Minnesota Senate

Electricity As A Vehicle Fuel Working Group

15 Dec 2025

Michael Masquelier
Chief Commercial Officer

0. AGENDA

1. ASPIRE Overview
2. AVTA Bus Transit Converts to 100% Electric with Wireless
3. Utah Electrification Initiative
4. UEI – Systems & Fleet Modeling
5. ASPIRE & Utah Projects
6. Connected & Autonomous Vehicles
7. Utah Inland Port – Funded Electrification Programs
8. SAE J2954 Standards & Testing Services

1. ASPIRE Overview

The NSF Engineering Research Center (ERC)

ASPIRE's Vision

ASPIRE is a multi-disciplinary effort **across ten Universities** and over **sixty partners.**

University of Colorado Boulder

UtahState University

Lead Institution

THE UNIVERSITY OF AUCKLAND NEW ZEALAND

THE UNIVERSITY OF TEXAS AT EL PASO

PURDUE UNIVERSITY

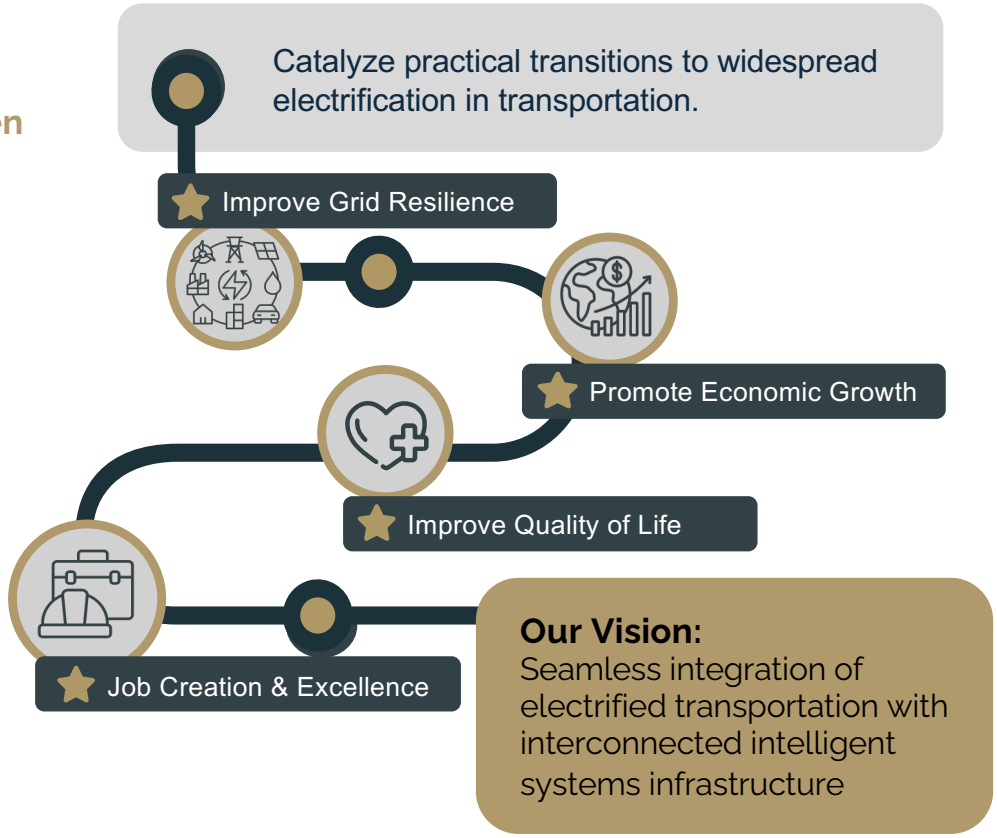
THE UNIVERSITY OF UTAH

Colorado State University

UCCS University of Colorado Colorado Springs

Cornell University

VIRGINIA TECH



What is ASPIRE?

Areas of Research

Data

- Data Analysis & Fusion
- AI / Optimization / Co-Sim
- Cybersecurity / IoT / Networks

Adoption

- User Acceptance
- Public Policy
- Economic Impact

Power

- Power Systems
- Grid Integrated Charging Systems
- Battery Systems

Transportation

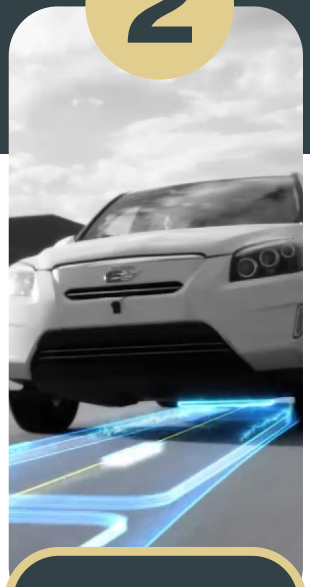
- Transportation Systems
- Transportation Infrastructure

ASPIRE Center Research Projects

1

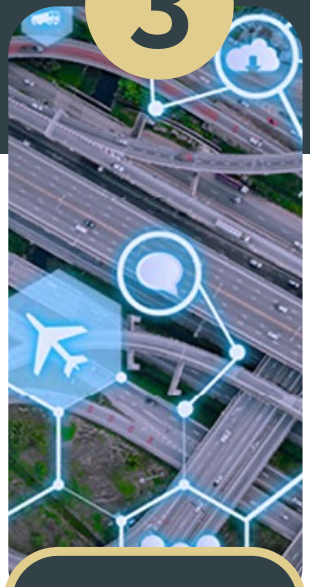
Charging Stations of the Future

2



Electrified Roadways

3



Systems of Systems

4

Workforce Pathways

ASPIRE - Industry & Innovation

Total Industry: 29

Total Innovation: 40

By the Numbers

$174 Million+ Funding Announced Since 2020

40,000+ Attendees Reached Through Events

450+ Faculty Students & Staff

240+ Peer Reviewed Publications

70+ Industry & Innovation (IIB) Members

39 Patents Awarded

ASPIRE EVR Testbed

Utah State University Innovation Campus

Electric Vehicle and Roadway Facility (EVR)

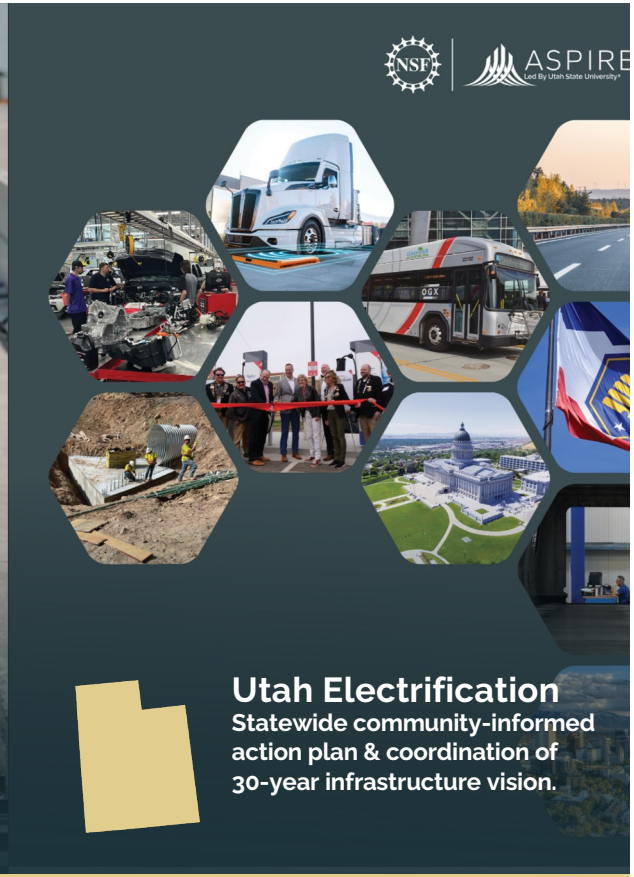
Megawatt Charger In-road Charger

Utah Pilot

Wireless megawatt and in-motion truck charging, multi-modal grid management, battery electric trainset

Indiana US 231/52

Quarter-mile 200 kW in-motion wireless charging with P3 relationships.



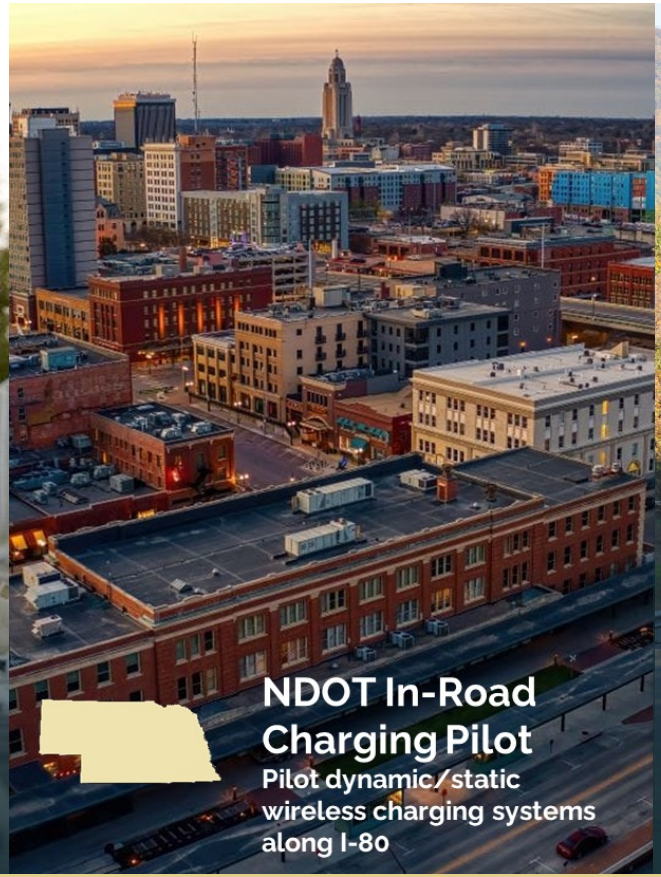
Utah Electrification

Statewide community-informed action plan & coordination of 30-year infrastructure vision.

P3 Technology Deployment Projects

Florida SR 516

In-motion wireless charging with interoperability among vehicle classes



NDOT In-Road Charging Pilot

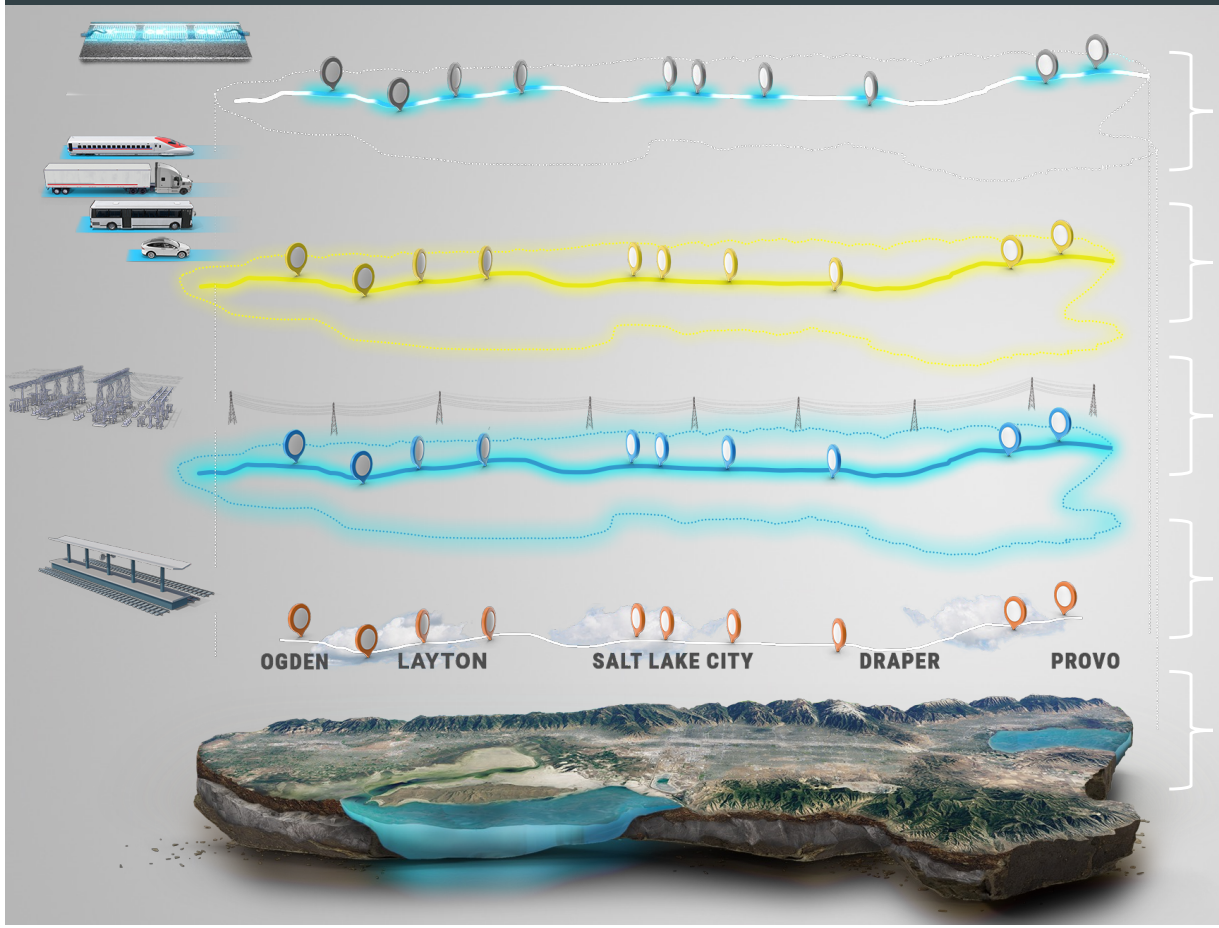
Pilot dynamic/static wireless charging systems along I-80

Pennsylvania Turnpike

Stationary and in-motion wireless charging business model & deployment on toll roads

P3 Technology Deployment Projects

Coordinated Multi-Modal Electrification



Electric roads leverage shared grid infrastructure along the corridor

Fast charging and hydrogen leverage rail infrastructure for trucks, buses, and passenger vehicles

Multi-megawatt substations at hubs with coordinated grid loading

Commuter and light rail serve as roadmap for intermodal charging hubs

Shared public infrastructure with load management reduces electricity cost for all loads, from vehicles and data centers

ASPIRE Commercialization

Electrified Roadways

Grid-Tied & Forming Converters

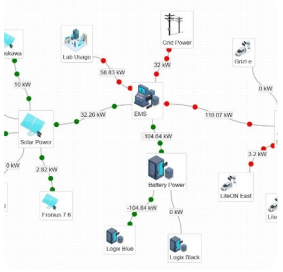
MW-Scale Wireless Charging

Power Systems & Transportation Modeling

Testing & Consulting Services

Fleet Electrification Modeling

Electrification Workforce Training



Smart Energy Management Systems

AI & Autonomous Vehicle Systems

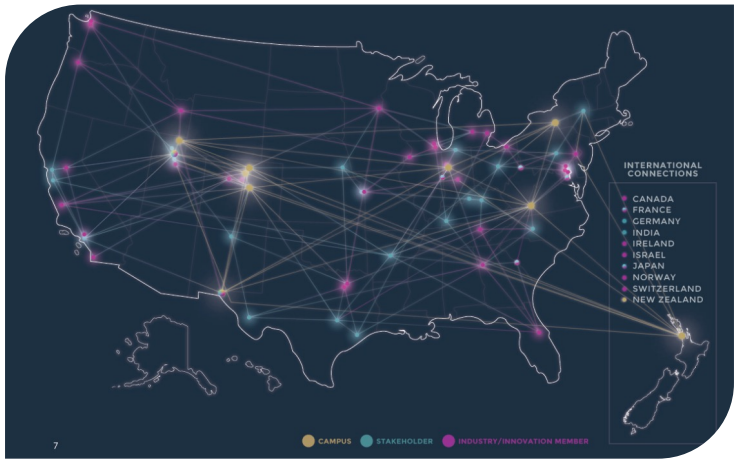
ASPIRE Nonprofit

ASPIRE

1. Development, demonstration and deployment, technology & workforce
2. Champion for industry transformations
3. Staff-led with university support

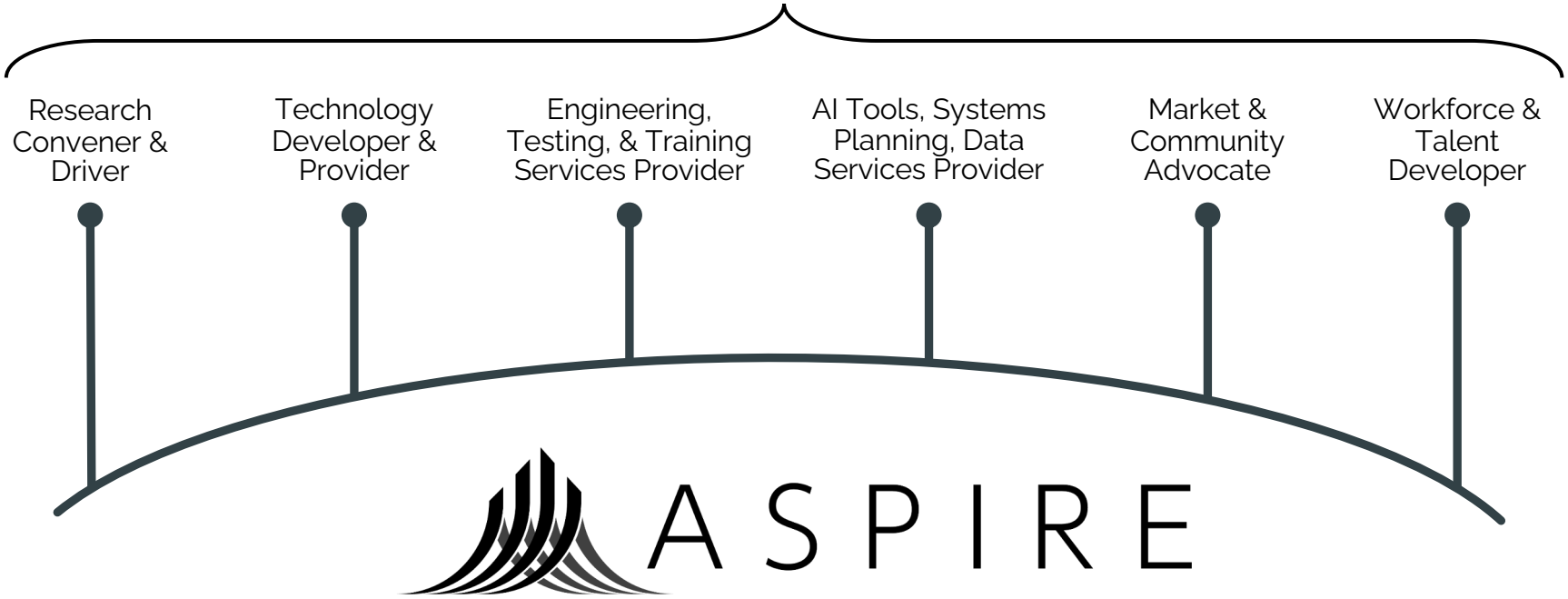
University Partners – Regional Hubs

1. Core research mission of ASPIRE
2. Faculty-led with ASPIRE support
3. Campus Directors, faculty, student ASA



Champion for Intelligent Cross-Industry Electrification

Technology Innovation & Deployment **Experiential Learning for Students**



Global Potential

Images: OpenAI. (2024). ChatGPT (4o) [Large language model].

National Deployment

International Reach

Standard Bearer
(NASA of Electrification)

Societal Impact

$150M Growth Target: Next 5 Years

$50M

University Research

$25M

Services

$50M

Electrified Transportation System (P3) Pilots & Deployments

$25M

Donations & Memberships

2. 1st U.S. Transit Agency – All Electric

Antelope Valley Transit Authority (AVTA)
Converts to 100% Electric with Wireless In-Route Charging

Rethinking Charging Strategies
with WAVE Wireless

Image has been altered to replace WAVE's former logo with WAVE's current logo

NASDAQ:

- **Wirelessly Charged** since 2018
- **Service Area:** over 200 square miles
- **Vehicles:** 47 wirelessly-equipped BEBs (28 on order)
- **WAVE Chargers:** 12 @ 250kW (+3 in 2022)
- **Longest Route:** 290 miles (vs. 155 miles range)

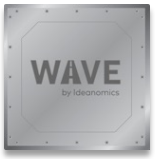
Highlights (2019- present)

4,461 MWh - energy delivered

2,478,257 range extension miles

Case Study | AVTA Vehicle Cost

To achieve more range

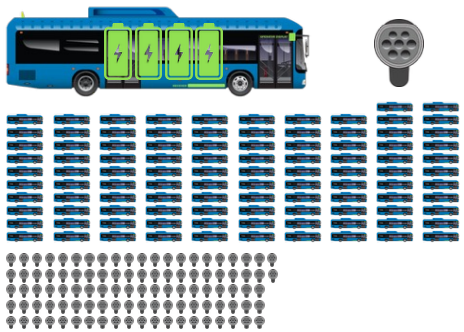
	standard-range: 155 mi	extended-range: 200 mi	WAVE range extension: 400 mi	Diesel-like range
			  *subtract 180 kWh of battery*	
Higher battery cost +	$780K	$810K (+30K)	*(-$70K)* than extended BEB	Reduced battery cost
Additional curb weight	32,369 lbs 324 kWh battery	35,419 lbs (+2,350 lbs) 446 kWh battery	32,265 lbs *(-3,154 lbs)* 266 kWh standard battery	Meets axle weight limits

Reducing Fleet Cost With WAVE Wireless

Transitioning from 65 diesels

102 BEBs w/ max. battery

102 conductive depot plug-ins



Fleet cost $84.0M

Charger cost $6.0M

Total cost over 12 years **$121.5M**

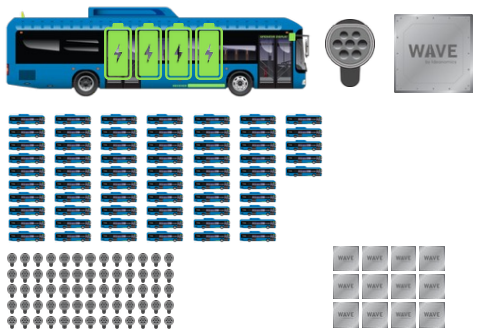
37 more BEBs needed to cover routes beyond standard BEB range

+ wireless to charging strategy

65 BEBs w/ max. battery

65 conductive depot plug-ins (37 less)

12 wireless in-route for 47 BEBs



Fleet cost $56.4M

Charger cost $11.5M

Total cost over 12 years **$96.3M**

$25.2M savings over 12 yrs.

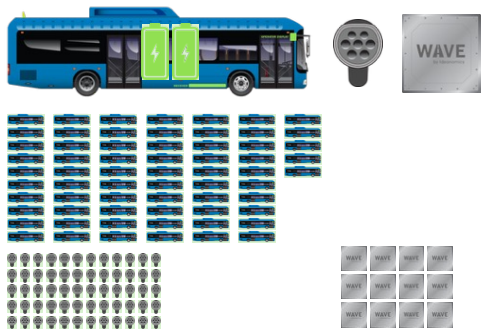
1:1 replacement ratio achieved

$70K less per BEB

65 BEBs w/ **lighter battery**

60 depot plug-ins (42 less)

12 wireless in-route for 47 BEBs



Fleet cost $52.0M

Charger cost $11.2M

Total cost over 12 years **$87.8M**

$33.7M savings over 12 yrs.

$8M+ saved by reduced battery and O&M costs

WAVE by Ideanomics

3. Utah Electrification Initiative

Funded by SB125 (2023)

What is S.B.125 of '23?

S.B.125 launched Utah's strategic Intelligent and Electrified Transportation plan to:

- Boost mobility & economic growth
- Create meaningful jobs
- Build resilient communities
- Improve air quality

Utah Electrification Initiative

Cross-Industry Coordination
Collaborate with state agencies, UDOT, UTA, GOEO, & GOED, and industry partners (Kenworth, UPS, etc.)

Data-Driven Solutions
Deliver timely, accurate, and relevant data.

Technical Expertise
Provide innovative research with up-to-date insights.

Community Integration
Bring stakeholders together to allow communities to determine the best options for their areas.

State Electrification Ecosystem Development

9 Industry Advisory Board

Pursuant to the legislation, this initiative's efforts are under the direction of a Steering Committee and Industry Advisory Board (IAB). The IAB is comprised of an 18-member executive team who chair nine advisory teams.

Each advisory team includes stakeholders, industry partners, and government agencies to provide guidance to the planning effort by imparting information and insight relevant to their specialized expertise.

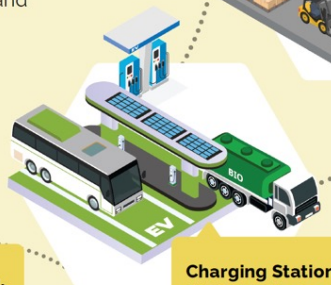
Public & Private Transportation Systems

On- and Off-Road Heavy-Duty Vehicles

To join one of the teams on the Industry Advisory Board,
Contact **Sara.Shaffer@usu.edu.**

Electrified Aviation

On Road Light- & Medium-Duty Vehicles

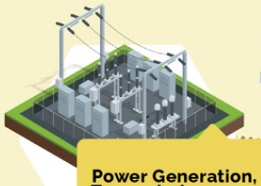


Charging Stations: EVSE Products, Networks, Sites, Installation, & Operations

On- and Off-Road Heavy-Duty Vehicles

Workforce Development

Community Development & Engagement



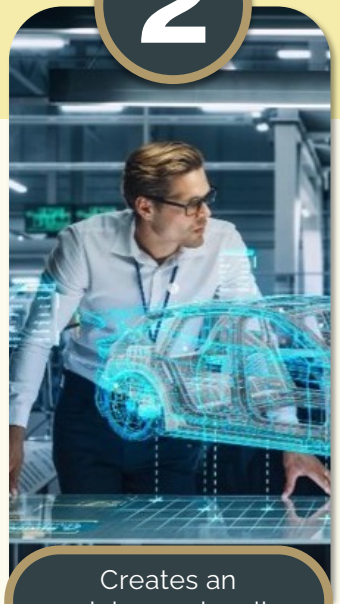
Power Generation, Transmission, Storage, & Distribution

State Electrification Ecosystem Development

1

Carefully balanced market-driven approach that is responsive to the legislation.

2



Creates an evolving regionally-adapted planning process towards a 30-year vision.

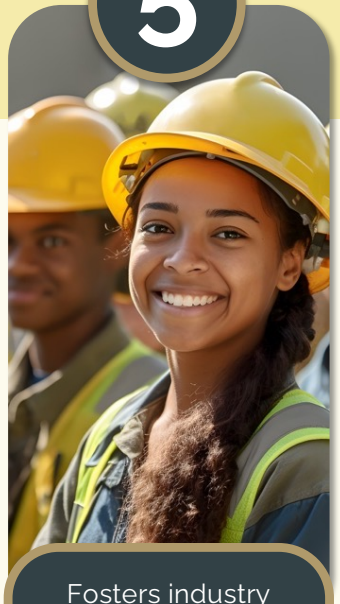
3

Sets forth intelligent communication with the electrical grid & traffic management systems.

4

Promotes steady use of the electrical grid to improve how and when energy is consumed.

5



Fosters industry innovation, creates jobs, and trains a dynamic workforce.

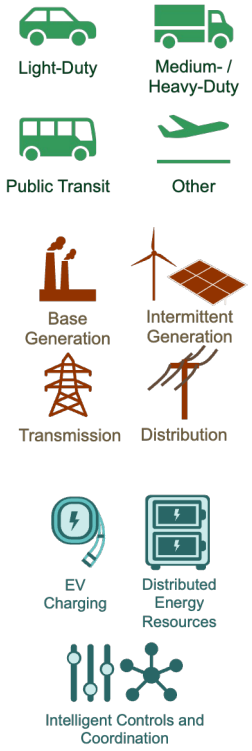
4. UEI – Systems & Fleet Modeling

Power & Transportation Systems Modeling

ASPIRE
Kyle Goodrick, David Trinko

Plan: Model Everything

Cars, trucks, buses, trains, planes, power plants, transmission assets, distribution assets …



Vehicle movement needs and growth

Grid resource availability and plans

Technology development, availability, and cost scenarios

Comprehensive system model
searches for the best feasible system configuration

System Design and Features

- Pace of EV feasibility for each sector and use case
- Planning and rollout of charging and grid infrastructure

Outcomes

- Air quality and human health
- Jobs and economic growth

Actionable insights

guide the development of Utah's future transportation and power systems.

Illustrating the Modeling Effort

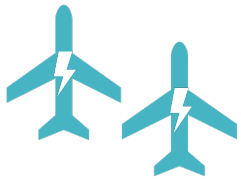
Example case studies surface insights across sectors

Example 1:
Large-scale **coordination of electrified freight** and the grid

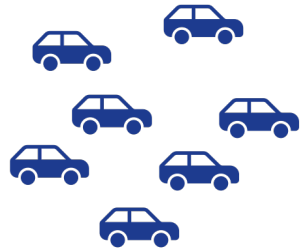
Example 2:
Detailed analysis for **lowest-cost fleet electrification** planning

Example 3:
Comprehensive bus system analysis to **avoid unnecessary grid upgrades**

Example 4:
Least-cost **aircraft electrification** for training flights

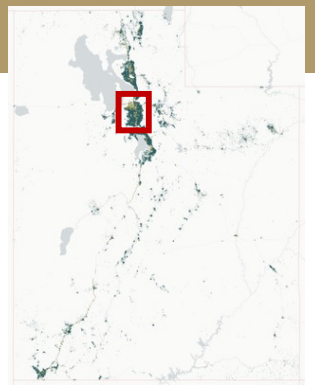


Example 5:
Market-driven **light-duty EV adoption modeling** to anticipate localized resource needs



5 select pieces of the comprehensive Utah system model

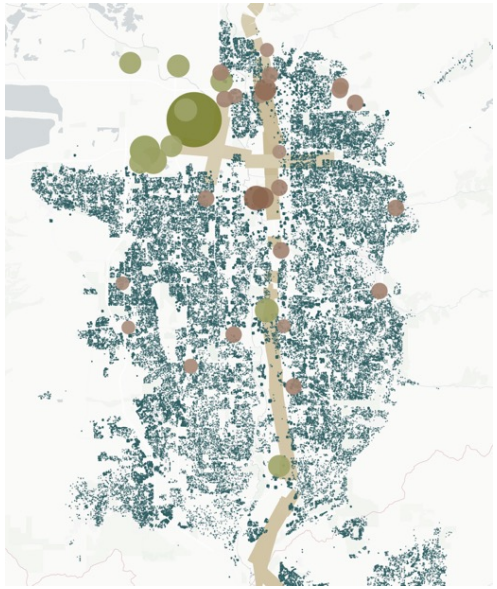
Modelling What, When, and Where



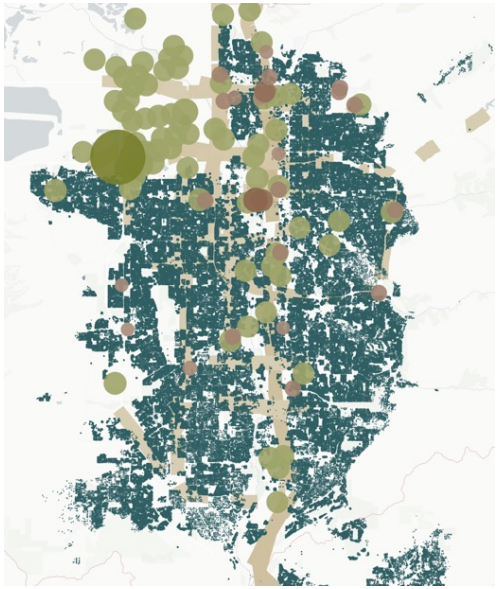
Systems approach:

- **Comprehensive assessment** of charging demand for all sectors in the state
- Leveraging **spatial and temporal flexibility**
- **Minimizing overall system cost** while satisfying transportation requirements
- Comparing outcomes across potential plans and scenarios to **derive actionable insights**

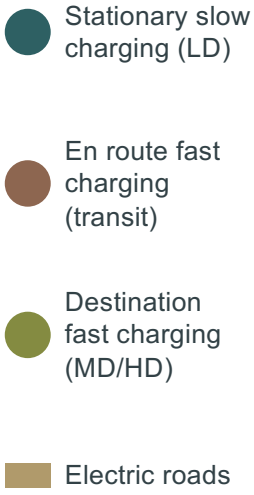
2034



2044



2054



Example: Electrified Freight Coordination

Matching power supply and demand

Upgrade values are for a subset of long-haul HD trucks, not all EVs

Not enough grid capacity

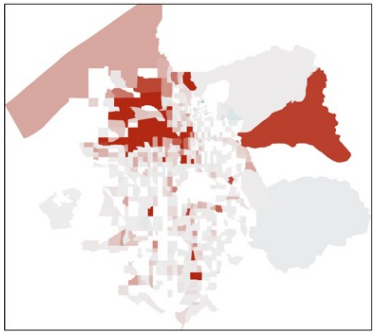
Extra grid capacity

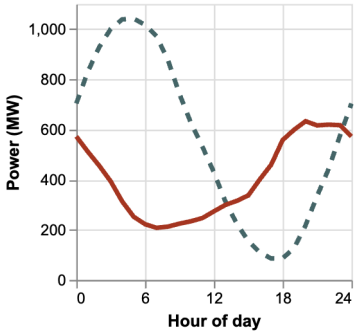
Grid power availability

EV charging demand

Unmanaged:
EVs charge whenever they want, unconstrained

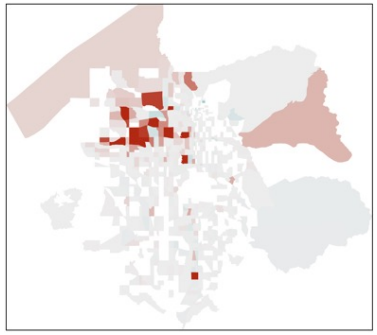
2,500 MW of local upgrades: $1.7B

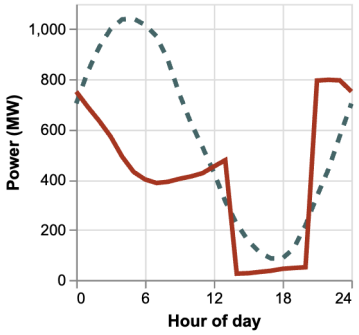




Incentivized:
EVs seek minimum-cost charging, considering time-of-use costs

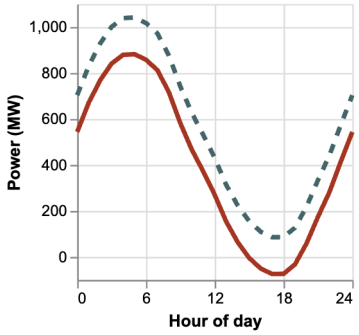
750 MW of local upgrades: $0.5B





Coordinated:
EVs charge at times that result in minimum system cost

250 MW of local upgrades: $0.2B



Fleet Electrification Modeling Example:

Feasibility assessment and charging system analysis

Task:

- Choose which trucks to electrify
- Decide what kind of chargers to install
- Specify when and where trucks charge

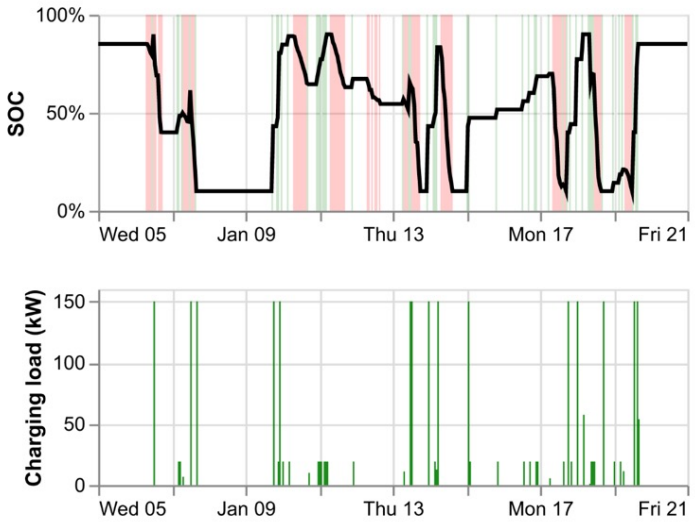
Constrained by:

- Fleet operations cannot be disrupted

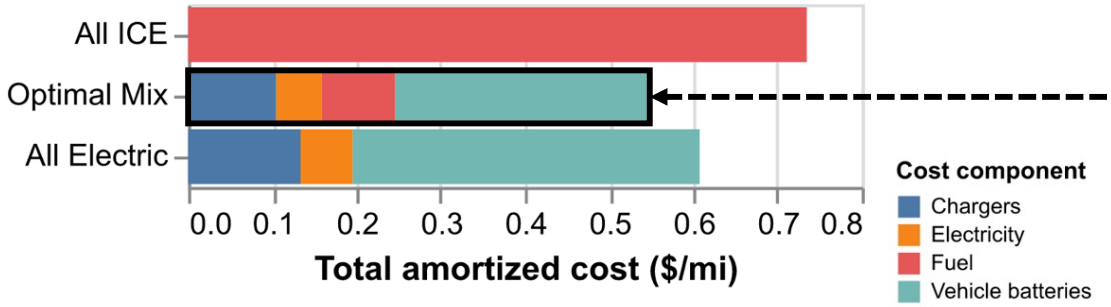
Objective:

- Minimize overall cost
  - → vehicles, fuel, electricity, chargers

Zoom in on one truck:



RSD fleetwide:



Case study illustrates that **the optimal plan for a fleet may be partial electrification** in the near term

Fleet Electrification Modeling & Workshop

October 2

Electrifying Smarter

Fleet owners & operators are invited to a free workshop to discuss all aspects of fleet electrification. Participants will have the opportunity to **engage with industry representatives, explore strategies for building a fleet electrification plan,** and receive the latest information on current programs and incentives.

Join Us!

In partnership with:

- Utah Clean Energy
- NACFE

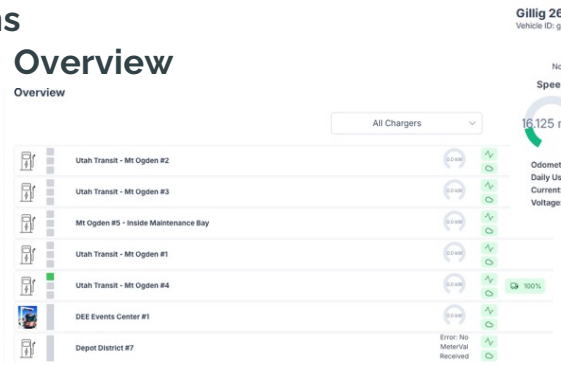
Scan to Register

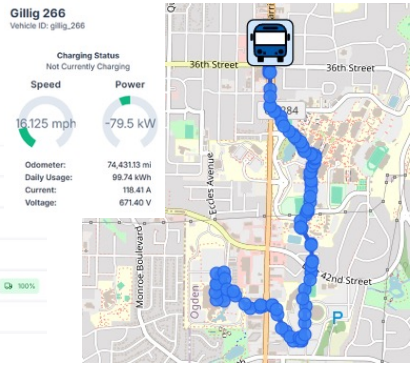
UTA Interactive Dashboard

Deployed Version at High Valley Transit: August 11

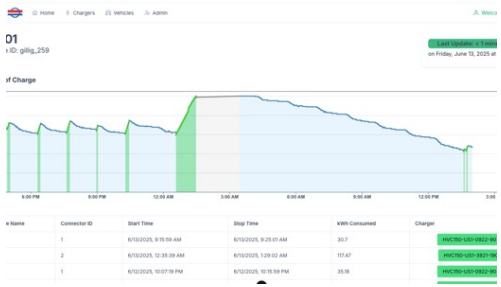
Leveraging Models for Real-World Applications

Overview

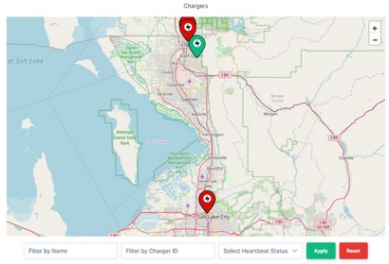




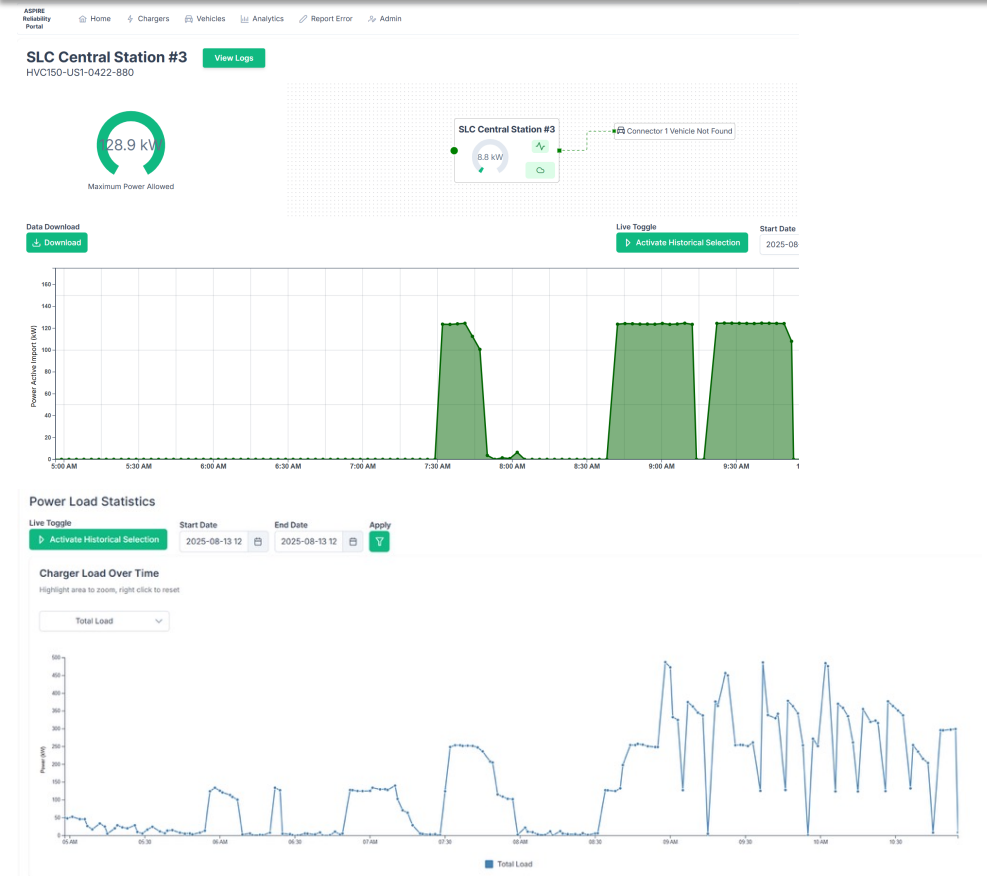
Vehicle State of Charge



Charging Locations

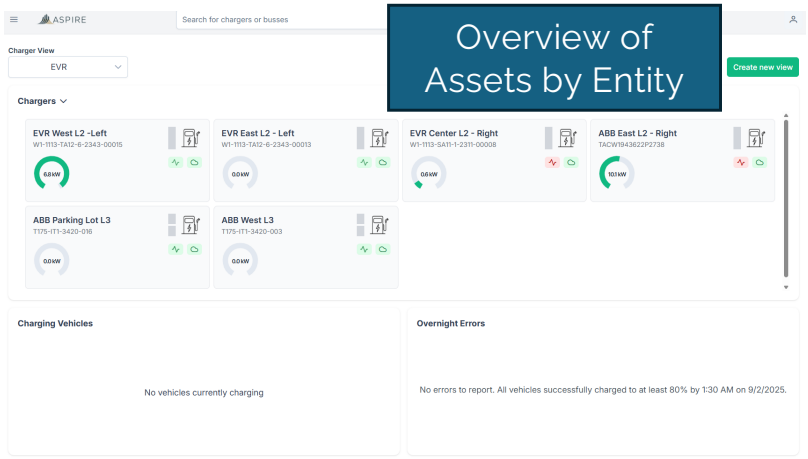


ASPIRE Reliability Dashboard



ASPIRE Charge Control and Fleet Operations service

- Currently servicing >150 chargers throughout Utah
- Cybersecurity protocols in place for enterprise applications
- Enables real-time visibility, control, and reliability assessment



Overview of Assets by Entity

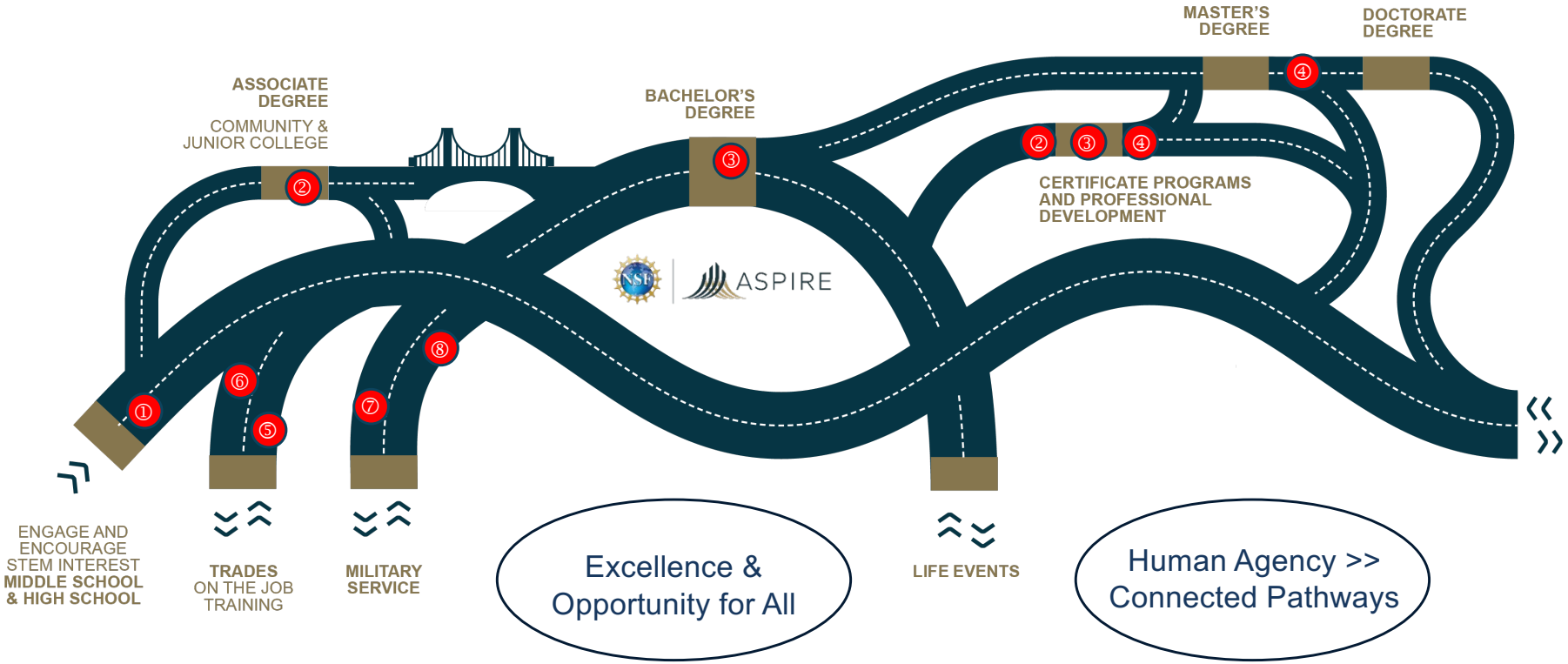
Utah Electrification Planning Resources

UtahElectrification.com/About

More resources can be found here.

Produced in conjunction with DE-EE0009224, supporting the Western Smart Regional EV Adoption and Infrastructure at Scale (WSEV@SCALE) project

Electrification Workforce Development Pathways



UEI Newsletter

New Email Resource

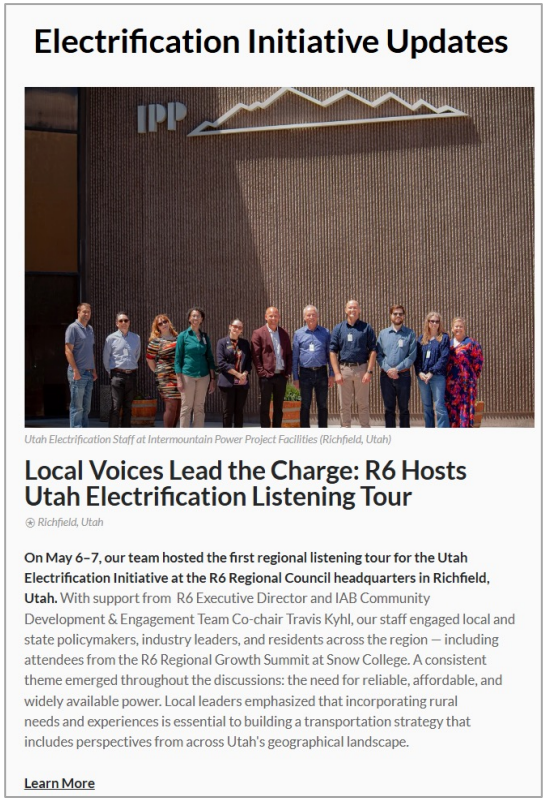
Project Objectives:

Mechanism to keep stakeholders & the public informed about key developments in electrification across the state.

Sections:

- Electrification perspectives
- Progress updates, highlights, & expert insights
- Statewide news section (broader ecosystem updates)
- Events

Audience: 350 contacts
Open Rate: 45%



Electrification Initiative Updates

Utah Electrification Staff at Intermountain Power Project Facilities (Richfield, Utah)

Local Voices Lead the Charge: R6 Hosts Utah Electrification Listening Tour

Richfield, Utah

On May 6–7, our team hosted the first regional listening tour for the Utah Electrification Initiative at the R6 Regional Council headquarters in Richfield, Utah. With support from R6 Executive Director and IAB Community Development & Engagement Team Co-chair Travis Kyhl, our staff engaged local and state policymakers, industry leaders, and residents across the region — including attendees from the R6 Regional Growth Summit at Snow College. A consistent theme emerged throughout the discussions: the need for reliable, affordable, and widely available power. Local leaders emphasized that incorporating rural needs and experiences is essential to building a transportation strategy that includes perspectives from across Utah's geographical landscape.

Learn More

Utah Electrified Transportation

Welcome to the inaugural edition of the
Utah Electrification Newsletter!

Carlos Braceras
Executive Director,
Utah Department of Transportation (UDOT)

Utah's transportation success builds on a legacy of innovation—from the 1869 transcontinental railroad to air taxis, a statewide trail network, and connected autonomous vehicles, we continually push boundaries to provide a holistic transportation system that meets the evolving needs of our state. We achieve excellence through a culture of collaboration and shared vision, which is also at the heart of a bold, 30-year journey to strategic electrification. We are working with our Industry Advisory Board (IAB) to shape a resilient system that meets the wide-ranging needs of all Utahns.

Join us as we build on a legacy of innovation to power the future.

Annual Report

Updates & Links

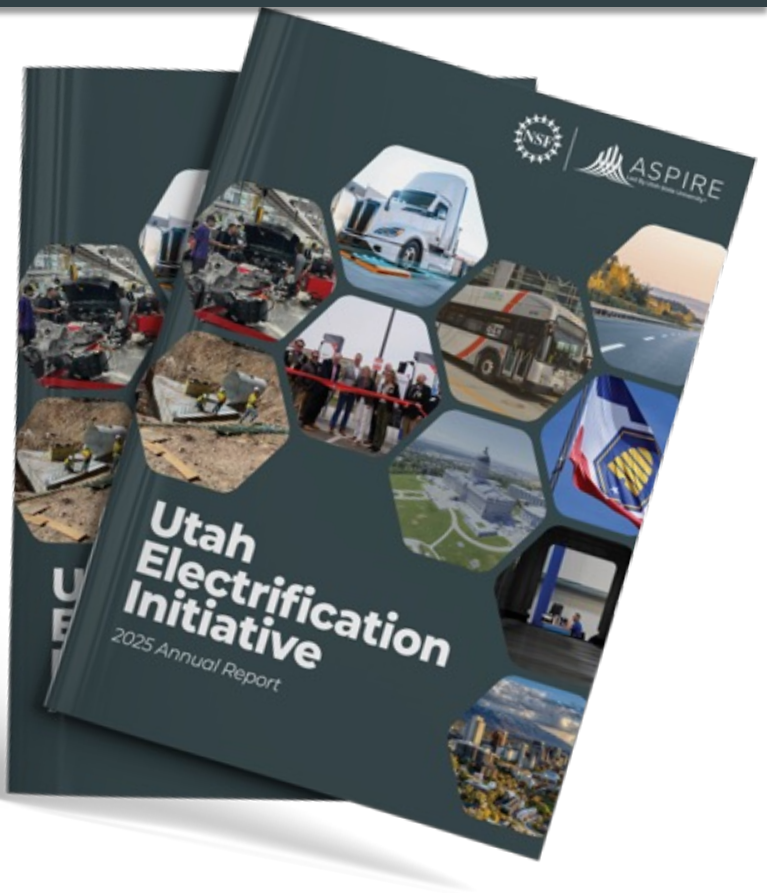
Final Report Available Now!

- Full Report here:

Scan to read the full report

- Highlights Booklet here:

Scan to read the highlights



5. ASPIRE & Utah Projects

Freight Electrification & More

Megawatt Charging

Stationary 1 MW inductive wireless charger for class 8 trucks

Deployment Progress

- **Kenworth Class 8 Truck**
  - More than 1,800 miles of validation testing completed in Seattle.
  - Utah's cold climates and mountain passes.
  - Pulling "Rocky Mtn Doubles" at capacity
  - Inland Port site construction – civil scope is complete, grid interconnect is scheduled for March
  - EVR site construction – civil scope is complete, grid interconnect is complete, installation of hardware is scheduled
- **Two UPS routes**
  - Utah Inland Port, SLC – Logan, 193 miles
  - Utah Inland Port, SLC – Orem, 187 miles

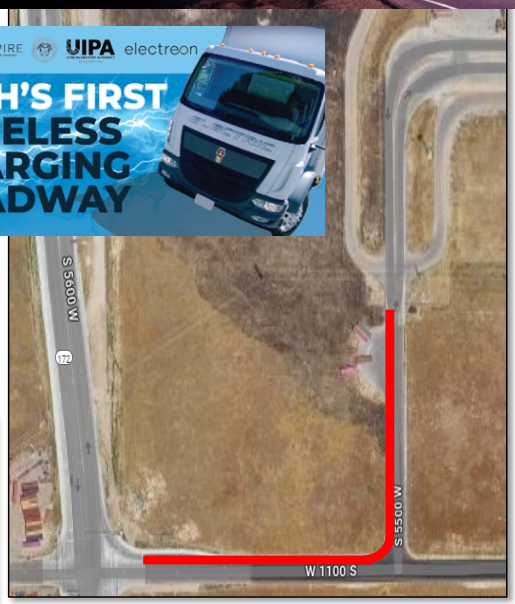
KENWORTH · UPS · UtahState University · UTAH INLAND PORT AUTHORITY · ROCKY MOUNTAIN POWER · WAVE

Wireless Roadway Demonstration

Dynamic wireless charging to support freight movement

Middle-Mile Freight Electrification

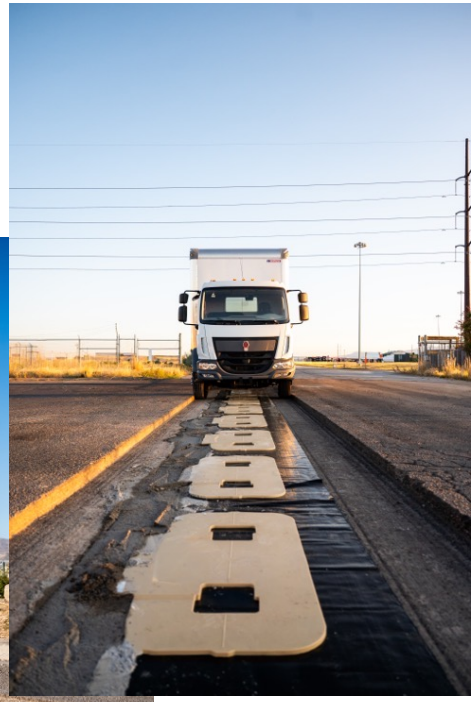
- **Purpose**
  - Facilitate short-haul movement of freight to distribution centers in Salt Lake County in proximity to the Utah Inland Port
- **Location**
  - Utah Inland Port, 5600 W 1100 S, Salt Lake City
- **Updates**
  - Both static and dynamic wireless charging systems
  - Class 6 Kenworth K270E truck has been procured. Currently in Salt Lake receiving upgrades.
  - RFI coordination with industry, Port, and IAB to coordinate fleet operator “Ride and Drive”



Utah Inland Port, SLC – Construction Continuing

UIPA/SLCIT – DWPT Installation

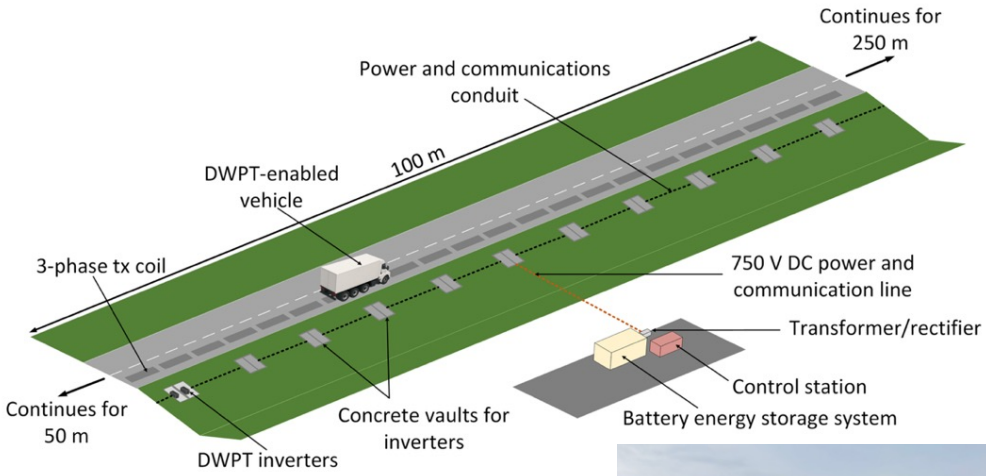
UIPA/SLCIT – DWPT Installation



UIPA/SLCIT – EV Charge Lane

Purdue DWPT – EVR Site Installation

US 52/231 DWPT Project



Indiana's high-power (200 kW) DWPT testbed for Class 8 trucks

P3 with **INDOT/Cummins**

No range anxiety, cheaper EVs, public infrastructure w/ high utilization, reliable, grid friendly, **financially feasible**, …

2025 IEEE PES Energy and Policy Forum, Technology Innovation Award

6. Connected & Autonomous Vehicles

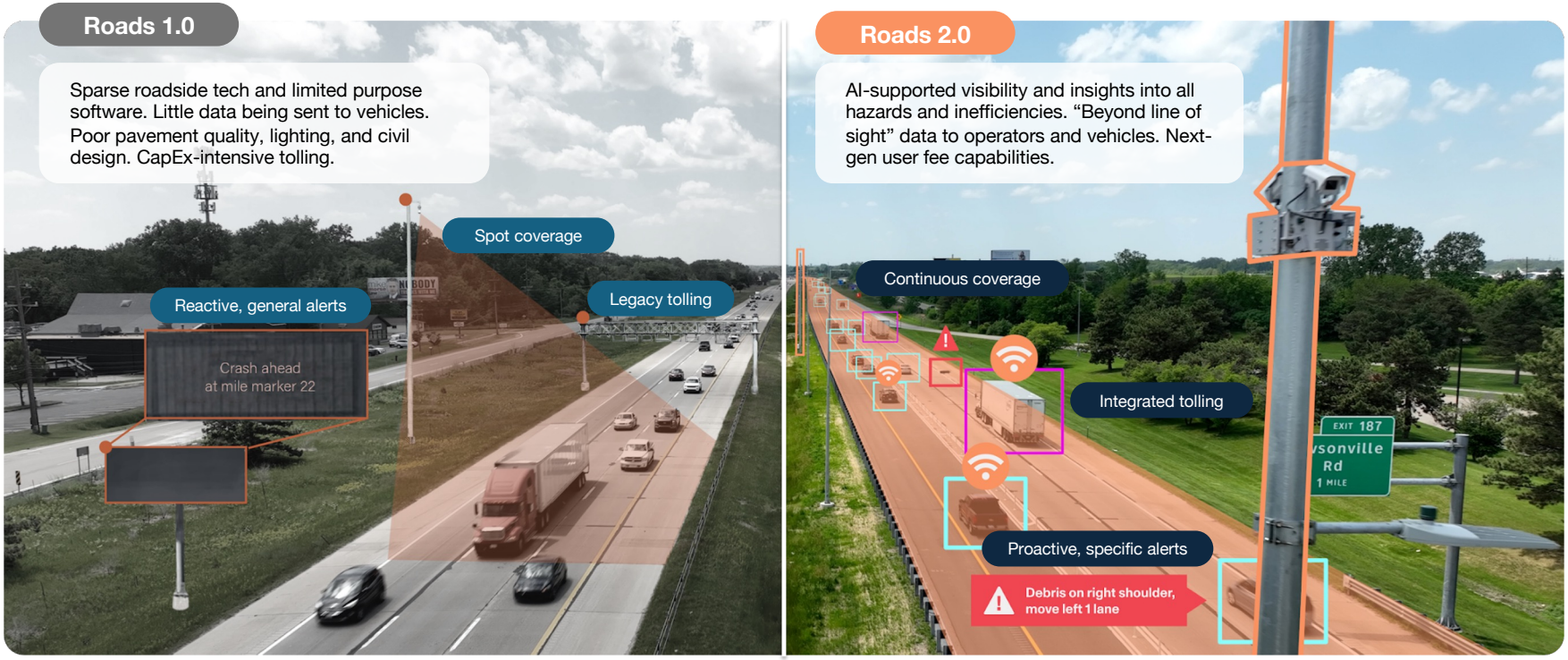
ASPIRE & Members

Connected & Autonomous Vehicles

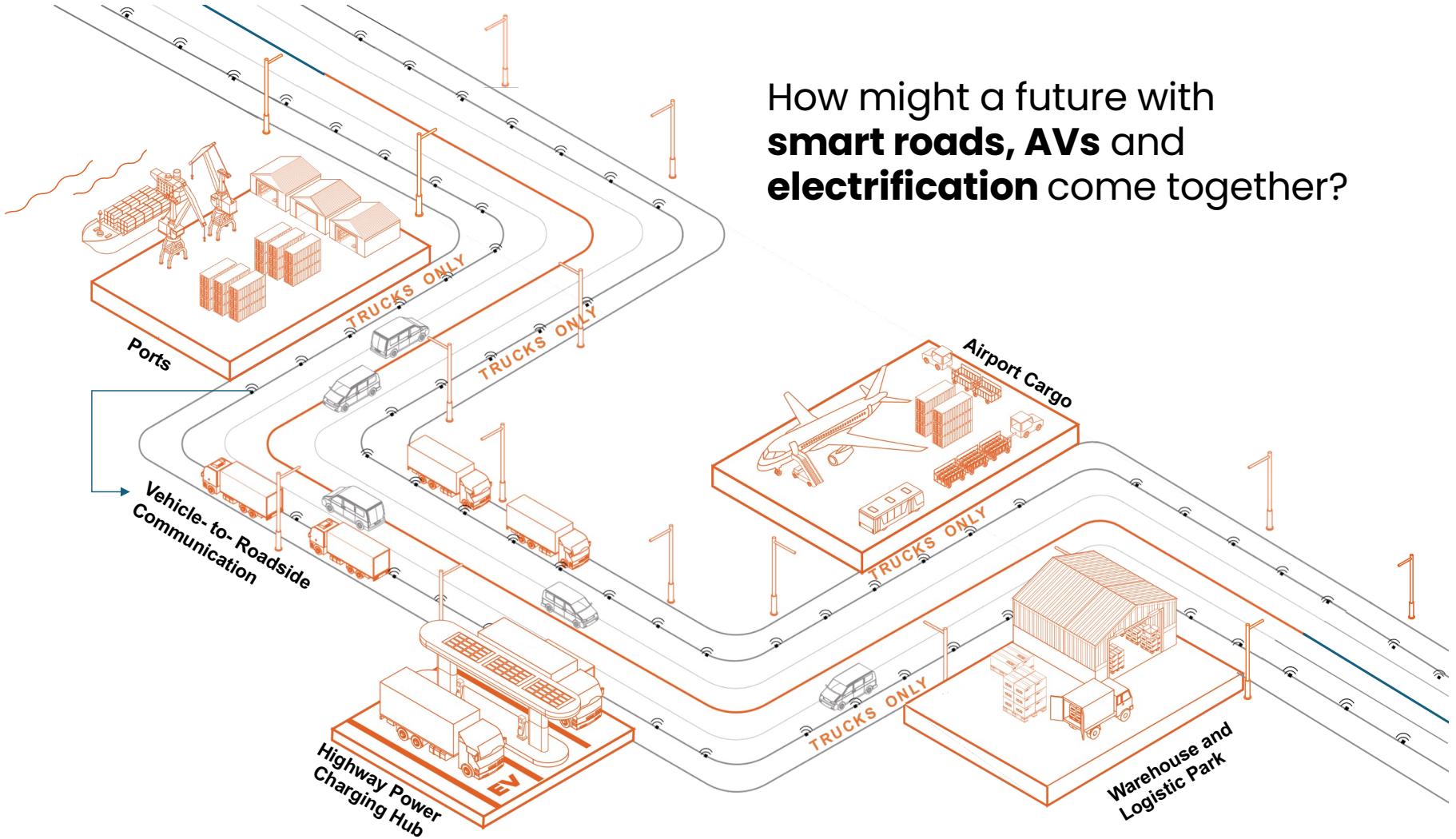
Chris Armstrong
Chief Product Officer

Cavnue aspires to be the world's leading smart road developer

We deliver digital and physical infrastructure improvements that enable the safe, efficient, and automated transportation of goods and people



How might a future with **smart roads, AVs** and **electrification** come together?



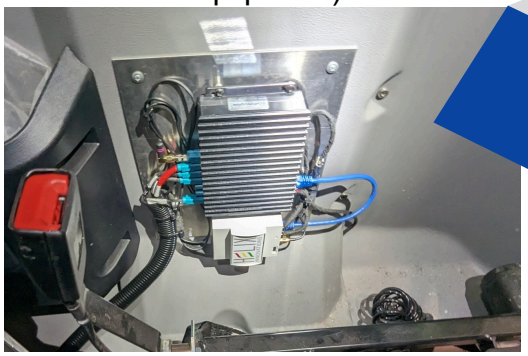
UDOT Connected Vehicle System Components

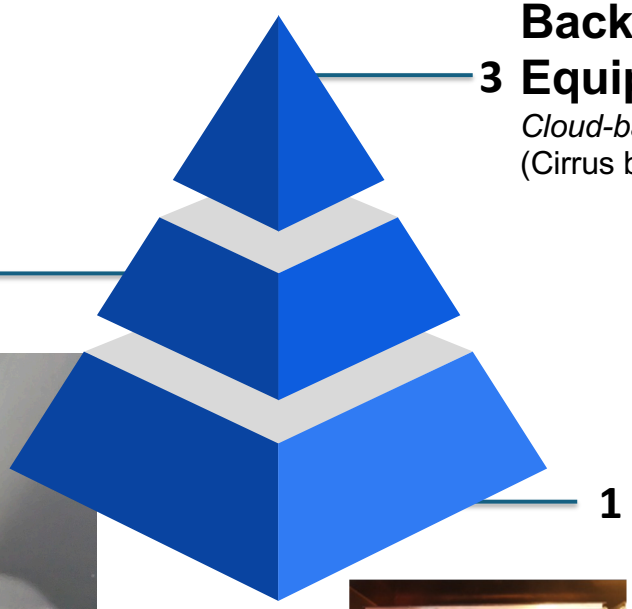
Phillip Castro, P.E.
Transportation Technology Project Manager, UDOT

On-Board Equipment

On-Board Unit
(C-V2X Radio)

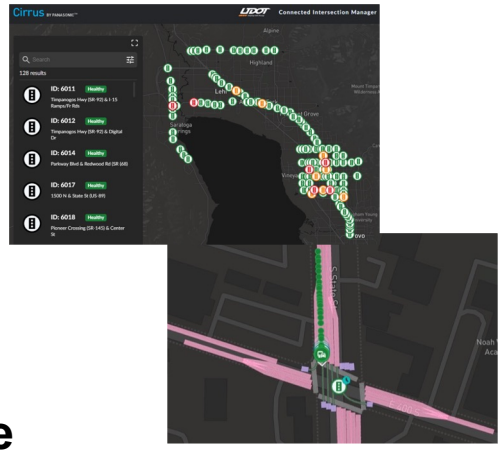
On-Board Processor
(interface between On-board unit and Vehicle equipment)





Back-end Equipment

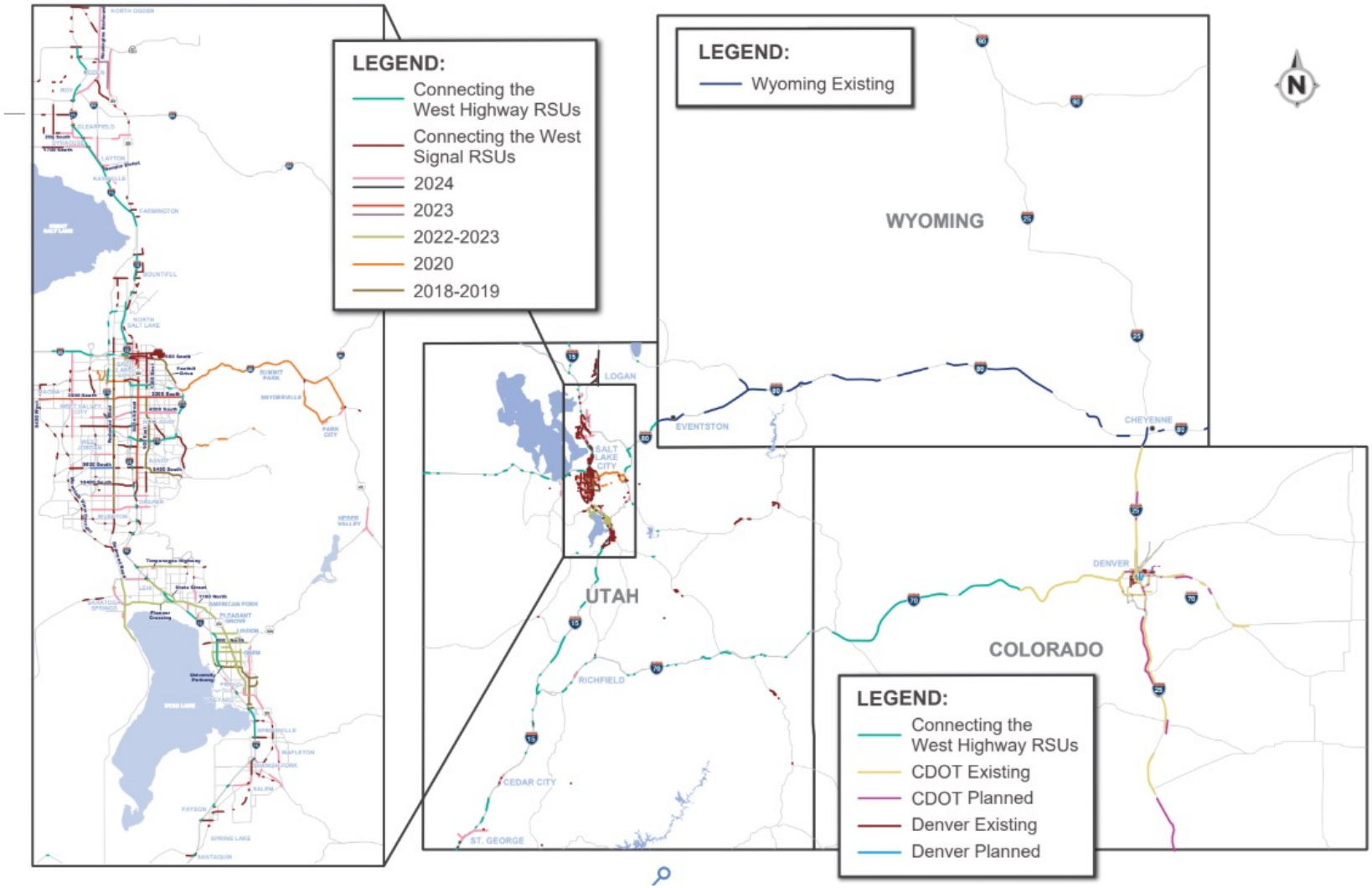
Cloud-based Analytics
(Cirrus by Panasonic)



Roadside Equipment

Roadside Unit
(C-V2X Radio)

Signal Control Module
(interface between Roadside unit and Signal controller)


LEGEND:
Connecting the West Highway RSUs
Connecting the West Signal RSUs
2024
2023
2022-2023
2020
2018-2019
LEGEND:
Wyoming Existing
WYOMING
N
UTAH
COLORADO
LEGEND:
Connecting the West Highway RSUs
CDOT Existing
CDOT Planned
Denver Existing
Denver Planned

Connected Vehicle Technology

Long-term goal is safety

1. Reduced crashes, injuries, fatalities by warning drivers

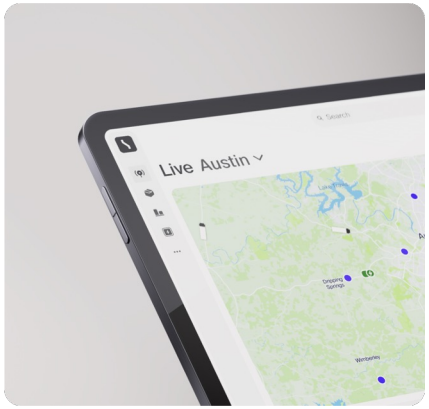
Current use cases:

1. Transit Signal Priority
2. Snowplow and emergency vehicle preemption
3. Vehicle insights (weather / hard braking)
4. Curve Speed Warning
5. Gain insight on Air Quality
6. Spot Weather Impact Warning
7. Disabled Vehicle Alert
8. Variable Speed Limits (in development)
9. Vulnerable Road User Warning (in development)

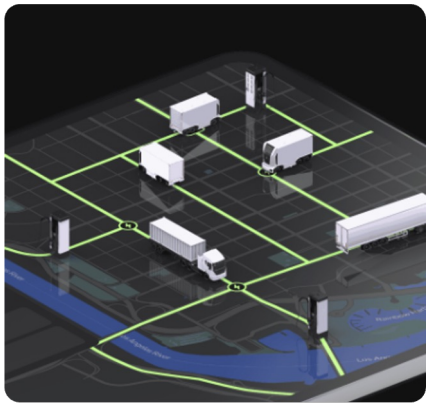
Einride is the transformation partner for the future of road freight – offering a turnkey solution for electric transports at a competitive rate

Sean Ackley
VP Energy Charging & Infra, NAM

Einride customer offer



Assessment



Planning

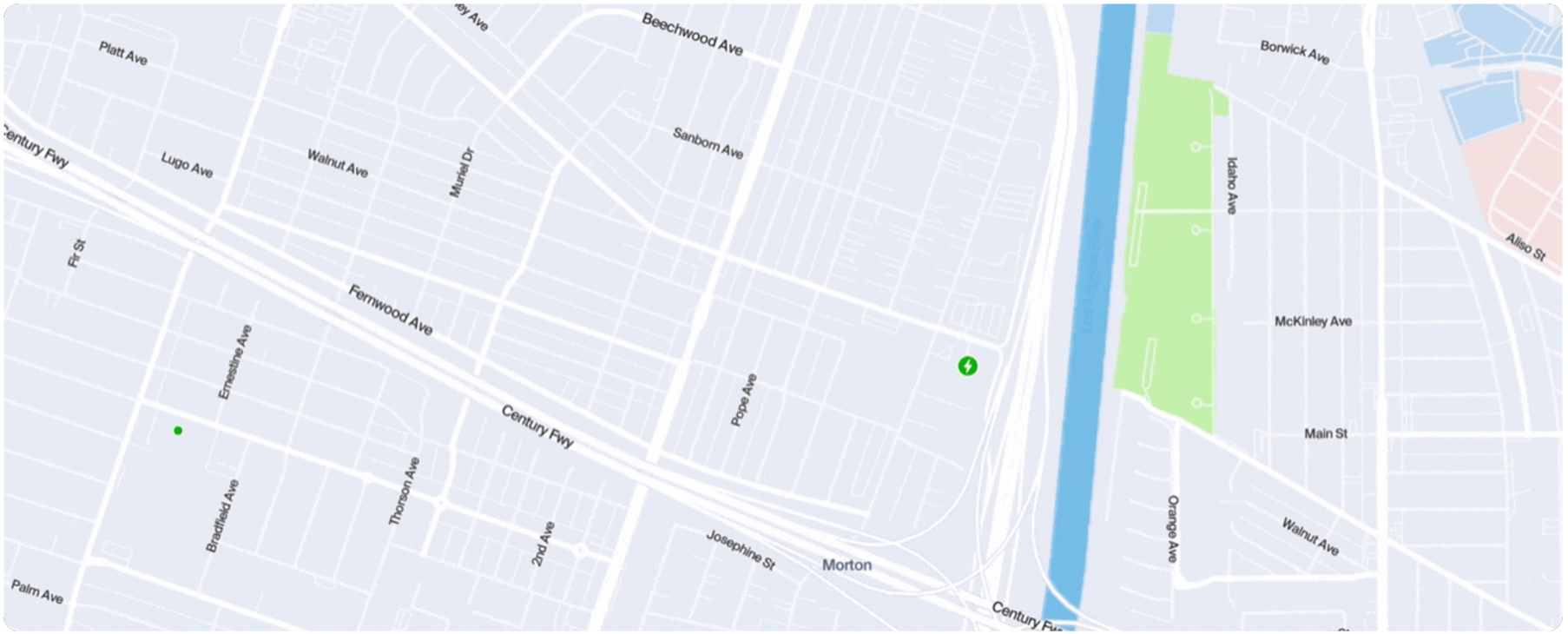
Deployment

Operations

Einride business model

Freight Capacity as a Service: Multi-year operational contracts and Joint Business Plans for transition of heavy-duty transport to electric and electric autonomous

Powered by data & driven by AI: Einride engages customers and captures demand with cutting edge analytics systems to provide actionable plans



Excerpt from Einride customer data on US transportation network

NSF | ASPIRE

Core Partner Institutions

Utah State University — Lead Institution

UTEP

The University of Auckland

Purdue University

University of Colorado Boulder

Affiliated Partner Institutions

Colorado State University

Cornell University

UCCS University of Colorado Colorado Springs

Virginia Tech

The University of Utah

7. Utah Inland Port Electrification Programs

UDAQ – EPA Clean Ports Award

$110 million Clean Ports Program Zero Emission Technology Deployment Grant

- Largest environmental grant award in UT history and largest Clean Ports Program award made to an inland port
- Supports deployment of electric trucks, cargo-handling equipment, and related infrastructure to reduce emissions and improve regional air quality.
- Funding exclusively for proven zero-emission vehicles and equipment technologies that operate at the Salt Lake City Intermodal Terminal (SLCIT).

Utah Department of Environmental Quality

Program Highlights:

Clean Ports Program	Clean Heavy-Duty Vehicles	Beehive Emissions Reduction Plan
$110M	**$60M**	**$75M**
Awarded – In Progress	**Awarded – Initiation (2026)**	**Awarded - In Progress**
Funding is exclusively for proven zero-emission vehicles and equipment technologies for Utah inland port freight activities	**$18M for Class 6 and 7 trucks**	Reduce emissions in the state and advance clean energy – funding activities for transportation
Program to **provide up to 90% cost-share** towards purchasing new zero emission vehicles and infrastructure **+100 trucks anticipated**	Incentivize replacement of existing internal combustion engine HD vehicles with zero emission	Policy and incentives to voluntarily increase MD/HD zero emission vehicles – **support fleet electrification**

https://deq.utah.gov/air-quality/upcoming-air-quality-funding

https://deq.utah.gov/air-quality/beehive-emission-reduction-plan

ASPIRE – SuperCharge Program

ASPIRE

U.S. Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

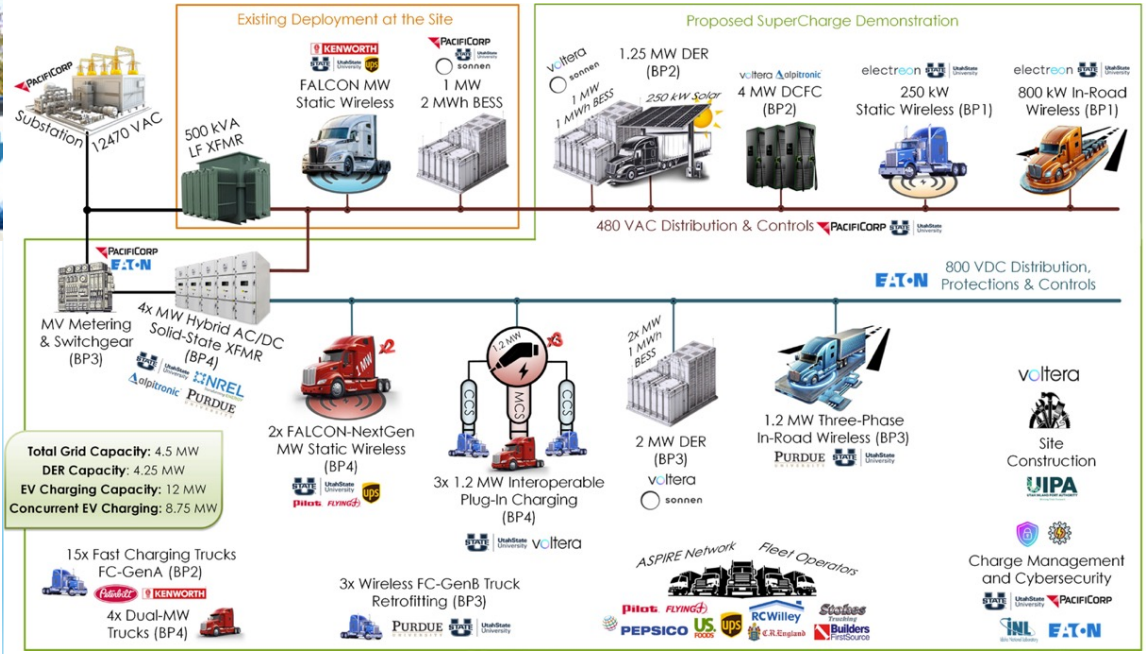
SuperCharge: Sustainable Utilization of Power Infrastructure Enabling Rapid and Replicable MHDVs Charging through Hybrid AC/DC Distribution Networks and Renewable Grid Energy Integration

Funding Opportunity Announcement (FOA) Number: DE-FOA-0003344 - Sub-Topic A. Innovative Depot Charging Infrastructure Design and Development to Support Electrified MHDVs Near Hubs, Ports, & other Logistics Operations

Lead Organization: Utah State University
Technical Point of Contact: Dustin Maughan (dustin.maughan@usu.edu)
Business Point of Contact: Curtis Timmerman (Curtis.timmerman@usu.edu)

Voltera	PACCAR	Eaton	PacifiCorp	NREL	Alpitronic	Purdue	UPS	Pilot F J	Sonnen
Geoff Gunn	Ryan Monahan	Ahmed Mohamed	James Campbell	Ken Kelly	Tripp Burwell	Steve Pekarek	Ryan Bankerd	Allie LaCroix	Blake Richetta

$44M Project
First CaaS in Utah
Budget for ~19 HD Trucks
Announced, pending DOE release



8. SAE J2954 Standards & Testing Services

ASPIRE Co-Chairs for HD & DWPT

ASPIRE
Michael Masquelier & Regan Zane

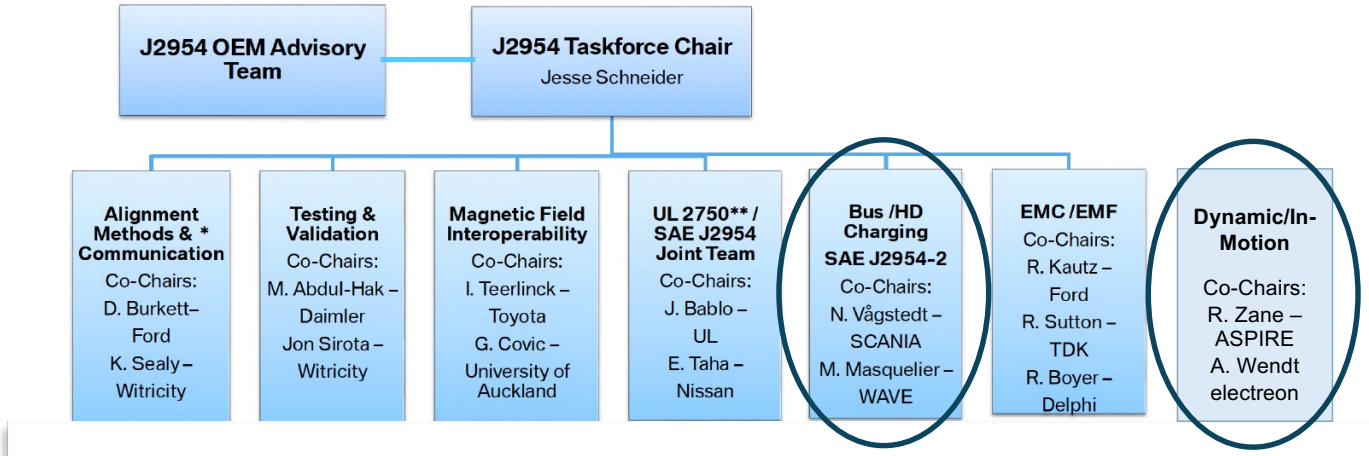
Why Wireless Power Transfer?

Electric Vehicles/ Charging are becoming mainstream especially because of environmental initiatives.

WPT is the EV Game Changer: Upcoming Commercialization of WPT to gain higher acceptance of EVs. Touchless, Transparent to the Customer - Automated Charging and Parking possible. Enabling Fully Autonomous Taxis as well.

Standards and Adoption | SAE

SAE J2954 Taskforce Structure: OEM/ Supplier Co-Chairs



SAE J2954/2 establishes an industry-wide specification guideline that defines acceptable criteria for the interoperability, electromagnetic compatibility, minimum performance, safety, and testing for wireless power transfer for high power wireless charging of BEV and PHEV vehicles, for heavy-duty, off-road and equipment applications (defined as HD).

Global WPT Standards Harmonization

IEC 61980-2: WPT System & Communication Requirements

↕ Agreement

OR **ISO 15118-20**: Wireless WPT Vehicle / Grid Communication (part of ISO 15118 comprehensive set)

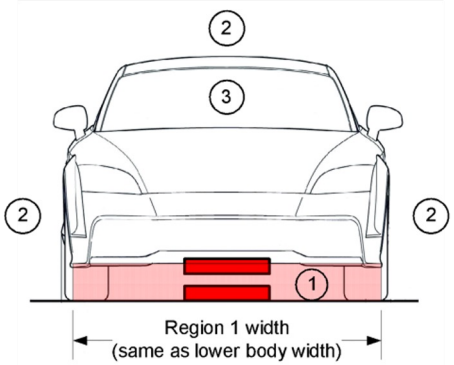
SAE J2847/6: WPT Vehicle / Grid Communication (light-weight option based on JSON) □ Harmonization planned with ISO 15118-20

IEC 61980-1: Verification Wireless Charging Safety – [Agreement with ISO 19363] (See also ISO 6469-3 for VA Safety)

UL 2750: (Draft) Verification of Wireless Charging Base Safety – [MOU with SAE J2954]

LDV SAE J2954 Standard (Update)- (TRL-9)
Aligns UL 2750 WPT Certification Test: Preparing Mass Market

- SAE J2954 Standard (2022 Update) defines required testing for WPT 1-4 (3.3-22kW)
- Goal: Allow UL 2750 to create a clear GA (Ground Assembly) certification test to help develop a safe infrastructure
- Critical to have ability to do a 3rd party of supplier system testing for WPT Safety, EMF Exposure according to SAE J2954
- Future certification enables OEMs & Suppliers to validate for mass market



SAE J2954 Standard VA/GA Test Stand (e.g. INL)

SAE J2954/x Standard SCOPE

Vehicle to EVSE Alignment Methods

Interoperability Specification

Acceptable Charging

Safety Limits and Targets

EMC/ EMF Limits

SAE J2954

Verification Testing SAE & UL

ASPIRE EVR Testbed

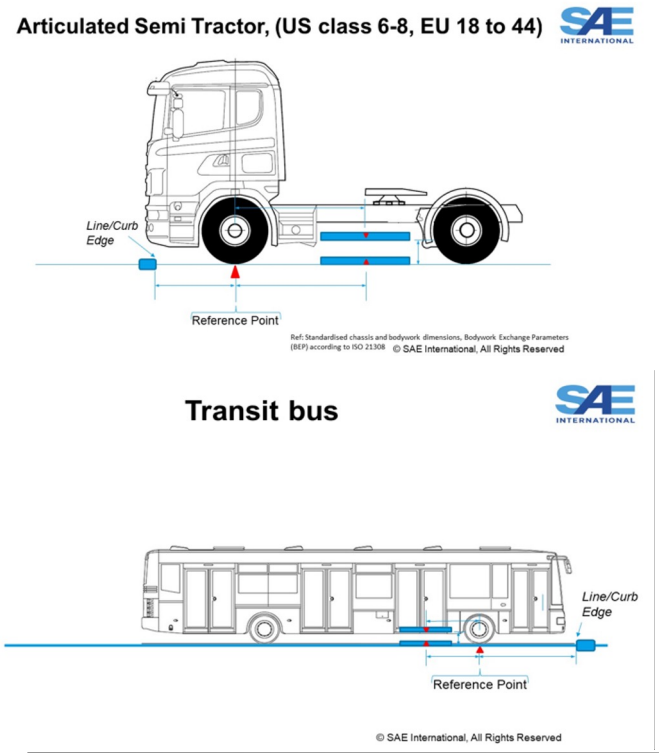
ASPIRE, Utah State University

Electric Vehicle and Roadway Facility (EVR)

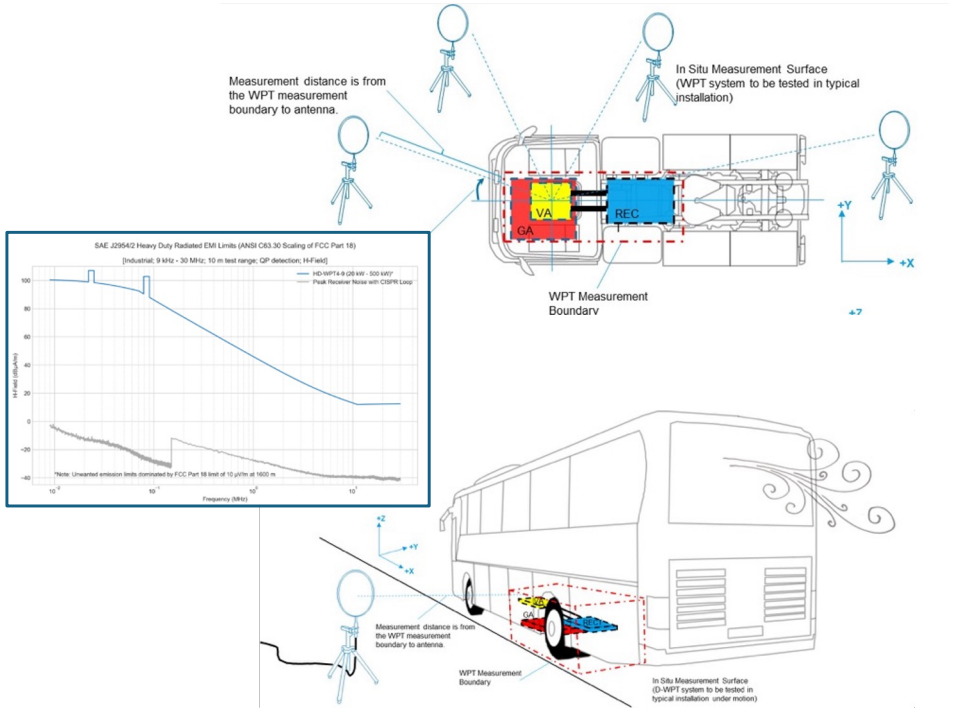
Megawatt Charger In-road Charger

TIR SAE J2954/2 HD Tractor & Bus VA/GA WPT Placement with EMC/EMF Testing and Limit Specification

HDV Vehicle & Ground Assembly Placement



HDV EMC/ EMF Static & Dynamic Testing



Michael Masquelier
Chief Commercial Officer
michael.masquelier@usu.edu

Thank You!

Questions?