Comprehensive Modeling and Analysis of Clean Energy Transition in Freight Transportation: Stakeholder Behavior, Infrastructure Planning, and Impacts – Project 11

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

Exhibit D

Recipient/Grant (Contract) Number: The University of Tennessee; University of Illinois - Chicago, Grant No. 69- A3552348338

Center Name: Center for Freight Transportation for Efficient and Resilient Supply Chain (FERSC)

Research Priority: Improving Mobility of People and Goods

Principal Investigator(s): Bo Zou (UIC), Jane Lin (UIC), Kazuya Kawamura (UIC), Abolfazl (Kouros) Mohammadian (UIC), P.S. Sriraj (UIC)

Project Partners: IDOT

Research Project Funding: $195,000 Federal and $120,000 non-Federal funding

Project Start and End Date: 08/01/2024 – 07/31/2025

Project Description: The objective of this project is to perform a suite of behavioral, planning, operational, and environmental analyses and develop relevant models and tools to prepare the US freight transportation sector for the transition from diesel to electric and hydrogen energy sources at both regional and local scales. This project aims to conduct an interdisciplinary investigation into the potential costs, benefits, and impacts of energy for freight. It will explore aspects such as infrastructure deployment, ownership and operating cost, air quality and exposure benefits, and health impacts, as well as the socioeconomic, organizational, regulatory, and institutional factors influencing the transition.

Task A: Clean Energy Transition Perception Survey. This task will design and administer a comprehensive online survey to understand stakeholders' perception of clean energy transition in the freight transportation sector. We aim to recruit a diverse list of freight stakeholders to participate in the study, including fleet owners, couriers, shippers, third-party logistics providers, and truck drivers. Their input on the transition to clean energy is crucial for shaping effective policies and strategies for clean energy transition.

The primary focus of the survey will be on three sets of research questions. (i) Perceptions and Attitudes: How do stakeholders think and feel about moving away from fossil fuels? (ii) Influence of Pre-existing Ideas: How do pre-existing ideas about politics and energy affect stakeholders' views on energy transition? (iii) Malleability of Public Opinion: How malleable is public opinion about the energy transition? How does it change over time? Can positive or negative information about the clean energy transition increase or decrease the support for it? Apart from the three sets of research questions, we will collect information among the survey participants of their socio-demographics, underlying values and beliefs, and perception about the energy industry, as well as short-term cues which could explain participants' perceptions towards clean energy.

Deliverables: Year 1: (i) a memorandum summarizing literature review and inputs obtained from stakeholders on survey design, and (ii) survey recruitment and administration plan. Year 2: (iii) survey results, (iv) cleaned and analyzed dataset, and (v) dissemination report.

Task B: Clean Energy Infrastructure Planning. In this task, we will explore clean energy infrastructure system design for freight transportation in a network setting. As both electricity and hydrogen are possible clean energy options for freight vehicles, two infrastructure subsystems will be considered. The two options can be complementary given their different characteristics such as the technology development status, adoption and ownership cost, existing infrastructure support, and associated vehicle driving range. For example, electric trucks are technologically more mature and deployed at an early stage, while hydrogen trucks are more advantageous with longer driving range, shorter refueling time, and greater payload capacity. As such, we may consider the two options individually and jointly in evaluating the freight transportation system performance.

Deliverables: Year 1: (i) data collection and assembly, (ii) scenario development for freight fleet clean energy transition, and (iii) preliminary modeling of refueling infrastructure location and capacity determination. Year 2: (iv) refined modeling of refueling infrastructure planning, (v) hydrogen production and distribution network design, and (vi) report writing and dissemination.

Task C: Air Quality, Exposure, and Health Impact Analysis at Community Scale. This task will assess air quality, exposure, and health impact of clean energy transition at the community level. We will first build baseline profiles of the study communities in terms of air pollution sources, emissions, exposures, and associated inhalation doses by fusing different air monitoring data sources. The, we will develop an air quality prediction model to analyze different local air pollution mitigation scenarios as a result of the clean energy transition. This will be constructed in collaboration with community stakeholders.

Deliverables: Year 1: (i) data collection and assembly, (ii) local air quality mitigation scenarios identified in collaboration with communities, and (iii) mobile source emission estimation. Year 2: (iv) air dispersion modeling and pollutant concentration predictions, (v) impact analysis, and (vi) integrated toolkit for environmental impact analysis.

Task D: Community Outreach. In this task, we will work with local communities to obtain their inputs for the toolkit of Task C to ensure that the toolkit fits the needs of the communities and the toolkit is widely disseminated once it is completed. We recognize that it typically takes years for a decision support tool such as the toolkit to be adopted by local communities and NGOs and impact their planning and policy decisions. As such, a mechanism will be established to help the communities learn and use the toolkit, to inform their decisions in the long run.

Deliverables: Year 1: (i) a memorandum summarizing inputs from local stakeholders on the design and use of the toolkit, and (ii) detailed dissemination plan for the toolkit. Year 2: (iii) toolkit user manual and training material that are accessible to non-experts, (iv) refinement of the toolkit as needed based on feedback from the training sessions, and (v) dissemination report.

US DOT Priorities: By developing models and tools to support the clean energy transition in the US freight sector, the project dovetails with the FERSC goals of maintaining the US economic competitiveness and security, and the US DOT strategic goal of Economic Strength and Global Competitiveness. It further aligns with the US DOT strategic goals of Transformation, and Sustainability. The research team aims to engage many stakeholders, including Illinois DOT, the Chicago Metropolitan Agency for Planning (CMAP), trucking associations, local communities, and non-governmental organizations (NGOs) to obtain inputs that will reflect the critical issues facing the various stakeholders and facilitate the model and tool development.

Outputs: The immediate technology transfer will be sharing research findings with the stakeholders surveyed, through presentations, project reports, and publications. In addition, we will leverage our close relationships with local governments, and NGOs in the Chicago region to develop and disseminate the toolkit that fits the need of community stakeholders. These communities often lack expertise to take advantage of relevant grants from EPA, the US Economic Development Administration, and other sources to address issues and create well-paying jobs. Our technology transfer activities will help them build grant development capacities to pursue such grant opportunities.

Education of community staff will be conducted through various community outreach events. We will further leverage this project to work with regional agencies such as CMAP who are concerned about creating action plans. The research findings will also support the continued development of the existing transportation degree-granting programs at UIC, to cultivate future professionals and civic leaders equipped with the knowledge and skills necessary to prepare for and capitalize on the clean energy transition.

Outcomes/Impacts: This project aims to perform a suite of behavioral, planning, and environmental analyses and develop relevant models and tools to prepare the US freight transportation sector for the clean energy transition at different geographical scales. Four research tasks encompassing stakeholder perception survey, infrastructure planning, environmental impact assessment, and tool development for local community use will be conducted. This project dovetails with the FERSC goals of maintaining the US economic competitiveness and security, and the US DOT strategic goal of Economic Strength and Global Competitiveness. It further aligns with the US DOT strategic goals of Transformation, and Sustainability. Various stakeholders will be engaged during the project along with technology transfer, education, and workforce development activities.