EVs@Scale

U.S. Department of Energy

A Summary of EVs@Scale Consortium

Andrew Meintz

EVs@Scale Consortium Chair

Chief Engineer for EV Charging and Grid Integration National Renewable Energy Lab

EVs@Scale Lab Consortium

Objectives

- Adapt to rapidly evolving technology landscape
- Maximize multi-lab coordination
- Identify and prioritize long-and short-term RD&D
- Timely support to address urgent challenges
- Support Administration and IIJA (BIL) transportation electrification objectives

Consortium Features

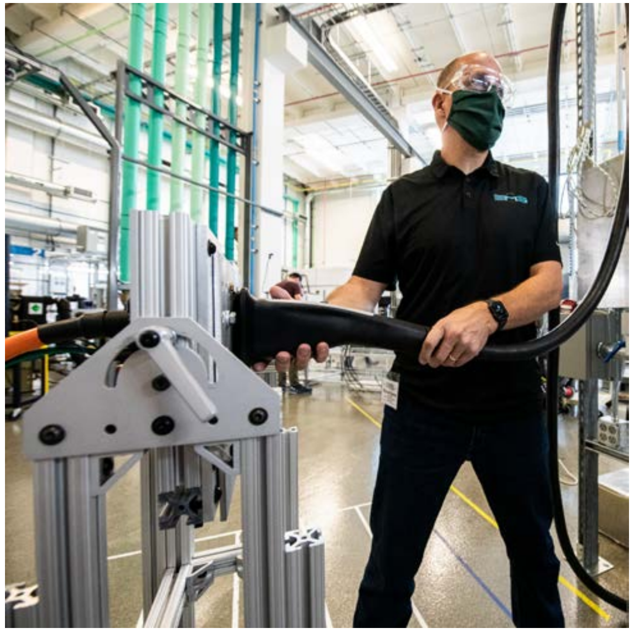
- Six Labs – ANL, INL, NREL, ORNL, PNNL, SNL
- 5 R&D pllars aligned with G&I R&D pillars
- Stakeholder Engagement and Outreach

Scope

Precompetitive research, development, and demonstration to supports a nationwide network of electric vehicle charging that is harmonized with the grid

Consortium Objectives

- Develop charging technologies and standards needed to meet U.S. goals of transitioning to a nationwide fleet of on-road vehicles powered by electricity, bringing the transportation sector closer to a net-zero-emission future
- Bring together the national laboratories’ hardware and software expertise, capabilities, and facilities related to EV charging, charge management, grid services, grid integration, and cyber-physical security.
- Enable highly coordinated, targeted research to be initiated and successfully conducted that is in step with rapid changes in the EV charging



Industry engagement with Consortium members to support development of Megawatt Charging System (Dennis Schroeder / NREL)

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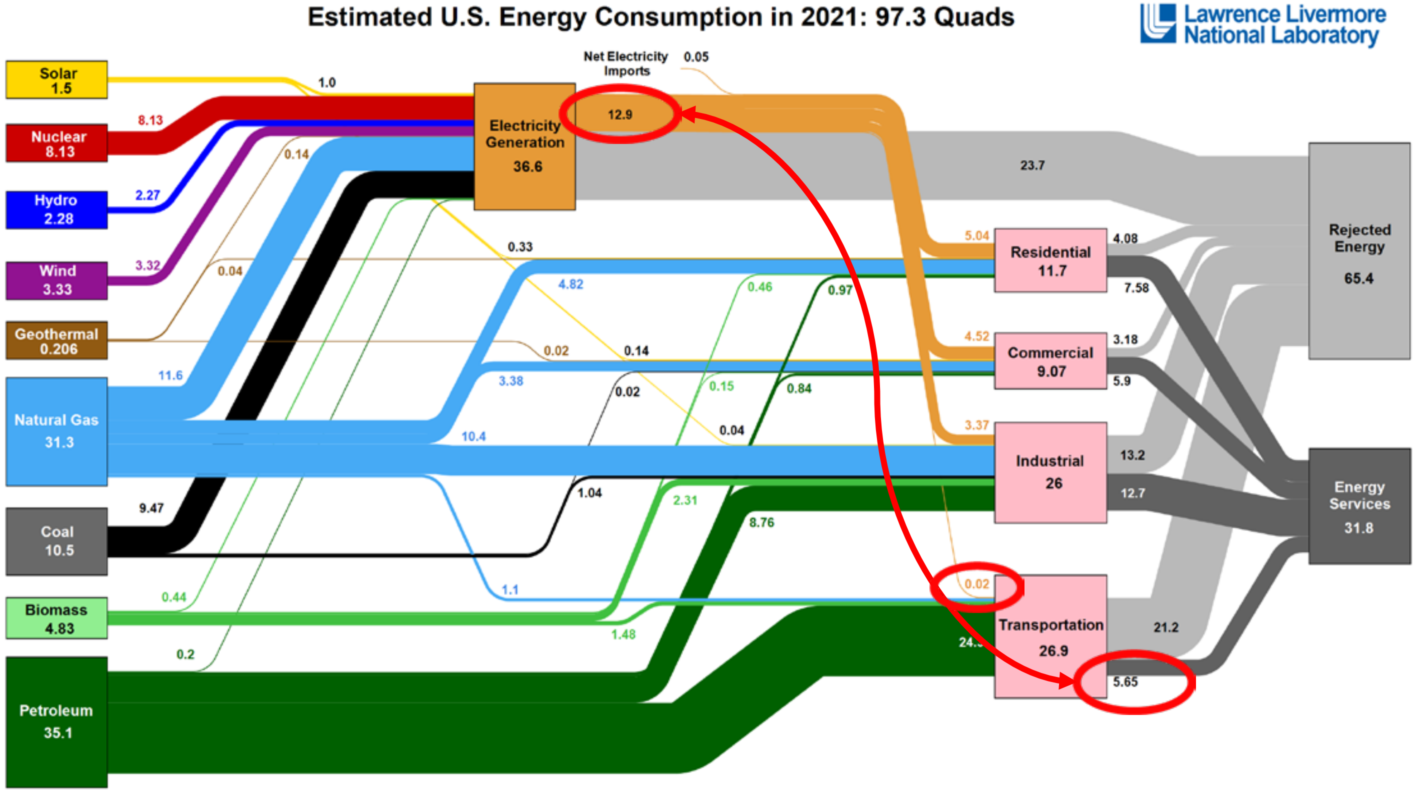
Electricity Generation and Transportation are two sectors that traditional have been very distinct and not connected



Source: LLNL March, 2022. Data is based on DOE/EIA MER (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

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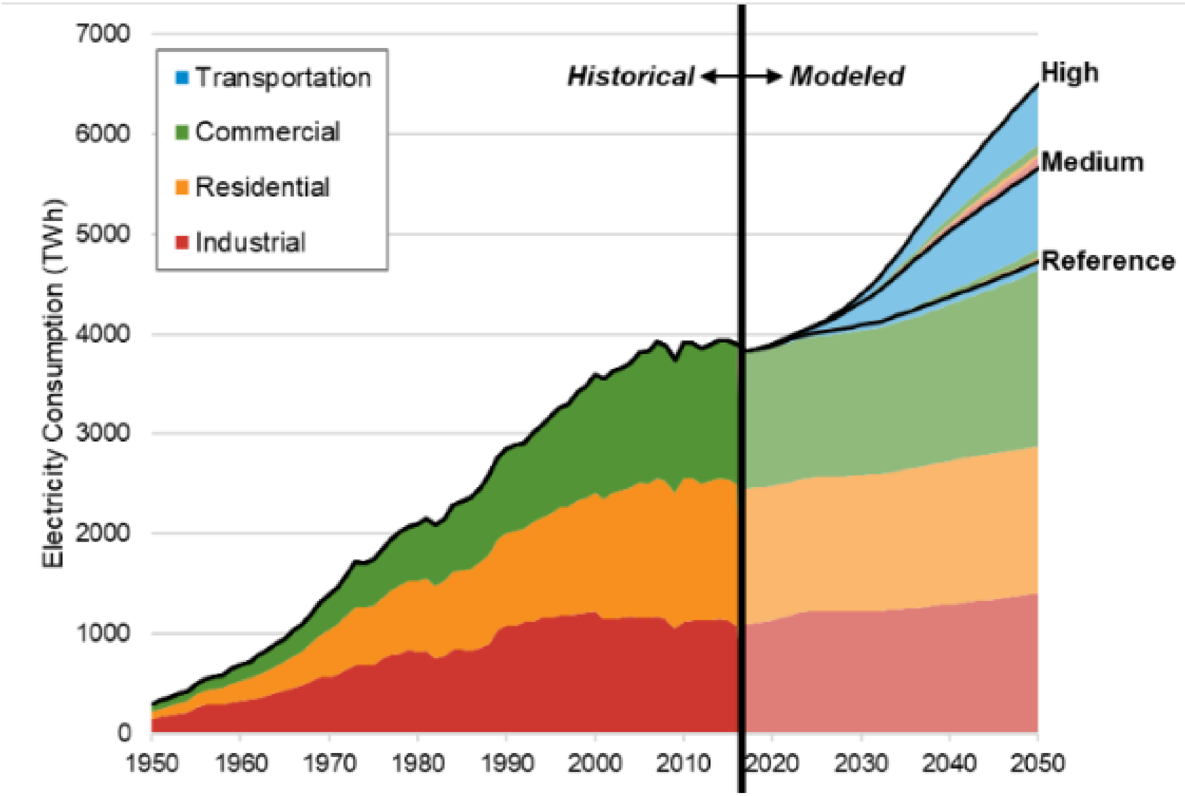
Impact of Transportation Electrification - Sector Coupling



Historical and Projected annual electricity consumption[3]

How will electricity generation and the transportation sectors work together?

What research can we do to ensure a safe, smooth, and seamless transition?

How could a grid-integrated charging network support intermittent generation?

[3] Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States. NREL/TP-6A20-71500

Smart Charge Management

Develop SCM and VGI strategies and tools suitable across transportation vocations

High Power Charging

Expand understanding of HPC characteristics and develop technologies to meet concentrated EV HPC demands and improve grid connectivity

Wireless Power Transfer

Develop and validate high-power dWPT from proof-of-concept to a practical roadway-integrated system

5 Pillars of EVs@Scale Lab Consortium (continued)

Cyber-Physical Security

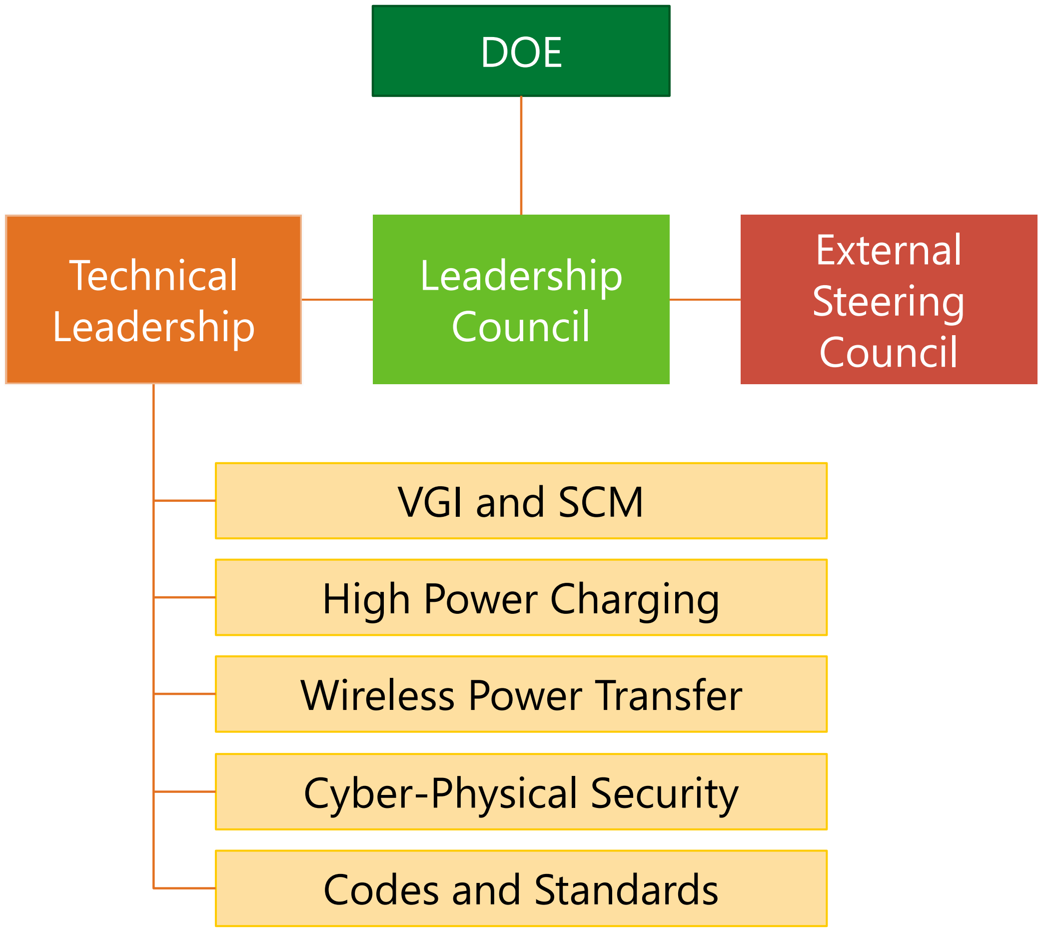
Identify and address challenges to high-power charging security, safety, infrastructure and grid operations reliability, and consumer confidence

Codes and Standards

Address standards challenges for high-power EV charging, grid impacts, interoperability, and safety

Consortium Structure

- Leadership Council
  - Andrew Meintz (NREL, chair), Dan Dobrzynski (ANL, rotating co-chair), Burak Ozpineci (ORNL), Summer Ferreira (SNL), Rick Pratt (PNNL), Tim Pennington (INL)
- External Steering Council
  - Utilities, EVSE & Vehicle OEMs, CNOs, SDOs, Gov't, Infrastructure
- Consortium Pillars and Technical Leadership
  - Vehicle Grid Integration and Smart Charge Management (VGI/SCM): Jesse Bennett (NREL), Jason Harper (ANL)
  - High Power Charging (HPC): John Kisacikoglu (NREL)
  - Wireless Power Transfer (WPT): Veda Galigekere (ORNL)
  - Cyber-Physical Security (CPS): Richard "Barney" Carlson (INL), Jay Johnson (SNL)
  - Codes and Standards (CS): Ted Bohn (ANL)



VGI and SCM: FUSE Approach

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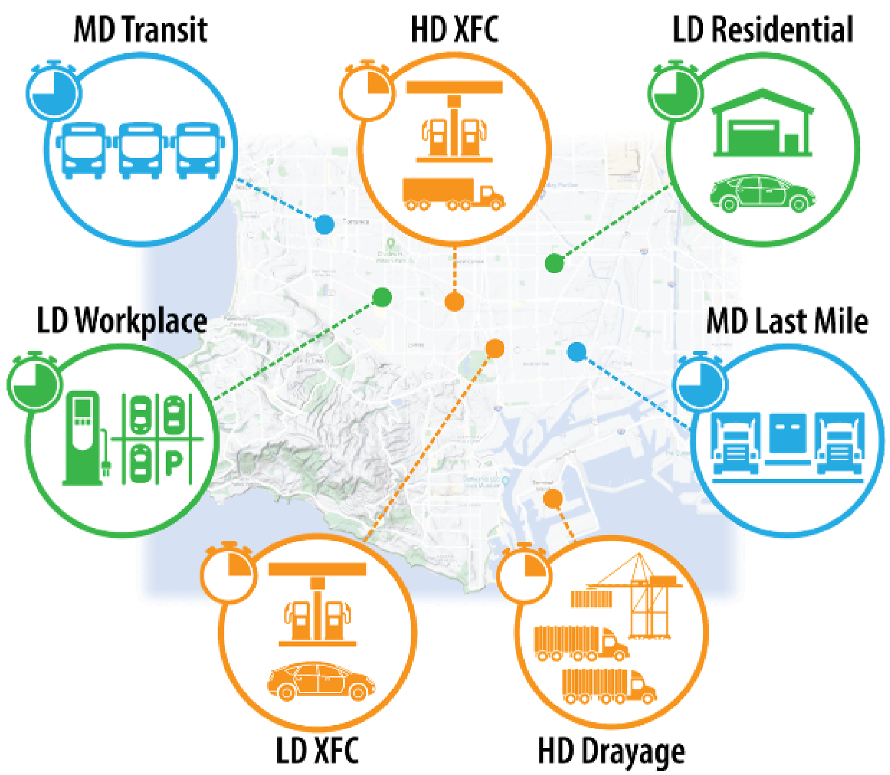
- **This project will analyze and demonstrate SCM and VGI approaches to reduce grid impacts from EVs@Scale as a result of the charging needs of the LD, MD, and HD on-road electrified fleet.**

- **SCM/VGI Analysis**
  - Assess the potential charging demand for EVs@Scale and determine the uncontrolled charging grid impacts.
  - Develop and analyze the effectiveness of various VGI and SCM strategies at mitigating the grid impacts of charging EVs@Scale

- **SCM/VGI Demonstration**
  - Expand on existing SCM/VGI strategies to adapt to the evolving needs EVs@Scale throughout a wide range of vehicles and vocations.
  - Develop enabling technologies to demonstrate the potential for new and existing SCM and VGI in a laboratory and real-world environment.
  - Coordinate with Codes and Standards Pillar to determine the potential of existing technologies and need for future developments.



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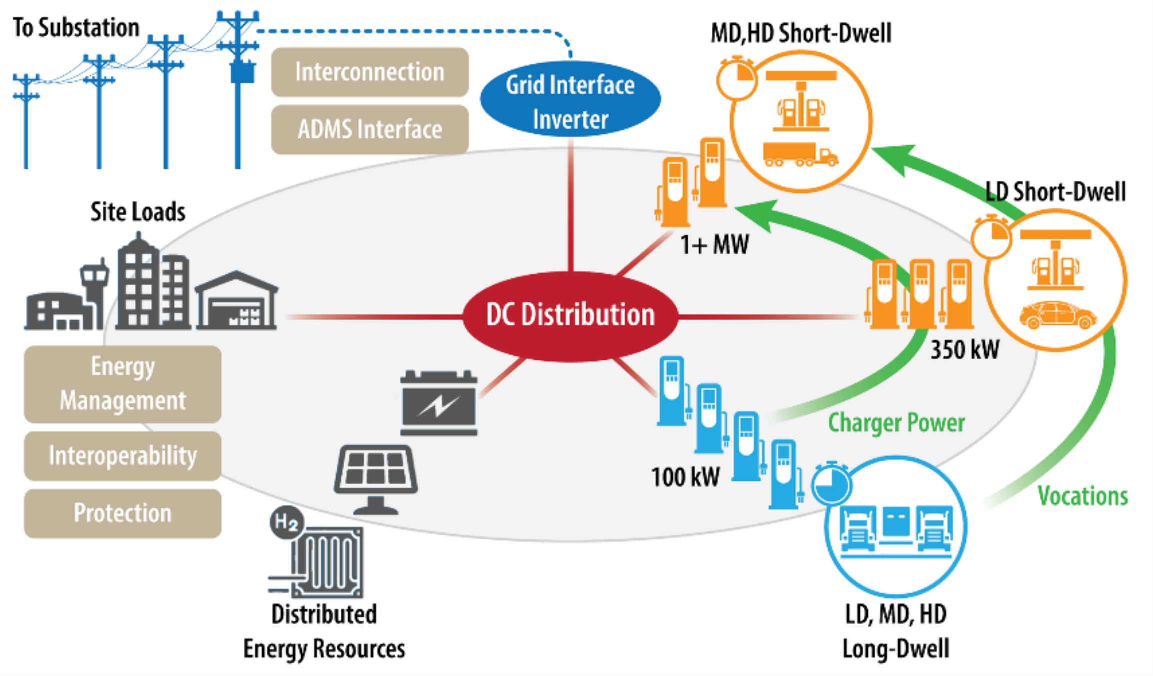
High Power Charging: eCHIP Project Overview

Objective: Develop plug-and-play solution allowing charging site to organically grow with additional chargers and distributed energy resources through predefined compatibility with standards that will ensure interoperability and reduce upfront engineering expense

Outcomes:

- Develop and demonstrate solutions for efficient, low-cost, and **high-power-density DC/DC** for kW- and MW-scale charging
- **Broadly identify limitations and gaps** in DC distribution and protection systems that allow for modular HPC systems
- Determine interoperable hardware, communication, and control architectures for high-power charging facilities that support **seamless grid integration and resilient operation**



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High Power Charging: NextGen Profiles Project Overview

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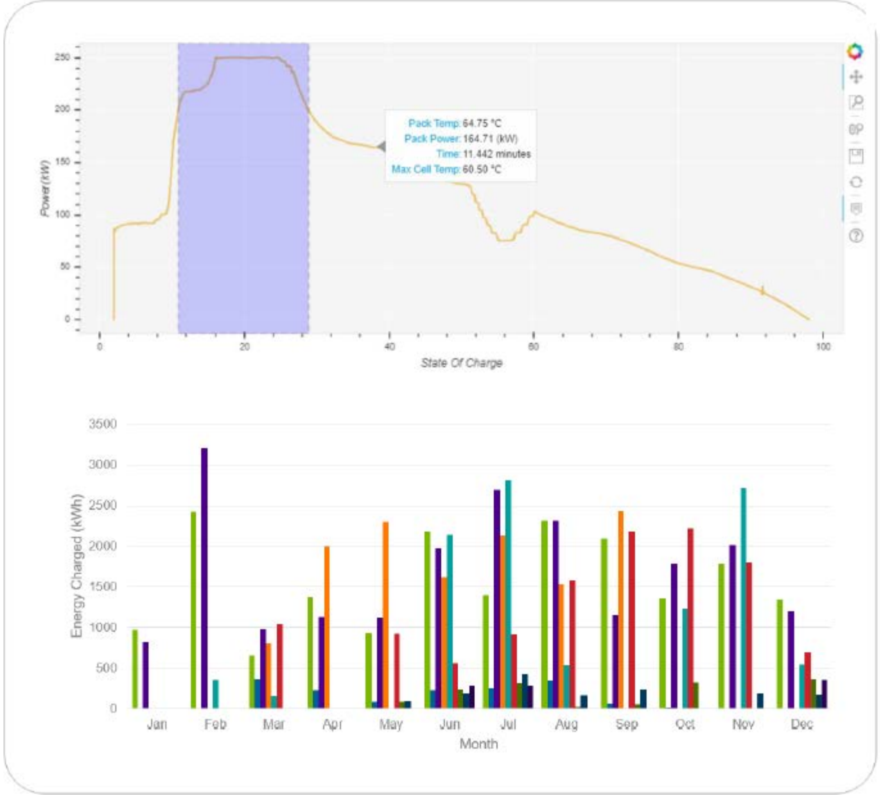
Objective: Assess a portfolio of EVs and EVSE that are expected to utilize High Power Charging (>200 kW) to understand charging rates, time, and grid impact. Provide DOE, stakeholders, and the public with insight into the capability of HPC to support en route charging and higher power depot charging for larger vehicles.

Outcomes:

- Assessments at **baseline and modified boundary conditions** (cold, warm, grid).
- System **responses to grid disturbances** & charging management.
- Assess conductive and wireless systems
- Perform **fleet utilization analysis**
- Collaborate with OEMs and industry
  - Procedure development
  - Testing assets



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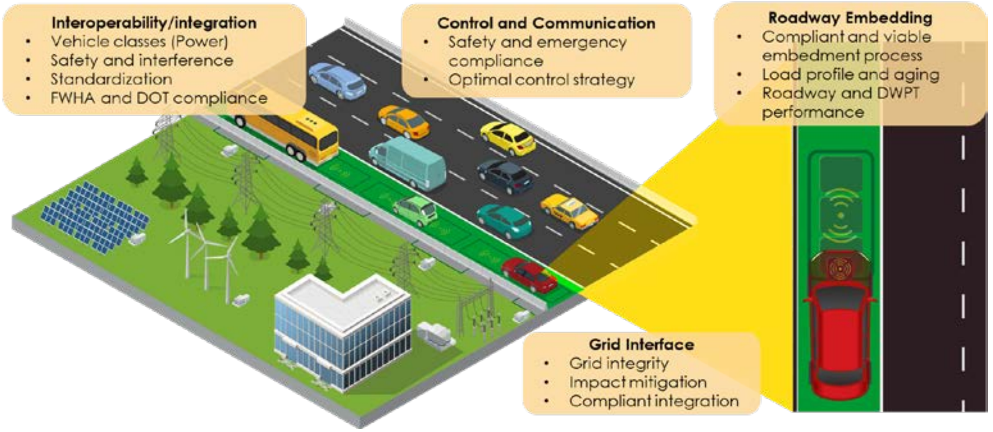
EVs@Scale VGI and SCM: Dynamic Wireless Power Transfer

Objective: Develop and validate technologies and solutions to transition high-power dynamic wireless (HPDW) charging of electric vehicles (EVs) from an early-stage proof-of-concept system to a practical roadway-integrated dynamic wireless power transfer (DWPT) system suitable for deployment at-scale.

Outcomes:

- Evaluation of comprehensive data from dynamic wireless charging system including
  - Real-world data from dynamic charging system installed at ACM
  - Safety and inter-operability
  - Life-cycle and accelerated aging impact on coupler and roadways using heavy-vehicle simulator
- Solutions to system- and component-level barriers for real-world deployment of HPDW systems.
- Validated HPDW coil architectures and embedding techniques suitable for different roadways, environmental conditions, use cases, and system life-cycle.



Collaboration:

- Virginia Tech. Transportation Institute, American Center for Mobility, TDOT, MDOT, VDOT, FWHA, OEMs (Stellantis and Hyundai), and Utilities (TVA, DTE).

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Cyber Physical Security: *CyberPUNC Approach*

Objective:

Contribute to the continuously evolving cyber-physical security methods and solutions needed to ensure EV charging infrastructure safety, reliability, & resiliency.

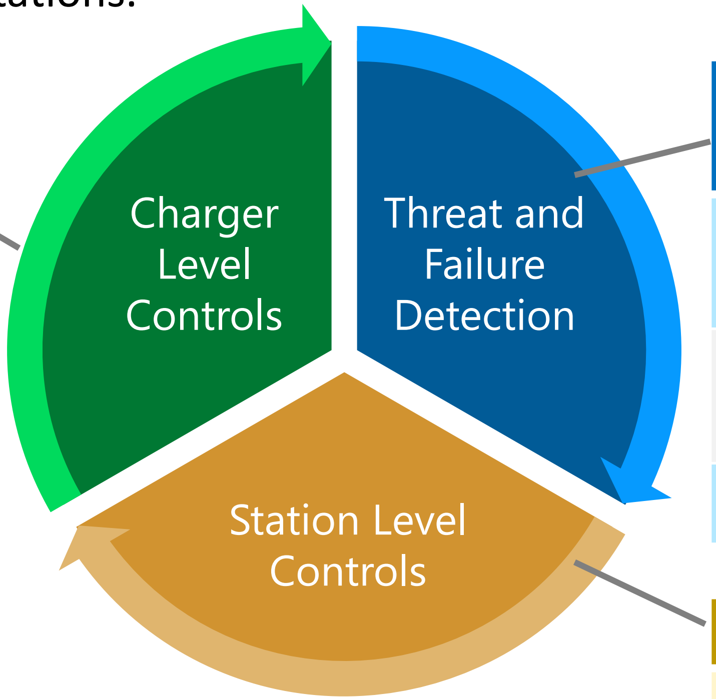
Four main project areas that focus upon challenges and barriers:

1. Implementation and utilization of the latest security methods
   a) Public Key Infrastructure: Implementation and Vulnerability Assessment
   b) Demonstrate Zero Trust Architecture for EV Charging Infrastructure
2. Identify vulnerabilities in new technology features and standards
   a) Supply Chain Security
   b) Wireless Power Transfer (WPT) Hardware-in-the-Loop Security Assessment
3. Methods to identify, protect, detect, respond, and recover from cyber-physical security events impacting EV charging infrastructure
   a) Safety Instrumented System (SIS) for High-Power DC Charging Infrastructure
   b) Cybersecurity Tools Application for EV Charging Infrastructure
4. Training for the EV charging infrastructure cybersecurity workforce
   a) *CyberAuto* Challenge
   b) *CyberStrike* Training for Network Defenders

Overall Approach:

Develop control and anomaly detection techniques to improve the resiliency of the electric grid and charging stations.

Charger Level Controls
Electric vehicle charger topologies and controls
Electrical vehicle charger fault identification
Electrical vehicle charger resilient operations



Threat and Failure Detection
Cyber security threats and attacks
Physical equipment threats and attacks
Communication failures

Station Level Controls
Electrical charging network
Supporting Energy Storage / Renewables
Islanding Options

Validation of technology development performed in both controller hardware in the loop and hardware platforms.

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Codes & Standards Overview

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Objective: Codes & standards support priorities focus on development of the most critical standards for EVs at Scale, i.e., high power DC charging, storage (microgrid, DERMS) integrated with DC charging, vehicle-grid integration, high power scalable/interoperable wireless charging and vehicle-oriented system standards and energy services to support transparent optimized costs/delivery.

Outcomes:

- Establish and complete draft of SAE J3271 Megawatt Charging System (MCS), AIR7357 TIRs
- Create work group to develop EV Standards Roadmap based on 2012 ANSI EVSP roadmap
- Develop and demonstrate a reference DC as a Service (IEEE P2030.13) implementation with off-the-shelf hardware and Open API Energy Services Interface (ESI) implementation
- Study and summary reports in support of identified high importance standards
- Active participation in SDO standards meetings/committees to close gaps in EVs@Scale standards

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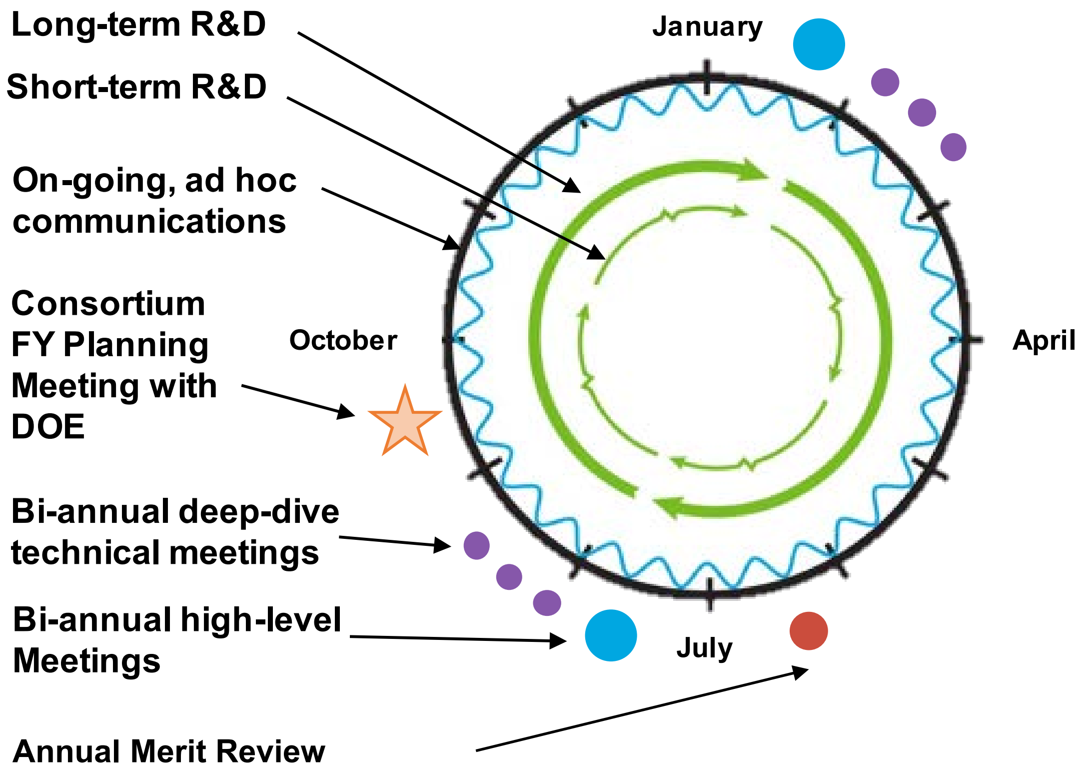
Collaboration and Coordination

- **External Steering Committee**
  - Utilities, EVSE & Vehicle OEMs, CNOs, SDOs, Gov't, Infrastructure
- **Direct interaction for each pillar projects**
  - Utilities, EVSE & Vehicle OEMs, CNOs, SDOs, Gov't, Infrastructure
  - Webinars / Project discussions
- **Bi-annual high-level meetings**
  - Rotation among labs with discussion on all pillars
- **Bi-annual deep-dive technical meetings**
  - VGI/SCM, HPC & WPT, and CPS with C&S incorporated into all meetings



EVs@Scale Lab Consortium Stakeholder Engagement and Outreach

BIANNUAL STAKEHOLDER MEETING

- Open Virtual Forum
- Common Understanding / Direction
- Long / Short Term Plans
- RFI and Stakeholder Feedback
- Visibility
- High Level Information Exchange
- Comprehensive Situational Awareness
- Long / Short Term R&D Results
- FOA Information

DEEP DIVE TECHNICAL MEETINGS

- Detailed Technical Discussions
- Stakeholder Feedback
- Active Pool of Project Stakeholders
- Support for RFI Process
- Project Plans and Progress
- R&D Agility
- Short Inception IABs
- Tech Transfer

DEDICATED ENGAGEMENT WEBSITE

- Continuous Stakeholder Engagement
- Formal and Informal Communications
- Enable Project Participation
- Meeting Logistics
- Ease of Information Exchange
- Project Updates and Review
- Record of Information

Importance of Stakeholder Engagement

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Our Bi-Annual Meetings and Deep-Dives are open to industry experts to help us better shape the R&D efforts for EVs@Scale.

We need your input to identify:

- Partners for our R&D efforts to help with insight, data, and other resources.
- Progress in our activities to ensure timely research is available to key stakeholders
- Priorities for R&D that accelerates the transition to EVs at Scale.

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Thank You

Andrew.Meintz@NREL.gov

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