Systems of Systems

Modeling to Guide the Nation's Path Forward

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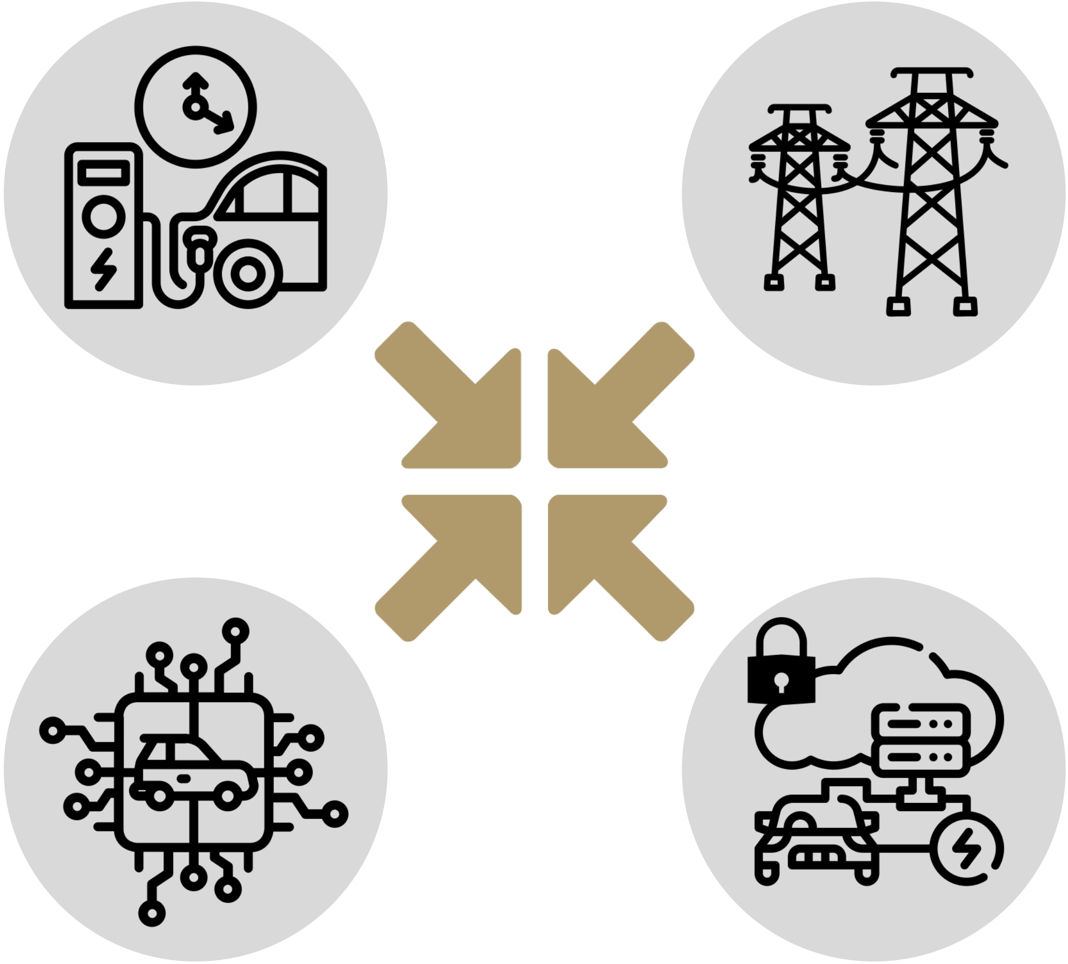
Systems of Systems

Core efforts increase abilities to co-simulate power & transportation systems



Adoption
What factors affect the adoption of EVs? EV charging infrastructure? What are the critical barriers to adoption?

Power Systems & Markets
How does EV charging affect power system operations, dynamics, stability, energy prices?

Transport Systems & Behaviors
How might travel behavior & transportation system usage change?

Charging Security & Management
How to manage charging, ensure security/reliability, & protect privacy?

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Other efforts improve evaluations of the influences & impacts of electrification

Environmental Impacts

How will emissions from the energy & transportation sectors change? Different spatial distributions?

Social Implications

Do certain communities have disparate access to EVs and charging stations? How to best engage with community members?

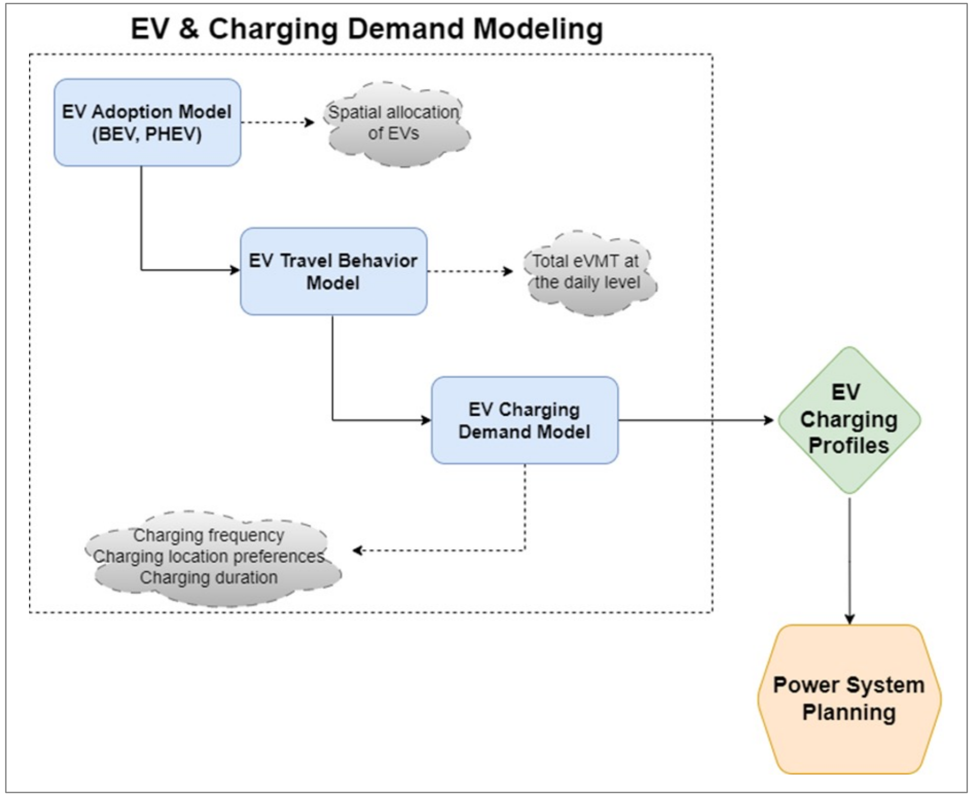
Health Impacts

What are the health impacts of electrification scenarios & charging technologies? How are health benefits distributed?

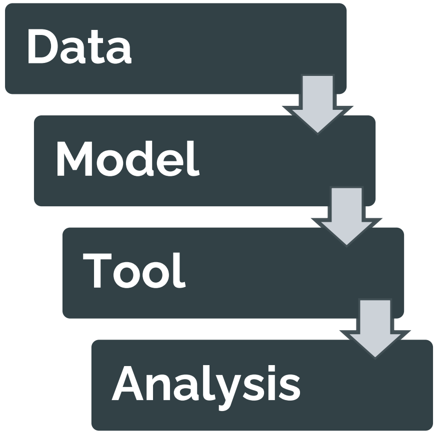
Policy-Making

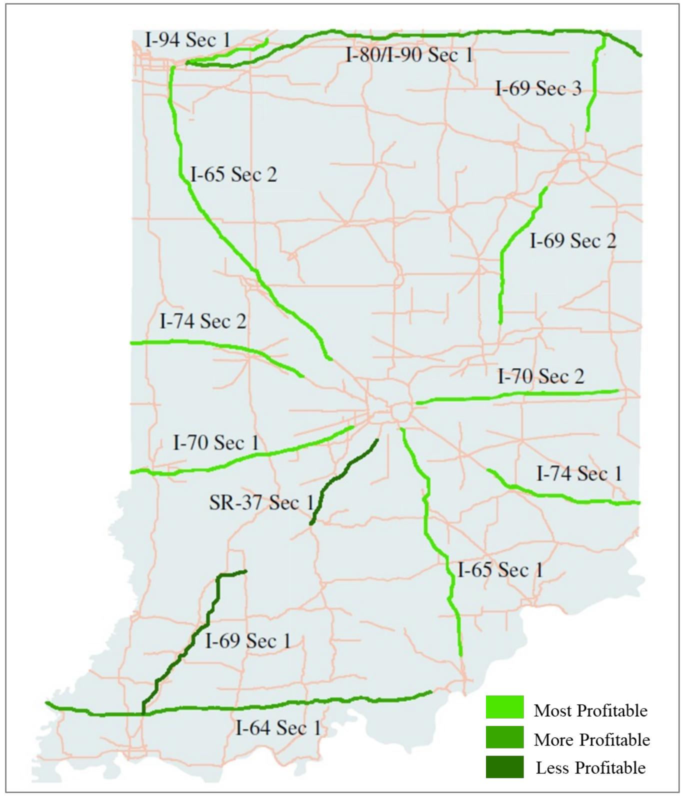
What are policy-related facilitators & barriers to EV & EVCI adoption? How do political orientations affect public perceptions?

1. Power–Transportation System Integration

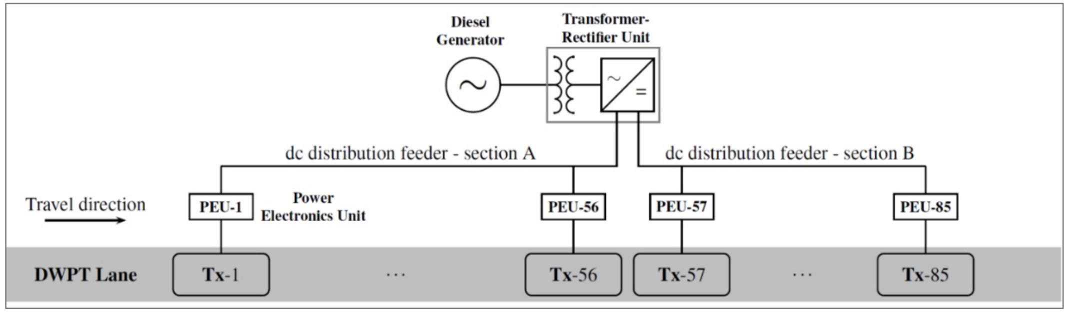


Framework for simulating EV charging profiles based on adoption, travel behavior, and charging demand models.





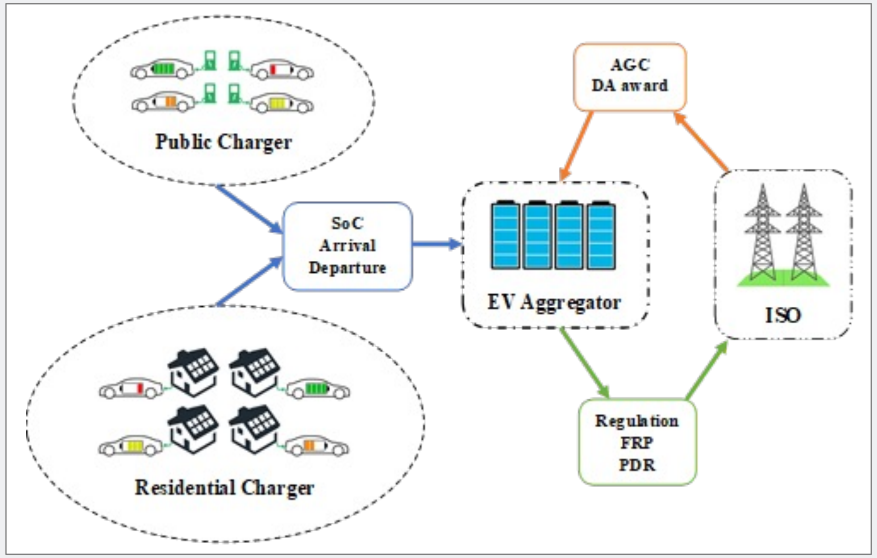
Feasibility analysis of dynamic wireless power transfer (DWPT) in Indiana.



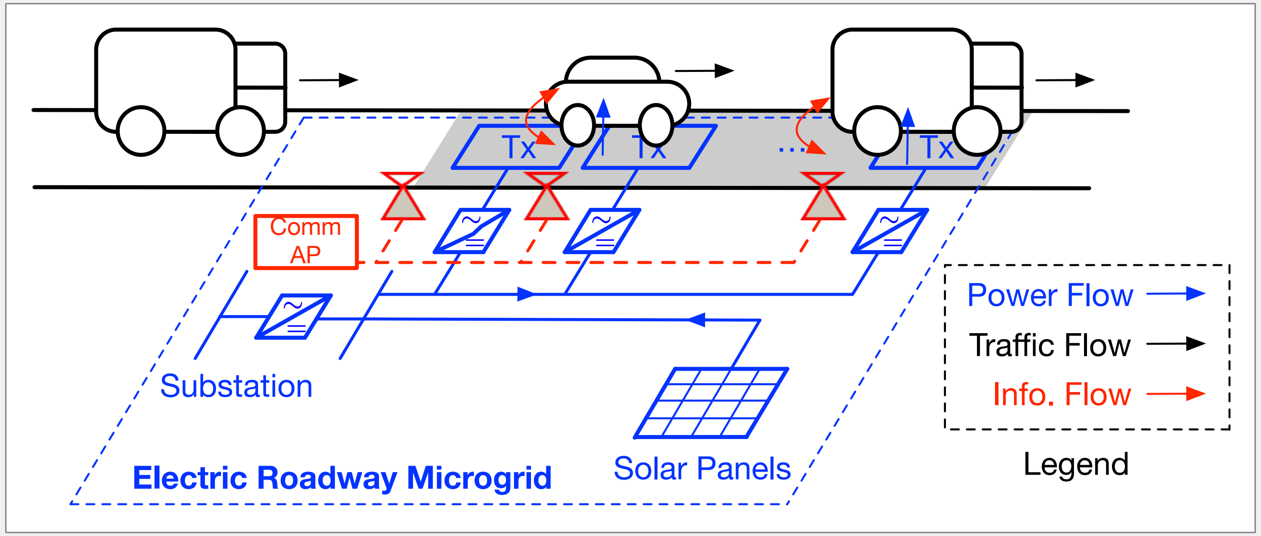
System architecture of an electric roadway simulator.

2. Managing EV Charging & Markets

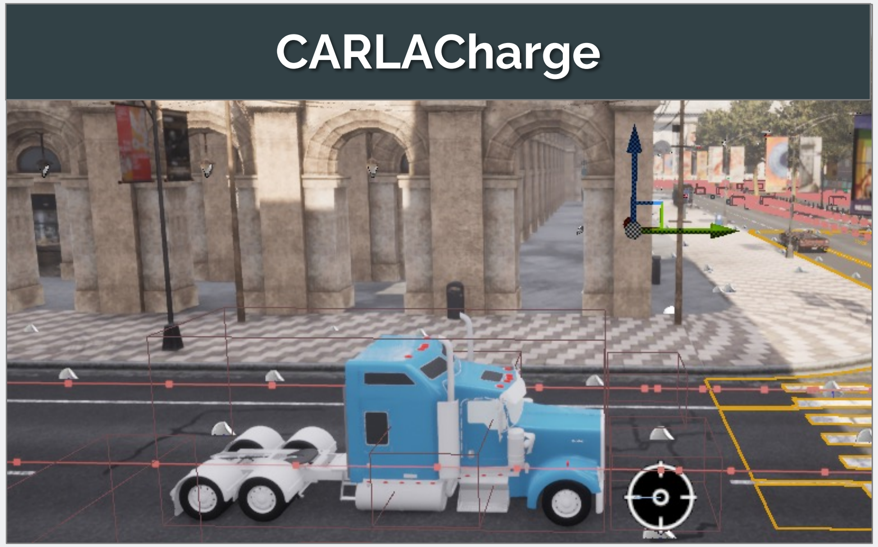
Vehicle & grid models, linked to real-world data & testbeds



Framework of the EV aggregation algorithm.



Conceptual framework of the electric roadway microgrid model.

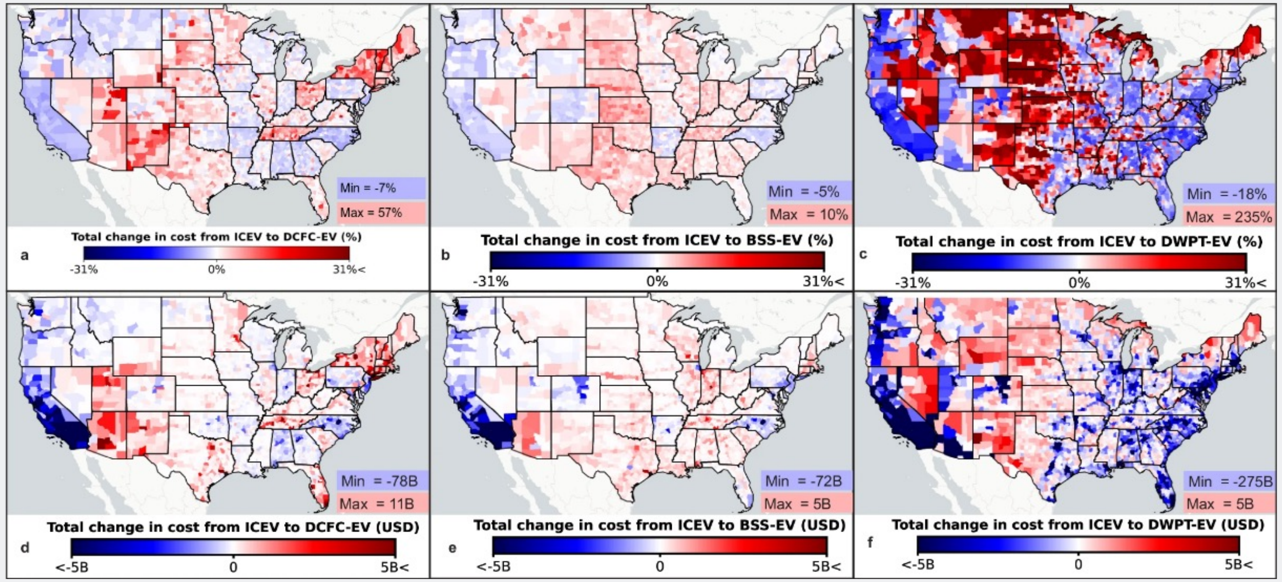


An electric truck in the CARLACharge software simulates the effectiveness of DWPT.

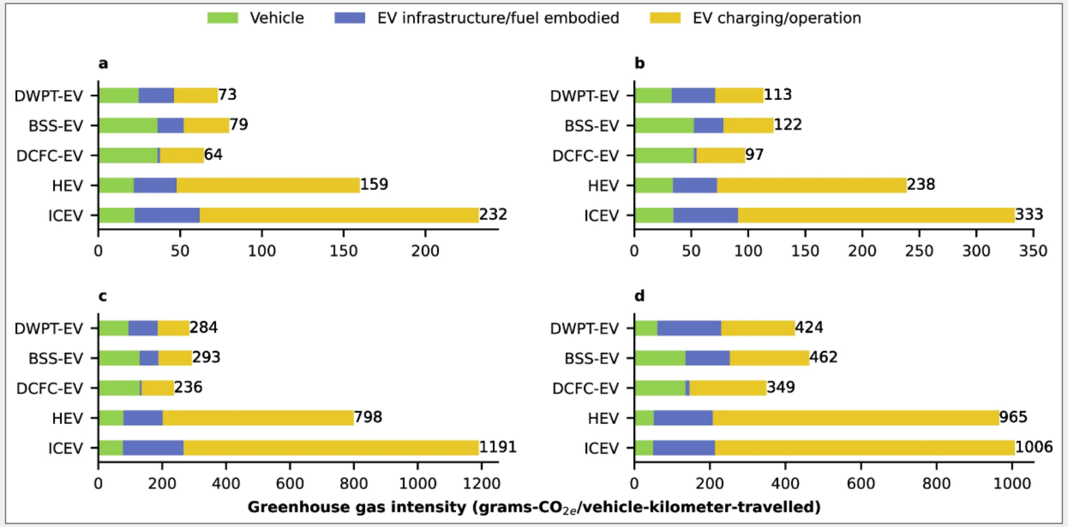
3. Evaluating EV Charging Systems

Integrated Techno-Economic Analysis (TEA) & Life-Cycle Assessment (LCA)

- DC Fast Charging vs. Battery Swapping vs. Dynamic Wireless Power Transfer



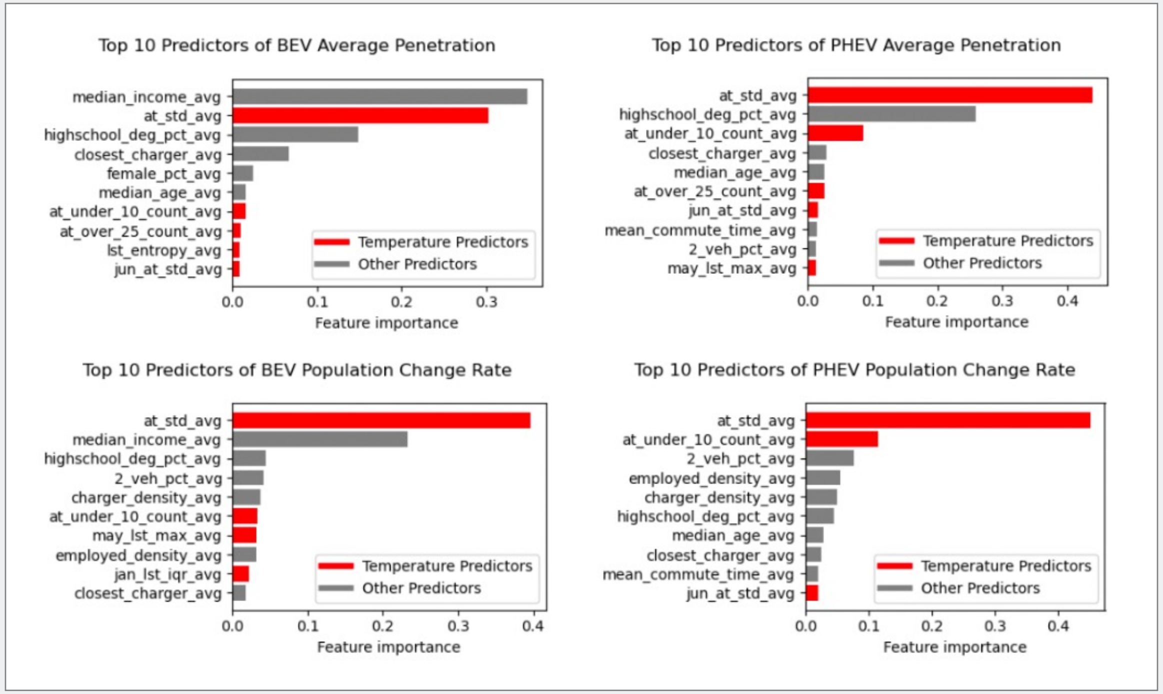
Change in total cost of ownership due to electric vehicle (EV) adoption.
County level results are presented for the change in total cost of ownership due to the transition from ICEVs to EVs (**a**–**c**) as a percentage and (**d**–**f**) in billions of 2022 US Dollars. Each map corresponds to EVs charged via (**a**, **d**) DCFC, (**b**, **e**) BSS, and (**c**, **f**) DWPT.



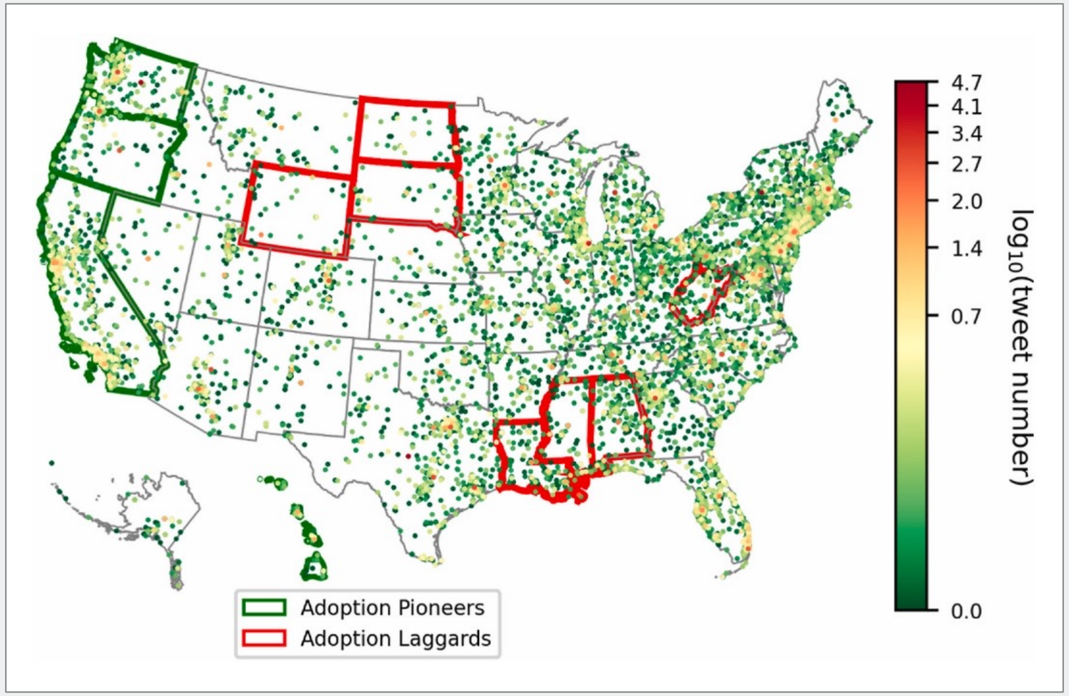
Breakdown of the lifetime greenhouse gas (GHG) intensity.
Results are for an average **a** passenger car, **b** light-duty truck, **c** medium-duty vehicle, and **d** heavy-duty vehicle in the contiguous United States. The vehicle scenarios include electric vehicles (EVs) charged via DCFC, BSS, and DWPT. Results are compared to an internal combustion engine vehicle (ICEV) and hybrid electric vehicle (HEV) from each category.

4. Advancing EV Adoption Models

Use of varied datasets reflects the interdisciplinary nature of adoption research.



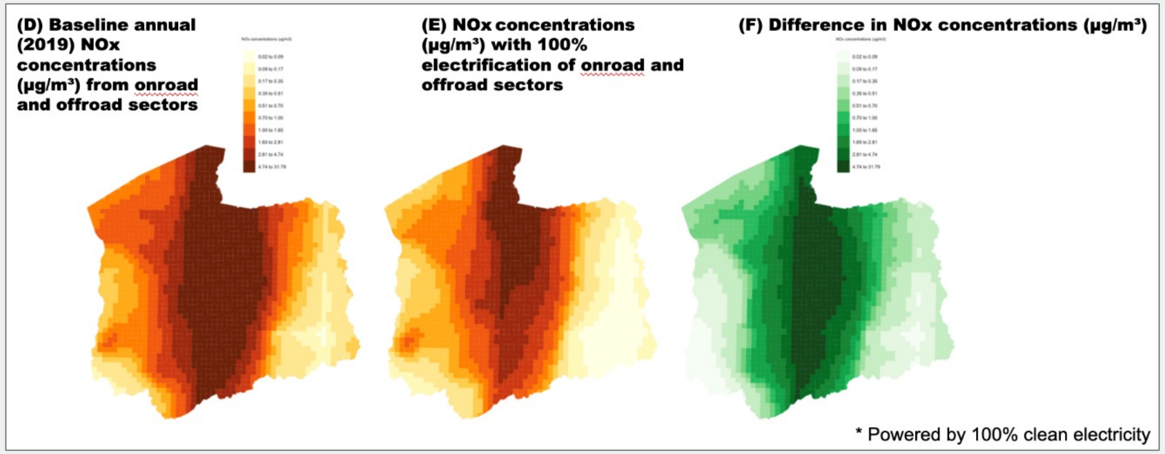
Temperature variables are the most important predictors of EV adoption.
Results are from random forest models of BEV and PHEV population penetration rates and population change rates, using ZIP code level data from seven U.S. states.



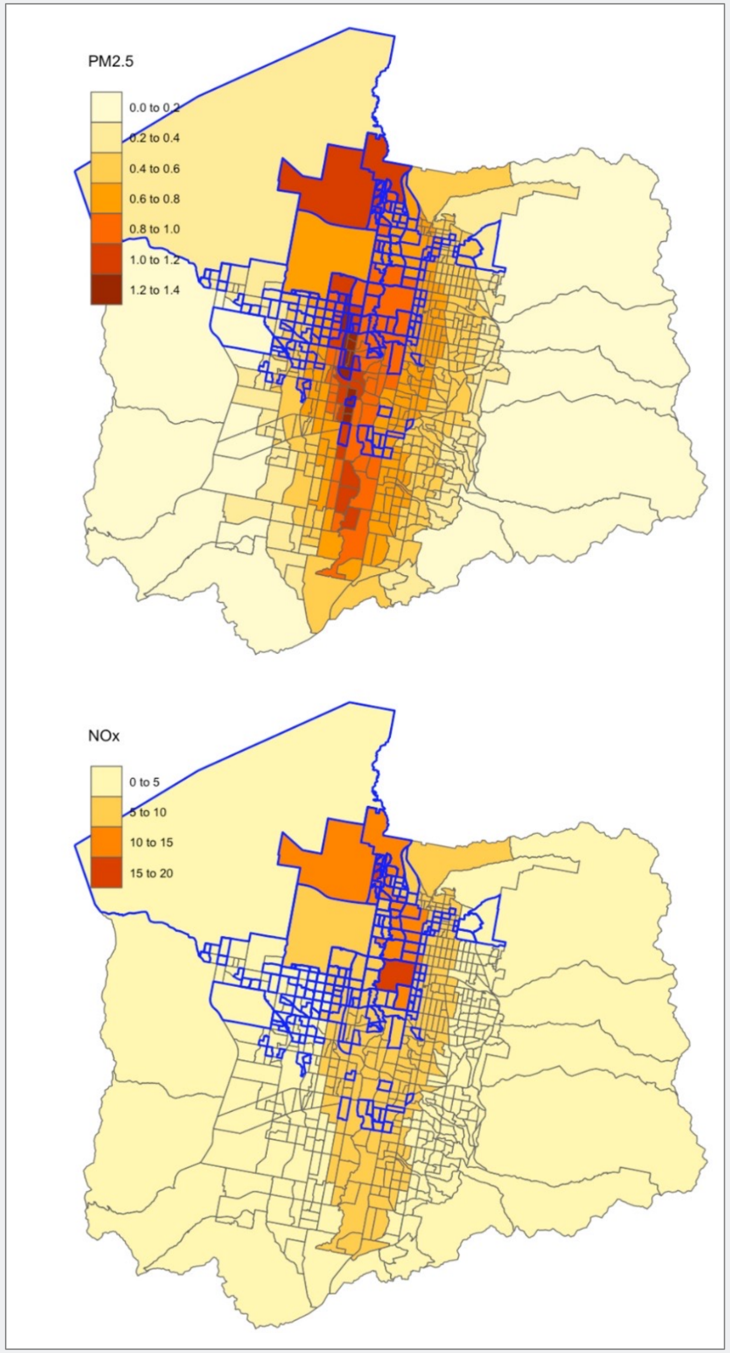
Tweets about EVs are spatially distributed across U.S.
Tweet results are superimposed upon a map showing US states as adoption “pioneers” or “laggards” based on the percentage of registered EVs in 2022.

5. Impacts to Health, Environment, Access

Working with/in communities to understand perceptions and analyze societal impacts.



Reductions in NOx concentrations (µg/m³) associated with a scenario of 100% electrification* of on-road and non-road emissions sectors.



Disadvantaged communities experience more transportation-related pollution.

Maps show the spatial distribution of PM2.5 and NOx concentrations (µg/m³) from the transportation sector in Salt Lake County, UT. Blue outlines indicate Census block groups with EJScreen demographic index scores (a combination of low-income and minority populations) in the 75^{th} percentile or higher in the country.

Future Systems of Systems

What are our plans for ASPIRE in Years 5, 6–10, and beyond?

Co-Simulate Power & Transportatio n Systems

Support Pathways to a Diverse Workforce

Model & Evaluate Influences & Impacts

Funding to Support Activities & Goals

Industry Engagement

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THE BORDERPLEX ALLIANCE
A Binational Economic Alliance
Juárez · El Paso · Las Cruces

EP TX
CITY OF EL PASO

Cummins

DRIVE CLEAN INDIANA

The Electric Company
El Paso Electric

Ford

INDIANA DEPARTMENT OF TRANSPORTATION
INDOT

GEOTAB

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ROCKY MOUNTAIN POWER

GREATER INDIANA

SLCgreen

UDOT
Keeping Utah Moving

UTAH INLAND PORT AUTHORITY
Moving Utah Forward

UTA

Xcel Energy

Data
Are you willing to share data about adoption, vehicles, charging, costs, etc.?

Models & Tools
Do you have (or a need for) new tools, models, analyses about P–T systems?

Sponsorship
Would you like to support research activities, student travel, internships?

Questions
What important questions can we help answer through our convergent research?

Patrick Singleton

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Thank You!

Questions?

Panel Discussion

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Modeling to Guide the Nation's Path Forward

MODERATOR:
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University of Texas at El Paso

Hal Johnson
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Utah Transit Authority (UTA)

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Jason Quinn
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Emma Rieves
Graduate Research Assistant, Geography
University of Colorado Boulder

ASPIRE Annual meeting

Sept 2024

Hal Johnson, Utah Transit Authority (UTA)
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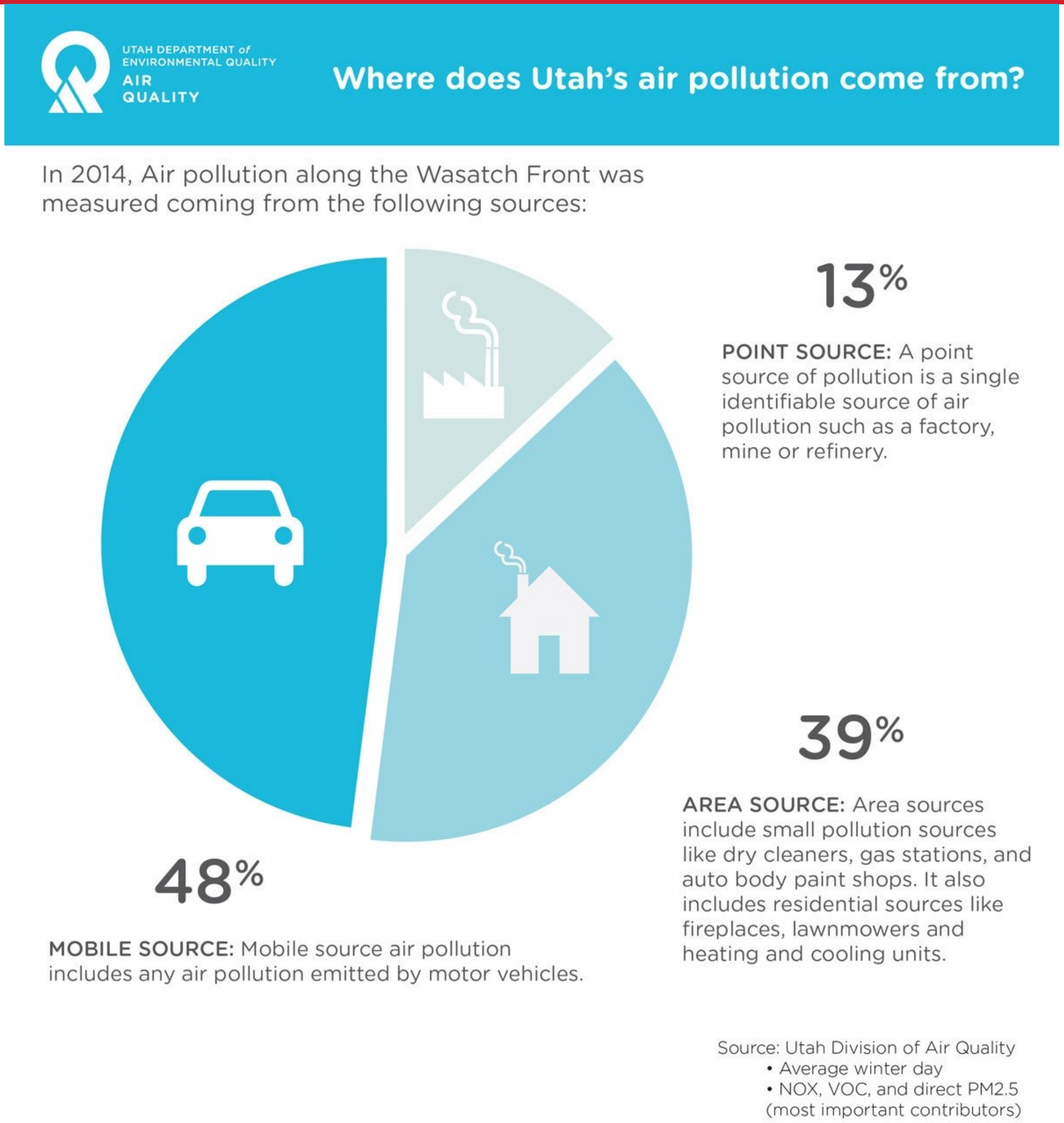
UTA

UTA Fast Facts

- ❑ UTA serves over **80%** of the state's population
  - ❑**1,400** square miles service area across seven counties
- ❑ **38,800,000** boardings system wide boardings projected in 2024 (90% of pre pandemic)
- ❑ **96** regular bus routes plus 18 Flex routes
  - ❑ **713** buses utilized
- ❑ **45.2** miles of light rail (TRAX) on **3** lines
  - ❑ **50** stations
- ❑ **83** miles of commuter rail (FrontRunner)
  - ❑**15** stations
- ❑ **4 micro transit Zones**
- ❑ **34** Battery buses (30 in the pipeline)

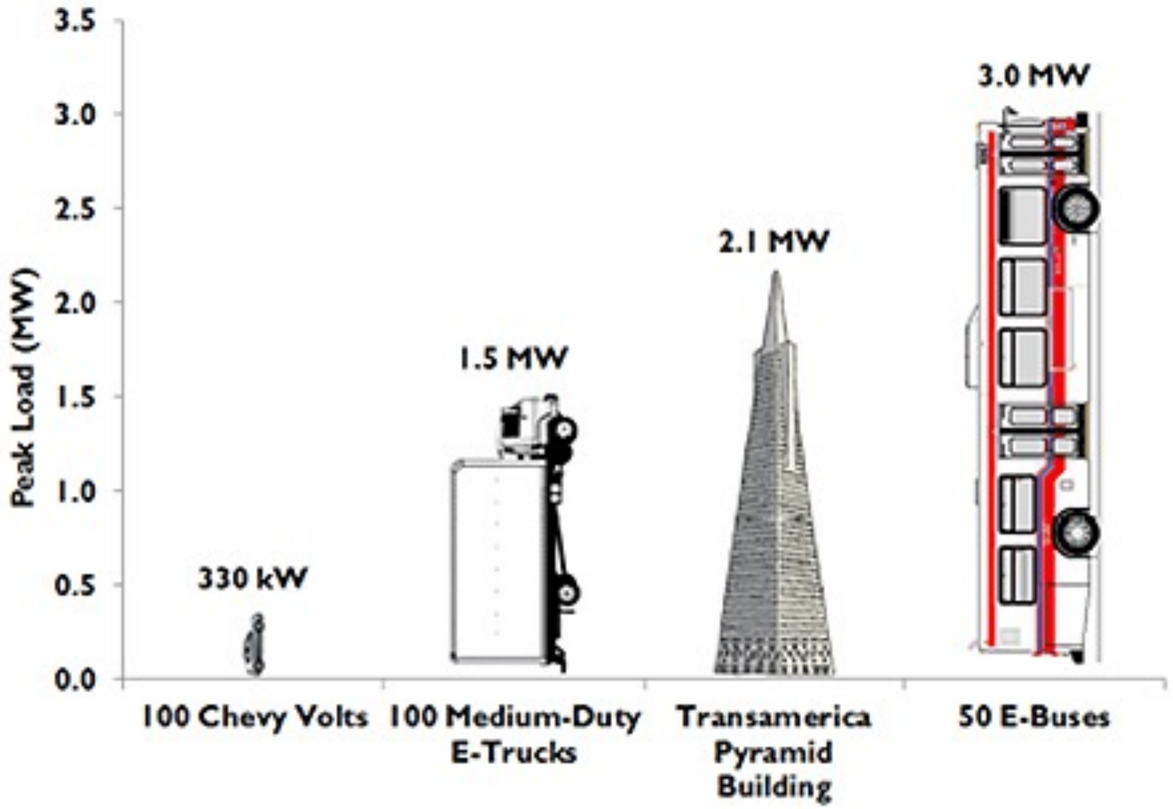
Why Electrify Transportation?



- Electrification can reduce emission from mobile and area sources
- Opportunities to better utilize electricity when it is available through batteries on vehicles and wayside storage
- Attract industry and economic development
- More consistent pricing of energy

Grid Impact of Electric Buses

Figure 14: Peak loads for various electric vehicle fleets (without mitigating grid impacts)



Assumptions: the Chevy Volt charging rate is 3.3 kW, the medium-duty E-Truck charging rate is 15 kW and the E-Bus charging rate is 60 kW. The peak load for the Transamerica Pyramid building is from [26].

Shared Electric Echo System Vision

UTA RMP Partnership Key Areas

WATTSMART COMMUNITIES

Energy Efficiency

Electric Vehicles

Electrical Infrastructure

Grid Resilience

Research and Grants

Clean Energy Focus Areas

UTA and Rocky Mountain Power (RMP) have an interagency partnership.

SB 125 Details

- ❑ Designates ASPIRE as the lead research center in developing a strategic action plan for the electrification of transportation infrastructure
- ❑ The plan will guide the transition to an electrified and intelligent transportation system
- ❑ Creates a Steering Committee and Industry Advisory Board
- ❑ ASPIRE partners with the University of Utah, Brigham Young University, and eight other universities across the world in its research, which is supported by NSF, industry partners, and research grants from the U.S. Departments of Energy and Transportation
- ❑ Requires ASPIRE to prepare first annual report by August 2024 (annually thereafter)

Utah Intelligent Electrified
Transportation Action Plan

Utah Intelligent Electrified Transportation Action Plan

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Panel Questions

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The Systems of Systems project involves experts from many different disciplines, working together on convergent research to solve challenging societal problems.

What is the value of a multidisciplinary center like ASPIRE?

Panel Questions

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The Systems of Systems project has ambitious goals around integrating knowledge and addressing issues in many different systems: transportation, power, the economy, the environment, public health, policy-making, etc.

What are some of the biggest challenges to understanding and modeling these various systems and their interactions?

Panel Questions

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What are you most excited about regarding the future of ASPIRE and electric transportation systems?

Are there any initiatives, collaborations, or potentials for growth, research, and application that you are looking forward to?