Infrastructure Working Council (IWC) Meeting

Day One Presentations

Birmingham, AL

March 29, 2017

Government Policy Update

Electric Transportation

John Halliwell
Technical Executive

Infrastructure Working Council
March 29, 2017

Federal Activities

- The Auto Alliance[1] sent a letter to the head of EPA asking for reopening of midterm review of Corporate Average Fuel Economy (CAFE)standards for MY2022-2025 (February 2017)
- The Association of Global Automakers, Inc.[2] sent a letter to the head of EPA asking for reopening of midterm review of CAFE standards for MY2022-2025 (February 22, 2017)
- Alliance of Automobile Manufacturers filed suite in DC court[3] seeking to overturn EPA's Final Determination of CAFE (March 13, 2017)

1: Alliance members: BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, Volvo Car USA

2: Association members: Aston Martin, Ferrari, Honda, Hyundai, Isuzu, Kia, Maserati, McLaren, Nissan, Subaru, Suzuki, Toyota

3: United States Court of Appeals for the District of Columbia Circuit – case no. 17-1086, Document no. 16665924

Federal, continued

- State of California files motion in DC court[4] to intervene in Alliance of Automobile Manufacturers suite (March 14, 2017)
- President announced he will issue an executive order to EPA instructing it to reopen the midterm review of CAFE standards for 2025 (March 16, 2016)
- EPA exemption that allows California to enforce more stringent vehicle emissions standards: Rumblings that EPA may work to resend (press from 1st week of March)
- EPA Clean Power Plan – White House is expected to issue an executive order beginning the process of resending the EPA Clean Power Plan (press from 1st week of March)
- Administration released a proposed budget plan (March 2017)
  - Cuts EPA by $2.6B (~ 31%); includes elimination of the Energy Star program
  - Cuts DOE budget by $1.7B (~ 5.6%)

4: United States Court of Appeals for the District of Columbia Circuit – case no. 17-1086, Document no. 1666025

State Activities

- NY State instituting a $2000 electric vehicle rebate on April 1, 2017 – details yet to be revealed (February 2017)
- NY State governor announces Charge NY program; includes install of 450 charging stations (150 at workplace) ($4.8M) (March 2017)
- Utah legislature voted not to extend their $1500 rebate for EVs that expired at the end of 2016 (March 2017)
- Massachusetts legislature approved an additional $12M to support the state's EV rebate program (February 2017)
- Bill introduced in Colorado to end $5000 PEV rebate by Dec 31, 2017 (March 2017)
- The Bay Area Air Quality Management District in California offering $5M in grant funding (Charge! Program[5]) for public charging infrastructure in FY 2017 (March 2017)

5: http://www.baaqmd.gov/?sc_itemid=F026D4AC-FE69-4FBD-9232-187E17FC428D

State Activities, continued

- Bill introduced in California (AB1); related to raising of gas tax; includes $165 fee for zero emission vehicles (December 5, 2016)
- Massachusetts Board of Building Regulations and Standards voted to table new requirements for EV ready homes and parking lots (February, 2017)
- Illinois Commerce Commission announces 18 month study – "Utility of the Future" (March 21, 2017)
- Ohio Public Utilities Commission announces PowerForward Initiative – ~ 1 year study with public meetings; 2018 Vision Document (March 22, 2017)

State PEV Registration Fees as of March 7, 2017

States with EV Fees:		
State	**Fee**	**Notes**
Colorado	$50	PEV
Georgia	$300	Commercial PEV
Georgia	$200	Non-commercial PEV
Idaho	$150	PEV
Michigan	$100	EV
Michigan	$30	PHEV (> 4 kWh)
Missouri	$75	PEV
Nebraska	$75	PEV
North Carolina	$100	EV
Virginia	$64	EV
Washington	$100	PEV < 30 mile range
Washington	$150	PEV > 30 mile range
Wyoming	$50	PEV

Legislation being considered:		
State	**Fee**	**Notes**
California	$165	AB1 - in committee
Indiana	$150	
Kansas	$180	bill tabled
Kentucky	$100	
Maine		
Minnesota	$75-$85	
Montana	$300	
New Hampshire		
North Carolina	$150	
Oklahoma	$100	BEV; HB1449; passed house
Oklahoma	$30	PHEV; HB1449; passed house
South Carolina	$120	proposed fee is biennial
Tennessee	$150	
Texas		bill tabled
Wisconsin		

Together…Shaping the Future of Electricity

EPRI IWC Meeting

March 29, 2017

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Robert Graham
Vehicle Technologies Office Director
Office of Energy Efficiency and Renewable Energy

Vehicle Technologies Office - Scope

Batteries and Electric Drive

- Advanced batteries
- Advanced electric drive technologies
- Grid integration
- Infrastructure

Energy Efficient Mobility Systems (EEMS)

- SMART Mobility
- Connected and Autonomous Vehicles
- Modeling

Outreach & Deployment

- Deployment – Clean Cities, Fueleconomy.gov
- Alternative fuel infrastructure
- Local/regional support

Advanced Technologies for Efficient, Affordable, Competitive, and Clean Transportation

Materials Technology

- Carbon fiber composites
- Lightweight metals
- Joining
- Materials enabling higher efficiency propulsion systems

Fuels and Lubricants

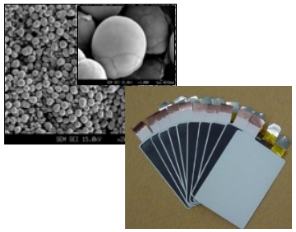
- Co-Optima
- Clean/efficient combustion fuel characteristics
- Advanced lubricants

Advanced Combustion Engines

- Combustion R&D (low temperature combustion, lean-burn, direct injection)
- Emission controls
- Heavy-duty (tractor trailer and truck) efficiency

VTO Battery R&D - Reducing Cost

Batteries and Electric Drive



Battery Materials Chemistry

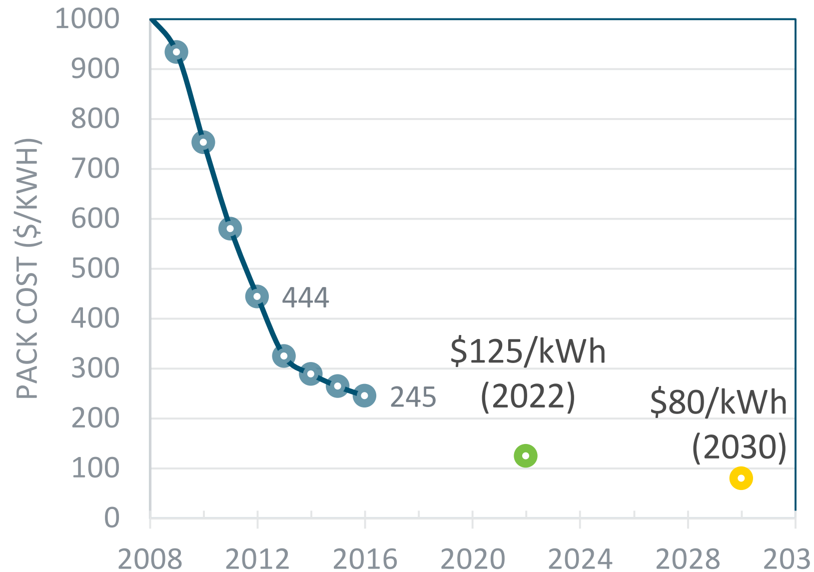
Manufacturing Processes

Cells

Production in US facilities

2016 Chevrolet Volt

VTO R&D has lowered the cost of batteries by **75%**



3x decrease

VTO Charging R&D – Reducing Time

	Level 1	Level 2	50kW DC Fast Charger	140kW Tesla Supercharger
Examples of Charging Stations				
Electrical Current Type	AC	AC	DC	DC
Range per Charge Time	2-5 miles/ 60 minutes	10-20 miles/ 60 minutes	50-70 miles/ 20 minutes	170 miles/ 30 minutes
Vehicle Charge Ports	J1772	J1772	J1772 combo CHAdeMo	Tesla combo

Extreme Fast Charging – up to 350kW

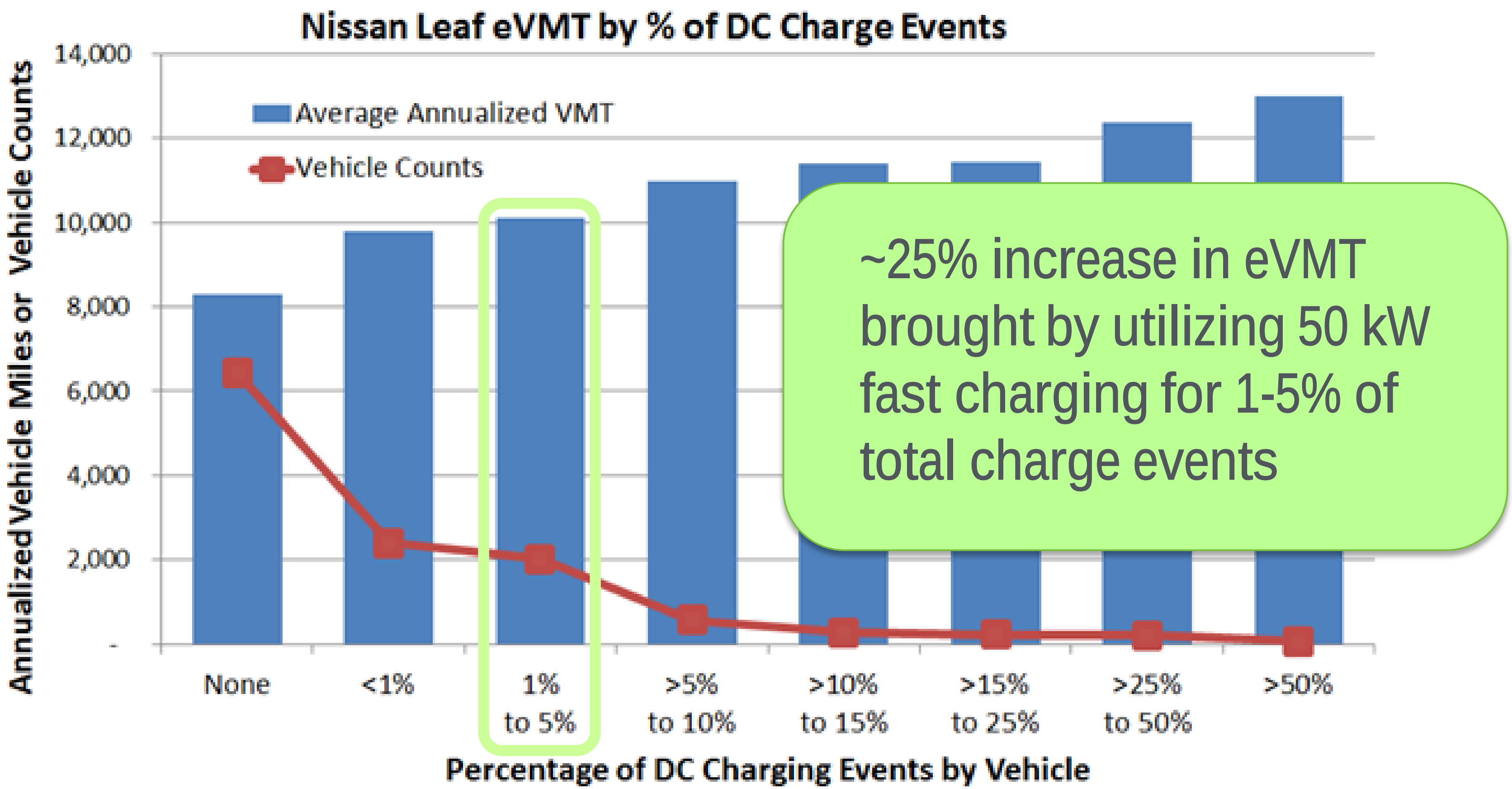
~15 mins to charge for 200 miles

Provides significantly faster charge rates than anything else on the market

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

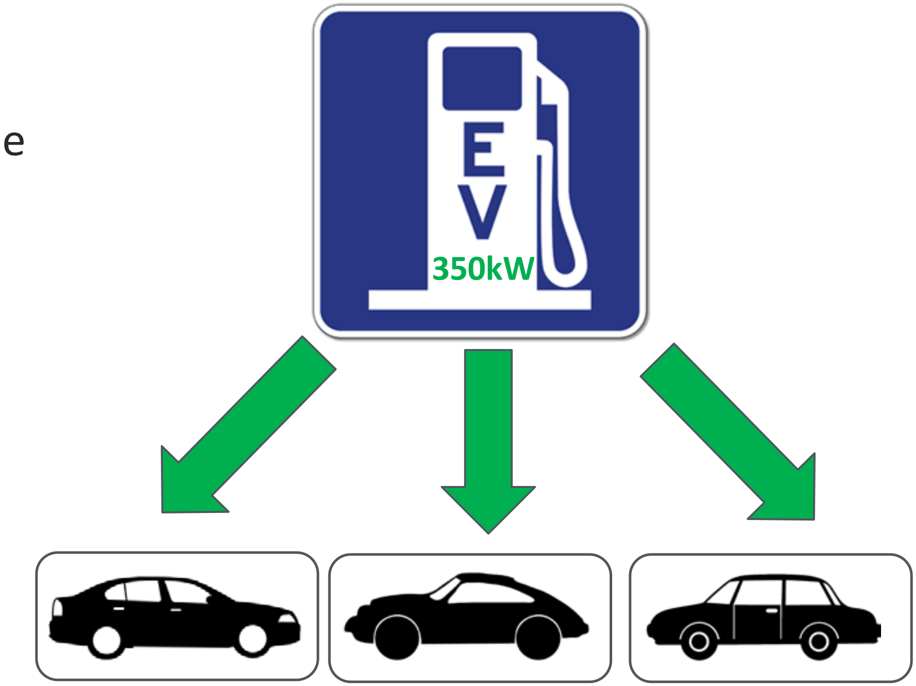
Why Fast Charging?

- Large increase in EV utility (VMT) is realized with DCFC (50 kW) charge events

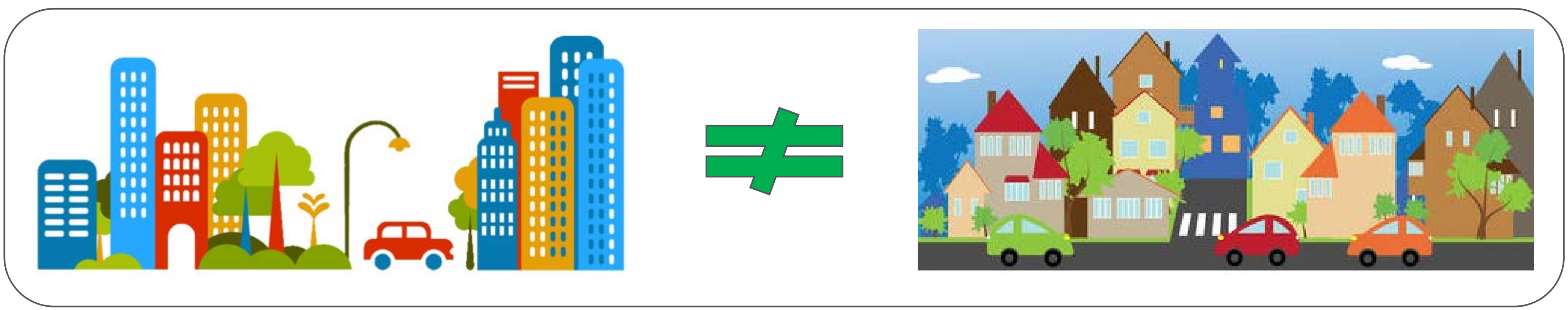


Source: McCarthy, Michael. "California ZEV Policy Update." SAE 2017 Government/Industry Meeting, Society of Automotive Engineers, 25 January 2017, Walter E. Washington Convention Center, Washington, DC. Conference Presentation.

Charging Station Design – Technology Assumptions and Questions



- Battery technology will allow EVs to be capable of 350 kW charging
- Charging stations are backwards compatible
- Urban and rural sites have different requirements/usage patterns
- **Does 50-150 kW charging require similar infrastructure?**
- Does a high power fast charger network require a profitable business model?



System Design Factors / Implications to Consider

- Charge time
- Location (**URBAN**/**RURAL**)
- Availability
- Charge price/value
- How will power requirements change over 5, 10, 15 years?

Customer Requirements

- Charger power level
- Number of chargers at a site
- Site footprint
- Grid capacity required for the site
- Environment design considerations
  - Cooling, corrosion, snow removal, etc.

Site Design Requirements Drive Costs

Cost Parameters

- System Design costs
- Installation costs
- Operating costs
- Maintenance costs

A Viable Business Model for DC Fast Charging Sites

- Financial analysis of public-private partnerships to identify sustainable charging stations business models

- Methodology
  - Use publicly available Excel-based model: *EV Charging Financial Analysis Tool*
  - Design urban and rural charging station complexes
  - Validate cost and use assumptions with industry and research experts
  - Test interventions by public sector that capture some public value of electric vehicles
  - Evaluate effects of private sector value capture on project financial performance
  - *Identify key factors affecting financial performance of DC fast charging sites*

Atlas Public Policy: Financial Performance of DC Fast Charging Complexes – Jan 2017

Charging Station Analysis Fundamentals

COSTS

- Capital
  - Full equipment, construction, & installation costs
- Operating
  - Electricity, site lease, maintenance, etc.
- Financing
  - Equity & debt

- Direct
  - Energy fee, per-use fee, subscription fee, advertising
- Indirect
  - Automaker or retail host revenue sharing, utility partnerships, public benefits

REVENUE

Atlas Public Policy: Financial Performance of DC Fast Charging Complexes – Jan. 2017

Thank You

chargepoint

Ultra-fast DC Fast Charging Design Architecture

Mike Waters, Director of Utility Solutions

EPRI IWC

March 29, 2017

Where DC Fast Needs to Be

+ A modular system that grows with demand and scales without stranded investment
+ Supports today's battery technologies *and* tomorrows charging requirements
+ Accommodates intelligent power sharing that:
  - Leverages the utility connection by intelligently managing power distribution among cars
  - Charges more cars, faster by monitoring car charging rates, battery level, and available power at the site
+ Power conversion efficiency to maximize ROI for operators & minimize wasted energy
+ Designed for driver engagement and ease of use
+ Equipped with sophisticated network monitoring, diagnostics, machine learning to:
  - Maximize uptime so stations are always available for drivers that depend on them
  - Allow for proactive problem resolution to reduce operating costs and recurring expenses

What's Express Plus?

A scalable ***platform*** targeted at ultra fast DC charging

Future proof: designed for today's and tomorrows cars	Displays and design deliver exceptional driver experience	Modular system scales without stranded investment	Dynamic power management charges more cars, faster	Lightweight liquid cooled cables are easy for drivers to maneuver	Efficient power conversion reduces costs & wasted energy

Overview of subsystems

Express Plus Station

-chargepoin+

+ Power Capabilities
  - Supports 0 to 2 power modules to deliver up to **62.5 kW** independently
  - Capable of 400 A max @ 1000 V max (400 kW output)
+ Aesthetically pleasing, functional design
  - Dual Displays (10” LCD w/touch for interaction, 20” LED display for status/notification)
  - Light weight, flexible, liquid-cooled cables with integrated cable management
  - 1 to 3 Connectors from the following types: CCS Type1, CCS Type2, CHAdeMO, GB, and others on an as needed basis
+ Technology
  - ChargePoint Network and Mobile Application integration
  - Quad Core Processor
  - 2 Cameras (License plate detection, occupancy detection, vehicle identification etc.)

Power Module: Basic Building Block

+ 31.25 kW maximum output per module
+ 78 A maximum current
+ Supports 200 V - 1000 V vehicle battery architectures
+ No tools required for replacement!

Expand Station Power with Power Cube

- Centralized power conversion for 1 to 8 stations
- Houses 1 to 16 power modules for up to 500kW of DC power (max 1000V, max 1250 A)
- Can start partially populated with power modules, and scale with power and/or redundancy when needed
- 1.75 m x 1.75 m x 1.75 m outer dimension
- Aesthetically designed to not require concealment
- Modules can be added easily for expansion or replacement

Power Management

Power Management Features

- **Dynamic Power Management**: Allows a fixed maximum power output per station or lets the system dynamically manage the power distribution per station. Power is intelligently allocated among vehicles based on each battery's state of charge (SoC) and instantaneous maximum charge rate.
- **Power Module Energy Balancing**: Balances the number of hours of operation of each module and optimizes power module usage
- **Remote Energy Management**: Supported through the ChargePoint Network API services

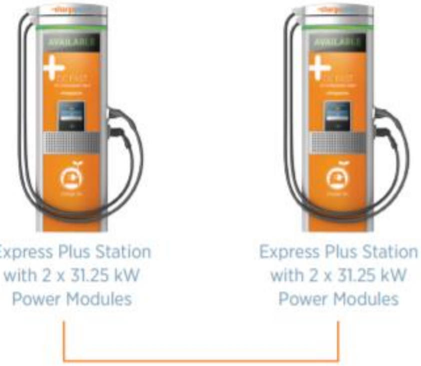
Advantages:

- Optimizes infrastructure costs
- Enables statistical multiplexing of the available power from the utility drop
- Minimizes charging time for drivers
- Offers different configurations that can be optimized for specific site and use cases

Express and Express Plus Configurations

Two Port Configuration

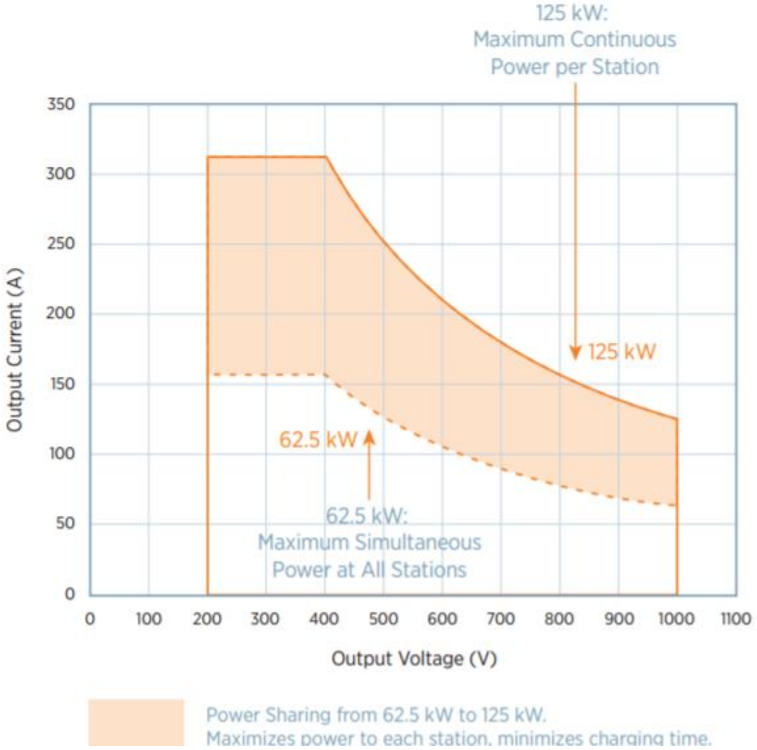
2 Express Plus Stations



Express Plus Station with 2 x 31.25 kW Power Modules

Express Plus Station with 2 x 31.25 kW Power Modules

Shared 125 kW
Up to **125 kW** max continuous power per station and **62.5 kW** max simultaneous power on two stations



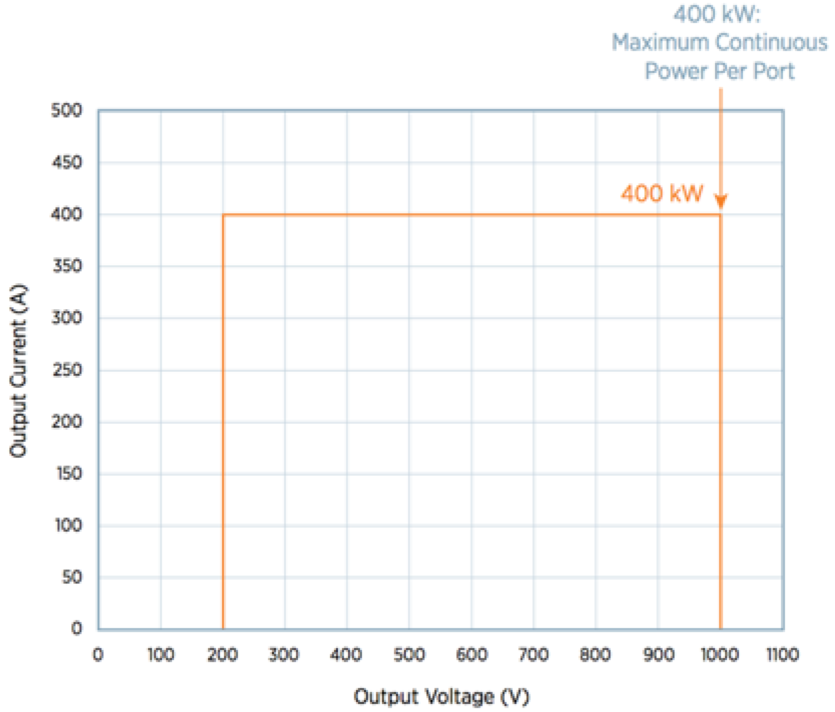
Singe Port Configuration

1 Power Cube + 1 Express Plus Station

Express Plus Station
without Power Modules

Power Cube
with 13 x 31.25 kW Power Modules

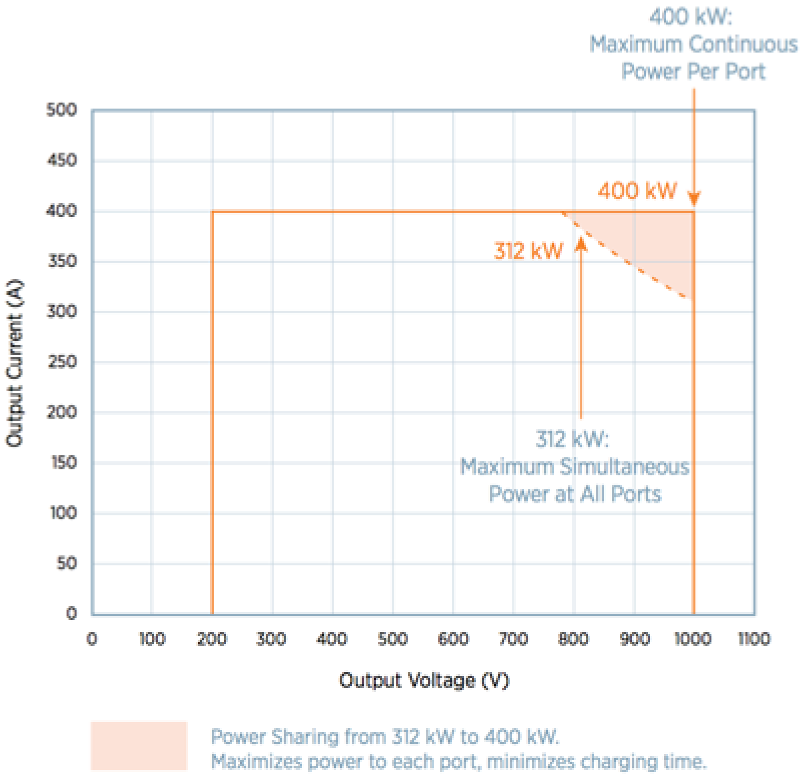
400 kW
Up to **400 kW** max continuous power per station



Two Port Configuration

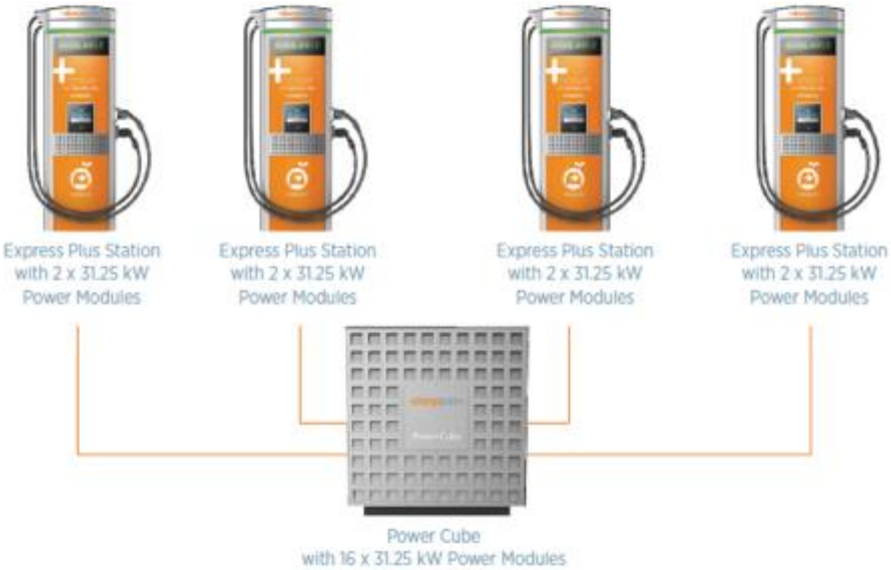
1 Power Cube + 2 Express Plus Stations

Shared 625 kW
Up to **400 kW** max continuous power per station
and **312 kW** max simultaneous power on two stations

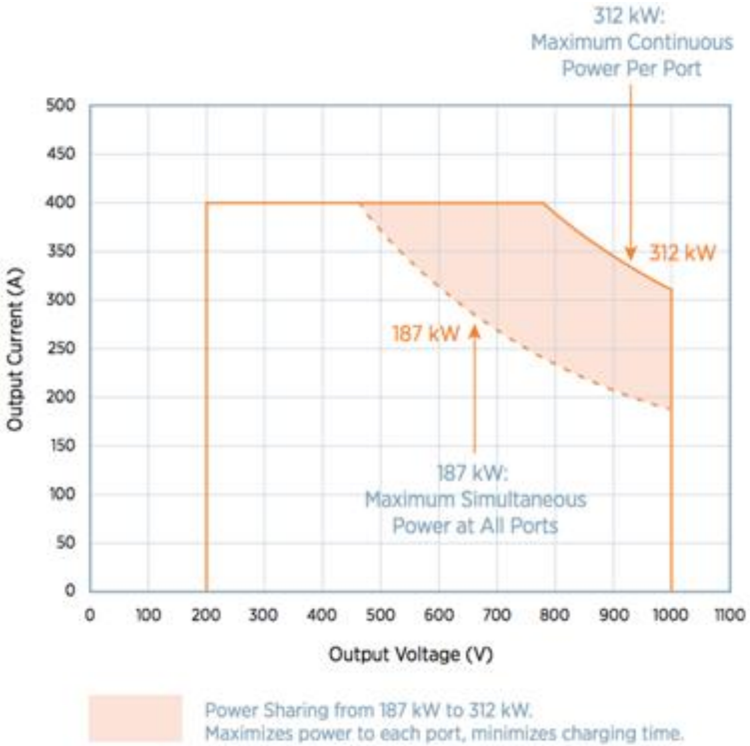


Four Port Configuration

1 Power Cube + 4 Express Plus Stations

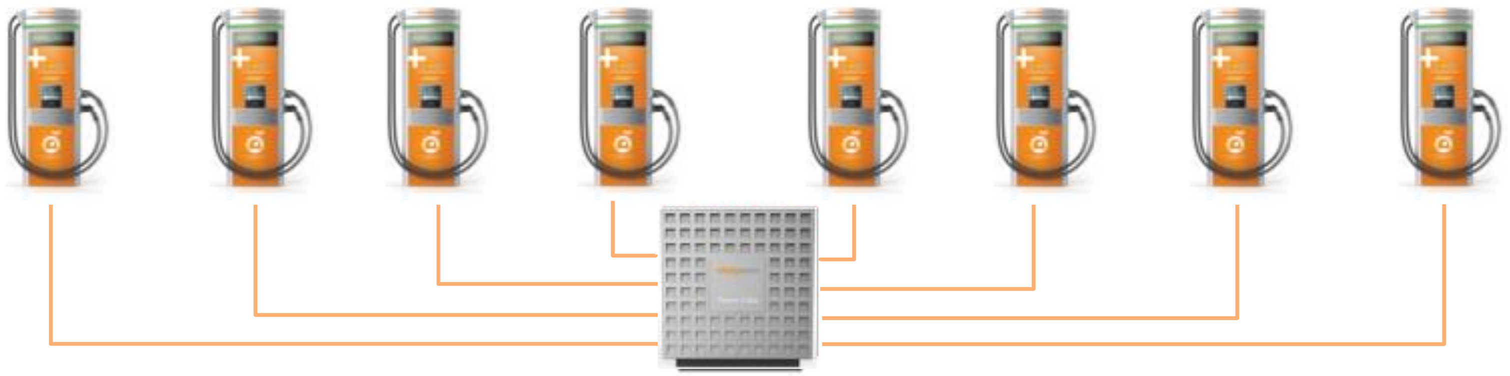


Shared 750 kW
Up to **312 kW** max continuous power per station and
187 kW max simultaneous power on all four stations



Eight Port Configuration (in planning)

1 Power Cube + 8 Express Plus Stations



Shared 1,000 kW

Up to **187 kW** continuous per port and
125 kW max simultaneous on 8 ports

Thank You

Mike Waters
mike.waters@chargepoint.com

SAE INTERNATIONAL

WIRELESS POWER TRANSFER TECHNOLOGY, ALIGNMENT & TEST STANDARDIZATION

SAE J2954

EPRI MEETING

MARCH 29TH, 2017

JESSE SCHNEIDER
TASKFORCE CHAIR SAE J2954
WIRELESS POWER TRANSFER

SAE INTERNATIONAL

WIRELESS POWER TRANSFER FOR LIGHT-DUTY PLUG-IN/ ELECTRIC VEHICLES AND ALIGNMENT METHODOLOGY, SAE J2954

Background:

SAE J2954 is performance-based using a „Testing Station“ where vehicle OEMs and infrastructure companies can either use the J2954 coil specifications or prove performance compatability through testing.

In addition, location of the coil in the parking spot as well as a specification for vehicle alignment and automated charging will be provided in SAE J2954.

SAE INTERNATIONAL

SAE J2954 WPT CALIFORNIA TECHNOLOGY FORUM

Outline:

SAE J2954 Structure Update

Overview Standards

Timeline & Interim Test Results

Testing with Industry & US DOE

Alignment

Conclusion

SAE J2954 Taskforce Structure: OEM/ Supplier Co-Leads

INTERNATIONAL

J2954 OEM Advisory Team

J2954 Taskforce Chair
Jesse Schneider

Team update:

Alignment Methods
Co-Chairs:
D. Burkett– Ford
K. Sealy – Witricity

Testing
Co-Chairs:
M. Abdul-Hak – Daimler
A. Namou– GM
Jon Sirota – Witricity

Magnetic Field Interoperability
Co-Chairs:
I. Teerlinck – Toyota
G. Covic – University of Auckland

UL 2750 / SAE J2954 Joint Team**
Co-Chairs:
J. Bablo – UL
E. Taha – Nissan

HD Charging SAE J2954/2
Co-Chairs:
N. Vågstedt – SCANIA
M. Masquelier – WAVE

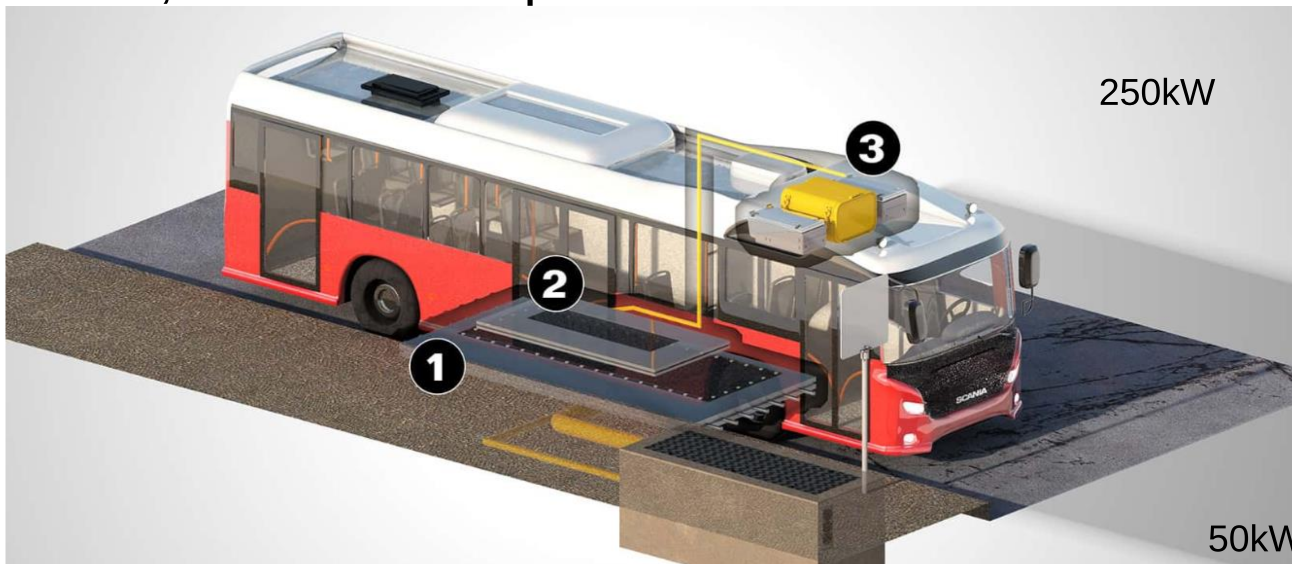
EMC /EMF
Co-Chairs:
R. Kautz – Ford
R. Sutton – TDK
R. Boyer – Delphi

SAE J2954 Main Team:
Wireless Power Transfer Vehicles and Alignment Methodology

SAE J2954/2 Scope: Heavy Duty Vehicle Wireless Charging WPT 5-WPT 6 (23-250kW+) Kickoff 2/2017

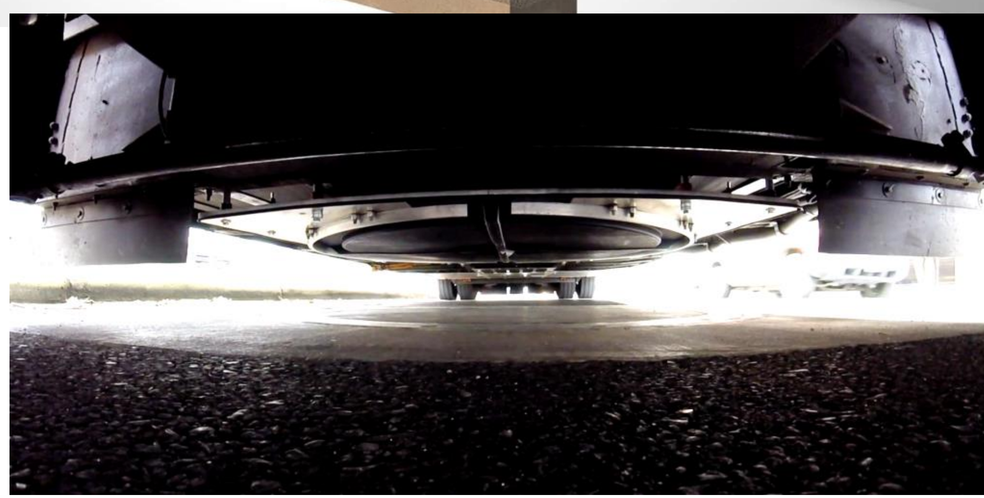
Applications in Testing in Korea, California and Europe

250kW



120 kW

50kW

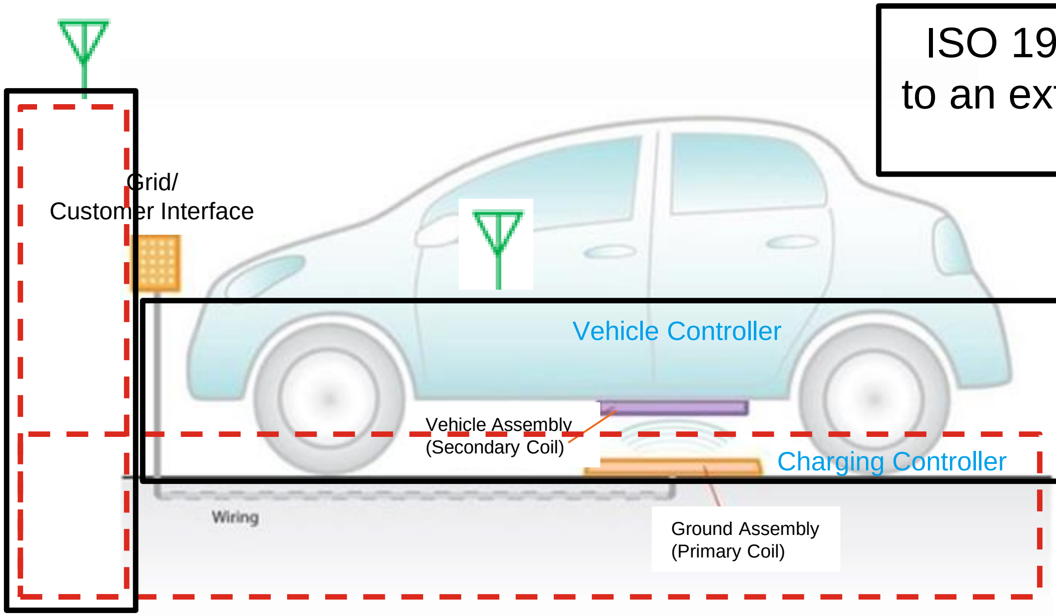


Vehicle-Infrastructure Wireless Charging Standards SAE, UL, ISO, IEC

Communication

SAE J2836/6: Use Cases and Communications
SAE J2847/6: WPT Communication PHEV and the Utility Grid
SAE J2931/6: Digital Communication for WPT for PHEV
ISO 15118-2, Ed. 2: V2G Use Cases and Communications

Vehicle Assembly



ISO 19363: Wireless connection to an external electric power supply *(Vehicle Side Only)*

PSDO Agreement

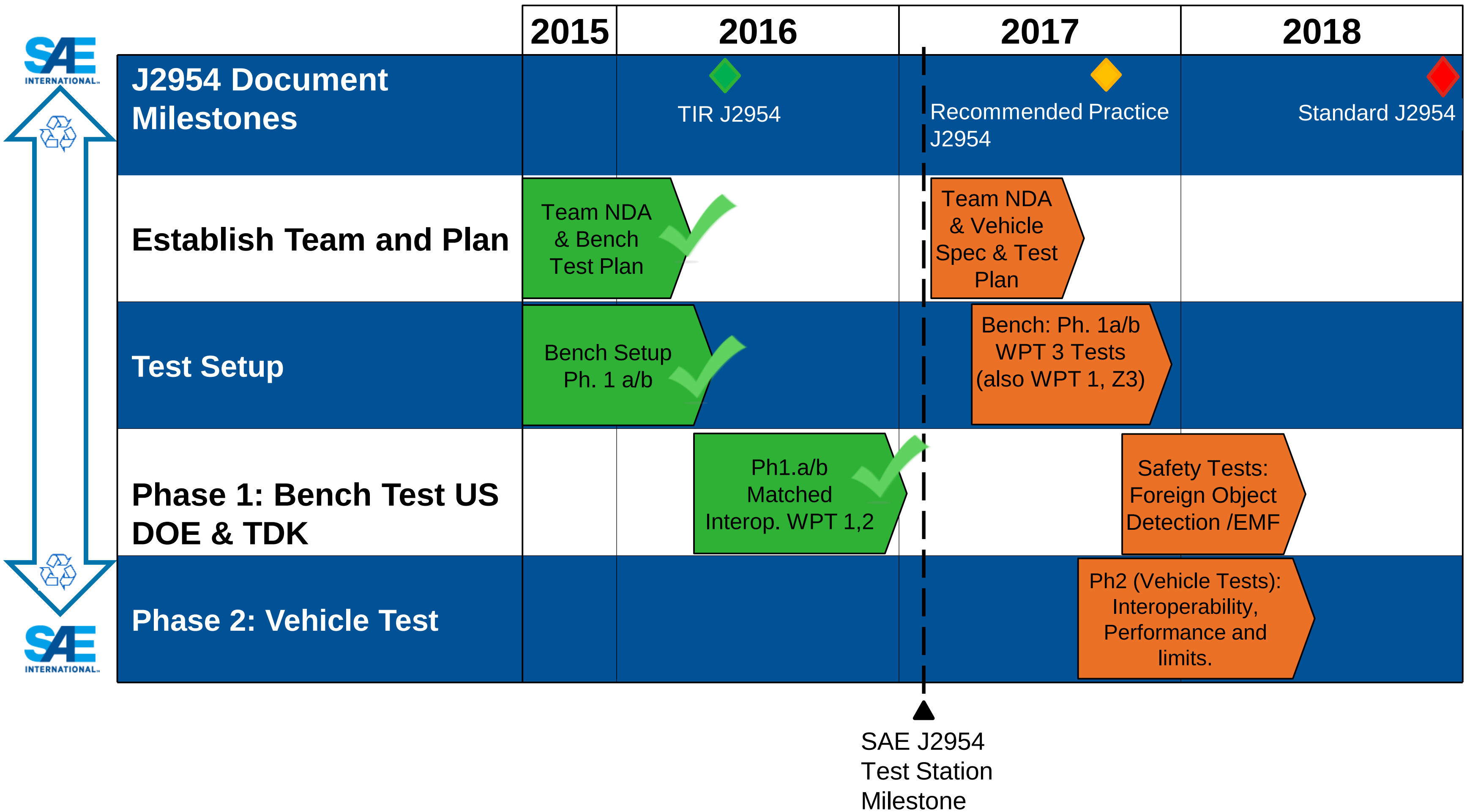
Ground Assembly

UL 2750:(Draft) Verification WPT GA Safety &
IEC 61980-3 WPT for GA
(Infrastructure Only)

MOU

SAE J2954: Wireless Power Transfer and Alignment
(BOTH Vehicle and Infrastructure)

SAE J2954 Light Duty Milestone Project Time Line – Status & Testing Planning with US DOE & Industry



J2954 Testing Scope:
Bench and Vehicle Testing

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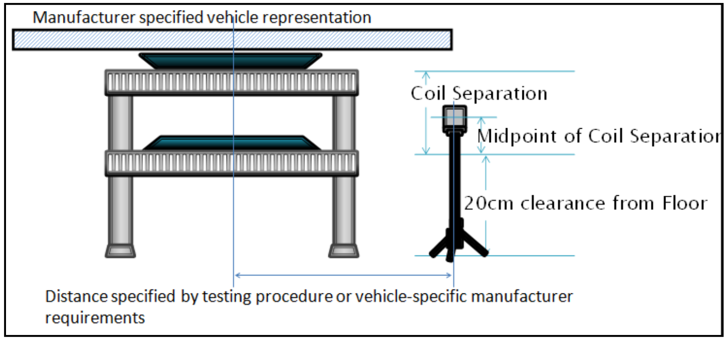
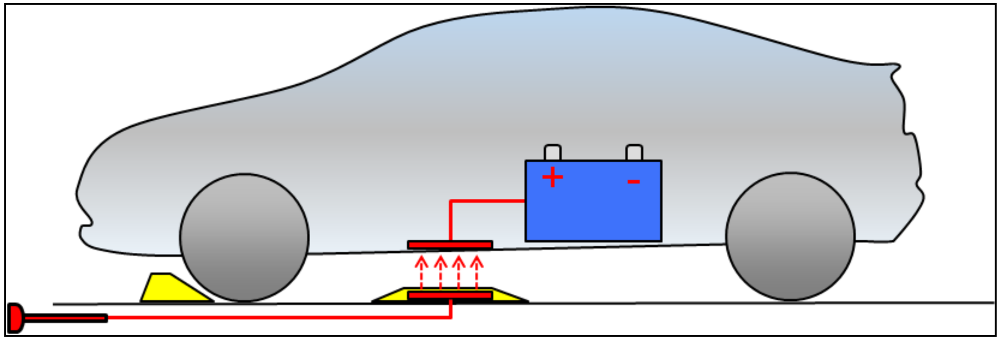
SAE J2954 Ratings Test

Verification Testing

Test for Matching Coils		Test for Mismatched Coils	
Design Validation Test – Bench Level	Design Validation Test – Vehicle Level	Design Validation Test - Bench Level	Design Validation Test – Vehicle Level





Component Bench Testing

Vehicle Testing

Testing Summary at Idaho National Lab and TDK in 2016
Test report in 2017

Key Results Overview INL (through US DOE)

Across all coil misalignments, coil gaps, power levels, and output voltages

• Nearly all interoperable WPT combination achieved full power transfer to WPT 1 (3.7kW), WPT 2 (7.7kW) with different Topologies (Circular & D-D):

• Matched WPT:

– System efficiency ranged from 80.3% (Misaligned) to 93.2% (Aligned)

• Interoperable WPT (including different topologies, different power levels WPT 1-2):

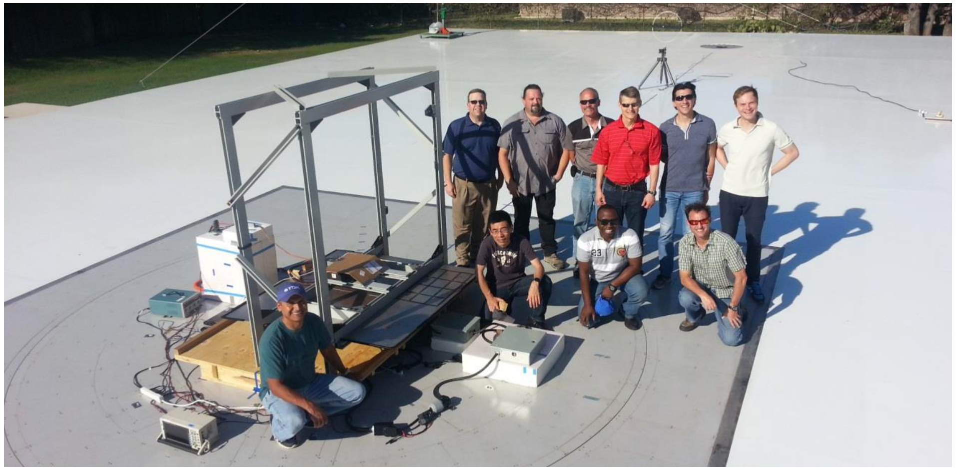
– System efficiency ranged from 79.9% (Misaligned) to 92.4% (Aligned)

Key Results from TDK Testing

EMF Test Bench Measurements (directional)

WPT 1 – 2.88uT peak

WPT 2 – 4.63uT & 21.49uT peaks



Communications Methodologies vs. Distance Overview

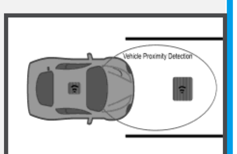
SERVICES GPS+ DSRC + SAE Standards

Integrated Vehicle Navigation

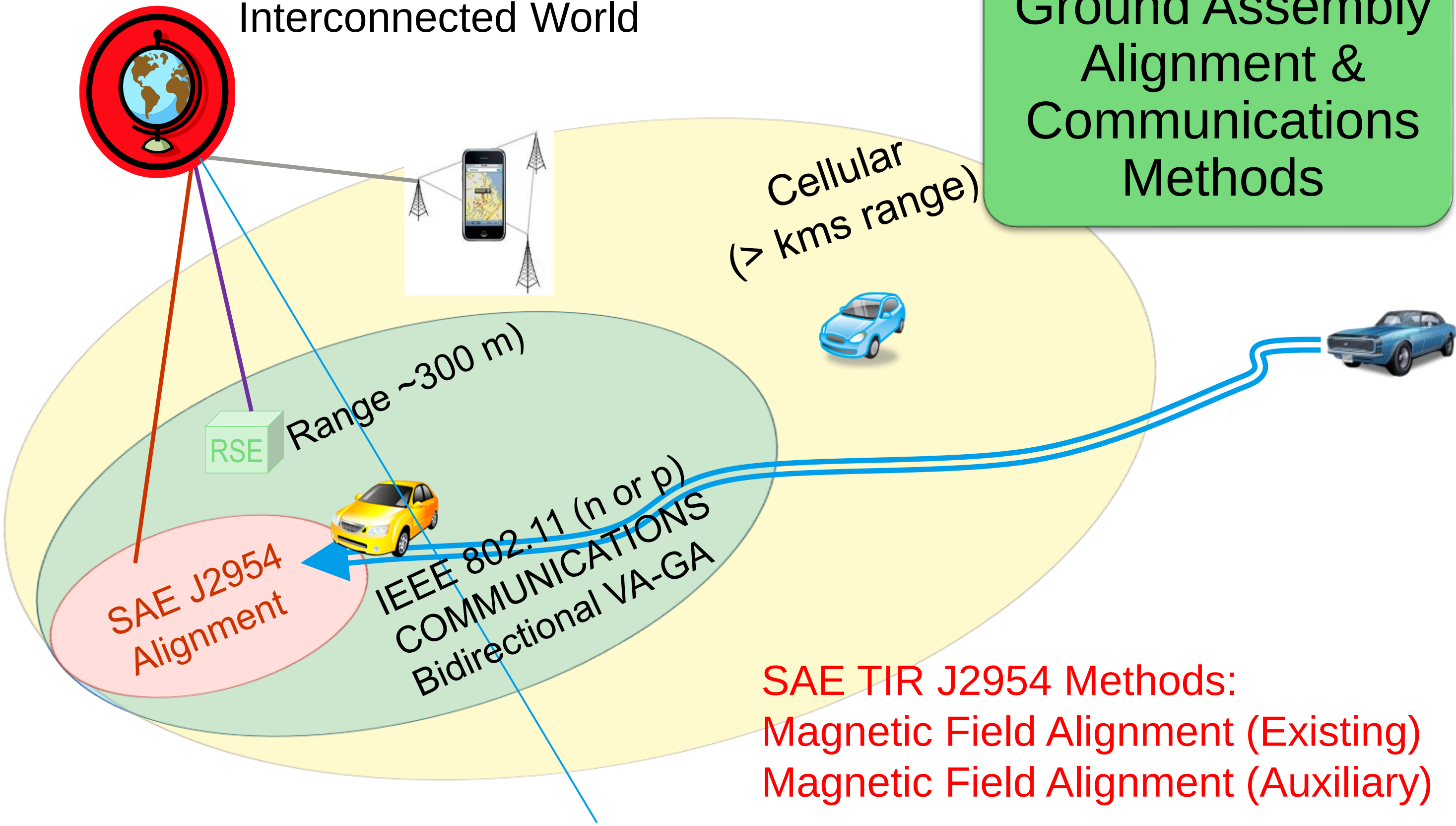
Locations of Electric Charging Stations

Charging & ePayment Solutions

SAE J2954 Vehicle to Ground Assembly Alignment



Vehicle to Ground Assembly Alignment & Communications Methods

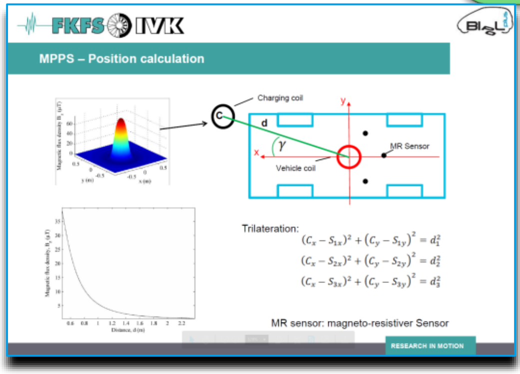


SAE TIR J2954 Methods:
Magnetic Field Alignment (Existing)
Magnetic Field Alignment (Auxiliary)

SAE Interconnected communication layers will enable the private sector & public interests to co-exist

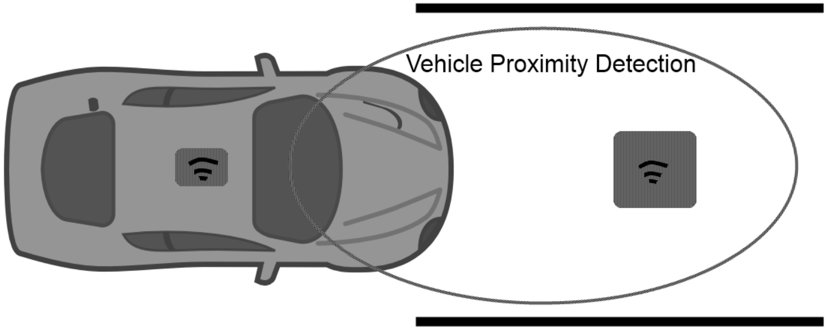
SAE TIR J2954 Vehicle Alignment Methods
To be decided in 2017 between the following two methods

Vehicle to EVSE Alignment Methods



- **Magnetic Field Alignment (Existing Coils)**

A small magnetic field is generated by the GA power transfer coil. The magnetic field is detected by the VA power transfer coil.. Range <2m



- **Magnetic Field Alignment (Auxiliary)**

A signal is transmitted from the VA using auxiliary coils. The GA receives signal and relays positional information back to the vehicle via the communications interface (e.g., 802.11). System range >5m.

SAE J2954 Status Standardization:

- **TIR J2954 (Technical Information Report) Published 2016**
  - Specification for Vehicle and Ground Infrastructure WPT and alignment
  - WPT 1 & WPT 2 Specifications in 2016
  - Downloadable under: http://standards.sae.org/j2954_201605/
  - US DOE & Idaho National Lab component and later vehicle bench testing ending in December, 2016

- **SAE J2954 Recommended Practice Phase: 2017**
  - Establish Circular Topology Test Stand up to 7.7kW (WPT2).
  - Specifications included up to 11kW (WPT3)
  - Testing WPT 3 on Test Bench/ Vehicle Testing WPT 1-3

- **Standard Phase: SAE J2954 in 2018**

- **H.D. Charging TIR J2954-2 Kick-off February, 2017, timeline to 2019.**

- **Commercialization of Wireless Power Transfer for EVs in 2020!**

SAE INTERNATIONAL

The SAE J2954 Main Wireless Power Team at F2F Meeting in Ingolstadt, Germany at Audi

J2954 Press Releases: 2016-2017

- http://www.prweb.com/releases/2017/01/prweb14005112.htm
- http://www.sae.org/servlets/pressRoom?OBJECT_TYPE=PressReleases&PAGE=showRelease&RELEASE_ID=3415

THANK YOU

QUESTIONS?:

J2954 WPT TASKFORCE

JESSE.SCHNEIDER@WEB.DE

SAE TIR J2954 Published in 2016

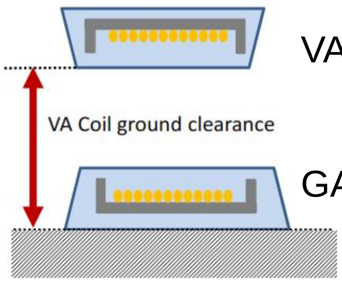
- The first phase of standardization, the guideline SAE TIR J2954, "*Wireless Power Transfer for Light-Duty Plug-In/ Electric Vehicles and Alignment Methodology*" has been approved for publication.
  - Download under:
    http://standards.sae.org/j2954_201605/

- This document is the first of its kind (6 years in the making) to specify both the vehicle and ground (infrastructure) assemblies and provide guidance for safety, interoperability, EMF/EMC, alignment as well as testing for Wireless Power Transfer of EV/PHEV

SAE J2954 TIR WPT Classes

Interoperability:

Mounting and Height Classes

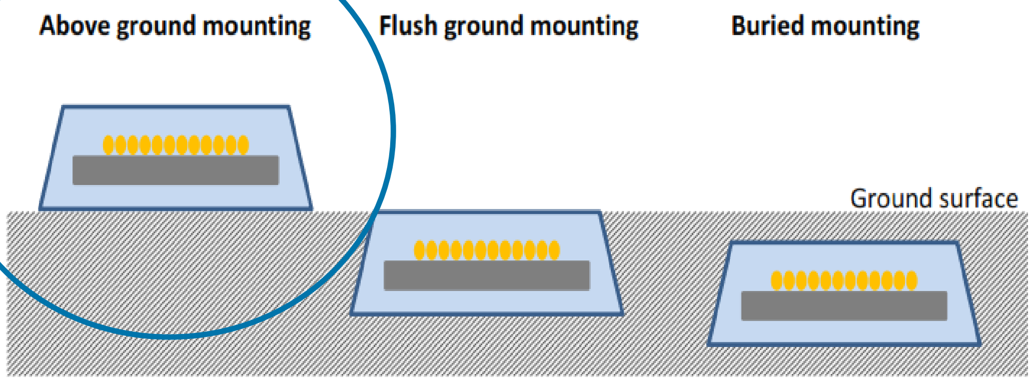


Specification of the Z-classes for Above Ground Mounting

Z-Class	Vehicle Assembly (VA) Coil ground clearance range (mm)
Z1	100 – 150
Z2	140 – 210
Z3	170– 250

Mounting Categories

Defined in SAE TIR J2954



To be defined in SAE J2954 Standard

NISSAN GROUP
OF NORTH AMERICA

Infrastructure Overview

EPRI IWC Meeting
March 29, 2017

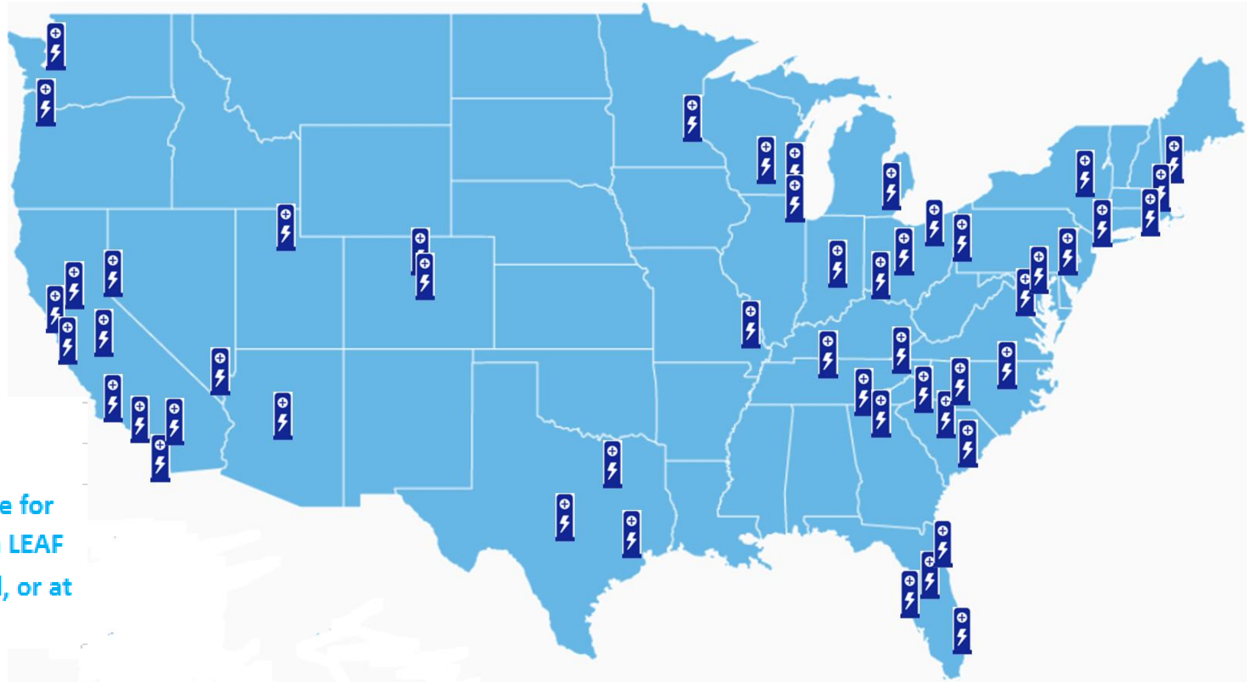
JeSean Hopkins
Nissan North America, Inc.

Leadership in Metro Fast Charging

Success in building metro area networks to complement home and workplace charging and create driver confidence

No Charge to Charge is available in:

- Albany
- Atlanta
- Austin
- Baltimore
- Boston
- Charleston, SC
- Charlotte
- Chattanooga
- Chicago
- Cincinnati
- Cleveland
- Colorado Springs
- Columbia, SC
- Columbus
- Dallas-Ft. Worth
- Denver
- Detroit
- Fresno
- Greenville-Asheville
- Houston
- Indianapolis
- Jacksonville
- Knoxville
- Las Vegas
- Los Angeles
- Madison
- Miami
- Milwaukee
- Minneapolis-St. Paul
- Monterey
- Nashville
- New York
- Orlando
- Palm Springs
- Philadelphia
- Phoenix
- Pittsburgh
- Portland, ME
- Portland, OR
- Providence
- Raleigh-Durham
- Reno
- Sacramento
- Salt Lake City
- San Diego
- San Francisco
- Santa Barbara
- Seattle
- St. Louis
- Tampa-St. Pete
- Washington DC



EZ CHARGE

Customers can find chargers eligible for No Charge to Charge via the Nissan LEAF EZ-Charge[SM] App for iOS or Android, or at EZ-Charge.com/stations

MORE THAN
250,000
Global Sales
LEAF is the world's best-selling EV

MORE THAN
100,000
US Sales

30 MINUTES
Public quick chargers can deliver 80 miles of range in about 30 minutes

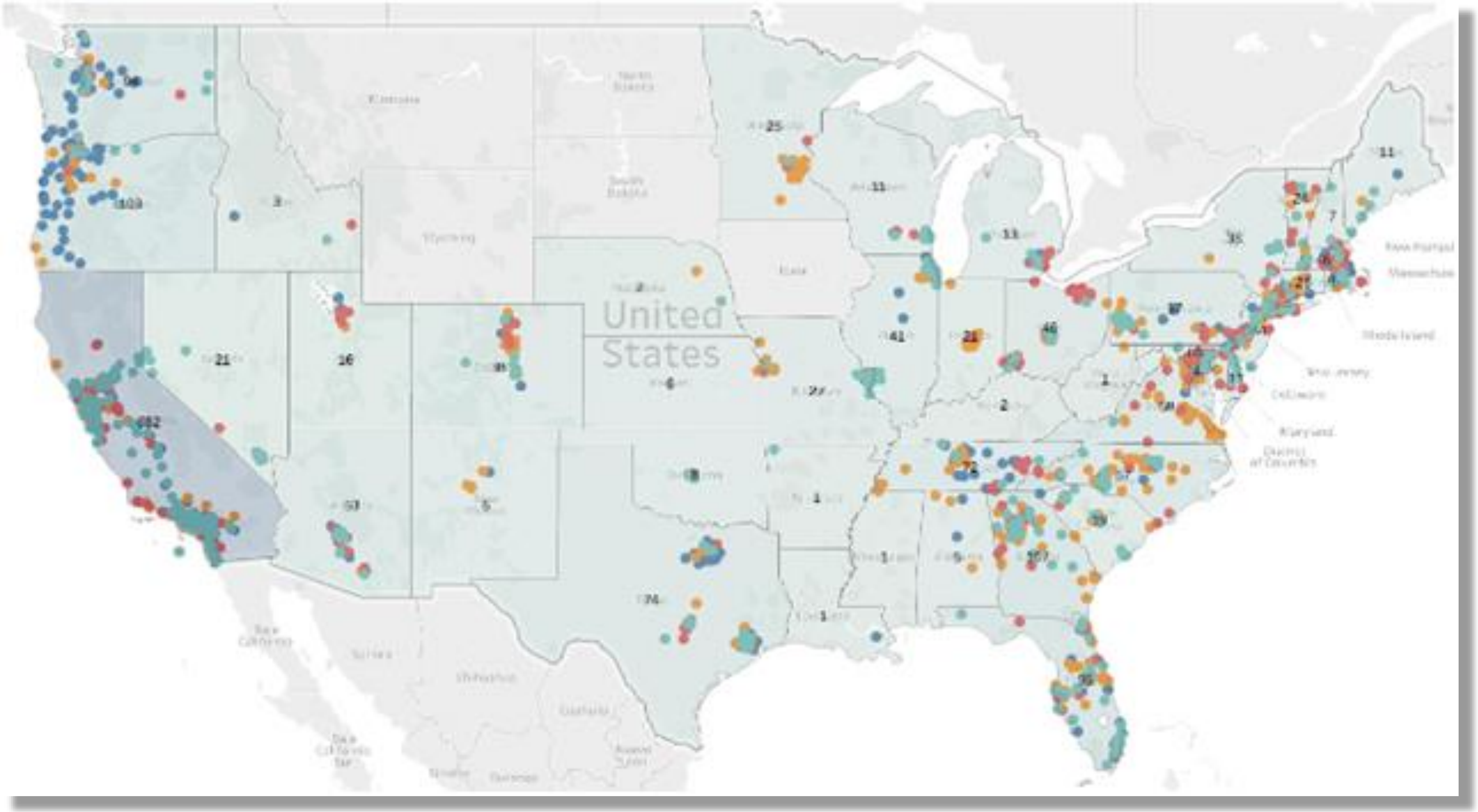
107
Miles of range on 2016 LEAF SV and SL models

NISSAN GROUP
OF NORTH AMERICA

CHAdeMO Growth Across the US

Over 2,100 publicly accessible CHAdeMO Fast Chargers have been installed in key EV sales markets over the last 4 years

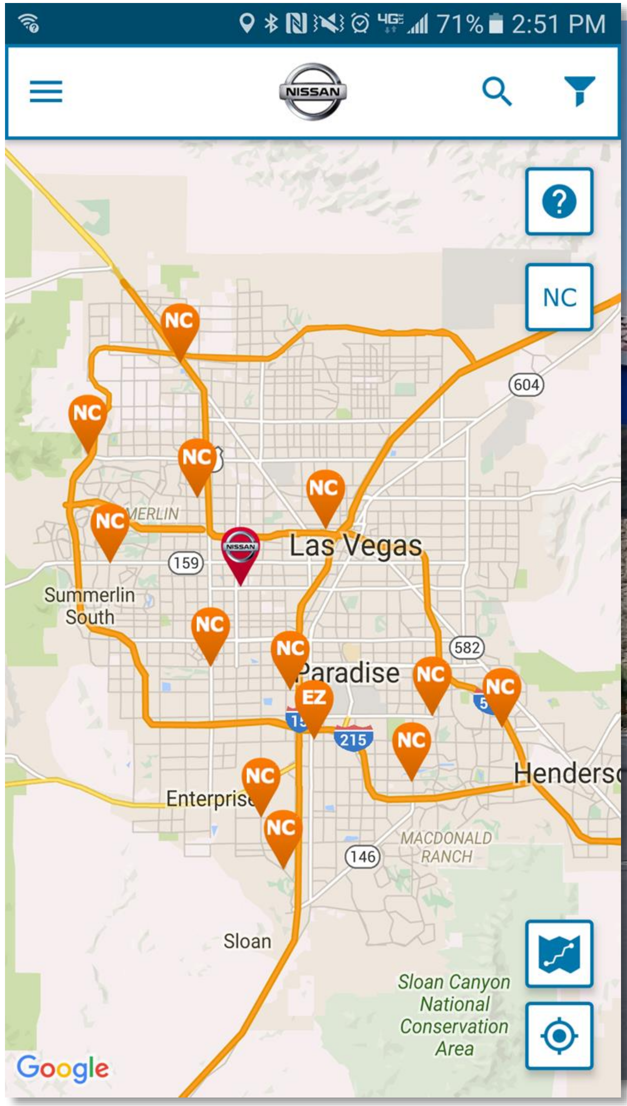
2013 2014 2015 2016

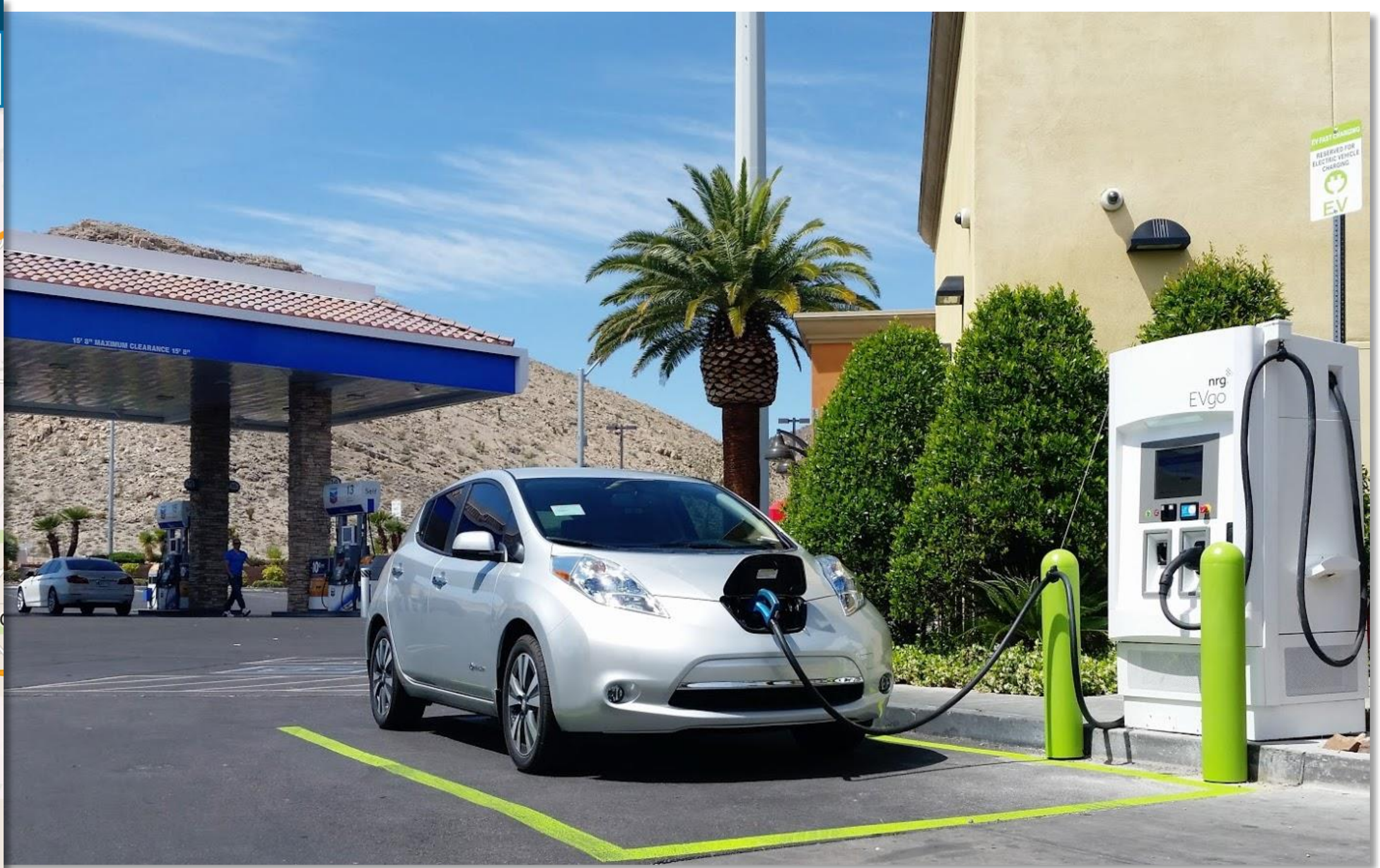


Year	Cumulative
2013	607
2014	1179
2015	1686
2016	2110

Market Coverage

Metro area coverage includes dual-capable Fast Chargers at retail & hospitality sites with many local and national brands

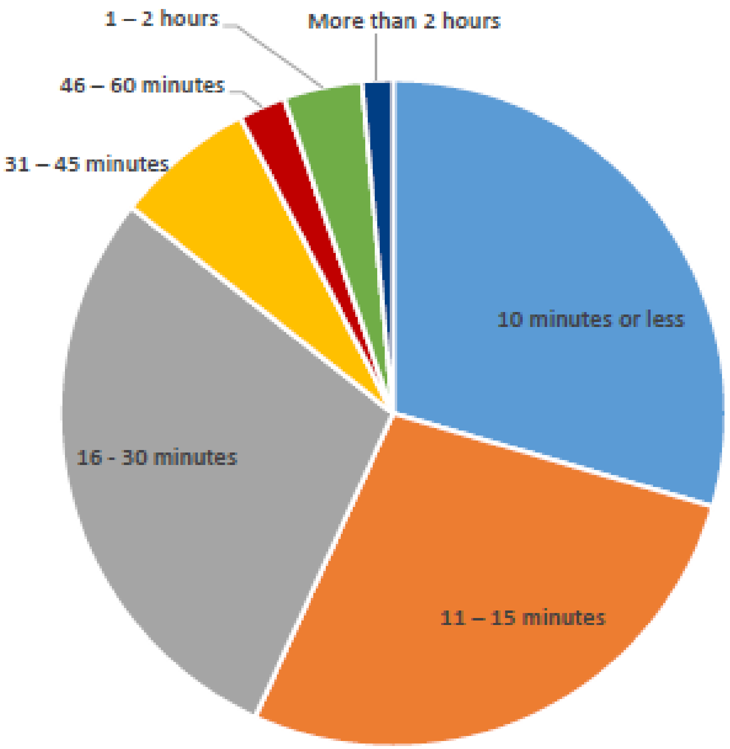




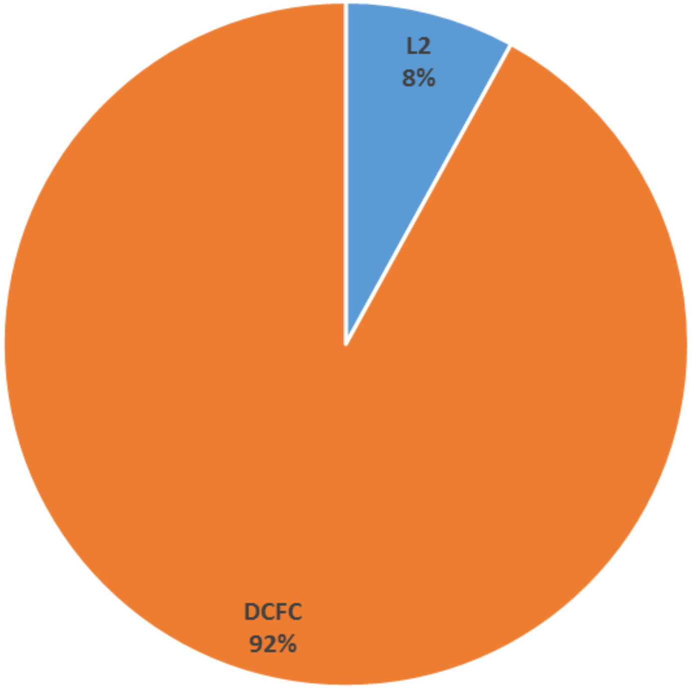
The Need for Greater Speed

Owners and intenders want charging times closer to traditional fueling. LEAF drivers greatly prefer Fast Charging in public

BEV owner wait time expectations on DCFCs



Recent monthly LEAF charging sessions at locations with collocated L2 & DCFC



‘5R’ Building Blocks of a National HPC Network

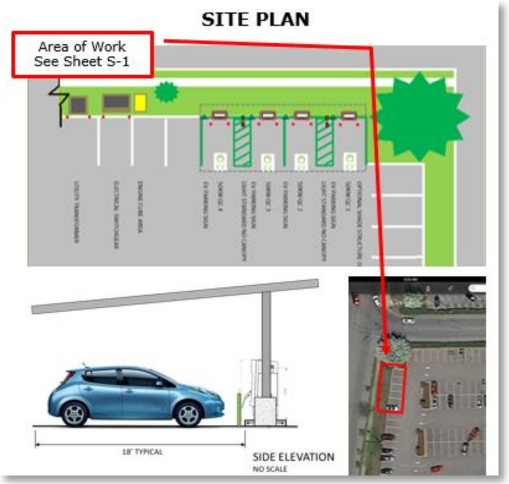
High powered charging is needed to connect metro areas nationally and ultimately, be competitive with liquid fuel

RELIABLE	• Equipment Service Level Agreement (SLA) with no less than 48 hour inoperability • Field-based technicians for rapid response • Domestic parts supply needed to ensure SLA • Consistent customer experience across the country (aesthetics, price, payment options power output)
REDUNDANT	• Multiple chargers required per location to increase driver confidence • ‘Fueling station’ model provides access despite queuing or inoperability risks • Provides higher level of visibility of infrastructure for EV and non-EV drivers
RELEVANT	• Equipment needs to service all fast charge capable EVs • Connector ‘standards’ a non-issue with dual-capable charging stations the new ‘standard’ • Upgradability and backwards compatibility for future and existing EVs
RAPID	• Need to meet customer expectations of 30 mins or less to charge despite battery size • Closer wait time experience to traditional fueling increases EV accessibility • Large power requirements need proactive involvement of utilities - power availability and demand chargers will make or break ROI
REGIONAL	• Phased approach will allow for more traveled corridors to be prioritized • Rural areas needed to allow national travel, dispenser requirements may be minimized • Metro ‘hubs’ still required as UIO grows

From Metro to National: How Do We Get There?

Key principles to creating an open, reliable, consistent and sustainable high powered charger network

1. Vehicles & vehicle demand
2. Powertrains & systems
3. Dual standard & cable technology
4. Consistency & reliability of experience
5. Streamlined permitting
6. Ubiquitous payment systems
7. Utility proactivity
8. Operating cost efficiency
9. OEM collaboration
10. Patient capital



Thank you

ELECTRIC POWER RESEARCH INSTITUTE

Infrastructure Working Council (IWC) Meeting

Day One Presentations

Birmingham, AL

March 29, 2017

Open Vehicle Grid Integration Platform Phase 2 Development and Demonstration Program

George Bellino

EPRI IWC
Birmingham, Alabama
28 Mar 2017

Origin of the Open Vehicle Grid Integrated Platform

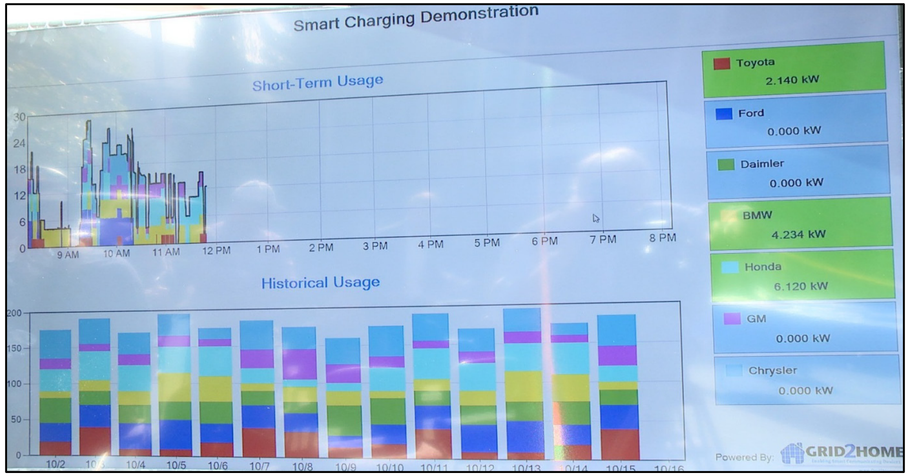
- Circa 2012 - Several automakers came together to discuss PEV/Utility integration
  - Focused on Issues
    - Costs and complexity for individual OEM communications interface development
      - 3000 Utilities and approximately 15 Major Automaker OEMs
    - Technology challenge to communicate through a single interface to all OEM PEVs
    - How to unify with Utilities on standard communications protocols and interoperability
    - How to determine value of EV grid services – what impacts need to be addressed
    - Determination of Utility and energy market aggregation value
      - Value differentiation between Aggregated OEMs vs Individual OEMs

- 2013 Developed the OEM/EPRI OVGIP Collaboration

Phase 1: Proof Of Concept "The Big Demo", Sacramento – Basis for OEM / Utilities Collaboration Led by EPRI

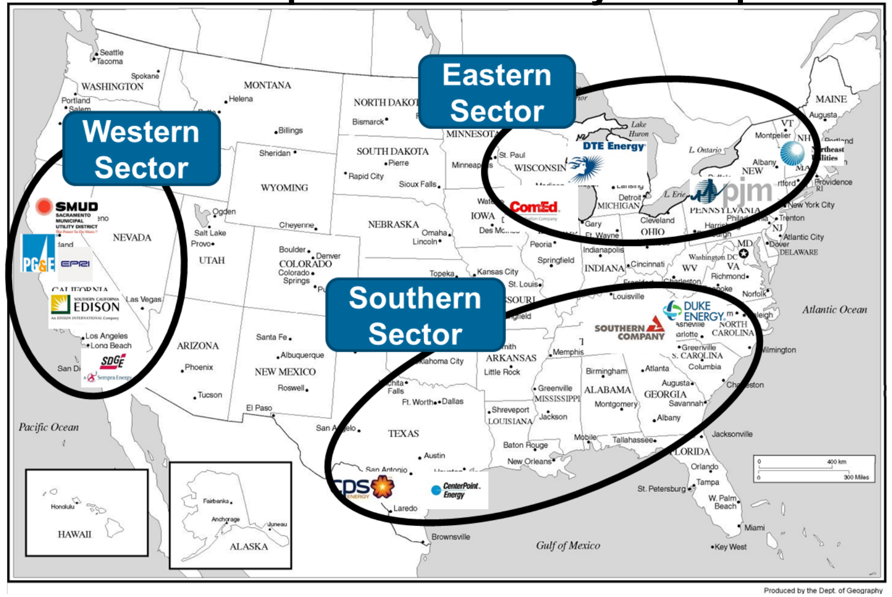
- Development Phase: 08/2013-10/2014
- Completed 10/16/2014 at SMUD
- Live Event - Executed OpenADR2.0b DR Event signal through OVGIP to manage 7 OEM PEVs
- Demonstrated Interoperability with multiple protocols
  - SEP2.0, ISO/IEC 15118, OpenADR2.0b, Telematics

Charge Status Display



The Line Up: 7 OEM PEVs

Phase 1 Footprint and 12 Utility Participants



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OVGIP Phase 2 Team Organization

OEM Collaboration Team

BMW
Fiat Chrysler Group (In process)
Ford
Honda
Mercedes-Benz
Nissan
Toyota
[GM, Tesla] – Observers
[VW Group] – Considering Joining

EPRI Member Utilities

Consolidated Edison
Hawaiian Electric
Pacific Gas & Electric Co
Puget Sound Energy (In process)
San Diego Gas & Electric
Southern California Edison
Southern Company

Program Coordination Team

EPRI
Automotive OEMs
Sumitomo Electric (SEI)
Utility Staff

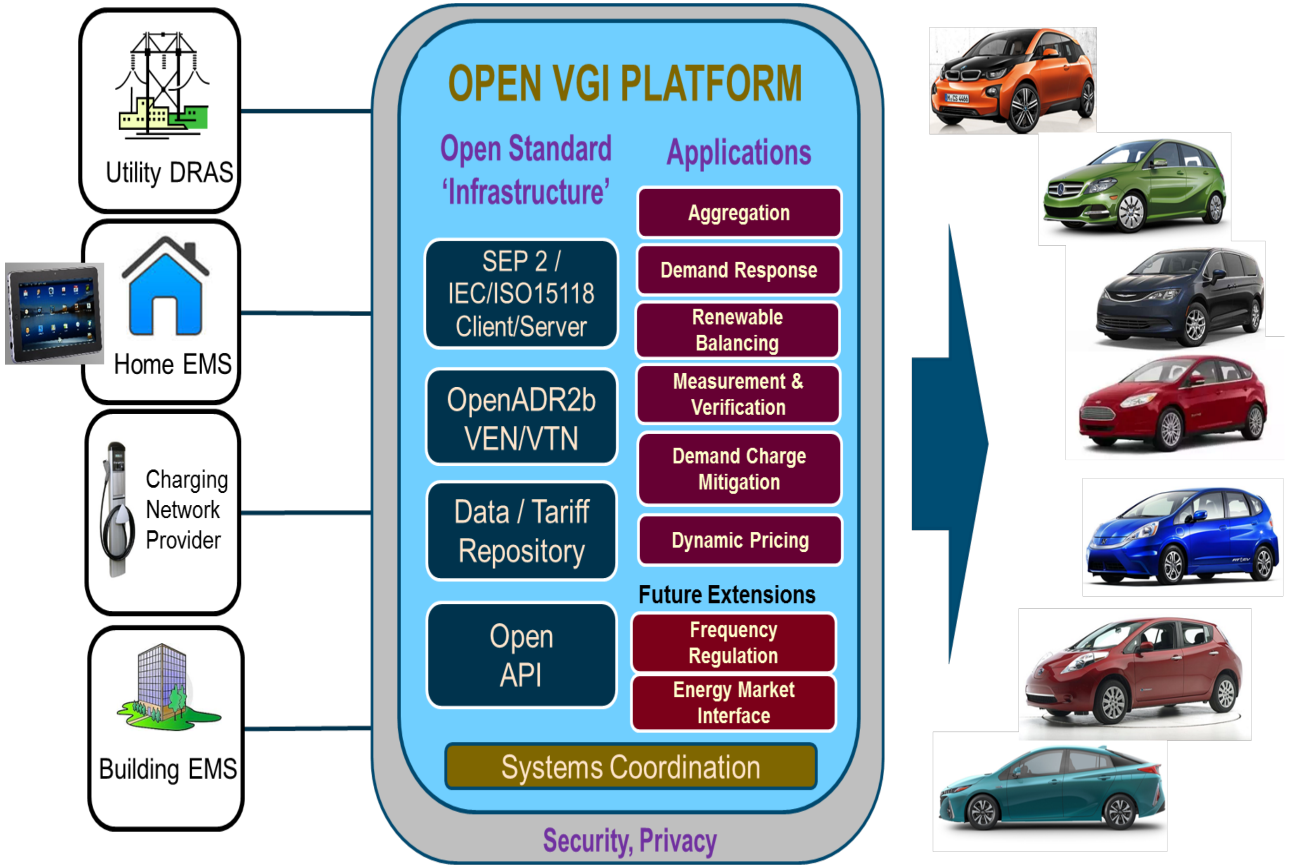
Program Management

EPRI

IT Solution Developer

Sumitomo Electric (SEI)

OVGIP Architecture Overview

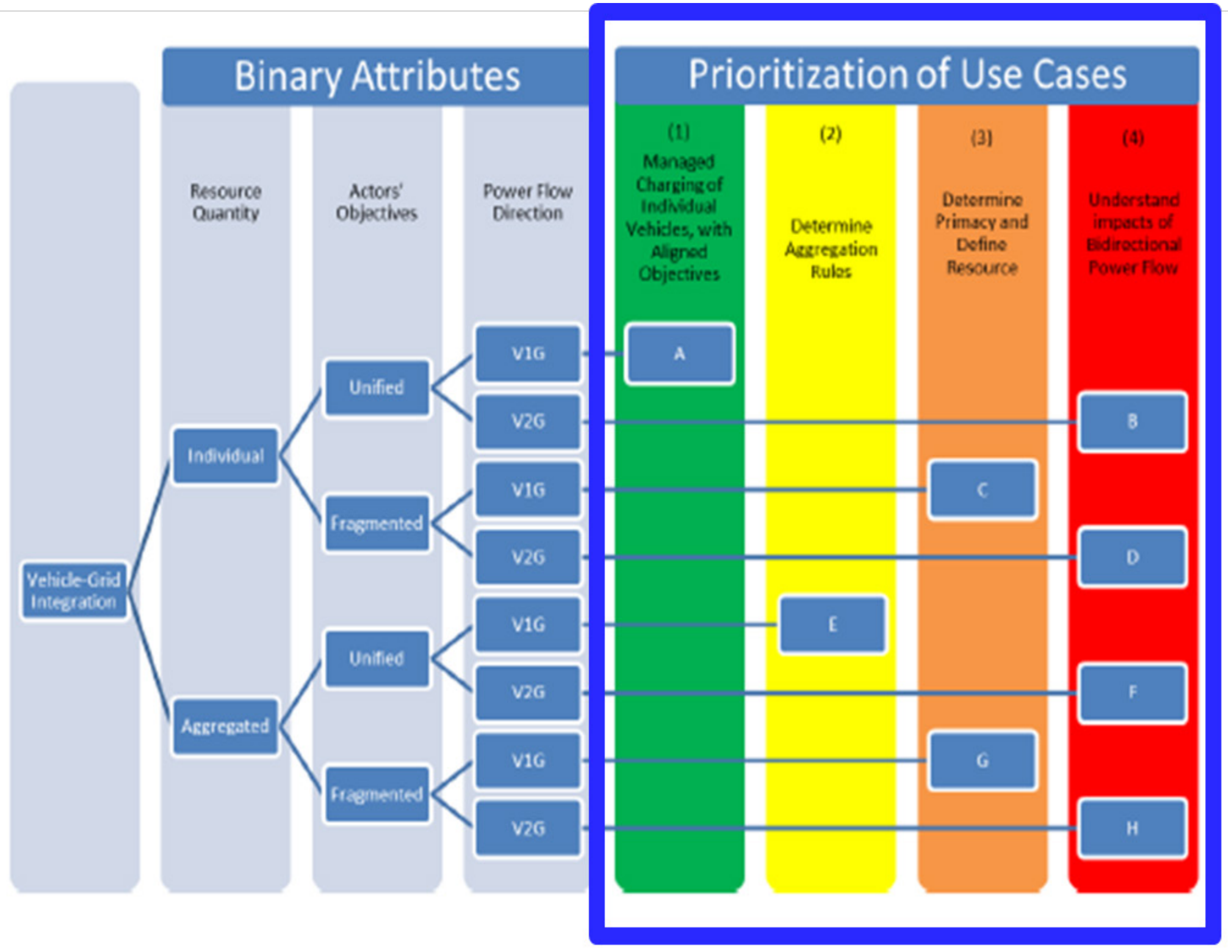


Operating System/Applications Structure

- Provides Unified PEV Utility Interface
- Provides Interoperability between standard and non-standard interface protocols/APIs
- Adapts progressive evolution of IT technology and standards
- Leverages OEM alternatives for in-vehicle VGI communications
- Responsive to Utility and ISO Aggregation dispatch and M&V requirements
- Supports EMS Network Interfaces for premise VGI Services
- Provides aggregated OEM data mining resources
- Enables additional grid service provider interfaces and integration

OVGIP Use Cases Align with CPUC VGI Use Case Priorities

VGI Use Case Priorities



OVGIP Use Cases

1 Automated Utility Electricity Rate Tariff Processing

2 Aggregation Services for Locational Demand Response

3 Interface with Home Energy Management System / ESI

4 Interface with Building Energy Management System

5 Dynamic Pricing

6 Interface with EVSE Network Provider

7 Optimized Load Management (ISO/IEC 15118)

8 Vehicle Roaming

9 EVSE Networking Functionality

10 Metering and Data Exchange

11 Customer Enrollment and Administration

Overview of Utility Programs

Hawaiian Electric	• Controlled Fleet Charge Management Demonstration Program
Consolidated Edison	• Off Peak Charging Customer Incentive Program • Non Tariff Based – verification through on vehicle data - Pay for Performance
SCE	• Capacity Bidding Program utilizing aggregated DR • Residential Customers • Compensation based on whole house load reduction per 10/10 Baseline (Green Button customer data)
PG&E	• Energy Market DR Participation Program through Schedule Coordinator • Aggregated Residential DR Customers • Capacity Bid by SubLAP (LAP = Load Aggregation Point)
SDG&E	• Aggregated Residential DR Customer Program (Conceptual Development) • Dynamic Pricing based
Southern Company	• HEMS OVGIP Interface Program – Lab Evaluation pilot

The Progression for Open VGI Platform Development

V1G Load Capacity Aggregation	DSM Localized Load Control	DER – V1G Load Control Integration	V2G - Reverse Power Flow Integration	Interactive DER Management and Control
Ability to respond to aggregated regional DR load control signals	Customer ability to control PEV load through interface with local energy management systems	Integration of PEV load control with Utility and ISO DER management systems and energy market processes – ancillary services and frequency regulation	Introduction and integration of PEV V2G capable technology and communications standards	Integration of V2G dynamic interactive control with Utility and local Smart Inverter DER management systems.

Validated Pilots Enable Increased Program Complexity and Sophistication Levels

Roadmap to VGI Technology Infrastructure Deployment

Definition (6-8 Mos)

Standards Definition

- VGI Working Group formulation
- Alignment of Goals and Evaluation Criteria
- Standards Evaluation and Recommendation
- Implementation Guide
- Reference Design Demonstration

Preliminary Assessment Program

- ISO / Energy Markets – Aggregated Services
- Distribution Grid Services – Demand Side Management; PV Overgen Support; Ramping Support
- Participation in broader categories of storage related services

Pre-Production Readiness (12-18 Mos)

Pre-Production Deployment

- Programs and Incentives as defined from Preliminary Assessment
- Broad customer enrolment and participation
- Technology on Vehicles conforming to Validated Recommendations from VGIWG

M&V Value Driven Verification

- Customer Participation as a Function of Incentives and Program Execution Approach
- Value to Grid through M&V data
- Participation from all IOU customers
- Refined Valuation Assessment Model(s)

Real World Technology Costs and Performance Verification

- Cost to develop, deploy and deliver; Fixed, Variable
- Cost to perform M&V
- Technology Performance to deliver the intended use cases
- Feedback to Product Design Engineers

VGI Deployment (12 Mos)

Wide Deployment of VGI Infrastructure

- Refined Programs and Incentives
- Refined M&V Methods
- Approved Rate Cases
- Approved Participation in broader DER program offerings
- Productionized VGI technology infused into the infrastructure on-vehicle and on-EVSE (as appropriate)

** Scope of EPRI's Proposal for CEC GFO 16-303 Group 1*

Questions To Be Addressed

- How are utilities envisioning the deployment of EVs in their territories?
- What distribution system reliability and efficiency benefits can EVs provide through VGI services?
- What cost trade off values do utilities see from EV participation in grid services?
- What are the most valued EV Grid Service use cases and prioritization?
- What are the key PEV grid-integration challenges?
- Can utilities create VGI programs at scale to demonstrate meaningful economic value to PEV owners?

Need a collaborative process to define economically viable VGI programs to provide a path to production deployment

Together…Shaping the Future of Electricity

INL's Testing Supports Wireless Power Transfer Codes & Standards Development

IWC meeting March 29, 2017

Barney Carlson
Idaho National Laboratory
Energy Storage & Transportation Systems

INL/MIS-17-41396

Electric Vehicle Infrastructure (EVI) Lab at INL

- Support codes and standards development and harmonization
  - Wireless Power Transfer (WPT):
    - SAE J2954
  - Conductive EVSE:
    - EnergyStar for EVSE
    - SAE J2894 (power quality)
    - Grid Modernization (GMLC)
- Measure performance metrics
  - Power transfer capability, Efficiency, EM-field emissions, Power quality
  - Response to dynamic grid events
  - Cyber security vulnerability assessment
- Wide range of input power
  - 120 VAC to 480 VAC 3ϕ
  - 400 kVA total capability
- Bench and vehicle testing capabilities

https://avt.inl.gov/panos/EVLTour/?startscene=pano5141

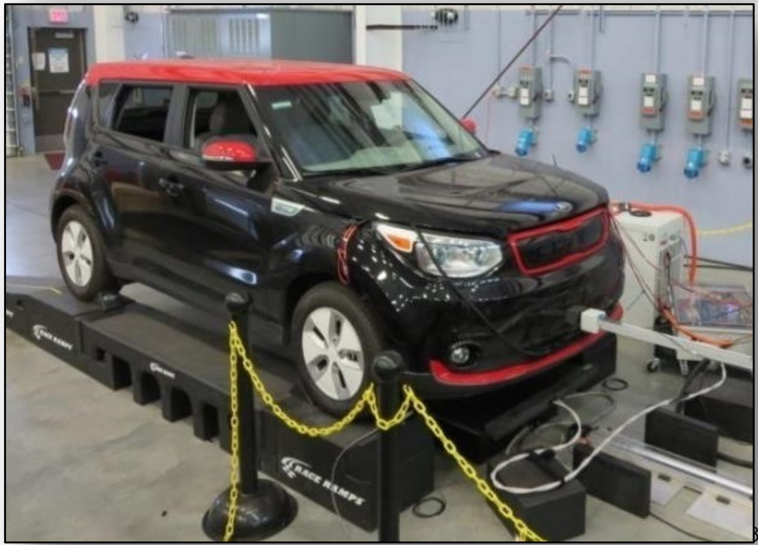
INL's Testing of Wireless Power Transfer (WPT)

<u>Bench testing capability</u>

- Test WPT system off-board the vehicle
- Standardized technology evaluation
- Fiberglass frame supports vehicle components
- Motor-controlled coil positioning system
- Battery emulator

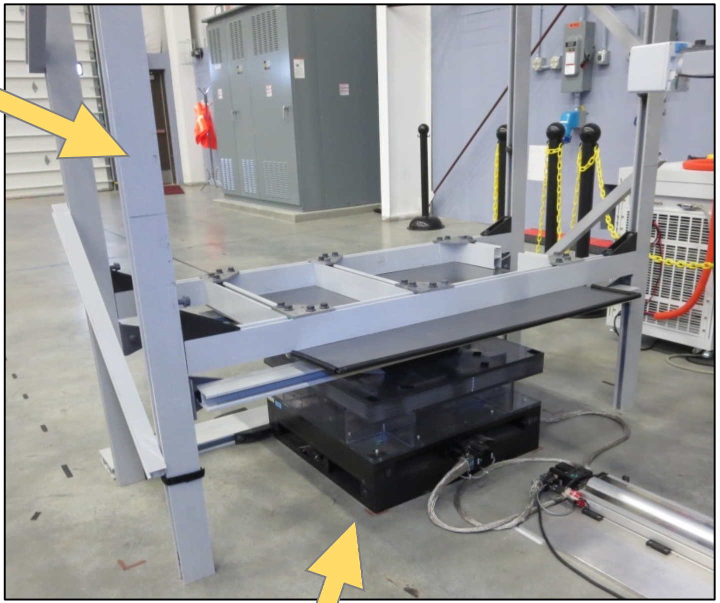
<u>Vehicle testing capability</u>

- Testing of WPT systems integrated into the vehicle
- Non-metallic vehicle ramps used to elevate vehicle
  - provide necessary space for the coil positioning system

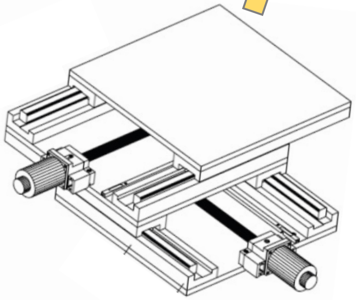


Bench Test Fixture

- Fiberglass strut frame supports:
  - Vehicle side
    - Coil assembly
    - Output power electronics
  - Steel floor pan mimic plate
    - per SAE J2954 specifications
  - Aluminum shield
    - between coil and steel mimic plate
    - per SAE J2954 specifications

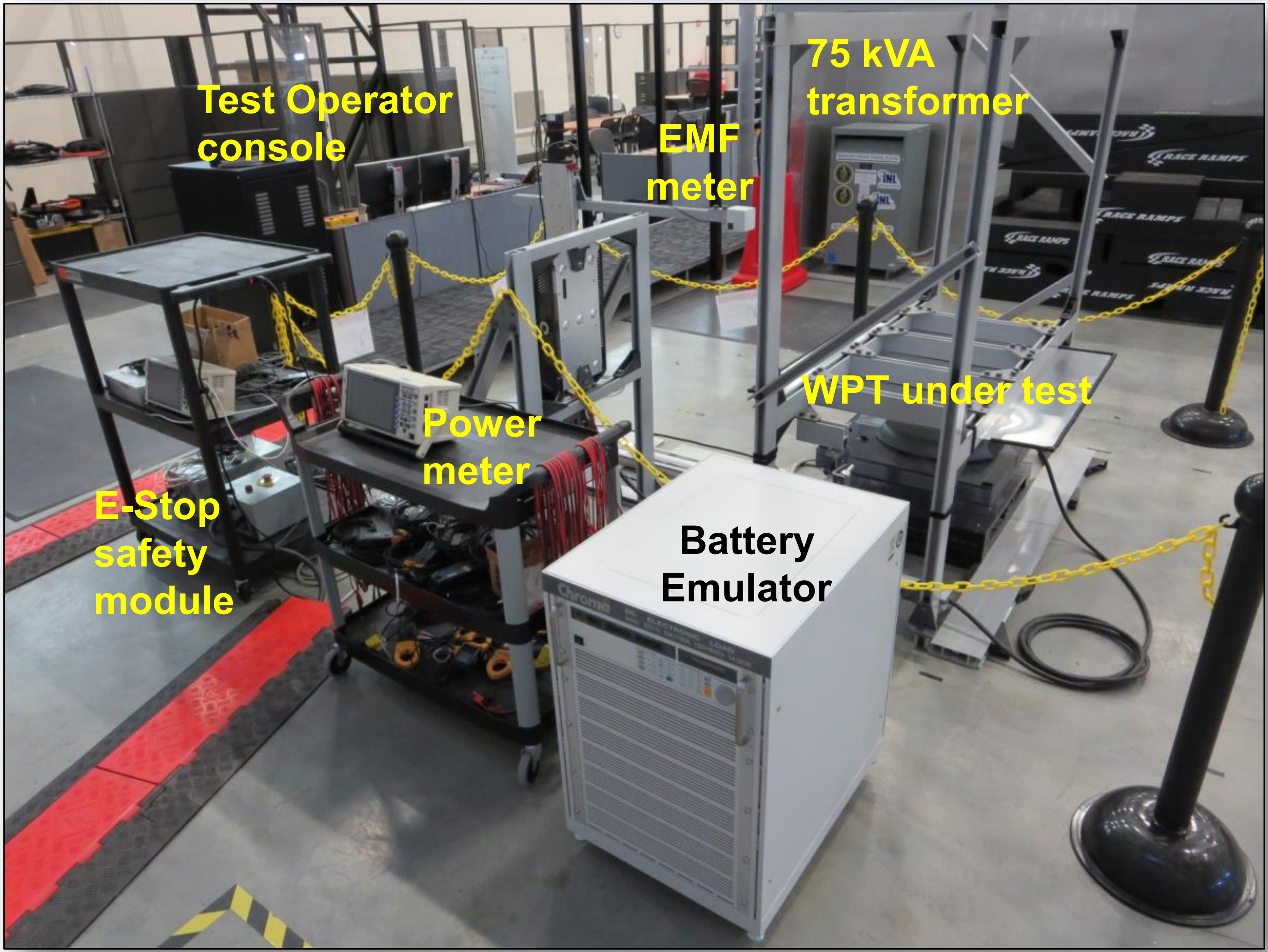


- Coil positioning system
  - used to accurately align /misalign the WPT coils
    - Ground coil moved with respect to the fixed vehicle assembly
  - Servo-motors driven via LabVIEW host control for semi-automated testing



- DC Load: Battery Emulator

Photo of INL Bench Test Setup



INL's EVI Lab Measurement Equipment

- Efficiency and Electrical Power Quality
  - Hioki 3390 Power Meter
    - 0.15% accuracy
    - 4 channels
      - Voltage
      - Current Probes

- Electro-magnetic field
  - Narda EHP-200a
    - 9 kHz – 30 MHz

- Surface Temperature
  - FLIR SC640 infrared camera connected to PC
- Custom LabVIEW host control and data acquisition

LabVIEW Host Control and Data Acquisition

- Operating condition (requested power, coil gap, misalignment ,etc.)
- System efficiency (calculated real-time)
- Power transfer (input power, intermediate nodes, output power)
- Power Quality (power factor, current THD, etc.)
- Electromagnetic field (H-field, E-field)

Wireless Charging Interoperability Testing at INL to support SAE J2954 development

- Eight wireless charging systems evaluated
  - Daimler / Jaguar Land Rover / Qualcomm (Z1, Z2, Z3)
  - Nissan / WiTricity (Z1, Z2, Z3)
  - Toyota (Z1, Z2)
- INL Bench testing evaluated interoperability performance of various:
  - coil topology, gap class (Z1, Z2, Z3), and power class (WPT1, WPT2)
    - System Efficiency
    - Power transfer capability
    - Power factor
    - Magnetic and Electric field
  - Test results supported SAE J2954 results-based decisions for developing the draft documents

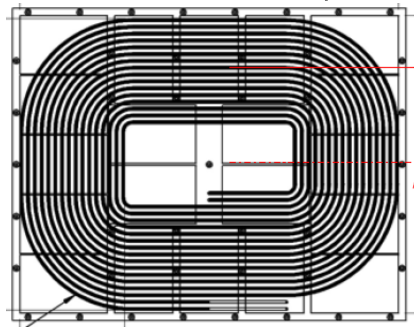
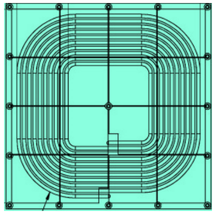
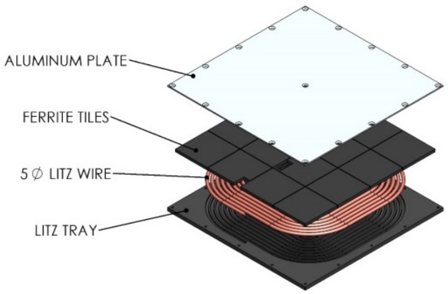
Testing Wireless Charging Interoperability

- ***Matched*** operation (baseline)
  - Ground assembly (GA) and vehicle assembly (VA) are
    - from same manufacturer
    - same coil topology

- ***Interoperable*** operation
  - GA and VA from differing:
    - Design and coil topology (Single-coil or Multi-coil)
    - Manufacturers
    - Power classes
    - Z (gap) classes

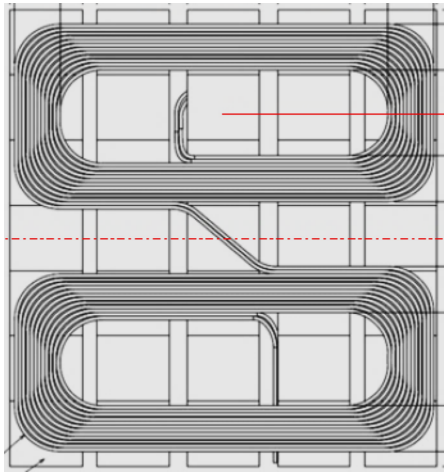
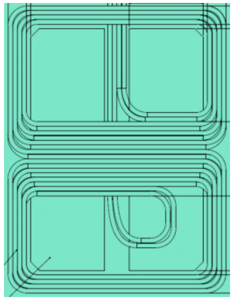
Systems Tested

- Single-coil (circular or rounded rectangle)
  - Toyota: 3.5 kW (WPT1)
  - WiTricity / Nissan: 7.0 kW (WPT2)

Photos / drawings from WiTricity

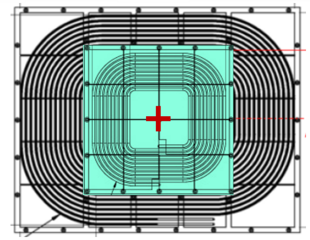
- Multi-coil (Double-D)
  - Qualcomm: 7.0 kW (WPT2)

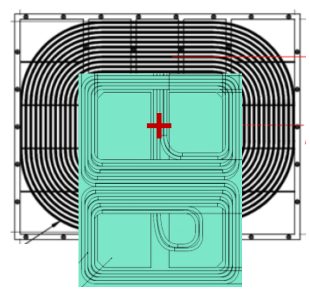

Photos / drawings from Qualcomm

Interoperability Testing

- Single-coil GA with Single-coil VA



- Single-coil GA with Multi-coil VA



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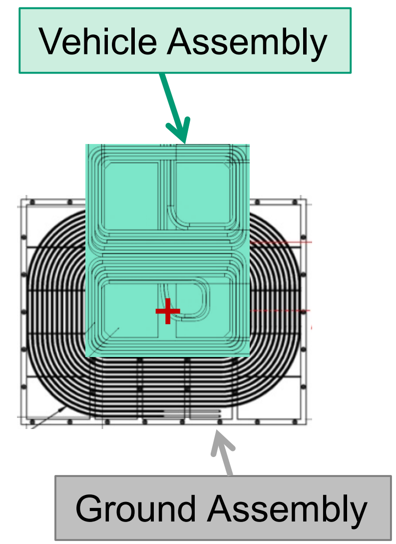
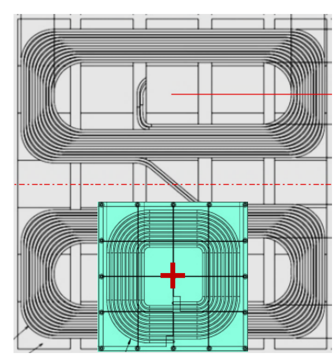


- Multi-coil GA with Single-coil VA



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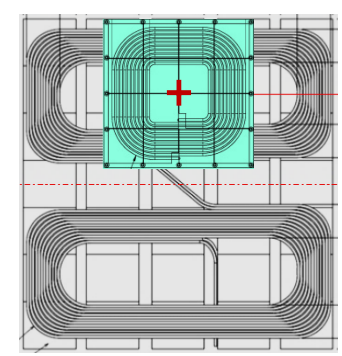
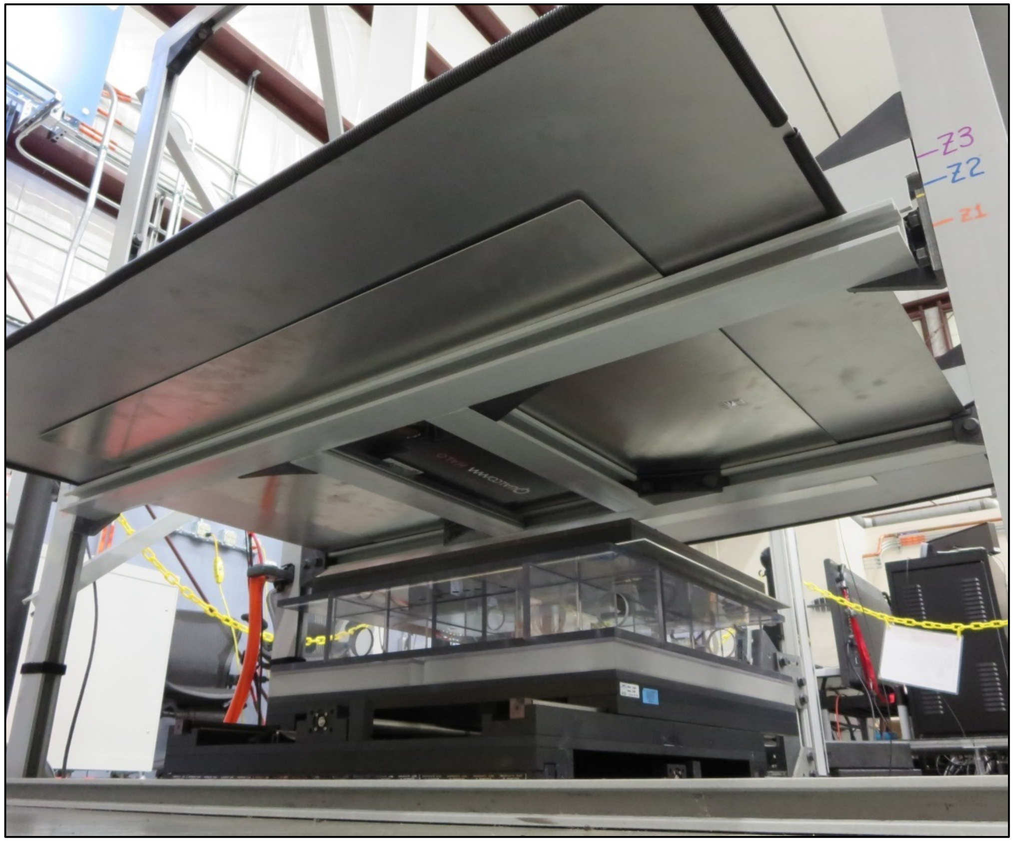


Bench Testing

- Test variables include:
  - Ground Clearance (coil gap)
    - Z1 (100, 125, 150 mm)
    - Z2 (140, 175, 210 mm)
    - Z3 (170, 210, 250 mm)
  - Coil misalignment
    - Aligned: (0,0) mm
    - Misaligned: up to (±75, ±100) mm
  - Power Transfer
    - 100% and 50%
  - Output Battery Voltage
    - 280, 350, 420 VDC



Collaboration throughout testing

- Multiple researchers from each company visited INL during testing:
  - Real-time control and tuning of wireless charging operation
  - Collaborate on interoperable control strategies / optimization
  - Observe system performance (efficiency, EM-field, power quality, etc.)

Results Overview

- Test results provided to the SAE J2954 committee
  - Graphical and Tabular results
    - System Efficiency (%)
    - Power Factor
    - Magnetic field (A/m)
    - Electric field (V/m)
    - Operating frequency (kHz)
    - Test conditions
      - Coil alignment position (X, Y, Z)
      - Input voltage
      - Output voltage
      - Input power
      - Output power

Results Overview

Across all coil misalignments, coil gaps, power levels, and output voltages

- **Nearly all interoperable WPT combination achieved *full power transfer***

- Matched WPT:
  - System efficiency ranged from 80.3% to 93.2%
  - H-field ranged from 6.8 A/m to 55 A/m
  - E-field ranged from 45 V/m to 239 V/m

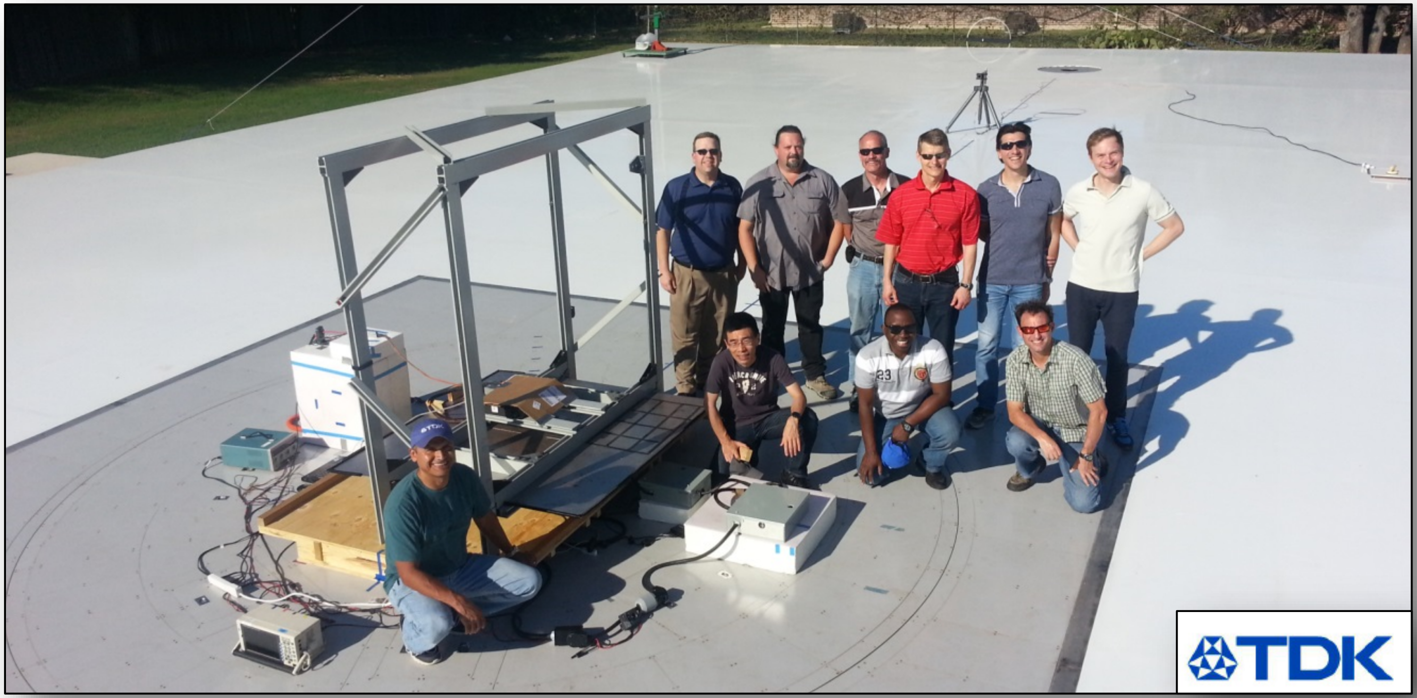
Note:
ICNIRP Limit (2010):
H-field: 21 A/m
E-field: 83 V/m

- Interoperable WPT:
  - System efficiency ranged from 79.9% to 92.4%
  - H-field ranged from 6.7 A/m to 168 A/m
  - E-field ranged from 60 V/m to 390 V/m

- All systems achieved (matched and interoperable):
  - high power factor ($\geq$0.95)
  - very low input current THD

EMC Testing Collaboration with TDK

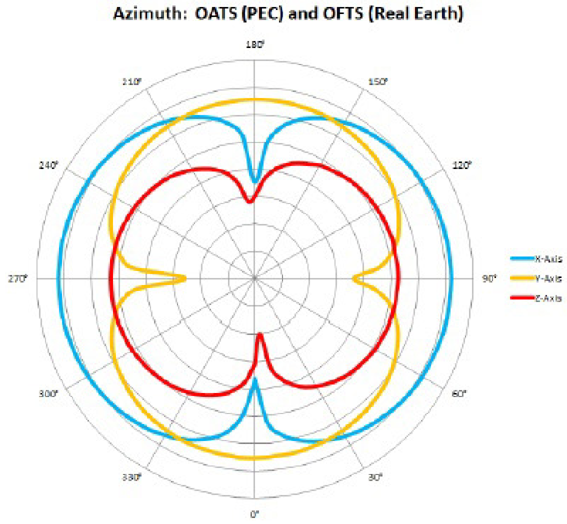
- TDK has world class EMC / EMF test facilities in Cedar Park, TX
  - Anechoic Chambers, Open Area Test Sites (PEC and earth ground)
- INL supported EMC / EMF testing at TDK in Cedar Park, TX
  - Matched and interoperable WPT testing was conducted
    - Qualcomm, Nissan / WiTricity, Toyota WPT systems
  - Results are critical for SAE J2954 development and harmonization

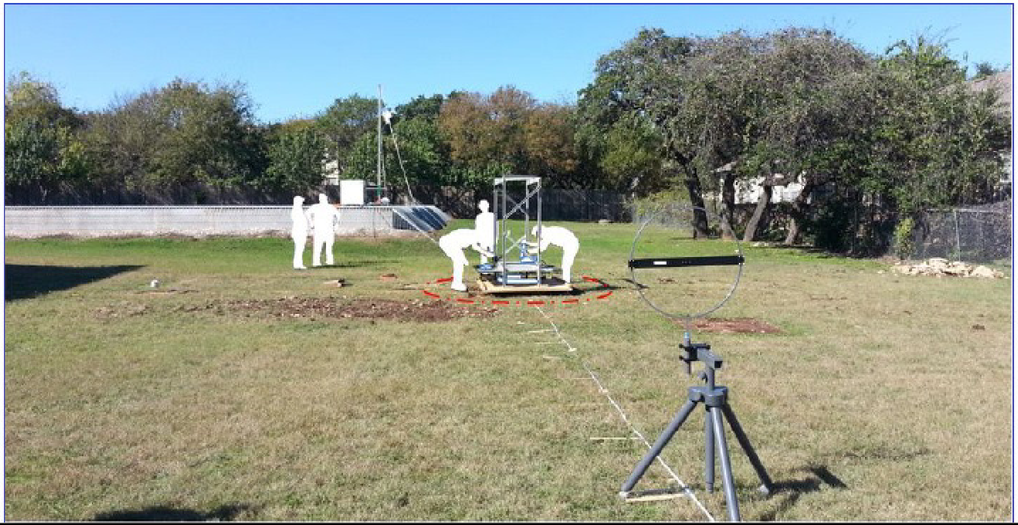


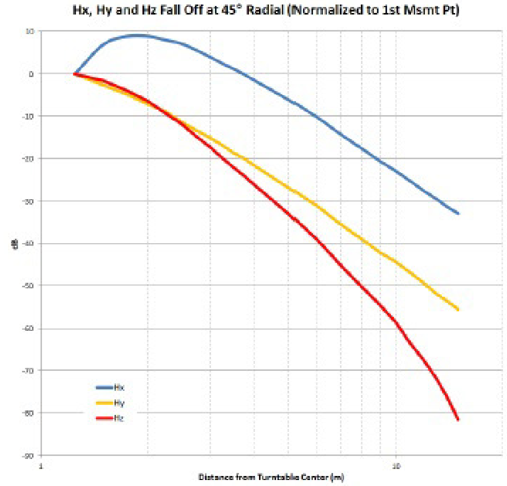
EMC / EMF Testing at TDK in Austin, TX

EMC: OATS (PEC surface) and OFTS (real earth surface)

TDK







Next Steps for SAE J2954

- 2016 Test Results:
  - Supported decisions for choosing reference coil design
    - WPT1 (Z1 ,Z2) & WPT2 (Z1, Z2, Z3)
  - Provided from SAE to ISO to support standardization harmonization

- SAE J2954 committee identified further testing needs (2017)
  - Higher power WPT 3 design validation (11 kW)
  - High coil gap (Z3) validation (WPT1)
  - Vehicle WPT testing for correlation to bench testing
  - Debris / foreign object detection and response
  - Product WPT systems interoperability with the reference design

- Feb. 2017: Med Duty (J2954/2) kicked off (50 kW – 250 kW)
- Mid 2017: target to publish SAE J2954 Recommended Practice
- End of 2018: target to publish SAE J2954 Standard

Summary

- INL interoperability WPT testing successfully completed (2016)
  - over 4,500 test conditions measured over 20 weeks
  - INL supported EMC/EMF testing at TDK
  - Provided a solid foundation for
    - Results-based decisions
    - Supporting codes and standards document
      - Development
        - TIR, Recommended Practice, Standard
      - Harmonization
        - with other International standards

- Results showed interoperable functionality for all WPT combinations
  - Nearly all interoperable combinations are <u>full power capable</u>

Acknowledgement

This work is supported by
the U.S. Department of Energy's
EERE Vehicle Technologies Office

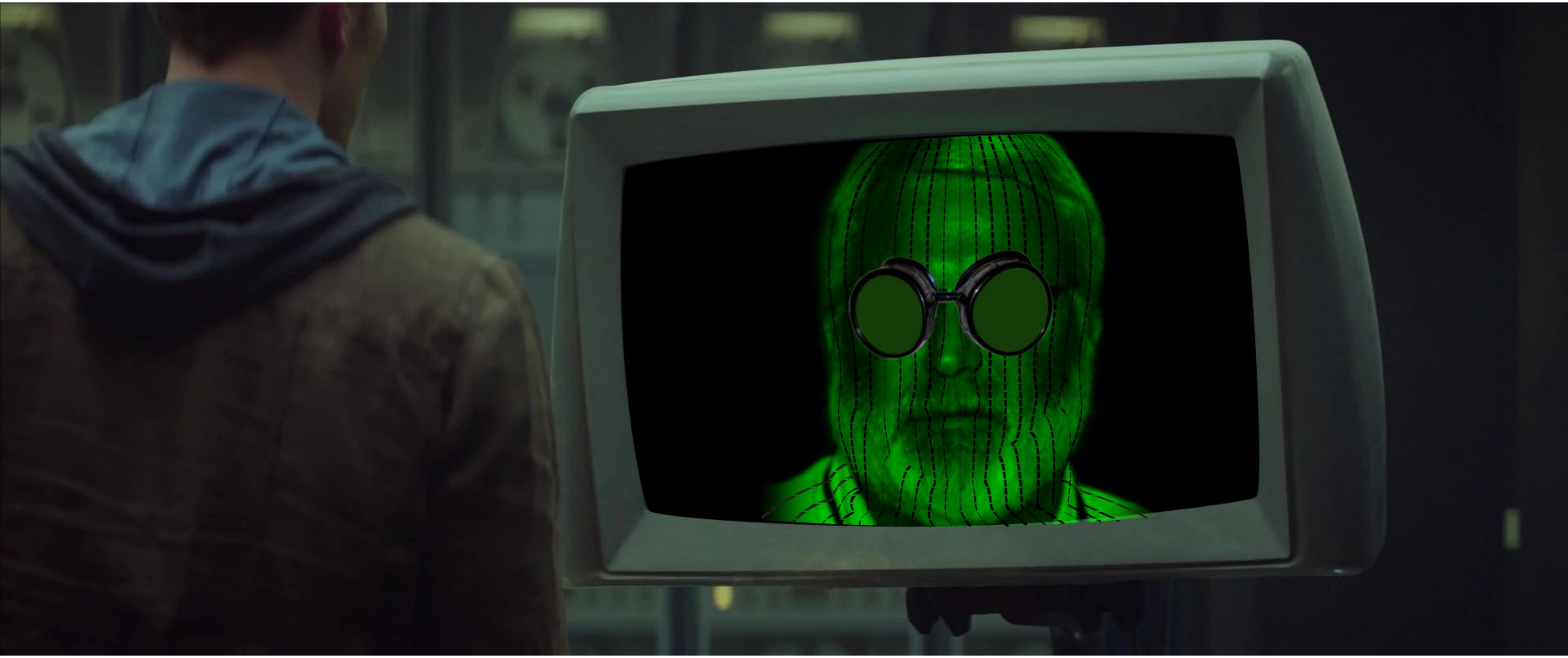
More Information

http://avt.inl.gov

http://at.inl.gov

Jim Francfort's consciousness to be digitized in INL High Performance Computing Cluster

Although Jim's body is retiring, his digital brain will live on at INL to provide expert advice on plug-in electric vehicles in perpetuity

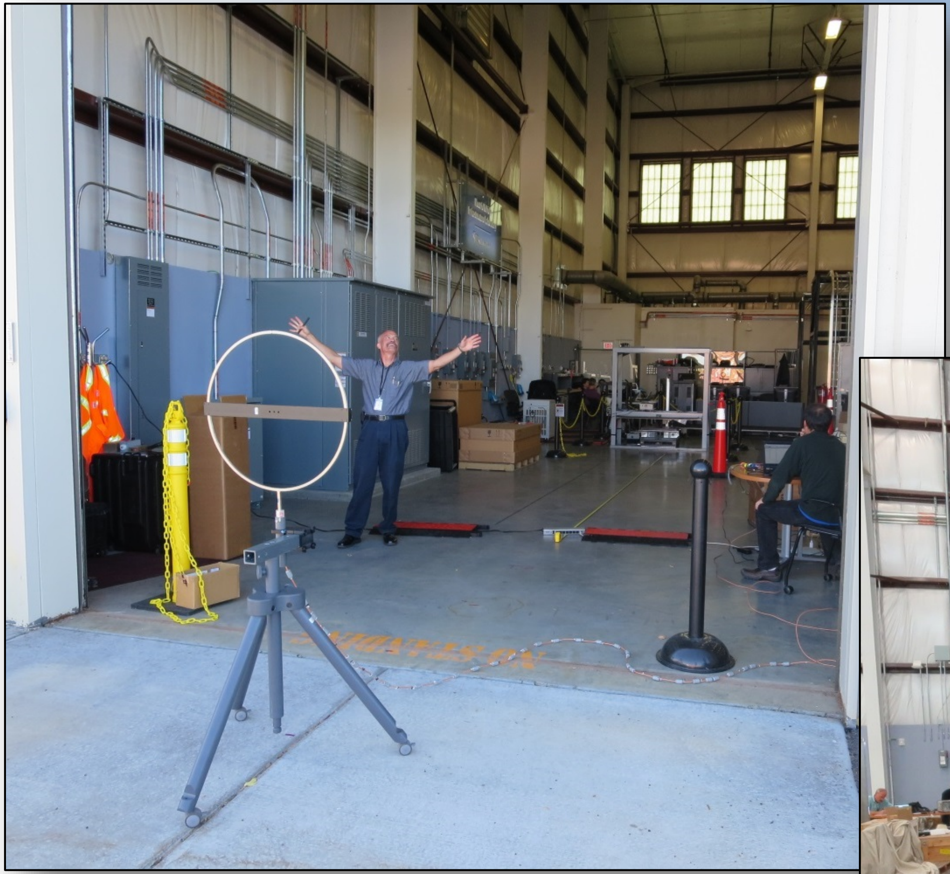


Idaho National Laboratory

Back-up Slides

INL Safety during Testing

- EM-field safety boundary around WPT systems
  - EM-field public exposure limit
- Temperatures measured
  - Thermal imaging
- Emergency Stop electrical disconnect
  - Remotely disconnect input voltage with contactors and E-stop button
- "*Test In Progress*" sign
  - Informs other staff of status of WPT operation




TEST IN
PROGRESS


TDK


TDK
TDK


TDK

Collaboration throughout testing

- Research staff from TDK and Delphi collaborated at INL
  - TDK and Delphi supported EMF / EMC measurements with high accuracy EMC antennas, analyzers, and meters
  - Measured EMF / EMC from 1.0 m to 20 m distance from WPT
    - Measurements up to 5 m provided high value, interoperable data
    - INL's lab is not specifically designed for mid / far field measurements (>5 meters)

60cm loop antenna at 5 meters

SAE J1772™
Status Update

John Halliwell
Technical Executive

Infrastructure Working Council
November 15, 2016

Contents

- Timeline
- Face to Face Meeting
- Comment Summary
- Next steps

Version 7 - J1772™ Original Timeline

Version 6 – Published in February 2016

Start	Open for New Comments	Resolve Comments	Task Force Ballot	Review Results	
Mar 15, 2016	12 Weeks	20 Weeks	2 Weeks	2 Weeks	
	Jun 7, 2016	Oct 25, 2016	Nov 8, 2016	Nov 22, 2016	

Hybrid Committee Ballot	Formatting	Review Results	Motor Vehicle Council Ballot	Review Results	Publish	
4 Weeks	6 Weeks	1 Week	4 Weeks	1 Week	1 Week	**Mar 21, 2017**
Nov 22, 2016	Dec 20, 2016	Jan 31, 2017	Feb 7, 2017	Mar 7, 2017	Mar 14, 2017	

Comment Period Closed

Version 7 - J1772™ Udpated Timeline

Version 6 – Published in February 2016

Start	Open for New Comments	Resolve Comments	Task Force Ballot	Review Results	
Mar 15, 2016	12 Weeks	45 Weeks	2 Weeks	2 Weeks	
	Jun 7, 2016	April 15, 2017	April 30, 2017	May 15, 2017	

Hybrid Committee Ballot	Formatting	Review Results	Motor Vehicle Council Ballot	Review Results	Publish	**Oct 21, 2017**
4 Weeks	6 Weeks	1 Week	4 Weeks	1 Week	1 Week	
Jun 15, 2017	Jul 15, 2017	Sep 1, 2017	Sep 7, 2017	Oct 7, 2017	Oct 14, 2017	

Original Plan was Mar 21, 2017

New Comment Period Closed - June 7, 2016

Day Long Face to Face Meeting on March 6, 2076

Meeting focused on all open comments

- 10 comments related to IEC harmonization on DC charging
  - Working to coordinate this with Maintenance Team 5 (MT5)
- Reviewed all but three remaining comments
- These comments remain open:
  - 6, 7 (inlet/plug pin heights)
  - 34 (undefined DC charging shutdown)
  - 37-44, 46, 47 (IEC harmonization)
  - 18-20 (word usage)
  - 57 (DC charge pause)
  - 68 (latch width)
- That's 18 comments left to resolve…

Next Steps

- Email and web meetings to resolve remaining comments
- Resolve or defer leftovers to version 8 – goal is to wrap up discussion by April 15, 2017
- Hold 14 day ballot in J1772 task force
- Roll through SAE process

Together…Shaping the Future of Electricity

ELECTRIC POWER RESEARCH INSTITUTE

ELECTRIC POWER RESEARCH INSTITUTE

Main Title

Subtitle

Speaker's Name

Speaker's Job Title

Event Name

Date

Title and Content

Two Content

Comparison

Title Only

Highlight box

Section Header

Together…Shaping the Future of Electricity

SAE PEV Communication & Interoperability Task Force Status

Infrastructure Working Council (IWC) Meeting
March 29th, 2017
Barber Vintage Motorsports Museum,
6030 Barber Motorsports Parkway
Leeds, AL

Index

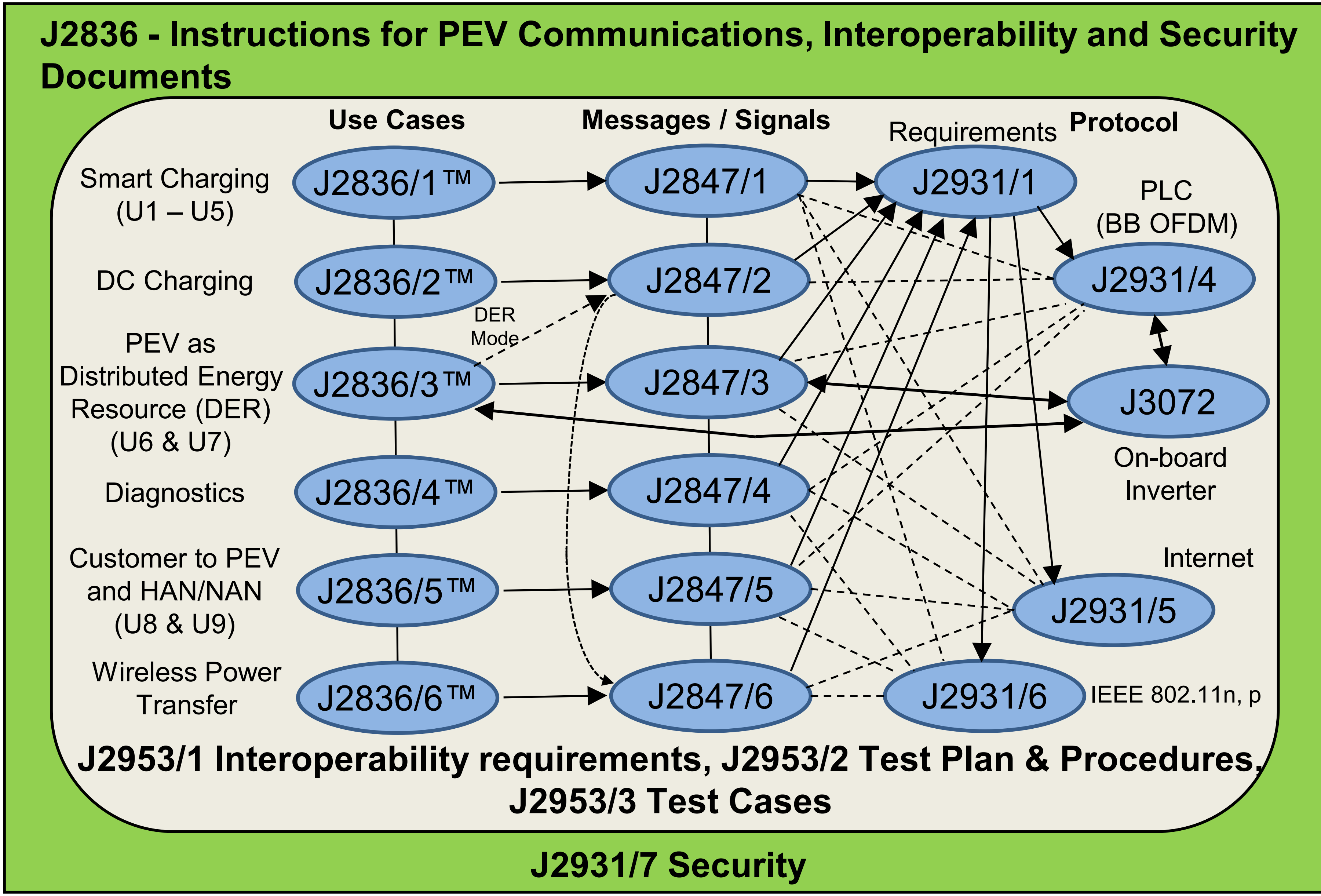
- SAE & ISO Communication Background
- Current Status
  - Active/Open documents
  - More planned to be opened this year
  - Summary of document categories
- Overall Summary

SAE and ISO 15118 Background

SAE Communication Background
Major Documents and Functions

1. J2836™ - Instructions and Use Cases (establishes requirements)
   - ❖ Technical Information Report (TIR)
2. J2847 – Messages, diagrams, etc. (derived from the use case requirements)
   - ❖ -2 is a Standard, others are Recommended Practice (RP)
3. J2931 – Communication Requirements & Protocol
   - ❖ TIR
4. J2953 – Interoperability
   - ❖ RP
5. J3072 – Interconnection Requirements for Onboard, Utility-Interactive, Inverter Systems
   - ❖ Standard

SAE Document Interaction



Rich Scholer - SAE Communication and Interoperability Task Force

ISO 15118 ED 1

- ISO 15118-1: Road vehicles - Vehicle to grid communication interface
  - Part 1: General information and use-case definition (J2836)
- ISO 15118-2: Road vehicles – Vehicle to Grid communication Interface
  - Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements (J2847)
- ISO 15118-3: Road Vehicles - Vehicle to grid communication interface
  - Part 3: Physical layer and Data Link layer requirements (J2931)
- ISO 15118-4 Ed.1: Road vehicles — Vehicle to grid communication interface
  - Part 4: Network and application protocol conformance test (J2953 is Interoperability)
- ISO 15118-5 Ed.1: Road vehicles - Vehicle to grid communication interface
  - Part 5: Physical and data link layer conformance test (J2953 is Interoperability)
- ISO 15118-6 Ed. 1.0: Road vehicles - Vehicle to grid communication interface
  - Part 6: General information and use-case definition for wireless communication (J2836/6)
- ISO 15118-7 Ed. 1.0: Road vehicles - Vehicle to grid communication interface
  - Part 7: Network and application protocol requirements for wireless communication (J2847/6)
- ISO 15118-8 Ed. 1.0: Road vehicles - Vehicle to grid communication interface
  - Part 8: Physical layer and data link layer requirements for wireless communication (J2931/6)

ISO 15118 ED 2

- ISO 15118-1: ED 2 - Road vehicles - Vehicle to grid communication interface
  - Part 1: General information and use-case definition (J2836)
- ISO 15118-2: ED 2 - Road vehicles – Vehicle to Grid communication Interface
  - Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements (J2847)
- ISO 15118-3: ED 2 - Road Vehicles - Vehicle to grid communication interface
  - Part 3: Physical layer and Data Link layer requirements (J2931)
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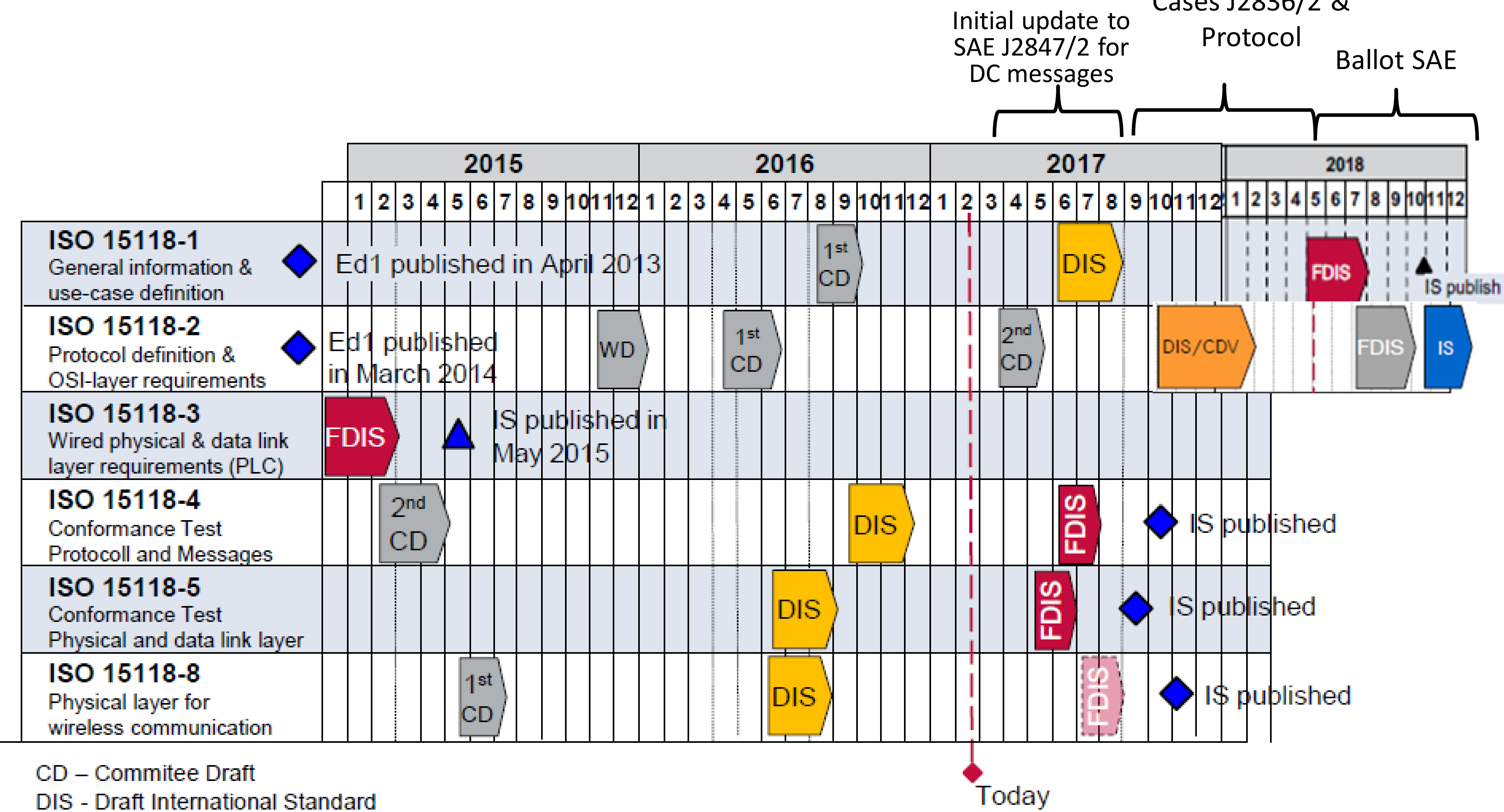
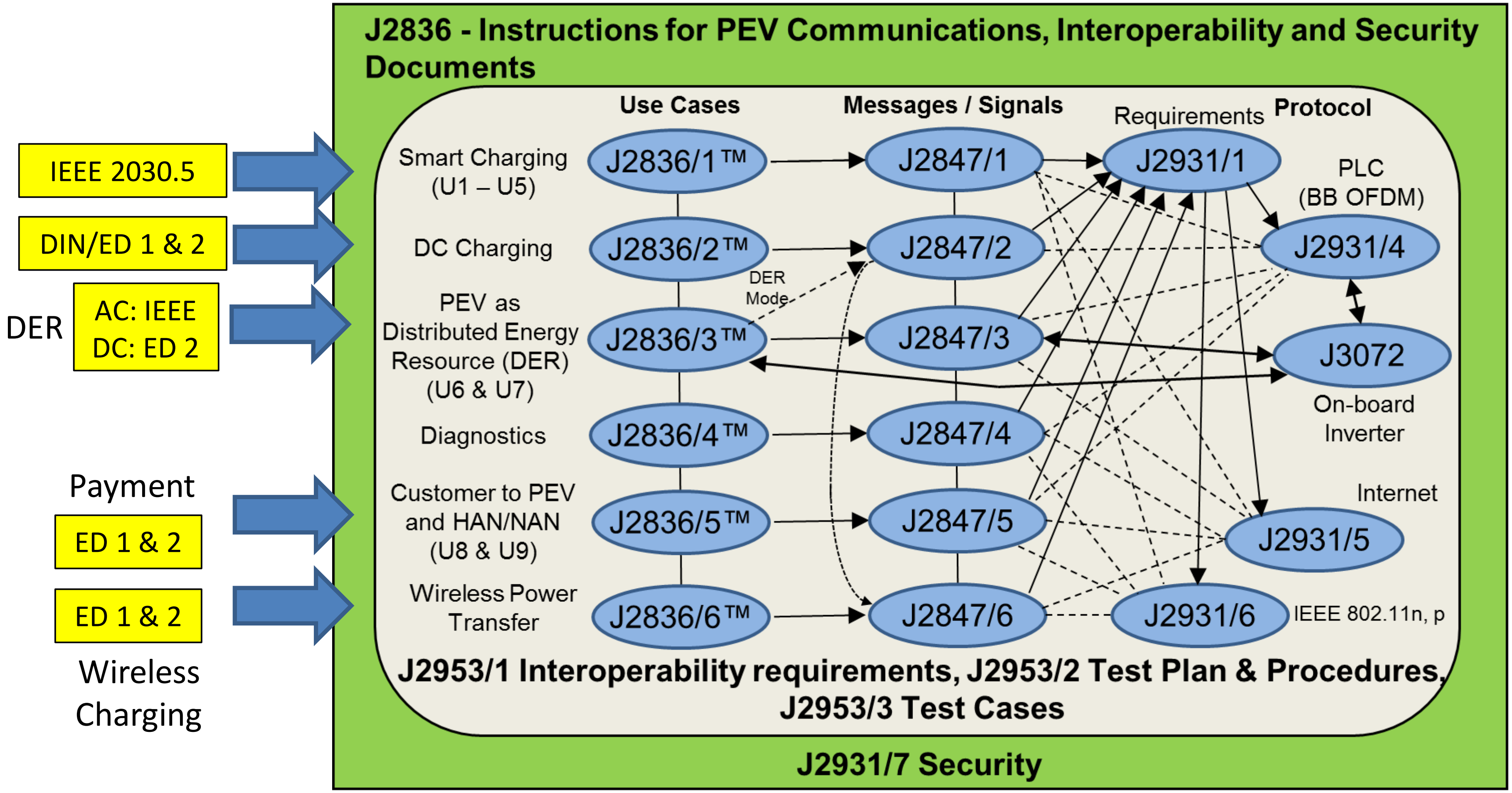
- ~~ISO 15118-6 Ed. 1.0: Road vehicles - Vehicle to grid communication interface~~
  - ~~Part 6: General information and use-case definition for wireless communication~~ (J2836/6)
- ~~ISO 15118-7 Ed. 1.0: Road vehicles - Vehicle to grid communication interface~~
  - ~~Part 7: Network and application protocol requirements for wireless communication~~ (J2847/6)
- ISO 15118-8 Ed. 1.0: Road vehicles - Vehicle to grid communication interface
  - Part 8: Physical layer and data link layer requirements for wireless communication (J2931/6)

ISO/SAE Schedule



CD – Commitee Draft
DIS - Draft International Standard
FDIS - Final Draft International Standard
IS - International Standard

SAE/IEEE/ISO/DIN common material



DIN/ISO: DIN 70121:2014, ISO 15118 ED 1, ED 2

DER: J2847/2 for DC DER using ED 2, J2847/3 for AC DER using IEEE

Current Status

Active/open SAE documents

1. J2836™ – V1 - Instructions for PEV Communications, Interoperability and Security Documents
2. J2836/4™ - V1 – Diagnostics
3. J2836/5™ - V2 – Customer to PEV Use Cases
4. J2847/2 – V4 - DC Charging messages/signals
5. J2931/1 – V4 – Communication Requirements
6. J2931/7 – V1 - Security
7. J2953/1 – V2 - Interoperability requirements
8. J2953/2 – V2 – Interoperability Plan and Report
9. J2953/3 – V1 – Interoperability Test Cases

Open mid-2017

10. J2836/2™ - V2 – DC Charging Use Cases
11. J2836/6™ - V2 – Wireless Charging Use Cases
12. J2847/6 – V2 – Wireless Charging messages/signals
13. J2931/6 – V2 Wireless Charging protocol

Summary of active documents in 8 categories:

1. New document "J2836 - Instructions for PEV Communications, Interoperability and Security Documents"
   1st cut of the document is posted with meetings starting in April. The intent is to summarize Bubble & Venn diagrams, then instructions, history and future plans for the documents based on functional objective (e.g. (1) if I want to do V2G with an off-board inverter, what documents and items within them do I need, (2) What do we intend for V3 of J2953, etc…)
2. Diagnostics - J2836/4 Use Cases
   1st meeting in Feb, with 2-3 more, then publication.
   V1 includes the analogue diagnostics for the Control Pilot & Prox for opens, shorts low and high at various points.
   V2: Plan to re-open for additional charging requirements (AC, DC, WPT …)
3. Customer to PEV
   J2836/5 Use Cases, U10 for payment is posted & 1st meeting to be scheduled soon.
   Next steps are messages/protocol documents
4. DC Charging (J2847/2 - V4), to harmonize with ISO
   ISO 15118-2 ED 2, start of CD2 started in April 2017, should be ready to update SAE standards. Verify technical changes at DIS stage (Oct 2017)
   Plan to open Use Cases (J2836/2™) June 2017 when ISO 15118-1 ED 2 in DIS
   Update J2931/1 Requirements along with J2847/2 updates

Categories (cont)

5. PEV as a Distributed Energy Resource (DER) - Hank McGlynn is lead
   J2836/3™ - V2 - Use Cases for the PEV Communicating as a Distributed Energy Resource (DER)
      Published Jan 2017.
   J2847/2 updates are next (for off-board inverters), if 15118 ED 2, DC DER is not sufficient.
6. Wireless Charging – April 2017, plan to open use cases (J2836/6™, messages J2847/6 and protocol (J2931/6) to harmonize with ISO 15118 ED 2, is ready for DIS
   Still missing some Fine Positioning messages in one of the annexes.
7. Security – Gorden Lum is lead
   J2931/7 – V1 – Security details - Continuing monthly meetings and reviewing other security documents for reference. V1 ballot expected 3Q 2017.
8. Interop – Ted Bohn is lead
   J2953/1 – V2 - Interoperability requirements
   J2953/2 – V2 – Interoperability Plan and Report
   J2953/3 – V1 – Test Cases (DC charging is 1st, potentially AC Test Cases)
   Need to include any changes from J1772, V7 in J2953/1 & /2.
   To include all Golden Test Device (GTD) test cases (safety, AC, DC).
   Test Event #6 in France June 22nd 23rd along with ISO 15118 ED 2 meetings and GTD is planned to be tested (1st time).

Summary/Backup

Use Case Document Status - TIR

J2836™ - Instructions for PEV Communications, Interoperability and Security Documents

- V1 Started – Meetings planned for 2Q-3Q 2017, expected publication 4Q 2017.

J2836/1™ - Utility Use Cases

- V1 Published 4-8-10

J2836/2™ - DC Charging Use Cases

- V1 Published 9-15-11
- V2 Planned to reopen June 2017 to incorporate ISO 15118-1 ED 2 (then revisit at DIS level for technical changes)
  - Expected publication 2Q 2018

J2836/3™ - PEV as a Distributed Energy Resource (DER) Use Cases

- V1 Published 1-3-13
- V2 Published 01-18-2017

J2836/4™ - Diagnostics Use Cases

- V1 Started for failures on control pilot and prox, adding diagnostics
  - Expected publication 4Q 2017
- V2 expected to reopen 1Q 2018, will be next after J2953/1 & /2 (Interoperability) for DC charging is complete, GTD is validated for DIN and ISO 15118 ED 1.
- V3 for WPT

Use Case Document Status – TIR (cont)

J2836/5™ - Customer to PEV Use Cases

- V1 published 5-7-15
- V2 reopened for U10 (Payment)

J2836/6™ - Wireless Charging Use Cases

- V1 Published 5-3-13.
- V2 Planned for updates from 15118-1 ED 2 at DIS stage
- V3 Potentially for dynamic WPT

Signal/Message Document Status – RP/Standard

J2847/1 - Utility signals/messages
- V1 Published 6-16-10, V2 5-9-11, V3 11-9-11, V4 11-5-13

J2847/2 - DC Charging (Standard)
- V1 Published 10-21-11,
- V2 – 8-20-12 to align with J1772 V5 (DC charging).
- V3 Published 4-9-15 to align with DIN SPEC 70121 V6a
- V4 restarted (June, 2015) to cover
  - EVSE inverter with DC RPF (J2836/3 V2)
  - Include ISO/IEC 15118-2 ED 2 updates (variations to DIN SPEC 70121)
  - Include common items to Wireless Charging updates

J2847/3 - PEV as a Distributed Energy Resource (DER)
- V1 Published 12-10-13

J2847/4 - Diagnostics
- Waiting for J2836/4™ V1 & J2953/1 & /2 V2 & /3 V1 (Interoperability)

J2847/5 - Customer to PEV
- Meetings to start after J2836/5™ Use Case 10 is complete.

J2847/6 - Wireless Charging
- V1 published 8-5-15
- V2 planned for unresolved issues from V1 and updates from ISO 15118-2 (ED 2).
- V3 potentially for dynamic

Requirements and Protocol Documents - TIR

J2931/1 – Requirements

- V1 Published 1-24-12, V2 Published 9-7-12
- V3 Published 1-5-15 for DC Charging
- V4 Reopened for Security additions & ISO 15118 ED updates

J2931/4 – PowerLine Carrier (PLC) – wired communication protocol

- V1 Published 7-26-12, V2 Published 11-14-13
- V3 Published 10-22-15 for DC Charging

J2931/5 – Telematics – wireless communication protocol

- Waiting for J2847/5

J2931/6 – Wireless Charging communication protocol

- V1 Published 8-27-15
- V2 Will reopen for updates to 15118-3 ED 2
- V3 Will reopen for dynamic

J2931/7 - Security

- V1 being finalized to move into ballot

Interoperability Documents - RP

J2953/1 – Requirements

- V1 Published 10-7-13.
  - V1 started testing for the analogue communications (J1772™ control pilot and prox).
- V2 is addressing digital communication for DC charging
- V3 planned to include WPT

J2953/2 – Test plan

- V1 Published 1-22-14
- V2 Adding V1 updates and DC Charging
- V3 planned to include WPT

J2953/3 – Test Cases

- V1 started to capture Safety, AC and DC test cases

On-board Inverter - Standard

J3072 – Interconnection Requirements for Onboard, Utility-Interactive, Inverter Systems

- V1 published 4-9-15.

The End

Questions?

SAE Medium/Heavy Duty Task Force Update

Includes:
J3068 - Handheld 3-phase AC
J3105 - Overhead DC

Barber Motorsports Museum
Birmingham, Alabama 35094 USA

Rodney McGee
Chairman
SAE Medium/Heavy Duty Task Force

Tuesday, March 28, 2017 (Truck/Bus)
Wednesday/Thursday, March 29-30, 2017 (IWC)

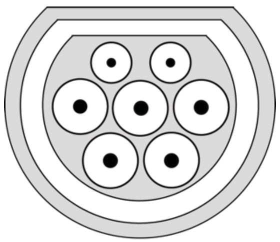
Current Documents Under Development

- **EV Power Transfer using Three-phase Capable Coupler (J3068)**
  - Three-phase AC for usage with on-board or integrated chargers
  - Co-leds Jim McLaughlin and Lennart Balgård
- **EV Power Transfer using Overhead Coupler (J3105)**
  - Overhead DC charging
  - Led by Mark Kosowski
- **Wireless charging**
  - Not in this SAE TEVHYB13 MD/HD Task Force
  - Covered by sub-group as part of J2954 effort
  - Aims for 250kW power level (vs 22kW)

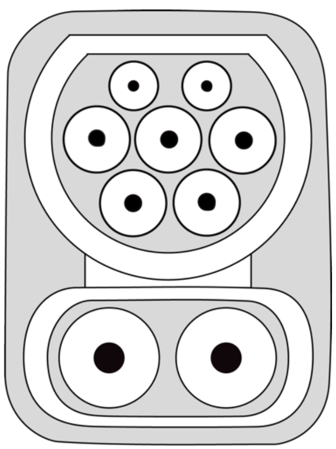
J3068 Overview

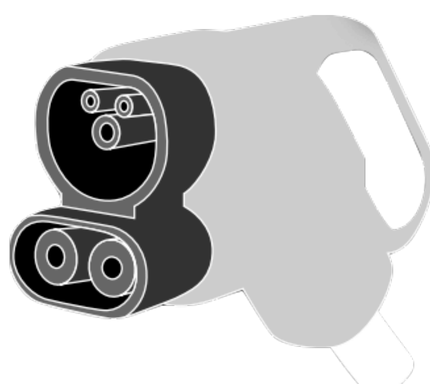
- EVSE
  - Must be evaluated to UL-2594, UL-2231
- Cordset / Coupler
  - Must be evaluated to UL-2251
  - Directly refers to IEC mechanical drawings
    - AC --- 62196-2 Sheets 2-IIf and 2-IIe
    - AC+DC --- 62196-3 Sheet 3-IVa and 3-IVc
- Power levels and voltage
  - Voltages
    - USA 208/120Y & 480/277Y VAC
    - Canada 208/120Y & 600/347Y VAC
  - Power example
    - 16A 480VAC 3ø = 11kW
    - 80A 480VAC 3ø = 65kW
    - 160A 480VAC 3ø = 133kW
    - 160A 600VAC 3ø = 166kW

SAE J3068



Inlet Configurations	Description	Utilizable Nominal Input Voltages
J3068 AC_6	AC only	VAC_{nom} 208/120Y, 480/277Y, 600/347Y
J3068 AC_6/DC_8	AC on 6mm pins DC on 8mm pins	VAC_{nom} 208/120Y, 480/277Y, 600/347Y VDC 1000 max
J3068 DC_8	DC on 8mm pins only	VDC 1000 max





Note: Other configurations are not currently discussed in the document

J3068 News and Updates

- Meetings and documents
  - Next meeting in early April
  - Expect a topic to follow mid-April
  - Move the document towards it's ballot this year
- Prototype demonstration project
  - Start planning for interoperability testing
  - Ensure availability of tested / listed components to build J3068 systems for North American market

J3068 News and Updates

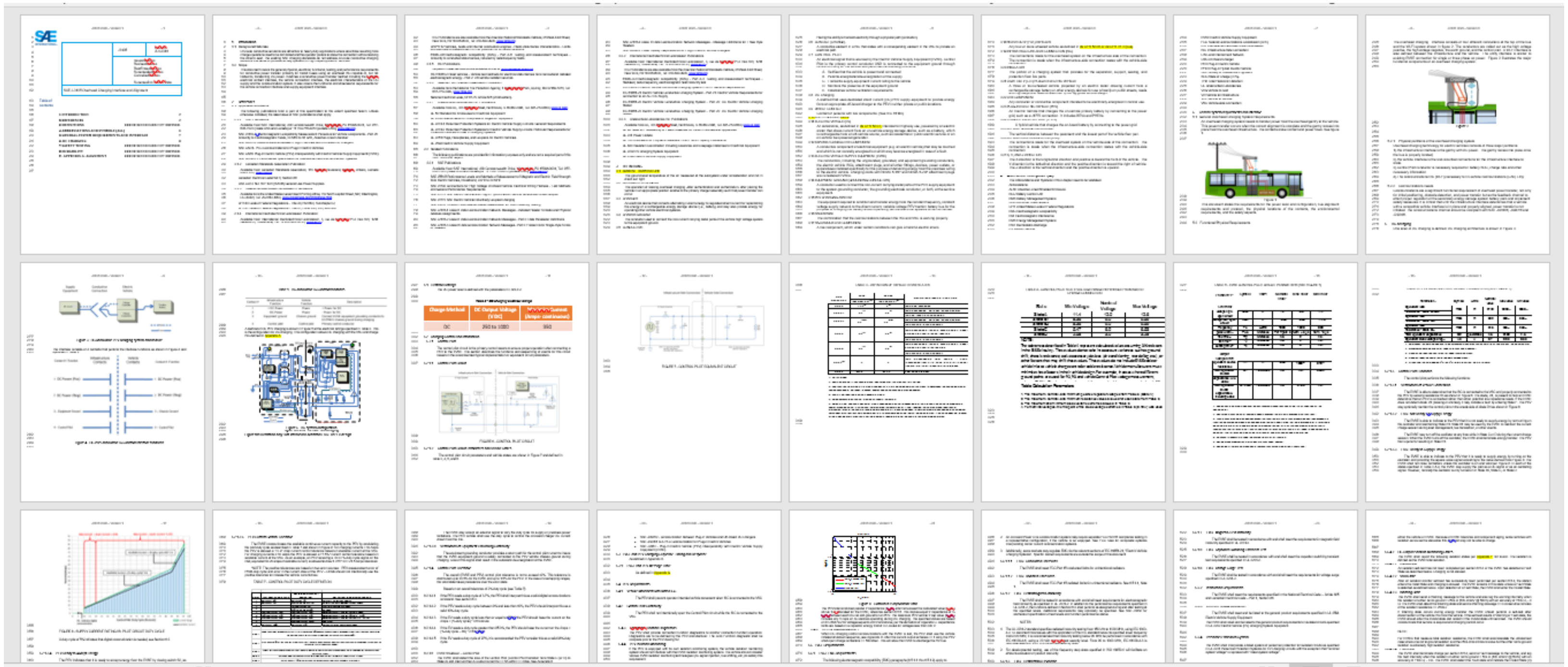
J3105 Approved Requirements

Item	J-3105 Requirements
Power Configuration	DC
Mating Apparatus Mounting Location	overhead
Loss Of Power Self Return	yes
Number of Contacts	Earth, Plus, Neg, Pilot
Pantograph Type	top-down
Pantograph mounting	Infrastructure side
Buy America Reasonably Expected	yes
Minimal Acceptable Lateral Tolerance (in)	24
Minimal Acceptable Longitudinal Tolerance (in)	18
Stopping Reference	Center Line of Front Door
Connection Point on the Roof	Near Front
Snow Handling	yes
HV Touch Safe While Not Charging	yes
HV Touch Safe While Charging	yes
Communication Protocol	J1772 CCS Variant
Compensation for Kneeling	yes
Operational Temperature	-40C to +45C
Wind tolerance	Absolutely
Connection Noise	Low
Connection Sequence	Pilot and PE first, then HV contacts

Overhead Charging Requirements

- **Two Power Levels are being considered-**
  - Level 1: 250 to 1000 V up to 600 A
  - Level 2: 250 to 1000 V up to 1500 A
  - Level 1 and Level 2 need to be compatible
- **Study has occurred to finalize the position on the bus roof**
- **Connection geometry is being considered**

J3105 Document Status



Currently, ~57 pages long Includes references, and basic requirements

TIR planned to be complete in the 4th Quarter 2017

Joining the Task Force (TEVHYB13)

- **Two documents are being developed under the SAE Medium and Heavy Duty Vehicle Conductive Charging Task Force**
  - EV Power Transfer using Overhead Coupler (J3105)
  - EV Power Transfer using Three-phase Capable Coupler (J3068)
- **Download the form to join the task force**
  - http://bit.ly/sae-join
  - Return to SAE Staff:
    - Pat Ebejer   pebejer@sae.org

Questions?