ASPIRE

AAPA Webinar

Electrifying Port Freight: Insights from the ASPIRE Center and Its Pioneering Electrified Roadway Projects

June 18, 2024

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1. ASPIRE VISION

SUSTAINABLE & EQUITABLE, RESEARCH, PROJECTS

ASPIRE's Vision

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

University of Colorado Boulder

UtahState University

The University of Auckland New Zealand

UTEP

Purdue University

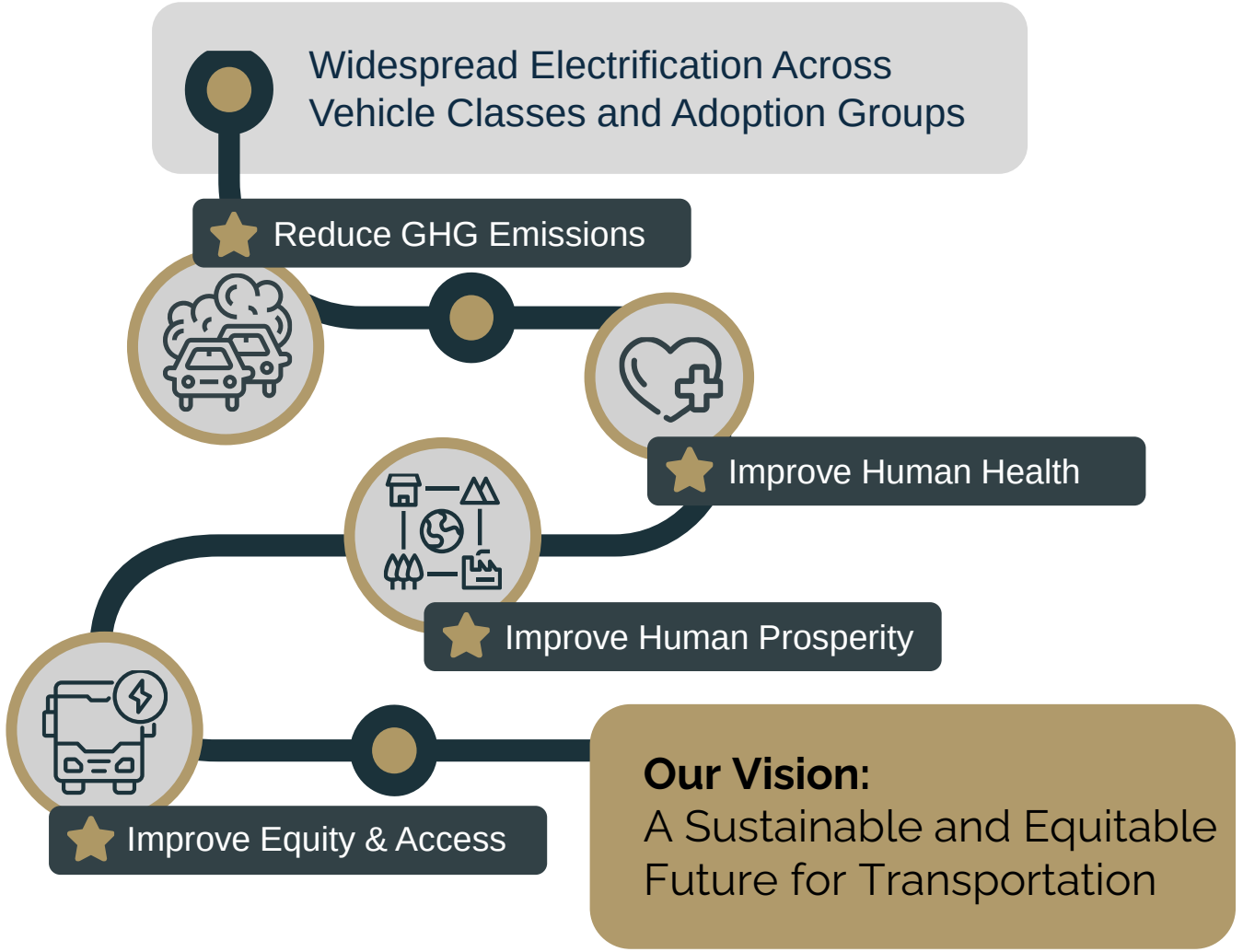
The University of Utah

Colorado State University

UCCS University of Colorado Colorado Springs

Cornell University

Virginia Tech



What Is Electrified Transportation?

ASPIRE

Energy Diversity | **Vehicles Fleets** | **Electrified Roadways** | **Roads & Buildings** | **Moving People Moving Goods**

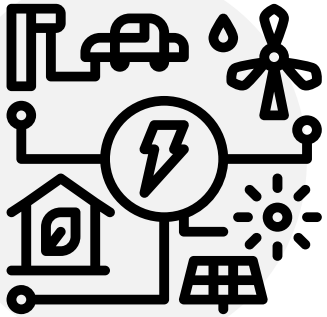
More than just EVs

Four Converging Trends

ASPIRE

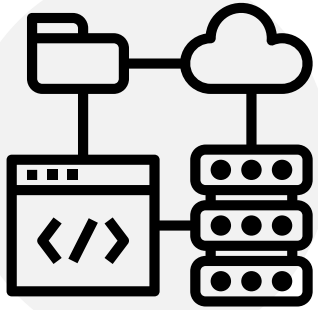
Autonomous

Electrified



"ACES"

Connected



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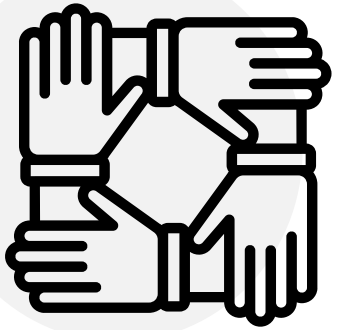


ASPIRE *by the Numbers*

From our 2023 Annual Report

124million **in total funding**

14+
Patents Awarded

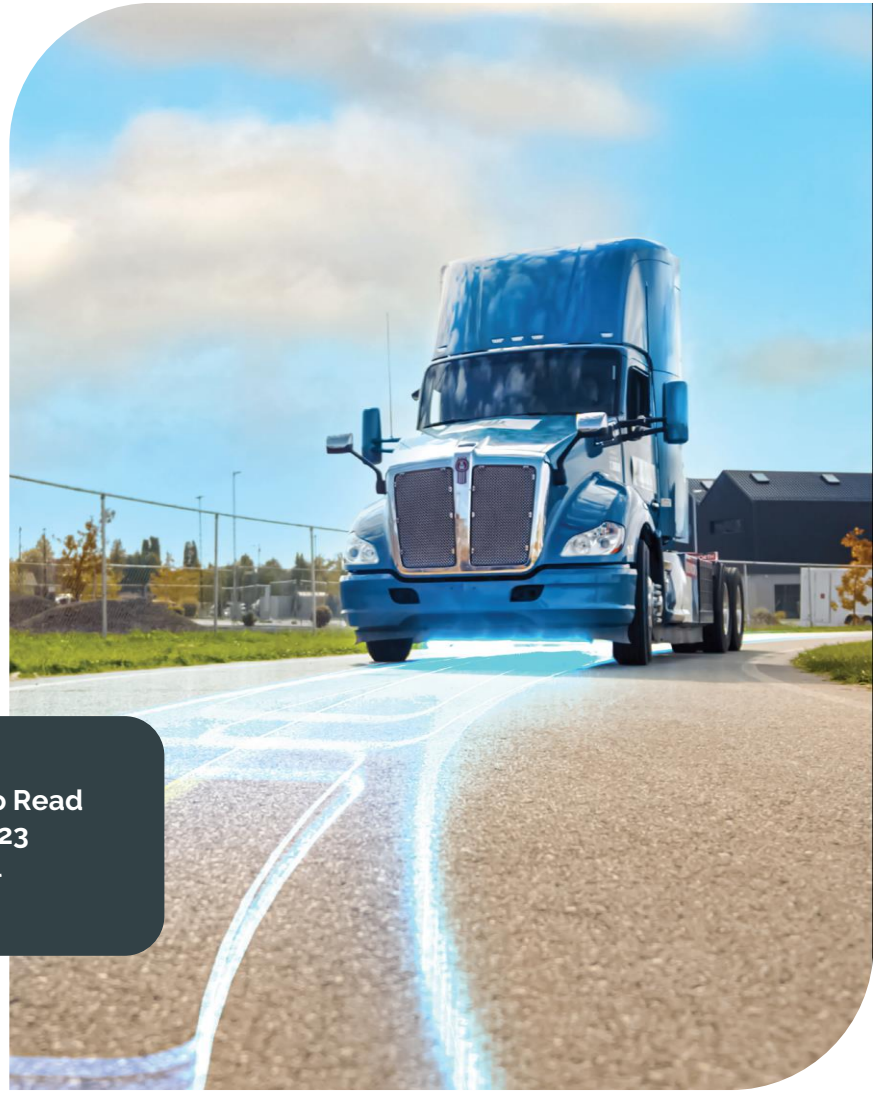
60+
Industry & Innovation (IIB) Members

140+
Peer Reviewed Publications

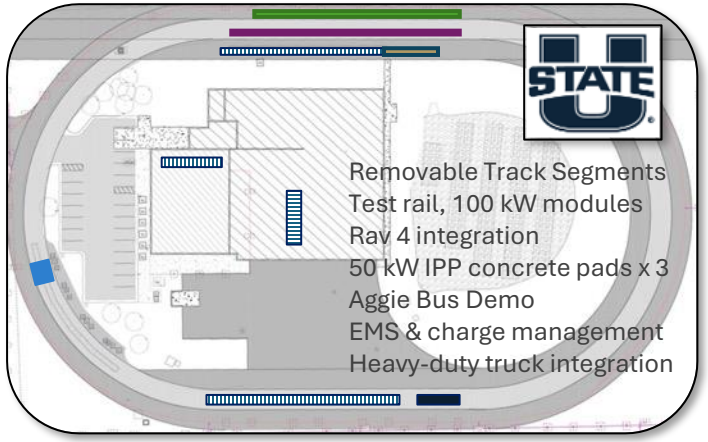
400+
Faculty, Students & Staff

11,500+
Attendees reached through events

Scan to Read The 2023 Annual Report



Growth Trajectory

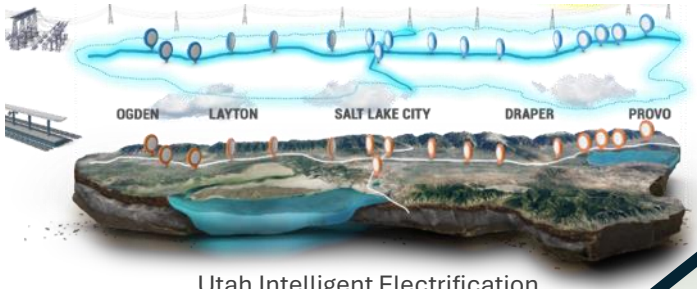


IPT 200kW 40m DWPT

CFX ¾ Mile Pilot

Purdue 200 kW DWPT 2023

Utah 1MW Charging Pilot with Kenworth & UPS



Utah Intelligent Electrification Planning Initiative

Electreon 25 kW+ x 3 50m DWPT

WPT Pad

50 kW 10m DWPT

Michigan / Electreon ¼ Mile Pilot

Indiana ¼ Mile Pilot

Utah / ASPIRE / Stadler Battery-powered Passenger Train

$100M Achieved

60+ Industry Members

2012 WAVE Spin Out

2015 EVR and SELECT

2020 ASPIRE Engineering Research Center

2021, 2022, 2023 Pilot Projects UT, IN, FL, MI, PA

2024 EVR Expansion, ASPIRE HQ, Utah Planning Initiative

Industry + Innovation

ASPIRE

ABB
AECOM
CBMM
INNOVATE • RESPECT • COMPETE
LG
esri
THE SCIENCE OF WHERE
electreon
ep SYSTEMS
HYSTER-YALE
DARKPULSE
ENRX
GEOTAB
Ford
INDUCTEV
Kiewit
MAGMENT
JOHN DEERE
HYPERCRAFT
ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP
TOYOTA
INTEGRATED ROADWAYS
KENWORTH
A PACCAR COMPANY
WiTricity
Powering life, wirelessly.
WAVE
by Ideanomics
SCANIA
Schneider Electric
STELLANTIS
Southwire
HNTB
Cummins

CALSTART
CENTRAL FLORIDA EXPRESSWAY AUTHORITY
CONEXUS INDIANA
DFW
INDIANA DEPARTMENT OF TRANSPORTATION
VDOT
Virginia Department of Transportation
FORTH
HEAL UTAH
HEALTHY ENVIRONMENT ALLIANCE OF UTAH
Hill Air Force Base
IAPA
Illinois Asphalt Pavement Association
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
MICHIGAN OFFICE OF FUTURE MOBILITY & ELECTRIFICATION
NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY
North Central Texas Council of Governments
ITS AMERICA
OAK RIDGE National Laboratory
OHIO TURNPIKE
PENNA TURNPIKE
RMI
ENERGY. TRANSFORMED.
SANDAG
UAPA
"Paving the Future"
UTAH CLEAN CITIES
Clean Fuels • Clean Strategies • Clean Air
UTAH GOVERNOR'S OFFICE OF ENERGY DEVELOPMENT
UTAH INLAND PORT AUTHORITY
UTA
THE RAY
Let's drive the future.
DEPARTMENT OF TRANSPORTATION
Argonne NATIONAL LABORATORY
UDOT
Keeping Utah Moving
THE BORDERPLEX ALLIANCE
A Binational Economic Alliance
Juárez · El Paso · Las Cruces
INL
Idaho National Laboratory
NORTH CAROLINA Turnpike Authority
SMUD
Powering forward. Together.
IMTA
INDIANA MOTOR TRUCK ASSOCIATION
SINCE 1934

2. ASPIRE RESEARCH

ENERGY MANAGEMENT, SMART GRID, COMMAND & CONTROL

Areas of Research

Equity

- Social Equity
- Environmental Justice
- Technology & K-22 Education

Data

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

Adoption

- User Acceptance / Society
- Public Policy / Economy
- Techno-economics

Power

- Power Systems
- Grid Integrated Charging Systems
- Battery Systems

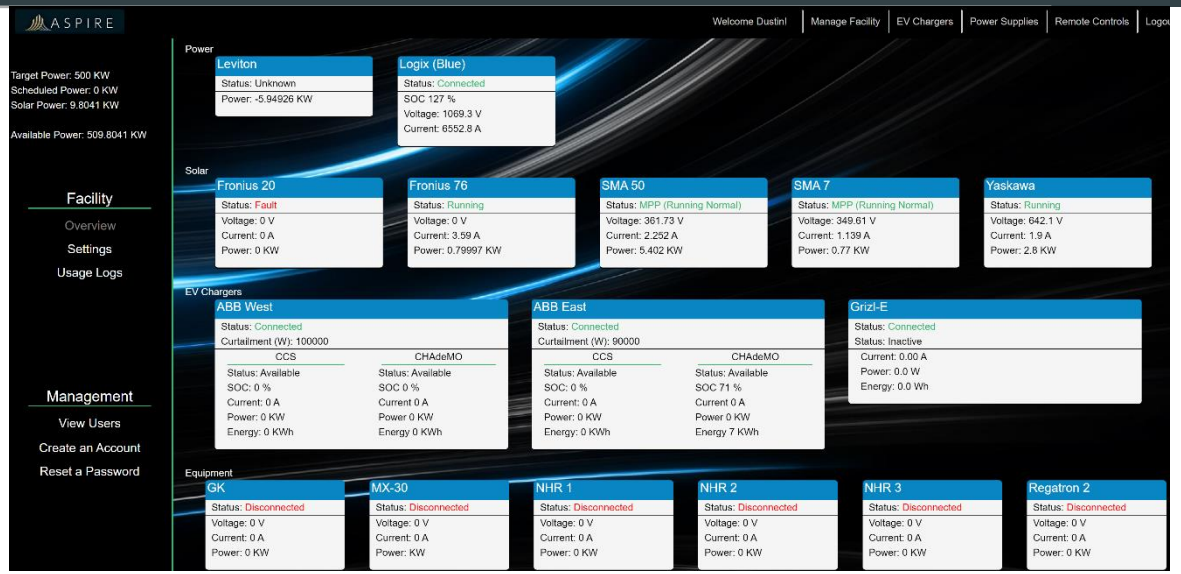
Transportation

- Transportation Systems
- Transportation Infrastructure

Energy Management System

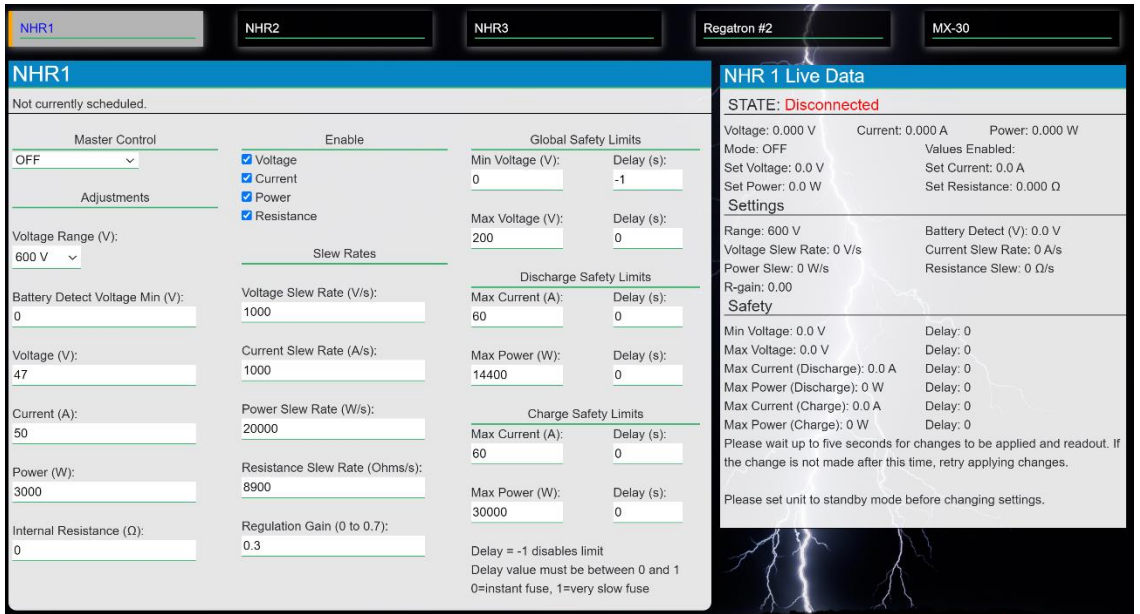
Purpose

- **Facilitating high-power testing**
  - 128 kW solar power, 260 kWh battery storage, 750 kW utility service, 250 kW battery test, 60 kW CNG generator, flexible power supply, battery emulator, battery cycler, grid emulator, and vehicle lift
- **Minimizing electric utility bill**
  - Lower peak load charges
- **Testing with managed distributed energy sources**

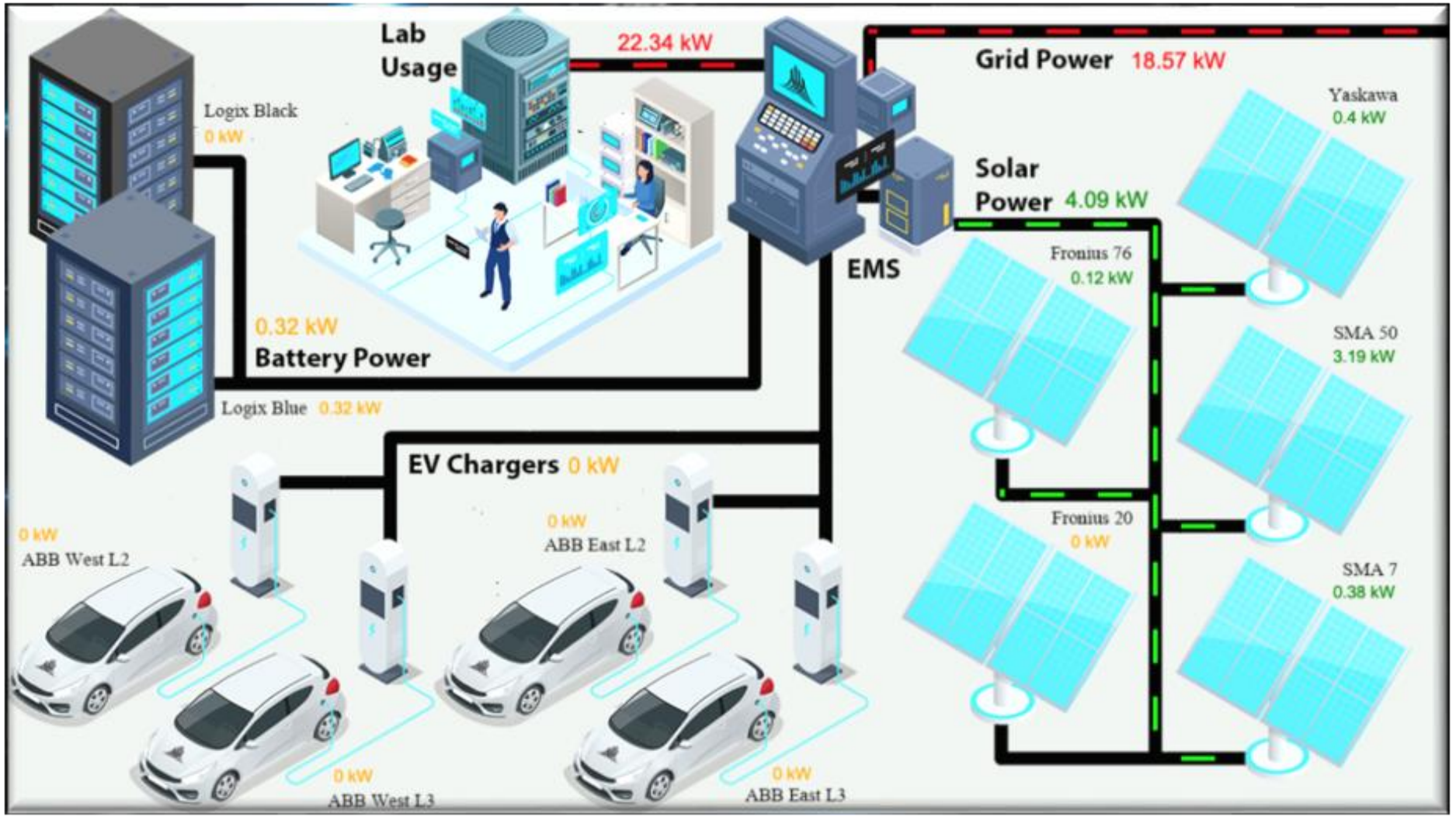


Future Enhancements

- **Established communication with devices**
- **Created common central control**
- **Equipment types**
  - Solar inverters
  - Power supplies
  - Battery inverters
- **Controllable parameters**
  - Voltage
  - Current
  - Curtailment



Command & Control



3. REAL-WORLD DEPLOYMENTS

Examples of Port & Related Deployments

Public Transit & Port Deployments

WAVE
Inductive Charging

Most applications today are for light-duty vehicles. But in-road wireless charging can extend to transit buses and other medium- and heavy-duty vehicle applications.

Port of Los Angeles

Port – Drayage & CHE

500 kW wireless charger

Class-8 Port Drayage Truck

Universal Studios

Hollywood Trams Go Electric with Wireless Charging

250 kW wireless charger

52-ton container handler

4. ELECTRIFICATION PROJECTS

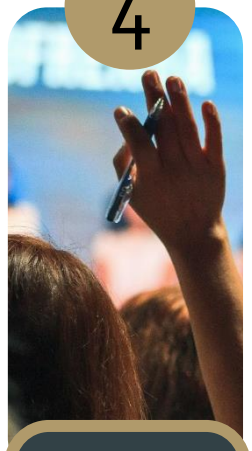
ASPIRE Center deployment of electrified transportation projects

ASPIRE NSF Engineering Research Center

Charging Stations of the Future

Electrified Roadways

Systems of Systems



Learning & Engagement

Virginia Tech

The University of Auckland, New Zealand

University of Colorado Boulder

The University of Utah

Utah State University

UTEP

UCCS University of Colorado Colorado Springs

Colorado State University

Purdue University

Cornell University

Megawatt Charging

Stationary inductive wireless charger for class 8 trucks

Coming September 2024

- **Kenworth Class 8 Truck**
  - More than 1,800 miles of validation testing completed in Seattle.
  - Truck has been rebuilt after testing to handle Utah's cold climates and mountain passes.
  - Construction bids for Inland Port site are being received.
  - Construction is advancing at ASPIRE's Electric Vehicle Roadway (EVR) in Logan.
- **Two UPS routes**
  - Utah Inland Port, SLC – Logan, 193 miles
  - Utah Inland Port, SLC – Orem, 187 miles

KENWORTH

ups

Detroit, Michigan 14th St

Michigan DOT / Electreon / ASPIRE

Motor City's Electrified Roadway

- **Dynamic Wireless Charging**
  - ¼ mile of Electreon inductive-charging roadway in Detroit's historic Corktown neighborhood.
  - Electreon technology uses inductive coupling between copper coils installed below the road surface that transmit to receivers installed on electric vehicles.
  - Powers a shuttle equipped with an Electreon receiver.
  - Fully operational since November 2023.
  - The Electreon system has been installed in ASPIRE's EVR testbed at USU in Logan, Utah.

MDOT
Michigan Department of Transportation

electreon

Detroit, Michigan 14th St

Michigan DOT / Electreon / ASPIRE

Credit: MichiganDOT

https://eepower.com/news/detroit-tests-nations-first-wireless-ev-charging-road/#

Credit: AP Photo/Paul Sancya
https://www.fox8live.com/2023/11/29/new-technology-installed-beneath-detroit-street-can-charge-electric-vehicles-they-drive/

US 231 / US 52, West Lafayette, IN

Indiana DOT / ASPIRE – Purdue / Cummins

Charging Vehicles Big and Small at Highway Speeds

- **Dynamic Wireless Charging**
  - ¼ mile of electrified roadway under construction in West Lafayette, IN.
  - Uses the ASPIRE – Purdue system designed to work at higher power levels for heavy duty freight.
  - The ASPIRE – Purdue system has been installed in ASPIRE's EVR testbed at USU in Logan, Utah.

INDIANA DEPARTMENT OF TRANSPORTATION

ASPIRE

PURDUE UNIVERSITY

Cummins

Credit: Purdue University/Greta Bell

https://www.purdue.edu/newsroom/releases/2024/Q1/building-the-first-highway-segment-in-the-u.s-that-can-charge-electric-vehicles-big-and-small-as-they-drive.html#:~:text=%E2%80%94%20At%20the%20%E2%80%9CCrossroads%20of%20America,charge%20while%20driving%20on%20highways.

US 231 / US 52, West Lafayette, IN

Indiana DOT / ASPIRE – Purdue / Cummins

Credit: Purdue University
https://www.purdue.edu/newsroom/purduetoday/releases/2024/Q2/purdue-indot-and-partners-break-ground-on-highway-test-bed-to-develop-wireless-charging-for-electric-vehicles.html

US 231 / US 52, West Lafayette, IN

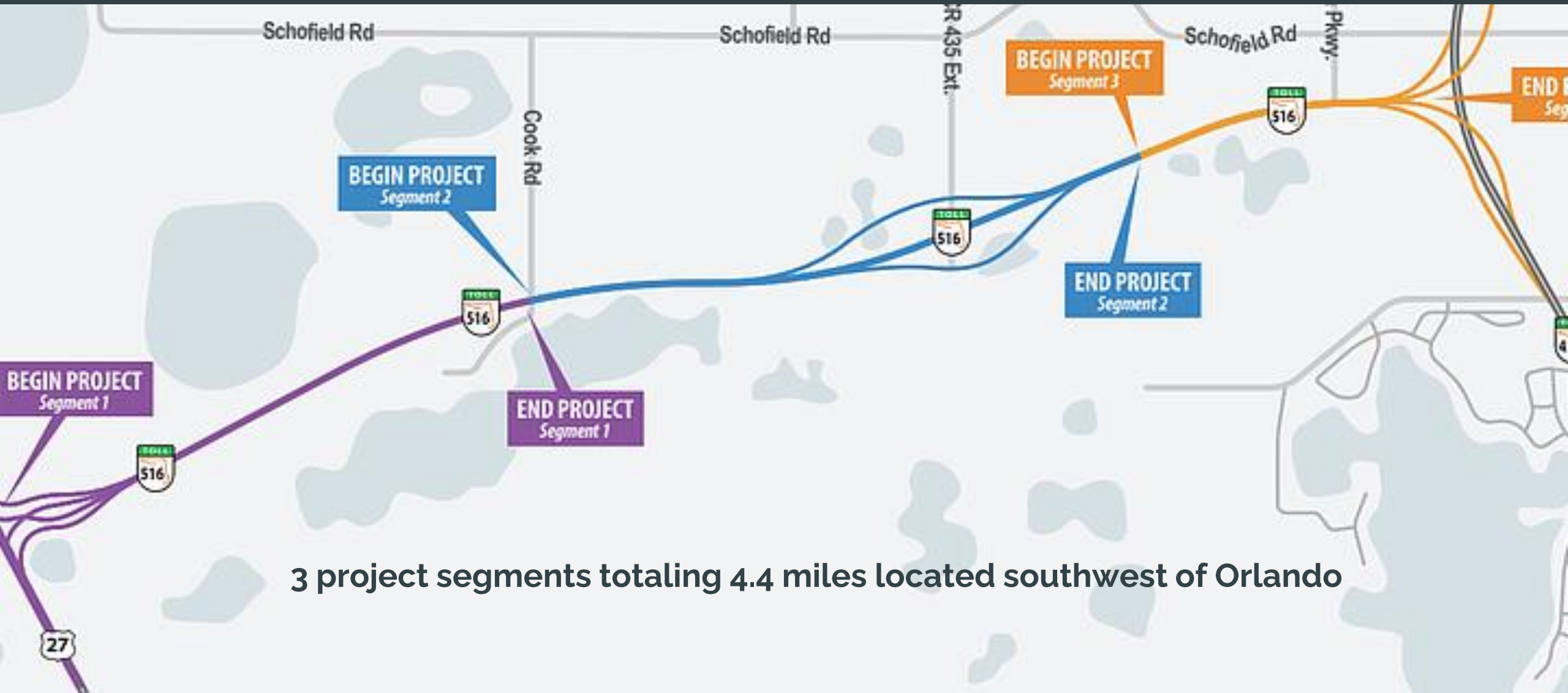
Indiana DOT / ASPIRE – Purdue / Cummins

Credit: Purdue University/Greta Bell

https://www.purdue.edu/newsroom/releases/2024/Q1/building-the-first-highway-segment-in-the-u.s-that-can-charge-electric-vehicles-big-and-small-as-they-drive.html#:~:text=%E2%80%94%20At%20the%20%E2%80%9CCrossroads%20of%20America,charge%20while%20driving%20on%20highways.

SR 516 – Lake/Orange Expressway

Central Florida Expressway / ENRX / ASPIRE



3 project segments totaling 4.4 miles located southwest of Orlando

SR 516 – Lake/Orange Expressway

Central Florida Expressway / ENRX / ASPIRE

SR 516 – Lake/Orange Expressway

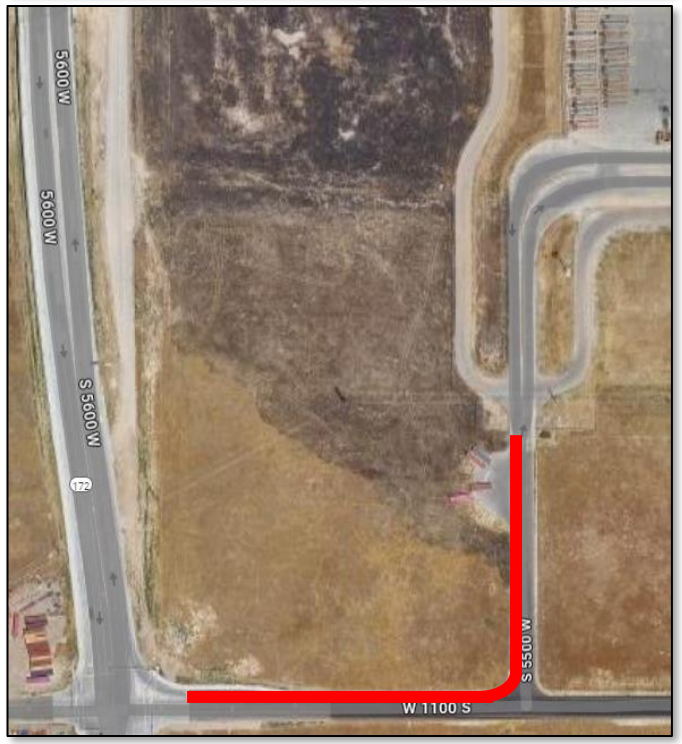
Central Florida Expressway / EMRX / ASPIRE

Utah Inland Port, SLC

ASPIRE – USU / Kenworth

Drayage Freight Electrification

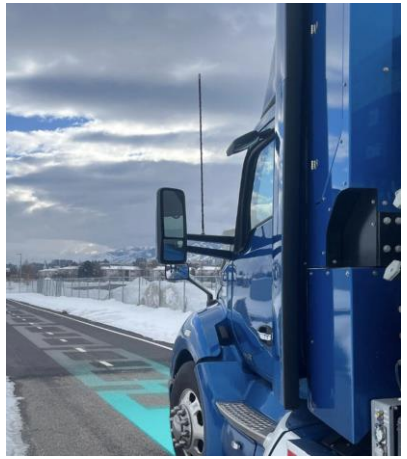
- **Purpose**
  - Facilitate short-haul movement of shipping containers to storage facilities within the Utah Inland Port
- **Location**
  - Utah Inland Port, 5600 W 1100 S, Salt Lake City
  - Entrance to Union Pacific Intermodal Terminal
- **Technology**
  - Combination of static and dynamic wireless charging demonstrating how the truck can work using both systems.
  - Includes both the Michigan Electreon system and the Indiana ASPIRE-Purdue system.
  - Present deployments will inform improvements at Utah location that increases the power, truck clearance, and makes electronics advancements.

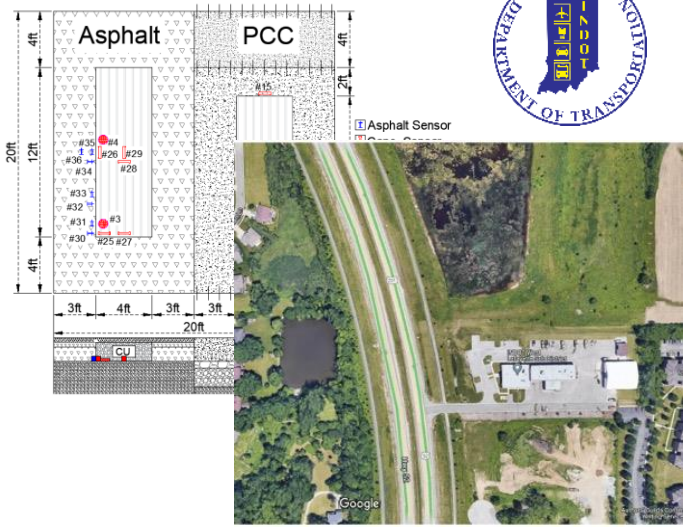


In-Motion Charging

$60M Funding in 4 States

MDOT





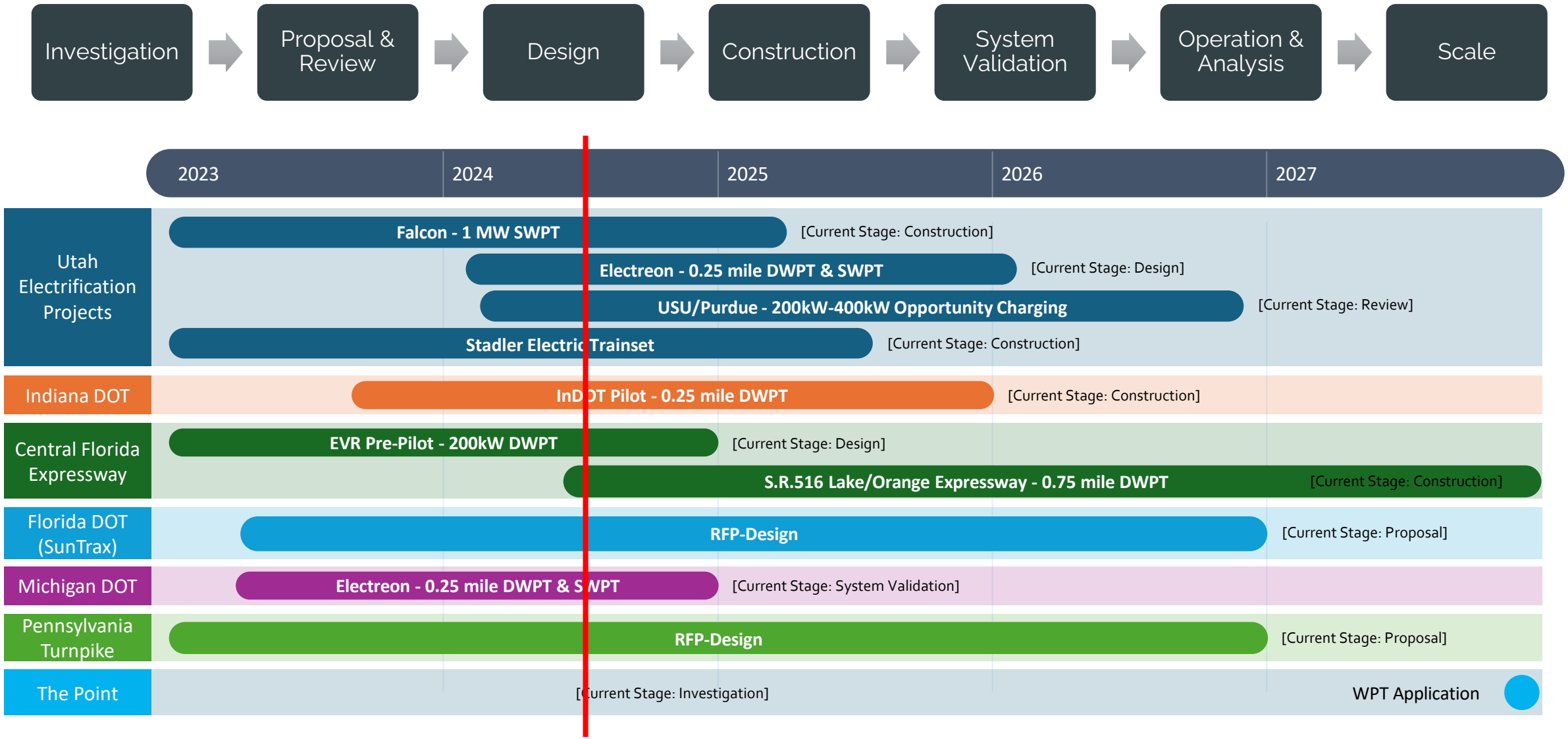
INDIANA DEPARTMENT OF TRANSPORTATION
INDOT

CENTRAL FLORIDA EXPRESSWAY AUTHORITY

FDOT

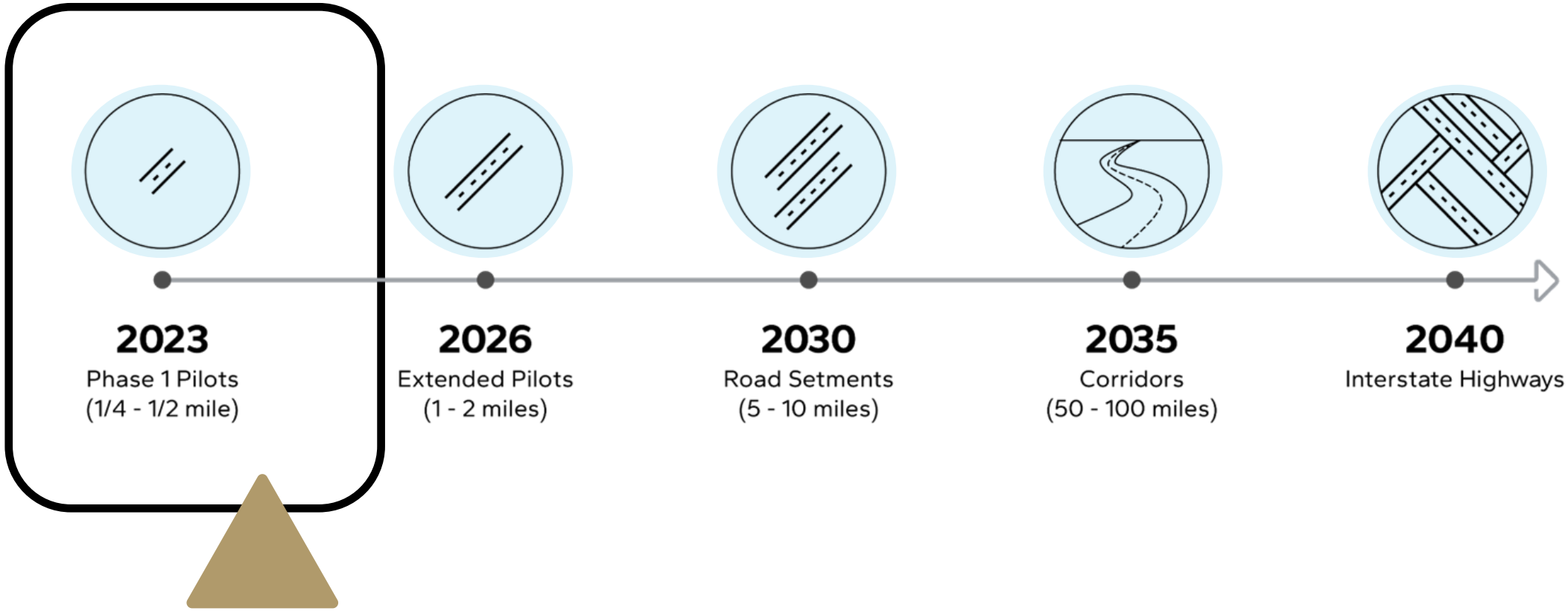
UIPA
UTAH INLAND PORT AUTHORITY
Moving Utah Forward

ASPIRE - Commercial Projects



Roadway-Electrification Roadmap

20 Year



5. National ZE Freight Strategy

Joint Office

EPA Clean Ports

Linked to the National Zero-Emission Freight Corridor Strategy

National Zero-Emission Freight Strategy

Phase 1 (2024-2027)

Establish Hubs

- Favorable launch areas
- Immediately suited to early deployments
- High concentration of first and last-mile delivery trucks
- Initial focus on port drayage

Prioritization

- States that encourage ZEV deployment
- EPA nonattainment areas
- I-80 and 100-mile freight corridor (I-15)
- 40% benefits to disadvantaged communities

National Zero-Emission Freight Strategy

Appendix A: Phase 1 & 2

ZEV Freight Hubs (UT)

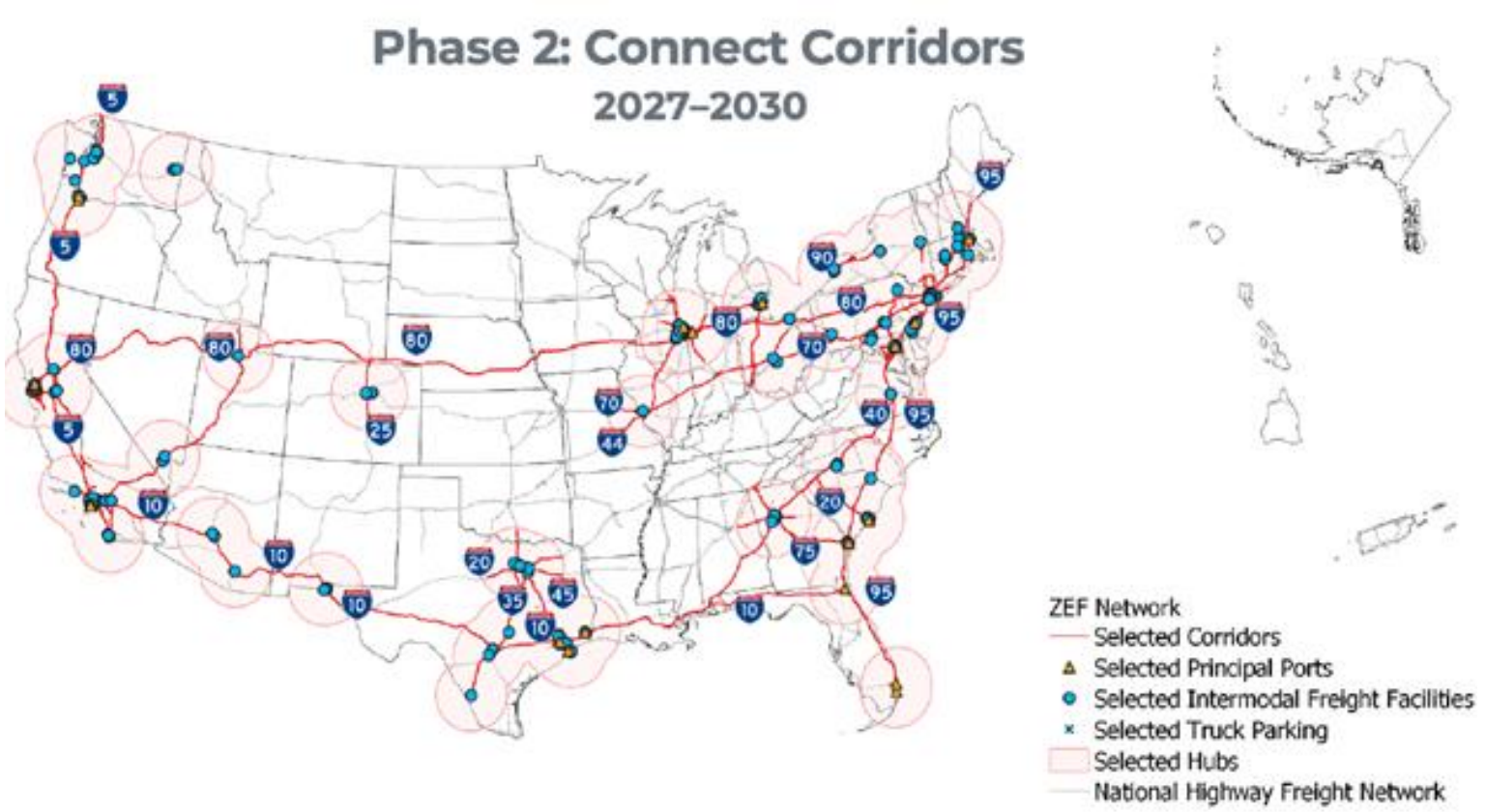
- Intermodal Freight Air-to-Truck
  - SLC International Airport
- Intermodal Freight Rail
  - Union Pacific Intermodal Terminal, Salt Lake City (Utah Inland Port)

National Zero-Emission Freight Strategy

Phase 2 (2027-2030)

Connect Hubs

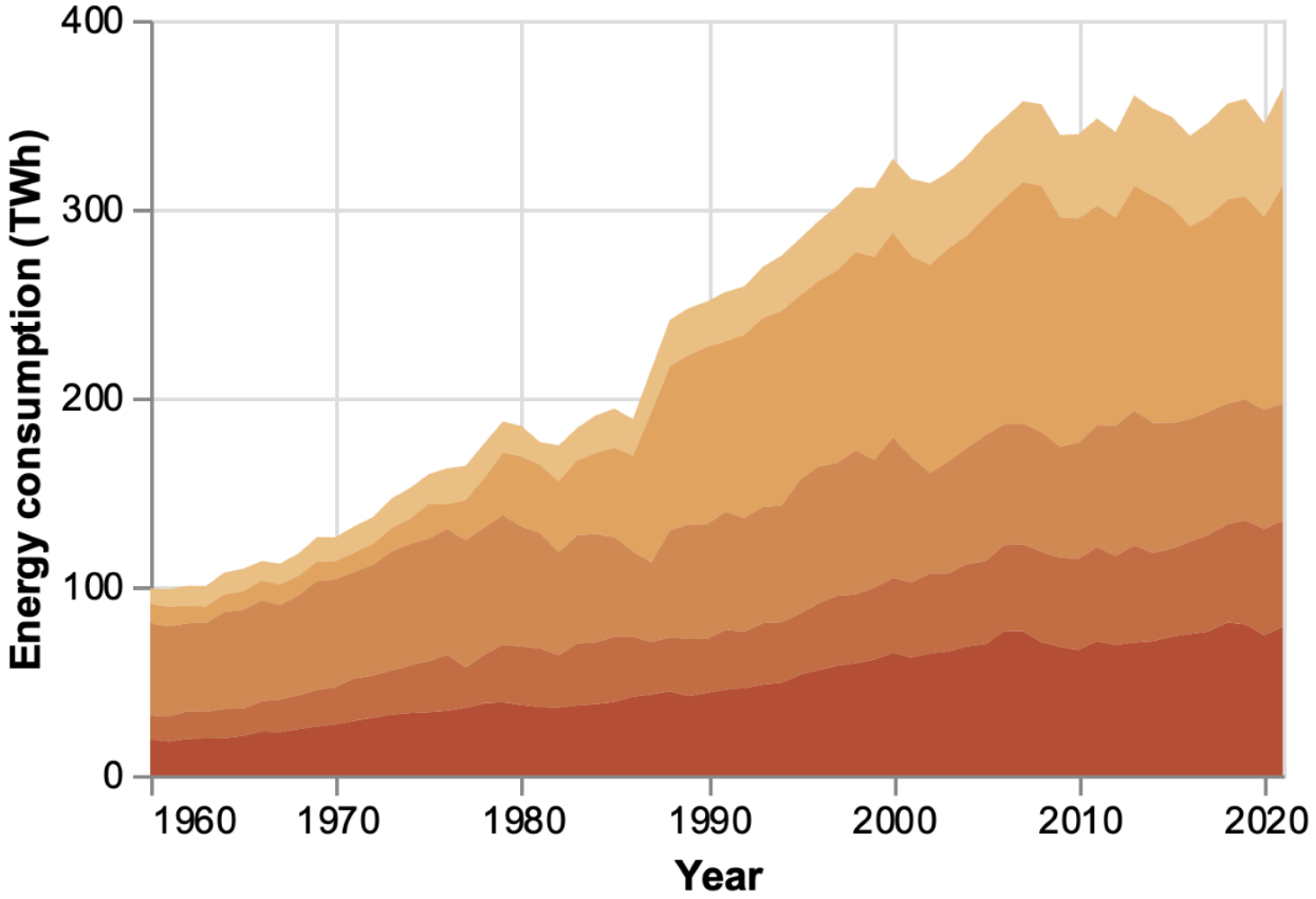
- I-80 connected coast-to-coast
- I-15 will connect SLC to San Diego
- Initial long-haul deployments begin
- I-80 Northeast and Midwest freight will move through Utah to ports in Seattle, Portland, and Oakland via I-80; and to ports in Los Angeles and Long Beach via I-15, and vice versa
- DOE will deploy Hydrogen Hubs
- Port drayage operations expand to additional ports



6. Modeling & Simulation

"Some" ASPIRE Initial Data & Capabilities

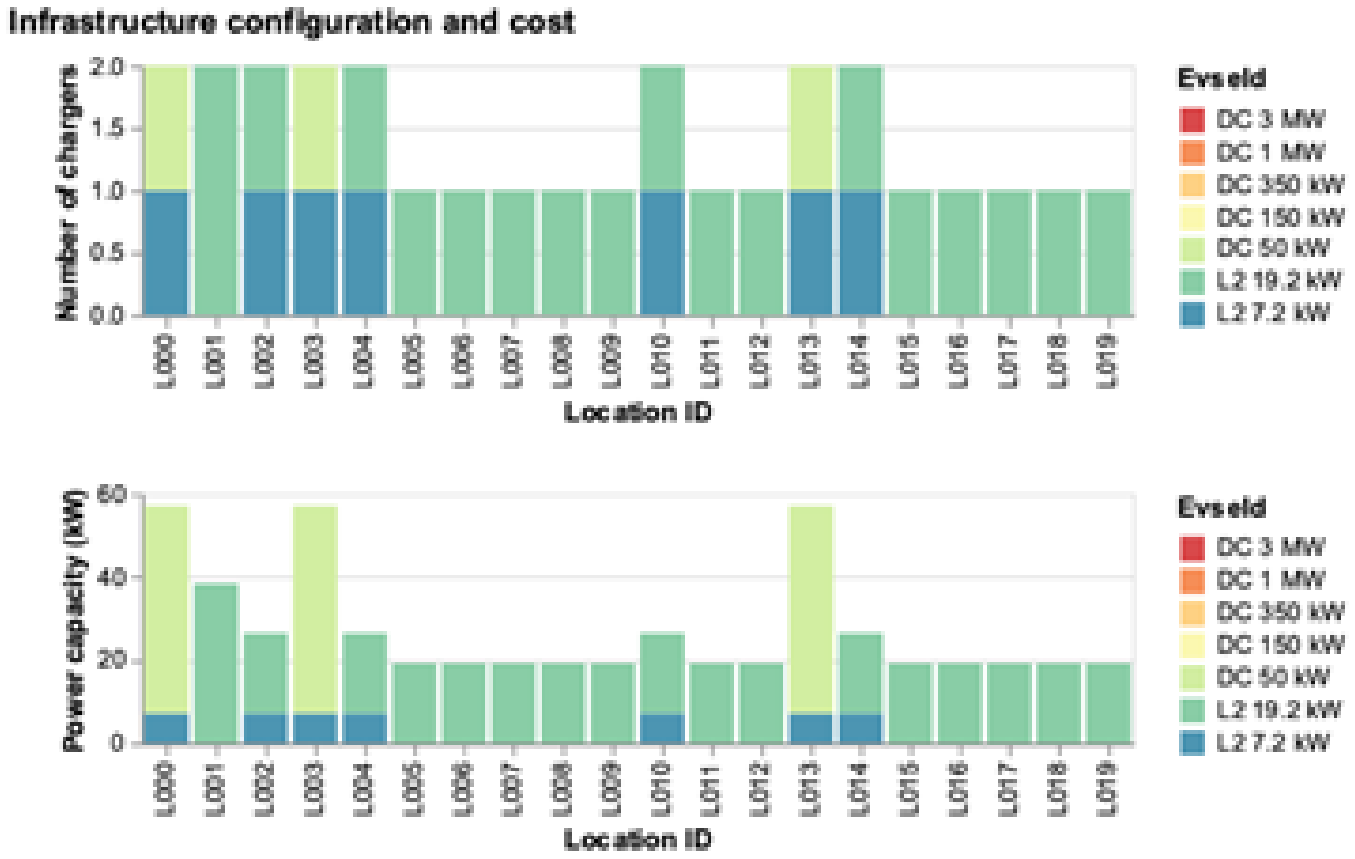
Energy Consumption



History of total annual energy consumption in Utah, inclusive of all energy sources, across five sectors

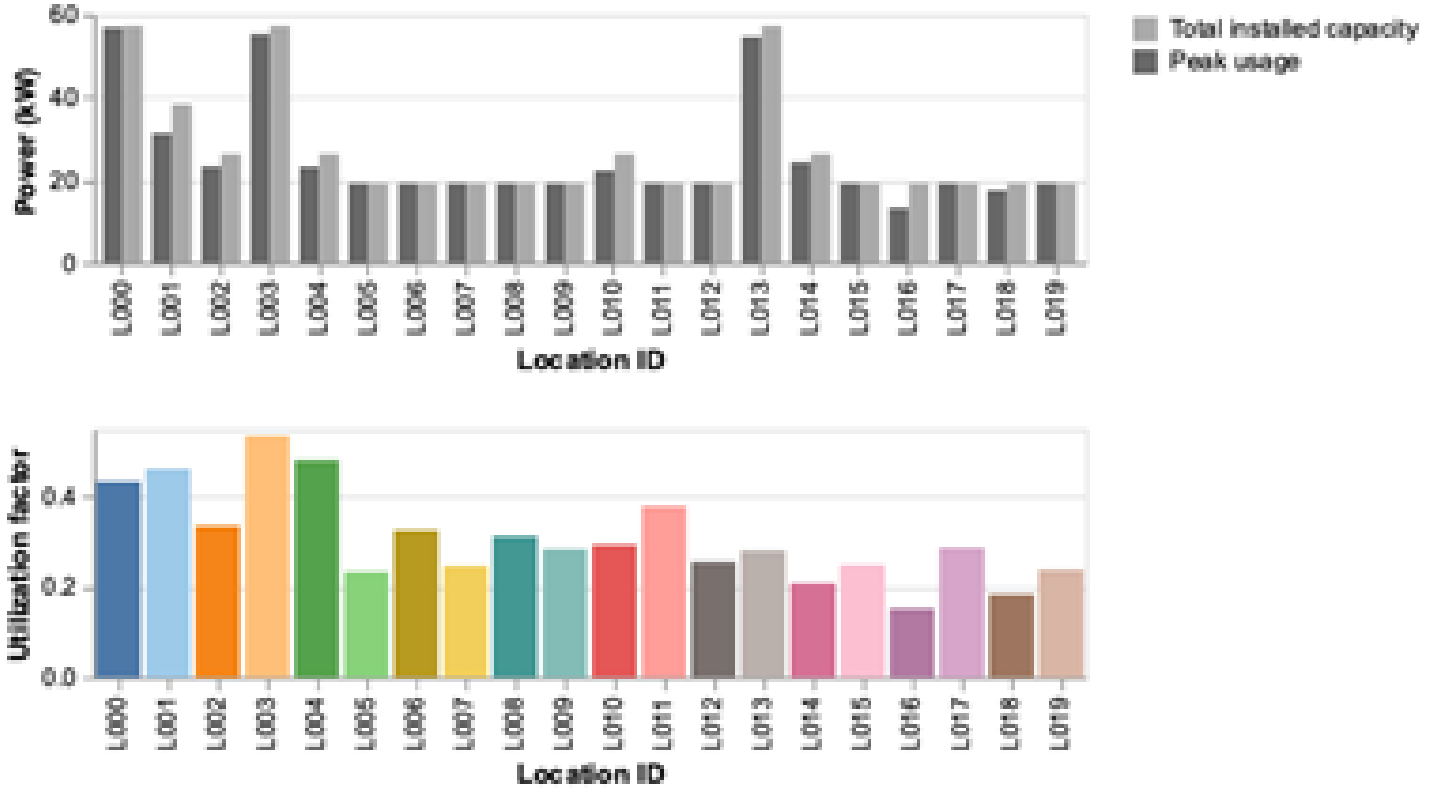
Data from U.S. Energy Information Administration

Infrastructure Optimization Tool



Subset of results from infrastructure optimization tool, taken from the linked interactive dashboard. These results are for an example problem with randomized vehicle driving schedules, with 30 vehicles that travel between 20 distinct locations. The goal of the optimization is to minimize the net present cost of the system, which comprises the cost of energy for charging, the cost of converting vehicles to electric, and the cost to install the charging infrastructure.

Infrastructure Optimization Tool



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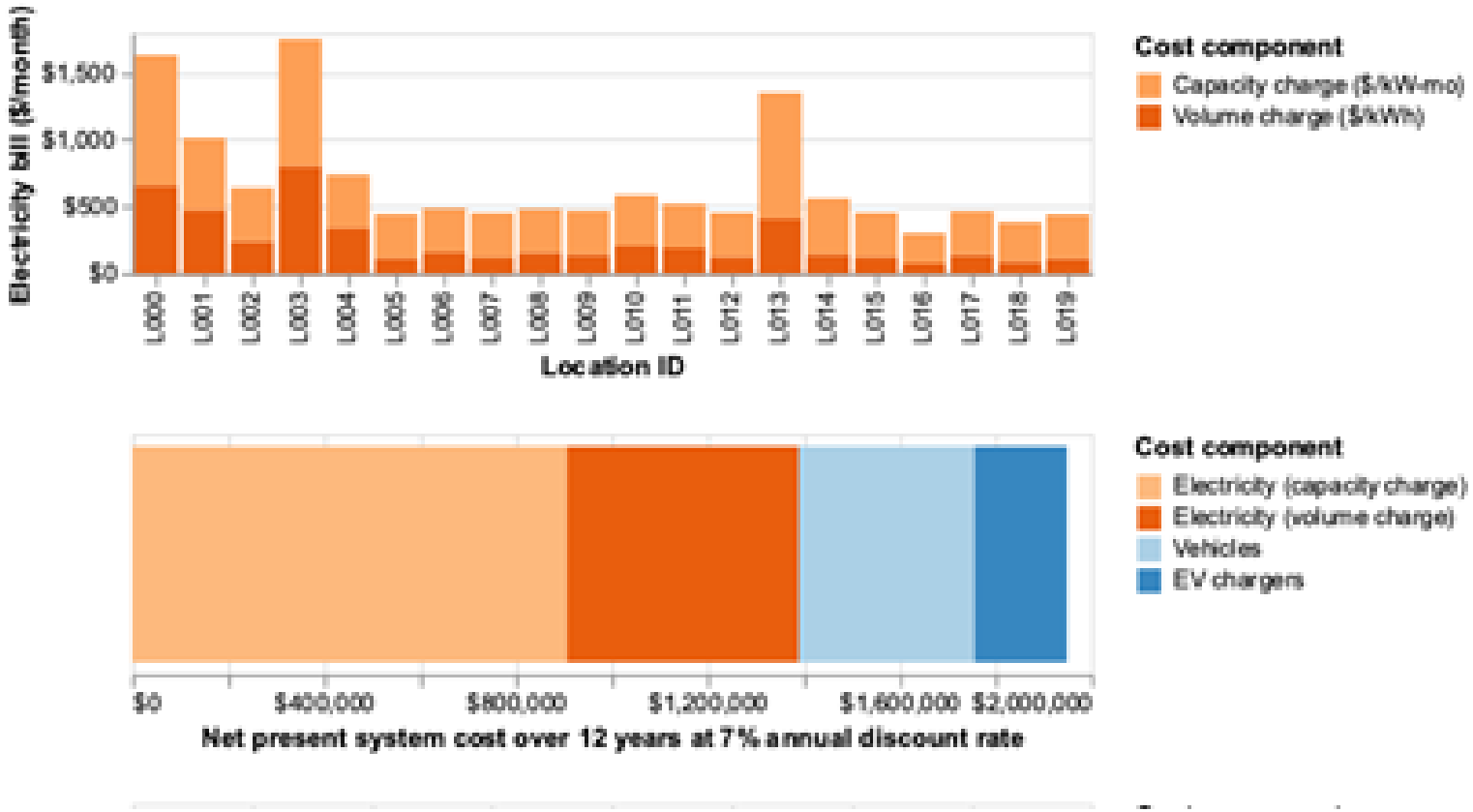

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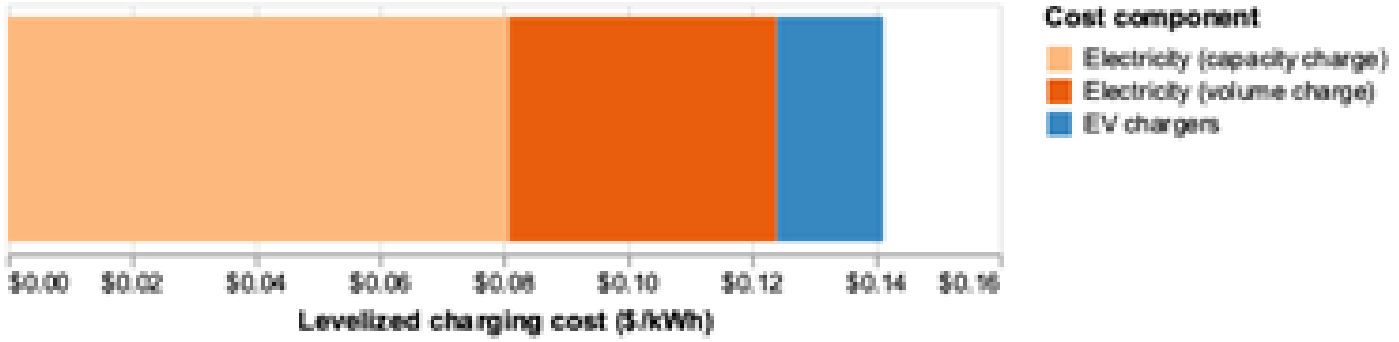

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Class 8 Truck Dwell Times >30 Minutes

Class 8 truck stops where dwell times are at least 30 minutes. Data from Geotab.

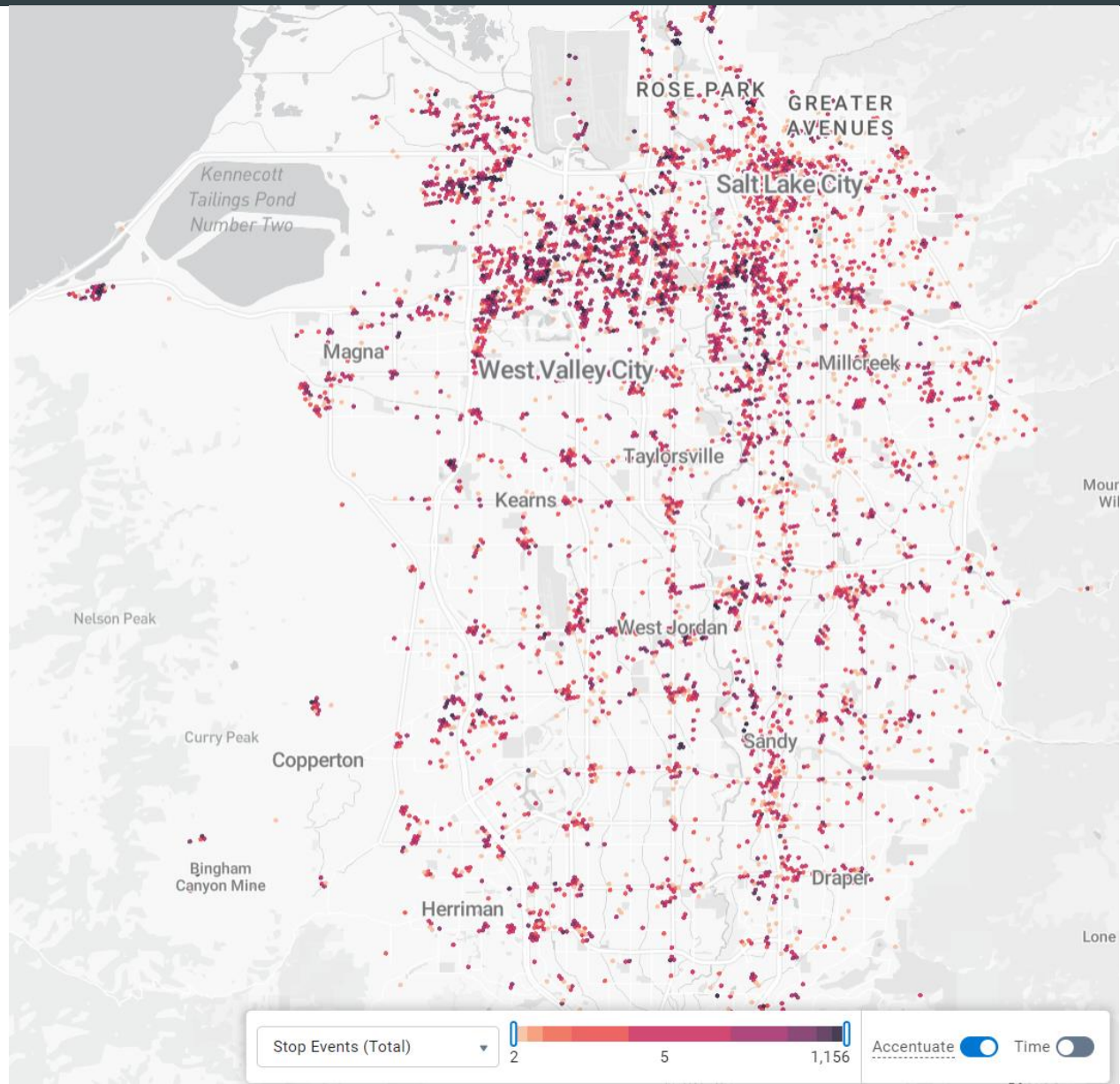
CLASS 8

OVER 33,001 POUNDS

Heavy* isn't enough of an adjective – these trucks are called *severe-duty

Most big rigs, along with cement trucks and dump trucks

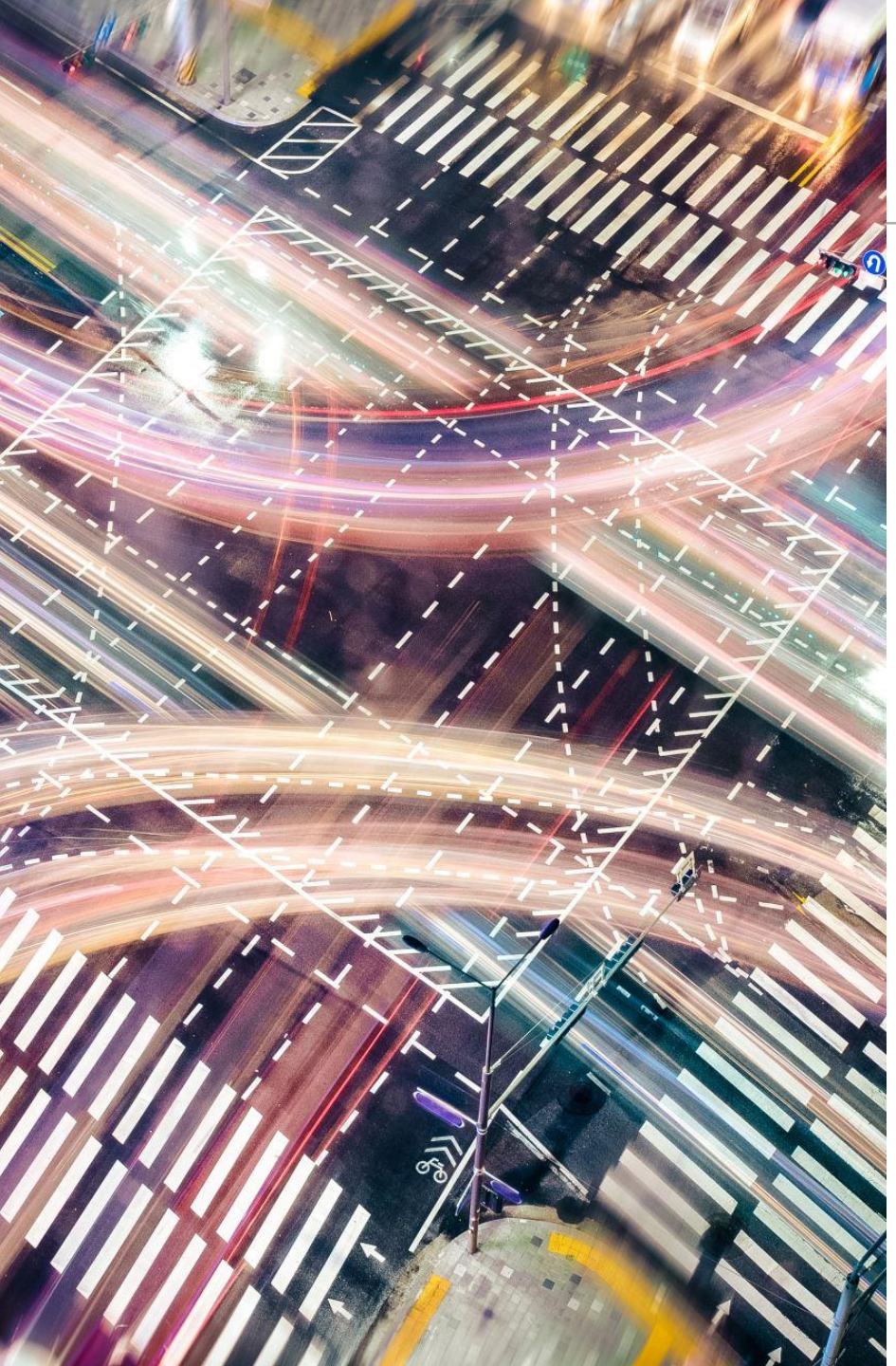
Famous representation: Optimus Prime



7. The ASPIRE Network

How YOU Can Work With Us

ASPIRE Network



ASPIRE

Electrification Workforce Development

Transitional Reskilling & Upskilling and Regionalized Customization

Training & Certification

Scalable & Intersectoral

Targeted & Adaptable

What is SB125?

SB125 launched ASPIRE's strategic Intelligent and Electrified Transportation plan for Utah to:

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

Utah Electrification Initiative

Cross-Industry Coordination

Collaborate with state agencies, UDOT, UTA, GOEO, & GOED, and industry partners, like 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.

Our Vision

Our goal is to define and develop a strategic action plan for intelligent electrified transportation infrastructure throughout Utah. This will entail strategies encompassing all vehicle classes and modes of travel — including public transportation — and charging infrastructure. It is vital that we incorporate the expertise and lived experiences of people, communities, businesses, universities, state agencies, industry experts, and non-profits across the state to improve health and quality of life.

How YOU Can Partner with ASPIRE

Strategic Planning

- Electrified Transportation Plan
- Multi-Modal Mobility
- Improved Air Quality
- Economic Growth

Stakeholder Coordination

- Project Management
- Workforce Development
- Leverage ASPIRE Industry & Innovation Network

Proposal

- Support or Lead Role
- Technical Guidance
- Trusted Guide
- Standards & Interoperability

Implementation

- Requirements Planning
- Design
- System Validation
- 3rd Party Evaluation & Reporting

ASPIRE

AAPA Webinar

Electrifying Port Freight: Insights from the ASPIRE Center and Its Pioneering Electrified Roadway Projects

June 18, 2024

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2023 Annual Report

Michael Masquelier
Chief Commercial Officer
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