Transportation Infrastructure Electrification Certificate Program

CTIPS-006 – Full Project Description

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University

University of Utah

Principal Investigators

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Description

The future of electrified transportation infrastructure operates at the nexus of several critical industries (such as Transportation, Building, Power/Energy, Information Technology, Data Science, Social Equity, and Economics) that have historically operated independently, and the ever-increasing overlap among them has little to no strategic coordination. A coherent understanding of these complex interactions is required to capture and harness convergence across these industries and scientific communities and to reshape forever the future. The Transportation Infrastructure Electrification Certificate Program will be a collaborative effort pulling domain experts from the aforementioned disciplines and to train graduate students by applying cross-domain knowledges to tackle one of the most significant social issues of our time, preparing them to adapt to an increasingly interdisciplinary world, as well as increasing awareness of the many social equity issues permeating life in the U.S. and elsewhere.

The program's vision is to create entirely new lines of thinking on how city, highway, electric grid infrastructures are designed, how vehicles and operators interact with those systems, and how to integrate private sector partners and public resources in the human interface of planning, economics, and policy.

Project Objectives

Under the IIJA and the vast investment in clean energy and vehicle electrification, it is perceived that a large number of well-paying jobs to be expected in this area of people who understand systems of systems operations, possess the skills in AI, mixed modeling, programming and open science, and have such transdisciplinary background for electrification.

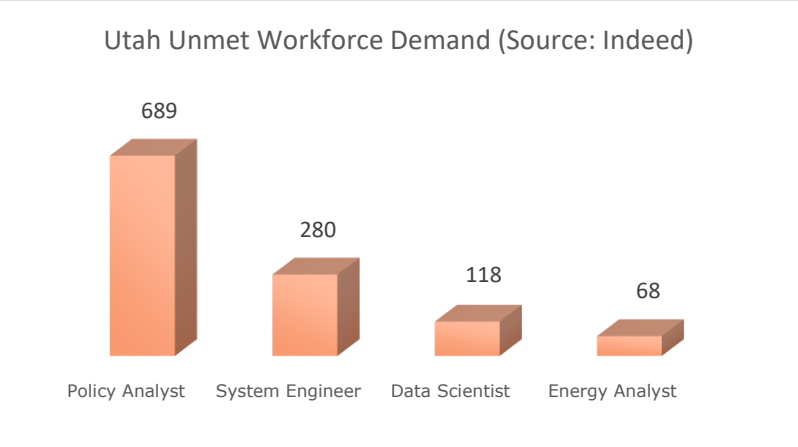
The objective of this project is to establish a self-sustained transportation infrastructure electrification certificate program. Student enrollment in the program is achieved as a stackable certificate on top of a regular graduate degree. Students with appropriate backgrounds may be allowed into the program as non-matriculated students. The successful award of the certificate results from the completion of 15 student credit hours of work at the graduate level. This program provides education in this area to engineering and science graduate students beyond one single domain background. We expect the well-crafted curriculum will attract additional students of myriad backgrounds (e.g., civil engineering, electrical engineering, computer science, planning, business, economics, public policy) who are interested in sustainability and electrified transportation theme in general, even for those who may not be able to obtain the full certificate, yet would like to gain relevant knowledge in one or two courses. we expect a steady-state production of about 50-100 graduates per year to provide a workforce that not only possesses the needed technical skillsets in the domain, but also has a leadership vision.

Relevance to Strategic Goals

The proposed project will address the USDOT strategic goal of *economic strength and global competitiveness*, and will also address climate and sustainability as the secondary strategic goal.

The nation's electricity system is transitioning to a clean and sustainable electric power sector to address climate, air quality, and sustainability. Yet, increasing renewable sources induces challenges to the reliable and efficient operation of the power grid due to their (sometimes) intermittent nature. In addition, analysts suggest that electric vehicle (EV) adoption levels will increase to 30% of new sales in the next ten years, bringing significant uncertainty and risks to the grid. Emerging technologies such as electric-powered drone delivery system (urban air mobility), and Autonomous, Connected, Electric, Shared (ACES) vehicles further push the need for a robust transportation electrification system to meet the ever-increasing demand. The Bipartisan Infrastructure Law (BIL) authorizes $1.2 trillion to combat facets of these problems, including funds to improve healthy, sustainable transportation options for millions of Americans and build a network of EV chargers to facilitate long-distance travel and provide convenient charging options.

A significant and growing demand exists throughout the intermountain region for a skilled workforce in transportation infrastructure electrification. Utah currently has over 1,000 open jobs in related areas (see Figure). This program will prepare students to take on these jobs with well-rounded technical skillsets for solving societal pressing issues with a deep understanding of social equity and policy implications. Recipients of the certificate should be qualified for most of these jobs; we expect a steady-state production of about 50-100 graduates per year to provide workforce in this domain.



Outputs through Technology Transfer

The objective of this project is to establish a self-sustained transportation infrastructure electrification certificate program.

Expected Outcomes and Impacts

Program Logistics:

- 15 credit hours
- Courses will be offered online to accommodate students not resided in Utah. However, in-person discussions will be facilitated for projects and the internship course (detailed below). Each course will be co-designed by the paired faculty of similar expertise and taught in submodules
- University Connected Learning (UCL) at the University of Utah will assist with production, marketing and launch of the program
- Certificate includes credit for industrial experience as part of the internship program
- Full-time students can complete in 2 semesters; part-time students can complete the certificate in 3 or more semesters; must complete in 2 years
- Eligible: graduate students and non-matriculated students
- Students may start the program in Fall, Spring or Summer

Of the 15 required credit hours, 12 must be from the required courses offered through the program. The four required well-crafted courses **represent an entirely new direction and concept of education for training the next generation of system engineers/planners/scientists** working in the electrified infrastructure technology space. We provide descriptions of these proposed courses and the submodules that will be jointly designed by the program-affiliated faculty members across the two campuses with consultations from our industry partners.

Required courses:

1. Systems of Systems Approach to Electrified Transportation (3 student credit hours)

Content Description	The course will introduce the systems associated with electrified transportation and the concept of taking a systems-of-systems approach to understanding and leveraging their interdependencies. These include electric vehicles (from passenger to delivery and freight), charging equipment and network providers, charging site locations, electric utility (from generation to delivery), roads and parking, traffic and traffic management, end users and fleet operators, and the environment and society.
Submodules	Systems of Systems Engineering; Economics; Air Quality; Equity; Policy
Education Outcome	• Recognize the systems associated with electrified transportation and their interdependencies • Understand the meaning of a systems-of-systems approach to considering the transition to electrified transportation • Explain at the conceptual level how the interdependencies among the systems in electrified transportation may impact adoption, the environment, and society

2. AI-Enabled Electrified Transportation Network Modeling (3 student credit hours)

Content Description	The course will teach techniques to plan and model electrified transportation networks, including both private vehicles and public transit. The planning analysis includes electric vehicle (EV) and electric bus (EB) demand estimation, charging infrastructure deployment, and charging schedule management. The network modeling will cover joint consideration of transportation and power grid for optimal infrastructure deployment, and discuss the social equity and policy implications.
Submodules	Charging Infrastructure Planning, Transportation Network Modeling, Learning-based Approach in AI, Data Science, Equity; Policy
Education Outcome	• Understand critical components in transportation electrification • Construct computational model to estimate the EV and EB charging demand and the associated charging infrastructure siting • Recognize the importance of social equity and policy influence in transportation electrification

3. Urban Sustainability and Energy Modeling (3 student credit hours)

Content Description	The course will introduce models for simulating the energy profile in an urbanized area, incorporating building electricity usage, EV charging, and distributed renewable energy generation. As a result of the transportation electrification and increasing EV penetration, a strong spatio-temporal correlation of energy needs exists between building and transportation sectors. The course will cover physics-based energy models to explore urban energy load profiles and tie that with sustainability design of urban areas.
Submodules	Learning-based Approach in AI, Data Science, Air Quality; Energy Modeling; Planning
Education Outcome	• Understand the interdependency of transportation, building, power grid as a result of infrastructure electrification • Model the energy consumption across an urban-scale region • Interpret the energy modeling results within the sustainability development and planning context

4. Transitioning to the Electric Grids of the Future

Content Description	The course will review existing practices from generation to loads and introduce the path forward for grid modernization in the era of connected communities, distributed energy resources, and electrified transportation. models will be developed for each of the major sub-systems in the grid and analysis will be applied to consider how future flexible, predictable, and controllable loads will serve as resources to support decarbonizing the grid while maintaining reliability and reducing cost. Air quality impacts will be considered for current and future grid energy mixes, and impacts of policies and rate structures on equitable and sustainable growth will be evaluated.
Submodules	Electric Generation, Transmission, Distribution; Charging System Solutions; Infrastructure Planning, Economics, Policy, Air Quality, Equity
Education Outcome	• Understand the operation and limitations of the existing electric grid system in the U.S. and the need for grid modernization to support rapid growth • Model major subsystems of the electric grid and analyze impacts of recent and upcoming sources and loads • Understand the path forward to equitable and sustainable growth through grid decarbonization with distributed resource management and updates to planning, policies, and rate structures

On top of the four required courses, students enrolled in the program are expected to register for an internship course (3 student credit hours). Our industry partners will provide the internship positions. The work performed by the students will be reviewed and approved through a signed agreement between the two universities and the industry partners. This is to ensure that the work performed is of mutual interest to the program and our industry partners, and the students could directly apply what they have learned in the program into practice.

Work Plan

The Transportation Infrastructure Electrification Certificate Program will go through the October university approval process. The approval process at the University of Utah is presented in the table below:

Approval Body	October Process Cycle
Graduate Council (Holly Lumbert)	10/31
Executive Committee (Jane Laird)	11/21
Academic Senate (Jane Laird)	12/05
Peer Review Committee (Lyndi Duff)	01/18
Board of Trustees (Karen West)	02/14
SVPAA Approval (Ann Holbrook)	03/16
NWCCU (Holly Lumbert)	03/23

Thus, the program may launch by Summer 2025 semester (else Fall 2025). Students will be recruited by making the program known to all the engineering students that are currently enrolled in both universities as well as advising it as a certificate program to the prospective students with the assistance of UCL. In either case, data will be collected by the UCL and Directors of the program based on directly tracking students admitted to the program as well as data available from the Office of Budget and Institutional Analysis. This data will include:

- Number of participating students
- Number of students receiving certificate (i.e., graduates)
- Number of student interns
- Number of students obtaining employment in Utah industry

Year 1:

- Establish program
- Advertise program
- Course design with industry partners' involvement and internship program logistics
- Report status to state
- Student recruitment

Year 2:

- Continue student recruitment
- Run intern projects
- Graduate first set of students
- Collaborations with other state universities
- Report data to state

Project Cost

Total Project Costs:	$100,000
CTIPS Funds Requested:	$ 50,000
Matching Funds:	$ 50,000
Source of Matching Funds:	Utah State of Higher Education