E-Mobility in Cold Climates: Coordination of Electricity and Transportation Networks

Recipient/Grant (Contract) Number: 69A3552348310

Center Name: Pacific Northwest Transportation Consortium (PacTrans)

Research Priority: Improving the Mobility of People and Goods

Principal Investigator(s): Mohammad Heidari Kapourchali (UAA), Osama Abaza (UAA)

Project Partners:

Research Project Funding: $40,000 federal; $40,000 non-federal match

Project Start and End Date: 8/16/2023 – 8/15/2025

Project Description: Electric vehicles have shown great potential in reducing fossil fuel consumption and greenhouse gas emissions. The total number of electric vehicles on the road reached 5.1 million in 2019 and will increase to more than 100 million by 2030. Over the next five years, the U.S. will deploy DC fast charging stations along its interstate highway system under the National Electric Vehicle Infrastructure (NEVI) formula program. The large-scale deployment of NEVI charging stations will significantly increase charging demand, posing challenges to power systems. Charging stations on the road would also have an impact on traffic flow, thereby coupling the electricity and traffic networks tightly. In September 2023, at the Alaska Infrastructure Development Symposium, the Alaska Energy Authority (AEA) and the Alaska Department of Transportation and Public Facilities (DOT&PF) announced their first round of awards for NEVI funding. AEA and DOT&PF selected projects in nine Alaskan communities for a total investment of $8 million. The $6.4 million in NEVI funding will be matched with $1.6 million from private entities selected to install, own, and operate the new electric vehicle (EV) charging stations.

Alaska villages are also seeing increased interest in electrical vehicle adoption. As part of a National Science Foundation project (EVITA), the PI has been investigating the interactions of electrical vehicles with cold weather, the electricity grid, people, and policy in the Arctic. The EVITA project, like mainstream electric vehicle research, focuses on electrical vehicle operation and planning from the perspective of the energy network. To fully understand the EV integration impacts, the behavior of electric vehicles needs to also be studied from the transportation network perspective. The study will be of significant importance in Alaska, as the unforgivable climate of the Arctic lowers electric vehicle efficiency and range, increases energy use and EV dwelling time, slows charging, and can decrease reliability and damage electrical efficiency. This proposed project aims to model the impact of electric vehicles on both the power grid and traffic flow. This will involve developing models for integrated electric and transportation networks, formulating optimal strategies for charging and discharging electric vehicles, and determining the ideal placement of charging stations. Successful completion of the proposed project has the potential to provide insights to legislators and policy-makers on the incentives that electrical vehicles could offer to improve the traffic network operation and resilience.

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US DOT Priorities:
The project aligns with the U.S. Department of Transportation (USDOT) priorities and the Research, Development, and Technology (RD&T) strategic goals by facilitating the integration of EVs into the power grid and transportation networks. This project supports USDOT's focus on promoting sustainable transportation, reducing greenhouse gas emissions, and enhancing the resilience of transportation infrastructure. It engages in transformative research by developing new models for integrated electric and transportation networks, optimizing EV charging strategies, and assessing the placement of charging stations. Such research is pivotal for understanding and maximizing the benefits of EVs in terms of traffic network operation and resilience, especially in challenging climates like Alaska's.

Outputs:
The expected outputs of this research project include new methodologies, analytical models, and simulation tools for understanding and optimizing the integration of EVs with power grids and transportation networks. The project is likely to yield valuable data, develop innovative software, and potentially lead to patent filings or new inventions related to EV infrastructure and efficiency. Additionally, it may foster new partnerships beyond the UTC consortium, involving stakeholders in energy, transportation, and technology sectors, thereby enhancing collaborative efforts towards sustainable transportation solutions.

Outcomes/Impacts:
The outcomes and impacts of this project are expected to significantly influence the transportation system, its associated regulatory, legislative, or policy frameworks. The application of the project's outputs could lead to the development of new standards or practices for integrating EVs into existing transportation networks, potentially resulting in improved safety, reliability, and durability while reducing costs. Moreover, the research could inform policy decisions, guiding the creation of incentives or regulations that promote EV adoption and infrastructure development, thereby enhancing the sustainability and efficiency of the transportation system.

Final Research Report: *will provide upon completion of the project*