can work on internal communications to raise awareness about the benefits of EVs and increase comfort with this new technology. Education and awareness campaigns can give staff an extra nudge to use EVs in the motor pool and help overcome real or perceived barriers about how and when to use these vehicles. EV driving and charging training could occur at new employee orientation, and other activities could be planned to expose the city personnel to opportunities to drive or ride in electric vehicles.

1.9 STRATEGY: **Recognizing the City's plans to convert 75% of its transit fleet to compressed natural gas from wastewater methane capture, develop a strategy to replace the remainder of the transit fleet with alternative fuels, including electric buses, on a reasonable but aggressive timeline based on expected fleet turnover and expansion.**

The City is in the process of converting 75% of the transit fleet to clean compressed natural gas from wastewater processing. The City plans to transition the remaining 25% of the transit fleet to other alternative fuels. This includes electric transit buses but is not limited to them. The conversion to an electric transit buses can be based on expected transit fleet turnover and expansion and anticipated uptake of compressed natural gas buses. The strategy can be based on direct benefits such as fuel and maintenance savings, Strategic Plan alignment, and indirect benefits such as carbon emissions reduction, increased resilience, and air quality improvements.

1.10 ACTION: **Leverage potential funding, such as Volkswagen Settlement Funds, future Federal Transit Administration bus electrification funds, and possible Duke Energy rebates to purchase an initial number of electric buses and charging infrastructure.**

Near-Term Action

- Create a plan for electrified transit bus adoption to prepare the city for emerging financial assistance through public and private programs

In 2018, the Federal Transit Administration announced $84.5 million in grants for low and zero-emission transit buses and infrastructure. In April 2019, Duke Energy proposed a $76 million electric transportation program in North Carolina that includes a proposal to install and operate more than 100 electric transit bus charging stations for transit agencies that procure electric buses (this proposal was not yet approved at the time this study was published). Through proactive planning, the City of Raleigh can position itself to be highly competitive for these types of funding incentives to achieve a zero-emission transit fleet.

1.11 ACTION: **Equip City departments with electric mowers and other equipment where noise is of concern. Explore partnership with North Carolina State University's Grounds Management to quantify the direct and indirect benefits to converting lawn mowing equipment to electric to support future Raleigh investment.**

Near-Term Action

- Begin converting maintenance equipment (such as lawn mowing and lawn care equipment) to electric and conduct cast study to understand benefits

Several City departments including Parks, Recreation & Cultural Resources, and Transportation use lawn maintenance and other types of equipment for maintaining City resources. Investments in electrified equipment can be used to test the technology and the public's response. The City can partner with local organizations like North Carolina State University to conduct a case study to quantify and monitor the financial benefits of converting to electric equipment. This includes lower fuel and equipment maintenance costs as well as community benefits such as reduced noise and air pollution.

1.12 ACTION: **Expand research and piloting of hybrid bucket trucks in the City's fleet.**

The City of Raleigh has begun researching opportunities for hybrid bucket trucks that can operate on-board equipment with electricity to reduce emissions and noise. The City can expand this research and pilot use of hybrid bucket trucks. The City can draw on lessons from others, such as the Orlando Utility Commission, which has put these trucks into service and can provide data about fuel savings, noise reduction, improved safety, and other benefits.

Municipal Fleet Electrification: Lead and Collaborating Departments

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
1.1 Strategy	Develop municipal fleet targets and timelines for replacing a majority of the light-duty municipal fleet with electric vehicles by a reasonable but aggressive date based on expected light-duty fleet turnover.	Engineering Services	Budget and Management Services Information Technology Executive team, multi-departmental
1.2 Action	Based on existing telematics, begin replacing the City of Raleigh's light duty fleet with highway speed EVs when the use case aligns with the performance of EVs on the market	Engineering Services	Budget & Management Services Finance Departments with fleet vehicles Information Technology
1.3 Action	Install required charging infrastructure to meet existing municipal fleet electrification needs and create an infrastructure strategy to support fleet electrification growth.	Engineering Services	Development Services Transportation PRCR
1.4 Action	Develop and implement a strategic approach to municipal fleet telematics to make informed fleet conversion decisions.	Engineering Services	Information Technology
1.5 Strategy	Develop a municipal fleet conversion strategy that builds on lessons from initial efforts to bring fleet conversion to scale.	Engineering Services	Budget & Management Services Sustainability Multi-departmental team
1.6 Action	Explore vehicle lease-to-own programs that may de-risk technology investment and enable the City to capture the value of tax credits to reduce overall capital investment.	Engineering Services	Budget & Management Services Finance
1.7 Strategy	Develop an internal City strategy to require City staff to choose motor pool electric vehicles instead of gas cars whenever applicable.	Human Resources	Health and Safety Group Sustainability Engineering Services
1.8 Action	Conduct internal City education and training on EV driving and charging.	TBD	TBD
1.9 Strategy	Recognizing the City's plans to convert 75% of its transit fleet to compressed natural gas from wastewater methane capture, develop a strategy to replace the remainder of the transit fleet with alternative fuels, including electric buses, on a reasonable but aggressive timeline based on expected fleet turnover and expansion.	Transportation	Engineering Services Sustainability

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
1.10 Action	Leverage potential funding, such as Volkswagen Settlement Funds, future Federal Transit Administration bus electrification funds, and possible Duke Energy rebates to purchase an initial number of electric buses and charging infrastructure.	Transportation	Engineering Services Sustainability Finance Budget & Management Services
1.11 Action	Equip City departments with electric mowers and other equipment where noise is of concern. Explore partnership with North Carolina State University's Grounds Management to quantify the direct and indirect benefits to converting lawn mowing equipment to electric to support future Raleigh investment.	Engineering Services	PRCR Transportation Public Utilities
1.12 Action	Expand research and piloting of hybrid bucket trucks in the City's fleet.	Engineering Services - Vehicle Fleet Services	All users of bucket trucks

Charging Infrastructure

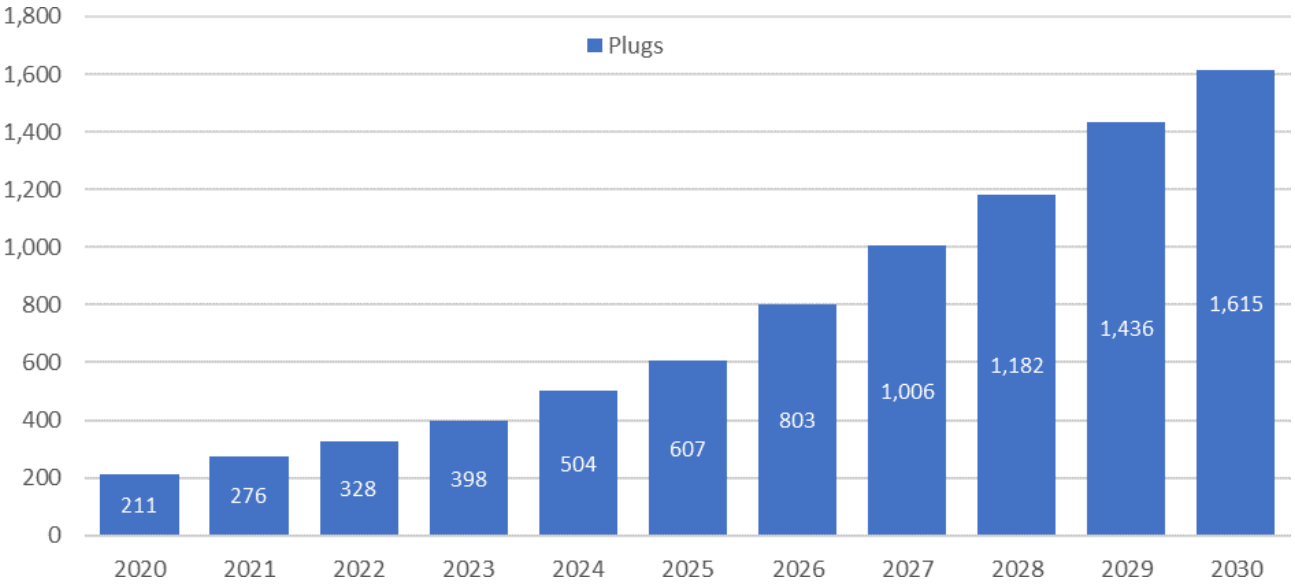
Overview

How and where to develop electric vehicle (EV) charging infrastructure are two central questions facing many cities as they consider the growing number of EVs owned by residents. This section describes strategies and actions that the city can undertake to expand public access to charging infrastructure through direct City investments to upgrade the current City-owned systems as well as requiring and encouraging building owners, businesses, and others to invest in charging. Because it is much more cost-effective to install conduit and electrical infrastructure for charging during new construction or large-scale remodels (rather than retro-fitting), the City can save itself and property owners substantial amounts of money by anticipating future needs for charging and then installing infrastructure when it is most economical. Public-private partnerships are a strong lever for the City to accelerate charging infrastructure development, driven by the economic benefits to employers and businesses of serving employees and customers interested in EVs and providing community-wide benefits of cleaner air and access to clean mobility.

There are different needs for DC fast charging and Level 2 chargers (see the call-out box on page 25 for information on these different types of chargers). The Raleigh area currently has fifteen DC fast charging stations, which exceeds infrastructure needs at least through 2020. However, Raleigh will eventually need thirty DC fast charging stations by 2030. The City of Raleigh and Wake County will need to be much more involved in growing the number of Level 2 nonresidential public plugs. Based on national estimates, Wake County cities will need approximately 1,600 Level 2 plugs in by 2030. Just over 200 Level 2 chargers will be needed in Wake County cities by 2020 to keep pace with the market, which is an increase of 77 plugs from today.[22]

[22] A valuable resource for tracking charging stations by location is the U.S. Department of Energy's Alternative Fuels Data Center, which maintains an up-to-date inventory and map of stations at https://afdc.energy.gov/fuels/electricity_stations.html

Wake County Cities: Level 2 Nonresidential Plugs Needed through 2030

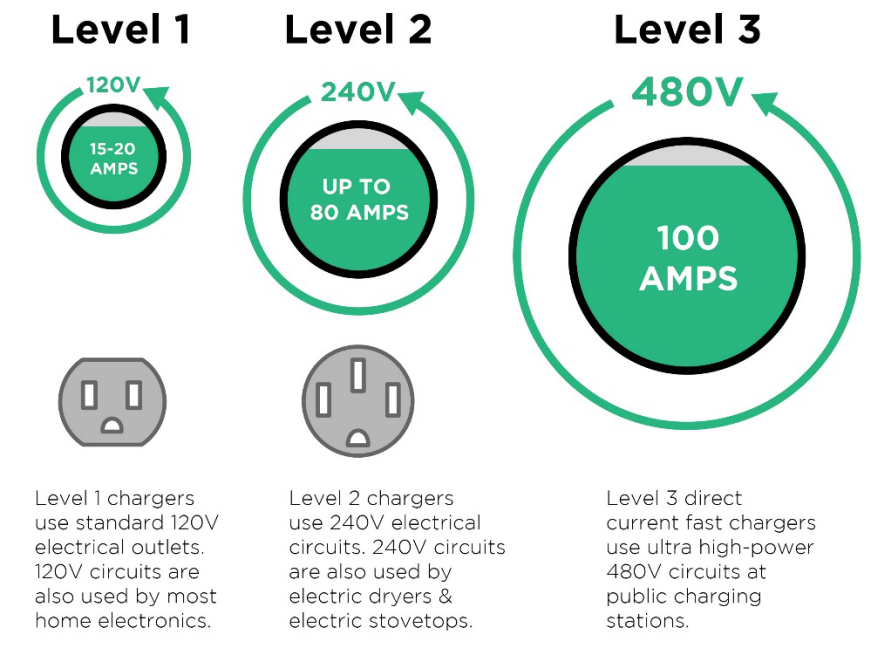


Source: Electrification Coalition Analysis based on data from the Energy Information Agency and U.S. Department of Energy

Types of EV Charging

There are three primary levels of EV charging:

- Level 1 Charger: 110 outlet, 15-amp circuit, non-networked. 10-20 hours to charge a vehicle.
- Level 2 Charger: 240/208-volt, 40-amp circuit, networked or non-network. 2-3 hours to charge.
- Level 3 DC Fast Charger: 240/208/440 volt, 3-phase, 100 amp+ circuit, networked, under 30 minutes to charge.



Source: BMW

Infrastructure costs vary according to charger type as indicated in the table below. They also vary by whether the installation is in a new building versus retrofitting an existing building. For existing buildings and facilities, site engineering such as laying conduit, adding electrical panels to accommodate load, and planning for parking spaces close to electrical access to prepare for charging infrastructure can often be a much more significant cost than charging equipment. According to a City of San Francisco case study, the cost of a Level 2 EV installation retrofit costs $3,500 compared against new construction, which costs less than $1,000.[23] In planning for EV charging infrastructure investments (primarily in existing construction), the City of Atlanta assumed a cost of $3,000 per charging station.[24] In the table below, the differences in the range of installation costs (right hand column) are largely due to differences in costs between new and existing buildings. Thinking ahead while doing new building construction can save substantial amounts of money.

Cost Ranges for Single Port Electric Vehicle Supply Equipment (EVSE)

Type of Charging	Unit Cost Range	Installation Cost Range
Level 1	$300 to $1,500	$0 to $3,000
Level 2	$400 to $6,500	$600 to $12,700
DC fast charging	$10,000 to $40,000	$4,000 to $51,000

Like all technologies, EV charging will evolve over time. The charging infrastructure industry is focused on increasing charging speed while improving the customer experience and minimizing electric utility grid impacts. Examples of impending hardware developments include technologies such as lightweight liquid cooled cables, wireless charging, low-cost energy storage, and charging robots. On the software side, the development of universal customer interface platforms, energy management, and artificial intelligence are underway and will impact the EV charging experience. That said, the Level 1-3 interfaces described above have remained stable over the last several years and are the basis for cities and others planning infrastructure investments.

The City of Raleigh owns and operates a total of 23 public EV charging stations. In 2018 these stations delivered 12,938 kWh at an average rate of 6 kWh per charge. Nearly 2,000 total charges have been logged.[25] In addition to City-owned chargers, much of the current EV infrastructure in Raleigh was developed by private network operators that lacked coordination and a shared vision of optimally placed charging infrastructure. This approach resulted in a market that requires EV drivers to have a variety of memberships, accounts, and RFID cards to access all publicly available chargers. As this was a pilot project, other cities benefited from City of Raleigh's experience as they began their own EV infrastructure projects.

Based on lessons learned and best practices from other municipalities, recommended strategies and actions for the City of Raleigh draw on the following key insights:

- **Breadth of Policy Approaches**: Policy approaches can include a combination of infrastructure incentives (home and public charging rebates or tax credits), permitting (e.g., streamlining permitting process for charging infrastructure), EV-friendly building codes and developer incentives, and pilot programs.
- **Encouraging Investment**: Infrastructure strategy should provide sustainable, multi-year consumer incentives and should be positioned as having multiple benefits (e.g., improved air quality, business development/revenue generation).

[23] See: http://www.swenergy.org/data/sites/1/media/documents/publications/documents/EV%20Building%20Code_cost%20effectiveness_1%20pager.pdf
[24] See: Electrification Coalition, Electric Vehicle Charging Infrastructure: The Atlanta Experience: https://www.electrificationcoalition.org/wp-content/uploads/2018/06/EV-Outreach-Brochure_Final.pdf
[25] Electrification Coalition analysis based on data from the City of Raleigh and Periscope, *Electric Vehicle Charging Station Viewlet*.

- **Multiple Players**: There are several potential partners in the EV infrastructure world, including Departments of Transportation, state energy offices, Metropolitan Planning Organizations, local governments, and utilities. These organizations should ideally share information and seek to align efforts as they develop EV infrastructure strategies.
- **Cost Savings Opportunities**: Requiring that new buildings and parking lots are designed and built with the proper EV infrastructure can save money in the future as it is more expensive to retrofit property for charging stations as opposed to including it in the construction process.

The City's approach could envision advancing infrastructure through:

- Direct City investment, including upgrades to the current City-owned system of chargers.
- Requirements and incentives for developers of new buildings to make them ready for future investments in charging (i.e., EV-ready).
- Public-private partnerships with Raleigh-area businesses who derive economic benefits from workplace and customer charging and with EV-infrastructure providers, utilities, and/or others that are in the business of selling electricity and EV-related services. These partnerships are a strong lever for the City to increase public access to charging through private investment.

Any publicly available EV charger should have a dedicated parking space where internal combustion vehicles are not allowed to park. Otherwise, EV drivers will not be able to charge and confidence in reliable availability of charging will be significantly diminished along with the investment in the charger. Dedicated EV charging spaces should have good signage and be painted as "EV Charging Only." Parking enforcement should ticket internal combustion vehicles parked illegally at EV chargers, including being responsive to EV driver complaints. Signage and enforcement should be complemented by a public education campaign emphasizing the availability of EV parking and the consequences of parking illegally in charging spots.

2.1 STRATEGY: **Advance EV-readiness in new and existing private commercial and multi-family buildings by:**

- 2.1A**: Exploring incentives and education to encourage developers of all new commercial and multi-family parking lots or structures to dedicate a certain percentage of spaces as EV-ready and that all new development of residential homes be equipped with the infrastructure needed to install EV charging stations, such as conduit, wiring, and electrical capacity.**
- 2.1B**: Streamlining and simplifying the permitting process for commercial property owners who wish to install charging infrastructure on existing commercial or multi-family properties.**

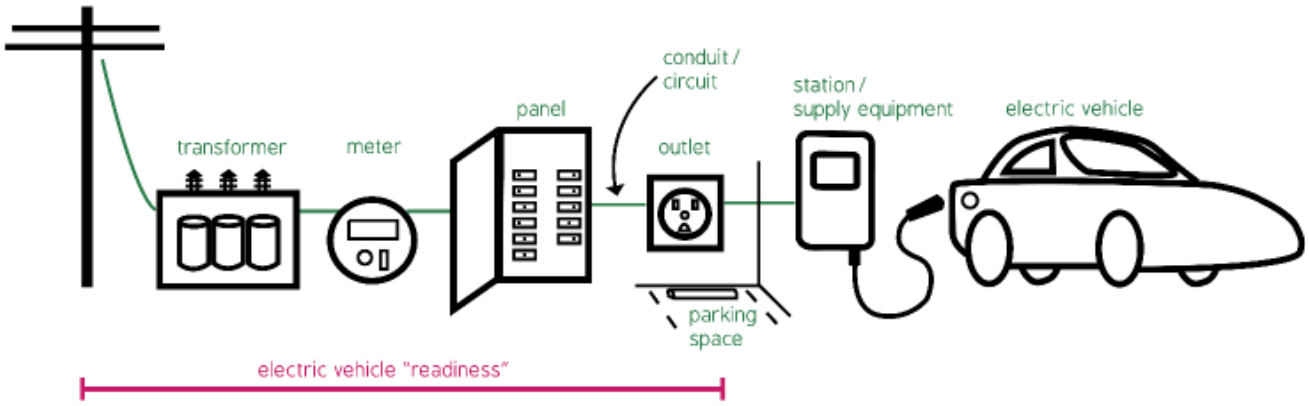
EV-ready ordinances require that new development with off-street parking provide the infrastructure that makes it relatively easy to install charging equipment in the future. During construction, these investments are comparatively low cost, and they avoid the sometimes-costly need to retrofit parking garages and areas in the future to accommodate parking. Once facilities are EV-ready, costs of installing charging are limited to the relatively modest cost of the charger itself, as summarized in the table "Cost Ranges for Single Port Electric Vehicle Supply Equipment" on page 26.

The city should engage in stakeholder outreach as part of the process of developing its approach and educate developers on the cost of EV-readiness and infrastructure in new and retrofitted facilities. The most effective strategy would be to require EV readiness in at least 20% of new parking spaces. Examples of cities that have EV readiness ordinances are described below.

In **Atlanta**, new facilities are required to be equipped with conduit and wiring needed to install EV charging stations. Twenty percent of spaces in all new commercial and multi-family parking structures must be EV-ready.[26] All new development of residential homes must also have the infrastructure needed to install EV charging stations.

In **Seattle**, the Department of Construction and Inspection, collaborating with the Office of Sustainability and Environment, amended its land use code to require all new development in the city with off-street parking to include the wiring and electrical power outlets for EV charging.[27] The number of EV-ready parking spaces required depends on the size and type of land use for the property.

EV Readiness



Source: City of Seattle

2.2 ACTION: **Lead by example by making all new and upgraded City buildings EV-ready. Require that all new City buildings and large renovations of existing buildings equip 20% of parking spaces with the infrastructure needed to install EV charging stations.**

Near-Term Action

- Adopt new building standards for all city-owned new construction and large renovations to ensure adequate conduit, panel boxes and circuits are installed to support 20% of parking spaces as EV charging stations

Based on conversations with City personnel, near-term opportunities for making sure new City investments are EV ready are the new civic campus and park-and-ride facilities.

[26] The text of Atlanta's EV-readiness ordinance (Ordinance 17-O-1654) can be found at this link: http://atlantacityga.iqm2.com/Citizens/Detail_LegiFile.aspx?MeetingID=2068&ID=13626&Print=Yes
[27] Information about Seattle's EV-readiness policy can be found at this link: https://www.seattle.gov/sdci/codes/changes-to-code/electric-vehicle-readiness

2.3 ACTION: **Ensure all City EV charging hardware and software investments are interoperable and support the functions needed to effectively manage a network of chargers and provide information for future data-driven decisions about electrification of vehicles and equipment.**

Near-Term Actions

- Determine required and preferred software and hardware specifications and key questions for vendors
- Identify an appropriate platform for networked EV charging data

Networked chargers supported by standards for interoperability allow communication between charging stations, a central network system, and utilities' information technology infrastructure. An advanced EV charging network with interoperable hardware and software allows operators to obtain real-time information on the performance of their EV charging stations, manage charging status, enable dynamic pricing tools, process payments, instantly detect faults, and issue tickets for servicing. The network management software takes the information from the charging station and communicates it to the back-office server at a utility, municipality or other administrator. On the consumer side, this allows for services such as billing, access control, authentication and payment. For the site host, it allows the host to set pricing and usage policies as well as use data to understand the behaviors and preferences of charging customers.

Developing standard criteria for charging equipment and software is an important step toward a networked and interoperable system. By utilizing shared industry-standard protocols for software and hardware, the City can connect a central management system with any charging station regardless of the vendor and integrate the system with mobile apps for users. In developing procurement approaches for hardware and software, including Requests for Proposals, the City can apply specifications and considerations such as those below. These specifications are based on current best practices. Technology changes over time, but these specifications provide a structure for engaging vendors on key topics, including any advances in technology compared to the current snapshot below.

Charging Network Management Software:

- **Cost and fee structure**---Charger network management software varies in price and functionality. It is important to know what the City wants before it shops. This is a rapidly evolving space with advancements occurring continually. Some network operators include the cost of their management into the price of the charger while others charge an annual fee. Annual fees typically range from $100-$250 per charger plug. A higher fee does not necessarily mean better quality, although it may mean greater functionality. If the City understands what it wants the chargers' software to provide (e.g., payment transaction, sustainability-related data, access control, etc.) it will find the right tool for the job. Choosing one charging network management software for all applications will make it easier to manage the charger network over time.
- **Open Charge Point Protocol-compliant** – The Open Charge Point Protocol (OCPP) is an open source application protocol for communication between electric vehicle charging stations and a central management system, also known as a charging station network. Most EV network management software is OCPP-compliant. By investing in this type of open source network management software, a city like Raleigh can operate the network with any hardware; if hardware is changed or upgraded, the City can keep its network. Conversely, OCPP-compliant means that network managers that like their hardware but not their software can switch to another OCPP-compliant network management provider who can operate the existing hardware.
- **Dashboard and data reporting that meets City needs**—This is an important function of network management software. As the City evaluates network management software companies, it should make sure the companies provide a demonstration of the dashboard showing data the City will be viewing, accessing, and exporting; this will make sure that the software system provides the information the City needs in an intuitive and manageable format.

- **Compatibility with existing City information technology and systems**—If the City wants an EV charger network that integrates with its buildings, Smart Cities or other software management systems, the City should be sure to make this a requirement in an RFP. It is important to note, however, that this requirement may limit the amount of available charging network management software platforms to choose from. If the City thinks it wants compatibility, it should first make sure there are enough companies in the market that can deliver with proven success.
- **Privacy and security, including a commitment and process for upgrades over time**—It goes without saying that network privacy and security are critically important. For this reason, it is recommended that the City's Information Technology Department lead the procurement process to ensure the platform selected meets the City's privacy and safety standards.
- **Demonstrated customer service excellence**—Like any technology, customer service for charging network management systems varies. The charger network management software company is the customer service front line for both the City and EV drivers. The phone number to their call center will be on the station to troubleshoot problems with drivers. However, if the provider delivers poor customer service, it will likely be the City that gets the frustrated call from a dissatisfied driver. Hence, it is important during the bidding process to require companies to demonstrate their customer service record and prove their ability to manage that service citywide.
- **Enabled processes for payment transactions**—If Raleigh chooses to charge for EV charging, it is important from an equity and access standpoint to consider what types of payment options the City wants provided (e.g., mobile app, credit card, etc.) and to select a platform that can provide those options. Additionally, the City may want to set different rates for residents, City employees, downtown workforce, etc.

Charging Hardware:

- **Price, Durability, and Functionality**—When it comes to charging hardware, you get what you pay for. The primary drivers of how much you pay for the physical charging hardware include durability, cord management options, display screen size and functionality, and power output. Whether considering DC fast chargers or Level-2 chargers, understanding the pros and cons of the various features is important. The City should pay attention to the basics such as:
    - What is the warranty period, what does it cover and what warranty extensions are offered?
    - Are the plugs, plastics and screen all UV resistant?
    - How is the cord kept off the ground?
    - If there is a screen, can it be seen in direct sunlight?
    - Are replacement parts readily available?
    - Are station function indicators and payment mechanisms easy to understand?
    - What are the chargers' uptime statistics?
    - How is ease of maintenance ensured?
- **J1772 standard for Level 2 Chargers and CHAdeMO/CCS Combo for DC fast chargers**—These are the industry standards. All EVs can use the universal J1772 Level-2 plug (including a Tesla with an adapter). There are two DC fast charger standards; CHAdeMo is the Asian standard (which a Tesla can use with an adapter) and CCS Combo is the SAE American and European standard. Most DC fast chargers come with both cords, providing all EVs with fast-charge capability to use the charger.
- **Underwriters Laboratories (UL) listed**—As with all electronics, the City should make sure the solution it purchases is UL listed.
- **Supports a variety of types of access controls**—As described above for software, the hardware should provide a variety of types of access (e.g., mobile app, credit card, etc.) to accommodate equity and access considerations. The City wants a hardware solution that provides the access controls the City determines are important.

- **Cord management**—There are many cord management strategies to keep cords off the ground and out of people's way. None are perfect and each has its flaws. Cord wraps require the user to wrap the cord over a hook or unit, which sometimes means users leave cords on the ground where they can get dirty or become a tripping hazard. (On the positive side there are no moving parts, so cord wrap systems are durable.) The other primary cord management system is a retractor system. This keeps the cord off the ground and out of users' hands. However, the retraction cord (which is often at head height) can become a "clothesline" hazard for people nearby and creates moving parts that decrease durability.
- **Power-share enabled**—Some hardware solutions allow for power sharing. If chargers are retrofitted in a location with limited power supply, power sharing technology enables those chargers to share the available power. For example, if a site's power supply will support four Level 2 chargers but the City has determined there is a need for eight chargers, chargers can be configured so that if four EVs are plugged in they draw power at full capacity. As additional EVs plug in, power is shared until up to eight are plugged in with each receiving power at half-capacity. This can be an effective fleet charging strategy when power supply is limited, or upgrade costs are prohibitive.
- **Maintenance**—The charger hardware components most susceptible to wear or failure are the plug handles, cord management retractors (if present), and LCD screens (if present). WIFI communications equipment inside networked chargers is prone to losing signal, especially in areas were a signal is weak (such as underground parking decks) and often requires a reset at the charger. Choosing hardware with a proven track record of durability, a 3-5-year extended parts warranty option, and readily available replacement parts is recommended.
- **Ability to brand or co-brand with the City**—Some chargers offer custom branding so the charger will look like City of Raleigh equipment, which can help broadcast the City's commitment to electric transportation. If this is desired, the City should be sure to select a hardware solution that offers this.
- **Ability to co-locate Smart City sensing or 5G technology with chargers**—If the City wants to integrate Smart Cities sensing or co-locate chargers with 5G technology installations or upgraded parking meters, the charger's size, shape and mounting patterns may become important to consider. Raleigh's Information Technology Department, Smart Cities, and Geographic Information System (GIS) initiatives will need to determine the desirability and viability of collocated technologies.

2.4 ACTION: **Based on an evaluation of current and likely future use, replace existing City-owned Level-2 public charging stations with Open Charge Point Protocol (OCPP)-compliant networked Level-2 chargers operated on a single best-in-class EV charging network management software platform and add new Level-2 chargers in locations of currently recognized need (see System Requirements for Charging Hardware and Software above).**

The City should replace its existing City-owned Level 2 charging stations with networked Level 2 chargers in locations that have demonstrated growing user demand over time as evidenced by the number and duration of uses. The City should also add chargers in new areas where City departments have identified clear potential demand (e.g., the Wilmington Street Station Parking Garage). Finally, the City should consider adding additional plugs by replacing single cord chargers with dual cord chargers, which can be cost effective when there is additional room in the existing panel box and conduit.

Near-Term Actions

- Based on an evaluation of current and likely future use, replace current Level 2 chargers with dual-cord networked options
- Install new EV chargers at the Wilmington Street Station Parking Garage near the Marbles Kids Museum and/or other high-traffic locations downtown

Networked chargers would enable the City to begin gathering use and performance data to inform future decisions about City-owned public charging investments and explore how EV charging stations can feed data into the City's other data systems (e.g., on building energy use, traffic, Smart City sensing, etc.). These investments will also allow future consideration for charging rates to generate revenue.

Key charging information to track through a networked system includes:

- Number of uses
- Number of unique users
- Duration of charge events
- Time of day used
- Amount of kWh dispensed
- How power demand relates to load or peak demand issues on the grid
- Greenhouse gas emissions reduction benefits
- Station operation (e.g., up-time and maintenance issues)

This data should be shared internally to support decision-making and investments as well as with the public to provide accountability and information about utilization of City investments. Among other uses, the data from these chargers can assist decision makers with:

- Determining areas with highest future unmet charging demand
- Determining where charger performance is an issue, for example, malfunctions caused by poor WIFI connectivity or hardware failures, or where internal combustion vehicle drivers are blocking access[28]
- Correlating use data with economic impact to determine characteristics of best-performing sites

[28] Additional ways that cities can get information on internal combustion vehicles blocking parking spaces dedicated to EV charging include customer complaints and parking enforcement.

Should Cities Charge to Charge?

Recent State legislation in North Carolina allows the City of Raleigh to charge drivers for electricity at publicly available charging stations (under previous law, it was illegal for anyone other than a utility to resell electricity except in a few cases). While allowing the public to charge for free at city-owned charging facilities in the past may have helped encourage adoption of electric vehicles, it also has important considerations:

- If the City continues to offer free charging, this would compete with the private market and discourage private investment in public charging.
- With the shift to electrification of transportation, all residents can benefit from clean air, increased mobility, etc., but EV drivers also benefit from access to and the convenience of charging. Considerations should include who pays for EV-related infrastructure and who benefits.
- There could be unintended consequences from free charging related to parking, such as EV drivers utilizing parking spaces beyond the time needed for charging. Charging for use can help regulate EV driver habits and therefore EV station availability.

The City can choose how much to charge, and it should consider the pros and cons of various options. For example, the City could charge fees that cover the infrastructure investment and maintenance to fully recover the city's costs (in addition to parking rates). Alternatively, the city could charge an amount equivalent to what residents would pay at home as a cost-equivalent alternative that recognizes not all residents have access to home charging. The City could also choose to charge market rates for vehicle charging, for example using a benchmark such as rates from Duke Energy's EV Pilot Project.

If Raleigh chooses to charge for EV charging, it should ensure that payment options are accessible and equitable by providing a variety of ways to pay (e.g., mobile app, credit card, etc.).

2.5 ACTION: **Encourage EV adoption and clean mobility through EV charging at City-owned park-and-ride facilities where feasible and integrate with zero-emission shuttles from park-and-ride lots to downtown.**

Near-Term Actions

- Install EV charging at 20% of parking spaces in new and renovated park-and-ride lots
- Explore opportunities for making park-and-ride lots resiliency hubs through solar and battery storage for EV charging that can support emergency operations
- Make use of an EV shuttle to transport people from park-and-ride lots to downtown

Expanding the City's park-and-ride facilities connected to transit and shuttles is a key strategy for reducing downtown congestion and pressure on downtown parking decks, which can improve the quality of life in the city center and provide residents with quick and convenient commutes. Equipping new and renovated park-and-ride lots with EV parking spaces and chargers encourages residents to switch to zero-emission travel without adding to congestion and parking concerns downtown. Adding zero-emission shuttles to downtown can make entire commutes emission free.

This strategy of EV charging at park-and-ride lots combined with zero emission shuttles has a set of multiple benefits:

- The equivalent of electrified workplace charging for commuters, including for City of Raleigh employees
- Charging for EV visitors
- Increased transit and shuttle ridership

- Reduced congestion
- Potential City fleet remote charging at park-and-ride facilities, including at night when facilities are less utilized
- For City employees parking remotely, increased utilization of EV motor pool (lowering Total Cost of Ownership compared to a similarly utilized internal combustion vehicle)

Parking and Park-and-Ride Lots

Raleigh is predominantly a car-oriented city. Only 6% of households do not own a car. Most of the labor force in Wake County commute in single occupancy vehicles.

There are multiple overlapping interests related to vehicle mobility in both the downtown core and connecting corridors. Downtown Raleigh businesses are interested in maintaining parking in the downtown core, including on-street parking and parking decks. City of Raleigh is responsible for on-street parking and curbside management, which includes bike lanes and bike racks, parking meters, and to some extent electric vehicle charging stations. Parking decks in the downtown core are usually full during weekdays, and the City has no plans to develop additional parking decks currently. As the parking capacity fills up downtown, park-and-ride facilities can provide convenience and improved access to downtown. EV chargers at park-and-rides are an amenity that can attract EV drivers to these facilities and can encourage additional drivers to adopt EVs. Parking rules will need to allow vehicles to remain parked all day in park-and-ride spaces equipped with chargers where Level 1 chargers would give drivers a partial charge in a normal workday and Level 2 chargers would give them a full charge.

2.6 STRATEGY: **To position Raleigh to be aligned with the growing EV market, create an EV-ready strategy that identifies locations for future charging stations. As funds become available to support additional City-owned stations, this strategy will enable the capturing and execution of funds.**

Near-Term Action

- Proactively identify good site locations for EV charging through GIS data layer analysis on key spatial data on transportation, land use, and technology

Locating EV charging stations requires balancing multiple considerations including community demographics and population density, housing stock composition, and travel corridors. A large proportion of Raleigh housing is single-family owner-occupied. Given growth rates, much of the housing is relatively new (especially in suburbs) and can accommodate home charging. Therefore, public charging outside of downtown Raleigh is necessary but not critical to the overall EV market. In and around downtown Raleigh, however, there is a greater need for public charging. Downtown has a higher proportion of multi-unit family dwellings, with greater density and less likelihood to have on-site charging. Downtown also has a vibrant nightlife and many public institutions and amenities that attract drivers, including those with EVs.

Level 2 public charging should be located near highly trafficked destination points, such as schools, libraries, healthcare, and multi-family buildings. Fast charging should be focused in high-traffic corridors. Other characteristics of good locations include safe, well-lit, easy walking distance to amenities and destinations (e.g., retail, restaurants, entertainment, etc.), and ample parking. The City can use GIS assets and capabilities in this planning, drawing on spatial data related to:

- Multi-unit dwelling zoning and permits
- Smart City sensing needs
- 5G data tower placements
- City-owned public parking
- Privately-owned public parking

- Future Raleigh building locations and density priorities
- City daily egress and ingress transportation routes and density
- Department of Transportation road widening and improvement plans (allowing EV chargers to be installed as part of these projects)
- Future park-and-ride lots
- City parks and community centers
- Neighborhoods dependent on on-street parking
- Zip-code level EV ownership density
- Demographics cross-referenced with likely adopter data
- Commercial districts

Spatial analysis should also incorporate equity-related measures such as income, vehicle ownership, and air quality. It is important to note, however, that installing EV chargers in low-income neighborhoods or neighborhoods of color may not be the most effective way to provide equitable benefits from transportation electrification. See the section of this study on "Equity and Access."

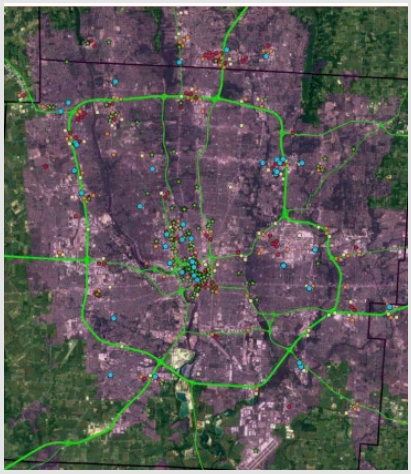
Although different cities will weigh various considerations differently, one example comes from Portland, Oregon where the city's Electric Vehicle Strategy has a strong emphasis on equity. [29] The city based its plan on prioritizing charging infrastructure in areas of the city that have:

- Fewer existing public charging stations
- Limited access to frequent transit and bike routes
- Higher proportions of multifamily housing and garage-free homes
- Large businesses with employees commuting long distances
- Residents with higher average vehicle miles traveled
- Destinations (recreation sites, event venues, etc.) people tend to travel longer distances to access

[29] City of Portland, *Electric Vehicle Strategy*: https://www.portlandoregon.gov/bps/article/619275

Spatial Analysis of Charging Locations in the City of Columbus, OH

As part of a needs assessment produced by the National Renewable Energy Laboratory for the Smart Cities Initiative in Columbus, Ohio, large concentrations of Level 2 charging units were found to be needed around multi-family dwellings and other residential units and a smaller number of DC fast-chargers along highly-trafficked corridors. As part of this study, a spatial simulation using INRIX data identified up to 300 public Level 2 "hot spots," each within a 800-foot distance from a geotagged location.



Results of the analysis generally coincided with the locations of existing or planned public Level 2 chargers, which the report says, "confirms local intuition on the placement of chargers." The City of Raleigh can use its GIS resources to inform spatial analysis—and leverage the "local intuition" that high-value areas are near highly trafficked destinations and multi-family buildings.

Source: Eric Wood, Clement Rames, Matteo Muratori, Sesha Raghavan, and Stanley Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," National Renewable Energy Laboratory, February 2018.

2.7 ACTION: **Maximize opportunities to integrate EV charging with Smart Cities technologies and services.**

Near-Term Action

- Assess technology compatibility and co-location opportunities (via GIS) for charging and Smart City technology, including sensing, cell towers, and camera placement

The City is implementing and exploring several Smart City solutions to use information collection and analysis to better provide services and manage transportation challenges. The City can maximize opportunities to integrate Smart City hardware with EV charging, for example co-locating cameras and sensors with charging infrastructure. The City can also ensure that EV charging data can be integrated with Smart City software and analysis.

City staff working on Smart Cities, GIS, and infrastructure for new communications technologies like 5G should be involved in planning new charging infrastructure to identify technical and economic opportunities from co-locating technologies. Each technology has specific location criteria that can be analyzed, for example using GIS to generate overlays and identify where co-location is most beneficial.

2.8 ACTION: **Build strategic partnerships with nearby municipalities, NGOs and electric utilities to connect Raleigh's transportation electrification infrastructure strategies to regional resilience efforts. Focus on building the capacity of individuals, communities, institutions, businesses, and systems in Raleigh to adapt to chronic stresses and acute shocks.**

Near-Term Action

- Monitor emerging pilot project and financial opportunities related to State (e.g., Executive Order 80) and utility transportation electrification strategies and programs aligned with City of Raleigh climate mitigation and resilience goals

Charging technologies can be combined with solar panels and electricity storage to make these facilities resiliency hubs allowing for electricity supply separate from the power grid for emergency operations.[30] Proposed electrification at City-owned park-and-ride lots are a potential opportunity. The City can also pursue partnership with Duke Energy to explore co-locating strategic Raleigh-owned charging infrastructure with on-site solar power generation, battery storage, and energy management to help manage day-to-day grid performance. These systems may also provide power to essential electric vehicles, meet first responders' needs and provide other electricity services during grid failure events.

Integrating electric vehicles into the City's and the region's vehicle fleet enhances energy security. Today, North Carolina municipalities and residents rely on imported gas and diesel for their transportation needs. Most of that petroleum supply comes from Texas through the Colonial Pipeline. When storms and other disruptive events strike the ports of Galveston and Houston (let alone other vulnerabilities in the global oil supply chain), the pipeline can be shut down. This results in fuel shortages for North Carolina. Diversifying fuel sources to include reliable electricity that is less prone to disruption, can be generated locally from renewable sources, and can be stored in batteries makes for a more resilient region.

2.9 ACTION: **Advance workplace charging through collaborative efforts with large employers that leverage recognition, branding, and competition.**

Near-Term Action

- Develop communications packages and reach out to local corporations about EV-readiness and workforce charging, including investing in charging in Raleigh's public parking decks

The City of Raleigh can build on its economic development collaboration with large employers in the city to invest in workplace charging in their own facilities and/or in City-owned parking decks. Workplace charging is a key opportunity to make it attractive for drivers to switch to EVs and to raise awareness among co-workers. Experience in other municipalities has shown:

- Employees with access to workplace charging are six times more likely to purchase an EV than people without access to workplace charging.[31] Reaching people through their workplace is an easier point of entry.
- Demand for EV's tends to cluster. Interpersonal influence of driving an EV is strongest from neighbor to neighbor, followed by the influence of coworkers and then family influence.[32]

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[30] For more information, see: http://resilience-hub.org/.
[31] See: U.S. Department of Energy, "Workforce Charging Challenge: Progress Update 2016: A New Sustainable Commute:" https://www.energy.gov/sites/prod/files/2017/01/f34/WPCC_2016%20Annual%20Progress%20Report.pdf
[32] Jansson, et al., "Adoption of alternative fuel vehicles: Influence from neighbors, family and coworkers," *Transportation Research Part D: Transport and Environment,* Volume 54, July 2017, Pages 61-73: https://www.sciencedirect.com/science/article/pii/S1361920915302534

- Ride and Drives—including in partnership with local businesses—are one of the most effective ways to change employees' opinions about EVs. For example, Smart Columbus (Ohio) offered 7,000 Ride and Drives in 2018. People who were "likely" or "very likely" to purchase an EV increased from 37% to 54% from pre- to post-drive.[33] There are groups in the Raleigh area who provide Ride and Drives including Triangle J Clean Cities Coalition, Plug-In NC, and the NC Clean Energy Technology Center.

Encouraging Workplace Charging

Forth Mobility is a leader in working with cities to advance workplace charging (see: forthmobility.org/why-electric/workplacecharging). Its communications to businesses focus on enhancing companies' brands, employee satisfaction, and public benefits of clean air. In Forth's flyer, "Why Install Electric Vehicle Chargers at your Workplace?" it emphasizes:

- 52% of employees believe their employers should be doing more for the environment
- Employees with workplace charging are 20 times more likely to drive an electric vehicle
- 41 million vehicles on the road will be electric by 2040
- EV drivers pay only 99 cents to drive the same distance as a gallon of gas in a conventional car.

2.10 ACTION: **Explore partnerships with industry, utility, and rideshare companies to create DC fast charging "hubs" of multiple chargers. The hubs should provide rapid charging to a variety of transportation uses, including private EVs, ridesharing, transportation network company vehicles, and delivery vehicles and could be located to encourage connectivity to other forms of mobility, including transit.**

Cities across the U.S. have taken a variety of approaches to investing in public DC fast charging. Some like Los Angeles have made substantial direct city investments in banks of these fast chargers. Others, like Portland, have focused on creating rules and resources, but have mainly relied on private sector investment. No matter the approach, these investments often involve partnerships between cities, utilities, private companies, and community groups working together in various ways to increase public access but also to achieve community goals, such as equitable access, zero-emission ridesharing, connections to transit, and others.

[33] Smart Columbus, "Ride & Drive Roadshow: A Practitioner's Guide to EV Test Drive Programs:" https://d2rfd3nxvhnf29.cloudfront.net/2019-09/X2019%20A%20Practitioner%27s%20Guide%20to%20Ride%20N%20Drives_compressed.pdf

The Electric Drive charging hub in **Austin, TX** shown at right is an example of a partnership between the City of Austin and Austin Energy for a charging hub that is operated by a private charging company. The hub is part of Austin Energy's Plug-In EVerywhere program with EV charging ports in 162 locations across the greater Austin area--a key strategy for the city to meet its goal of achieving net-zero carbon by 2050.

Seattle has developed a fast charging hub in a mixed residential and commercial neighborhood (Beacon Hill) near a light rail station that was located, in part to provide fast charging access to transportation network company drivers serving low- and middle- income residents. The hub has two on-street DC fast chargers in an area of free curb-side parking. It was developed as part of the city's Drive Clean Seattle program (targeting 30% EVs city-wide by 2030) under the city's initiative to provide EV charging access in the right-of-way.[34] Seattle City Light, the City-owned utility, funded and owns the chargers as part of its Public DC fast charging pilot project.[35]

The City of **Los Angeles**[36] has been a partner (along with a private charging provider and electric vehicle manufacturer) in developing seven DC Fast Charging stations throughout the city in parking garages. These hubs provide public charging but also dedicated charging for transportation network companies to promote EV adoption.

New York City[37] developed DC Fast Charging hubs in every borough in 2018 with a commitment to develop fifty hubs by 2020. The hubs are used by the public, transportation network companies, and municipal agencies. The city partnered with the utility Con Edison (through a $25 million EV demonstration project) to identify at least one site in every borough. In addition to the fast charging hubs, the New York Department of Transportation and Police Department plan to reserve access to 100 or more on-street parking spaces for Level-2 EV charging and may, if successful, expand to provide curbside charging citywide.

Typically, these cities site fast charging hubs in areas of high commercial activity near high-volume corridors where users can shop, go to appointments, or visit local eateries while charging and where high use vehicles—like ride-sharing vehicles—are likely to operate (e.g., taxis, Uber, or Lyft picking up or dropping off passengers). Seattle and other cities also consider neighborhood demographics and have prioritized installing charging in middle-income and low-income neighborhoods to increase access to clean mobility for residents and boost economic growth for local businesses.

[34] See: https://www.seattle.gov/transportation/projects-and-programs/programs/new-mobility-program/electric-vehicle-charging-in-the-public-right-of-way
[35] See; http://www.seattle.gov/light/electric-Vehicles/
[36] See: Los Angeles, CA – https://www.smartcitiesworld.net/news/news/public-ride-share-ev-charging-hubs-launched-in-los-angeles-4104
[37] See: https://www1.nyc.gov/office-of-the-mayor/news/600-17/leading-charge-mayor-fast-charging-ev-hubs-all-5-boroughs

Charging Infrastructure: Lead and Collaborating Departments

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
2.1 Strategy	Advance EV-readiness in new and existing private commercial and multi-family buildings by: 2.1A: Exploring incentives and education to encourage developers of all new commercial and multi-family parking lots or structures to dedicate a certain percentage of spaces as EV-ready and that all new development of residential homes be equipped with the infrastructure needed to install EV charging stations, such as conduit, wiring, and electrical capacity. 2.1B: Streamlining and simplifying the permitting process for commercial property owners who wish to install charging infrastructure on existing commercial or multi-family properties.	Planning and Development Services	Development Services Sustainability Transportation Housing and Neighborhoods
2.2 Action	Lead by example by making all new and upgraded City buildings EV-ready. Require that all new City buildings and large renovations of existing buildings equip 20% of parking spaces with the infrastructure needed to install EV charging stations.	Engineering Services	Transportation Information Technology Sustainability
2.3 Action	Ensure all City EV charging hardware and software investments are interoperable and support the functions needed to effectively manage a network of chargers and provide information for future data-driven decisions about electrification of vehicles and equipment.	Information Technology	Engineering Services Transportation
2.4 Action	Based on an evaluation of current and likely future use, replace existing City-owned Level-2 public charging stations with Open Charge Point Protocol (OCPP)-compliant networked Level-2 chargers operated on a single best-in-class EV charging network management software platform and add new Level-2 chargers in locations of currently recognized need.	Transportation	Information Technology Engineering Services Development Services

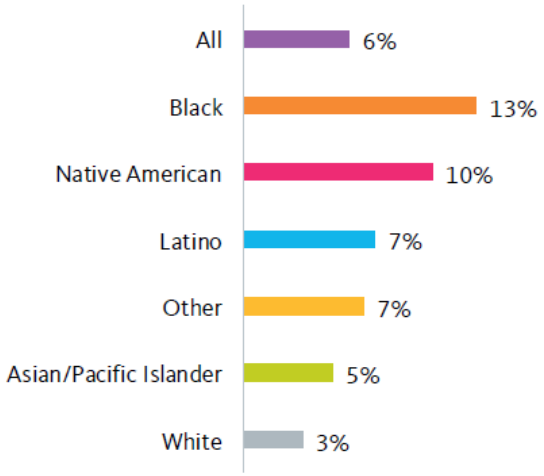
Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
2.5 Action	Encourage EV adoption and clean mobility through EV charging at City-owned park-and-ride facilities where feasible and integrate with zero-emission shuttles from park-and-ride lots to downtown.	Transportation	Engineering Services Information Technology Communications Economic Development & Innovation
2.6 Strategy	To position Raleigh to be aligned with the growing EV market, create an EV-ready strategy that identifies locations for future charging stations. As funds become available to support additional City-owned stations, this strategy will enable the capturing and execution of funds.	Transportation	Engineering Services Information Technology Parks, Recreation & Cultural Resources Sustainability
2.7 Action	Maximize opportunities to integrate EV charging with Smart Cities technologies and services.	Information Technology	Multi-departmental team (Smart Cities) Engineering Services
2.8 Action	Build strategic partnerships with nearby municipalities, NGOs and electric utilities to connect Raleigh's transportation electrification infrastructure strategies to regional resilience efforts. Focus on building the capacity of individuals, communities, institutions, businesses, and systems in Raleigh to adapt to chronic stresses and acute shocks.	Sustainability	All departments
2.9 Action	Advance workplace charging through collaborative efforts with large employers that leverage recognition, branding, and competition.	Economic Development & Innovation	Sustainability Communications Information Technology Transportation Engineering Services
2.10 Action	Explore partnerships with industry, utility, and rideshare companies to create DC fast charging "hubs" of multiple chargers. The hubs should provide rapid charging to a variety of transportation uses, including private EVs, ridesharing, transportation network company vehicles, and delivery vehicles and could be located to encourage connectivity to other forms of mobility, including transit.	Transportation	Information Technology Communications Housing and Neighborhoods

Equity and Access

Overview

Transportation electrification should benefit all Raleigh residents, with specific attention to improving quality of life in low-income communities and communities of color. Because new car owners (whether traditional vehicles or electric) tend to have higher incomes, there is a public perception that electric vehicles (EVs) are accessible primarily to higher-income households. According to a study of equitable growth in the Research Triangle Region, vehicle ownership is lower in the region for residents of color as illustrated in the chart at right.[38]

Percent of Research Triangle Region Households without a vehicle by race/ethnicity (2012)



Source: Equitable Growth Profile of the Research Triangle Region

Based on lessons learned and best practices from other municipalities, the recommended strategies and actions related to equity and access draw on the following key insights:

- Climate and environmental issues disproportionally affect communities with lower incomes and socio-economic status, and transportation electrification can play an important role in improving air quality and quality of life in areas most affected by environmental harms.[39]
- Cities have addressed equity and access through zero-emission public transit, access to EVs through car-sharing programs, and attention to charging infrastructure in low-income neighborhoods and multi-family buildings.
- It is important to involve the impacted community in discussions to be inclusive and allow residents to identify real transportation-related challenges that they and their communities are facing. To increase engagement, hold meetings

[38] See: PolicyLink and the Program for Environmental and Regional Equity (PERE), Equitable Growth Profile of the Research Triangle Region: https://www.policylink.org/sites/default/files/Triangle_J_Profile_Final_31March2015.pdf.
[39] See, for example, content and references in: Center for Climate and Energy Solutions, "Electrified Transportation for All: How Electrification can Benefit Low-income Communities": https://www.c2es.org/site/assets/uploads/2017/11/electrified-transportation-for-all-11-17-1.pdf

in the communities that are impacted, as they face transportation, lifestyle and mobility challenges that might impact their ability to attend such a meeting.

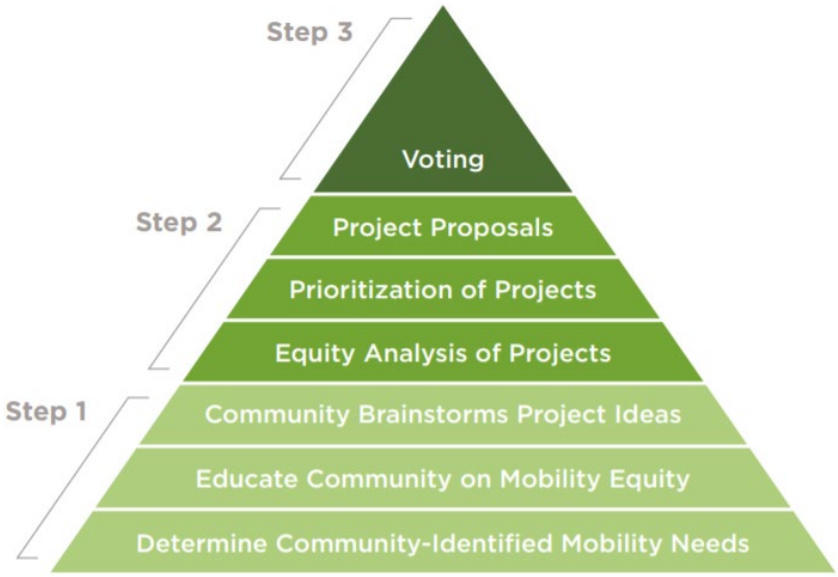
Many cities and States are seeking to ensure that their efforts to advance transportation electrification are equitable. There is no cookbook for doing so. To the extent that shared practices are emerging, this work starts by engaging community organizations and community members about the mobility-related challenges that they face and then working with them to determine how transportation electrification efforts can help address these challenges. Challenges might include poor air quality in low-income neighborhoods and neighborhoods of color, lack of access to transit or other mobility services (e.g., car-sharing), or gentrification and housing affordability that are driving residents to homes farther from work or school and necessitating longer travel. City departments with connections to community organizations and neighborhoods can help identify key groups and opportunities to meet with citizens about transportation electrification. In a 2019 presentation at the EV Roadmap conference, the CEO of the Fresno Metro Black Chamber of Commerce (California) provided three principles to guide this type of engagement on clean and equitable transportation:

- Invest in traditionally disinvested communities;
- Assign value to those traditionally left behind; and
- Move from conversations about disadvantaged communities to conversations with disadvantaged communities.

In contrast, based on the experience of the consulting team, some common mistakes cities and States make when working on equity and transportation electrification include:

- Not involving affected communities or advocates in discussions of transportation electrification
- Not meeting on these issues in the communities impacted or meeting at times or locations that make it difficult for community members to attend (e.g., during the day when many people are at work)
- Assuming that there are simple approaches to complex problems that involve history, poverty, mobility, housing affordability, and a range of other issues

The City should work with community members to understand their needs, build understanding of potential opportunities through education, and determine potential solutions. This effort can be guided by work of the Greenlining Institute whose report "Mobility Equity Framework: How to Make Transportation Work for People" illustrates a three-step process to move toward a community-centered transportation planning process that incorporates mobility equity.



The City is already pursuing best practices on equity and transportation through its work on the Wake County Transit Plan. In this effort, the City is hosting a series of conversations called Equitable Development around Transit[40] to discuss options with community members about expanding options for public transportation throughout Raleigh and the region. A key aspect of these conversations is routes for bus rapid transit where key priorities are to:

- Maintain and enhance housing affordability
- Ensure accessibility to service from existing residential areas
- Minimize displacement from rising real estate values
- Increase ridership
- Provide economic development opportunities

3.1 ACTION: **Partner with public health researchers and organizations to better understand the localized air quality issues impacting citizens and specific transportation options that can improve health in these areas.**

Near-Term Action

- Align Raleigh's transportation electrification strategies and benefits analysis with City strategies to improve air and water quality as referenced in the Growth and Natural Resources section of the Strategic Plan

Often the communities that are most impacted by transportation-related emissions are low-income communities and communities of color.[41] Transportation electrification provides the opportunity to significantly reduce transportation-related emissions, especially the conversion of old diesel burning vehicles like transit and school buses to clean electricity.

3.2 ACTION: **Explore opportunities to build partnerships with Wake County and other strategic stakeholders to advance equity and access benefits derived from vehicle electrification.**

While the City of Raleigh only has direct authority of its own fleet and equipment, the City partners with others on many other aspects of transportation, including Wake County. The City can proactively collaborate and share information with these partners to identify opportunities that can increase mobility and quality of life through transportation electrification. The City and Wake County are already working closely together on multiple shared issues including transportation, affordable housing and equity. There is opportunity to continue to build on this and other strategic stakeholder partnerships to advance equity and access in the Raleigh community.

[40] See, Raleigh BRT: Equitable Development Around Transit: https://www.raleighnc.gov/business/content/PlanDev/Articles/LongRange/RaleighBRT.html
[41] See, for example, content and references in: Center for Climate and Energy Solutions, "Electrified Transportation for All: How Electrification can Benefit Low-income Communities": https://www.c2es.org/site/assets/uploads/2017/11/electrified-transportation-for-all-11-17-1.pdf

Opportunities for Wake County School Bus Electrification

Electrifying school buses is a key opportunity for leveraging the multiple benefits of electrification and promoting equity and environmental justice through transportation electrification. Replacing older diesel-powered buses with electric alternatives eliminates a significant source of air pollution, including for vulnerable young students and bus drivers who are in closest proximity to these emissions. Replacements also save on fuel and maintenance costs, benefits which accrue rapidly because of the high mileage of these buses. The Twin Rivers school district in California, for example, estimates that its electric school buses reduced fuel costs by around 80 percent with Lion electric buses that cost 19¢ per mile, compared to diesel buses that cost 82¢ per mile. Finally, electric school buses provide equitable access to new, clean mobility, and expose a broad swath of the population (and future drivers) who may not have otherwise been exposed to EVs, the opportunity to experience and learn about them.

Recognizing the benefits of replacing diesel school buses with cleaner alternatives—but also their higher upfront cost—the State of North Carolina is providing $12.2 million for up to 100% of the cost of school bus replacements in its Phase 1 Volkswagen Settlement Program, with over $1.5 million targeted for electric school buses. Duke Energy's proposed electric transportation program for North Carolina anticipates providing financial support to procure up to 85 electric school buses with the utility installing the associated charging infrastructure.

Source: School Transportation News, "Electric School Buses Are More Affordable Than You Think"; https://stnonline.com/partner-updates/electric-school-buses-are-more-affordable-than-you-think/

3.3 ACTION: **Work with transportation network companies to increase equity, access, and opportunity for low-income residents to participate in the lower-cost and higher-margin electric rideshare economy.**

Near-Term Action

- Evaluate opportunities to support ride-sharing and other options for expanding equitable access to clean mobility for low-income communities. Look for opportunities such as public private partnerships and opportunities to locate near Affordable Housing.

Ride-hailing companies including taxis, Uber and Lyft are working on pilot projects in partnership with utilities to provide lower-cost access to EVs for their drivers. Cities like Los Angeles (through its Blue LA program[42]) and Portland (through the Community Electric Vehicle Project[43]) have also initiated EV ride-sharing programs in neighborhoods that increase access of low-income residents and people of color to EVs. The City could look for public-private partnership opportunities to expand access to these ridesharing and ride-hailing opportunities in Raleigh.

[42] https://www.bluela.com/
[43] https://forthmobility.org/news/electrifying-community-car-share

3.4 STRATEGY: **Help ensure that residents without access to off-street charging can charge an EV by:**

- 3.4A: **Creating a right-of-way ordinance to allow curbside charging**
- 3.4B: **Encouraging charging in multi-family building parking facilities**

In many parts of the city—especially those with a high concentration of multi-family and dense single-family residential buildings—residents do not have access to off-street parking but instead need to use publicly available charging in parking decks or in the city right-of-way (curbside).

For curbside parking in the right-of-way, Seattle is an example of a city that has dealt with questions of authority, insurance, enforcement and siting allowances through the *EV Charging in the Public Right of Way (EVCROW) Program*.[44] Through the program, the Seattle Department of Transportation allows EV charging infrastructure providers to install publicly-available EV charging infrastructure in curbside parking areas. The program was an explicit response to the fact that most people in the city are renters and many don't have a designated off-street parking spot where they can install a home charging station. The program emphasizes development of DC fast charging hubs on non-residential streets near businesses and other amenities in neighborhoods outside of downtown, which are accessible to nearby residents and others. These curbside charging stations are available to the public, and existing parking regulations continue to apply. In Los Angeles, the city has taken a different approach by investing in publicly available Level 2 chargers mounted on light poles. The Bureau of Street Lighting has installed 132 of these Level-2 chargers, which provide distributed access to charging at curbside throughout the city.[45]

For new multi-family buildings, EV-readiness ordinances (see Strategy 2.1) are a valuable strategy for ensuring that multi-family residents have parking spaces that are (or can be) equipped with EV charging infrastructure. Some jurisdictions, like California, are building EV charging requirements into multi-family building codes.[46] Installing EV charging infrastructure during construction is usually much more cost-effective than retrofitting parking areas in existing multi-family buildings. For existing buildings, cities can help owners and tenants understand the benefits and process for installing charging equipment through information and outreach. For example, Seattle City Light provides a step-by-step overview that walks through the process of developing EV charging in multi-family buildings from evaluating charging opportunities to equipment installation. The guidance approaches the process as a community project that involves specific roles and responsibilities for tenants, building representatives, contractors, and utilities.[47]

3.5 STRATEGY: **Work with others to create an EV charging station installation handicap parking standard.**

Development of charging stations should be done with accessibility in mind. New infrastructure, cords, and location of parking in relation to curbs (and handicap parking spaces) can create new accessibility challenges for EV drivers with disabilities and the broader community navigating new infrastructure. While the federal Americans with Disabilities Act dictates the height and curb reach for chargers, local code dictates parking configuration requirements (such as requiring handicap parking at chargers), and there is no standard approach. Raleigh should work with others to ensure that charging infrastructure is accessible and doesn't create new accessibility challenges for residents.

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[44] Seattle Department of Transportation, "Electric Vehicle Charging in the Public Right-of-Way (EVCROW) Program: https://www.seattle.gov/Documents/Departments/SDOT/NewMobilityProgram/EVCROW_Program.pdf. See Also: Erica Barnett, "A New Seattle Program Will Set Aside Parking Spots Throughout the City for Electric Vehicle Charging", Seattle Magazine: https://www.seattlemag.com/news-and-features/new-seattle-program-will-set-aside-parking-spots-throughout-city-electric-vehicle.

[45] Los Angeles Bureau of Street Lighting: http://bsl.lacity.org/smartcity-ev-charging.html

[46] California Air Resources Board, "Electric Vehicle (EV) Charging Infrastructure: Multi-family Building Standards": https://ww3.arb.ca.gov/cc/greenbuildings/pdf/tcac2018.pdf

[47] See: Seattle City Light, "Electric Vehicle Service Equipment for Multi-Family Housing": https://www.seattle.gov/light/electricvehicles/docs/Electric_Vehicle_Service_Equipment_for_Multi.pdf

Equity and Access: Lead and Collaborating Departments

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
3.1 Action	Partner with public health researchers and organizations to better understand the localized air quality issues impacting citizens and specific transportation options that can improve health in these areas.	Sustainability	Communications Housing & Neighborhoods Transportation
3.2 Action	Explore opportunities to build partnerships with Wake County and other strategic stakeholders to advance equity and access benefits derived from vehicle electrification.	Sustainability	Housing and Neighborhoods Economic Development & Innovation
3.3 Action	Work with transportation network companies to increase equity, access, and opportunity for low-income residents to participate in the lower-cost and higher-margin electric rideshare economy.	Transportation	Economic Development & Innovation
3.4 Strategy	Help ensure that residents without access to off-street charging can charge an EV by: 3.4A: Creating a right-of-way ordinance to allow curbside charging 3.4B: Encouraging charging in multi-family building parking facilities	Development Services	Transportation Planning/Real Estate City Attorney Risk Management
3.5 Strategy	Work with others to create an EV charging station installation handicap parking standard.	Transportation	Development Services Engineering Services

Equitable Economic Development and Public Engagement

Overview

Transportation electrification provides new opportunities to attract economic development, cultivate a culture of innovation and entrepreneurship, and create jobs. It leverages and advances the region's strong regional technology industry and can help the community attract and retain employees and employers by improving mobility and quality of life. Transportation electrification can generate jobs for infrastructure installation and maintenance, including through City partnerships with local educational institutions to develop and support professional programs.

4.1 ACTION: **Engage in strategic partnerships to advance workforce development initiatives related to transportation electrification.**

Near-Term Action

- Leverage public-private partnership strategies to include engaging stakeholders in efforts to enhance economic development, equity and access, and workforce development through transportation electrification

Key opportunities for strategic partnerships include:

- Build from City of Raleigh's existing relationships with training and academic institutions, such as Wake Technical Community College to explore opportunities for transportation electrification training programs to meet the City's fleet needs and those of the broader region.
- Strengthen the relationship with institutions that are working on enhancing the workforce for transportation electrification, such as North Carolina State University, which hosts organizations like the FREEDM Systems Center and the North Carolina State Clean Energy Technology Center.
- Inventory and engage with regional companies and organizations concerned about future potential disruption to fossil fuel transportation jobs (e.g., vehicle manufacturing and supply chain, gas stations and related convenience stores, and vehicle repair and maintenance businesses) to identify concerns and assist, as needed, with connecting potentially disrupted employees with workforce development and training opportunities (e.g., community colleges).
- Engage with large downtown employers and other concentrated employment areas of Raleigh around ways Raleigh can support workplace charging for employees to coordinate the City's broader transportation electrification goals and employers' employee attraction and retention efforts.
- Assess City of Raleigh's procurement strategies for transportation electrification to support women-owned and minority-owned businesses, such as car dealerships selling EVs or charging infrastructure providers.

- Work with the 11 Economic Development Alliance partners representing areas around Raleigh to determine their needs and unique challenges and how transportation electrification connects to their priorities.

4.2 ACTION: **Engage regional businesses and entrepreneurs in the transportation electrification sector to identify demonstration and collaboration opportunities to advance electrification.**

Technology companies, the health care industry, large employers and many in the start-up community, among others, have a vested interest in transportation electrification. These businesses may have assets such as land, talent, or technology that can be leveraged by the City of Raleigh to accelerate transportation electrification. The Office of Economic Development & Innovation can create a list of potential business partners and conduct outreach to explore where mutually beneficial opportunities for collaboration may exist.

An example of this type of public and private sector collaboration is Drive Electric Northern Colorado's public ride and drive event as part of National Drive Electric Week 2019. The city of Fort Collins, CO held the event,[48] which features EVs to test drive, along with Lightening Systems, a company based in nearby Loveland, CO that provides electric power trains for medium and heavy-duty delivery vehicles and transit buses.[49] There have to-date been several events in and around Raleigh, including electric vehicle shows, ride and drives, EV driver meetups, and fleet technology conferences. City of Raleigh should continue to support and participate in these events.

4.3 ACTION: **Integrate information into economic development marketing campaigns that showcases Raleigh's innovative electric mobility solutions to reinforce Raleigh's position as an international leader in technology innovation and support business recruitment efforts.**

The City of Raleigh can leverage its implementation of the recommended strategies and actions in this study by communicating its innovation and ambition in a way that helps the city attract economic development. Columbus, Ohio, the recipient of $50 million from the U.S. Department of Transportation's first-ever Smart City Challenge, is a leader in marketing its embrace of transportation electrification. While Columbus is in a unique position with this funding, cities like Raleigh can learn from Columbus' approach to marketing, which describes the cities' effort as "reinvention of mobility" and characterizes it as part of a broader embrace of innovation leading to "a future beyond what anyone has yet imagined."[50] A key target audience in Columbus is businesses with demonstrated interest and action around innovative leadership to drive growth. With Columbus' marketing focus on innovation and economic development, the city has used the Smart City Challenge opportunity to engage private sector businesses to leverage the Smart City funds through the Columbus Partnership, a non-profit organization made up of CEOs of the region's largest private sector employers that committed to private investment in aligned initiatives through the Acceleration Fund.[51] While Columbus is engaging leading businesses, it is also seeking to spark the imagination of the general public. A visible public expression of Columbus' approach and marketing is the Experience Center,[52] which showcases smart mobility

[48] http://driveelectricnoco.org/wp-content/uploads/2013/03/National-Drive-Electric-Week-2019.pdf
[49] https://lightningsystems.com/
[50] https://smart.columbus.gov/
[51] https://smart.columbus.gov/funding-sources/acceleration-fund
[52] https://smart.columbus.gov/get-involved/experience-center

technologies. Portland, Oregon, in partnership with Forth Mobility, has also developed a similar public marketing space through its downtown EV Showcase, which is complemented by a virtual version online.[53]

4.4 ACTION: **Create a public education and awareness campaign to increase the community's understanding of the broad benefits of transportation electrification, dispel myths, incorporate outcomes of funding opportunities such as the Volkswagen Settlement, and communicate Raleigh's transportation electrification implementation objectives.**

Near-Term Action

- Develop an external communications strategy to inform residents about the benefits of EVs and Raleigh's commitments and actions related to transportation electrification

Public education and awareness can include informing residents about the City's transportation electrification objectives and related strategies and investments. This can emphasize how these strategies and investments will benefit citizens and the community while building awareness about the benefits of personal electric vehicle (EV) ownership.[54] It can place Raleigh's work in the context of larger regional, state, and national mobility transformation.

4.5 ACTION: **Begin building relationships with rideshare companies and other partners to explore ways to encourage electrification of transportation network company fleets (e.g., taxis, Uber, and Lyft).**

As transportation network companies increase operations in cities around the country, there is increasing interest in leveraging this emerging sector to reduce transportation emissions. A potential model for Raleigh is the partnership between Lyft and Georgia Power in Atlanta. In alignment with Lyft's commitment to reduce emissions and improve city life, the company is expanding the availability of "environmentally-friendly transportation solutions" in the city.[55] The rideshare company recently partnered with Georgia Power to launch the Charge Up Atlanta project, which incentivizes owners of electric vehicles to join the rideshare company's fleet.[56] The expansion is part of Lyft's Express Drive rental program – a partnership with various companies that lets drivers rent electric vehicles that can also be used for personal use. In addition to the benefit of lowering emissions, Lyft drivers save money through lower fuel costs and affordable rental rates.[57]

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[53] https://forthmobility.org/showcase
[54] A useful source for communications materials related to electrified transportation is Veloz (www.veloz.org), a multi-sector collaborative advancing electrified transportation, and its "Electric for All" initiative (www.electricforall.org/).
[55] https://www.11alive.com/article/news/lyft-to-add-more-electric-cars-to-atlantas-rideshare-fleet/85-fd0828cc-5257-4903-be78-74fa4907b82b
[56] https://www.chargeupatlanta.com/
[57] https://blog.lyft.com/posts/2019/2/6/making-cities-more-liveable-with-electric-vehicles

Equitable Economic Development and Public Engagement: Lead and Collaborating Departments

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
4.1 Action	Engage in strategic partnerships to advance workforce development initiatives related to transportation electrification.	Economic Development & Innovation	Transportation Engineering Services Sustainability
4.2 Action	Engage regional businesses and entrepreneurs in the transportation electrification sector to identify demonstration and collaboration opportunities to advance electrification.	Transportation	Economic Development & Innovation Information Technology Sustainability
4.3 Action	Integrate information into economic development marketing campaigns that showcases Raleigh's innovative electric mobility solutions to reinforce Raleigh's position as an international leader in technology innovation and support business recruitment efforts.	Economic Development & Innovation	Communications Housing & Neighborhoods
4.4 Action	Create a public education and awareness campaign to increase the community's understanding of the broad benefits of transportation electrification, dispel myths, incorporate outcomes of funding opportunities such as the Volkswagen Settlement, and communicate Raleigh's transportation electrification implementation objectives.	Sustainability	Communications Transportation Information Technology Economic Development & Innovation
4.5 Action	Begin building relationships with rideshare companies and other partners to explore ways to encourage electrification of transportation network company fleets (e.g., taxis, Uber, and Lyft).	Economic Development & Innovation	Sustainability Transportation Communications Information Technology

Implementation Roles and Responsibilities

Overview

Implementing the goals and objectives described in this study will require clear leadership, departmental ownership, and inter-departmental coordination. To help ensure that these elements are integrated and operationalized successfully, this strategy should be embedded into the City's guiding documents such as the Strategic Plan, 2030 Comprehensive Plan, and other plans and initiatives. The City's Strategic Plan is a three to five-year plan that focuses on near term initiatives and actions, while plans such as the 2030 Comprehensive Plan facilitate long term best practices.

To help operationalize the transportation electrification strategies and actions recommended in this study in the near term, the City can utilize the Strategic Plan's structure of governance, accountability, and collaboration. Leveraging the important role played by the Budget & Management Services Department in Strategic Plan implementation can help align the ambitions of this study to the potential investments of time and resources. The City can learn by focusing on near-term actions and early implementation wins. The City can then over time evaluate if transportation electrification has the potential to develop into an explicit program, requiring more formal organization and dedicated capacity.

5.1 ACTION: **Include transportation electrification as an initiative within the City of Raleigh's Strategic Plan. Identify connections between the specific recommended actions and strategies in this study with the Key Focus Area sections of the Strategic Plan.**

The six key focus areas of the City of Raleigh's Strategic Plan include: Growth & Natural Resources; Transportation & Transit; Economic Development & Innovation; Organizational Excellence; Safe, Vibrant & Healthy Community; and Arts & Cultural Resources. Within each of these areas, there are initiatives that relate to the transition to transportation electrification. Among the six key focus areas, the Growth & Natural Resources component commits the City to "encourage a diverse, vibrant built environment that preserves and protects the community's natural resources while encouraging sustainable growth that complements existing development." Transportation electrification's contribution to sustainable growth is particularly relevant to Objective 3 of this focus area, which commits the City to "optimize public infrastructure projects to address community resiliency, sustainability, and efficiency" and is the objective that encompasses Raleigh's Community-wide Climate Action Plan. Although specific actions identified in the transportation electrification study relate to several initiatives throughout

all the six key focus areas of the Strategic Plan, it is helpful to identify an anchor area that allows staff to utilize the structure of the Strategic Plan process to collaborate and move work forward.

The Strategic Plan provides the context for leadership and accountability for implementation of the transportation electrification study. A CORE Team of senior managers and topical experts oversees Strategic Plan implementation for each of the key focus areas. An Assistant City Manager is assigned to and leads up each key focus area of the study. Work is typically undertaken by a cross-departmental Initiative Team that provides regular semi-annual updates to (and receives feedback from) the CORE team and Assistant City Manager. The Budget and Management Services Department houses the Strategic Plan. Budget and Management analysts serve as organizers behind each of the Strategic Plan key focus areas, getting updates from Initiative Teams and coordinating the regular check-ins. Utilizing this structure for implementation of this study will ensure leadership, accountability, and coordination and tap the full potential of transportation electrification to contribute to the strategic vision of the City.

5.2 ACTION: **Establish an internal Initiative Team with representation from across City departments and external stakeholders to undertake the implementation activities identified in the study, coordinate implementation efforts across departments, and monitor and report on implementation progress. As part of this work, craft a longer-term approach for managing transportation electrification and mobility as a program. The Office of Sustainability could serve as the convener of the team, and the different initiatives and actions should be led by the designated department leads and supporting departments.**

The Initiative Team overseeing implementation of the study can draw heavily from the cross-departmental Steering Committee that developed the study and additional departments that play key roles related to the study's proposed strategies and actions. It should include representatives from:

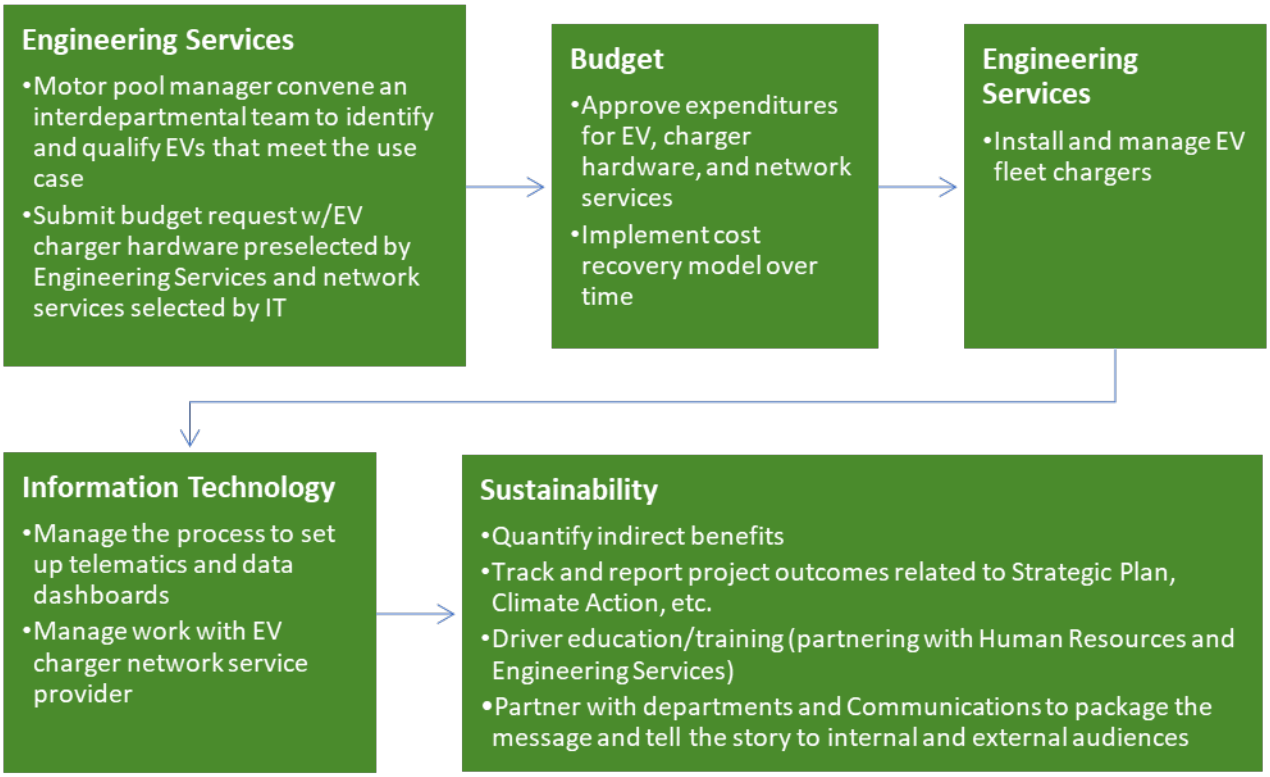
- Budget & Management Services
- Development Services
- Economic Development & Innovation
- Engineering Services
- Finance
- Housing & Neighborhoods
- Information Technology
- Planning
- Parks, Recreation, & Cultural Resources
- Public Utilities
- Sustainability
- Transportation

Implementing the proposed strategies and actions in this study should draw on several departments to play critical roles and will require strong cross-departmental coordination. The roles departments play will leverage their core responsibilities and expertise but be adapted to the context of transportation electrification. For example:

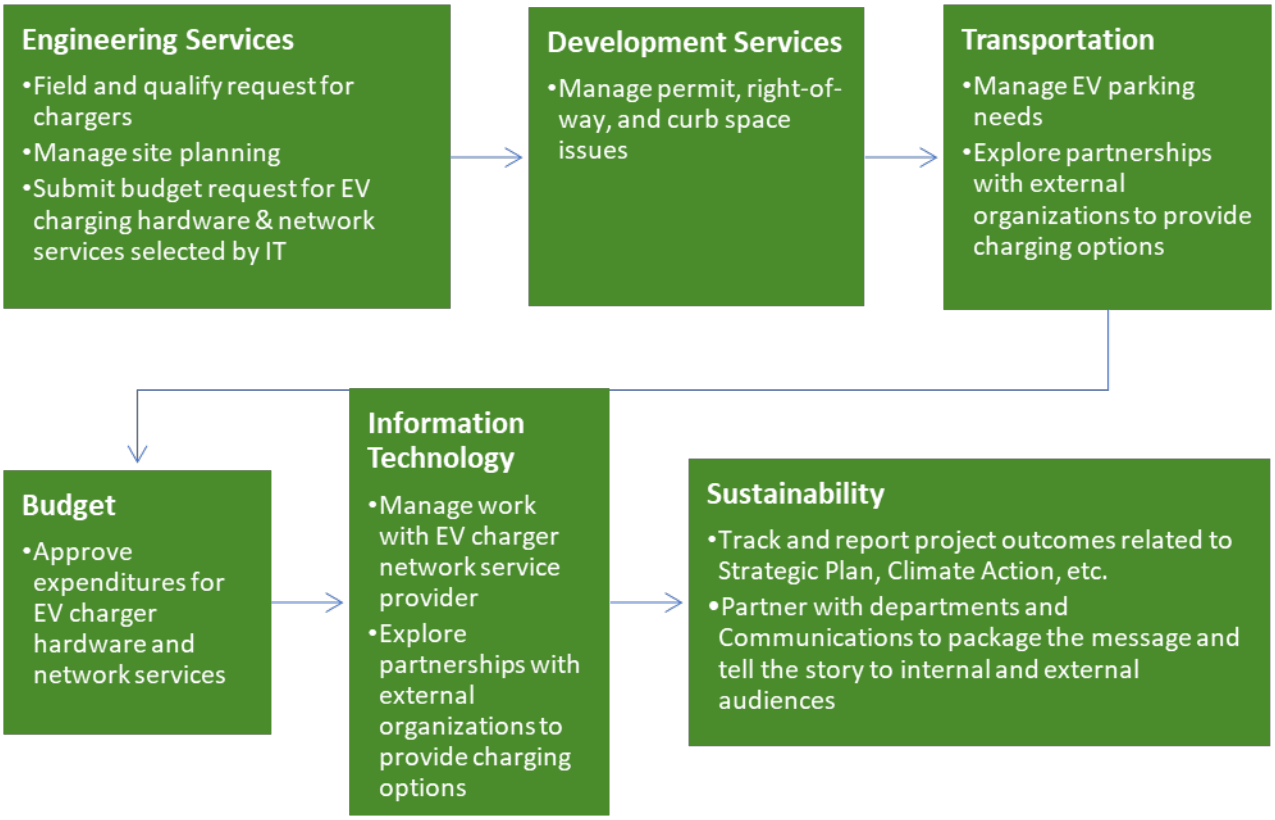
- **Engineering Services**: Responsible for charger hardware, City fleet charging location identification, fleet and public charger operations and maintenance.
- **Information Technology**: Responsible for charging and network management software, Geographic Information System (GIS) overlay mapping, and Smart Cities integration including working with the local business and stakeholder community.
- **Transportation**: Responsible for on-street and parking deck management, public charger location identification, relationships and education with local businesses and organizations related to transportation.
- **Planning and Development Services**: Responsible for land use and EV-ready ordinances and right-of-way issues.
- **Budget & Management Services**: Responsible for resource allocation decisions and coordinating work in the context of the Strategic Plan.
- **Finance**: Responsible for purchasing decisions.

- **Sustainability:** Responsible for convening the Initiative Team to facilitate updates and reporting as well as supporting education and outreach activities.
- **Economic Development & Innovation:** Responsible for leading public-private partnerships and engagement with the business community, equipment and service providers, and other stakeholders.

A primary responsibility of the Initiative Team will be to determine the specific contributions of each department in implementing actions. For example, the allocation of responsibility for motor pool fleet purchases may look like the diagram below. This illustrates how the city could implement Action 1.2: *Based on existing telematics, begin replacing the City of Raleigh's light duty fleet with highway speed EVs when the use case aligns with the performance of EVs on the market.*



The allocation of responsibilities for upgrading City-owned chargers available for public use would engage departments in a different way, as illustrated below. This illustrates how the City could implement Action 2.4: *Based on an evaluation of current and likely future use, replace existing City-owned Level-2 public charging stations with Open Charge Point Protocol (OCPP)-compliant networked Level-2 chargers operated on a single best-in-class network and add new Level-2 chargers in locations of currently recognized need.*



5.3 ACTION: **As implementation proceeds beyond an initial set of near-term activities, evaluate the need for additional staffing to oversee transportation electrification and mobility efforts.**

Many cities committed to transportation electrification recognize that they need to establish a position to oversee this work. Internally, this is the person who ensures that planned actions are implemented and coordinates efforts across departments. Externally, this person is the recognized "go to" lead for community organizations, companies, and others involved in electrification efforts. As the City moves from implementing the near-term actions identified in this study to longer-term integration of transportation electrification into the City's operations and development, dedicated staff will be needed to lead and coordinate this work.

Every city has a different structure and is organized differently. As the City of Raleigh and partners establish actions and start to embed initiatives into their work, there will be opportunity to build on successes and wins to further move this work forward. As this happens, the City should evaluate opportunities to assign one or more staff to oversee and manage transportation electrification initiatives and continue to help drive this work forward within the organization and with community partners.

Seattle's "Go To" Person for Electrification: The Green Fleet Manager

In Seattle, the "go to" person for transportation electrification is the Green Fleet Manager whose responsibilities include:

- **Manage the city's Green Fleet Action Plan**, including keeping the plan current through discussions with stakeholders and new recommended strategies for meeting the city's greenhouse gas reduction targets through electrification.
- **Develop standards for purchase of zero and low-emission vehicles** based on availability of technology in the marketplace, charging and fueling infrastructure, and emissions characteristics.
- **Plan and coordinate installation of charging infrastructure** through planning and design of a comprehensive charging network and coordinating the installation of electric vehicle (EV) charging infrastructure at facilities and properties where vehicles park overnight.
- **Improve fleet operational efficiency** by consulting with city departments to assess their service delivery and identify opportunities to reduce fuel by changing the way service is delivered.
- **Push vehicle market development** by conveying technical and operational requirements to dealers and manufacturers and using the power of collective purchasing to accelerate market development for a range of vehicle classes.
- **Communicate successes** through communication briefs, case studies, and other documents that tell the city's story of early leadership and lessons and represent the city in regional efforts to advance transportation electrification.

Source: City of Seattle, Green Fleet Manager Job Description: https://www.governmentjobs.com/jobs/2110286/green-fleet-manager/agency/seattle/apply

5.4 ACTION: **Proactively build transportation electrification investments into the City's operating budget and Capital Improvement Program based on funding availability.**

Near-Term Actions

- Establish an internal process for assessing the return on investments in transportation electrification, including financial metrics as well as those related to greenhouse gas reductions, improved air quality, and other factors

Transportation electrification will require new City investments, whether for vehicle replacements in the City's Operating Budget or new equipment and infrastructure that fits into the City's Capital Planning Process. These investments can be treated like any other, requiring an evidence-based description of needs and proposed solutions to ensure a prudent use of the public's resources. Justifications should address the broad range of benefits, some easy to quantify and some not, that show these investments support the City's Strategic Plan and vision. The City can identify innovative solutions for funding that allow it to reap savings and to overcome any budget-related challenges of moving from a fossil-fuel based fleet to an electrified one.

Implementation Roles and Responsibilities: Lead and Collaborating Departments

Action/ Strategy	Topic Summary Description	Lead Department	Collaborating Departments
5.1 Action	Include transportation electrification as an initiative within the City of Raleigh's Strategic Plan. Identify connections between the specific recommended actions and strategies in this study with the Key Focus Area sections of the Strategic Plan.	Budget & Management Services	Engineering Services Transportation Sustainability Information Technology
5.2 Action	Establish an internal Initiative Team with representation from across City departments and external stakeholders to undertake the implementation activities identified in the study, coordinate implementation efforts across departments, and monitor and report on implementation progress. As part of this work, craft a longer-term approach for managing transportation electrification and mobility as a program. The Office of Sustainability could serve as the convener of the team, and the different initiatives and actions should be led by the designated department leads and supporting departments.	Sustainability	Engineering Services Transportation Budget & Management Services Transportation Electrification Project Steering Committee
5.3 Action	As implementation proceeds beyond an initial set of near-term activities, evaluate the need for additional staffing to oversee transportation electrification and mobility efforts.	Sustainability	Information Technology Engineering Services Transportation Human Resources
5.4 Action	Proactively build transportation electrification investments into the City's operating budget and Capital Improvement Program based on funding availability.	Budget & Management Services	Engineering Services Transportation Sustainability Information Technology

Conclusion

This study has explored the ways that the City of Raleigh can become a community that embraces the many benefits of transportation electrification. The process of engaging City of Raleigh personnel in the work has allowed them to dig deeper into the issues of how to implement specific actions and strategies for electrification. If predictions hold true that over half of all new vehicles sales in 2040 will be electric vehicles (EVs) and a third of all vehicles on the road will be electrified, the City can be a leader by starting now to ensure that this trend benefits all of its residents, the environment, and the economy. This study recommends a range of strategies and actions that can set the City of Raleigh on a strong path of transportation electrification to advance the City toward its vision *to pursue a world-class quality of life by actively collaborating with our community towards a fulfilling and inspired future for all*. The recommended strategies and actions are informed by insights into key lessons and best practices from around the country and calibrated to the City of Raleigh's specific context, needs, and opportunities.

By initiating this study, the City of Raleigh has signaled its interest in a forward-thinking approach to transportation electrification within the broader context of economic development, equity, services to citizens, environmental stewardship, and prudent use of public resources. Moving forward will require many steps by the City but also public-private partnerships to developing EV infrastructure to meet projected demand. Applying an equity lens to transportation electrification is another area in which the City can demonstrate its leadership and benefit all its residents.

The path recommended in this document will include learning and adaptation over time as implementers develops insights from early steps about how to make this transition but also as the reality of what is possible unfolds through changes in technology, policy, and the expectations of residents. It will require that City personnel work together in new ways, drawing on the deep expertise and capacity within City government. It will also involve new engagement with communities, businesses, and residents who are part of this journey. The recommendations provided in the “Implementation Roles and Responsibilities” section will be critical to make sure the study does not sit on the shelf: integrating this work within the City’s Strategic Plan process, engaging a cross-departmental Initiative Team with clear internal leadership, and budgeting and investing to support the actions recommended in the study. The City should go into this work optimistic and inspired about the many ways that transportation electrification can benefit every resident of Raleigh, helping it remain truly world-class and the place that an increasing number of people choose to work, invest, and live.

Attachment 1: Key Transportation Electrification Organizations and Jurisdiction Activity

As the City of Raleigh works to advance transportation electrification, it may wish to consult leading transportation electrification organizations and/or become more familiar with the work of other leading cities and States, national convenings, and businesses. This field is moving rapidly, so any list risks being quickly out of date. However, below is a list of organizations, cities, state-level initiatives, and companies that have demonstrated sustained commitment to transportation electrification. Also included are some key national and regional convenings that bring together representatives from the public, private, and non-profit sectors interested in transportation electrification.

Leading Transportation Electrification Organizations:

- **Alternative Fuels Data Center** (U.S. Department of Energy): Provides information, data, and tools to help fleets and other transportation decision makers find ways to reach their energy and economic goals through the use of alternative and renewable fuels, advanced vehicles, and other fuel-saving measures: afdc.energy.gov
- **Climate Mayors EV Purchasing Collaborative**: City-led initiative to pool purchasing power of cities interested in purchasing fleet vehicles; also provides information about EVs and electrified fleets: www.driveEVfleets.org
- **Electrification Coalition**: Nonpartisan, not-for profit group of business leaders committed to promoting policies and actions that facilitate the deployment of electric vehicles on a mass scale in order to combat economic, environmental, and national security dangers caused by our dependence on oil: www.electrificationcoalition.org/
- **Forth Mobility**: Non-profit organization that advances transportation electrification through community, government and business partnerships and increases understanding of EVs through events like ride-and-drives and convenings: forthmobility.org
- **International Center for Clean Transportation**: Leading research organization on clean transportation, including electrified transportation policy, technology, and market development: theicct.org
- **Veloz:** Public-private collaboration to advance transportation electrification, specializing in creative public outreach: www.veloz.org

U.S. Cities Leading the Way on Transportation Electrification:

- **Austin, TX (Austin Energy)**: https://austinenergy.com/ae/green-power/plug-in-austin
- **Chicago (Drive Electric Chicago)**: https://www.chicago.gov/city/en/progs/env/drive_electric_chicago.html
- **Columbus, OH (Smart Columbus)**: https://www.columbus.gov/smartcity/
- **Denver, CO**: https://www.denvergov.org/content/denvergov/en/environmental-health/environmental-quality/Alt_Fuels.html
- **Orlando, FL (Drive Electric Orlando)**: http://pluginperks.com/
- **Rochester, NY (Rochester EV Accelerator)**: https://www.rochesterevs.com
- **San Francisco, CA**: https://www.sfmta.com/projects/electric-mobility-san-francisco
- **Seattle, WA (Seattle City Light):** http://www.seattle.gov/light/electric-Vehicles/

State EV Programs:

- **Charge Ahead Colorado:** https://www.colorado.gov/pacific/energyoffice/charge-ahead-colorado
- **Charge NY (New York):** https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY
- **Drive Electric Northern Colorado:** http://driveelectricnoco.org/
- **Drive Electric Vermont:** https://www.driveelectricvt.com/
- **EV Connecticut:** https://www.ct.gov/deep/cwp/view.asp?a=2684&q=525224&deepNav_GID=1619
- **Go Electric Oregon:** https://goelectric.oregon.gov/
- **Illinois Green Fleets:** https://www.illinoisgreenfleets.org/
- **Plug-in NC (North Carolina):** http://www.pluginnc.com/

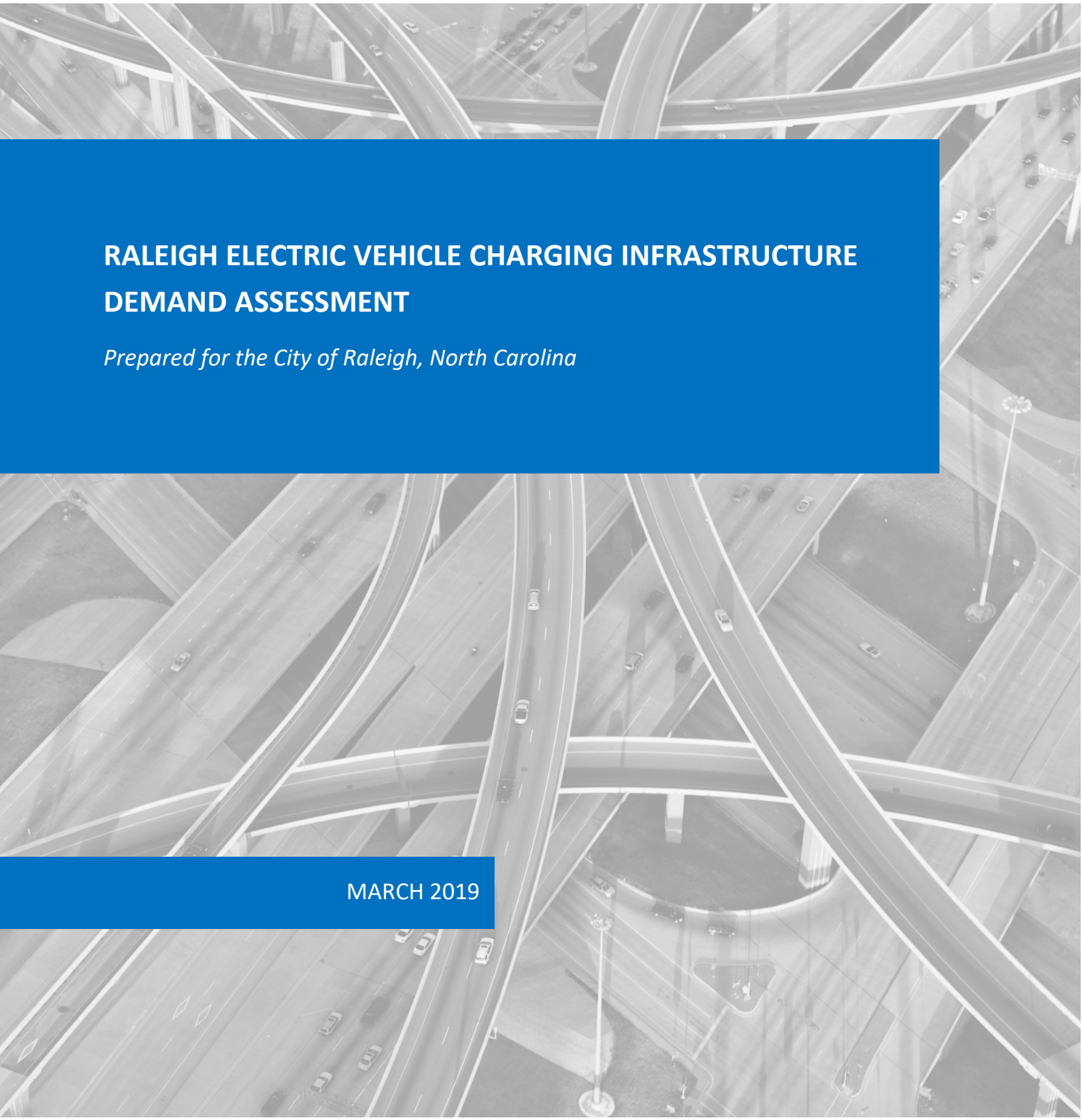
National and Regional Convenings on Transportation Electrification:

- **Advanced Clean Transportation (ACT) Expo:** https://www.actexpo.com/
- **EV Roadmap:** https://roadmapforth.org/
- **Green Transportation Summit & Expo:** http://www.gtsummitexpo.socialenterprises.net/

EV Charging Companies Active in North Carolina:

- **Blink:** https://www.blinkcharging.com/
- **Brightfield Transportation Solutions:** http://brightfieldts.com/
- **Chargepoint**: https://www.chargepoint.com/
- **EVGo:** https://www.evgo.com/
- **GE Watt Station:** https://www.gewattstation.com/connect/
- **Greenlots:** https://greenlots.com/
- **Webasto:** https://www.evsolutions.com/

Attachment 2: Demand Assessment



RALEIGH ELECTRIC VEHICLE CHARGING INFRASTRUCTURE DEMAND ASSESSMENT

Prepared for the City of Raleigh, North Carolina

MARCH 2019

Introduction

The mission of the City of Raleigh is to "build a stable platform of evolving services for our community through which we champion positive and sustainable growth and realize visionary ideas for all, with the vision of pursuing a world-class quality of life by actively collaborating with the community towards a fulfilling and inspired future for all." In order to achieve this, the City has commissioned a study evaluating the current state of its electric vehicle (EV) infrastructure and charting a future strategic direction that draws on models and best practices from around the world and a clear understanding of Raleigh's role in the context of regional transportation. This is an opportunity for Raleigh to be a regional and national leader in accelerating the transition to electric vehicles through the right mix of investments, policies, programs, and partnerships. This effort will contribute to the many reasons that Raleigh continues to attract people to live, work, and invest.

Like many cities in the United States, the City of Raleigh is projecting to have massive growth in the electric vehicle (EV) segment of new automobile sales. Between now and 2030, growing population, a well-educated workforce in technical sectors, and declining battery costs will contribute to the region's EV growth. Working with disadvantaged communities to extend the market beyond the segment of the population that can afford to purchase a new EV will be an important future priority. By extension, these dynamics will require the city to aggressively expand charging infrastructure to plan for anticipated future demand.

Many of the EV market challenges that persist around the country are prevalent in Wake County. These include perceived low number of available charging stations which go hand-in-hand with range anxiety, which are the two largest barriers to purchase by potential EV owners. Raleigh must also consider the unique factors of its own demographics and market in order to plan accordingly for the EV charging network that can simultaneously facilitate and support this growth. This Demand Assessment is a tool intended for use by the City's program managers, policymakers, and other parties to facilitate discussions on developing an effective local EV strategy that aligns with statewide and national goals.

SECTION 1

Raleigh Demographic Profile

The Southeastern United States has undergone significant population and demographic change over the last several decades. Intraregional migration from the Northeastern and Midwestern U.S. to the Southeast has increased North Carolina's resident population and, concurrently, brought new wealth and economic opportunity to the region.[58] More than 1 million people now reside in Wake County, up from just below 270,000 in 1975. Sustained population increases between 1970 and 2010 resulted in a 22 percent peak growth rate in the five years between 1990 and 1995.

Population growth has slowed in recent years. Despite continued increases at the state level[59], estimates from North Carolina's State Demographer project Wake's population to slow to around 9 percent quinquennially through 2035. As North Carolina's population ages, the difference between interstate migration and intrastate birth and death rates will slow the rate of increase.[60] The result is a forecast population increase in Wake County to approximately 1.5 million residents in 2035, up approximately 36 percent from 2017 levels (Figure 1).[61]

This tremendous growth is fueled, in part, by Raleigh's central location in North Carolina and status an innovation hub. High-tech startups and businesses concentrate around reputable research and academic institutions to reduce geographic barriers and improve collaboration.[62] Consequently, Raleigh's labor force has been transformed over the last several decades. Nearly 20 percent of the city's workforce is employed in highly skilled sectors, including science, education, and health services. In the EC's experience, those employed in these higher income industries have traditionally held more favorable opinions toward EVs than the general population.

Additionally, according to the U.S. Census Bureau's American Community Survey, approximately half of Raleigh residents have earned at least a bachelor's degree.[63] And Raleigh is approximately 50 and 20 percentage points above the state national average bachelor's degree attainment rates, respectively. For these reasons, it is not surprising that the city and its constituent Durham-Chapel Hill metropolitan statistical area (MSA) rank among the most well-educated regions in the country.[64]

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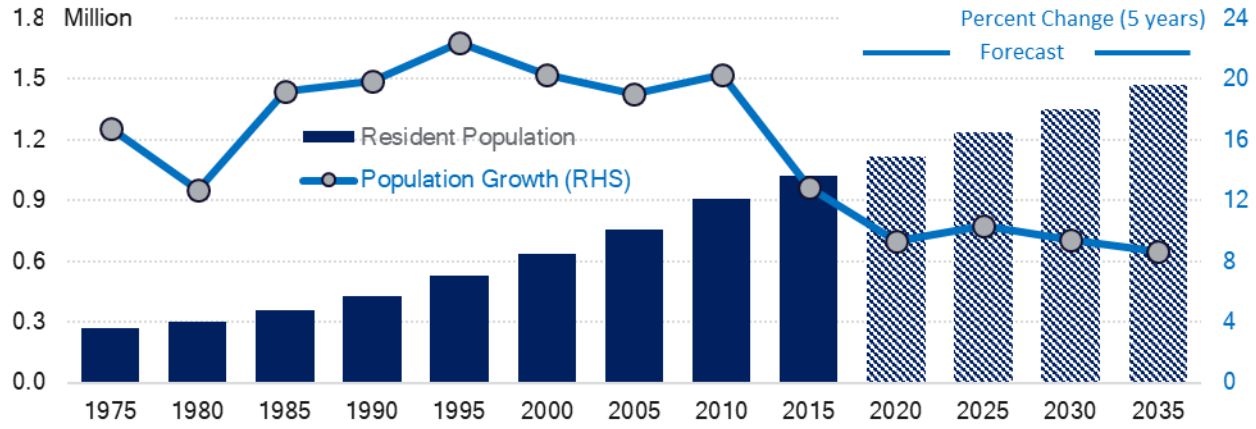
[58] See, e.g., Tim Henderson, "Americans are Moving South, West Again," The Pew Charitable Trusts, January 8, 2016; and Rebecca Tippett, "5 Facts to Know About Migration Between NC and Other States," UNC Carolina Population Center, January 9, 2018.
[59] Note: The University of Virginia's Weldon Cooper Center expects North Carolina's population to grow approximately 10.5 percent between 2020 and 2030, ranking as the 13th fastest-growing State in the country.
[60] North Carolina Office of State Budget and Management, *Regional and County Population Change in North Carolina: Summary of Trends from April 1, 2010 through July 1, 2016*, December 2017.
[61] EC analysis based on data from the U.S. Census Bureau and the North Carolina State Demographer; and State of North Carolina, Budget and Management Office, "County/State Population Projections," nd.
[62] See, e.g., Jeff Barrett, "Why Raleigh, North Carolina, Will Be the Next Startup Hub," Inc.com, Inc., June 25, 2018; and Martin Neil Baily and Nicholas Montalbano, *Clusters and Innovation Districts: Lessons from the United States Experience,* The Brookings Institution, December 2017.
[63] EC analysis based on data from the U.S. Census Bureau. Note that the proportion of Raleigh residents holding a bachelor's degree has risen roughly 4 percentage points over the seven years, from 46.6 percent to 50.8 percent. This proportion is approximately on par with educational attainment in Wake County.
[64] See, e.g., WalletHub, "Most & Least Educated Cities in America," July 24, 2018;

Figure 1: Wake County, North Carolina Population, 1975 to 2035



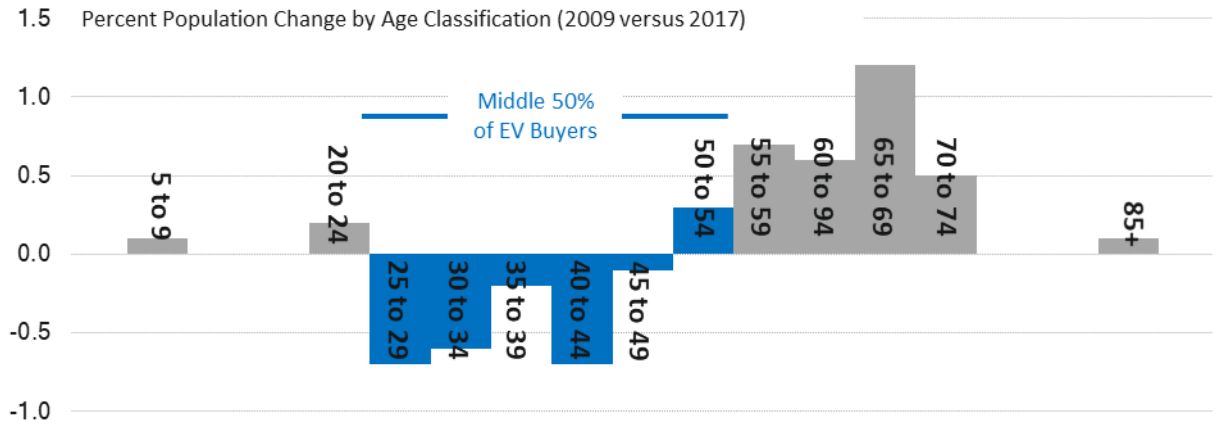
Source: EC analysis based on data from the U.S. Census Bureau and the North Carolina State Demographer.

In Wake County, this high concentration of skill and talent supports a median household income of $73,577, approximately 28 percent above the national average.[65] Compared to the state, Raleigh's unemployment rate is also low at 3.3 percent and has tracked below the U.S. national average for the past several years.[66] Through 2026, North Carolina's Department of Commerce anticipates the state labor market will add 389,000 new jobs with the drivers of this employment growth expected to be in Raleigh's aforementioned core sectors.[67]

Like much of the Sun Belt, older residents and retirees are also driving some of Raleigh's population increase. Older residents are aging in place while population growth in the age 50+ segment increases.[68] To some extent, population change has already been observed. Between 2009 and 2017, the distribution of Raleigh's 55- to 74-year-olds grew by an average of 0.75 percent. Figure 2 shows how most growth occurred in the 65- to 69-year-old segment. Meanwhile, the proportion of 25- to 49-year-olds decreased by 0.49 percent. Due to their financial capacity to pay for new technologies, and higher inclinations to buy EVs, current market research suggests the middle 50 percent of EV buyers are between the ages of 25 and 54 years old.[69] Long term, a growing share of aging residents could place some downward pressure on regional EV demand. Still, in the future, it is unlikely that older residents will continue to have the same cautionary attitudes about EVs.

[65] Department of City Planning, City of Raleigh, North Carolina, 2017 Data Book, September 2018; and EC analysis based on data from the U.S. Census Bureau American Community Survey 2017 for Wake County.
[66] EC analysis based on data from the Bureau of Labor Statistics.
[67] North Carolina Department of Commerce, Press Release, North Carolina Employment Projections to 2026, October 10, 2018.
[68] William H. Frey, "Sun Belt Population Growth Hits Modest Snag, Census Data Show." The Brookings Institution, December 22, 2017; and Jingjing Jiang, "Millennials Stand out for Their Technology Use," Pew Research Center, May 2, 2018.
[69] Note: Residents over age the age of 65 do purchase EVs, but at rates of purchase that are generally lower than younger cohorts. See, e.g., Hedges and Company, New Car Buyer Demographics 2019, n.d.

Figure 2: Age Group Population Change in Raleigh

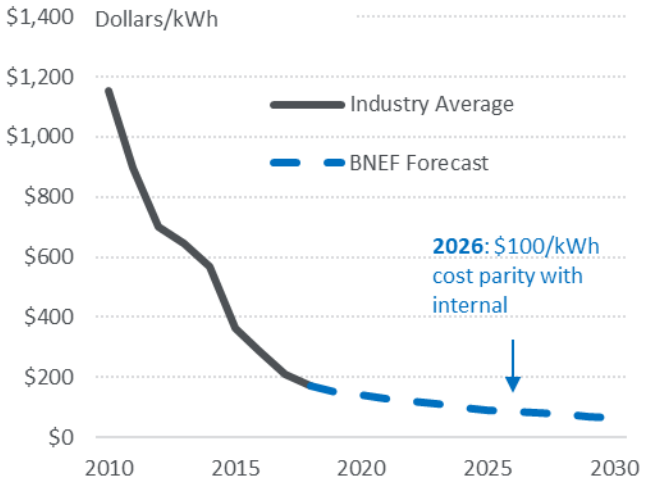


Source: EC analysis based on data from the U.S. Census Bureau, American Community Survey

Over the next several decades, the region's existing economic capacity and increasing population will continue to build interest in EV adoption. By extension, these dynamics will require the city to aggressively expand charging infrastructure to plan for anticipated future demand. This is especially true as the price of the standard lithium-ion battery back declines and EVs become affordable to new segments of the consumer market nationally. For reference, the average battery pack cost approximately $400 per kilowatt hour just five years ago.[70] Today, those costs have declined to around $175 per kilowatt hour and continue to fall as automakers boost EV research and development spending (Figure 3).

This Raleigh resident profile suggests the city, and the broader Wake County area, is ready for future EV adoption. Despite some indicators that the population is aging, the workforce's strong tech focus alongside high rates of net regional migration will bring many EV enthusiasts to Raleigh and fuel demand for new charging infrastructure. However, this concentration of enthusiasts is not enough for the market to develop on its own. Dedicated plans and supportive policy can complement important consumer education campaigns that meet the region's needs and help increase adoption. In Raleigh, this means planning for an infrastructure that will achieve high utilization rates. To do this, the city can help make electrified

Figure 3: Electric Vehicle Battery Pack



Source: Bloomberg New Energy

[70] Mark Kane, "Lithium Battery Pack Prices to Fall From $209 Per KWh Now To <$100 By 2025," Inside EVs, January 25, 2018.

transportation a practical option for hundreds of thousands of residents. [71] The next section will provide a snapshot of these patterns and contextualize them in terms of future EV market growth in North Carolina.

SECTION 2

Raleigh Infrastructure and Travel Profile

For the past one hundred years, the consumer automobile experience has been relatively consistent in certain aspects. Consumers bought cars from dealers and drove and parked them whenever and wherever they wanted. With rare exceptions, refueling options were fast and almost limitless, requiring no advanced planning. The widespread adoption of EVs requires some important shifts from this model. Based on existing battery technology, both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) require comparatively frequent recharging to benefit from electric propulsion. Because PHEVs maintain the use of an internal combustion engine, the recharging issue is less of a constraint to mobility.[72] BEVs most certainly need reliable access to charging units while drivers are carrying out daily commutes and other trips that extend beyond the base range of a battery.

Public charging is an important element of a developing market. Although at-home charging can fulfill up to 80 percent of an EV's charging needs, motorists are accustomed to filling up using the current network of ubiquitous gasoline infrastructure.[73] Inability to locate charging even creates hesitancy in the minds of some consumers, called "range anxiety." A recent Volvo/Harris poll found that three in four American drivers agree that EVs will likely be the dominant future transportation mode. Nevertheless, 58 percent fear they will run out of power before being able to charge their vehicle.[74] More than any other impediment to EV adoption, running out of power and the perceived low availability of charging stations far exceed other concerns (Figure 4). Level 3 "DC Fast Charging" units obviate some of these issues. While a standard 240-volt Level 2 charger can give EV owners a recharge in less than 8 hours, DC installations are notable for charging up 80 percent of EV batteries in less than 20 minutes.[75]

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[71] Note: Drivers choose electrified transportation options when they make economic sense to them. See, e.g., Louise Bruce, Margaret Harris, and Mark Burgess, "Charge up then charge out? Drivers' perceptions and experiences of electric vehicles in the UK," *Transportation Research Part A* 59, 2014, p. 278-87; Ona Egbue and Suzanna Long, "Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions," *Energy Policy 48*, 2012, p. 717-29; and Consumer Federation of America, Press Release, "New Data Shows Consumer Interest in Electric Vehicles is Growing," September 19, 2016.

[72] See, e.g., AFDC, Plug-in Hybrid Electric Vehicles, n.d.

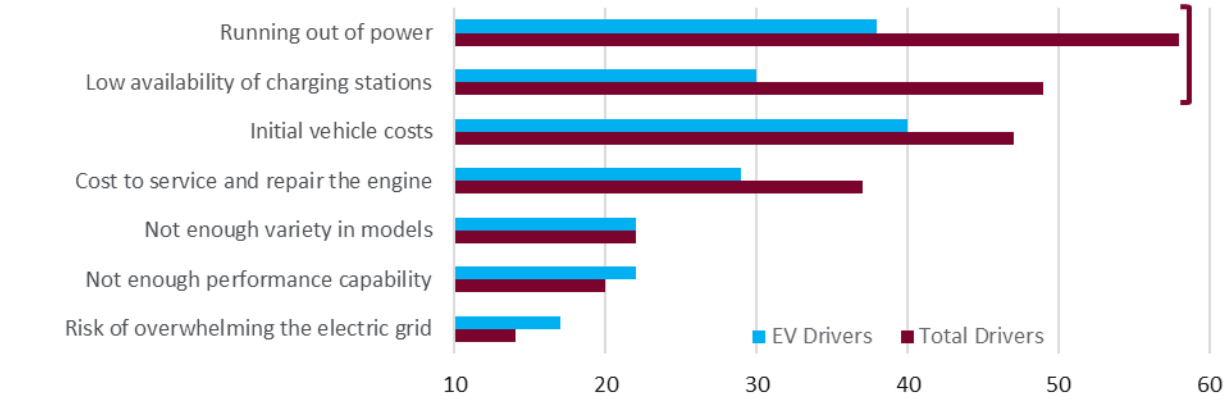
[73] Nigel Berkeley, David Bailey, Andrew Jones, and David Jarvis, "Assessing the transition towards Battery Electric Vehicles: A Multi-Level Perspective of drivers, and barriers to, take up," *Transportation Research Part A* 106, December 2017 at 320-32.

[74] Rob Stumpf, "Americans Cite Range Anxiety, Cost as Largest Barriers for New EV Purchases: Study," The Drive, February 26, 2019.

[75] U.S. Department of Energy, *Costs Associated with Non-Residential Electric Vehicle Supply Equipment: Facts to Consider in the Implementation of Electric Vehicle Charging Stations,* November 2015.

Figure 4: Top Barriers to Purchsing an Electric Vehicle

Percent Agree



Source: Volvo/Harris Poll, February 26, 2019.

Public charger costs are important considerations from a municipal financing standpoint. The cost of a single port electric vehicle supply equipment (EVSE) unit ranges from $300 to $1,500 for Level 1, $400 to $6,500 for Level 2, and $10,000 to $40,000 for DC fast charging. Installation costs can also vary widely, from $0 to $3,000 for Level 1, $600 to $12,700 for Level 2, and $4,000 to $51,000 for DC fast charging.[76] In some states with more limited EV charging infrastructure, Level 3 units are the only publicly-available chargers, in part because they were privately financed.[77] The consequence of this sizable financing gap is that there are fewer Level 3 chargers. Cultivating a built environment with data informed by commuting patterns can help strategically place these units.

Equity issue

Not all drivers have access to charging at home if they live in a multi-unit dwelling such as an apartment building. Making sure that people of all incomes and housing status have access to charging stations will be an equity issue that the City of Raleigh will need to address.

Built Environment

Raleigh is a city where a large proportion of units are single-family owner-occupied units. Like most cities with a growing number of EVs, an increasing share of owners prefer to power up at home on their Level 2 chargers rather than rely on public plugs. In Raleigh's downtown, where there is a higher proportion of multi-unit dwellings, unfavorable condominium rules and older construction homes, may not support as large a share of home charging units. Drivers may require more dedicated public charging access in these areas.[78]

Due to the South's high population growth rates, the U.S. Census Bureau's American Housing Survey shows a large proportion of the region's housing units are new constructions (generally built after

[76] Ibid.
[77] EC analysis based on data from the Atlas EV Hub and the Alternative Fuels Data Center.
[78] Diana Lopez-Behar, Martino Tran, Jerome Mayaud, Thomas Froese, Omar Herrera, and Walter Merida, "Putting electric vehicles on the map: A policy agenda for residential charging infrastructure in Canada," *Energy Research and Social Science* 50, April 2019, p. 29-37.

the year 2000).[79] An analysis by UNC's Carolina Population Center confirms that 2000 to 2010 was the peak decade for most home constructions in Raleigh.[80] For at-home charging, this means that many of the city's suburban homes are likely to be outfitted with modern capabilities that would support EVSE installation. In fact, the South leads the nation with over 38 percent owner-occupied homes, enabling many owners to install equipment without hinderance or delay.[81] The region's warmer climate means there are fewer garages or carports for EVSE, which is neither helpful nor a hindrance to maintaining at-home EVSE with standard weatherproofing.

As Raleigh's population continues to grow, the number of single occupancy homes will also increase, encouraged by the metropolitan region's comparatively low population density. Therefore, in areas outside of Raleigh's downtown, the installation of public charging units will be necessary, but uncritical for the development of the overall market. In and around downtown Raleigh, meanwhile, a higher proportion of multi-unit family dwellings will require dedicated access to public charging infrastructure to support higher urban traffic flows and a denser concentration of resident populations. As a point of comparison, data collected by ChargePoint in Columbus, Ohio, showed that multi-unit family dwellings typically use Level 2 chargers and have the longest "dwell" times on average because vehicles are often plugged in overnight.[82] Multifamily dwellings also generally use the most energy per charging event compared to other classifications, like retail or workplace charging, despite these locations' heavy concentration of DC fast-chargers (Table 1).

Like many urban centers, Raleigh's downtown integrates residential and commercial properties into its urban core. As a result, the city has a vibrant nightlife, for example containing the highest concentration of live music venues and craft breweries in the state.[83] [84] Studies of spatial and temporal mapping show public places, like schools and libraries, are among the most highly-trafficked destination points. As part of a needs assessment produced by the National Renewable Energy Laboratory for the Smart Cities Initiative in Columbus, Ohio, large concentrations of Level 2 charging units were found to be needed around multifamily dwellings and other residential units and a smaller number of DC fast-chargers along highly-trafficked corridors.[85] As part of this study, a spatial simulation using INRIX data identified up to 300 public Level 2 "hot spots," each within a 800-foot distance from a geotagged location. Results were generally coincident with the locations of existing or planned public Level 2 EVSE, which the report says, "confirms local intuition on the placement of chargers."[86] An exercise like this could be useful to the City of Raleigh at a future time.

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[79] EC analysis based on data from the U.S. Census Bureau. Note that Raleigh is segmented out as an MSA in the National Housing Survey's analysis of housing units, so the housing stock of Atlanta was used as a comparison given its geographic proximity and similar population density.
[80] Rebecca Tippett, "Peak construction: When did NC housing stock grow the most?," UNC Carolina Population Center, February 24, 2014.
[81] EC analysis based on data from the U.S. Census Bureau 2017 National Housing Survey and Oak Ridge National Laboratory.
[82] Eric Wood, Clement Rames, Matteo Muratori, Sesha Raghavan, and Stanley Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," *National Renewable Energy Laboratory*, February 2018.
[83] VisitRaleigh.com, Facts About Raleigh, N.C., n.d.
[84] Note: Many of these businesses are likely to attract EV enthusiasts and potential EV drivers. This was the Electrification Coalition's experience operating an accelerator community in Northern Colorado. See, e.g., Electrification Coalition, *Drive Electric Northern Colorado Case Study,* 2016.
[85] Eric Wood, Clement Rames, Matteo Muratori, Sesha Raghavan, and Stanley Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," National Renewable Energy Laboratory, February 2018.
[86] Ibid. at 32.

Table 1: Charging Statistics by Location Type and Level using ChargePoint Data in Columbus, Ohio

Location type	*Level*	*kWh / Charging event*	Charging duration	Dwell time plugged in (min)
Education	L2	8.6	133	175
Healthcare	L2	9.6	137	217
Hospitality	L2	10.7	164	367
Multifamily	L2	14.2	177	532
Municipal	L2	10.1	135	378
Parking	L2	7.9	120	260
Parks and Rec	L2	11.1	147	338
Retail	L2	5.3	84	189
Workplace	L2	7.4	112	240
Retail	DC fast charging	11.8	34	37
Workplace	DC fast charging	11.8	57	116

Source: Eric Wood, Clement Rames, Matteo Muratori, Sesha Raghavan, and Stanley Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," National Renewable Energy Laboratory, February 2018.

As the city considers rezoning applications that will increase Raleigh's density, especially to the south and west of downtown, it will be increasingly important to evaluate public charging needs of a growing EV market.[87] On a population density basis, Raleigh has room to accommodate these demands. Compared to metropolitan communities of a similar size, Raleigh's density rivals that of Atlanta, which is about 20,000 residents larger by population and approximately 370 persons less dense per square mile.[88] Atlanta has already had a positive experience with EVs. In 2014, it propelled the state of Georgia to a nation-leading EV market share of 1.9 percent of light-duty vehicle (LDV) sales. (This rate of EV adoption was far ahead of the country, at the time).[89]

Travel Patterns

Planning and density matter to charger utilization in terms of the built environment, but so do commuting patterns. Despite significant investments in GoRaleigh, the NCSU Wolfline, and other public transportation options, Raleigh is predominantly a car-oriented city. According to surveys administered by the U.S. Census Bureau, the average Raleigh household owns 1.74 motor vehicles. Only 6 percent of households *do not* own a car.[90] In 2017, these rates supported total vehicle registrations nearing 800,000 in the city, a rate that has grown around 2.8 percent annually on average since 2013.[91]

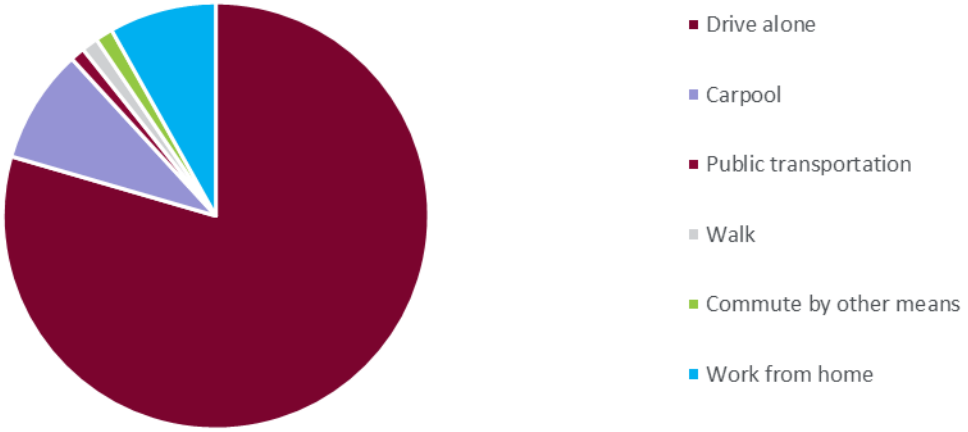
Statewide increases in population and car ownership help drive increases in vehicle miles traveled (VMT). North Carolina motorists drove 11.5 billion miles in 2017, an increase of about 3.6 percent annually between 2013 and 2017.[92] Buses and transportation network companies can help alleviate some passenger trips, but nationally, it is light-duty vehicles that account for the largest share of VMT.[93] According to the U.S. Census Bureau's 2017 American Community Survey, only 20 percent of

[87] See, e.g., Ben Graham, "Developer pitches 9 acres of mixed-use south of downtown Raleigh," Triangle Business Journal, October 8, 2018.
[88] EC analysis based on data from the 2017 U.S. Census estimate.
[89] Keybridge LLC, "Impact of Eliminating the Zero-Emissions Vehicle Tax Credit on the Georgia State Economy," February 18, 2015.
[90] Governing.com, *Vehicle Ownership in U.S. Cities,* 2016 based on data from the U.S. Census Bureau American Community Survey.
[91] Wake County Government, *Data Dashboard,* 2017 based on data from the North Carolina Department of Transportation.
[92] Ibid.
[93] Bureau of Transportation Statistics, Share of Highway Vehicle-Miles Traveled (VMT) by Vehicle Type, 2017.

Wake County residents walk, carpool, use public transportation, or commute by other means (Figure 5). [94] The majority—eight in ten of the 420,000 employed in the County's labor force—commute to work alone in a single occupancy vehicle.

Figure 5: Wake County Commuting Preferences 2017

Percent Share of Labor Force above age 16



Source: EC analysis based on data from the U.S. Census Bureau.

As Raleigh has continued to grow, commute times have also increased to 25 minutes on average, or about 72 seconds longer than in 2013.[95] Alongside increases in population, urban density, and VMT, longer commute times may imply longer waits, greater travel distances, and/or higher traffic volumes. Since commuting times for all transportation modes have increased since 2013, these changes may be more reflective of changing populations and urban densities than volumes. (Vehicle telematics research and mapping could confirm if this is the case).

Recommendations

1. **Raleigh should encourage the placement of light-duty EV charging stations to support the region's growing market.** This can be done by placing Level 3 chargers along highly trafficked corridors, concentrating Level 2 chargers around multifamily dwellings, and by promulgating supportive state and municipal policies that encourage EV adoption countywide (Section 4). As shown in this analysis, Raleigh's concentration of newly constructed single-family housing units outside the urban core present an opportunity to educate consumers about EVSE incentives. In Raleigh's downtown and inside the beltline, the city can plan dedicated public and workplace chargers.[96]

[94] EC analysis based on data from the U.S. Census Bureau's American Community Survey 2017.
[95] EC analysis based on data from the U.S. Census Bureau's American Community Survey 2017.
[96] Note: It is important to note that these newly constructed homes may not be equipped with sufficient electrical capacity to charge plug-in battery packs overnight. Insofar as it is possible to identify the number of residential units where this is true, any future analysis would require a more detailed engineering assessment of carport construction and dedicated vehicle parking space. See, e.g., Elizabeth Traut, TsuWei Charlie Cherng, Chris Hendrickson, and Jeremy Michalek, "U.S. residential charging potential for electric vehicles," *Transportation Part D* 25, 2013, p. 139-45.

2. **Wake County and the City of Raleigh should conduct an electric bus charging infrastructure needs assessment.** The status of electric commercialization within MDHD classes varies.[97] Manufacturers face issues related to suppliers charging high prices, federal and state regulatory ambiguity, and challenging economies of scale.[98] In addition, high up-front costs are a barrier to the public transit financing process.[99] These issues are not to say electric fleets will not become commercially viable soon. Quite the contrary. Experts suggest states and municipalities begin planning for MDHD charging infrastructure given the anticipated pace of deployment. Many other cities in the U.S., such as Asheville, Seattle and LA, have already set goals that they are well on their way to meeting for transit electrification.

3. **An emphasis on equity should be placed on future market growth.** To ensure that all neighborhoods in Raleigh have access to EVs and charging stations, the City should partner with community representatives to plan for EV market growth. This can be accomplished a number of ways: meeting with affected residents; facilitating access to the used EV market; assessing how EVs make sense to these groups; increasing EV awareness by using trusted messengers such as community-based organizations; enlisting auto dealers to sell EVs by helping educate other auto dealers on EV benefits and incentives; and diversifying the EV workforce by facilitating careers in EV and EVSE manufacturing, repair and maintenance.[100]

SECTION 3

Outlook for Public Charging Needs

Many Level 2 charging stations are currently available to Raleigh EV drivers. The city has installed a total of 23 public EV charging stations. This year, those stations have delivered 12,938 kWh at an average rate of 6 kWh per charge. Nearly 2,000 total charges have been logged.[101] Alternative Fuels Data Center has logged 60 public charging stations in the City of Raleigh, more than three-quarters of which are at Levels 1 and 2.[102] Nearly nine out of every ten chargers are accessible 24 hours per day. Raleigh's downtown zip code of 27601 hosts the highest concentration of 10 charging stations, followed by 9 stations within the city's southwestern 27606 zip code and 8 within its northwestern 27607 zip code.[103] Statewide, AFDC says North Carolina has 560 public charging stations, of which Raleigh accounts for 11 percent of the state total.[104] Combined, the cities of Raleigh, Durham, Chapel Hill, and Cary represent more than one-quarter of the state's public EV charging infrastructure.

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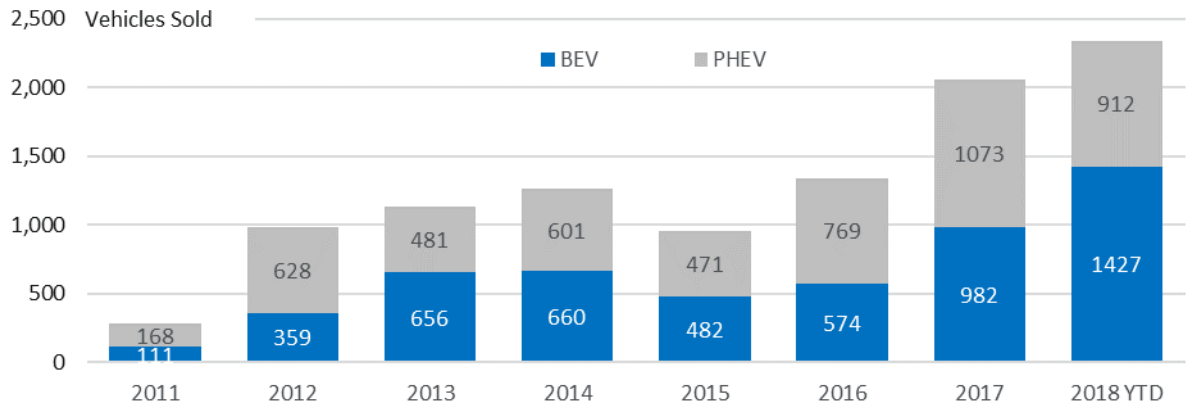
[97] ICF International Inc., *Medium- and Heavy-Duty Electrification in California,* December 2018.
[98] See, e.g., North American Council for Freight Efficiency, *Amping Up: Charging Infrastructure for Electric Trucks,* March 2019.
[99] See, e.g., Duke Energy, Presentation on Financing Electric Vehicle Infrastructure, 2016; and Bloomberg New Energy Finance, *Electric Busses in Cities: Driving Towards Cleaner Air and Lower CO_2,* March 29, 2018.
[100] Joel Espino, *5 Steps for Electric Vehicle Equity,*The Greenling Institue, August 17, 2016.
[101] EC analysis based on data from the City of Raleigh and Periscope, *Electric Vehicle Charging Station Viewlet.*
[102] EC analysis based on data from AFDC.
[103] EC analysis based on data from AFDC and UnitedStatesZipCodes.org.
[104] EC analysis based on data from AFDC.

These stations support the region's growing EV market. Since 2011, North Carolina's total EV stock has grown to nearly 10,400 vehicles, approximately 51 percent of which are BEVs.[105] As has been the trend nationally, the BEV share of the total market has grown as Tesla increases deliveries of its Model 3 sedan. Consequently, the BEV share of North Carolina's new EV sales increased by 13 percent year-on-year (y/y) in 2018 to 61 percent.[106] These changes correspond to national EV market dynamics, which see similar y/y growth and expansion of BEV market share. Estimates from Bloomberg New Energy Finance (BNEF) presented earlier in Figure 3 show declining battery costs into the 2020s. These cost declines will occur contemporaneously with new model offerings.[107] Most analysts now project permanent and sustained shift away from PHEVs that will lower the PHEV share of the plug-in electric market overall.[108]

Figure 6: North Carolina EV Sales, 2011-18



Note: Data through August 2018. It's important to note that Q3 and Q4 2018 were robust months for the national EV market.

Source: The Alliance of Automobile Manufacturers

In North Carolina, one would expect a growing BEV segment to support the state's rising number of on-road EV stock. Without a more favorable suite of state and municipal EV adoption incentives, it is unlikely that the state's EV adoption rate will exceed the nation as a proportion of new LDV sales. In 2018, EVs represented only 1 percent of North Carolina's new LDV sales (+0.5 percent from 2017).[109] Nationally, EVs are now above 2 percent of LDV sales.[110] This trend will change as the U.S. EV market becomes more competitive, but the state's growth rates are not likely not be as robust as the national average.

Methodology and Limitations

This study deduces Wake County's infrastructure needs from the U.S. Department of Energy's Energy Efficiency and Renewable Energy's (EERE) national analysis of the current and projected

[105] EC analysis based on data from the Alliance of Auto Manufacturers' U.S. Light-Duty Advanced Technology Vehicle Sales Dashboard.
[106] Ibid.
[107] See, e.g., Jamie LaReau, "GM Plans Expanded Bolt Production, 20 New Electric Vehicles by 2023," Detroit Free Press, June 12, 2018.
[108] See, e.g., Bloomberg New Energy Finance, *Electric Vehicle Outlook 2018;* and JPMorgan Chase & Co., *Driving into 2025: The Future of Electric Vehicles,* October 25, 2018.
[109] EC analysis based on data from the Alliance of Auto Manufacturers and IHS Markit Inc.
[110] EC analysis based on data from the Alliance of Auto Manufacturers and BEA.

growth rates in the population, automotive market, and EV adoption. Given the early stage development of a national EV market, forecasts for adoption frequently vary depending on several assumptions, including uptake rate, component and manufacturing cost, and production levels. This study uses EIA's reference case scenario for U.S. adoption rates, which is historically more conservative than those developed by other agencies, like Bloomberg New Energy Finance or the International Energy Agency.[111] Therefore, EV adoption numbers may be larger than forecast and projections may change depending on future technology or policy.

A baseline projection developed by EERE was used to estimate Wake County's EV charging needs in 2030. As part of a national assessment, EERE segments the Level 2 and DC fast-charging requirements of cities, towns, rural areas, and interstates given several assumptions about anticipated increases in electricity demand and EV adoption rates.[112] EERE then identifies the approximate number of stations and plugs needed to meet national demand that year. EERE national data was inputted into a model that deduced the growth rates for the state and Wake County. Population parameters based on state vehicle registration, population, and workforce size helped scope the size of the state and Wake County to 2030.[113]

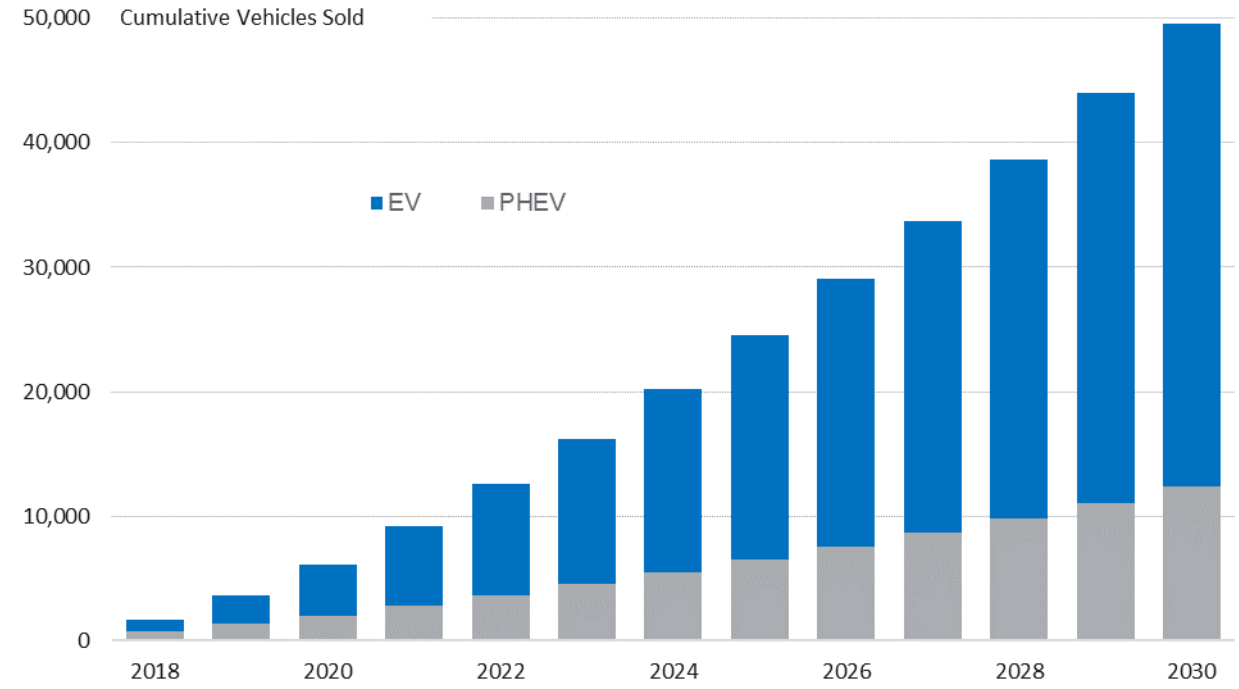
This study focuses exclusively on public Levels 2 and 3 chargers given that most EV owners will do most of their charging at home and install private EVSE. It is also intended to provide a general overview of charging needs from one specific reference point. A more expansive analysis using the inputs identified earlier in this paper (such as income, workforce, age, commuting and car ownership trends) may reveal more robust regional EV demand that would be forecast under EIA and EERE's conservative scenarios. The analysis is also limited by focusing exclusively on the LDV segment given the status of commercialization within MDHD fleets.

Estimating Raleigh's Infrastructure Gap

Wake County EV sales are projected to increase from 541 in 2017, to 5,100 in 2030. More than three-quarters of those sales will be BEVs. These increasing sales volumes will result in a local EV stock numbering 50,000 in 2030, more than 37,000 of which will be BEVs. This significant rate of growth will be propelled by increases in the statewide EV stock to 311,000 EVs, representing less than 3 percent of the total national on-road vehicle fleet in 2030. Wake County adds nearly 23,000 EVs between 2019 and 2025.

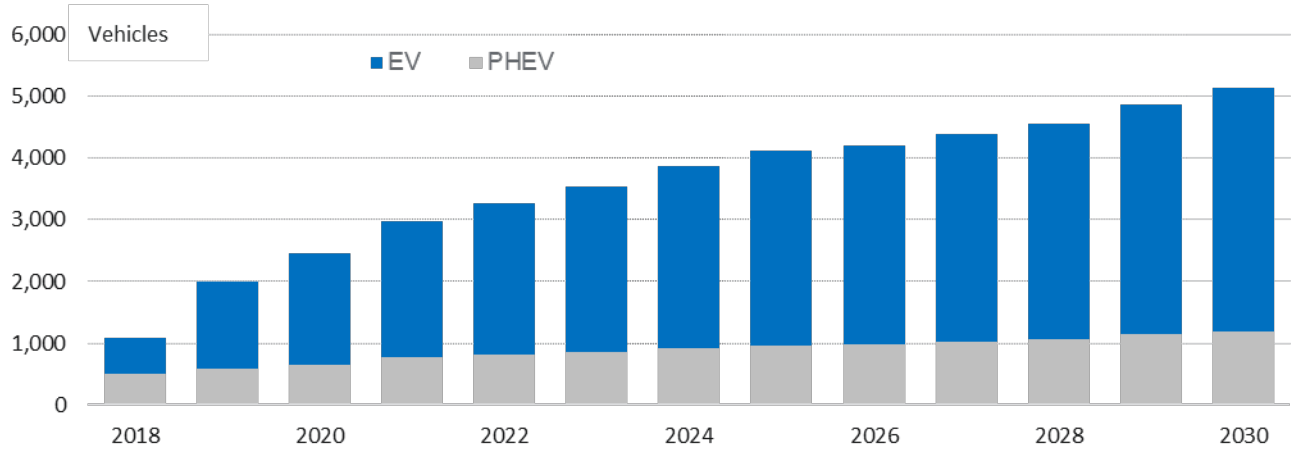
[111] Bloomberg New Energy Finance, *Electric Vehicle Outlook 2017,* at 3; and International Energy Agency, *Global EV Outlook 2018.*
[112] EERE, *National Plug-in Electric Vehicle Infrastructure Analysis,* September 2017.
[113] EC analysis based on data from the U.S. Census Bureau, Wake County Government, the North Carolina Department of Transportation.

Figure 7a: Wake County Projected EV Stock



Source: EC analysis based on data from EIA and EERE.

Figure 7b: Wake County Projected New EV Sales



Source: EC analysis based on data from EIA and EERE.

EERE has estimated the approximate number of DC fast-charging stations required to meet nationwide demand in 2030: 4,900 DC fast-charging stations in U.S. cities; 3,200 DC-fast charging stations in towns; and 400 DC fast-charging stations placed along interstate corridors. Following Columbus' experience placing public fast-chargers[114], these interstate stations should be located at

[114] Eric Wood, Clement Rames, Matteo Muratori, Sesha Raghavan, and Stanley Young, "Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio," *National Renewable Energy Laboratory*, February 2018.

high-traffic thoroughfares throughout the region. This analysis suggests *a minimum* of 30 DC fast-charging stations will be needed countywide. Currently, the Raleigh area has 15 DC fast-charging stations, according to AFDC, a number that puts the county on track to achieving DC fast-charging needs in 2030. A minimum of 18 stations should be placed in Wake County cities, 11 in towns, and at least 1 along high-traffic thoroughfares. These stations will require at least 99 DC fast-charging plugs.

Table 2: Raleigh's DCFC Infrastructure Needed Through 2030

Year	DCFC Station Count	DCFC Plug Count
2020	10	33
2025	19	61
2030	30	99

The city and county will need to be much more involved in growing the number of Level 2 nonresidential public plugs. Nationally, EERE estimates approximately 451,000 plugs will be needed to meet 2030 demand in cities. An additional 99,000 plugs will be needed in towns, and 51,000 in rural areas.[115] In Wake County, this equates to approximately 1,600 Level 2 plugs in cities and 2,150 plugs countywide. Approximately 200 Level 2 chargers will be needed countywide by the end of 2019 to keep pace with the market—an increase of 77 plugs from today.

SECTION 4

Role for State and Local Policy

Throughout the past decade, the U.S. private and public sectors have invested heavily in developing EVs and an advanced transportation ecosystem. BNEF estimated total global venture capital and private equity investment in advanced transportation between 2007 and 2012 at $4.5 billion.[116] Daimler is investing more than $23 billion by 2030 into battery cells to prepare for its future mass production of hybrid and electric vehicles.[117] The company is also planning on investing over $12 billion in next generation EVs, including a $1 billion investment in a battery plant in Alabama.[118] Tesla Motors has expanded its charging network to include more than 618 fast charging stations.[119] Public sector research, development, and deployment initiatives have complemented this private activity. Federal government spending on advanced vehicle R&D alone has totaled more than $4.2 billion since 2000.[120]

The federal government offers a tax credit worth up to $7,500 to PEV buyers and several states also offer a rebate or tax credit.[121] Federal, state, and local governments also play an important role in incenting the installation of EV charging infrastructure. PEV-supportive policies are emerging at all levels of government, including non-monetary incentives like high-occupancy vehicle (HOV) lane

[115] EC analysis based on data from EERE.
[116] EC interviews with BNEF.
[117] Edward Taylor, "Daimler to Buy $23 Billion of Battery Cells for Electric Car Drive," *Reuters*, December 11, 2018.
[118] Christoph Rauwald, "Mercedes Unveils First Tesla Rival in $12 Billion Attack," Bloomberg, September 4, 2018.
[119] AFDC, "Electric Vehicle Charging Station Locations," n.d.
[120] Kelly Sims Gallagher and Laura Diaz Anadon, "DOE Budget Authority for Energy Research, Development, and Demonstration Database," Energy Technology Innovation Policy, John F. Kennedy School of Government, Harvard University, June 2017

access and preferred parking, which improve the buyer/driver value proposition. Increasingly, widespread efforts are also focused on community-level education and experiential activities. These include partnerships between public and private entities like the Rochester EV Accelerator or Drive Electric Northern Colorado, which are community initiatives designed to achieve widespread deployment of PEVs.

Cities have an important role in this transition to transportation electrification. Municipal governments can write EV-friendly building codes and incentives for developers, pilot local projects that demonstrate the value of electric vehicles or charging infrastructure, and position EV readiness as an economic development tool. This systemic focus on state and local policy levers positions EVs as a bipartisan issue and helps build coalitions of advocates among conservation groups, automakers, and the clean tech industry. Cities are also in the best position to engage with utilities, helping to identify regulatory barriers on the resale of electricity for charging and leveraging the allocation of federal transportation investments.

Table 3: North Carolina EV Readiness Policy Assessment

North Carolina exempts EVs from emissions testing. Some commercial and public buildings offer privileged parking for EVs. North Carolina's fleet programs include purchase goals, efficiency requirements, and subsidies to local government purchasers. Duke Energy also offers EVSE installation rebates. Through Nissan, Duke offers a $3,000 rebate on a Leaf purchase. The following list of incentives are current as of March 2019; blue denotes EV-supportive policies.

Laws & Regulations	
Increased Registration Fee	YES ($130)
Insurance Non-Discrimination	NO
[Commercial] PEV Charging Retail Rate Exemption	NO
Emissions Testing Exemption	YES
HOV Lane Access	YES
Aftermarket Conversion Inspection & Fee	NO
Public Entity EVSE Authorization	NO
Parking Preference	NO

State Incentives / Subsidies	
Vehicle Tax Credit	NO
Vehicle Tax Exemption	NO
EVSE Tax Credit	NO
EVSE Incentives [Loans, grants, rebates]	NO
EVSE Policies for Condominiums	NO
AFV Personal Property Tax Reduction	NO
AFV Acquisition Goal [fleet purchase]	YES
AFV Use & Efficiency requirements	YES
Alternative Fuel [Sales] Tax Exemption	YES
AFV State Purchase Fund [subsidy]	YES
AFV Retrofit Fund [subsidy]	YES

State Incentives / Subsidies	
State Highway EVSE Authorization	YES

State Policy Studies	
AFV Infrastructure Incentive Study	NO
ZEV Plan	YES

Utility / Private Incentives	
Residential Charger Rebates	NO
PEV Purchase Rebate	NO
Rate Incentive [Time of Use]	NO
Charging Providers Regulated As Utilities	YES
EV Portfolio Standard for TNCs	NO

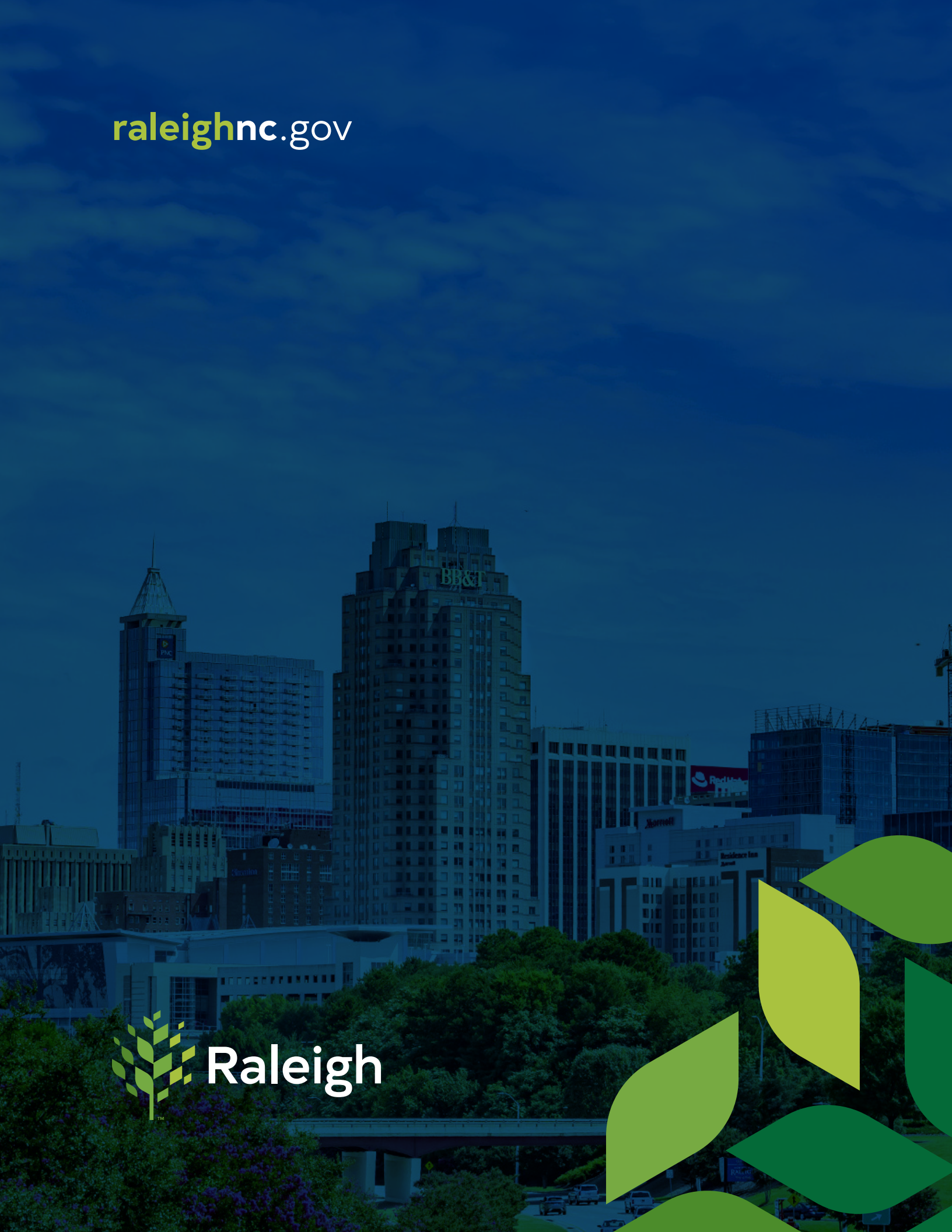
Citywide Incentives	
EV-Friendly Building Codes and Incentives for Developers	NO
EV Infrastructure Project	YES
Streamlined Permitting Process for EVs	YES

SECTION 5

Conclusion

The recent population growth and shifting demographic factors in Wake County towards a highly educated workforce in technical fields present a ready-made opportunity for EV growth, especially when facilitated by the City of Raleigh to build a supporting network of charging stations. By working with disadvantaged communities, the City can ensure that cleaner transportation becomes a reality for all of its residents. This Demand Assessment has provided a look at the demographic trends in Raleigh and what this means for the EV market; an assessment of the status of the current charging station network as well projected infrastructure needs, and how the built environment and traffic patterns are impacting the market; and a round-up of state and local policy that either conforms to best practices or could be altered to create a more EV-friendly environment. With a deep understanding of the market and recommendations for how to facilitate future growth, Raleigh can immediately affirm how transportation electrification contributes to City of Raleigh's Strategic Plan, and ensure that future development is equitable and contributes to economic development.

raleighnc.gov



Raleigh