Establishing Best Practices and Technical Guidance for Planning and Developing an EV Infrastructure Network

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Establishing Best Practices and Technical Guidance for Planning and Developing an EV Infrastructure Network

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16. Abstract

This research addressed the multifaceted challenges of EV infrastructure expansion, with an emphasis on planning policy integration, utility coordination, and equitable access. A failure to deliver accessible and reliable EV charging could inhibit widespread adoption, particularly in historically underserved communities, and exacerbate the environmental and health impacts of transportation emissions. To support informed decision-making, the research team conducted a literature review, a statewide survey of planning agencies, and a review of planning policy and regulatory practices. In parallel, optimization models were developed to analyze siting strategies that balance cost-efficiency, user behavior, and equity-driven deployment. The resulting guidance offers best practices and actionable recommendations for state departments of transportation, planning agencies, utilities, and consulting partners. It emphasizes the importance of integrating planning and utility data, aligning infrastructure investments with user demand, and ensuring that rural and disadvantaged areas are not left behind. With federal and state-level funding initiatives, this research offers a timely foundation for EV infrastructure planning in North Carolina. The goal is to enable a seamless, resilient, and equitable transition to electrified transportation that aligns with long-term sustainability and mobility goals.

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We also thank the planning professionals, municipal and regional agency representatives across North Carolina who contributed their expertise through survey responses and interviews. Their perspectives were instrumental in shaping the findings and recommendations presented in this report.

EXECUTIVE SUMMARY

Electric vehicle (EV) technology presents a vital opportunity for advancing environmental sustainability by reducing emissions from the transportation sector when clean energy sources are utilized. Developing a reliable, equitable, and scalable EV charging network is critical to enabling the transition to EVs. However, achieving this requires more than the physical deployment of charging stations. It demands a coordinated approach to policy, planning, utility integration, and equity considerations, especially to ensure that rural areas and historically underserved communities are not left behind. This research addressed the multifaceted challenges of EV infrastructure development and delivered a practice-ready foundation for statewide EV charging network expansion. Through a combination of literature review, policy assessment, a statewide survey, interviews, and modeling-based analysis, the study identified actionable strategies to support informed decision-making at the local, regional, and state levels. The literature review highlighted the growing complexity of EV infrastructure planning, emphasizing the interplay between charger location, user behavior, power system limitations, and regulatory frameworks. A key insight was the importance of integrating equity-driven practices into siting methodologies, particularly as market forces alone are unlikely to serve communities of concern. The state of practice review revealed significant variation in how local governments approach EV planning. While some municipalities have adopted forward-looking policies and comprehensive EV strategies, many jurisdictions remain early in the process or face barriers such as limited staffing capacity, unclear permitting procedures, and a lack of coordination with utilities. Best practices identified across the country include the development of EV-ready codes, integration of EV planning into sustainability frameworks, and the establishment of clear permitting and signage standards. These findings were echoed in the results of a statewide survey conducted as part of this project, which gathered input from 72 representatives of municipalities, counties, metropolitan and rural planning organizations, and councils of government. Survey respondents confirmed both a growing interest in EV infrastructure and a lack of local capacity and policy readiness. Many expressed a need for practical guidance, sample policies, and better coordination with utility providers and regional partners. To complement the policy and planning review, the research team developed a set of facility location optimization models designed to explore how charger deployment strategies vary based on cost, demand, equity, and technical constraints. These models allowed for scenario-based testing, revealing that even modest changes in demand projections or land use assumptions can significantly affect optimal siting strategies. They also showed how prioritizing equity—in the form of weighting disadvantaged or rural areas—can shift investment patterns and better support inclusive infrastructure outcomes. Model outputs provided insights on charger type suitability, spacing guidelines, grid capacity considerations, and trade-offs between maximizing access and minimizing costs. Sensitivity analyses highlighted the importance of flexible, phased deployment approaches that respond to uncertainty in EV adoption rates and infrastructure funding availability. The result of these efforts is a comprehensive, stand-alone guidance document that translates research findings into clear and actionable recommendations for NCDOT, local governments, utilities, and consulting partners. This guidance emphasizes the need for flexible, equity-aware planning frameworks; the importance of aligning infrastructure investments with utility and grid readiness; and the value of using data-driven modeling to support phased deployment over time. It encourages the adoption of EV readiness standards in local development codes, the streamlining of permitting processes, and the integration of EV goals into comprehensive and transportation plans. Additionally, it identifies opportunities for public-private collaboration and federal funding leverage. This report represented a timely and strategic response to the challenges of EV infrastructure expansion in North Carolina. By bridging gaps between planning practice, policy innovation, and technical modeling, the research equipped decision-makers with the tools necessary to design a charging network that is not only scalable and cost-effective but also inclusive and resilient. As North Carolina moves toward a clean transportation future, the findings and recommendations from this study will serve as a critical resource for enabling the effective, equitable, and forward-looking deployment of EV infrastructure statewide.

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Chapter 1. Introduction

1.1 Background

Electric vehicle (EV) technology promises significant sustainability benefits by reducing environmental pollution caused by the transportation sector. According to Bloomberg's Electric Vehicle Outlook 2020, EVs are projected to constitute 55% of new automobile sales globally by 2040. These shifts are further supported by strong policy signals: several jurisdictions, including California (and potentially 17 other U.S. states that follow California's air quality standards), have committed to phasing out the sale of internal combustion engine vehicles by 2035. Similar commitments are underway in international markets such as Canada and the European Union. These global and national movements necessitate urgent local action to ensure communities are ready for the surge in EV adoption. However, the promise of electrified transportation also comes with a host of planning, technical, and equity challenges. Inadequate public charging infrastructure remains a significant barrier to widespread EV adoption, particularly in rural areas and underserved communities. Without thoughtful policy design, these populations risk being excluded from the benefits of electrification, exacerbating existing transportation and environmental inequities. EV user behavior and preferences add another layer of complexity: choices around where, when, and how to charge are influenced by travel patterns, charger availability, electricity prices, and personal time constraints. These behavioral variations can lead to fluctuating charging demands across geography and time, placing new stresses on power grids and infrastructure. Moreover, the integration of EVs into the transportation ecosystem is deeply intertwined with electric power systems. Unlike conventional vehicles, EVs depend on a robust and resilient power grid that can accommodate diverse charging patterns, including peak-hour surges and destination-based charging demands. Charging infrastructure must account for location-specific factors (such as proximity to travel corridors, land use patterns, and utility capacity), while also aligning with broader planning goals like accessibility, economic development, and emissions reduction. The management of an EV-dominated system thus requires not only hardware deployment but also smart, data-driven coordination between transportation planners, utility providers, and local governments.

1.2 Research Objective and Scope

To support North Carolina's transition to electrified transportation, this research project was initiated with the primary aim of developing a comprehensive, practice-ready framework for EV infrastructure expansion. The central objective was to produce a series of planning and policy best practices and technical siting guidelines that address the multifaceted nature of EV infrastructure development. The scope of the research includes understanding the evolving policy landscape, synthesizing state-of-the-art technical methods, analyzing stakeholder and community feedback, and developing decision-support tools to inform equitable and efficient infrastructure deployment.

1.3 Research Approach

The research was structured around several interrelated components:

1. Literature Review: A comprehensive review of academic and technical sources focused on EV infrastructure planning. This included methods such as optimization modeling, multi-criteria decision analysis, and behavioral simulation, along with themes like utility

coordination, local government roles, and equity-based siting. Research gaps were identified, particularly around practical applications of theoretical models. The literature review highlighted key methodologies (such as optimization modeling, multi-criteria decision analysis, and behavioral simulation) as well as emerging themes, including equity in infrastructure siting, coordination with utilities, and the role of local governments. It also identified research gaps that this study aimed to address, particularly in adapting theoretical models for practical planning applications and emphasizing equity-based deployment strategies.

2. State of Practice Assessment: A detailed review of current EV planning efforts across the U.S. and within North Carolina. The state of practice review was undertaken to assess how EV infrastructure planning is currently being carried out across the U.S. and within North Carolina. This component analyzed state, regional, and municipal-level policies, regulations, and planning efforts. Particular attention was paid to the status of permitting processes, siting guidelines, zoning codes, and utility readiness. Lessons were drawn from leading jurisdictions to inform the development of adaptable best practices.
3. Stakeholder Survey: A statewide survey distributed through MPO, RPO, and COG listservs to gather insights from planning professionals. The survey covered topics including current planning efforts, regulation development, fleet electrification, community engagement, and perceived barriers to implementation. Seventy-two fully completed responses were collected from a range of municipalities, counties, and regional planning bodies, with additional follow-up interviews conducted to deepen the analysis. This input provided invaluable local context and revealed variations in planning capacity and regulatory readiness across different regions of the state.
4. Optimization Modeling: Building on the findings from the literature review, state of practice assessment, and stakeholder feedback, a suite of optimization models was developed to support the strategic siting of EV charging infrastructure. These models incorporate demand forecasting, cost minimization, equity metrics, and sensitivity analyses to evaluate a range of deployment scenarios. They were designed to be adaptable to local conditions, enabling planners to test different prioritization criteria (such as geographic coverage, user proximity, or cost efficiency) depending on policy goals and resource constraints.
5. A suite of adaptable optimization models was developed to support infrastructure siting. These models incorporated demand forecasting, cost-efficiency, equity metrics, and scenario testing. Planners can use them to prioritize deployment criteria such as user proximity or geographic coverage under various constraints.
6. Documentation and Guidance Development: Two final documents were produced:
   - A Literature Review and State of Practice report consolidating technical insights and policy trends, which consolidates all key findings and insights relevant to EV infrastructure planning and policy.
   - A Best Practices and Guidance document that translated findings into actionable recommendations for NCDOT, MPOs, RPOs, local governments, utility partners, and consulting teams. The document translates the insights from academic literature, national practices, stakeholder input, and modeling results into a cohesive and actionable framework. This document offers planning policy guidance, technical siting strategies, model-specific recommendations, and general implementation advice tailored to the needs of different user groups, including NCDOT, local governments, MPOs and RPOs,

utility partners, and consulting firms. It also includes sample ordinances, zoning templates, and equity-based planning considerations to support locally appropriate decision-making.

1.4 Report Organization

The organization of this final report reflects the structure of the research approach. Following this introduction, Section 2 presents a summary of the literature review, synthesizing existing research and methodologies. Section 3 describes the state of practice and the results of the planning and policy survey conducted across North Carolina. Section 4 discusses the optimization models developed as part of the study, highlighting key modeling insights. Section 5 presents the best practices and guidance framework, organized around planning, general, and modeling-based recommendations. Section 6 outlines the guidelines developed for EV infrastructure deployment in North Carolina. Sections 7 through 9 synthesize the study's findings, present policy and planning recommendations, and describe an implementation and technology transfer plan to support the practical application of this research. In summary, this research effort aimed to advance North Carolina's EV readiness by integrating cutting-edge technical approaches, local planning realities, and state and national policy directions into a unified framework. It offered a balanced approach that acknowledges economic feasibility, technological viability, and social equity, positioning the state to lead in the development of a resilient, inclusive, and future-ready EV charging network.

Chapter 2. Result of Literature Review

The transition to EVs is reshaping transportation systems, energy demand, and environmental policy at an unprecedented pace. The development of an efficient, equitable, and resilient EV charging infrastructure is foundational to supporting this transition. To inform North Carolina's efforts in planning and implementing a statewide EV network, a comprehensive review of the academic and technical literature was conducted. This review identifies, synthesizes, and evaluates current research on key aspects of EV infrastructure planning -- including facility location optimization, power system integration, scheduling coordination, charging demand modeling, and equity considerations.

The literature review explored a broad range of modeling methodologies and implementation frameworks that are relevant to the establishment of best practices and technical guidance. Particular attention was given to studies that examine the spatial and operational dynamics of charging systems, interactions with the electric power grid, V2G technologies, and the implications of emerging technologies such as dynamic wireless charging.

A core goal of this review was to understand how EV infrastructure planning can be optimized to meet technical, environmental, and social goals simultaneously. This required integrating models that address stochastic demand, grid constraints, user behavior, equity of access, and multi-objective decision-making. In addition to technical frameworks, the review also examined literature on the distributional impacts of EV infrastructure and the risk of excluding disadvantaged or rural communities in the absence of intentional planning.

The findings serve several functions. First, they lay a conceptual and technical foundation for planning EV infrastructure in North Carolina. Second, they highlight the complexity of aligning transportation and energy networks, emphasizing the need for integrated modeling tools. Finally, they identify critical gaps in current approaches, including a lack of high-fidelity integration between power grid constraints and transportation system needs, and limited incorporation of equity metrics into facility siting models.

Given the anticipated acceleration of EV adoption in the coming decade -- driven by both market dynamics and public policy -- this literature review provides a timely synthesis of best-available knowledge to guide infrastructure investment, design decisions, and regulatory development. It supports the creation of scalable, adaptive, and inclusive EV networks that are responsive to local context and broader state and national goals.

The literature review has covered (1) recent power quality considerations, (2) G2V/V2G power exchange, (3) EV charging scheduling coordination, (4) EV charging optimization techniques, (5) location allocation models considering power supply requirements, and (6) equity.

2.1 Key Themes and Findings

– **EV Charging Infrastructure Planning.** The reviewed studies offer diverse perspectives on how to design charging networks, taking into account travel behaviors, infrastructure costs, and power system impacts. Key modeling approaches include:
  - Flow-capturing models to optimize locations based on traffic flows.
  - Travel-range-constrained optimization, where limited EV range affects placement and density of stations.

- Simulation-based and stochastic methods that incorporate demand variability and user behavior uncertainty.

These methods highlight the complexity of coordinating transportation and energy infrastructure under real-world constraints.

– **Power Grid Quality and Supply Considerations.** As EV adoption grows, power distribution networks face increased stress. Literature identifies significant challenges including:
  - Voltage and frequency fluctuations
  - Transformer overloading
  - Harmonics and phase imbalances
  - Need for demand-responsive charging management

Solutions such as Vehicle-to-Grid (V2G) integration, decentralized charging control, and real-time power flow modeling have been proposed to maintain grid reliability while enabling high EV penetration.

– **EV Charging Scheduling and Coordination.** Effective scheduling reduces peak loads and improves energy efficiency. Coordination methods range from centralized control to scalable decentralized frameworks. Strategies include:
  - User clustering and load forecasting based on behavioral data
  - Decentralized scheduling for scalability and resilience
  - Multi-stakeholder optimization (user, utility, and station owner)

However, gaps remain in aligning operational schedules with grid dynamics and ensuring real-time responsiveness.

– **Optimization Techniques for Siting and Operations.** Advanced optimization techniques aim to minimize cost and maximize utility across stakeholders. These include:
  - Multi-objective models that consider environmental, economic, and technical goals
  - Mixed-integer nonlinear programming (MINLP) for location-routing and energy scheduling
  - Bi-level frameworks that co-optimize traffic and power networks

Studies consistently highlight the importance of integrating transportation modeling with grid optimization to avoid siloed planning.

– **Equity in EV Infrastructure Planning.** Equity is a critical yet underdeveloped aspect of infrastructure planning. Literature reveals:
  - EV ownership in North Carolina is concentrated among high-income, male, metro-area residents with home-charging access.
  - Charging station availability correlates with income and race, but not necessarily population density.
  - Disadvantaged communities face systemic barriers such as multifamily housing constraints, lack of home or workplace charging access, and affordability issues.

Federal tools like the Justice40 Initiative, EJSCREEN, and new equity-focused planning frameworks have emerged to help agencies evaluate and address disparities.

2.2 Lessons Learned

- **Integration Across Systems Is Essential.** EV infrastructure cannot be planned in isolation. Charging station deployment must account for grid capacity, travel demand, scheduling, and real estate constraints. Planning frameworks should tightly couple transportation and power system modeling.
- **User Behavior and Demand Are Stochastic.** Deterministic models, while easier to apply, may not capture the heterogeneity in charging patterns. Incorporating behavioral data and uncertainty is critical to improve model realism and robustness.
- **Optimization Must Serve Multiple Objectives and Stakeholders.** Effective solutions must balance the needs of EV users, charging operators, utilities, and policymakers. Multi-objective optimization and participatory planning approaches are key enablers.
- **Equity Requires Intentional Action.** Without deliberate strategies, market-driven EV adoption risks reinforcing spatial and socioeconomic disparities. Equity-sensitive siting models and policy incentives are necessary to ensure inclusive infrastructure growth.
- **Technical Performance Varies in Practice.** Real-world charging performance often falls short of lab specifications, with environmental conditions, vehicle architecture, and infrastructure limitations contributing to performance gaps. Infrastructure planning should reflect these variances.

The literature highlights that building an efficient, equitable, and resilient EV infrastructure network requires coordinated, data-driven planning grounded in interdisciplinary modeling. This review identifies methodological advances and persistent challenges that shape future research and policy. As North Carolina expands its EV infrastructure, these insights provide a critical foundation for informed decision-making and innovation.

A detailed review of the literature is included in the combined Literature Review and State of Practice document.

Chapter 3. Results of State of the Practice Review

The state of the practice review provides an in-depth examination of the current policies, planning approaches, technical standards, and implementation practices that guide the deployment of EV charging infrastructure across the United States, with particular emphasis on federal frameworks, North Carolina's policy environment, and local government activities. This review captures emerging best practices, highlights key gaps, and identifies lessons to inform technical guidance for infrastructure expansion in North Carolina.

EV technology in the automobile market is rapidly growing, and EVs are increasingly becoming a key area of policy focus at all levels of government. Municipalities and other planning authorities may pursue EV charging infrastructure for a variety of strategic reasons, including:

- Better serving their constituents and communities
- Promoting economic development
- Serving publicly owned fleet vehicles
- Meeting environmental goals such as the reduction of greenhouse gas (GHG) emissions

The creation of EV charging infrastructure is critical to supporting the broader public and private adoption of EVs. This state of the practice captures national, state, and local government policies and planning approaches with the goal of identifying best practices, emerging opportunities, common barriers, and policy disconnects in the current regulatory landscape.

EV technology offers significant sustainability benefits, especially in reducing emissions from the transportation sector. According to Bloomberg New Energy Finance, Electric Vehicle Outlook 2020, EVs are expected to constitute 55% of new vehicle sales globally by 2040. Several U.S. jurisdictions, led by California and 17 other states following its air quality standards, have committed to phasing out gasoline-powered vehicles by 2035. International markets such as Canada and the European Union have made similar commitments, further accelerating the global transition.

At the federal level, the government has developed a light-duty vehicle purchasing plan targeting a fleet of approximately 650,000 zero-emission vehicles (ZEVs) by 2030. These policies reflect a coordinated push toward clean transportation and have direct implications for EV infrastructure planning nationwide.

Developing a better understanding of policies, best practices, and technical siting requirements for EV charging infrastructure is key to preparing for the ensuing surge of EVs. With the EV market expected to exceed 50% of new vehicle sales by 2040, there is an urgent need to prepare infrastructure now. Federal legislation such as the Infrastructure Investment and Jobs Act and the Inflation Reduction Act, along with state-specific policies like North Carolina Executive Orders 80 and 246, are shaping the funding landscape, establishing deployment requirements, and advancing environmental equity goals.

This review provides a foundation for aligning policy initiatives with practical implementation needs. The review has covered (1) federal plans, programs, and standards, (2) North Carolina NEVI plan, (3) regional and local planning standards, (4) North Carolina local government EV policies and practices, and (5) building and site design requirements.

3.1 Key Themes and Findings

– **Federal Framework and NEVI Program**

The federal government plays a foundational role in shaping EV infrastructure policy through programs such as the National Electric Vehicle Infrastructure (NEVI) Formula Program and the Charging and Fueling Infrastructure Discretionary Grant Program. The NEVI Formula Program allocates $5 billion over five years to states to support EV charging corridors. States must submit EV Infrastructure Deployment Plans annually, addressing site strategies, equity, contracting, cybersecurity, and evaluation frameworks. NEVI guidance emphasizes:

- Technology standards (e.g., DC Fast Charging and Level II requirements)
- Buy America requirements
- Accessibility and ADA compliance
- Equity considerations through tools like the Justice40 mapping criteria
- Resilience planning for natural disasters and emergency events

NEVI-compliant plans must identify corridors for charging infrastructure every 50 miles and provide deployment timelines, site layouts, and stakeholder engagement documentation.

– **North Carolina's NEVI Plan and Policy Landscape**

North Carolina's NEVI Plan adopts a two-phase implementation approach:

- Phase I focuses on Alternative Fuel Corridors (AFCs), prioritizing interstate travel.
- Phase II addresses community-based charging to fill local gaps.

The state anticipates receiving $109 million in federal NEVI funding, which is strategically deployed through public-private partnerships. Importantly, equity is a central tenet of the state's approach, with a focus on ensuring access in disadvantaged and rural communities. Maps of proposed clusters and Justice40 tracts help visualize equitable deployment goals.

In parallel, Executive Orders 80, 246, and 271 establish clear goals:

- 1.25 million ZEVs by 2030
- 50% of light-duty vehicle sales to be electric by 2030
- GHG reductions of 50% (from 2005 levels) by 2030

The combination of federal funding and state policy creates a robust framework that North Carolina can build upon to accelerate EV infrastructure deployment and fleet electrification.

– **Local Government Roles and Regulations**

Municipalities and counties in North Carolina have a growing influence on EV infrastructure through:

- Zoning and permitting authority
- Subdivision exactions and site design standards
- Public EV charging initiatives on government-owned property
- Fleet electrification targets

Examples include:

- Charlotte: 20% of parking in new developments must be EV-ready, 2% must have chargers installed.
- Holly Springs and Garner: Specific thresholds mandate charger installation based on lot size.
- New Hanover County: Proposed text amendment requiring 20–30% of parking to be EV-ready in new developments.

These policies reflect a shift from voluntary adoption to code-integrated mandates, which normalize EV infrastructure inclusion in urban planning.

Furthermore, many jurisdictions have begun treating EV infrastructure as a community service, paving the way for requirements in new subdivisions. However, implementation remains uneven across the state, with several municipalities still in early planning stages.

– **Building and Site Design Standards**

Across North Carolina and the U.S., site design policies are evolving to:

- Differentiate between EV-ready, EV-capable, and EV-installed parking spaces
- Standardize conduit and electrical capacity requirements for new construction
- Incentivize EV charging through sustainable development point systems or amenity credits

Cities like Middletown, CT, and Portland, OR, mandate a minimum percentage of EV-ready spaces in multifamily and commercial projects. In Lakewood, CO, developers earn sustainability points for installing EV infrastructure.

These policies help address one of the biggest infrastructure challenges: the difficulty and expense of retrofitting existing buildings, especially in multi-unit dwellings. Site-readiness provisions offer a cost-effective pathway to scaling infrastructure over time.

– **Planning and Coordination Mechanisms**

EV infrastructure planning is increasingly supported by:

- Clean Cities coalitions facilitating local stakeholder coordination and rural outreach
- Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs) incorporating EV planning into long-range transportation plans
- Local EV master plans (e.g., Broward MPO, NYSAMPO) providing templates for permitting, zoning, and partnership strategies

In some regions, participatory planning tools such as interactive mapping platforms (e.g., Washington State DOT's crowdsourced charging map) engage the public in siting decisions. These tools help incorporate real-time user input, enhancing transparency and prioritizing high-demand areas.

– **Power Supply Requirements and Grid Integration**

Planning for EV infrastructure must consider electric grid limitations, especially:

- Transformer capacity
- Voltage stability

- Peak load management

Studies and agency reports emphasize the importance of:

- Standardized connectors (e.g., J1772, CCS, NACS)
- Megawatt charging systems (MCS) for freight applications
- Interoperability across charging platforms
- Real-time performance data to inform planning and pricing

Resilience strategies -- such as mobile charging units, redundant siting, and climate-adaptive infrastructure -- are critical in disaster-prone regions like North Carolina. Temperature sensitivity, real-world charging behavior, and fleet operation dynamics (e.g., HVAC loads in cold starts) must also be modeled.

3.2 Lessons Learned and Gaps Identified

Lessons Learned

- A two-phase approach (AFC-first, then community) is a scalable strategy to expand coverage efficiently.
- Equity requires proactive planning, including mapping, outreach, and tailored funding.
- Local government engagement is vital—municipal codes, permitting standards, and land use planning play critical roles.
- Fleet electrification by cities drives demand and public visibility.
- Site readiness standards can future-proof new developments without large upfront costs.

Gaps and Needs

- Inconsistent policy adoption across local jurisdictions leads to fragmented deployment.
- Retrofitting existing infrastructure in multifamily buildings remains a technical and policy challenge.
- Data interoperability between utility networks, transportation planners, and developers is lacking.
- Performance standards for real-world charger behavior under diverse environmental conditions are underdeveloped.
- Planning tools for grid-aware, equity-sensitive optimization remain limited in practice and availability.

North Carolina stands at a critical inflection point in EV infrastructure development. The federal NEVI program, state-level executive orders, and emerging local regulations together provide a robust foundation, but coordinated action is needed to bridge remaining gaps. By aligning federal, state, and local planning; standardizing site-readiness policies; and embedding equity and power system integration into siting decisions, the state can lead in building a scalable, resilient, and inclusive EV charging network.

This review of the state of practice serves as both a snapshot of current efforts and a roadmap for strategic expansion. The insights gathered directly informed the best practices and technical guidance developed in this project's final phase.

A detailed review of the literature is included in the combined Literature Review and State of Practice document.

Chapter 4. Results of Survey on Planning Processes and Local Policies

To better understand the landscape of EV infrastructure planning and policy implementation at the local level in North Carolina, the research team developed and disseminated a comprehensive survey targeting planning administrators, engineers, and transportation officials across the state. The survey aimed to gather first-hand insights on the presence and characteristics of local ordinances, planning standards, permitting processes, fleet electrification efforts, and public engagement surrounding electric vehicle (EV) charging infrastructure.

The instrument was disseminated via listservs associated with Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), and Councils of Government (COGs), following consultation with NCDOT to ensure broad and relevant distribution. The full version of the survey instrument can be found in Appendix A of the Best Practices and Guidance document.

A total of 72 responses were received from a variety of public agencies and jurisdictions throughout North Carolina. The respondents represented a wide cross-section of local government organizations, including municipalities (39%), counties (21%), MPOs, RPOs, and regional COGs. In terms of professional background, 64% of respondents were planning staff or administrators, while an additional 17% were engineers, public works, or utilities staff. This blend of planning and technical perspectives provided valuable insights into both the policy and operational dimensions of EV infrastructure deployment.

This survey was structured to cover (1) status of EV charging infrastructure plans and policies, (2) EV infrastructure siting and permitting, (3) perception of stakeholder feedback, and (4) opportunities and barriers to implementation.

4.1 Key Themes and Findings

– **Status of EV Planning and Policy Adoption**

Survey responses revealed a high degree of variability in the extent to which jurisdictions across North Carolina have incorporated EV considerations into their plans, codes, and operations. While some municipalities and counties have adopted explicit ordinances or EV readiness requirements for new developments, a significant number remain in preliminary or exploratory stages of planning.

A majority of respondents (over 60%) indicated that their jurisdiction does not currently require EV charging infrastructure in new residential or commercial developments, although several noted that such requirements are being actively considered or drafted. Some jurisdictions have implemented voluntary incentive-based approaches, while others have mandated a certain percentage of EV-ready or EV-installed parking spaces in site plans or zoning codes.

Only a small share of jurisdictions have adopted formal EV master plans, but interest is growing in incorporating EV infrastructure goals into Comprehensive Plans, Transportation Improvement Programs (TIPs), and local Sustainability or Climate Action Plans. The responses suggest that while awareness of EV infrastructure needs is increasing, local policy frameworks have not yet matured uniformly across the state.

– **Permitting, Siting, and Technical Standards**

The survey responses also highlighted considerable differences in the clarity, consistency, and coordination of permitting processes for EV charging installations. Several jurisdictions noted that standard permitting checklists or review protocols for EV chargers do not yet exist, creating uncertainty for developers and applicants. In some areas, chargers are reviewed as part of broader electrical or site work, without dedicated workflows or review criteria.

Among jurisdictions with more advanced practices, permitting processes typically consider:

- Electrical load calculations and transformer capacity
- Parking layout and ADA accessibility
- Site lighting, signage, and stormwater compliance
- Zoning compatibility and land use designations

Respondents emphasized the need for interdepartmental coordination between planning, engineering, inspections, and utilities staff to streamline reviews. Some localities have begun standardizing permitting documentation, while others expressed a desire for state-level guidance or templates to help establish local permitting norms.

In terms of EV infrastructure siting, most respondents noted that their jurisdiction has not yet developed a formal siting strategy for public or private chargers. Siting decisions tend to be reactive -- based on developer interest, grant funding, or utility programs -- rather than guided by modeling or planning tools. However, several respondents expressed interest in data-driven siting methods that incorporate travel patterns, equity considerations, or grid capacity.

– **Stakeholder Feedback and Public Engagement**

A key goal of the survey was to assess how local governments perceive public and stakeholder reactions to EV infrastructure efforts. Overall, responses indicated that public attitudes are generally positive or neutral toward EV adoption and charging infrastructure development. Communities with high visibility EV deployments (e.g., near schools, downtowns, or parks) reported increased awareness and curiosity among residents.

Several respondents noted growing public support tied to environmental and health co-benefits, while others cited anecdotal opposition related to perceived costs, parking impacts, or aesthetic concerns. Public engagement around EV infrastructure is still emerging, and most jurisdictions have not conducted formal outreach or listening sessions specific to EV charging.

Institutional stakeholders -- such as local utilities, school districts, transit agencies, and regional planners -- were generally seen as supportive collaborators. However, some respondents mentioned that the pace of coordination and capacity constraints among stakeholders could slow down implementation, especially when infrastructure crosses jurisdictions or utility service territories.

– **Barriers and Opportunities to Implementation**

The survey results identified a range of technical, financial, regulatory, and organizational barriers to EV infrastructure deployment at the local level. The most frequently cited challenges included:

- Lack of funding for public infrastructure or local planning capacity
- Uncertainty about permitting requirements or technical specifications
- Grid constraints and transformer upgrades needed for high-capacity chargers
- Inconsistent local policies, especially in rural or smaller jurisdictions
- Limited staff capacity to take on new EV-related planning or enforcement tasks

At the same time, respondents pointed to several emerging opportunities:

- Federal and state funding programs (e.g., NEVI, IIJA, IRA)
- Support from utilities for make-ready infrastructure
- Public interest in sustainability and fleet electrification
- Collaboration with Clean Cities coalitions and regional organizations

Respondents frequently mentioned the value of model ordinances, case studies, and templates that could be adapted locally, particularly in jurisdictions where EV planning is just beginning. There is also a strong interest in education and training opportunities for planning staff to build capacity in technical siting, permitting, and long-range EV infrastructure forecasting.

4.2 Follow-Up Interviews and Documentation Review

To enrich the survey data and gain a deeper understanding of local practices, the research team conducted follow-up interviews with a subset of survey participants. These conversations offered valuable qualitative insights into how decisions are made on the ground, the interplay between policy and practice, and the role of political support or community priorities in driving EV initiatives. Interviewees discussed:

- The timing and motivation behind adopting EV-related ordinances
- Interdepartmental collaboration and decision-making processes
- Specific barriers encountered during project implementation
- Recommendations for state support, including technical assistance and funding navigation

Additionally, the research team reviewed local policies, ordinances, and planning documents provided by participating jurisdictions. This policy scan helped validate and contextualize survey findings, revealing recurring themes such as:

- The use of EV-ready definitions (EV-capable, EV-installed) in zoning codes
- Inclusion of EV infrastructure in parking minimums or site plan checklists
- References to state climate goals and local greenhouse gas inventories as policy drivers

4.3 Summary and Next Steps

The survey and interview data collectively highlight the high level of interest among North Carolina's local governments in advancing EV infrastructure, but also point to a significant need for guidance, capacity building, and standardization. The diversity of responses -- ranging from jurisdictions with mature EV regulations to those just beginning to explore the topic -- illustrates the uneven landscape of EV planning across the state.

These findings directly informed the development of a stand-alone Best Practices and Guidance document, which compiles both statewide and national practices and offers targeted insights based on stakeholder experiences. That guidance, developed alongside modeling efforts and the state of practice review, aims to provide practical tools and strategic direction for municipalities and regional agencies preparing for a rapidly electrifying transportation future.

Chapter 5. Results of Optimization Models for Expansion of Charging Network

To support policy-aligned, grid-sensitive, and equitable EV infrastructure expansion, a suite of optimization models was developed and applied using empirical data from Raleigh, North Carolina. These models were designed to capture critical trade-offs among coverage, cost efficiency, demand uncertainty, and power system constraints. The overarching objective was to formulate and test a rigorous methodology for identifying optimal siting strategies that can guide the deployment of EV charging infrastructure across diverse geographic and demographic contexts in North Carolina.

The modeling approach was grounded in three core components: (1) economic efficiency, (2) energy feasibility, and (3) equitable access. The study incorporated a dataset that included 75 potential candidate sites for EV charging stations, 75 demand points derived from spatial population and equity metrics, and 37 local power substations representing grid availability and constraints. Demand points were identified using the transportation disadvantage index (TDI), a composite indicator of socioeconomic vulnerability. TDI values ranging from 0 to 21 were used to ensure a representative sample of disadvantaged communities, enabling the models to address the equity dimension of infrastructure planning.

Each potential charging station site was selected based on strategic proximity to transportation hubs, business districts, healthcare centers, rest areas, and existing transportation corridors. The inclusion of existing infrastructure and land use patterns ensured that candidate sites reflected real-world deployment opportunities. In parallel, demand locations were mapped using EV registration data, population density metrics, and geographic dispersion. Travel distances between demand points and candidate charging station sites were computed using the Google Maps API to generate realistic travel cost matrices.

Power grid integration was a central modeling component. The capacities of the 37 substations were extracted from public records and technical documentation and were included as hard constraints within the models. This allowed the optimization models to ensure that the addition of new EV charging infrastructure would not exceed local grid capabilities or compromise grid stability. The resulting dataset was comprehensive and spatially aligned, making it suitable for running optimization models with multiple constraints and objectives.

Three optimization models were formulated and tested. Model 1 aimed to maximize demand coverage under deterministic demand assumptions, subject to constraints on facility capacity and geographic coverage. The goal was to ensure that each demand node had access to at least one charging facility within a specified travel radius. This model prioritized accessibility and equity by ensuring broad spatial coverage, especially for disadvantaged populations identified through TDI scores. Model 2 was designed to minimize total system costs under deterministic demand, incorporating both fixed facility opening costs and variable user travel costs. This cost-based model introduced a trade-off between maximizing coverage and minimizing expenses, thereby allowing planners to explore budget-constrained deployment strategies. Facility opening costs were derived from market benchmarks and adjusted to local conditions, while travel costs were calculated based on real-time distance data and assumed vehicle energy consumption rates. Model 3 extended the second model by introducing stochastic demand scenarios, reflecting temporal fluctuations in charging needs throughout the day and week. This approach accounted for uncertainty in user behavior, load peaks during commuting hours, and variable grid loads. Multiple demand scenarios were generated to simulate high-demand time blocks (e.g., weekday mornings, weekend evenings), and a robust optimization framework was used to derive siting solutions that performed well across all scenarios. This model offered valuable insights into the resilience of the charging network design under real-world uncertainties.

Across all three models, key decision variables included binary placement indicators for new facilities, flow allocation variables for user demand, and capacity allocation constraints for substations. The optimization problems were formulated as mixed-integer linear programs (MILPs) and solved using commercial solvers.

The output of each model provided a list of recommended EV charging station locations, the projected demand coverage, and total system cost metrics. In Model 1, the optimized placement configuration achieved near-complete coverage of demand points, including those in high-TDI (i.e., more disadvantaged) areas. This result demonstrated that even under a pure accessibility objective, it is possible to ensure equity-driven deployment without substantial sacrifice to system efficiency. Model 2 highlighted cost minimization opportunities by identifying a more selective set of charging station sites. The optimized solution in this case included fewer total stations but achieved a high level of demand satisfaction at a lower overall system cost. However, the trade-off was a reduction in spatial equity, as some rural or high-TDI zones were deprioritized in favor of more densely populated urban centers. This finding highlights the importance of incorporating equity metrics explicitly when making cost-driven decisions. Model 3 yielded the most nuanced siting strategy by balancing cost, equity, and temporal flexibility. The stochastic model prioritized locations with both high base demand and the potential to serve variable peak loads. As a result, the final siting solution from Model 3 included some high-TDI zones that were omitted in Model 2, suggesting that when temporal demand variability is accounted for, the value of spatially dispersed infrastructure increases. Moreover, the model identified grid stress points where additional substation capacity would be needed to support reliable operation under high-load scenarios.

A comparative analysis of the three models revealed important policy implications. First, model selection should be informed by planning priorities: equity-first planning aligns with Model 1, while cost-focused strategies benefit from Model 2. Model 3 is best suited for integrated planning efforts where resilience and adaptability are top priorities. Second, incorporating grid constraints early in the planning process is essential to avoid infeasible deployments or expensive retrofits. Third, optimization models can highlight not only where to build but also when to invest, offering a phased deployment strategy that aligns with projected demand growth and funding availability.

In addition to model development, the study conducted extensive sensitivity analyses to explore how variations in key input parameters (such as budget availability, substation capacity, and user behavior assumptions) affected siting outcomes. These analyses helped identify robust strategies that were less sensitive to fluctuations in demand or energy supply. For instance, a 20% reduction in assumed substation capacity shifted optimal site locations toward areas with newer, higher-capacity substations, reinforcing the importance of integrating utility data in planning decisions.

Finally, a series of policy-relevant insights were extracted from the modeling results. These include the need to develop standardized siting criteria that incorporate equity thresholds, the potential for cross-agency data sharing to enhance siting decisions, and the value of adaptive planning that accommodates demand variability and evolving EV adoption trends. The models developed in this study serve not only as decision-support tools but also as demonstration cases for how technical modeling can bridge the gap between transportation planning and power systems management.

The full model specifications, parameters, solution outputs, and visualization of results are included in the Best Practices and Guidance document, Section 7. This technical supplement provides additional detail on model formulations, data sources, constraint structures, and scenario configurations, and can be used by planners, consultants, and engineers to replicate or extend the modeling approach in other regions of North Carolina or beyond.

Chapter 6. Guidelines for EV Charging Network Expansion

To support the equitable and strategic expansion of EV charging infrastructure across North Carolina, the research team developed a comprehensive set of guidelines. These guidelines are grounded in the project's multi-phase research process and draw directly from literature and state-of-practice reviews, a statewide planning survey, stakeholder interviews, and EV infrastructure optimization models and sensitivity analyses. Together, these sources provide a robust foundation for generating actionable and context-sensitive planning, policy, and modeling recommendations that are responsive to the challenges and opportunities facing communities across the state.

The purpose of these guidelines is to inform planning authorities, state and local agencies, utility partners, and policy stakeholders in implementing charging infrastructure that is scalable, resilient, cost-effective, and inclusive. The recommendations support efforts to align local implementation with broader climate, mobility, and equity goals, while recognizing that successful deployment will require coordination across jurisdictions and infrastructure systems.

The guidelines synthesize insights from:

- A critical literature review of academic and industry research on EV infrastructure modeling, system integration, and equity;
- A state of the practice review, encompassing local, state, and federal planning initiatives and implementation frameworks;
- A statewide survey of planning professionals in North Carolina, capturing on-the-ground experiences, priorities, and constraints;
- A set of facility location optimization models and sensitivity analyses, offering data-driven perspectives on trade-offs across planning priorities.

Through this triangulated approach, the guidelines aim to promote EV infrastructure deployment that is scalable, equitable, technically sound, and locally adaptable.

The full set of recommendations is detailed in the Best Practices and Guidance document. What follows is a high-level summary of that framework, organized into three thematic categories: (1) Planning and Policy Guidance, (2) General Modeling-Driven Recommendations, and (3) Model-Specific Recommendations.

6.1 Organization of the Guidelines

– Planning and Policy Guidance

The planning and policy recommendations focus on actions local governments and regional entities can take to update ordinances, streamline permitting, and integrate EV infrastructure into broader planning frameworks. These recommendations stem directly from the findings of the statewide survey and review of policies across the U.S., with emphasis on best practices that are both effective and adaptable. Key recommendations include:

- **Develop or update zoning and development ordinances.** Local governments should adopt clear, consistent definitions of EV infrastructure types (EV-capable, EV-ready, EV-installed) and embed requirements into zoning codes and site plan review standards.

- **Adopt EV readiness requirements.** Communities may require or incentivize that new residential and commercial developments include EV-capable or EV-ready infrastructure, reducing future retrofit costs and ensuring long-term flexibility.
- **Incorporate EV charging into comprehensive and sustainability plans.** EV infrastructure goals should be aligned with local land use, climate, and transportation goals. This encourages consistency across planning documents and supports eligibility for grant funding.
- **Create clear and expedited permitting processes.** Many jurisdictions currently lack defined permitting pathways for EV chargers. Local governments should develop specific checklists, interdepartmental review procedures, and designated review timelines to facilitate efficient project delivery.
- **Deploy public charging infrastructure as a leadership model.** Local governments can demonstrate commitment by installing public chargers at libraries, parks, and government buildings, which also helps fill network gaps and build public awareness.
- **Encourage fleet electrification and infrastructure planning.** Municipal fleets, transit agencies, and schools can electrify operations in phases, accompanied by planning for depot-based and public charging needs.
- **Establish signage, accessibility, and wayfinding standards.** Local policies should specify how chargers are marked, accessed, and designed to accommodate ADA requirements, ensuring equitable and user-friendly deployment.
- **Use incentives and fee structures to guide behavior.** Local governments may offer reduced permitting fees, parking incentives, or grants to encourage charger installation. Conversely, enforcement policies can protect charger accessibility.
- **Coordinate with MPOs, utilities, and neighboring jurisdictions.** Regional consistency in policy and siting will improve network reliability and public confidence. Joint planning processes can leverage economies of scale and improve outcomes for smaller jurisdictions.

These planning and policy tools can help local governments create a supportive environment for EV infrastructure growth, aligned with both public needs and private sector expectations.

– General Modeling-Driven Recommendations

The general recommendations represent high-level strategic actions applicable across a wide range of jurisdictions and geographies. These insights were derived primarily from literature, the state of the practice review, survey data, and follow-up interviews. They are meant to be broadly adoptable by municipalities, MPOs/RPOs, and state agencies regardless of size, technical capacity, or existing EV infrastructure maturity.

Key themes and recommendations include:

- **Increase planning capacity at the local level.** Most local governments in North Carolina lack the staff or resources to address EV infrastructure planning in a dedicated, sustained way. Technical assistance, regional coordination, and sample policies can help overcome this barrier.
- **Improve interagency coordination.** EV infrastructure intersects with land use planning, transportation, public works, and utility operations. Local agencies should establish

cross-departmental working groups or coordination protocols to reduce redundancy and confusion.

- **Align EV charging plans with grid capacity.** Utilities should be engaged early in the siting process to ensure that selected locations are viable from a load and transformer capacity standpoint. "Make-ready" programs can reduce infrastructure delays.
- **Adopt flexible, phased deployment strategies.** Rather than attempting to build out a full network at once, planners should adopt a phased approach that builds incrementally based on demand, funding availability, and capacity constraints.
- **Address equity in infrastructure distribution.** State and local agencies should use tools such as TDI and Census data to identify priority areas underserved by EV infrastructure. Incentives or mandates may be necessary to drive private investment to these locations.
- **Develop standardized data-sharing practices.** Many local agencies lack access to EV registration data or charging behavior. State-level coordination can help promote data-sharing agreements and develop centralized dashboards to support planning.
- **Leverage federal and state funding opportunities.** The NEVI program, IIJA, and IRA provide significant funding opportunities for EV infrastructure. Agencies must be proactive and well-positioned with site plans and permitting procedures to capitalize on this funding.
- **Promote public-private partnerships.** While public investment is crucial, long-term network growth will rely on partnerships with private charging providers, automakers, and utilities. Local governments can reduce costs and extend reach by facilitating access to public land or co-investing in infrastructure.

These general strategies provide the scaffolding for more detailed planning and modeling guidance tailored to specific decision-making contexts.

– **Model-Specific Recommendations**

The modeling component of this project included the development and evaluation of facility location optimization models and sensitivity analyses to explore how different planning objectives affect charging network outcomes. These models were designed to inform state and regional-level decisions and to test trade-offs in real-world deployment scenarios.

Key model-informed recommendations include:

- **Balance multiple planning objectives.** Optimization scenarios show that there is often a trade-off between minimizing costs and maximizing access or equity. Multi-objective modeling can help planners make informed choices about these trade-offs.
- **Use scenario-based planning to manage uncertainty.** EV demand growth is inherently uncertain. Scenario analyses (e.g., high-demand vs. low-demand growth) allow planners to stress test infrastructure plans and develop phased rollout strategies.
- **Prioritize equity explicitly in siting models.** Models that assign higher weights to disadvantaged communities or rural gaps can guide infrastructure toward areas traditionally overlooked by market-based deployments. This supports federal Justice40 goals.
- **Account for land use and permitting constraints.** Modeling should incorporate zoning, accessibility, and utility data to ensure that recommended sites are physically and legally viable. This improves implementation feasibility and avoids wasted planning effort.

- **Stage infrastructure build-out over time.** Rather than treating infrastructure deployment as a one-time optimization problem, planning should use dynamic or time-phased models to reflect budget constraints, vehicle adoption trends, and evolving technology.
- **Differentiate charger types based on trip characteristics.** Models suggest that high-demand commuter corridors benefit from Level 3 DC fast chargers, while residential or workplace settings are better served by Level 2 chargers with lower infrastructure costs.
- **Use clustering and demand analysis to improve network coverage.** Clustering techniques based on population, employment, and travel data can identify key nodes for regional planning. This improves efficiency by aligning infrastructure with travel behavior.
- **Incorporate grid constraints and transformer capacity in models.** Electrification models must go beyond geographic coverage and integrate power system constraints to ensure that chargers can be deployed where capacity exists or where upgrades are feasible.

The modeling component reinforces the importance of using quantitative tools to guide complex planning decisions. When paired with community input and practical considerations, these models offer a powerful decision-support framework for identifying optimal locations, evaluating trade-offs, and justifying public investments.

6.2 Key Takeaways

The guidelines developed through this project represent a comprehensive, integrated approach to EV charging infrastructure planning in North Carolina. Organized across general, policy, and model-specific dimensions, these recommendations provide a flexible framework for implementation across diverse geographies, planning capacities, and infrastructure maturity levels. By drawing from national best practices, technical modeling, and local government input, these guidelines support both short-term readiness and long-term scalability. They empower municipalities, MPOs, and state agencies to make informed decisions aligned with sustainability, mobility, and equity goals -- positioning North Carolina as a leader in EV infrastructure deployment. The full set of detailed recommendations, including sample ordinance language, policy references, and planning tools, is available in the accompanying Best Practices and Guidance document.

Chapter 7. Findings and Conclusions

This research effort aimed to support the planning, policy design, and technical siting of EV infrastructure across North Carolina. The study incorporated a multi-faceted approach that included a literature review, an assessment of current practices and policies, a statewide survey and interviews with planning professionals, and a suite of optimization models. The findings emphasize that the development of a reliable, scalable, and equitable EV charging network requires an integrated strategy following evidence-based planning, policy alignment, and user-focused design.

From the literature review, a key finding was the complexity and interdependency of EV infrastructure with both transportation systems and electric power networks. Planning EV charging networks must account not only for vehicle range and trip patterns but also for grid capacity, spatial equity, and emerging vehicle-to-grid technologies. Modeling techniques such as flow-capturing, range-constrained optimization, and stochastic programming were found to be essential tools for siting infrastructure under uncertainty. In addition, equity-focused studies highlighted the need for prioritizing historically underserved areas, where the market alone may not drive infrastructure investment.

The state of practice assessment revealed varying levels of preparedness among local governments. Some municipalities have taken proactive steps to adopt EV ordinances, develop sustainability plans, and establish permitting frameworks for charging infrastructure. However, many localities still face challenges such as a lack of dedicated staff, technical expertise, and inter-agency coordination. Barriers also include unclear permitting processes, limited guidance on siting, and difficulties navigating federal and state funding mechanisms. Survey and interview results revealed high levels of interest in EV infrastructure planning but also highlighted widespread uncertainty around how to implement effective and equitable policies.

Modeling and optimization analyses added further insight into how EV charging infrastructure can be expanded most effectively. The models revealed that optimal charger locations vary significantly depending on whether cost minimization, equity goals, or demand coverage is prioritized. Sensitivity analyses showed that small variations in demand patterns or funding assumptions can substantially shift siting priorities. Importantly, equity-driven siting objectives, when incorporated into the model, redistributed chargers to underserved areas, though with increased cost, a tradeoff that planners must navigate.

These findings lead to several overarching conclusions. First, a successful EV infrastructure strategy must integrate planning and utility data, consider diverse user needs, and actively work to reduce disparities in access. Second, flexibility in deployment, supported by scenario analysis and phased planning, is necessary to adapt to rapidly evolving EV adoption trends. Finally, while technical modeling is essential, the local policy environment and institutional capacity will ultimately determine whether EV infrastructure plans are implemented effectively and equitably.

Chapter 8. Recommendations

Based on a comprehensive synthesis of literature, policy reviews, stakeholder input, and modeling results, this study offers a series of recommendations to guide the expansion of EV charging infrastructure in North Carolina. These recommendations are intended for multiple stakeholders, including state transportation agencies, metropolitan and rural planning organizations (MPOs/RPOs), local governments, utility partners, and private sector collaborators. The overarching goal is to ensure that the state's EV charging network is scalable, efficient, and equitable.

A central recommendation is the need to enhance planning capacity at the local and regional levels. Many jurisdictions lack the technical expertise and staffing required to incorporate EV infrastructure into land use, transportation, and sustainability planning efforts. The state should provide support for training, technical assistance, and the development of standardized policies to empower local governments. Establishing clear EV readiness policies within zoning and development codes, such as requirements for EV-capable or EV-ready parking in new developments, can lay the groundwork for long-term growth.

To reduce implementation delays, local governments should streamline permitting processes for EV infrastructure projects. This includes establishing interdepartmental workflows, setting defined timelines for application review, and providing transparent guidance to developers. Additionally, local and state agencies should proactively align EV infrastructure planning with existing transportation and climate goals. For example, integrating EV deployment strategies into comprehensive plans or resilience frameworks can maximize co-benefits and funding synergies.

Equity must remain a guiding principle in both policy and practice. Public agencies should use data-driven tools such as NCDOT's Transportation Disadvantage Index (TDI) and Environmental Justice (EJ) maps to identify areas that have been historically underserved and prioritize them in siting decisions. Incentives and public investment can be targeted to fill gaps where market forces are unlikely to support private infrastructure deployment. Outreach and community engagement should also be conducted early and often to incorporate diverse voices into infrastructure planning.

From a technical perspective, the state should continue to invest in modeling tools that support evidence-based decision-making. Facility location optimization models developed in this research allow agencies to evaluate different siting objectives (e.g., cost, coverage, and/or equity) and to perform sensitivity analyses under changing assumptions. These tools can be embedded within NCDOT workflows or offered as a resource to MPOs and local governments. Additionally, collaboration with utilities will be essential to ensure that EV charging expansion is coordinated with grid capacity and load management efforts.

Finally, partnerships with the private sector should also be pursued, especially for high-traffic corridors and retail or workplace charging sites. Leveraging federal funding opportunities is also critical. Agencies should designate dedicated staff or consultants to track and pursue competitive grants, and coordination across agencies will be essential to maximize funding impact.

These recommendations establish a framework that balances local flexibility with state-level coordination, equity with efficiency, and long-term resilience with near-term action. Implementation of these strategies will ensure that North Carolina is well-positioned to lead in the nationwide transition toward clean and inclusive mobility systems.

Chapter 9. Implementation and Technology Transfer Plan

Effective implementation of the recommendations and guidance developed in this study requires a coordinated and phased approach that leverages planning frameworks, institutional partnerships, and actionable tools. The technology transfer strategy centers on embedding the research findings into agency workflows, policy development processes, and infrastructure investment planning across North Carolina.

A foundational element of implementation is the dissemination of the Best Practices and Guidance document, which consolidates planning recommendations, policy templates, and technical siting insights into a practitioner-ready format. This document is designed for use by NCDOT staff, MPOs and RPOs, local government planners, utilities, and consultants. It should be distributed widely through professional networks, planning listservs, and agency partnerships, and presented at regional planning forums, webinars, and workshops to encourage adoption. Where feasible, tailored briefings or training sessions can be organized for different user groups, such as local planning departments, regional transportation planners, and permitting staff.

Another key strategy is to integrate the optimization models developed in this research into NCDOT's internal planning toolkit or partner them with platforms used by MPOs and regional partners. These models support infrastructure siting decisions under different objective functions (e.g., cost, demand coverage, equity) and can be used to assess trade-offs and conduct sensitivity analyses. A technology transfer activity may involve developing a user interface for these models or creating decision support templates that simplify scenario evaluation for planners without modeling expertise.

Institutional coordination will be critical for effective implementation. This includes strengthening collaboration between NCDOT and local governments, regional planning organizations, electric utilities, and the private sector. Facilitating cross-agency working groups or EV infrastructure task forces can help align timelines, share data, and resolve jurisdictional overlaps. These forums also provide opportunities to review permitting processes, identify funding sources, and plan for utility readiness. Where appropriate, pilot projects can be launched in select regions to test EV readiness policies or phased deployment approaches, with results feeding back into the statewide strategy.

At the local level, adoption of EV-friendly zoning standards and permitting frameworks will be an essential first step. This includes incorporating EV-ready requirements in new developments, defining charger types in development codes, and formalizing review timelines for EV infrastructure proposals. Examples provided in the guidance document can serve as starting points for local adaptation.

From a technology transfer perspective, the research findings can also inform ongoing state efforts. Lessons learned can be shared with other states and national organizations via conference presentations, journal publications, or collaborative research initiatives. Additionally, implementation teams should maintain feedback loops with early adopters to refine tools and guidance as real-world challenges emerge.

The goal of this implementation plan is to ensure that the research outputs, including the technical models, policy insights, and best practice guidance, are not only adopted but also actively shape the planning and deployment of EV infrastructure across North Carolina. Through sustained engagement, technical support, and cross-sector collaboration, this research can support a durable and inclusive transition toward electric mobility statewide.

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