



NSF Engineering Research Center

Advancing Sustainability through Powered
Infrastructure for Roadway Electrification

ASPIRE Overview

David Christensen
Innovation Director

ASPIRE Vision

Sustainable and Equitable Future for Transportation

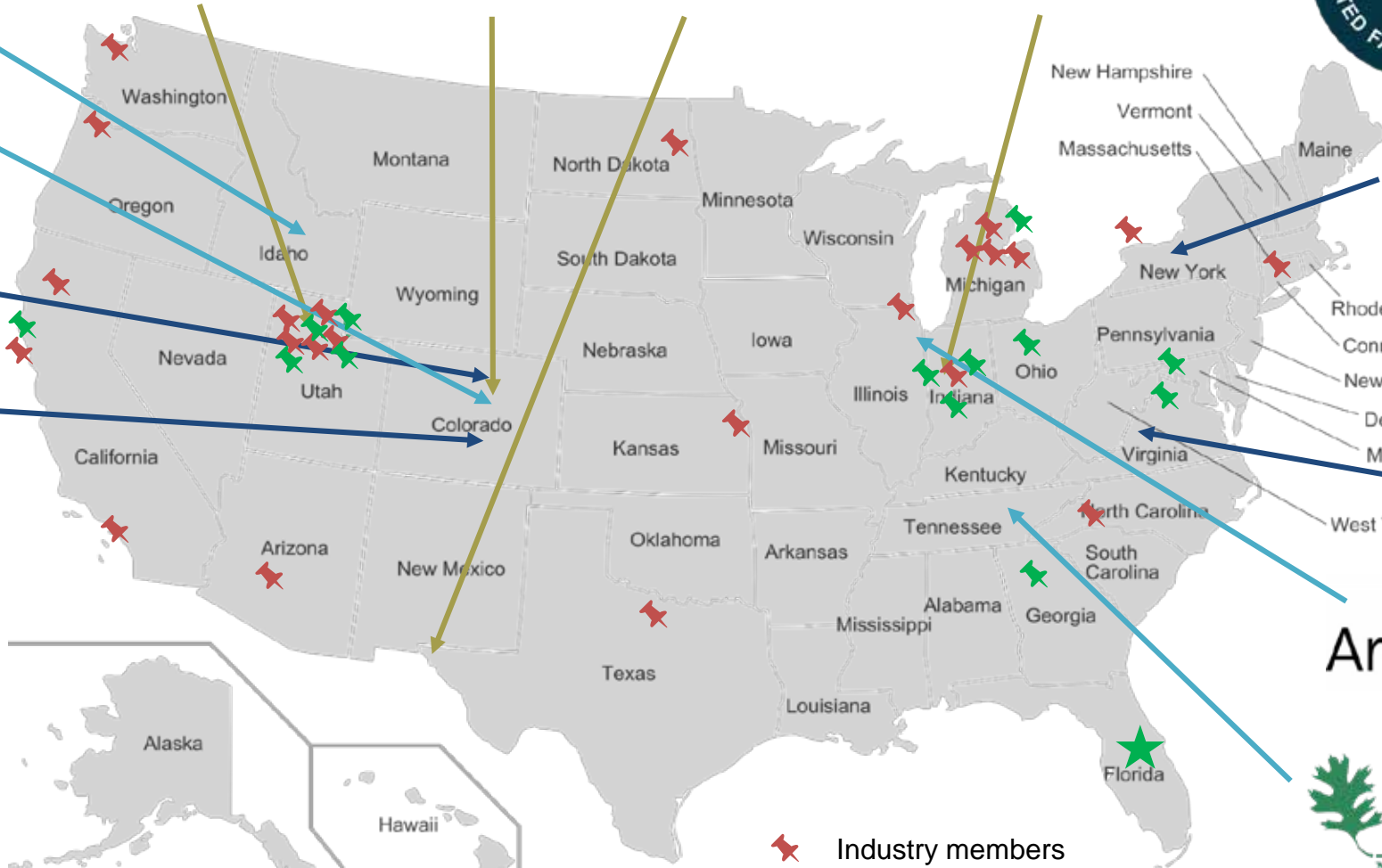
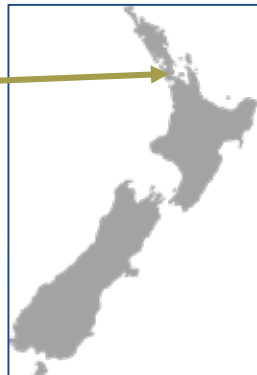
Improve Human Health
Improve Human Prosperity
Improve Equity and Access

Widespread Electrification
Across Vehicle Classes
& Adoption Groups

Strategic Partnerships



THE UNIVERSITY OF AUCKLAND
NEW ZEALAND



Cornell University

Israel
Sweden



📌 Industry members

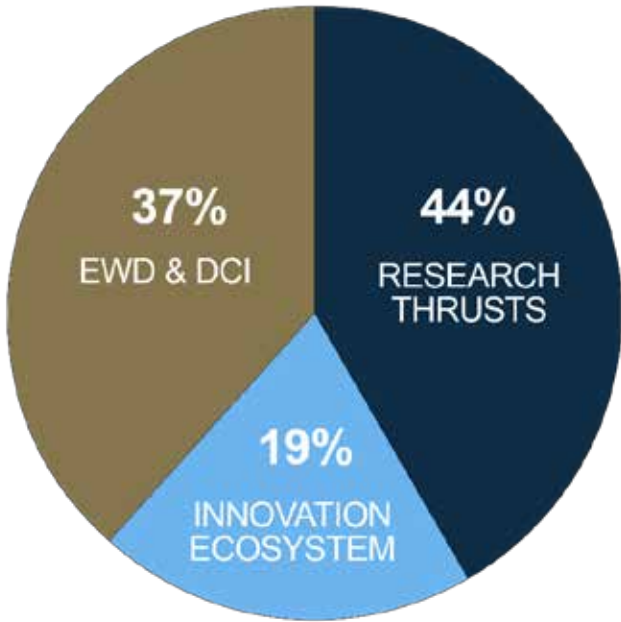
🌱 Innovation partners



10 Year Resource Plan

Center Foundation and Fundamental Convergent Research

Leveraging across REDI Applied Research & Development



Industry Members

Innovation Partners



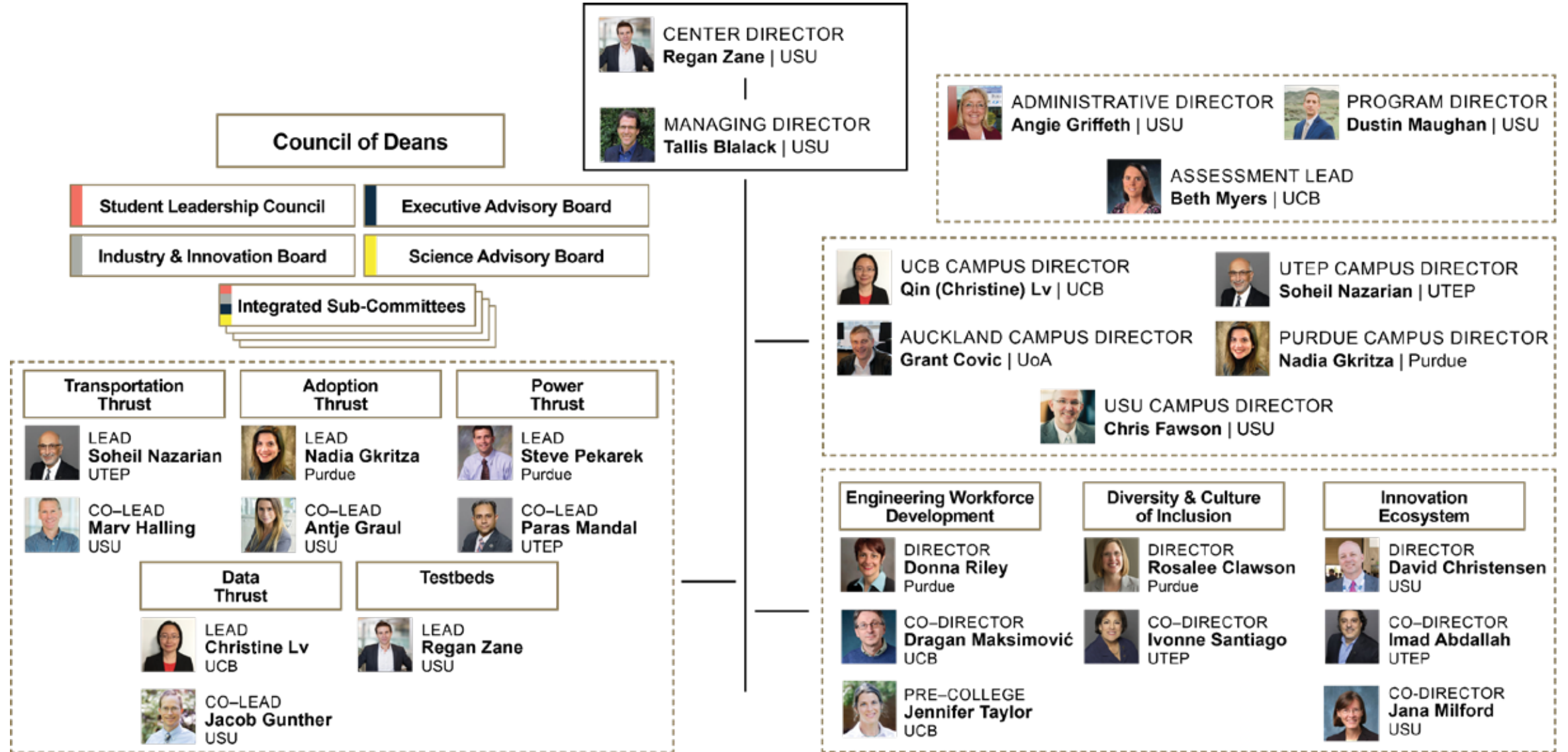
Federal Cost-Share
\$51M \$8M

State Membership
\$6M \$20M

Sponsored Research and P3 Pilots
\$150M

Total \$235M

ASPIRE Leadership Team



Adoption Research Thrust

THE HOWARD BAKER FORUM



U.S. Department of Transportation



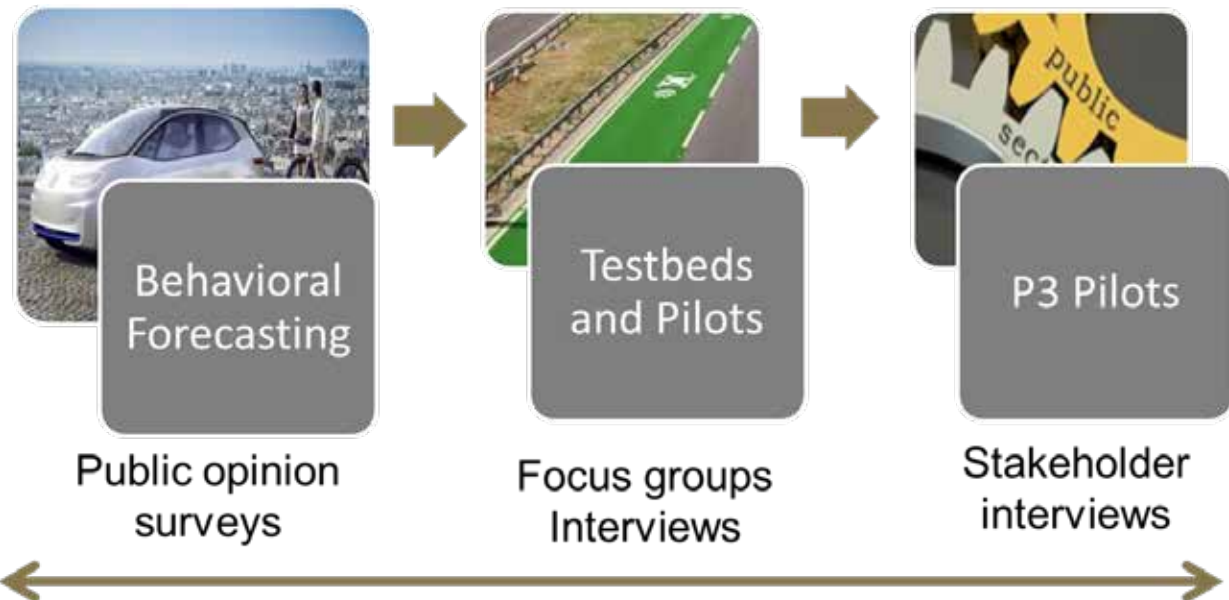
Lead: Gkritza
Co-Lead: Graul

Sub-Areas of Adoption

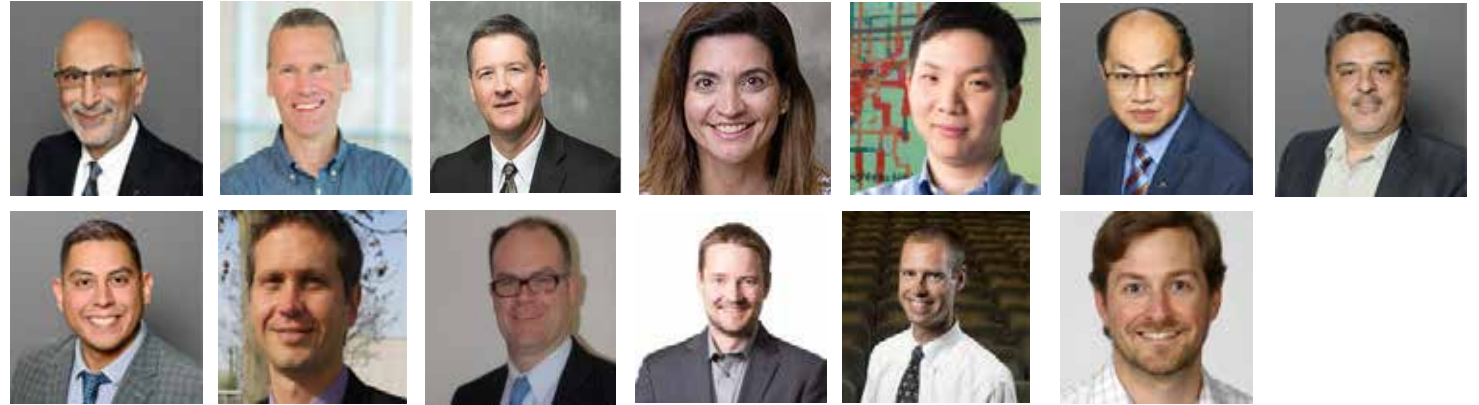
User Acceptance / Society

Public Policy / Economy

Techno-economic Systems /
Environment / Society



Transportation Research Thrust



Lead: Nazarian
Co-Lead: Halling

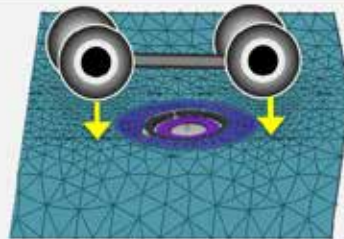
Sub-Areas of Transportation

Transportation Infrastructure

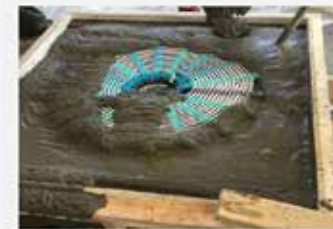
Optimize life cycle of a long-lasting and economical powered infrastructure

Transportation Systems

Optimize power consumption considering traffic behavior/demand



Charging Element-Materials Interaction



Material / Design / Construction



Infrastructure Life Cycle Process



Travel Behavior / Demand

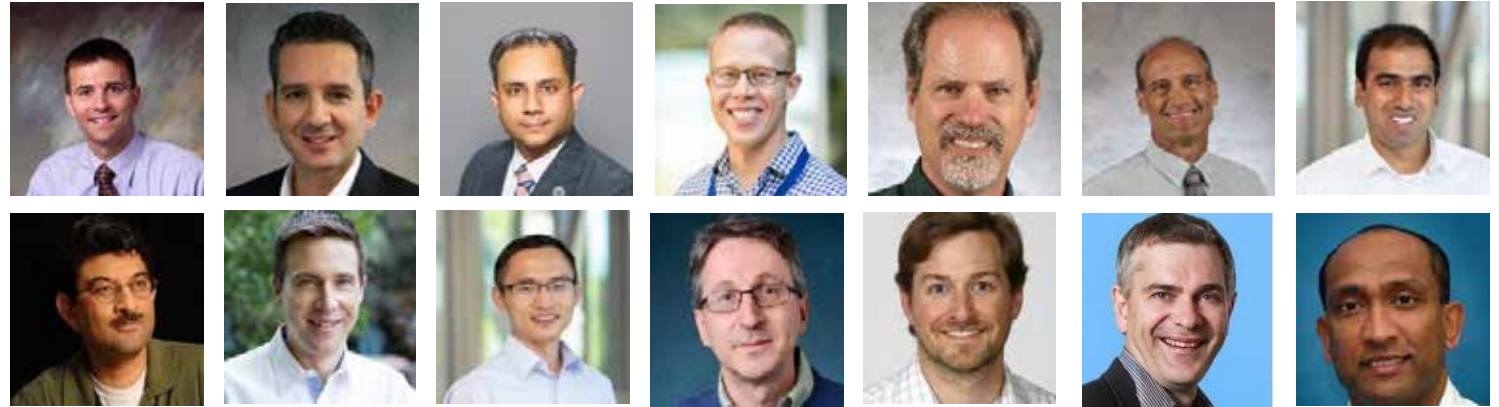


Traffic-Power Network



Dynamic Pricing and Regional Impacts

Power Research Thrust



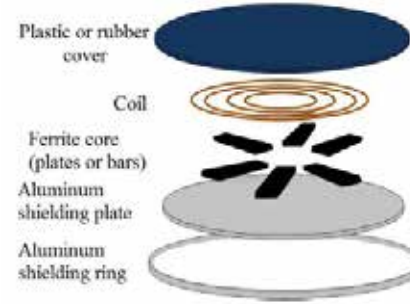
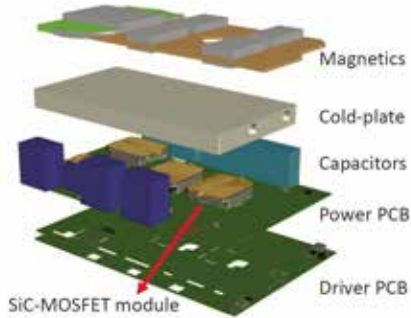
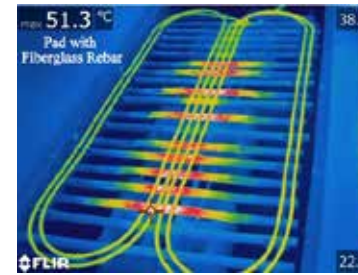
Lead: Pekarek
Co-Lead: Mandal

Sub-Areas of Power Team

Power System Modeling, Control, and Grid Integration

Power Electronics, Charging Hardware/Control/Thermal

Battery/Energy Storage Modeling and Control



Data Research Thrust



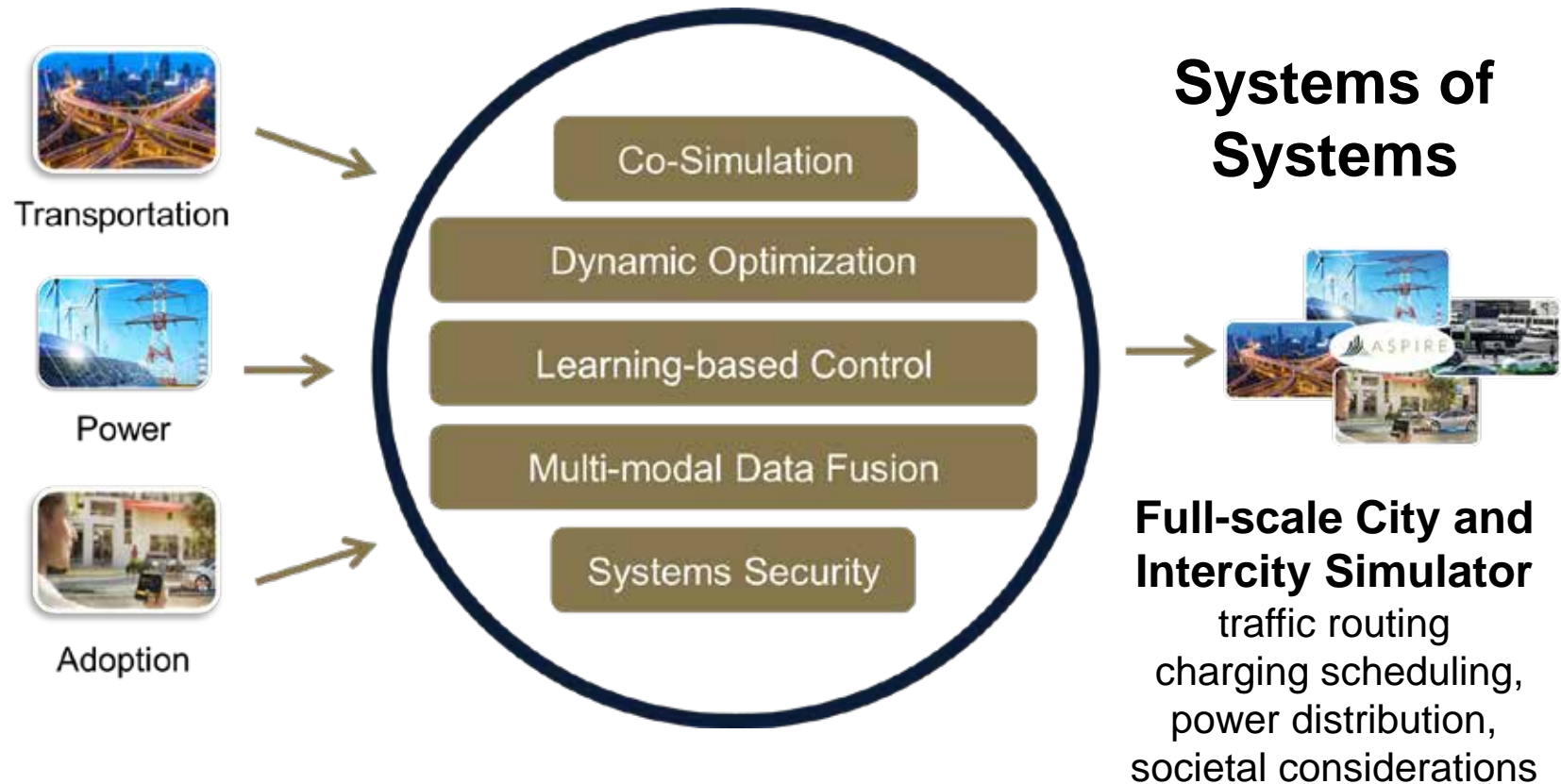
Lead: Qin (Christine) Lv
Co-Lead: Jacob Gunther

Sub-Areas of Data

Data Analytics, Data Fusion,
Machine Learning

Optimization Theory, Operations
Research, Co-simulation

Communication Networks, IoT,
Real-time / Embedded Systems,
CPS Security



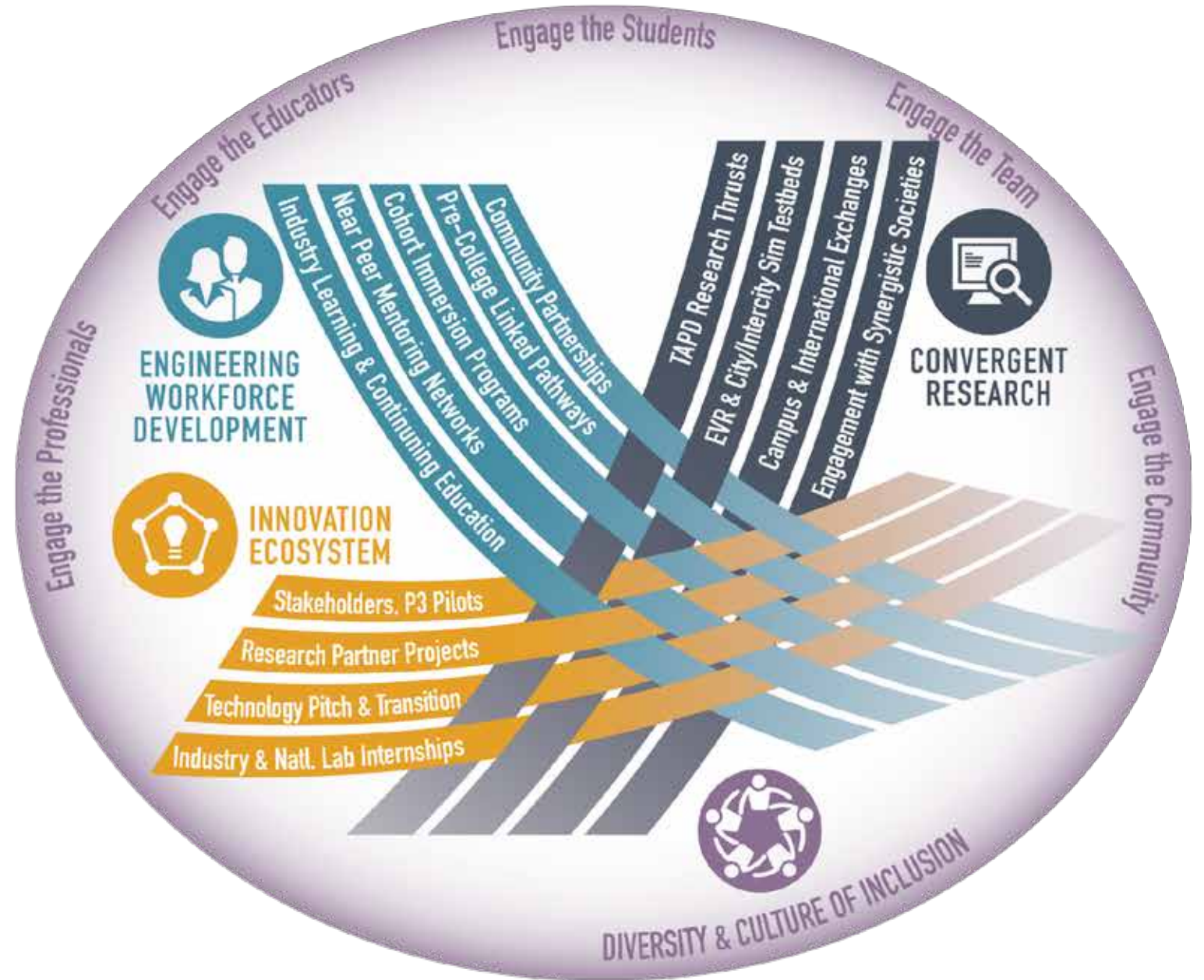
ASPIRE ERC Woven REDI Program

Research

Engineering
Workforce
Development

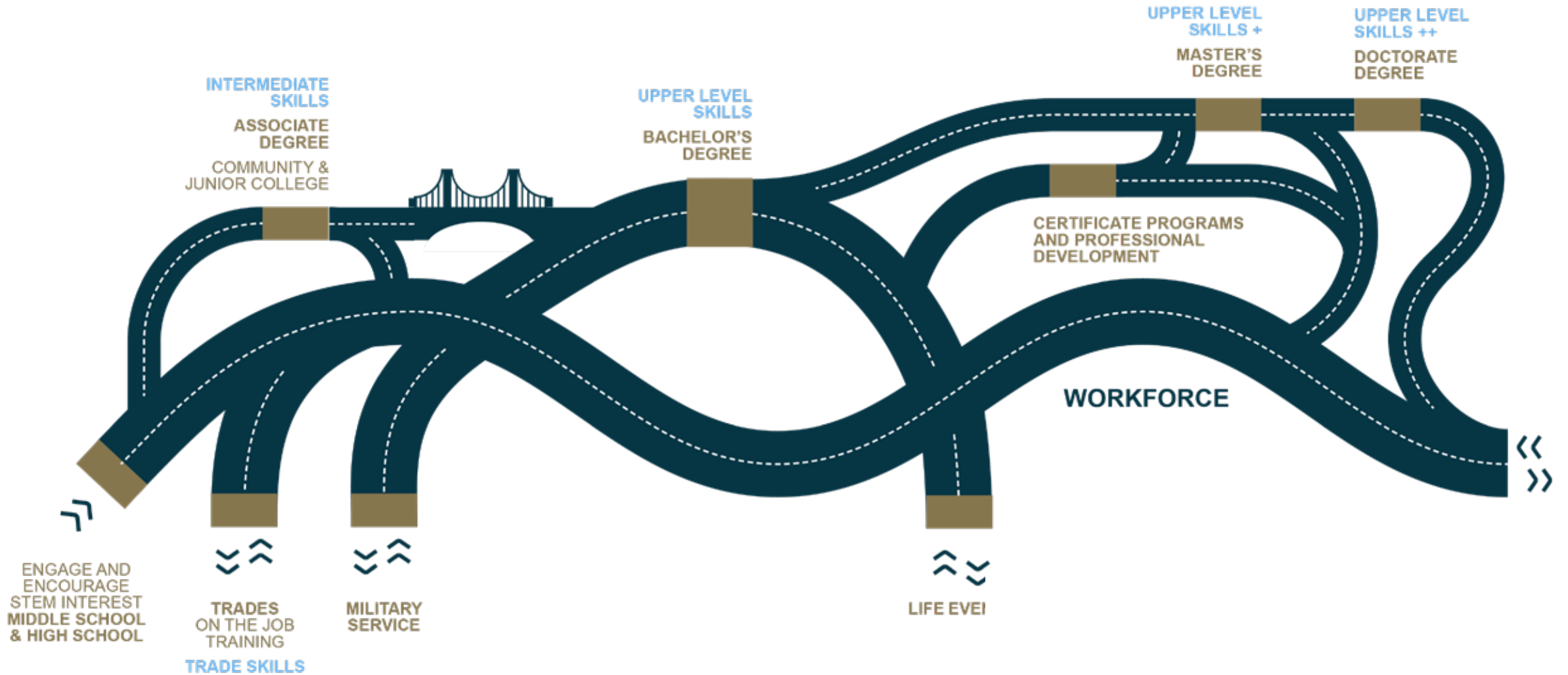
Diversity and
Culture of
Inclusion

Innovation
Ecosystem

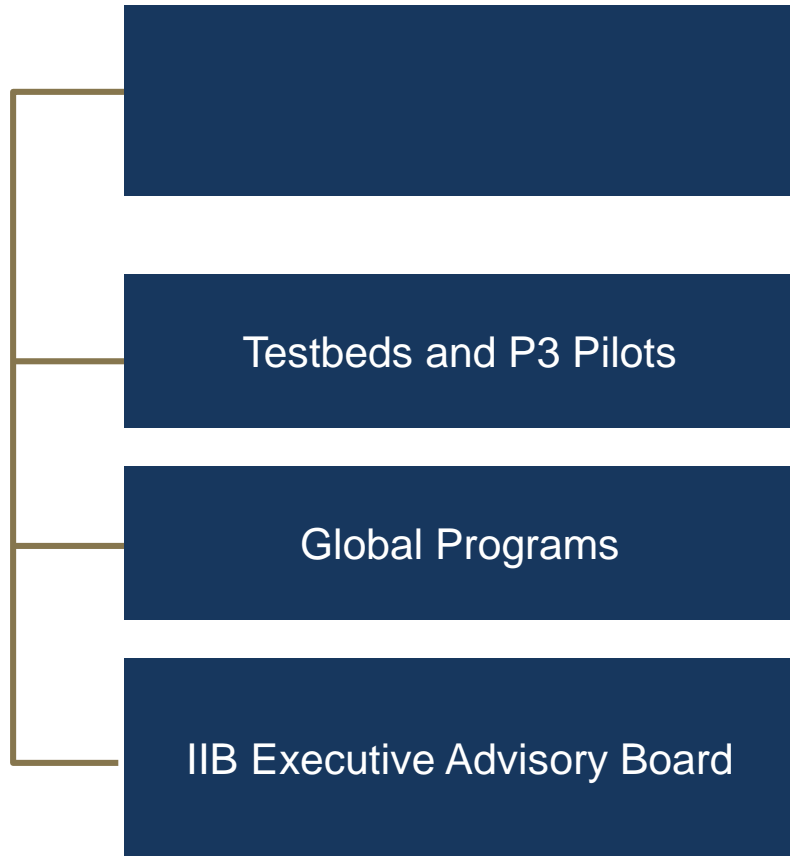


ASPIRE EWD & DCI Team

Pathways & Roadways



Innovation Ecosystem



Single Tier Membership	\$15k annual fee No overhead = 100% to Center operations
Research Partners Projects	\$40k investment in students per project No overhead = 100% support for students EWD/DCI components in each project
Sponsored Projects	Stakeholder engagement in sponsored projects and P3 pilot projects
Assessment & Feedback Loop	30+ industry members by 2025 90%+ of industry members in Research Partner projects P3 pilot projects launched in >5 states by 2030

IIB Members



Incoming



Rethink Industries
and Boundaries



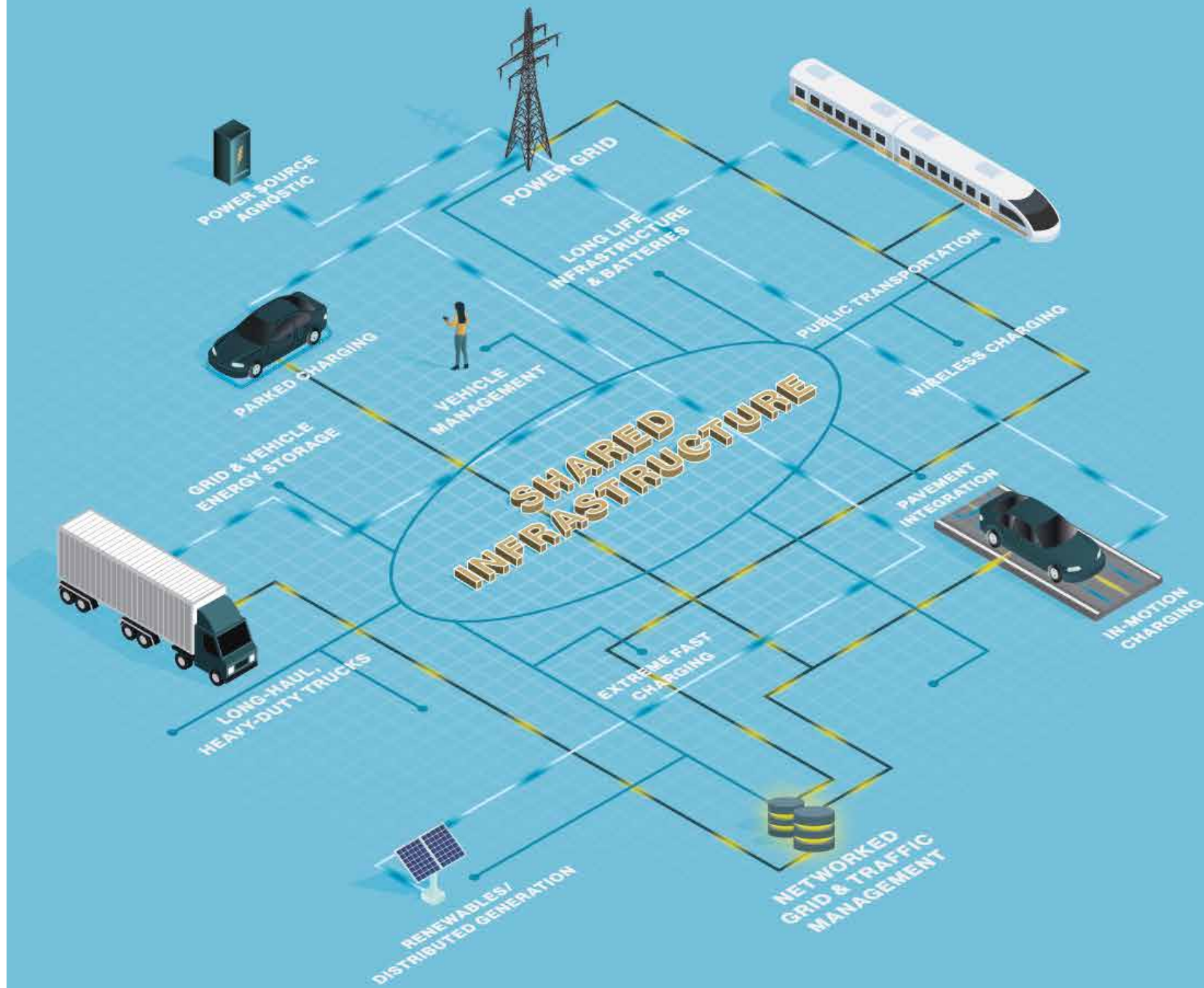
High Utilization
Public & Shared
Infrastructure



Nation is at a
Crossroads



More Connected
More Managed
Charging



CHARGING

- Grid Integration
- Roadway Charging
- Parked Charging

NETWORKING

- Grid Management
- Traffic Management
- Vehicle Management

USERS & VEHICLE CLASSES

- Personal Vehicles to Commercial Fleets
- Passenger Cars to Heavy-duty Trucks
- Public/Private, Shared, Autonomous



Technology Solutions

Power Where the Rubber Meets the Road

Powered Infrastructure & Roadway Electrification



Wireless & Wired, In-motion
& Parked Charging

Co-optimized Power Grid
& Roadway Networks

Retrofit or Standard
Receiving Modules on
Battery Electric or Hybrid Car



Favorable Impacts

Grid



Connected
Flexible
Predictable
Managed

Vehicle



Smaller Battery
Longer Life
Light to Heavy
Duty
Parked, Urban,
Highway

User



Reduced Cost
Seamless
Experience
Personal,
Shared, Fleet,
Autonomous
Equitable

Environment

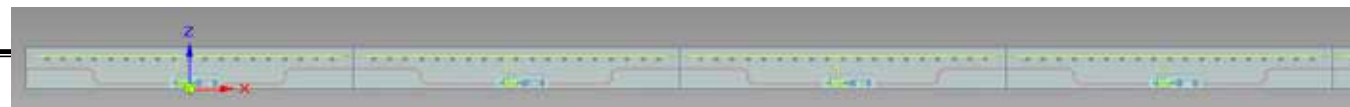


Improved
Health
Localized and
Lifecycle
Emissions
Reduced
Battery Impact

Electric Vehicle & Roadway (EVR) Facility



- Electric Vehicle & Roadway (EVR) Research Facility and Test Track
 - 750 kW utility, 4800 ft² dual high bay, ¼ mile electrified track, Dynamometer, Vehicle Lifts, L2/DCFC EVSE, DC & AC micro-grid, 128 kW solar array, 120 kWh on-site energy storage
 - Multiple concrete embedded, in-road power transfer coils in high bay building and test track
 - Coordination with and integration across SELECT Center partner labs





Systems of Systems Testbeds

Full Scale City & Intercity Simulator



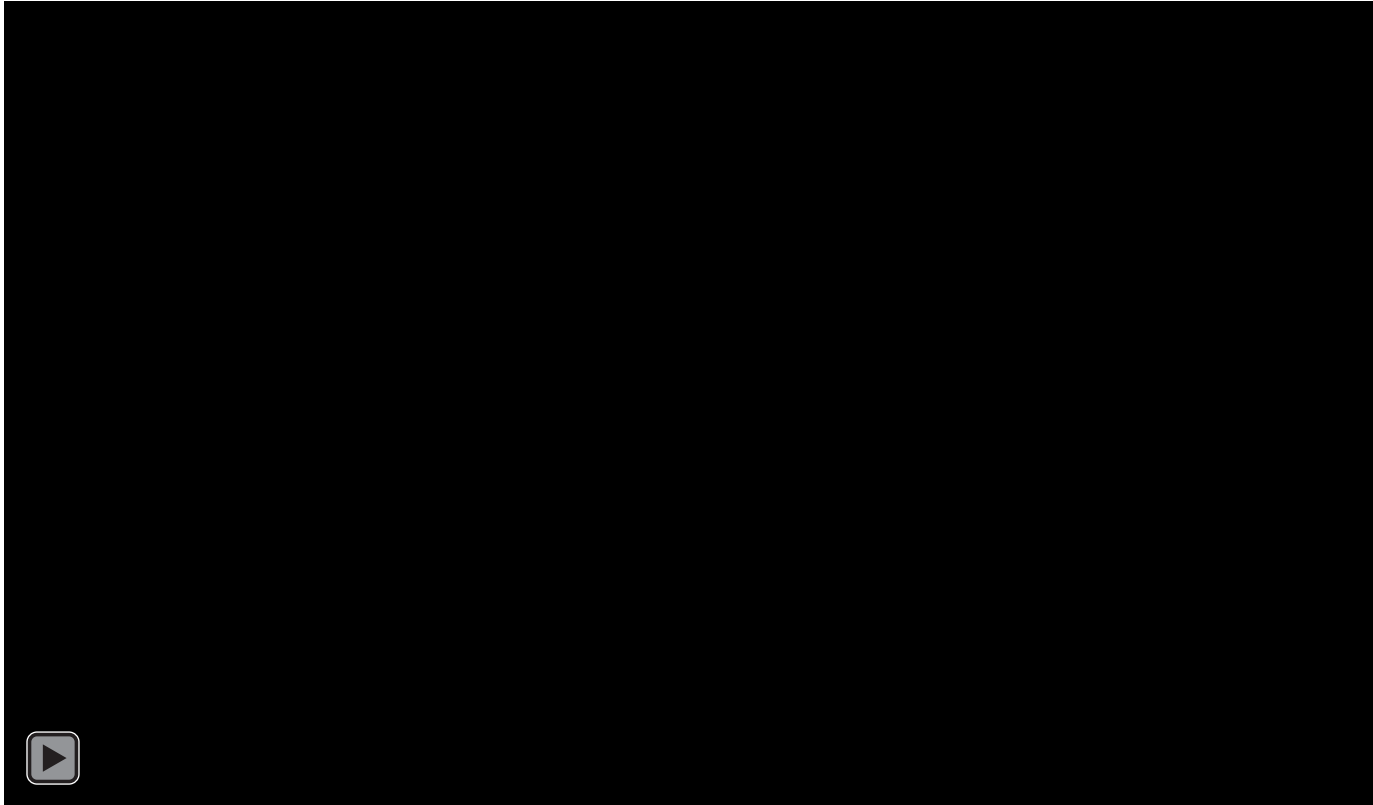
- Expansive co-simulation, synthetic models of grid, traffic, charging, & society
- Quantified analysis of the interactions between technology and society (policy, incentives, demand response, pricing, behavior & choice, economics, adoption)
- HIL linked to EVR hardware testbed
- Publicly released by Year 10

Electric Vehicle and Roadway (EVR)

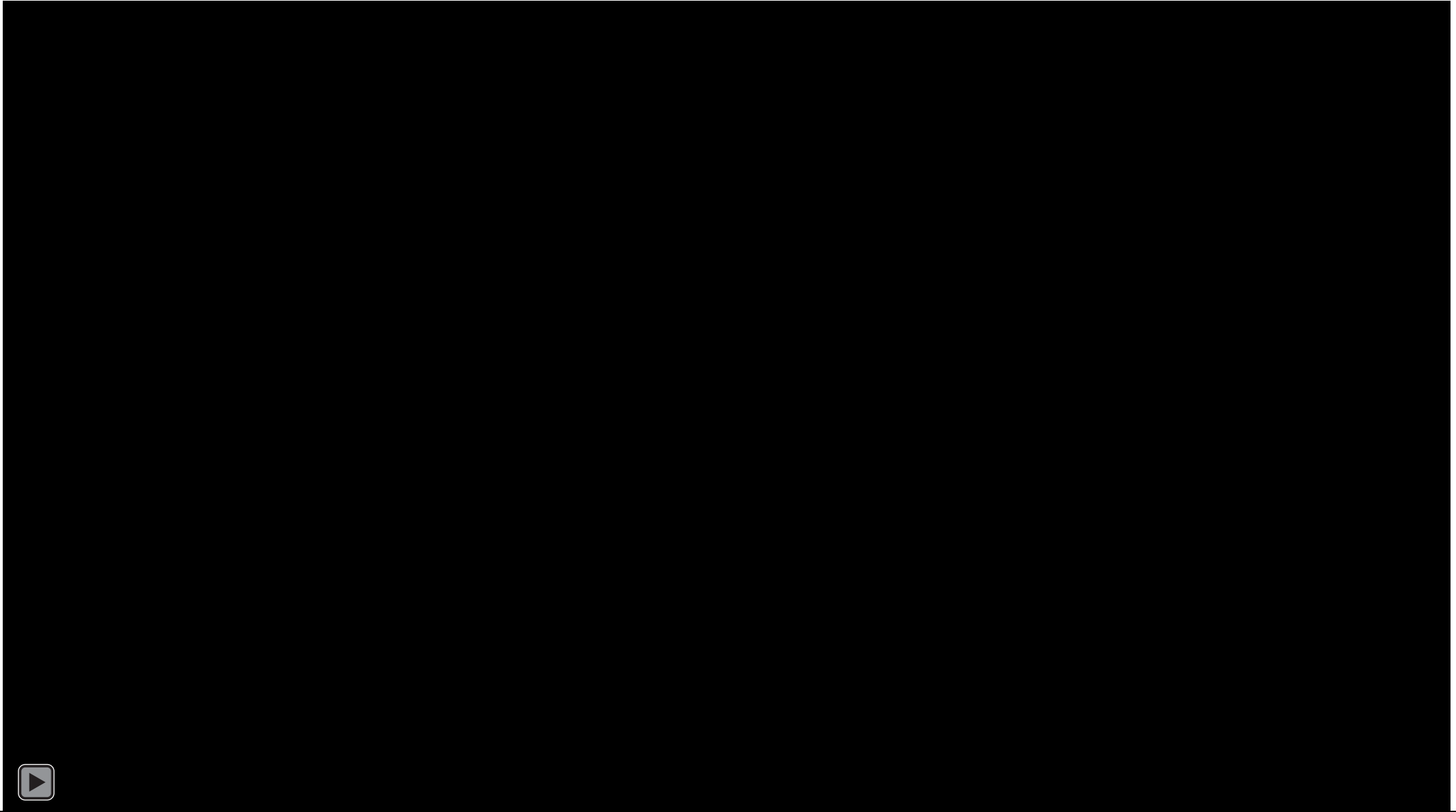


- Quarter-mile electrified test track
- 128 kW solar power, 100 kW/kWh battery, 750 kW utility service, 250 kW battery test
- Stationary and in-motion wireless and wired charging, grid integration, real-time grid-vehicle interaction
- Expansion: Heavy duty trucks and HIL
- Key resource for EWD-DCI activities

Electric Roadway Research



Smart Powered Roads Concept for Pilot





Public-Private-Partnership (P3) Pilots

Urban Intermodal Hub in Salt Lake City, UT



Megawatt Wireless Charging in Seattle & Portland

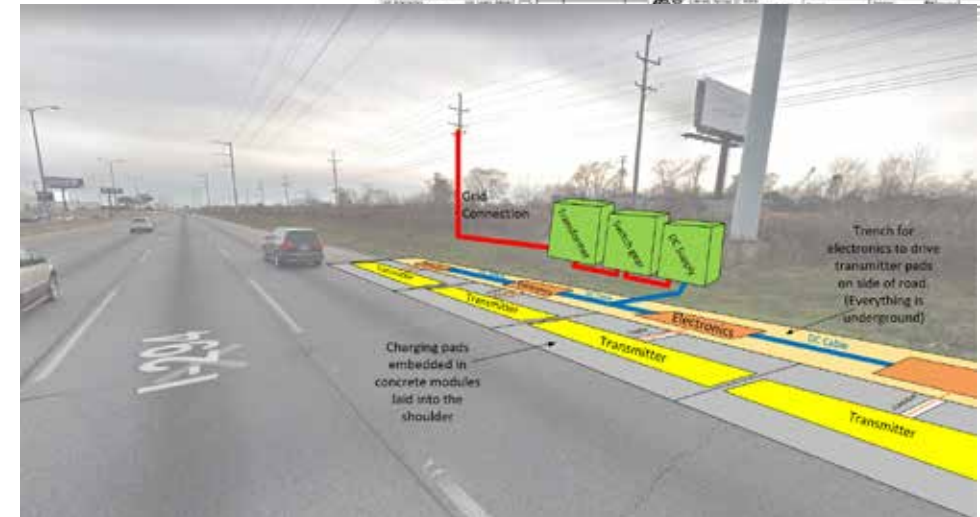
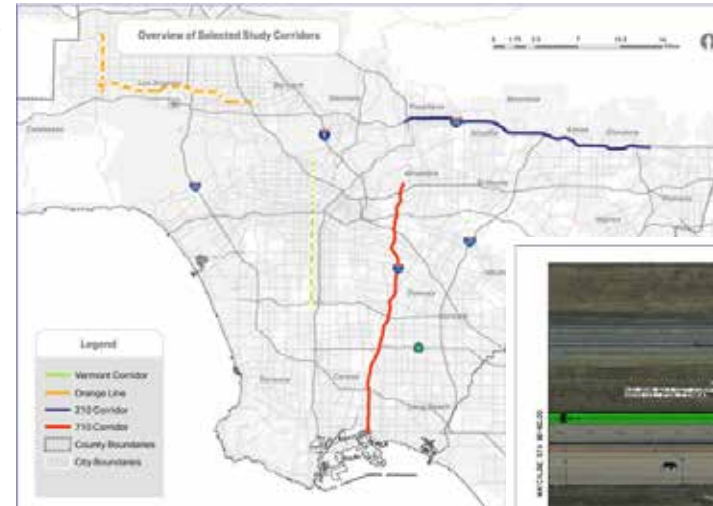


Dynamic Charging Highway near Chicago, IL



Developing Pilot Projects

- Orlando, FL – Central Florida Expressway
- Salt Lake City, UT – Inland Port
- Austin, TX – Hwy 130
- Dallas, TX – Frito Lay DC/Fleet
- Lenexa, KS – Kiewit
- Lordstown, OH – Ohio Turnpike
- Indianapolis, IN – IndyGo BRT, I-70
- Los Angeles, CA – LA Metro, Griffith Park
- San Diego, CA – SANDAG
- Atlanta, GA – Port
- Peachtree Corners, GA – Municipal Corridors
- Denver, CO – DIA
- Chicago, IL – Illinois Tollway



ASPIRE Year 1+ Projects

Wireless eXtreme Fast Charging

Baseline key WXFC metrics and identify targets based on adoption drivers, LD to HD

Develop and validate high fidelity electro-thermal-mechanical models for components, pavements and batteries to increase C-rate and power density

Demo >1 MW MD/HD, >200 kW LD, and >2 kW drone at EVR

Long Life Smart Powered Pavements

Baseline key DWPT metrics and identify targets based on adoption drivers, LD to HD

Advance solutions in passive cooling, pavement integration, autonomous alignment, long life operation, power distribution, and vehicle side controls for DWPT

Demo >100 kW continuous DWPT over 20 meter section at EVR with mix of LD to HD

Systems for @Scale Charging Sites

Baseline key metrics for wired/wireless charging sites based on adoption drivers

Advance solutions for MV grid-tie, shared power distribution, DER integration, site-level pavement integration, smart and secure charge management

Demo >500 kW, MV grid-tie system with smart charge management at EVR

Systems of Systems Optimization

Establish baselines for adoption, sustainability, TEA and LCA for transportation electrification

Establish an architecture for open-source, dynamic co-simulation and optimization of power, transportation and EV charging networks

Develop case studies for proposed LD to HD rollout of combined technologies

Market & Workforce Development

Baseline stakeholder perception and information gaps

Launch stakeholder PR campaign (web, social media, community engagement)

Publish quarterly market intelligence reports

Launch professional and curriculum development for pre-college, trades, 2-year colleges

Build college grad skillsets: cohorts, curriculum, ugrad, internships, international visits

Baseline longitudinal research and strategic change structures

PAST: Fill up at a fueling station; carry energy storage onboard.

TODAY: Charge at convenient locations via plug-in charging stations; carry energy storage onboard.

TOMORROW: Energy (ideally locally produced) comes to your vehicle where and when you use it, networked with the grid and traffic management—integrated with parking, drive throughs, or roadways while .



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