**Describe your community and its economic landscape.**

Chattanooga, Tennessee is a city that has experienced immense economic development over the last 30 years, transitioning from an industrial manufacturing economy to a tourist and gig economy primed for the 21st century. Even so, many industries still find Chattanooga attractive, with Volkswagen employing 5,500 workers to manufacture electric vehicles along with standard Volkswagen vehicles. Chattanooga has embraced innovation, with its municipal fiber, EPB, and an innovation district buttressing downtown. With a population of 184,086, Chattanooga is one of the fastest growing cities in Tennessee. Additionally, Chattanooga has emerged as a key player in the transportation and logistics industry, thanks to its strategic location along major transportation corridors, including Interstate 24 and Interstate 75. The city’s investment in projects to enhance public transit, develop biking and walking trails, and promote sustainable transportation options demonstrates the commitment to improving transportation infrastructure.

One of the noteworthy aspects of Chattanooga’s technological advancement is the recent partnership between EPB and Qubitekk to provide the world’s first commercially available quantum network. This cutting-edge technology has not only positioned Chattanooga as a leader in connectivity but has also fostered innovation in various sectors, including transportation. The community is home to a diverse and skilled workforce, supported by educational institutions like the University of Tennessee at Chattanooga.

Chattanooga’s strengths in manufacturing, transportation, and innovations make it an ideal candidate for transportation research. These factors collectively contribute to the city’s goal of creating a more efficient, connected, and sustainable transportation system for its residents.

**Describe your mobility or automotive challenge.**

**Mehdi** :

Our research challenges have focused on optimizing electric vehicle infrastructure deployment and accurately quantifying the environmental benefits of EVs. By utilizing usage patterns several initial installations can hopefully be used to determine the best locations for charging stations. This will help identify sites where sufficient demand exists to warrant continued investment once grant funding ends. Defining optimal power levels for urban, rural, and highway charging stations is also aimed for by modeling drivers' electricity needs. Matching capacity to local requirements avoids overbuilding while still allowing fast charging. Finally, tools are planned to be developed that calculate greenhouse gas reductions from EVs using local power generation data rather than national averages. This accounts for regional grid mixes and provides more precise estimates of location-specific climate impacts. These initiatives are intended to promote efficient, sustainable EV growth by maximizing station utility, optimizing power delivery, and demonstrating tangible emissions reductions. Applying data-driven methodologies to address these pressing challenges surrounding EV adoption and operation is eagerly anticipated.

[hannah-archer@utc.edu](mailto:hannah-archer@utc.edu)**Mina’s edits:**

Two challenging research questions in the world of electric vehicles (EVs) are related to 1) optimizing EV charging stations deployment and 2) accurately quantifying the environmental benefits of EVs.

In the State of Tennessee, numerous charging stations have been established with the aid of grants. However, as funding sources are finite, it becomes imperative to identify sites where there is sufficient demand to justify continued investment once grant funding expires. Investigating this research question is crucial, given the limited funding available to sustain these stations. Simultaneously, preserving or expanding the number of charging stations and enhancing the convenience for EV drivers are paramount objectives.

To fully understand the environmental benefit of EVs, one needs to address what are the local sources of energy at each station. As we all know, large-scale EV deployment will impact the health of distribution assets. We also need to consider the impact of external factors such as weather, traffic, and user behavior. The research to be investigated here is related to designing a tool that precisely calculates greenhouse gas reductions from EVs using local power generation data rather than national averages. This accounts for regional grid mixes and provides more precise estimates of location-specific climate impacts. These initiatives are intended to promote efficient, sustainable EV growth by maximizing station utility, optimizing power delivery, and demonstrating tangible emissions reductions. Applying data-driven methodologies to address these pressing challenges surrounding EV adoption and operation is eagerly anticipated.

**What sector does your mobility challenge most closely align with?**

**Research**

MINA ADDED: I would specifically mention this is related to Electrification at the very beginning and then you can continue with what you have.

**Mehdi**: In the realm of electrification, the research sector faces significant challenges related to understanding EV utilization rates, power-to-port ratios in various locations, and greenhouse gas (GHG) savings based on specific generation mixes. These challenges necessitate conducting studies that involve data collection, analysis, and the development of predictive models. Specifically, these studies focus on electrification, seeking to comprehend EV utilization rates, power-to-port ratios in different locations, and GHG savings based on specific generation mixes. These endeavors constitute essential research activities aimed at addressing the complexities of electrification.

In the transit sector, results of research into the challenges of EV utilization can result in practical applications to improve EV usage. In the transportation sector, these challenges relate to the practical application of research findings. This includes the implementation of charging stations in various locations, optimizing their power-to-port ratios, and measuring their impact on GHG emissions. These activities are crucial for the development of sustainable transit infrastructure.

While manufacturing could be indirectly involved, especially in the production of EVs and charging stations, the challenges you’ve outlined are more directly related to research and transit. However, the sectors are interrelated and advancements in one can drive progress in the others.

**Which, if any, community, company and/or university partners are you currently working with or would like to work with to help address this challenge?**

**Mehdi** : Working with Seven States Power, an energy solutions cooperative owned and operated by local power companies across the Tennessee Valley region. As experts in electric vehicle charging infrastructure, solar energy, battery storage, and other clean technologies, Seven States Power is an ideal partner for tackling challenges related to optimizing EV charging deployment and quantifying emissions reductions. Their real-world experience installing and operating EV charging stations provides invaluable insights into usage patterns and power demand needs. Collaboration with Seven States Power will be integral to modeling optimal station locations and capacity levels based on data-driven analysis.

Additionally, we are planning to establish partnerships with various research groups at the University of Tennessee Chattanooga and the Chattanooga Urban Informatics Partnership (CUIP). These collaborations aim to leverage their expertise and resources to further our research objectives. Engineers and scientists at these institutions have extensive knowledge of regional power generation mixes, grid operations, and sustainability initiatives. Their expertise could greatly strengthen methodologies for calculating location-specific EV emissions reductions based on local grid conditions.

Partnerships with these community cooperatives, companies, and universities will allow me to ground my research in practical knowledge and ensure real-world applicability. By leveraging their technical skills and regional focus, I am confident we can address pressing EV infrastructure and environmental analysis challenges facing the Tennessee Valley. I look forward to fostering these collaborations to promote efficient, sustainable electric vehicle adoption.

**Does your challenge exist in other communities or companies? If yes, please explain.**

**Mehdi**: The challenges of optimizing electric vehicle charging locations, capacity, and quantifying emissions benefits are certainly not unique to our region. These are statewide and regional challenges. As EV adoption accelerates globally, communities and companies worldwide are grappling with similar questions of how to build out charging networks efficiently and measure their impact.

For example, major metro areas like Los Angeles, San Francisco, and New York are struggling to meet fast charging demands while avoiding stranded assets from underutilized stations. Companies investing heavily in EV fleets, like Amazon, must also strategize optimal charging hub locations and power levels across diverse geographies. And sustainability-focused corporations want to accurately report portfolio-wide emissions reductions from electrifying their vehicles.

While the specifics may vary, the underlying challenges of right-sizing EV infrastructure based on data analysis and calculating verifiable climate benefits transcend regions. Local factors like policy incentives, driving patterns, fleet composition, and grid generation mix introduce nuance. But the methodologies we aim to develop, emphasizing usage modeling and granular emissions measurements, can serve as valuable templates. I hope that data-driven approaches to optimizing EV charging and quantifying impacts may ultimately inform and assist analogous efforts worldwide.

**Have there been any efforts to address the challenge in the past? If yes, please describe the outcome.**

**Mehdi**: This problem hasn’t been solved from an industry perspective. Some research studies have been carried out over the past few years. These studies have focused on forecasting electric vehicle charging loads, with most examining public charging stations over short 1-day horizons. Modeling approaches have included machine learning techniques like k-nearest neighbors (KNN), pattern sequence forecasting (PSF), and ensemble methods. While achieving reasonable accuracy, these efforts relied solely on past charging demand to predict future needs.

More recent work has started incorporating non-demand features like traffic patterns and weather data. For example, one study combined random forest, neural networks, and LSTM models with freeway traffic flow data to forecast public charging station usage. However, research has generally focused on individual locations rather than an entire charging network.

There have also been demand prediction initiatives leveraging EV user behavior data, like driving and charging history. But privacy concerns and data availability limit broader applicability. Studies on smart charging and fleet electrification optimization also exist, but do not address public infrastructure planning.

**Do you anticipate any infrastructure improvements that will be needed to address the challenge? If yes, please explain.**

**Mehdi**: While this research is focused on optimizing the use of existing electric vehicle charging infrastructure, expanding data collection systems would significantly assist the analysis. Access to robust real-world EV charging usage data is critical for accurately modeling demand patterns and station utilization over time. As such, upgrading monitoring and communications equipment at charging locations to transmit higher resolution usage data could greatly benefit the modeling and planning process.

Additionally, further developing integrations between charging networks and power grid operations would enable more precise calculations of location-specific emissions reductions. Direct data sharing between utilities and charging providers on generation sources and charging events would enhance the accuracy of EV climate impact quantification. This project is designed to work within current infrastructure limitations and provide actionable insights for better leveraging available resources. With sufficient baseline data collection, the models can be refined as expanded monitoring and grid integration upgrades are implemented. While not essential, maturing the underlying EV and grid data systems in parallel with the analytical approach would certainly be advantageous.

**How will a solution improve the quality of life in your community or company in the next five years?**

**Mehdi**: Optimizing electric vehicle charging infrastructure deployment and quantifying emissions impacts will accelerate EV adoption and sustainability in my community. Strategically locating charging stations based on data-driven demand analysis ensures convenient access for drivers. Right-sizing station power levels also enable faster charging times. Together, these improvements make owning and operating EVs more seamless. Additionally, accurately measuring local EV greenhouse gas reductions fosters further investment in clean transportation. Quantifying the tangible climate benefits related to EV use and renewable energy integration better informs policy-making and infrastructure planning.

Data-optimized charging networks and verified sustainability impacts will enable more residents, businesses, and municipalities to transition their vehicles away from gasoline. Accelerating this shift to electric transportation will significantly improve local air quality and public health outcomes. It will also demonstrate our commitment to reducing greenhouse gas emissions and building a carbon-neutral economy.

**List the top three R&D priorities of your company.**

1) City-wide R&D research, development, and deployment for connected and autonomous vehicles

2) Resilient and Sustainable energy and transportation system, electrification and its impact on the grid.

3) quantum information and technology and its application to the future of mobility.

**Please provide any additional information and attach any supporting documents (such as photos, case studies or anything else that would support your submission).**

**EV Infrastructure Optimization & Sustainability Analysis**

**Anticipated Infrastructure Improvements**

**- Data Collection Systems**

**- Real-world EV charging usage data critical for modeling**

**- Upgrade monitoring & communications at charging locations**

**- Transmit higher resolution usage data over time**

**- Grid Integration**

**- Direct data sharing between utilities & charging providers**

**- Generation sources and charging event data**

**- Enable precise location-specific emissions calculations**

**- Benefits**

**- Refine models as monitoring & integration upgrades implemented**

**- Work within current limitations, provide insights**

**- Maturing data systems in parallel advantageous**

**Improving Community Quality of Life**

**- Accelerate EV Adoption & Sustainability**

**- Optimal charging locations & sizing**

**- Faster charging, seamless EV ownership**

**- Quantify local GHG reductions**

**- Foster clean transportation investment**

**- Public Health & Environmental Benefits**

**- More EVs for residents/businesses/municipalities**

**- Improved air quality, reduced emissions**

**- Commitment to carbon-neutral economy**

**- Informed Policy & Planning**

**- Guide decision-making with verified impacts**

**- Better EV & renewable infrastructure planning**

**- Demonstrate sustainable mobility leadership**

**Previous Efforts & Limitations**

**- Short-term forecasting at individual locations**

**- Machine learning on past demand (KNN, ensembles, etc.)**

**- Recent work with traffic, weather data**

**- User behavior & fleet studies**

**- Privacy concerns, limited data availability**

**- Lacked holistic charging network planning component**

**- Didn't integrate power grid data for emissions analysis**