National Electric Transportation Infrastructure Working Council (IWC): 2011 Annual Report

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Technical Update, December 2011

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This is an EPRI Technical Update report. A Technical Update report is intended as an informal report of continuing research, a meeting, or a topical study. It is not a final EPRI technical report.

NOTE

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ABSTRACT

The National Electric Transportation Infrastructure Working Council (IWC) is a group of individuals whose organizations have a vested interest in the emergence and growth of electric transportation, in particular, the plug-in electric vehicle (PEV) industries as well as truck stop electrification (TSE) and port electrification. IWC includes representatives from electric utilities, vehicle manufacturing industries, component manufacturers, government agencies, related industry associations, and standards organizations. The objective of IWC meetings is to develop recommendations for PEV, truck stop electrification, and port electrification infrastructure standards and to serve as a forum for infrastructure problem solving and for information exchange between industries. During the second part of 2010 and leading into 2011, the IWC was reconfigured into the following four areas: Infrastructure Steering Committee, Non-Road Transportation Electrification Committee, On-Road Codes and Standards, and Advanced Electric Transportation Infrastructure Technology. This report discusses the 2011 activities of each committee and evaluates the revised mission statements.

Keywords
Plug-In Hybrid Electric Vehicles
Truck Stop Electrification
Port Electrification
Electric Vehicles
National Electric Transportation Infrastructure Working Council (IWC)

EXECUTIVE SUMMARY

Background

The National Electric Transportation Infrastructure Working Council (IWC) is a group of individuals whose organizations have a vested interest in the emergence and growth of electric transportation, in particular, the plug-in electric vehicle (PEV) industries, as well as truck stop electrification (TSE) and port electrification. IWC includes representatives from electric utilities, vehicle manufacturing industries, component manufacturers, government agencies, related industry associations, and standards organizations.

Objectives

To develop recommendations for PEV, truck stop electrification, and port electrification infrastructure standards and to serve as a forum for infrastructure problem solving and for information exchange between industries.

Approach

During the first part of 2010, the IWC was composed of four committees: Infrastructure Steering Committee, Plug-in Electric Vehicle Working Group (PEV), Transportation Electrification Committee (TEC), and the Code Revision Task Force. During the second part of 2010 and continuing into 2011, the IWC was reconfigured into the following four areas: Infrastructure Steering Committee, Non-Road Transportation Electrification, On-Road Codes and Standards, and Advanced Electric Transportation Infrastructure Technology.

Results

Infrastructure Steering Committee: Four IWC meetings were held in 2011. The ISC reviewed the results of the meetings of each of its committees and provided direction in the selection of topics for discussion. It also evaluated the revised mission statements of the PEV and TEC, adopted presenter and participant guidelines, and amended its by-laws to expand the number of voting members to 21. The ISC supported the successful Plug-In 2011 conference.

Non-Road Transportation Electrification Committee (previously the Transportation Electrification Committee): The IWC monitored the progress of the following non-road codes and standards: IEC TC18 MT26 (electrical installation in ships), IEC SC23H PT HVSC (IEC 62613 series on high voltage shore connection systems), and IEEE P1713 (Standard for Connecting Commercial Ships to Shore Power). The committee also obtained updates from EPRI's Port, Rail, Truck Electrification (PoRTE) Committee on various EPRI projects related to non-road electrification, including case studies of electric rubber-tired gantry cranes and electric ship-to-shore cranes, a cost-benefit analysis of refrigerated container racks, a PEV yard tractor demonstration, quantification of energy use and emission reduction with electric transportation in mining, and opportunities for rail electrification. Updates on truck stop electrification were presented by several TSE implementers and initial discussions were held on possible proposals for changes to Article 626 on electrified parking spaces for the next code cycle of the National Electrical Code (NEC). This included revision to the Code language to allow the truck parking space equipment to also be modified for use in charging electric vehicles. The committee obtained updates from the National Institute of Science and Technology (NIST) on the development of a framework to achieve interoperability of smart grid devices and systems, in particular, electric vehicle to grid interoperability.

On-Road Codes and Standards (previously under the Plug-In and Hybrid Electric Vehicle Working Group): The IWC worked with SAE J1772™ (Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler), dealing with charger configuration and ratings, terminology, coupler compatibility testing, a hybrid coupler design, and DC fast charge. The committee also monitored draft charging standards in China with a view towards future harmonization. The committee reviewed the work of the Society of Automotive Engineers (SAE) Communication Task Force for SAE J2293 which includes J2836 (information report including use cases) and J2847 (vehicle-utility communication). The committee was informed of new SAE efforts on EVSE compatibility (J2953) and on inductive charging (J2954). Updates were provided on the work of IEC TC69 WG4 (IEC 61851 series on EV conductive charging system), focusing on general requirements, construction and test requirements for connection to AC or DC supply, and both AC supply equipment and DC charging stations, with the goal of including the SAE J1772™ configuration for AC charging, adding configurations for DC and AC/DC charging and a new proposal for the control communication protocol. In related work, the committee also monitored the progress of IEC SC 23H (industrial plugs), in particular the general requirements and dimensional interchangeability of plugs, socket-outlets, vehicle couplers and vehicle inlets under IEC 62196 (conductive charging of electric vehicles).

Advanced Electric Transportation Infrastructure Technology (previously under Plug-In Hybrid and Electric Vehicle Working Group): The committee arranged presentations on various technologies including Pacific Gas & Electric (PG&E) DC fast charging demonstration project using a DC Level 2 charger; Tennessee Valley Authority (TVA)'s planned network of residential, commercial, and DC fast charging stations in a three-city area; CHAdeMO and DC charging stations in Japan; EVSE installations at a parking deck; National Renewables Energy Laboratory (NREL) Alternative Fueling Station Locator; and block heater plug infrastructure in Canada. Updates were provided on more than two dozen manufacturers of Electric Vehicle Supply Equipment (EVSE) related equipment, Underwriters Laboratories (UL) listed battery charging systems, UL listed EVSE units, and UL listed EV couplers. UL presented its Contractor Certification and Training Programs and the National Electrical Contractors Association described its training program for electrical contractors. The committee also reviewed draft provisions related to EV installation in California's green building standards and NREL's national EV permitting template. Updates were presented on Smart Energy Profile (SEP) 2.0, advanced metering, and National Institute of Science and Technology (NIST) activities. Electric utilities presented their perspectives on EV charging infrastructure costs, roaming, and billing reconciliation.

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INTRODUCTION

The National Electric Transportation Infrastructure Working Council (IWC) is a group of individuals whose organizations have a vested interest in the emergence and growth of the electric vehicle (EV) and plug-in hybrid electric vehicle (PHEV) industries, as well as truck stop electrification (TSE) and port electrification. The IWC includes representatives from electric utilities, vehicle manufacturing industries, component manufacturers, government agencies, related industry associations, and standards organizations.

The purpose of the Infrastructure Steering Committee (ISC) is to direct the activities of the IWC. The objective for the IWC is to develop recommendations for EV, Plug-in Electric Vehicle (PEV), truck stop electrification, and port electrification infrastructure standards and to serve as a forum for infrastructure problem solving and for information exchange between industries.

IWC committees meet four times a year to address the main areas of transportation electrification infrastructure research and development. Other subcommittees or task forces are formed by the ISC on an as-needed basis. During the first part of 2010, the IWC was composed of four committees: Infrastructure Steering Committee, Plug-in and Electric Vehicle Working Group (PEV), Transportation Electrification Committee (TEC), and the Code Revision Task Force. During the second part of 2010, the IWC was reconfigured into the following new four areas: Infrastructure Steering Committee, Non-Road Transportation Electrification, On-Road Codes and Standards, and Advanced Electric Transportation Infrastructure Technology. This same structure was followed for the 2011 meetings.

The IWC makes recommendations to such organizations as the Institute of Electrical and Electronic Engineers (IEEE), National Fire Protection Association (NFPA), American National Standards Institute, and the Society of Automotive Engineers (SAE). Recommendations focus on standards that promote widespread compatibility of PEV, truck stop electrification, and port electrification infrastructure; reduced cost; and consumer safety and convenience.

The IWC meeting is currently divided into three key sessions:

- Non-Road Transportation Electrification Activities
  - Codes and Standards Update
  - Port Electrification
  - Truck & Bus Electrification
  - Other Non-Road Activities and Relevant Electric Transportation Infrastructure
- On-Road Transportation Activities
  - Codes and Standards
  - Advanced Electric Transportation Infrastructure Technology

- Infrastructure Steering Committee (ISC)

Scope of This Report

IWC committees met four times in 2011 to address the main areas of EV, PEV, truck stop electrification, port electrification, and other transportation electrification infrastructure research and development.

Infrastructure Steering Committee: Four ISC meetings were held in 2011. The ISC reviewed the results of the meetings of each of its committees and provided direction in the selection of topics for discussion. It also evaluated the revised mission statements and amended its by-laws to expand the number of voting members to 21. The ISC supported the successful Plug-In 2011 conference.

Non-Road Transportation (previously the Transportation Electrification Committee): The IWC monitored the progress of the following non-road codes and standards: IEC TC18 MT26 (electrical installation in ships), IEC SC23H PT HVSC (IEC 62613 series on high voltage shore connection systems), and IEEE P1713 (Standard for Connecting Commercial Ships to Shore Power). The committee also obtained updates from EPRI's Non road Electrification Transportation Advisory Committee, formerly the EPRI Port, Rail, Truck Electrification (PoRTE) Committee on various EPRI projects related to non-road electrification, including case studies of electric rubber-tired gantry cranes and electric ship-to-shore cranes, a cost-benefit analysis of refrigerated container racks, a PHEV yard tractor demonstration, quantification of energy use and emission reduction with electric transportation in mining, and opportunities for rail electrification. Updates on truck stop electrification were presented by several TSE implementers and initial discussions were held on possible proposals for changes to Article 626 on electrified parking spaces for the next code cycle of the National Electrical Code (NEC).

The committee obtained updates from the National Institute of Science and Technology (NIST) on the development of a framework to achieve interoperability of smart grid devices and systems, in particular, electric vehicle to grid interoperability. During the year, the committee revised its mission statement, namely, to support the development of infrastructure to facilitate global electric grid connectivity of transportation systems: by assessing infrastructure requirements to minimize the negative impacts on utility and customer systems; by facilitating and actively participating in appropriate codes and standards committees to promote connection standardization, safety, efficiency and functionality of grid-connected transportation systems; and by supporting the implementation of electric transportation systems that benefit the consumers and reduce carbon footprint and dependency on oil in accordance with applicable laws and regulations.

The Non-Road Electrification (NRE) committee met quarterly with the other two IWC committees to discuss the issues facing each member electric utility. Throughout the year, presentations were delivered that included

- Truck Stop Electrification
- Battery Electric Buses and High Power Charging

- Electric motorcycles, mining vehicles and ultracapacitor electric buses
- California EV/PEV organizations (CalStart)
- Fast charging connectors
- Product testing and certification options to UL
- Isolated and non-isolated systems
- Market research on EVSE installations
- Power Quality (PQ) Spectrum of Analysis of on board chargers/utility impact
- Utility challenges and obstacles/discussion/future direction

On-Road Codes and Standards (previously under the Plug-In and Hybrid Electric Vehicle Working Group): The IWC worked with SAE J1772™ (Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler), dealing with charger configuration and ratings, terminology, coupler compatibility testing, a hybrid coupler design, and DC fast charge. With the (J1772) Standard's publication in 2010, work began to include information regarding new interfaces, ratings and construction for conductive charge couplers for dedicated DC and AC/DC charging. The committee has continued to monitor draft charging standards developed in China and Korea with a view towards future harmonization. The committee reviewed the work of the SAE Communication Task Force for SAE J2293 which includes J2836 (information report including use cases) and J2847 (vehicle-utility communication). Based on various predictions of likely scenarios, the committee discussed utility cases that could meet the need of many utilities to maximize participation of their customers in utility programs. The committee was informed of new SAE efforts on EVSE compatibility (J2953), a communications technology (J2931) and on inductive charging (J2954).

Updates were provided on the work of IEC TC69 WG4 and it's project teams (IEC 61851 series on EV conductive charging system), including the publication of the 2nd Edition of IEC 61851-1, *Electric vehicle conductive charging system - Part 1: General requirements*, and continuing to focus on the following specific requirements:

- 61851-21 Ed. 2.0: *Electric vehicle conductive charging system - Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply*,

  This work is being done jointly with ISO TC22 SC21's newly formed subcommittee developing ISO 17409 Electrically propelled road vehicles -- Connection to an external electric power supply -- Safety requirements.

- 61851-22 Ed. 2.0: *Electric vehicle conductive charging system - Part 22: A.C. electric vehicle charging station*,

- 61851-23: *Electric vehicles conductive changing system - Part 23: D.C. Electric vehicle charging station*,

- 61851-24: *Electric vehicles conductive charging system - Part 24: Control communication protocol between off-board d.c. charger and electric vehicle*.

IEC TC 69 is working with ISO TC22 under a joint ISO/IEC working group (JWG) to develop the new IEC 15118 series standards for Road vehicles - Vehicle to grid communication interface.

In related work, the committee also monitored the progress of IEC SC 23H (industrial plugs), in particular the general requirements and dimensional interchangeability of plugs, socket-outlets, vehicle couplers and vehicle inlets. SC 23H has published an updated IEC 62196-1, Edition 2.0 (October 2011), *Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 1: General requirements* and new IEC 62196-2, (October 2011), *Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories*. It is working on IEC 62196-3 *Plugs, socket-outlets, and vehicle couplers - conductive charging of electric vehicles - Part 3: Dimensional compatibility and interchangeability requirements for dedicated d.c and combined a.c./d.c. pin and contact-tube vehicle couplers*.

The committee completed the work of taking the 1997 IWC legacy document, updating the parameters, and creating SAE J2894 on charger grid power quality. Updates were provided on IEEE 1547 (Interconnecting Distributed Resources with Electric Power Systems) and specifically, draft document P2030.1 which addresses applications for electric-sourced vehicles and related infrastructure. With regards to the National Electrical Code (NEC), EPRI's NEC Task Force worked with the NEC Code Panel 12's Task Group to develop code proposals rewriting the entire Article 625 and issuing two TIA's that amend the 2011 NEC. They address (1) cord and plug connection of electric vehicle supply equipment and electric vehicle charging systems and (2) permits the use of automatic load management systems to control the load on a service or feeder. As a result, EPRI's TF's proposals were included in Code Panel 12's recommendations for change in the 2014 edition of the NEC.

Advanced Electric Transportation Infrastructure Technology related to On-Road and Non-Road (previously under Plug-In Hybrid and Electric Vehicle Working Group): The committee arranged presentations on various technologies including PG&E's DC fast charging demonstration project using a DC Level 2 charger; TVA's planned network of residential, commercial, and DC fast charging stations in a three-city area; CHAdeMO and DC charging stations in Japan; EVSE installations at a parking deck; NREL's Alternative Fueling Station Locator; and block heater plug infrastructure in Canada.

Updates were provided on more than two dozen manufacturers of EVSE related equipment, UL listed battery charger systems, UL listed EVSE units, and UL listed EV couplers. UL presented its Contractor Certification and Training Programs and the National Electrical Contractors Association described its training program for electrical contractors. The committee also reviewed draft provisions related to EV installation in California's green building standards and NREL's national EV permitting template.

Updates were presented on Smart Energy Profile 2.0, advanced metering, and NIST activities. Electric utilities presented their perspectives on EV charging infrastructure costs, roaming, and billing reconciliation. Related technologies pertaining to public charging, smart charging networks, transaction systems and payment processing systems were discussed. The PEV working group revised its mission statement, namely, to support the development and deployment of plug-in electric vehicles (PEVs): by facilitating and actively participating in appropriate codes and standards committees on PEVs to promote the safety and function of plug-in hybrid and electric vehicles; by facilitating the interoperability of public charging infrastructure for PEVs; and by identifying infrastructure and utility issues for PEVs as mobile distributed electric resources (V2G).

Key aspects of 2011 activities are summarized in this report under the following categories

- Non-Road Transportation Activities covered in 2011
- – Update on key topics, current activity
- – Summary of issues and gaps identified
- – Summary of individual standards and future activities
- On-Road Transportation Activities covered in 2011
- – Update on key topics, current activity
- – Summary of issues and gaps identified
- – Summary of individual standards and future activities

2

CODES AND STANDARDS FOR NON-ROAD AND ON-ROAD TRANSPORTATION

This chapter provides a list of all relevant codes and standards that are covered within the IWC Meetings.

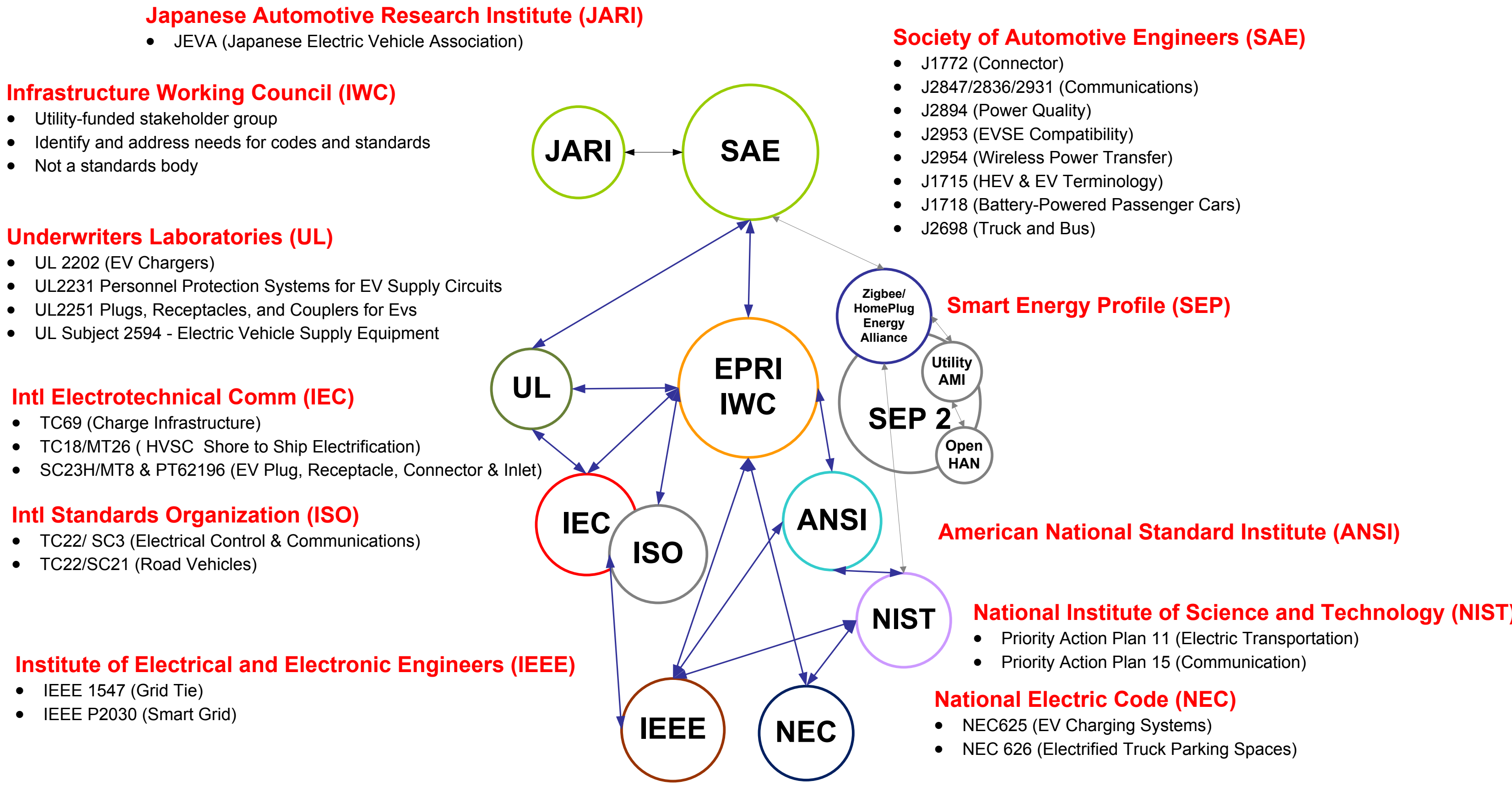

Figure 2-1
Code and Standard Committees for On-Road and Non-Road Transportation

Table 2-1
Standard Activity Updates

Document	Title	Status	URL	
SAE J1711	*Recommended practice for measuring the exhaust emissions and fuel economy of Hybrid-Electric Vehicles*	Issued 2010 Under Revision	http://standards.sae.org/j1711_201006	This SAE Recommended Practice establishes uniform chassis dynamometer test procedures for hybrid-electric vehicles (HEVs) that are designed to be driven on public roads. The procedure provides instructions for measuring and calculating the exhaust emissions and fuel economy of HEV's driven on the Urban Dynamometer Driving Schedule (UDDS) and the Highway Fuel Economy Driving Schedule (HFEDS), as well as the exhaust emissions of HEVs driven on the US06 Driving Schedule (US06) and the SC03 Driving Schedule (SC03). However, the procedures are structured so that other driving schedules may be substituted, provided that the corresponding preparatory procedures, test lengths, and weighting factors are modified accordingly. Furthermore, this document does not specify which emissions constituents to measure (e.g., HC, CO, NOx, CO2); instead, that decision will depend on the objectives of the tester. For purposes of this test procedure, an HEV is defined as a road vehicle that can draw propulsion energy from both of the following sources of stored energy: 1) a consumable fuel and 2) a rechargeable energy storage system (RESS) that is recharged by an electric motor-generator system, an off-vehicle electric energy source, or both. Consumable fuels that are covered by this document are limited to petroleum-based liquid fuels (e.g., gasoline and Diesel fuel), alcohol-based liquid fuels (e.g., methanol and ethanol), and hydrocarbon-based gaseous fuels (e.g., compressed natural gas). RESSÕs that are covered by this document include batteries, capacitors, and electromechanical flywheels. Single-roll, electric dynamometer test procedures are specified to minimize the test-to-test variations inherent in track testing and to conform with standard industry practice for exhaust emissions and fuel economy measurements. Also, this document does not include test procedures for "recharge-dependent" operating modes (see 3.1.12 for definition).
SAE J1715	*Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology*	Issued 2008 Under Revision	http://standards.sae.org/j1715_200802	This SAE Information Report contains definitions for electric vehicle terminology. It is intended that this document be a resource for those writing other electric vehicle documents, specifications, standards, or recommended practices. Hybrid electric vehicle terminology will be covered in future revisions of this document or as a separate document.
SAE J1718	*Measurement of Hydrogen Gas Emissions from Battery-Powered Passenger Cars and Light Trucks During Battery Charging*	Issued	http://standards.sae.org/j1718_200811	This SAE Recommended Practice describes a procedure for measuring gaseous hydrogen emissions from the aqueous battery system of a battery-powered passenger car or light truck. The purpose of this procedure is to determine what concentrations of hydrogen gas an electric vehicle together with its charger will generate while being charged in a residential garage. Gaseous emissions are measured during a sequence of vehicle tests and laboratory tests that simulate normal and abnormal conditions during operational use. The results of this test may be used to determine whether or not forced air ventilation is required when a particular electric vehicle and its associated battery and charging system are used in a residential garage.

Document	Title	Status	URL	
SAE J1772™	*SAE Electric Vehicle Conductive Charge Coupler (Dictates EVSE Design Requirements, Charging Levels, AC and DC Power Couplers for conventional and fast chargers)*	Issued 2010 For Purchase Under Revision	http://standards.sae.org/j1772_201001	This SAE Recommended Practice covers the general physical, electrical, functional and performance requirements to facilitate conductive charging of EV/PEV vehicles in North America. This document defines a common EV/PEV and supply equipment vehicle conductive charging method including operational requirements and the functional and dimensional requirements for the vehicle inlet and mating connector.
SAE J1773	*SAE Electric Vehicle Inductively Coupled Charging*	Issued 2009	http://www.sae.org/technical/standards/J1773_200905	This SAE Recommended Practice establishes the minimum interface compatibility requirements for electric vehicle (EV) inductively-coupled charging for North America. This part of the specification is applicable to manually connected inductive charging for Levels 1 and 2 power transfer. Requirements for Level 3 compatibility are contained in Appendix B. Recommended software interface messaging requirements are contained in Appendix A. This type of inductively-coupled charging is generally intended for transferring power at frequencies significantly higher than power line frequencies. This part of the specification is not applicable to inductive coupling schemes that employ automatic connection methods or that are intended for transferring power at power line frequencies. in the charge coupler). The charge controller signals the charger to stop charging when it determines that the batteries are completely charged or a fault is detected during the charging process.
SAE J1797	*Recommended Practice for Packaging of Electric Vehicle Battery Modules*	Issued 2008	http://www.sae.org/technical/standards/J1797_200806	This SAE Recommended Practice provides for common battery designs through the description of dimensions, termination, retention, venting system, and other features required in an electric vehicle application. The document does not provide for performance standards. Performance will be addressed by SAE J1798. This document does provide for guidelines in proper packaging of battery modules to meet performance criteria detailed in J1766
SAE J1798	*Recommended Practice for Performance Rating of Electric Vehicle Battery Modules*	Available	http://standards.sae.org/j1798_200807	This SAE Recommended Practice provides for common test and verification methods to determine Electric Vehicle battery module performance. The document creates the necessary performance standards to determine (a) what the basic performance of EV battery modules is; and (b) whether battery modules meet minimum performance specification established by vehicle manufacturers or other purchasers. Specific values for these minimum performance specifications are not a part of this document
SAE J2288	*Life Cycle Testing of Electric Vehicle*	Issued 2008	http://www.sae.org/technical/standards/J2288_	This SAE Recommended Practice defines a standardized test method to determine the expected service life, in cycles, of electric vehicle battery modules. It is based on a set of nominal or baseline operating conditions in order to characterize the

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	Battery Modules		200806	expected degradation in electrical performance as a function of life and to identify relevant failure mechanisms where possible. Accelerated aging is not included in the scope of this procedure, although the time compression resulting from continuous testing may unintentionally accelerate battery degradation unless test conditions are carefully controlled. The process used to define a test matrix of accelerated aging conditions based on failure mechanisms, and to establish statistical confidence levels for the results, is considered beyond the scope of this document. Because the intent is to use standard testing conditions whenever possible, results from the evaluation of different technologies should be comparable. End-of-life is determined based on module capacity and power ratings. This may result in a measured cycle life different than that which would be determined based on actual capacity; however, this approach permits a battery manufacturer to make necessary tradeoffs between power and energy in establishing ratings for a battery module. This approach is considered appropriate for a mature design or production battery. It should be noted that the procedure defined in this document is functionally identical to the USABC Baseline Life Cycle Test Procedure
SAE J2289	*Electric-Drive Battery Pack System: Functional Guidelines*	Issued 2008	http://www.sae.org/technical/standards/J2289_200807	This SAE Information Report describes common practices for design of battery systems for vehicles that utilize a rechargeable battery to provide or recover all or some traction energy for an electric drive system. It includes product description, physical requirements, electrical requirements, environmental requirements, safety requirements, storage and shipment characteristics, and labeling requirements. It also covers termination, retention, venting system, thermal management, and other features. This document does describe guidelines in proper packaging of the battery to meet the crash performance criteria detailed in SAE J1766. Also described are the normal and abnormal conditions that may be encountered in operation of a battery pack system --Purpose This document provides the guidelines for designing a battery system to package into manufacturer's electric drive vehicles. It lays the foundation for electric vehicle battery systems and provides information to assist in developing a robust battery system. --Field of Application This document applies to vehicles using electrically rechargeable storage traction batteries that provide energy and power to an electric drive system for propulsion, namely Electric Vehicles and some Hybrid Electric Vehicles. This document does not fully address all guidelines for mechanically rechargeable battery systems. Users of mechanically recharged batteries should evaluate applicability of individual sections of this document. --Product Classification The battery system is a vehicle subsystem that provides all or some of the traction power and energy for vehicles using electric drive systems. This document does not apply to low voltage non-traction battery supply systems. Product Description A battery system is the complete set of assemblies required to supply traction power and energy to an electric vehicle drive system. A battery pack is a single assembly with batteries that is part of a Battery System. In some cases a single pack may comprise the complete Battery System. Electric Drive vehicles may require an electrically rechargeable secondary battery to provide motive traction power and energy as well as power and energy for incidental loads like power steering, heating and air conditioning, FMVSS mandated exterior lighting, controls, customer convenience features, etc. The battery can also represent a significant physical load to the vehicle in terms of mass, volume, and controls complexity. Consequently, the battery exerts a significant factor in vehicle

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SAE J2293 / 1	*Energy Transfer System for Electric Vehicles – Part 1: Functional Requirements and System Architectures*	Issued 2008	http://www.sae.org/technical/standards/J2293/1_200807	SAE J2293 establishes requirements for Electric Vehicles (EV) and the off- board Electric Vehicle Supply Equipment (EVSE) used to transfer electrical energy to an EV from an Electric Utility Power System (Utility) in North America. This document defines, either directly or by reference, all characteristics of the total EV Energy Transfer System (EV-ETS) necessary to insure the functional interoperability of an EV and EVSE of the same physical system architecture. The ETS, regardless of architecture, is responsible for the conversion of AC electrical energy into DC electrical energy that can be used to charge the Storage Battery of an EV, as shown.
SAE J2293 / 2	*Energy Transfer System for Electric Vehicles – Part 2: Communication Requirements and Network Architecture*	Issued 2008	http://www.sae.org/technical/standards/J2293/2_200807	SAE J2293 establishes requirements for Electric Vehicles (EV) and the off-board Electric Vehicle Supply Equipment (EVSE) used to transfer electrical energy to an EV from an electric Utility Power System (Utility) in North America. this document defines, either directly or by reference, all characteristics of the total EV Energy Transfer System (EV-ETS) necessary to insure the functional interoperability of an EV and EVSE of the same physical system architecture. The ETS, regardless of architecture, is responsible for the conversion of AC electrical energy into DC electrical energy that can be used to charge the Storage Battery of an EV, as shown in Figure 1. The different physical ETS system architectures are identified by the form of the energy that is transferred between the EV and the EVSE, as shown in figure 2. It is possible for an EV and EVSE to support more than one architecture. This document does not contain all requirements related to EV energy transfer, as there are many aspects of an EV and EVSE that do not affect their interoperability. Specifically, this document does not deal with the characteristics of the interface between the EVSE and the Utility, except to acknowledge the Utility as the source of energy to be transferred to the EV.
SAE J2344	*Guidelines for Electric Vehicle Safety*	Issued 2010	http://www.sae.org/technical/standards/J2344_201003	This SAE Information Report identifies and defines the preferred technical guidelines relating to safety for Electric Vehicles (EVs) during normal operation and charging. Guidelines in this document do not necessarily address maintenance, repair, or assembly safety issues. The purpose of this SAE Information Report is to provide introductory safety guidelines information that should be considered when designing electric vehicles for use on public roadways. This document covers electric vehicles having a gross vehicle weight rating of 4536 kg (10 000 lb) or less that are designed for use on public roads
SAE J2380	*Vibration Testing of Electric Vehicle Batteries*	Issued 2009	http://www.sae.org/technical/standards/J2380_200903	This SAE Recommended Practice describes the vibration durability testing of a single battery (test unit) consisting of either an electric vehicle battery module or an electric vehicle battery pack. For statistical purposes, multiple samples would normally be subjected to such testing. Additionally, some test units may be subjected to life cycle testing (either after or during vibration testing) to determine the effects of vibration on battery life. Such life testing is not described in this procedure; SAE J2288 may be used for this purpose as applicable
SAE J2464	*Electric Vehicle Battery Abuse*	Issued 2009	http://www.sae.org/technical/st	This SAE Recommended Practice is intended as a guide toward standard practice and is subject to change to keep pace with experience and technical advances. It

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	Testing		andards/J2464_200911	describes a body of tests which may be used as needed for abuse testing of electric or hybrid electric vehicle batteries to determine the response of such batteries to conditions or events which are beyond their normal operating range. This document is derived from a similar document originally developed by the U.S. Advanced Battery Consortium
SAE J2758	*Determination of the Maximum Available Power from a Rechargeable Energy Storage System on a Hybrid Electric Vehicle*	Issued 2007	http://www.sae.org/technical/standards/J2758_200704	This document describes a test procedure for rating peak power of the Rechargeable Energy Storage System (RESS) used in a combustion engine Hybrid Electric Vehicle (HEV). Other types of vehicles with non fossil fuel primary engines, such as fuel cells, are not intended to use this test procedure
SAE J2698	*Primary Single Phase Nominal 120 VAC Wiring Distribution Assembly Design - Truck and Bus*	Issued 2008	http://standards.sae.org/j2698_200801	This SAE Recommended Practice covers the design and application of primary on-board wiring distribution system harnessing for surface vehicles. This document is intended for single phase nominal 120 VAC circuits that provide power to truck sleeper cab hotel loads so that they may operate with the main propulsion engine turned off. The power supply comes from alternative sources such as land-based grid power, DC-AC inverters and auxiliary power generators. The circuits may also provide power to improve vehicle performance through charging batteries or operating cold-weather starting aids. It does not provide guidance for electric or hybrid electric vehicle wiring circuits. Refer to SAE J1673 for high voltage automotive wiring assembly design. Engine block heaters are 120 VAC devices that are used on a multitude of vehicle platforms in addition to trucks with sleeper cabs. Generally, the engine block heater circuit is wired independent of hotel loads. SAE J2698 does not apply to independently wired engine block heater circuits. Engine block heaters that are integrated with hotel loads are subject to the guidelines in this recommended practice. It is understood that drivers may choose to operate 120 VAC devices with the truck moving or at rest. For example, a passenger may operate the microwave or watch television and need to operate an inverter. The environment that these devices are operated in can also vary with exterior ambient temperature extremes. Exposure to oil and vibration are other elements that typical household 120 VAC wiring would not normally be exposed to; therefore, the construction of this power distribution is made more robust for a mobile trucking environment. Driver interaction with the 120 VAC power through use of appliances or connection of cord sets requires special attention to safety aspects dictated in regulatory standards from Nationally Recognized Testing Laboratories (NRTLs) approved labs like Underwriters Laboratories (UL), Canadian Standards Association (CSA) or from the National Electric Code (NEC) that are not common practice with typical 12 VDC vehicle wiring. This recommended practice supports that all electrical materials, devices, components, appliances, fittings and equipment shall be Listed, Labeled or Certified to UL and CSA standards and shall be connected in an approved manner when

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				installed.
SAE J2836 / 1	*Use Cases for Communication between Plug-In Vehicles and the Utility Grid*	Issued 2010	http://standards.sae.org/j2836/1_201004	This SAE Information Report J2836 /1 establish use cases for communication between plug-in electric vehicles and the electric power grid, for energy transfer and other applications.
SAE J2836 / 2	*Use Cases for Communication between Plug-In Vehicles and the Supply Equipment (EVSE)*	Issued 2011	http://standards.sae.org/j2836/2_201109	This SAE Information Report J2836 / 2 establishes use cases for communication between plug-in electric vehicles and the electric vehicle supply equipment, for energy transfer and other applications
SAE J2836 /3	*Use Cases for Communication Between Plug-In Vehicles and the Utility Grid for Reverse Power Flow*	Under Development	http://standards.sae.org/wip/j2836/3	This SAE Information Report J2836/3 establishes use cases for communication between plug-in electric vehicles and the electric power grid, for reverse power flow.
SAE J2841	*Utility Factor Definitions for Plug-In Hybrid Vehicles Using Travel Survey Data*	Issued 2010	http://standards.sae.org/j2841_201009	The total fuel and energy consumption rates of a Plug-In Hybrid Electric Vehicle (PHEV) vary depending upon the distance driven. For PHEVs, the assumption is that operation starts in battery charge-depleting mode and eventually changes to battery charge-sustaining mode. Total distance between charge events determines how much of the driving is performed in each of the two fundamental modes. An equation describing the portion of driving in each mode is defined. Driving statistics from the National Highway Transportation Survey are used as inputs to the equation to provide an aggregate "Utility Factor" (UF) applied to the charge-depleting mode results.
SAE J2847 /1	*Communication between Plug-In Vehicles and the Utility Grid*	Issued 2011	http://standards.sae.org/j2847/1_201105	This SAE Recommended Practice J2847 / 1 establish requirements and specifications for communication between plug-in electric vehicles and the electric power grid, for energy transfer and other applications. Where relevant, this document notes, but does formally specify, interactions between the vehicle and vehicle operator
SAE J2847 / 2	*Communication between Plug-In Vehicles and the Supply Equipment*	Issued 2011	http://standards.sae.org/j2847/2_201110	This SAE Recommended Practice J2847/ 2 establish requirements and specifications for communication between plug-in electric vehicles and the EVSE.

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SAE J2847 / 3	*Communication between Plug-In Vehicles and the Utility Grid for Reverse Power Flow*	Under Development	**Error! Hyperlink reference not valid.**http://standards.sae.org/wip/j2847/3	This SAE Recommended Practice J2847/3 establishes the communication structure between plug-in electric vehicles and the electric power grid, for reverse power flow. This document identifies the equipment (system elements) and interactions to support grid-optimized AC or DC energy transfer for plug-in vehicles using Reverse Power Flow
SAE J2847 / 4	*Diagnostic Communication for Plug-in Vehicles*	Under Development	http://standards.sae.org/wip/j2847/4	This SAE Recommended Practice J2847/4 establishes the communication requirements for diagnostics between plug-in electric vehicles and the EV Supply Equipment (EVSE) for charge or discharge sessions. It takes the use case and general information identified in J2836/4™ and provides the detail messages and diagrams to implement the communication. This document identifies the diagnostic requirements and interactions to charge or discharge plug-in vehicles. Additional vehicle diagnostics may also be included.
SAE J2847 / 5	*Communication between Plug-in Vehicles and their customers*	Under Development	http://standards.sae.org/wip/j2847/5	This SAE Recommended Practice J2847/5 establishes the communication requirements between plug-in electric vehicles and their customers for charge or discharge sessions. It takes the use case and general information identified in J2836/5™ and provides the detail messages and diagrams to implement the communication. This document identifies the customer interface requirements and interactions to charge or discharge plug-in vehicles. This includes Vehicle Manufacturer specific messages regarding the plug-in vehicle and its operation.
SAE J2847 / 6	*Wireless Charging Communication between Plug-in Electric Vehicles and the Utility Grid*	Under Development	http://standards.sae.org/wip/j2847/6	This SAE Recommended Practice J2847/6 establishes signals and messages for communication between plug-in electric vehicles and the electric power grid, for wireless energy transfer. This is the 1st version of this document and completes step 1 effort that captures the initial objectives of the SAE task force. The intent of step 1 was to record as much information on "what we think works" and publish. The effort continues however, to step 2 that allows public review for additional comments and viewpoints, while the task force also continues additional testing and early implementation. Results of step 2 effort will then be incorporated into updates of this document and lead to a republished version. The requirements described here identify the equipment (system elements) and interactions to support wireless energy transfer use cases for plug-in vehicles, as described in SAE J2836/6™. Key system elements include the vehicle's rechargeable energy storage system (RESS), power conversion equipment (on-board and off-board), utility meter, optional advisory sub-meter (EUMD), load management system (LMS), and equipment for control, monitoring, and communication. System elements may be optionally packaged in various ways (either separately or in combination) to deliver implementations tailored to a given environment, such as a residential, public or commercial charging location. Implementations may also vary in relation to the vehicle itself. The charging control

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				technology will reside on the vehicle and premises.
SAE J2894 / 1	*Power Quality Requirements for Plug-In Vehicle Chargers – Part 1: Requirements*	Under Development	http://standards.sae.org/wip/j2894/1	The intent of this new document is develop a recommended practice based on EPRI™s TR-109023 EV Charging Equipment Operational Recommendations for Power Quality that will enable vehicle manufacturers, charging equipment manufacturers, electric utilities and others to make reasonable design decisions regarding power quality. The three main purposes are as follows: 1.To identify those characteristics of the AC service that may significantly impact the performance of the charging equipment. 2.To identify those parameters of PEV battery charging that must be controlled in order to preserve the quality of the AC service. 3.To recommend target values for power quality, susceptibility and power control parameters which are based on current U.S. and international standards. Furthermore, these recommended values should be technically feasible and cost effective to implement in PEV battery charging equipment
SAE J2894 / 2	*Power Quality Requirements for Plug-In Vehicle Chargers – Part 2: Test Methods*	Under Development	http://standards.sae.org/wip/j2894/2	This Recommended Practice is based on EPRI"s TR-109023 - EV Charging Equipment Operational Recommendations for Power Quality. The document will enable vehicle manufacturers, charging equipment manufacturers, electric utilities and others to make reasonable design decisions regarding power quality that are technically feasible and cost effective to implement. —Will address bi-directional energy flow. This Recommended Practice will include guidelines for: —Total Power Factor —Power Conversion Efficiency —Total Harmonic Current Distortion —Current Distortion at Each Harmonic Frequency —Plug in Electric Vehicle Charger Restart After Loss of AC Power Supply —Charger / Electric Vehicle Supply Equipment AC Input Voltage Range —Charger / Electric Vehicle Supply Equipment AC Input Voltage Swell —Charger / Electric Vehicle Supply Equipment AC Input Voltage Surge (Impulse) —Charger / Electric Vehicle Supply Equipment AC Input Voltage Sag —Charger / Electric Vehicle Supply Equipment AC Input Frequency Variations —In-Rush Current —Momentary Outage Ride-Through
SAE J2907	*Power rating method for automotive electric propulsion motor and power electronics sub-system*	Under Development	http://standards.sae.org/wip/j2907	Test method and conditions for rating performance of electric propulsion motors as used in hybrid electric and battery electric vehicles
SAE J2908	*Power Rating method for hybrid-electric and battery electric vehicle propulsion*	Under Development	http://standards.sae.org/wip/j2908	Test method and conditions for rating performance of complete hybrid-electric and battery electric vehicle propulsion systems reflecting thermal and battery capabilities and limitations

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SAE J2931 / 1	*Power Line Carrier Communications for Plug-in Electric Vehicles*	Under Development	http://standards.sae.org/wip/j2931/1	This SAE Recommended Practice JXXXX establishes the digital communication requirements for the Electric Vehicle Supply Equipment (EVSE) as it interfaces with a Home Area Network (HAN), Energy Management System (EMS) or the Utility grid systems. This Recommended Practice provides a knowledge base addressing the communication medium functional performance and characteristics, and interoperability to other EVSEs, Plug-In Vehicles (PEVs) and is intended to complement J1772TM" but address the digital communication requirements associated with smart grid interoperability
SAE J2931 / 2	*Inband Signaling Communication for Plug-in Electric Vehicles*	Under Development	http://standards.sae.org/wip/j2931/2	This SAE Recommended Practice J2931/2 establishes the requirements for physical layer communications using Inband Signaling between Plug-In Vehicles (PEV) and the EVSE. This also enables the onward communications via an EVSE bridging device to the utility smart meter or Home Area Network (HAN). This is known as Frequency Shift Keying (FSK) and is similar to Power Line Carrier (PLC) but utilizes the J1772™ Control Pilot circuit.
SAE J2931 / 3	*PLC Communication for Plug-in Electric Vehicles*	Under Development	http://standards.sae.org/wip/j2931/3	This SAE Recommended Practice J2931/3 establishes the requirements for physical layer communications using Power Line Carrier (PLC) between Plug-In Vehicles (PEV) and the EVSE. This also enables the onward communications via an EVSE bridging device to the utility smart meter or Home Area Network (HAN). This is known as Orthogonal frequency-division multiplexing (OFDM) and is Power Line Carrier (PLC) that can be transmitted using either the J1772™ Control Pilot circuit or the mains (AC or DC power circuits).
SAE J2931 / 4	*Broadband PLC Communication for Plug-in Electric Vehicles*	Under Development	http://standards.sae.org/wip/j2931/4	This SAE Technical Information Report J2931/4 establishes the requirements for physical and data-link layer communications using broad band Power Line Carrier (PLC) between Plug-In Vehicles (PEV) and an EVSE, DC off-board-charger or direct to the utility smart meter or Home Area Network (HAN). The PLC communication is applied to the charging main circuits as described in J1772™.
SAE J2931 / 5	*Telematics Smart Grid Communications between Customers, Plug-In Electric Vehicles (PEV), Energy Service Providers (ESP) and Home Area Networks (HAN)*	Under Development	http://standards.sae.org/wip/j2931/5	This SAE Recommended Practice J2931/5 establishes the security requirements for digital communication between Plug-In Electric Vehicles (PEV), the Electric Vehicle Supply Equipment (EVSE) and the utility, ESI, Advanced Metering Infrastructure (AMI) and/or Home Area Network (HAN). This is the 1st version of this document and completes step 1 effort that captures the initial objectives of the SAE task force. The intent of step 1 was to record as much information on “what we think works” and publish. The effort continues however, to step 2 that allows public review for additional comments and viewpoints, while the task force also continues additional testing and early implementation. Results of step 2 effort will then be incorporated into updates of this document and lead to a republished version.

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SAE J2931 / 6	*Digital Communication for Wireless Charging Plug-in Electric Vehicles*	Under Development	http://standards.sae.org/wip/j2931/6	This SAE Recommended Practice J2931/6 establishes the digital communication protocol requirements for wireless charging between Plug-In Vehicles (PEV), the Electric Vehicle Supply Equipment (EVSE) and the utility, ESI, Advanced Metering Infrastructure (AMI) and/or Home Area Network (HAN). This is the 1st version of this document and completes step 1 effort that captures the initial objectives of the SAE task force. The intent of step 1 was to record as much information on "what we think works" and publish. The effort continues however, to step 2 that allows public review for additional comments and viewpoints, while the task force also continues additional testing and early implementation. Results of step 2 effort will then be incorporated into updates of this document and lead to a republished version.
SAE J2931 / 7	*Security for Plug-in Electric Vehicle Communications*	Under Development	http://standards.sae.org/wip/j2931/7	Develop and document the functional and technical requirements for a standard telematics application programming interface that facilitates two way communications between the PEV telematics service provider and the Energy Services Provider. The telematics interface will provide access to consumer specific usage data e.g. instantaneous usage, consumption usage, volts, amps, VAR, power factor, etc. The telematics common interface solution will encompass, at minimum, four key interfaces: Aggregation, Control, TOU Rates, and Vehicle Information inclusive of interconnectivity with utility energy management systems, utility back office networks, ISOs, RTOs, and consumer home area networks. Use Cases are to be developed to define the attributes of key interface requirements and functionality. Requirements for implementation shall include compliance and/or interoperability with J2847 series of recommended practices, and with Smart Energy Profile 2.0 and/or OpenADR/OpenADE application standards.
J2953	*Plug-In Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)*	Under Development	http://standards.sae.org/wip/j2953	This SAE Recommended Practice J2953 establishes the interoperability requirements and specifications for the communication systems between Plug-In Vehicles (PEV) and Electric Vehicle Supply Equipment (EVSE) for multiple suppliers. This document supports the digital communication requirements within J2836™ that includes the use cases and general information for several communication approaches and J2847 includes the corresponding detail messages and state diagrams. J2931 identifies the requirements and protocols, as various options are available to the consumer and utility. Battery Electric Vehicles (BEV) were developed several years ago and the connector, EVSE and analogue interface was described in J1772™ and has been updated to better match Plug-In Hybrid Vehicle (PHEV) criteria. Utility companies are developing the smart grid communication and control system to balance this additional load with available distribution and several options will be available to the consumer. Plug-In Vehicle (PEV) and EVSE digital communication is required to insure the customer is able to roam and connector any PEV to any EVSE for these additional features. Considerably more manufacturers have entered the market PEVs and EVSEs with more BEV and PHEV combinations, and also offer a wide variety of EVSEs from 120V and 240V AC, plus DC charging where the EVSE includes an off-board charger for faster rates. This market will

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				continue to expand and change, and the customers need to connect and charge any PEV with any EVSE using their preferred communication medium and still interface with the local utility.
UL 50	*Standard for Enclosures for Electrical Equipment*	Issued	http://ulstandardsinfonet.ul.com/scopes/	This standard applies to enclosures for electrical equipment intended to be installed and used in non-hazardous locations in accordance with the Canadian Electrical Code, Part I, CSA C22.1, the provisions of the National Electrical Code, NFPA 70, and the provisions of Mexico's Electrical Installations, NOM-001-SEDE, as follows:
UL 1439	*Determination of Sharpness of Edges on Equipment*	Issued	http://ulstandardsinfonet.ul.com/scopes/	These requirements cover a test procedure to be used to determine the potential personal injury related to the sharpness of edges that are part of or associated with appliances and equipment
UL 2202	*EV Charging System Equipment*	Issued	http://ulstandardsinfonet.ul.com/scopes/	These requirements cover conductive and inductive charging system equipment intended to be supplied by a branch circuit of 600 volts or less for recharging the storage batteries in over-the-road electric vehicles (EV). The equipment is located on- or off-board the vehicle. Off-board equipment may be considered for indoor use only. The equipment is intended to be installed in accordance with the National Electrical Code, NFPA 70
UL 2231	*Personnel Protection Systems for EV Charging Circuits*	Issued	http://ulstandardsinfonet.ul.com/scopes/	These requirements cover devices and systems intended for use in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, Article 625, to reduce the risk of electric shock to the user from accessible parts, in grounded or isolated circuits for charging electric vehicles. These circuits are external to or on-board the vehicle
UL 2251	*Plug, Receptacles and Couplers for Electric Vehicles*	Issued	http://ulstandardsinfonet.ul.com/scopes/	These requirements cover plugs, receptacles, vehicle inlets, and connectors, rated up to 800 amperes and up to 600 volts ac or dc, intended for conductive connection systems, for use with electric vehicles in accordance with National Electrical Code (NEC), ANSI/NFPA-70 for either indoor or outdoor nonhazardous locations
UL 2594	*Electric Vehicle Supply Equipment*	Outline of Investigation	http://ulstandardsinfonet.ul.com/scopes/	This outline covers electric vehicle (EV) supply equipment, rated a maximum of 250 V ac, with a frequency of 60 Hz, and intended to provide power to an electric vehicle with an on-board charging unit. This outline covers electric vehicle supply equipment intended for use where ventilation is not required.
(formerly IEC/ISO/IEEE 60092-510) (now) IEC/ISO/IEEE 80005-1	*High Voltage Shore Connection Systems (HVSC Systems)*- Part 510: Special features	Under Development		This standard was developed jointly between IEC TC18 Electrical installations in ships and of mobile and offshore units, ISO TC8, Ships and Marine Technology Subcommittee SC 3, Piping and Machinery and IEEE IAS PCIC Marine Industry Subcommittee. This international standard (standard) describes HVSC systems, on board the ship and on shore, to supply the ship with electrical power from shore when ships shut down ship generators and to connect to shore power during stays in port. This standard is applicable to the design, installation and testing of HVSC systems and addresses: - HV shore distribution system, - shore-to-ship connection and interface equipment,

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				- transformers/reactors, - semiconductor / rotating convertors, - ship distribution system, and - control, monitoring, interlocking and power management system. The standard defines requirements that support, with the application of suitable operating practices, efficiency and safety of connections by compliant ships to compliant high-voltage shore power supplies through a compatible shore to ship connection.
IEC 60870-6	*Tele-control Protocols Compatible with ISO and CCITT Standards*	Under Revision	http://webstore.iec.ch/webstore/webstore.nsf/	The primary purpose of Telecontrol Application Service Element (TASE.2) is to transfer data between control systems and to initiate control actions. Data is represented by object instances. This part of IEC 60870 proposes object models from which to define object instances. The object models represent objects for transfer. The local system may not maintain a copy of every attribute of an object instance.
IEC 61334	*Distribution automation using distribution line carrier systems*	Under Revision	http://webstore.iec.ch/webstore/webstore.nsf/	Describes the structure of distribution networks for both medium and low-voltage levels and presents the architecture of a distribution automation system using distribution line carrier systems. This publication has the status of a Technical Report - type 3.
IEC 61850	*Power System IED Communication and Associated Data Models*	Under Revision Parts 4, 7-1, 7-2, 7-3, 7-4, 8-1, 9-2 and 90-1 issued late 2010-2011.	http://webstore.iec.ch/webstore/webstore.nsf/	IEC 61850-6:2009(E) specifies a file format for describing communication-related IED (Intelligent Electronic Device) configurations and IED parameters, communication system configurations, switch yard (function) structures, and the relations between them. The main purpose of this format is to exchange IED capability descriptions and SA system descriptions between IED engineering tools and the system engineering tool of different manufacturers in a compatible way. The main changes with respect to the previous edition are as follows: - functional extensions added based on changes in other Parts of IEC 61850, especially in IEC 61850-7-2 and IEC 61850-7-3; - functional extensions concerning the engineering process, especially for configuration data exchange between system configuration tools, added; - clarifications and corrections.
IEC 61581 series	*Electric vehicle conductive charging system – Part 1: General requirements*	Issued November 2010	http://webstore.iec.ch/webstore/webstore.nsf/	IEC 61851-1 applies to on-board and off-board equipment for charging electric road vehicles at standard AC supply voltages (as per IEC 60038) up to 1 000 V and at DC voltages up to 1 500 V, and for providing electrical power for any additional services on the vehicle if required when connected to the supply network. Electric road vehicles (EV) implies all road vehicles, including plug in hybrid road vehicles (PHEV), that derive all or part of their energy from on-board batteries. The aspects covered include characteristics and operating conditions of the supply device and the connection to the vehicle; operators and third party electrical safety, and the characteristics to be complied with by the vehicle with respect to the AC/DC EVSE, only when the EV is earthed.

Document	Title	Status	URL	
	Part 21 - Electric vehicle requirements for conductive connection to an AC/DC supply	Under revision		IEC 61851–21, together with part 1, gives requirements for conductive connection of an electric vehicle charging system to an AC or DC supply, for AC voltages according to IEC 60038 up to 1000 V and for DC voltages up to 1 500 V, This includes tests on the complete vehicle with the charging system installed and tests on the charging system as a component. This standard only covers the requirements that are measurable or identifiable on the charging interface, possible failure conditions that will influence the supply to the vehicle and safety related phenomena that are external to the vehicle that are caused by the charging when the vehicle is connected to the mains.
	Part 22 - AC electric vehicle charging station	Under revision		IEC 61851-22, together with part 1, gives the requirements for AC electric vehicle charging stations for conductive connection to an electric vehicle, with AC supply voltages according to IEC 60038 up to 1000 V .
	Part 23 - DC electric vehicle charging station	Under Development		IEC 61851-23, together with part 1, gives the requirements for DC electric vehicle (EV) charging or supply stations for conductive connection to the vehicle, with an AC or DC input voltage, up to 1000 V AC and up to 1500 V DC according to IEC60038.This part covers DC output voltages up to 1500 V.
	Part 24: Control communication protocol between off-board d.c. charger and electric vehicle	Under Development		This part of IEC 61851, together with part 2-3, applies to control communication protocol between off-board d.c. charging system and electric road vehicle, with an a.c. supply input voltages up to 1000 V and d.c. output voltages up to 1500 V for the conductive charging procedure (for d.c. supply to d.c. charger). This standard covers the physical layer, the data link layer, the application layer and other layers if needed.
IEC 61970	*Energy Management System Application Program Interface*	Under Revision	http://webstore.iec.ch/webstore/webstore.nsf/	Provides a set of guidelines and general infrastructure capabilities required for the application of the EMS-API interface standards. Describes typical integration scenarios where these standards are to be applied and the types of applications to be integrated. Defines a reference model and provides a framework for the application of the other parts of these EMS-API standards.
IEC 61968	*Application integration at electric utilities-system interfaces for distribution management (Data Models being extended with SmartEnergy 2.0)*	Under Revision Part 2 issued 2011.	http://webstore.iec.ch/webstore/webstore.nsf/	IEC 61968-9:2009(E) specifies the information content of a set of message types that can be used to support many of the business functions related to meter reading and control. Typical uses of the message types include meter reading, meter control, meter events, customer data synchronization and customer switching. Although intended primarily for electrical distribution networks, IEC 61968-9 can be used for other metering applications, including non-electrical metered quantities necessary to support gas and water networks
IEC 62196	*Plugs, socket-*	Issued:	http://webstore.i	IEC 62196-1 specifies the requirements for plugs, socket-outlets, connectors, inlets

Document	Title	Status	URL	
series	*outlets, vehicle couplers and vehicle inlets - Conductive charging of electric vehicles - Part 1: General requirements*	October 2011	ec.ch/webstore/webstore.nsf/	and cable assemblies as described in IEC 61851-1. Some charging can be achieved by direct connection from an electric vehicle to common mains socket outlets. Some modes of charging require a dedicated supply and charging equipment incorporating control and communication circuits. It is applicable to plugs, socket-outlets, connectors, inlets and cable assemblies for electric vehicles, herein referred to as "accessories", intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding 690 V AC, 50 - 60 Hz, at a rated current not exceeding 250 A; and 1,500 V DC, at a rated current not exceeding 400 A. This standard covers the mechanical, electrical and performance requirements for dedicated plugs, socket outlets, vehicle connectors and vehicle inlets for interfacing between such dedicated charging equipment and the electric vehicle.
	Part 2: Dimensional compatability and interchangeability requirements for AC pin and contact-tube accessories.	Issued: October 2011	http://webstore.iec.ch/webstore/webstore.nsf/	IEC 62196-2 applies to plugs, socket -outlets, vehicle connectors and inlets with pins and contact -tubes of standardized configurations, herein referred to a s accessories. They have a nominal rated operating voltage not exceeding 500 V AC, 50 – 60 Hz, and a rated current not exceeding 63 A three-phase or 70 A single phase, for u se in conductive charging of electric vehicles. This standard covers the basic interface accessories for vehicle supply as specified in IEC 62196-1, and intended for u se in conductive charging systems for circuits specified in IEC61851-1.
	Part 3: Dimensional compatibility and interchangeability requirements for dedicated d.c and combined a.c./d.c. pin and contact-tube vehicle couplers.	Under Development		IEC 62196-3 is applicable to vehicle couplers with pins and contact-tubes of standardized configuration for dedicated DC charging of electric vehicles, with rated operating voltage up to 1 000 V DC and rated current up to 400 A. This standard applies to a high power DC interface of vehicle couplers specified in IEC 62196-1, intended for use in conductive charging systems for circuits specified in IEC 61851-1 and IEC 61851-23 (under development).These vehicle couplers shall be used only in charging mode 4, case C, according to IEC 61851-1.
IEC 62210	*Data and Communication Security*	Under Revision	http://webstore.iec.ch/webstore/webstore.nsf/	Applies to computerized supervision, control, metering, and protection systems in electrical utilities. Deals with security aspects related to communication protocols used within and between such systems, the access to, and use of the systems. Discusses realistic threats to the system and its operation, the vulnerability and the consequences of intrusion, actions and countermeasures to improve the current situation
IEC 62325	*Framework for Deregulated Electricity Market Communications*	Under Development	http://webstore.iec.ch/webstore/webstore.nsf/	Gives technology independent general guidelines applicable for e-business in energy markets based on Internet technologies providing: a description of the energy market specific environment; a description of the energy market specify requirements for e business; an example of the energy market structure; an introduction to the modeling methodology; network configuration examples; a general assessment of communication security.
IEC 62350	*Communications*	Under	http://webstore.i	This technical report provides an overview of protection availability provided by

Document	Title	Status	URL	
	Systems for Distributed Energy Resources	Revision	ec.ch/webstore/ webstore.nsf/	residual current-operated protective devices (RCDs) complying with IEC standards for household and similar uses. It highlights the main parameters influencing protection reliability and provides information on how to install and operate RCDs in relationship to their environmental conditions after installation
IEC 62351 Parts 1-8	*Security for Protocols, network and system management, role based access control*	Under Revision Parts 7, 7-2 and 8 issued late 2010-2011	http://webstore.iec.ch/webstore/webstore.nsf/	Provides an introduction to the remaining parts of the IEC 62351 series, primarily to introduce the reader to various aspects of information security as applied to power system operations. The scope of the IEC 62351 series is information security for power system control operations. Its primary objective is to undertake the development of standards for security of the communication protocols defined by IEC TC 57, specifically the IEC 60870-5 series, the IEC 60870-6 series, the IEC 61850 series, the IEC 61970 series, and the IEC 61968 series
IEC/TR 62357	*Interoperability within TC57 in Long Term*	Under Revision	http://webstore.iec.ch/webstore/webstore.nsf/	Is a technical report describing all the existing object models, services, and protocols developed in technical committee 57 and showing how they relate to each other. Presents a strategy showing where common models are needed, and if possible, recommending how to achieve a common model.
IEC 62613 series	*High-Voltage Plugs, Socket-Outlets, Ship Connectors and Ship Inlets for High-Voltage Shore Connection Systems (HVSC systems) -Part 1 - General Requirements* *Part 2 - Interchangeability requirements for accessories to be used by various types of ship*	Issued: June 2011 Issued: November 2011 (pending)	http://webstore.iec.ch/webstore/webstore.nsf/ http://webstore.iec.ch/webstore/webstore.nsf/	IEC 62613 addresses the needs of IEC/ISO/IEEE 60092-510 High Voltage Shore Connection Systems standard, in terms of plugs, socket-outlet, ship connectors and ship inlets, herein referred to as "accessories", to deliver electrical power to ships in ports. IEC 62613 defines requirements that allow compliant ships to connect to compliant high-voltage shore power supplies through a compatible shore to ship connection rated currents not exceeding 500 A and rated operating voltages not exceeding 12 kV, 50/60 Hz. This standard applies to accessories with three-phase (3 poles and earth) with up to three pilot contacts, and a single-pole (Neutral) contact. Part 2 defines the interface details and dimensions so that accessories of like ratings from different manufacturers can be used interchangeably.
IEEE 1547	*Standard for Interconnecting Distributed Resources with the Electric Power System*	Issued	http://grouper.ieee.org/groups/scc21/dr_shared/	This standard establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).This document provide a uniform standard for interconnection of distributed resources with electric power systems. It provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.

Document	Title	Status	URL	
IEEE 519	*Harmonic Control in Electrical Power Systems*	Issued	http://grouper.ieee.org/groups/519/index.html	This guide applies to all types of static power converters used in industrial and commercial power systems. The problems involved in the harmonic control and reactive compensation of such converters are addressed, and an application guide is provided. Limits of disturbances to the ac power distribution system that affect other equipment and communications are recommended. This guide is not intended to cover the effect of radio frequency interference.
IEEE 1901	*Standard for Broadband over Power Line Networks*	Issued	http://grouper.ieee.org/groups/1901/	The project defines a standard for high-speed (>100 Mbps at the physical layer) communication devices via electric power lines, so-called broadband over power line (BPL) devices. This standard uses transmission frequencies below 100 MHz. It is usable by all classes of BPL devices, including BPL devices used for the first-mile/last-mile connection (<1500 m to the premise) to broadband services as well as BPL devices used in buildings for local area networks (LANs), smart energy applications, transportation platform (vehicle) applications, and other data distribution (<100 m between devices). This standard focuses on the balanced and efficient use of the power line communications channel by all classes of BPL devices, defining detailed mechanisms for coexistence and interoperability between different BPL devices, and assuring that desired bandwidth and quality of service may be delivered. The standard addresses the necessary security questions to provide privacy of communications between users and allow the use of BPL for security-sensitive services. It is limited to the physical layer and the medium access sublayer of the data link layer, as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model.
IEEE P1901.2	*Standard for Low Frequency Narrow Band Power Line Communications for Smart Grid Applications*	Proposed		
IEEE 2030	*IEEE Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), End-Use Applications, and Loads*	Issued	http://grouper.ieee.org/groups/scc21/2030/2030_index.html	This document provides guidelines for smart grid interoperability. It also provides a knowledge base addressing terminology, characteristics, functional performance and evaluation criteria, and the application of engineering principles for smart grid interoperability of the electric power system (EPS) with end-use applications and loads. The guide discusses alternate approaches to good practices for the Smart Grid.

Document	Title	Status	URL	
IEEE P2030.1	Draft Guide for Electric-Sourced Transportation Infrastructure	Under Development	http://grouper.ieee.org/groups/scc21/2030.1/2030.1_index.html	This document provides guidelines that can be used by utilities, manufacturers, transportation providers, infrastructure developers and end users of electric-sourced vehicles and related support infrastructure in addressing applications for road-based personal and mass transportation. This guide provides a knowledge base addressing terminology, methods, equipment, and planning requirements for such transportation and its impacts on commercial and industrial systems including, for example, generation, transmission, and distribution systems of electrical power. This guide provides a roadmap for users to plan for short, medium, and long-term systems.
IEEE P2030.2	Draft Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure	Under Development	http://grouper.ieee.org/groups/scc21/2030.2/2030.2_index.html	This document provides guidelines for discrete and hybrid energy storage systems that are integrated with the electric power infrastructure, including end-use applications and loads. This guide builds upon IEEE Std P2030 Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation With the Electric Power System (EPS), and End-Use Applications and Loads.
IEEE P2030.3	Draft Standard for Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications	Under Development	http://grouper.ieee.org/groups/scc21/2030.3a/2030.3_index.html	This standard establishes test procedures for electric energy storage equipment and systems for electric power systems (EPS) applications. It is recognized that an electric energy storage equipment or systems can be a single device providing all required functions or an assembly of components, each having limited functions. Components having limited functions shall be tested for those functions in accordance with this standard. Conformance may be established through combination of type, production, and commissioning tests. Additionally, requirements on installation evaluation and periodic tests are included in this standard.
ANSI	*Strategic roadmap of standards and conformity assessment programs for EVs in the United States*		http://www.ansi.org/standards_activities/standards_boards_panels/evsp/overview.aspx?menuid=3#Overview	The ANSI Electric Vehicles Standards Panel (EVSP), a cross-sector coordinating body, whose objective is to foster coordination and collaboration on standardization matters among public and private sector stakeholders to enable the safe, mass deployment of electric vehicles and associated infrastructure in the United States with international coordination, adaptability, and engagement. The EVSP will produce a strategic roadmap of the standards and conformity assessment programs, by year's end, needed for the widespread acceptance and deployment of electric vehicles. The panel will also provide on behalf of ANSI coherent and coordinated U.S. policy and technical input to relevant regional and international audiences on needed standards and conformity assessment programs in this area and will liaise and coordinate with other electric vehicle initiatives that are being undertaken.
NFPA 70	*Electric Vehicle*	2011 NEC	http://www.nfpa.	NEC Revision cycle started for 2014 Edition, proposals include reorganization of Article 625, with changes to allow additional cord and plug connected units, use of

Document	Title	Status	URL	
NEC Art. 625 NEC Art. 626	*Charging System*	Issued	org/catalog/	load management systems, additional options for flexible cord and cable types for power supply cord and output cable to EV, recognition of special provisions for isolated charging systems, identification of EV ready circuits and outlets, etc. Proposals submitted to NFPA November 4, 2011, Code Panel (CP) 12 meeting to review proposals January, 2012, CP report of findings, and additional comment period in 2012. Proposals for Article 626 include changes to recognize that equipment in Electrified Truck Parking Spaces may be used to supply electric power to EVs when parking spaces not occupied by trucks or that equipment may also be modified to include a means for EV charging. Proposals include addition to Scope to identify such use and reference to Article 625 for general requirements.

3
NON-ROAD TRANSPORTATION ACTIVITIES

Reduction of mobile source emissions from burning fossil fuels continues to make substantial progress in the transportation industry with additional advancements in technology development. Through EPRI IWC committees, members are taking steps to further reduce emissions through grid connected transportation activities. In order to reduce the use of oil and oil related products it is necessary to provide a viable alternate source of energy. Electricity is proving itself to be the alternative fuel for the transportation industry both on and off-road if used efficiently with existing and future safe technologies. Connecting transportation to the electrical grid is becoming more than an option. But, to provide for the interoperability of grid-connected transportation equipment, whether they are off-road vehicles such as forklifts, construction equipment or ocean going vessels berthed at ports, or on-road passenger vehicles and trucks utilizing stored electric energy as a means of propulsion, there needs to be connection equipment standardization. This standardization needs to be adopted through codes and standard activities to ensure that all who use the electric grid for transportation purposes can do so in a safe and efficient manner, with the emphasis on safety.

To address the standardization issue, EPRI through the IWC continues to participate in activities addressing the variety of codes and standards relating to the electric transportation industry. From December 2010 to August 2011, four Quarterly IWC meetings were held. In addition to the IWC meetings, the EPRI Non-Road Electric Transportation Industry Advisory Council meeting was held in Portland Oregon from September 27 – 29, 2011. Previous Non-Road Electrification Committee discussion topics addressed non-road issues including truck stop electrification, port electrification and the codes and standards these industries are facing. The PEVWG will continue to address similar issues as they relate to the on road concerns including codes and standards and charging levels and specific criteria for each technology.

A standing agenda item at each meeting includes a provision for updates regarding all non-road codes and standards. Included in these codes and standards are:

- Code and Standards Update
  - NFPA70, National Electric Code (NEC),
- Port Electrification
  - Shore power equipment and system standards through the IEC, ISO, and the IEEE.
- Truck and Bus Electrification
- EPRI Non-Road Advisory Committee updates
- Other Non-Road Activities and Relevant Electric Transportation Infrastructure

The following are the details of the aforementioned codes and standards. The three standards making bodies for shore power equipment and systems have come to an agreement and worked together so that the completed standard will be distributed under a triple logo including all three bodies.

National Electrical Code, NFPA 70-2011

General

The *National Electrical Code* is a national code of rules that covers the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways for the following:

(1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings.

(2) Yards, lots, parking lots, carnivals, and industrial substations.

(3) Installations of conductors and equipment that connect to the supply of electricity

(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center.

It is the most widely adopted code in the United States, used in all 50 states and all U.S. territories, and enforced by the mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors. The authority having jurisdiction for enforcement of the *Code* has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

It is also a living document, constantly changing to reflect changes in technology, its use continues to grow, providing the best technical information, ensuring the practical safeguarding of persons and property from the hazards arising from the use of electricity.

The National Electrical Code, NFPA 70 is revised and updated every three years in Revision Cycles that begin each year and that normally take approximately two years to complete.

Each proposed change or addition to the NEC requires a statement of the problem and substantiation for the proposal. The proposal must identify the specific section number, table number or equivalent section to be revised (or added) and a complete text of the proposal showing the wording to be added, revised or deleted. EPRI’s NEC Task Force (TF) have worked with various Original Equipment Manufacturer (OEMs), related experts and a Task Group of NEC's Code Making Panel 12 (CMP12) to prepare Code proposals and substantiations for the 2014 National Electrical Code.

Following the recent publication of the National Electrical Code, NFPA70 – 2011, the TF met during 2011 to review and consideration additional changes to articles 625 and 626, as well as other parts of the NEC. The TF made several suggestions for code proposals to article 625 through CMP 12's task group and developed additional code proposals for article 626 for the 2014 edition of the NEC.

All NEC proposals for the 2014 Code cycle were submitted by November 4, 2011. Subsequent proposals may also be submitted by Oct. 17, 2012 in response to the Code Panel's report on the initial proposals made. The first meeting of the NEC Task Force for the 2014 NEC cycle took place in December 2010 with additional meetings during 2011 during which time the changes to the 2011 NEC and the proposals being made by CMP 12 for the 2014 NEC were reviewed and discussed.

The two highlighted dates are "action" dates by which the EPRI NEC TF (1) submitted all proposals, with substantiation, to NFPA and (2) for further comments or modified proposals to NFPA in response to the NEC Code Panel's initial actions, comments and remarks contained in the Report on Proposals (ROP).

The NEC Task Force will reconvene mid-year 2012 at which time the NEC Code Panel's initial actions, comments and remarks contained in the Report on Proposals (ROP) will be reviewed for possible further comment and response during the 2014 NEC Code cycle.

Article 626

EPRI's NEC Task Force (TF) has worked with various Original Equipment Manufacturer (OEMs), and related experts to prepare Code proposals and substantiations for the 2014 National Electrical Code.

Key issues considered for 2014 code proposals included:

- Use of equipment at Electrified Truck Parking Spaces, Article 626, for Plug-in Electric Vehicle (PEV) charging covered by Article 625.
- Changes in the equipment due to modifications in the trucks using the equipment.
- Revisions due to Truck parking space and equipment configurations.

Of these items, only the recognition of alternative use of truck parking space equipment for EV charging was considered to be necessary.

The proposals made included references and language to permit truck stop parking supply equipment to be modified/used for charging electric vehicles when not in use for truck parking, and/or utilize the installed electric power supply for the installation of electric vehicle supply equipment and electric vehicle charging systems in accordance with article 625.

These NEC proposals for the 2014 Code cycle have been submitted by November 4, 2011. Subsequent proposals must also be submitted by Oct. 17, 2012 in response to the Code Panel's report on the initial proposals made. The NEC Task Force met during 2011 and will reconvene mid-year 2012 at which time the NEC Code Panel's initial actions, comments and remarks contained in the Report on Proposals (ROP) will be reviewed for possible further comment and response during the 2014 NEC Code cycle.

IEC Update

International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts.

Through its members, the IEC promotes international cooperation on all questions of electrotechnical standardization and related matters, such as the assessment of conformity to standards, in the fields of electricity, electronics and related technologies.

The IEC charter embraces all electrotechnologies, and energy production and distribution, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility, measurement and performance, dependability, design and development, safety and the environment.

Over 80 countries participate in the IEC work through their National Committees (NC). Technical Committees (TC) are formed under the rules of the ISO/IEC Directives that define the basic procedures to be followed in the development of International Standards and other publications. Technical Experts are assigned to work on a Project by their National Committees and participate as national delegations.

An International Standard is the result of an agreement between the member bodies of IEC and/or ISO. It may be used as such, or may be implemented through incorporation in national standards of different countries. International Standards are developed by IEC technical committees (TC) and subcommittees (SC) by a six-step process:

- **Proposal stage**
  The first step in the development of an International Standard is to confirm that a particular International Standard is needed. A new work item proposal (NP) is submitted for vote by the members of the relevant TC or SC to determine the inclusion of the work item in the program of work.
- The proposal is accepted if a majority of the members of the TC/SC votes in favor and if at least five P-members (countries) declare their commitment to participate actively in the project. At this stage a project leader responsible for the work item is normally appointed.
- **Preparatory stage**
  Usually, a working group of experts, the chairman (convener) of which is the project leader, is set up by the TC/SC for the preparation of a working draft. Successive working drafts may be considered until the working group is satisfied that it has developed the

best technical solution to the problem being addressed. At this stage, the draft (WD) is forwarded to the working group's parent committee for the consensus-building phase.

- **Committee stage**
  As soon as a first committee draft (CD) is available, it is registered by the IEC. It is distributed for comment and, if required, voting by the P-members of the TC/SC. Successive committee drafts may be considered until consensus is reached on the technical content. Once consensus has been attained, the text is finalized for submission as a draft International Standard (CDV).

- **Enquiry stage**
  The draft International Standard (CDV) is circulated to all IEC member bodies by the IEC for voting and comments within a period of five months. It is approved for submission as a final draft International Standard (FDIS) if a two-thirds majority of the P-members of the TC/SC are in favor and not more than one-quarter of the total number of votes cast are negative. If the approval criteria are not met, the text is returned to the originating TC/SC for further study and a revised document will again be circulated for voting and comment as a draft International Standard.

- **Approval stage**
  The final draft International Standard (FDIS) is circulated to all IEC member bodies by the IEC Central Office for a final Yes/No vote within a period of two months. If technical comments are received during this period, they are no longer considered at this stage, but registered for consideration during a future revision of the International Standard. The text is approved as an International Standard if a two-thirds majority of the P-members of the TC/SC is in favor and not more than one-quarter of the total number of votes cast are negative. If these approval criteria are not met, the standard is referred back to the originating TC/SC for reconsideration in light of the technical reasons submitted in support of the negative votes received.

- **Publication stage**
  Once a final draft International Standard has been approved, only minor editorial changes, if and where necessary, are introduced into the final text. The final text is sent to the IEC Central Office which publishes the International Standard.

A time table for this work is shown in Table 3-1.

Table 3-1
IEC Standards Activities

Project Stage	Associated Document Name	Abbreviation	Minimum Timeline (for comment and/or voting)
Proposal stage	New Work Item Proposal	NP	3 months for voting
Preparatory stage	Working draft	WD	12 months recommended
Committee stage	Committee draft	CD	2-4 months for comment
Enquiry stage	Enquiry draft	IEC/CDV	5 months for comment and voting
Approval stage	Final Draft International Standard	FDIS	2 months for voting
Publication stage	International Standard	IEC or ISO/IEC	1.5 months

IEC – High Voltage Shore Power Equipment

International Electrotechnical Commission (IEC) Technical Committee No. 18

IEC TC18 MT26 - The original title and number "IEC/ISO/IEEE 60092-510 Electrical installations in ships - Special Features - High Voltage Shore Connection Systems (HVSC-Systems)" has been changed to 80005-1 to identify to the proposed Standard as a triple logo standard. The title was proposed to be modified to *Utility Connections In Port – Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements*.

Maintenance Team 26 (MT26), now renamed Joint Working Group (JWG) 28, continued work on the comments received from National Committees and the IEC editorial staff during the Enquiry draft (CDV) stage, in preparation of issuing the CDV as an Final Draft International Standard (FDIS), for final voting. The CDV was accepted by a vote of 13 positive and 2 negative. The proposed standard (FDIS) will be followed by a two month period for voting. If approved, is expected to be published during the first part of 2012.

Key changes included the deletion of Annex A excluding the part referencing fibre optic connectors, which was moved to (new) clause 7.3.4. The specific annexes for each ship type was renumbered and all detailed references, information, dimensional details, etc. in favor of a specific referenced HVSC socket-outlet, plug, connector or inlet covered by the related annex in IEC 62613-2. The general requirements for these accessories in (80005-1) Annex A were referred back to IEC 62613-1.

JWG 28 addressed the remainder of the comments but indicated that new technical comments be addressed during the maintenance work once the standard is published. These new items included alternative methods for safety systems using pilot connections, equipotential bond monitoring, tolerances on the supply voltage range, communications and other general topics.

JWG 28 will handle the newly approved new work project to develop requirements for shore to ship communications including onshore power supply communications under IEC/ISO/IEEE 80005-2, *Cold ironing - Part 2: High voltage shore connection (HVSC) systems - Communication interface description*. The committee will meet in 2012. A convenor needs to be selected.

International Electrotechnical Commission (IEC) Sub-Committee SC23H

IEC 62613, *Plugs, Socket-Outlets, Ship Connectors And Ship Inlets For High-Voltage Shore Connection Systems, (HVSC-Systems)*

IEC 62613, Parts 1 and 2 have been developed by SC23H and published during 2011. The work was in response to the request from IEC TC 18, MT26. The Standards were divided into two parts:

- Part 1: *General requirements*. Contains constructional and test requirements for both 7.2kV and 12 kV plugs, socket-outlets (receptacles), connectors and ship inlets.
- *Part 2: Interchangeability Requirements For Accessories Used for Shore to Ship Connections for Various Types of Ship*. Contains specific drawings, details, dimensions and tolerances for devices identified by TC 18, MT26 as means for connecting various ship types to shore power. These details document the interface construction and physical dimensions necessary provide for the interchangeability of such accessories produced by various manufacturers.

DC Current Injection – Applicable Standards

There are quite a few standards that regulate the maximum allowable DC current that can be injected into the AC grid. This information was taken directly from a presentation given during the March 2010 meeting.

- IEEE1547: Standard for Interconnecting Distributed Resources with Electric Power Systems
- IEC 61726: Characteristics of the utility interface DIN VDE 0126: DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE, DIN VDE 0126-1-1, 2005
- UL 1741: UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
- IEEE 929-2000: Recommended Practice for Utility Interface of Photovoltaic (PV) Systems

- EN61000-3-2: Electromagnetic compatibility (EMC). Limits for harmonic current emissions (equipment input current < 16 A per phase.

Other Activities Discussed in 2011

EPRI Non Road Advisory Committee (PoRTE Committee) Update

The PoRTE Committee is now the EPRI Non – Road Committee. PoRTE Meeting in Memphis – Oct. 12-13, 2010

Dec2010

(See Presentation Attachment)

March 2011

Andra Rogers, EPRI, gave an update on the Port, Rail, Truck Electrification (PoRTE) activities. Among the key accomplishments in 2010 were the case study on electric refrigerated container racks, PHEV yard truck tour demonstrations, and studies on fuel cell powered materials handling equipment and mining electrification. She also presented projects for 2011, such as market assessments and program designs for various non-road electric transportation technologies. During discussion, Greg Nieminski requested that she inquire about general trends regarding worker injuries involving electrical issues that could be addressed by the National Electric Code.

June 2011

Andra Rogers, EPRI, gave an update on the Port, Rail, Truck Electrification (PoRTE) activities. For 2011, the PoRTE Committee has been merged into the larger Non-road Electric Transportation committee. The committee will deal with both non-road and on-road fleets. Mrs. Rogers described the goals, research areas and benefits of the EPRI non-road electric transportation program. Among the activities she highlighted was the non-road electric transportation market and environmental assessment model and demonstration. A non-road industry advisory council meeting is planned for September 27- 29 in Portland Oregon.

August 2011
There were no EPRI Non Road Committee updates available for August 2011

Truck Stop Electrification Updates: CabAire: Dec 2010:

Dan Shanahan, CMI/CabAire, gave a presentation on CabAire's configurable towers, their service module, and projects in North Carolina, Delaware, and Pennsylvania, as well as construction of new truck stop spaces in New Jersey and Delaware. He also described the designs of CMI/EVSE for pedestal-mounted chargers with retractable cable management for use in parking lots and garages. They are also developing residential EVSEs, industrial EVSEs for fleet yards and commercial vehicles, and a portable power tester for inspectors and electricians. During discussion, Mr. Shanahan noted that his cable system can handle drive-away and their residential Power Share system is undergoing UL testing and will be available around the first quarter of 2011.

Truck Stop Electrification Updates: Shorepower:

Dec 2010:

Jeff Kim, Shorepower, gave a presentation on the design and specifications of their level 2 ePump Stations for PEVs, NRTL certification, the ShoreNet user interface, and various installations including dual purpose solar carport stations in Oregon. He also described the Shorepower truck stop electrification system, Shorepower capable auxiliary power units (APUs), and a four-year demonstration project involving fifty sites across nine US interstate highways. Shorepower is also working on electric standby transport refrigeration units. During discussion, Mr. Kim noted that about half of APU's are electric capable.

Truck Stop Electrification Updates: EnviroDock:Dec 2010:

Ken Neal, EnviroDock, introduced his Virginia-based company, which was established in 2006. He described their E-Dock system, which is designed as a standalone unit for truck stops and a portable unit for distribution, warehouse, and truck stop markets. He also described their Window Service Module, their PowrDock pedestal for use with APU's and recreational vehicles, and their EnviroDock EVSE, which has a revenue grade meter with AMI communications. During discussion, he described the two portable units in Plaza 23 and planned installation of PowrDock pedestals in Dandridge Tennessee. He noted that idling laws vary from state to state and a uniform idling law is not expected in the future

POLA eRTG Project Update:

Dec 2010

Ted Yeider, PACECO, showed a video on the SegCart, an automated system that transports cargo containers within storage yards. The SegCart, which operates on a rechargeable electric battery, has a small footprint and weight and low power consumption, while reducing traffic congestion. Mr. Yeider showed how the loading cranes transfer containers to the SegCarts, forming container trains that move the containers to the appropriate stacking crane. Regarding the existing eRTG project in the Port of Los Angeles, PACECO is currently working with the building and safety department in the port to resolve the cable issues of shielded verses non-shielded cable.

Independent Electrical Contractors (IEC), Inc.:

Dec 2010:

John Masarick, Independent Electrical Contractors, Inc., gave a presentation on IEC, which has 3,500 members across the country with a focus on safety. He talked about the product areas, industry sectors, and types of construction that their members are involved in. The IEC has seats in all nineteen NFPA code panels, including Code Panel 12 for EVs and TSEs. The IEC also has a seat in a number of UL Standards Technical Panels (STP) of Underwriters' Laboratory including STP 2202 for charging system equipment, STP 2251 for EV connectors, and STP 2594 for EVSEs. The IEC is involved in apprenticeships and training and continuing education. Their resources include the IEC Insights magazine, safety guidelines and handbooks.

ISO/IEC/IEEE Standards Updates

Dec 2010
Greg Nieminski, EPRI Consultant, gave an update on the IEC standards. The previous meeting for IEC/ISO/IEEE 60092-510 on high voltage shore-to-ship connections was in November 2010. A committee draft for voting is being prepared for IEC review and circulation. With regards to IEC 62613, special requirements were developed to include non-rewireable, field-rewireable and non-field-rewireable accessories. Preliminary committee drafts for voting are still awaiting final engineering drawings. The standard is expected to be published in late 2011.

Non-Road NEC Proposals:

Dec 2010

Brian Sisco, Eaton, reported on the NEC Task Force meeting on December 6, 2010. There have been no injuries reported to the Task Force related to the TSE infrastructure. While there is a standard reefer (refrigerated truck) plug, there is no interlock requirement in Article 626. TSE implementers will probably not install electric refrigerated truck infrastructure until the safety aspect is addressed and standardized. The same space for trucks could in the future be used for EVs and plug-in hybrid vehicles. How do we cover combinations of Articles 625 and 626? During discussion, Mr. Nieminski noted that Articles 626 and 625 can be bridged by adding references. Ted Yeider, PACECO, said that he could provide information on safety issues regarding reefers. Dan Shanahan, CMI, also offered to provide information regarding the replacement of diesel refrigerated units with electrified reefers at a large distribution center in Chelsea Market, Boston. Ken Neal, EnviroDock, suggested that EVs may not want to use truck stop parking spaces since many are not well-lit nor perceived as safe environments. Others, however, pointed out that some new electrified truck stop parking spaces are clean and well-lit. Efrain Ornelas, PG&E, noted that EV charging is considered a service and not a resale of electricity. Currently, running refrigerated trucks is not considered idling, but there may be pressure to change this in the future for the purpose of reducing pollution and fuel consumption. Anyone interested in working with the NEC Task Force should contact the chair, Greg Nieminski.

Battery Electric Transit Bus:

Dec 2010

Stephen Brydon and Ben Herlinger, BC Transit, gave a presentation on BC Transit, its organization, strategic areas, and scope of service. Because they are subject to the government's carbon neutral regulations, BC transit has been testing clean energy and low carbon vehicle technologies including their 20 hydrogen fuel cell buses operating in Whistler since January 2010, natural gas buses, and battery electric buses. He described their Proterra battery-dominated fuel cell bus project in February-March 2010 wherein they simulated revenue service for urban and suburban routes. They are also interested in bus fast charging stations using a retractable catenary arm and a rapid charge source rated at 480V and 300-600A. BC Transit is exploring a collaborative partnership with BC Hydro, more electric bus demonstrations, and the testing of at least two vehicles and technology types. During discussion, they noted an estimated hydrogen fuel consumption of 11-12.5 kg H_2 per 100 km. They also estimated a five to ten minute fast charge corresponding to 3.25-3.3 kWh per km. Mr. Nieminski requested information about their battery voltage and the type of connector they were using.

APTA / CalStart:

March 2011

Fred Silver, CalStart, gave his perspective on battery electric bus. He contrasted different bus strategies involving opportunity charging versus periodic overnight charging, and alternative charging connections. He also described the need for topologies that reduce periodic high power demand and the "Zero Emission Bus Program". During discussion, Kerry-Jane King, NYPA, noted that the battery-to- battery topology, while useful in reducing peak loads has a low efficiency. Mr. Silver explained that the reason for the focus on the regular full size buses instead of the smaller buses is due to regulator priorities.

Bus High Power Charging (Foothill Transit):

March 2011

George Karbowski, Foothill Transit, talked about their electric transit bus charging station. In 2009, Foothill Transit received funding from the American Recovery and Reinvestment Act with supplemental funding from other state agencies. Their Ecoliner project uses a zero emission 35 ft Proterra bus with a composite body and Altairnano batteries. They use two 250 kWh chargers in the fast charge station. Their analysis showed a 400% improvement in fuel economy compared to CNG and diesel. Their monthly breakdown of costs showed the significant impact of demand charges. During discussion, Joshua Goldman, Proterra, said that the composite body weighs about 4,500 pounds compared to 6 to 8 thousand pounds for a stainless steel body. Mr. Karbowski said that the recyclable lithium batteries will be replaced every six years and that electric buses are less complicated than CNG and diesel. This project is being watched by their industry. SCE provided the transformer free of charge.

IEC 23H standards Updates:

March 2011

Greg Nieminski, EPRI Consultant, gave an update on the IEC standards. The high voltage shore equipment standard has a new number designation IEC/ISO/IEEE 80005 (previously IEC/ISO/IEEE 60092-510). Comments submitted on IEC 80005 Part 1 (general requirements) have been answered and a committee draft for voting is being prepared. IEC 80005 Part 2 (communication interface description) is a new work proposal. With regards to IEC 62613, the committee draft for voting for Part 1(general requirements) has been accepted and is being prepared as a final draft international standard. For Part 2 (interchangeability requirements) product drawings have been received and the committee draft for voting (CDV) is being prepared.

Non-Road NEC 626:

March 2011

Mr. Nieminski gave an update on the National Electrical Code Article 626 proposed revisions. The Task Force met in January in Dallas, TX. The primary interest was to expand the use of truck parking sites and charging equipment to charge EVs. If truck stop electrification equipment is modified to include EV charging, then Article 626 needs to be reviewed in detail to verify compliance with Article 625. Some issues relate to dual use purposes (powering TSE and/or EV charging), and potential maximum EV loads. Mr. Shanahan offered to provide additional information. If separate EVSE is installed, it would be covered by Article 625

Truck Stop Electrification Update:

March 2011

Dan Shanahan, CabAire, described the construction of truck stop electrification and their new cable management and Power Share products. The Power Share Module allows a homeowner to add EV supply equipment without having to do a service upgrade. The modules are designed for residential and multi dwelling units. The cable management systems include a garage overhead system, a marquee for parking lots, and industrial pedestal or wall mount units. During discussion, Mr. Shanahan and Jim Bianco, CabAire, explained that some modules send power to either the EV or the appliance, while others apportion the power between them. Their bollard or marquee can charge multiple vehicles. Mr. Nieminski pointed out ventilation requirement in the NEC with regards to their marquee design.

Nationally Recognized Testing Laboratory (NRTL):

March 2011

John Quigley and Gavin Campbell, Intertek, discussed NEC compliance, product testing certification, and OSHA recognition of NRTLs. A NRTL uses IEC, UL, NFPA, IEEE, ASTM, and other appropriate standards in certifying products. Manufacturers are not required to use UL for compliance testing. OSHA considers all NRTLs to be equivalent for the same product safety test standard; however, NRTLs have different levels of services, costs, certification marks, etc. Mr. Quigley and Mr. Campbell reviewed the list of UL, IEC, and SAE standards related to EVs and charging stations. During discussion, Mr. Quigley stated that Intertek does not develop standards, but they test to the international standards or customer specifications.

Non-Road NEC 626 Updates:

June 2011
Greg Nieminski, EPRI Consultant gave an update on the National Electrical Code Article

626 proposed revisions. The NEC Task Force met on January 21, in Detroit. The Task Force proposed to submit four revision proposals to the NEC. All the proposals pertain to changes in the code to allow electric vehicles to use installed sources of electric power at truck stops during times when trucks are not parked for their mandatory rest period.

IEC 80005 and 23H Standards Updates:

June 2011
Mr. Nieminski provided an update on the IEC standards. IEC/ISO/IEEE 60092-510, on cold ironing-high voltage shore connection systems-general requirements, is now IEC/ISO/IEEE 80005. IEC/ISO/IEEE 80005-1 has been sent to national committees for comments and voting with a closing date of August 5, 2011. IEC/ISO/IEEE 80005-2, which deals with the communication interface has been approved as a new work proposal. IEC 62613 dealing with connectors has been approved and sent out for publication. Comments were received on IEC 62613-2 regarding interchangeability requirements. Improved interface drawings have been requested from the manufacturer.

Utility Perspective and Update on TSE:

June 2011

Dave Hatfield, SMUD, shared the experiences and lessons learned by his utility with regards to truck stop electrification. He explained SMUD's strategic framework for their involvement in TSE, and he described their first TSE installation in 2004. The truck stop is now expanding their electrified parking spaces from the original 16 to 32. The barriers to TSE are diffused benefits and cost recovery. During discussion, Mr. Hatfield, reported that SMUD has detailed costs of installation and would be willing to share it with others.

Hands Free Charging:

June 2011

Satyajit Patwardhan, Green Dot, discussed hands free conductive charging. He presented the benefits of automotive charging such as ergonomic advantages, reducing missed charged cycles and avoiding wire trip hazards. He argued that hand-free inductive charging is inefficient, involves a heavy connector, and may pose hazards from stray magnetic fields, whereas hands-free conductive charging is efficient, uses a lightweight connector, has no magnetic fields, and uses simple power electronics. He then showed videos of Green Dot's technology, their ability to deal with parking misalignments, and their multiple layers of safety. During discussion, Mr. Patwardhan stated that technology has been tested for rain, moisture, corrosion resistance and snow.

Aluminum All Electric Bus:

August 2011

Sylvain Castonguay, Centre National du Transport Avancé, gave a background on CNTA and its consortium with ALCOA (see Presentation). He described the needs of their client RTC (Réseau de transport de la Capitale), the bus operator for Quebec. Their all electric aluminum bus uses a TM4 drive train, lithium iron phosphate batteries and a combination of 8 hour overnight charging and 5 minute quick charge for a total of 180 km range. There are four 200 kW quick charge stations. During discussion, Mr. Castonguay noted that they will monitor batteries, which will be discharged to 20% and quick charged to no more than 80%. Their batteries have a 120 kWh capacity. With a three year battery life, corresponding to about 2,000 cycles, the cost of battery replacement is cheaper than petroleum consumption. The participants expressed interest in remaining updated on the electric bus development.

Electric Mining Vehicle and Lito Green Motion Motorcycle:

August 2011

Francois Adam, ITAQ (Quebec Advanced Transportation Institute), described the interdisciplinary partnership and the projects of ITAQ (see Presentation). The Minautor Project pertains to a heavy duty underground electric vehicle applicable to mining where air quality and ventilation requirements are essential. The vehicle, which uses 20 kWh lithium ion batteries and an aluminum frame, is currently undergoing underground tests.

The SORA Project involves a new breed of electric motorcycles combined with information technology. The LITO Green Motion superbike has a top speed of over 160 kph, a battery pack for a 300 km urban range and a patented Safe Range System using GPS data to adjust motorcycle performance thereby ensuring that the destination is reached safely. During discussion, Mr. Adam noted that they expect the mining electric vehicle to be in commercial production in about one year. The vehicle has a payload of about 600 kg and the battery pack can do a full shift. The electric motorcycle has an on-board charger made to charge overnight.

Paradigm Shift: A proven Electric Solution for Urban Mass Transit:

August 2011

Min Yuan, Aowei Technology in Shang Hai, spoke in place of Jared Schnader, Foton America. He described the characteristics of ultracapacitors and their application as an advanced energy storage device and power source for a municipal bus. The ultracapacitor bus has been operating in Shanghai since 2006, traveling 2 million km in 5 years and transporting 8 million passengers. Its average energy consumption is 0.98 kWh per km with an energy recovery of 20-40% due to regenerative braking. Mr. Yuan showed short videos of the charging and discharging cycle of a bus en route and an ultracapacitor city bus at the 2011 World Expo, which used a 600-720 V, 250 A charge station They estimate up to $20,000 savings in fuel costs, very low emissions, and a very low ultracapacitor malfunction rate. During discussion, Mr. Yuan noted that the ultracapacitors are about half the cost of lithium ion batteries of the same capacity. He clarified that the maintenance record in his slide showing five ultracapacitor breakdowns refer to the whole fleet of 12 buses. A fully loaded bus can handle a 12% grade. Mr. Yuan also pointed out other ultracapacitor applications including a heavy duty platform truck and coal train.

NEC Non-Road 626 Updates:

August 2011

Greg Nieminski, EPRI Consultant, gave an update on the proposed revisions to the National Electrical Code Article 626. The NEC Task Force will meet on September 1 to finalize four proposals all of which are intended to permit EV charging in electrified parking spaces at truck stops. The changes will refer to Article 625 for EV charging.

IEC 23H Update:

August 2011:

Mr. Niemenski also gave an update on IEC 23H. IEC 62613-1 dealing with shore-to-ship connectors has been published. IEC 62613-2 regarding interchangeability requirements is now being translated to French. Comments have been received for IEC/ISO/IEEE 80005-1, on cold ironing-high voltage shore connection systems-general requirements, and the comments will be reviewed at an October 2011 meeting. The new work proposal for IEC/ISO/IEEE 80005-2, which deals with the communication interface, will also be discussed at the October meeting.

4
ON-ROAD TRANSPORTATION ACTIVITIES

To address the standardization issues within On-Road EPRI, through the IWC continues to participate in activities addressing the variety of codes and standards relating to the electric transportation industry. During 2011 to date there have been three (3) series of IWC meetings.

A standing agenda item at each meeting included a provision for updates regarding all on-road codes and standards. Included in these codes and standards are:

- On-Road Transportation Activities
- Codes and Standards
    - NEC Update
    - ISO/IEC Update
        - Mapping of efforts to SAE
        - SAE/ISO Joint Meeting Summary
    - SAE Update
        - Communication Update
            - J2836/J2847
            - J2931
        - Connector Update
            - J1772TM AC
            - J1772TM DC
        - Power Quality Update
            - J2894
        - New SAE Efforts in 2010
            - J2953
            - J2954
    - UL Update
        - UL AC & DC Charging Review
- Electric Vehicle Supply Equipment (EVSE) Hardware and Standards Update
- Relevant Electric Transportation Technology and Implementation
- Infrastructure Implemental Update

- Modeling of large EVSE installations
  - EV Project
- Other Activities
  - NPFA first responder training
  - NECA electrical contractor training
  - UL Contractor certification and training programs
  - DOE
    - National permitting template project
    - NREL mapping activities

This technical update provides an update on the various On-Road code and standard activities currently underway with SAE, NIST, IEEE, ISO & IEC. Standard, interoperable interfaces from the vehicle to the electric grid are essential for the successful implementation of Plug-in Electric Vehicles (PEVs).

National Electrical Code, NFPA 70-2011

The EPRI NEC Task Force (TF) was responsible for the inclusion of Article 625, ***Electric Vehicle Charging System*** in 1995, as well as numerous revisions in subsequent Code cycles.

During 2010, we have completed the process for the 15 Proposals submitted in November 2008 for the 2011 Edition of the NEC. The proposals to include electric motorcycles and to revise the definition of Rechargeable Energy Storage System were accepted. There were no changes to 625.13 and the Code Panel clarified that EVSE meeting the requirements of 625.18, 625.19 and 625.29 can be cord-and-plug connected even when the voltage is greater than 120 VAC. With regards to 625.29(B), the panel explained that the 18" lower height limit was based on the upper gasoline fume height limit and not related to the ADA. The Code Panel rejected other proposals of concern to the NEC Code Task Force.

The work needed to submit changes for the 2011 NEC was completed in 2009 with the Task Force's additional comments to the Code Panel 12's remarks. The majority of the proposals for Articles 625 Electric Vehicle Charging System were accepted.

During late 2010 and 2011, the EPRI NEC Task Force reviewed the 2011 NEC to formulate change proposals for NEC 2014.

This work will follow the timetable and steps outlined in section 3, National Electrical Code, NFPA 70-2011, General.

Key issues identified for possible 2014 code proposals include:

- Use of equipment at Electrified Truck Parking Spaces, Article 626, for Plug-in Electric Vehicle (PEV) charging covered by Article 625. Covered above in section 3 under the Non-Road NEC Article 626.
- Consideration for the inclusion of dc supply sources, such as battery banks
- Cable types and ampacities for the power supply cord and the output cable to the EV
- Location of the in-line personnel protection system device on a detachable cord set (cable unplugs at both ends and carried on-board the vehicle)
- Interactive systems, review of articles 702 and 705.
- Ventilation requirements
- Reference to Article 220 to include EV charging as an additional standard load
- Clarification of the ADA height requirements

Early in 2011, NEC Code Making Panel (CMP) 12 decided to form a special task group of some CMP12 members to reorganize and rewrite Article 625 to update the format and consider changes that could be proposed as Temporary Interim Amendments (TIA) to the 2011 NEC and as proposals for the 2014 edition of the NEC. Amongst the reasons cited for the formation of the CMP 12 Task Group were to address the needs of builders, electrical contractors and building codes requirements including EV Ready requirements, pre-installation and site requirements, expedite permit and inspection process, expand the use of cord and plug connected EVSE, correctly identify the load being added, address load diversity and the use of energy management systems and so forth.

Gery Kissel, General Motors, CMP-12 member was selected to chair the Article 625 CMP 12 group. Greg Nieminski, chairman of EPRI's NEC Task Force, joined the CMP 12 a member and liaison between CMP 12 and EPRI's NEC TF.

Both groups met several times during 2011, with an interchange of ideas, proposals and comments concluding in a webcast meeting on October 30, 2011 when the last remaining concerns of EPRI's NEC TF were addressed in the CMP 12's final code proposal being submitted for consideration for the 2014 National Electrical Code.

The CMP 12 group was successful in proposing two TIAs that were accepted by NFPA's Technical Committee and will be published as amendments to the 2011 Edition of the NEC. They have not gone through the entire codes and standards-making process of being published in an ROP and ROC for review and comment. These two TIAs are effective only between editions of the National Electrical Code. Each TIA automatically becomes a proposal for the 2014 edition of the NEC, as such is then subject to all of the procedures of the codes and standards making process. TIAs are published in NFPA News, and are included with any further distribution of the 2011 National Electrical Code after being issued.

One TIA (article 625-13) addressed the need to allow additional Electric Vehicle Charging Systems and <u>Electric Vehicle Supply Equipment to be cord and plug connected directly to a branch circuit dedicated for EVSE and terminating in a suitably rated receptacle.</u>

The second TIA (article 625-14) addressed the need to permit the use of automatic load management systems with Electric Vehicle Charging Systems and Electric Vehicle Supply Equipment Systems.

TIA 625.13: http://www.nfpa.org/Assets/files/AboutTheCodes/70/TIA70-11-2.pdf

TIA 625.14: http://www.nfpa.org/Assets/files/AboutTheCodes/70/TIA70-11-3.pdf

NFPA News, November, 2011:
http://www.nfpa.org/assets/files/PDF/NFPA%20News/NFPANews1111.pdf

IEC Update

International Electrotechnical Commission (IEC) Sub-Committee SC23H

IEC 62196 Plugs, Socket-Outlets, Vehicle Couplers and Vehicle Inlets - Conductive Charging of Electric Vehicles

SC23H, its Project Teams (PT) and Maintenance Team (MT8) published the following Standards:

- IEC 62196-1, 2nd Edition, October 2011, *Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 1: General requirements.*

IEC 62196-1:2011 is applicable to plugs, socket-outlets, connectors, inlets and cable assemblies for electric vehicles (EV), herein referred to as "accessories", intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding:

- 690 V a.c. 50 Hz - 60 Hz, at a rated current not exceeding 250 A,
- 1,500 V d.c. at a rated current not exceeding 400 A.

This second edition cancels and replaces the first edition published in 2003 and constitutes a technical revision.

Some of the challenges faced were addressed by resistive components (coding resistors) added to the EV connectors that allows the circuitry in the EVSE and electric vehicle to detect the maximum current permitted by the connector design.

Constructional and test requirements for shuttered socket-outlets required by some countries based on national regulations were recognized within the Standard as exceptions to the basic requirements allowing the identified countries to meet their regulations. ISO TC22 SC21's modified its requirements in ISO 6469-3 to allow an alternative construction that would satisfy the intent of the protection offered by shuttered devices on-board the vehicle.

Concerns for the possible exposure of electrically live plug blades or pins in the situation where the plug is pulled out from socket outlet first before EV connector are being addressed by developing communications and control circuitry to deenergize the circuit before contact with the live blades of the plug can occur.

- IEC 62196-2, October 2011, *Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories*.

IEC 62196-2:2011 applies to plugs, socket-outlets, vehicle connectors and vehicle inlets with pins and contact-tubes of standardized configurations, herein referred to as accessories. They have a nominal rated operating voltage not exceeding 500 V a.c., 50 to 60 Hz, and a rated current not exceeding 63 A three-phase or 70 A single phase, for use in conductive charging of electric vehicles. This standard covers the basic interface accessories for vehicle supply as specified in IEC 62196-1, and intended for use in conductive charging systems for circuits specified in IEC 61851-1:2010. It is to be read in conjunction with IEC 62196-1:2011.

Because of the continually changing technology, SC23H, MT8 expects to start a revision process in 2012 for IEC62196, Parts 1 and 2. China has requested that Part 2 be amended to add a basic unique AC coupler they use in their country.

- SC23H, PT 62196-3 continues working on a new Part 3. The scope of the standard has been expanded to include couplers that will permit either the connection of an AC or DC supply source thru a single inlet. The title of the Standard is proposed to be changed to Part 3 *Dimensional compatibility and interchangeability requirements for dedicated d.c and combined a.c./d.c. pin and contact-tube vehicle couplers*. The project team is preparing the first Committee Draft (CD) following its meeting in Munich, Germany in Mid-October, 2011. The CD will be sent out for a period of 3 months for comment by National Committees. The PT expects to meet three times during 2012 to complete the enquiry (CDV) stage, for a targeted publication in the first half of 2013.

Still to be addressed are new issues arising from the proposal that the same set of contacts on the vehicle inlet be used for either an AC or DC supply to the vehicle. Previously, this was not permitted due to the overheating and possible fire hazard that could occur if AC power were applied directly to the batteries or DC power was applied to low voltage AC control circuits in the vehicle. Automotive manufacturers now claim they can detect the type or frequency of the supply voltage and prevent such a hazard from occurring. Additional information, analysis and supporting details and are still needed to verify this claim.

A second issue involving the possible inadvertent disconnection of an electrically live DC connector from its inlet is being reconsidered. Previously, an abnormal test was conducted using the electric vehicle connector and inlet where the connector would be disconnected while at full load. This simulated the condition where the charging station was expected to shut off but due to a single failure could remain turned on. Damage to the connector was expected but was considered acceptable if no permanent shock hazard or fire hazard occurred after up to three removals under load. Connector manufacturers were concerned about the extra costs involved in designing a coupler that could meet these requirements and asked that IEC TC69 (Charging Stations) consider additional requirements for the equipment that would require some type of redundancy in the charging station such that this type of fault would be prevented from occurring in case of a single fault in the equipment. The details are to be discussed at the next TC 69 meeting in November, 2011 and February, 2012.

Lastly, the concern about connectors and inlets for grounded charging systems verses un-grounded isolated charging systems being used with the proper charging equipment (either isolated dc charging equipment or non-isolated dc charging equipment or both) is being discussed in TC69's PT 61851-23 (DC Charging Stations). Specific requirements will be needed to resolve this matter.

International Electrotechnical Commission (IEC) Technical Committee No. 69

WG4: IEC 61851 series *Electric Vehicle Conductive Charging System.*

Part 1 of this Standard, originally issued in 2001, has been reissued as a second edition in November, 2010. IEC 61851-1:2010 applies to on-board and off-board equipment for charging electric road vehicles at standard a.c. supply voltages up to 1 000 V and at d.c. voltages up to 1 500 V, and for providing electrical power for any additional vehicle functions if required when connected to the supply network. It includes characteristics and operating conditions for the EV coupler for connection to the vehicle and safety with respect to the charging system and vehicle using a.c./d.c. charging stations, when the EV is earthed.

The main changes with respect to the first edition of this standard are:

- revision of connector definitions and current levels (Clause 8);
- modification definition of pilot wire to pilot function;
- division of Clause 9 to create Clauses 9 and 11;
- Clause 9: specific requirements for inlet, plug and socket-outlet;
- Clause 11: EVSE requirements: the basic generic requirements for charging stations;
- renumbering and reorganization of the annexes;
- integrating the charging cable requirements (Annex A) into new Clause 10;
- new Annex A (normative) for all systems using a PWM pilot function with a pilot wire;
- new Annex B for coding tables for power indicator, with new values;
- new (informative) Annex C describing an alternative pilot function system.

The issue regarding the requirements for touchability of the live vehicle inlet contacts between the adopted requirements of IEC 61851-1 and the proposed ISO Standard 6469-3 has been addressed in ISO 6469-3 by including alternative requirements that meet the intent of those in IEC 61851-1. See IEC Update, International Electrotechnical Commission (IEC) Sub-Committee SC23H, IEC 62196-1.

- Part 21: *Electric vehicle requirements for conductive connection to an ac/dc supply*. This part covers additional requirements for the electric vehicle when connected to the EV supply equipment. After considerable discussion with ISO TC22 SC21, it was decided to split this part into an IEC standard (Part 21) addressing the charging equipment and a new ISO standard 17049 to address the vehicle requirements affecting the charging system. Initial discussions regarding this partitioning occurred in September 2011, with several meetings planned in 2012. Both electromagnetic compatibility and generated EM disturbances, electrical back feed from the vehicle through the branch circuit to the utility grid are to be addressed.
- Part 22: *ac electric vehicle charging station*. This part covers specific requirements for ac supply equipment providing electrical energy to the EV. A second CDV was distributed for comment by National Committees. The comments received were reviewed during a meeting in November 2011in conjunction with Part 21. A decision was reached during the November meeting to begin a revision process for 61851-1 and to consolidate the common requirements in both Parts 22 and 23 into Part 1. Following this work, a CDV for further comment and vote is planned..
- Part 23: *dc electric vehicle charging station*. Work began July 2010. Several additional meetings were held with improvements made to each subsequent working draft. Following the last meeting in October 2011 in Germany, a CD will be issued including the changes accepted based on approximately 350 comments received. The proposed standard will include dc supply equipment supplied from both conventional ac and dc sources such as battery storage systems and photovoltaic systems. Detailed requirements taken from UL 2231-1 Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements and for Isolation Transformers, taken from IEC 61558-1, 61558-4 and 61558-12 have also been proposed to be included in the draft CD being planned for circulation before the end of 2011 in preparation for a PT 61851-23 meeting in Japan in May, 2012. A CDV is anticipated for review and vote by National Committees following the May, 2012 meeting.
- Part 24: *Control communication protocol between off-board d.c. charger and electric vehicle.* Project team 61851-24 has met and begun work define the communications needed between the high power dc charging equipment and the PEV. It covers the physical layer, the data link layer, the application layer and other layers as needed. Following the first meeting in October 2010, the PT met twice in 2011 and is developing a working draft WD. A CD is planned for early 2012 for review and comment at the planned PT61851-24 meeting scheduled in Japan in May, 2012.

IEC TC 69 is working with ISO TC22 under a joint ISO/IEC working group (JWG) to develop the new IEC 15118 series standards for Road vehicles - Vehicle to grid communication interface. These include:

- ISO/IEC 15118-1 *Road vehicles - Vehicle to grid communication interface - Part 1: General information and use-case definition,*
- ISO/IEC 15118-2 *Road vehicles - Vehicle to grid communication interface - Part 2: Technical protocol description and open systems interconnections (OSI) layer requirements*, and
- ISO/IEC 15118-3 *Road Vehicles - Vehicle to grid communication interface - Part 3: Physical layer and Data Link layer requirements*

CD's have been issued for all documents. Comments were received for parts 1 and 2. They are being addressed. The closing date for comments for Part 3 is in January 2012.

SAE J1772™ Coupler Standard

J1772™ AC Level 1 and Level 2 connectors have been UL tested up to 75A AC, 240 VAC and are ready for the initial PEV deployments.

The present standard J1772:2010 covers the coupler for:

- AC Level 1:120V AC single phase (12 or 16 amp; 1.44 or 1.92kW)
- AC Level 2:240V AC single phase (≤ 80 amp; ≤ 19.2kW)

Coupler compatibility testing between manufacturers is underway with results expected by the end of the year to insure interoperability.

A hybrid connector is under evaluation that will be backward compatible and also include:

- DC Level 2: 200 –450V DC (≤ 200 amp; ≤ 90kW)

Work on defining AC and DC Level 3 charging continues in SAE J1772™.

The SAE J1772™ Standard contains all of the requirements for the EVSE for AC Level 1 and AC Level 2 charging. Work continues on AC Level 3 and DC charging.

The SAE J1772™ committee is currently conducting a series of meetings to amend the J1772™ document to reflect correction of typographical errors, address minor changes needed in the standard to address loose ends and to update technical content as needed. This effort is expected to wrap up in the first quarter of 2012.

Charging Scenarios/Mode Overview

SAE has defined three levels of AC and three levels of DC charging

- AC Level 1: Common household circuit rated to 120 volts AC and 15 or 20 amperes. The EVSE can be portable and is described as a "cord set". AC Level 1 relies on the J1772™ connector.

- AC Level 2: Permanently wired electric vehicle supply equipment used especially for electric vehicle charging; rated at 240 volts AC, up to 80 amps, and up to 19.2 kilowatts. AC Level 2 relies on the J1772™ connector.
- AC Level 3: TBD.
- DC Level 1: (Proposed) Use of an off-board DC charger through the J1772™ connector at a power level up to 36kW. DC Level 1 relies on the J1772™ connector.
- DC Level 2: (Proposed) Use of specialized DC charging connector (TBD) at a power level of up to approximately 90kW. The DC Level 2 connector has yet to be defined and may include dedicated communication pins.
- DC Level 3: TBD.

SAE J1772™ Configurations, Ratings and Use Strategy (Proposed)

- **AC Level 1** – 120V AC 1 Φ
  - Rated Current 12A or 16A
  - Rated Power 1.44kW, 1.92kW

J1772 AC Connector

- **AC Level 2** – 208/240V AC 1 Φ
  - Rated Current <=80A
  - Rated Power <= 19.2kW

- **AC Level 3** – TBD; AC 1 or 3 Φ?

Connector is TBD

- **DC Level 1** – 200-450V
  - Rated Current <=80A
  - Rated Power <= 36kW

- **DC Level 2** – 200-450V
  - Rated Current <=200A
  - Rated Power <= 90kW

Combo or CHAdeMO Connector

- **DC Level 3** – 200-600V
  - Rated Current <=400A
  - Rated Power <= 240kW

Connector is TBD

Now - Future

SAE Charging Configurations, Ratings and Use Strategy			
	**AC level 1** (SAE J1772™) PEV includes on-board charger 120V, 1.4 kW @ 12 amp 120V, 1.9 kW @ 16 amp Est. charge time: PHEV: 7hrs (SOC* - 0% to full) BEV: 17hrs (SOC – 20% to full)		***DC Level 1** EVSE includes an off-board charger 200-450 V DC, up to 20 kW (80 A) Est. charge time (20 kW off-board charger): PHEV: 22 min. (SOC* - 0% to 80%) BEV: 1.2 hrs. (SOC – 20% to 100%)
	AC level 2 (SAE J1772™) PEV includes on-board charger (see below for different types) 240 V, up to 19.2 kW (80 A) Est. charge time for 3.3 kW on-board charger PEV: 3 hrs (SOC* - 0% to full) BEV: 7 hrs (SOC – 20% to full) Est. charge time for 7 kW on-board charger PEV: 1.5 hrs (SOC* - 0% to full) BEV: 3.5 hrs (SOC – 20% to full) Est. charge time for 20 kW on-board charger PEV: 22 min. (SOC* - 0% to full) BEV: 1.2 hrs (SOC – 20% to full)		***DC Level 2** EVSE includes an off-board charger 200-450 V DC, up to 80 kW (200 A) Est. charge time (45 kW off-board charger): PHEV: 10 min. (SOC* - 0% to 80%) BEV: 20 min. (SOC – 20% to 80%)
*In development Voltages are nominal configuration voltages, not coupler ratings Rated Power is at nominal configuration operating voltage and coupler rated current Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack			
Notes: 1) BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100% 2) PHEV can start from 0% SOC since the hybrid mode is available. *ver. 082911*			

Figure 4-1
SAE Charging Configurations and Ratings Terminology (Proposed)

Proposed Coupler for AC & DC Charging

As noted in the previous section, three modes, or Levels, of charging have been defined for both AC and DC interfaces. AC Levels 1 and 2 can be accomplished using the SAE J1772^{TM} connector. A connector for AC Level 3 has not been defined. DC Level 1 also relies on the use of the J1772^{TM} connector.

One complication for use of DC over this connector is the lack of dedicated communication pins. This requires that PLC or signaling over the Pilot wire be used to control the DC messages between the PEV and the off-board DC charger. There was a joint OEM meeting on May 17-18, 2011 in Detroit, Michigan where it was agreed to pursue two PLC technologies as summarized in the Table below. A second issue involves the controlling circuitry within the EV that will be expected to distinguish between AC and DC power on the same terminals and insure that AC is not applied directly to the EV batteries, nor high voltage DC applied to the low voltage control circuitry. Proposals are being developed but have not been presented in detail with an analysis to prove that the vehicle controls can prevent a hazard. The details are expected in early 2012.

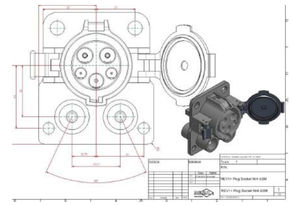
Technology	Medium	Status
HomePlug GreenPHY	pilot	primary
HomePlug GreenPHY	mains	backup
Texas Instruments G3	pilot	backup
Maxim G3	pilot	backup

Communications support while AC charging would mainly have a focus on interaction with a home area network, off-board energy management system or a utility advanced metering system. SAE has decided to rely on Smart Energy 2.0 protocol to support this communication. Here the focus is to provide bi-directional communication to and from the vehicle allowing the vehicle to report its energy needs and for an external source to manage charging.

Communications support for DC charging is focused on relaying tightly coupled messages from the vehicle charge controller to an off-board set of power electronics that provide the DC power to the vehicle. These messages can require a fast time response (Tens of milliseconds) and can be related to vehicle being able to safely charge.

During the joint OEMs meeting, the OEMs agreed that the working assumption for communications is HPGP (HomePlug Green PHY) over the control pilot wire in order to harmonize difference between SAE and ISO/IEC. However, detailed testing of both HPGP and G3 solutions will be performed in 2011 and quarter 1 of 2012 before a single solution is adopted by SAE for DC charging as well as utility charging

- **PHEV/EREV – Connector C1**
  - AC L1 and L2, DC L1; maybe largest volume of vehicles (90%)
  - C1 is the J1772 connector
  - Communication Protocol – PLC, Inband Signaling



- **BEV – Connector C2 Hybrid coupler**
  - AC L1 and L2, DC L1 and L2
  - C2 is the proposed J1772 combo connector
  - Communication Protocol – PLC, CAN, Inband Signaling
- **Commercial/Fleet Vehicles – Connector C3**
  - AC L3, DC L3
  - C3 is a TBD high power connector
  - Communication Protocol – TBD

Figure 4-2
Potential Coupler Use for Vehicle Charging

Coupler Compatibility / Interoperability Testing

Coupler compatibility / Interoperability testing between manufacturers were completed this year. Initially 5 coupler manufactures agreed to test. However after the initial interoperability mating tests, all but 2 manufactures pulled out of the more detailed testing. Between the remaining 2 manufactures (REMA and Yazaki), no issues were discovered.

Combo Coupler Development

The task force has been developing a combination or combo coupler for DC Level 2 charging. The combo allows for AC Level 1, AC Level 2, DC Level 1 and DC Level 2 charging with a single vehicle inlet.

The initial design's mechanical assist feature was deemed too complicated and the overall coupler size too large. This resulted in a design requirements survey to rank key requirements in an attempt to reduce mechanical complexity and physical size.

As a result, design changes were:

- 8mm pins (200 amp), no communications pins, no mechanical assist.
- Option provides the most current with the greatest incremental reduction in coupler width.

- Removal of communication pins reduced the coupler size and lowered the insertion force sufficiently to eliminate the need for mechanical assist.
    - Requires Power Line Carrier (PLC) for DC charge control
    - Current PLC direction is Green Phy on the Control Pilot circuit but other configurations are being tested

Other size reduction enablers:

- Revised DC sealing strategy
- Integrated AC keyway into DC terminal outer ring

7 industry partners, including vehicle OEMs are tooling the Combo coupler with 2 suppliers. Parts will be available beginning in late November, 2011.

J1772 Planned Revisions

J1772 has been revised to correct typographical errors, address minor technical issues and include a new appendix that describes an EVSE interoperability test procedure. This revision should be published in early 2012.

The subsequent revision to J1772 will include requirements for DC Level 1 and DC Level 2 charging.

When J1772, J2847, J2931 and J2953 are published/re-published early next year, these documents will support a complete DC charging system.

Harmonization

Portions of IEC 62196, Parts 1 and 2, for the AC rated EV couplers are equivalent documents to SAE J1772. 62196-2 also includes configurations used in Europe, Italy and in other countries. IEC 62196-3 will contain the proposed combined AC/DC interface being developed for SAE J1772 and Europe, as well as the Japanese "Chademo" DC coupler design, and a Chinese and Korean design.

IEC 61851-23 covers DC charging stations. It will include requirements and tests both isolated and non-isolated DC charging systems.

SAE J2836™/2847/J2931/J2953 Communication Standards

The SAE J2836™, J2847, J2931 & J2953 Communication Committee continues to work toward standardized communications for plug-in electric vehicles (PHEV).

2011 Activities

Key efforts in 2011 include:

- Completion of DC charging 1st step publication of J2836/2™ & J2847/2
- Completion of communication requirements as it relates to PowerLine Carrier (PLC) captured in J2931/1
- Completion of EPRI authored PLC test plan. This leads to testing of PLC products for Utility and DC charging messages using EPRI's test plan and schedule
- In support of the SAE Hybrid J2836™, J2847, J2931 & J2953 Committee, EPRI has undertaken evaluation of a set of power line carrier (PLC) technologies.
- PLC testing currently underway at EPRI Knoxville laboratory and other national laboratories namely ANL

– Qualcomm HPGP hardware

– Texas Instruments G3 hardware

– Maxim Semiconductor G3 hardware

- Progress on PEV communications interoperability in J2953/1
- The Use cases, general information and architecture are also being developed and/or updated for the following

– Reverse Power Flow (J2836/3™ & J2847/3)

– Diagnostics (J2836/4™ & J2847/4)

– Customer to PEV and HAN/NAN communication (J2836/5™ & J2847/5).

Communication Standards Structure and Breakdown

There are six major documents starting with J2836™ for Use Cases and General info. The requirements derived from these use cases are then fed into the corresponding J2847 document that includes more detail for messages, sequences and detail info.

SAE J2931 was formed in 2010. Work continues on the SAE J2931 communication standards to support AC and DC charging (off-board) and the advanced applications including reverse energy flow, utility programs, diagnostics, and the customer interface. The J2931 document identifies the communication protocol requirements and J2953 identifies the interoperability. Figure 4-3 shows the summary of these four standards and the various slash sheets and their specific function.

The task force has four distinct document numbers with several slash sheets for the various functions.

- J2836™ - Use Cases
- J2847 – Corresponding Requirements (to use cases)

- J2931 – Communication Requirements
- J2953 - Interoperability

The SAE J2836™, J2847, J2931 & J2953 Communication Standard interaction is shown in Figure 4-4 for these along with specific examples in Figures 4-5 & 4-6. The six slash sheets of J2836™ Use cases, correspond to the slash sheets of J2847 to include the signals, messages, diagrams and other requirements.

J2931/1 includes the protocol requirements for all the J2847 documents and PLC is shown for the "wired" communication requirement for (1) association and (2) DC charging/discharging as J2931/2, /3 & /4.

J2931/5 includes telematics protocol requirements and is used primarily for the J2836/5™ and J2847/5 documents but is also a means to communicate for the other functions. This is the same for the /6 series as it applies to wireless charging.

These are then wrapped by the J2953 documents for interoperability and then an overall wrap for security is included in J2931/7/. The security may vary slightly as it applies to the utility messages with a subset also included for DC charging. The wireless charging approaches that already use DSRC may have yet another variation for security and this medium is also used for Vehicle to Vehicle (V2V) or Vehicle to Beacon communication and is being proposed for wireless charging since the vehicle could be charged while mobile.

Note: J2931-3 & 4 documents for PLC are "under consideration" at this point, or "works in progress" and will be formalized once we have vetted through the EPRI testing process and determine which solutions are acceptable. J2931/5, 6 & 7 are proceeding within their respective teams.

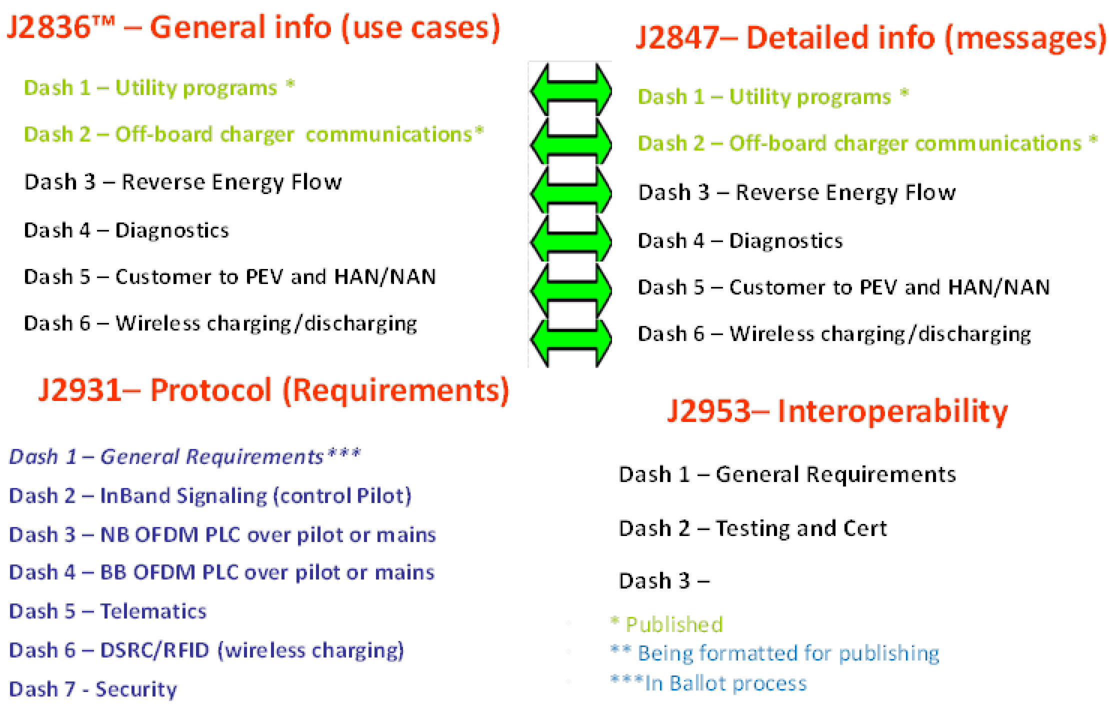


Figure 4-3
Summation of SAE Communication Standard

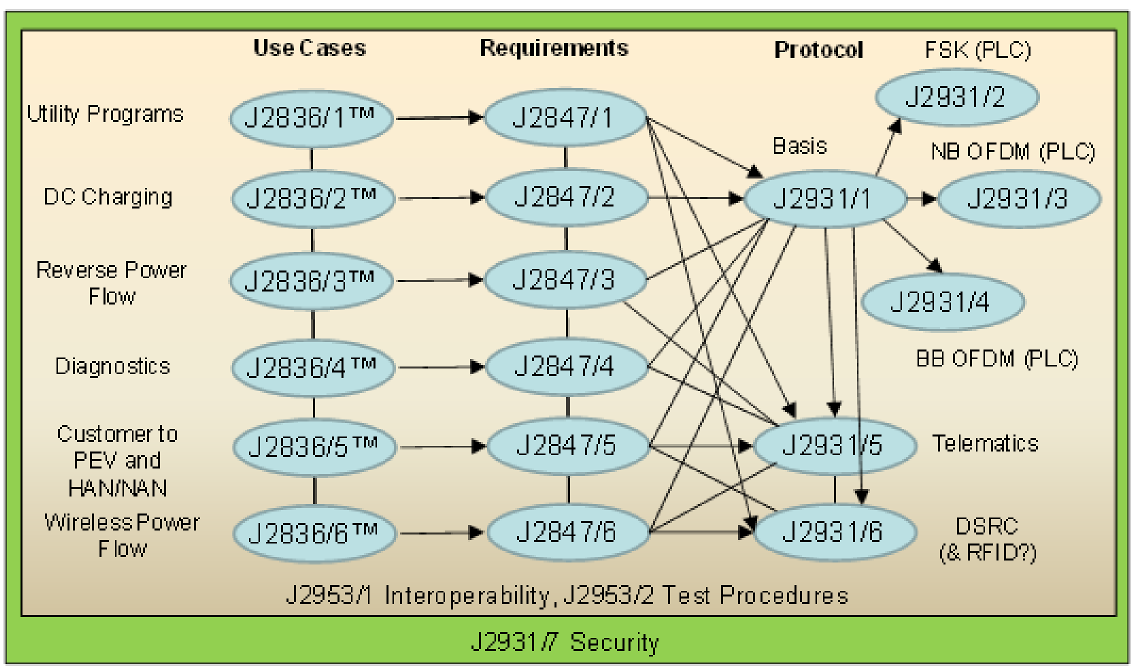


Figure 4-4
Summation of SAE Communication Standards

Figure 4-5 shows an example for DC Charging. The primary documents would be J2836/2™, J2847/2 and J2931/1 but if Diagnostics and Customer to PEV interaction is included, then the /4 & /5 documents would be applicable. These are stand-along documents and yet build on each other and in certain cases are combined. This does require PLC wired communication for control of the off-board charger but can also include diagnostics and customer to PEV communication using telematics and potentially DSRC.

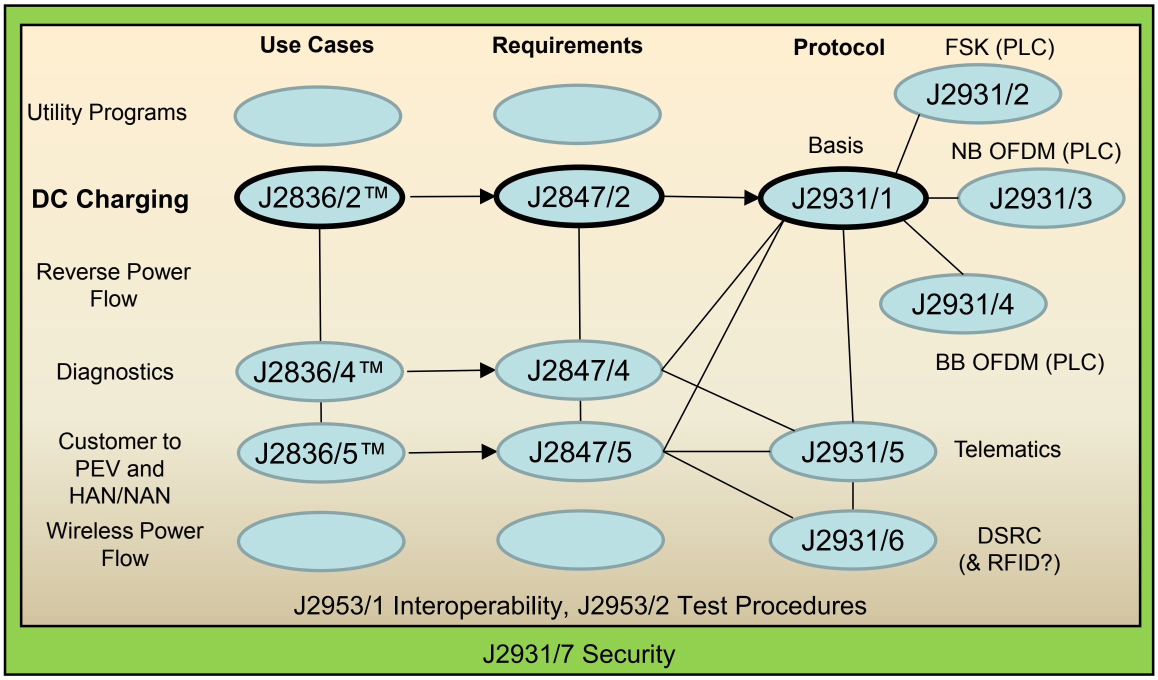


Figure 4-5
DC Charging Interaction

Figure 4-6 shows how the documents can build on each other in the case of Vehicle to Grid Reverse Energy Flow, with off-board conversion. The off-board conversion would use the basis of DC Charging (since this is DC Discharging) and combine with the V2G communications in the /3 set of documents. With on-board conversion, the /2 set of documents would not be included.

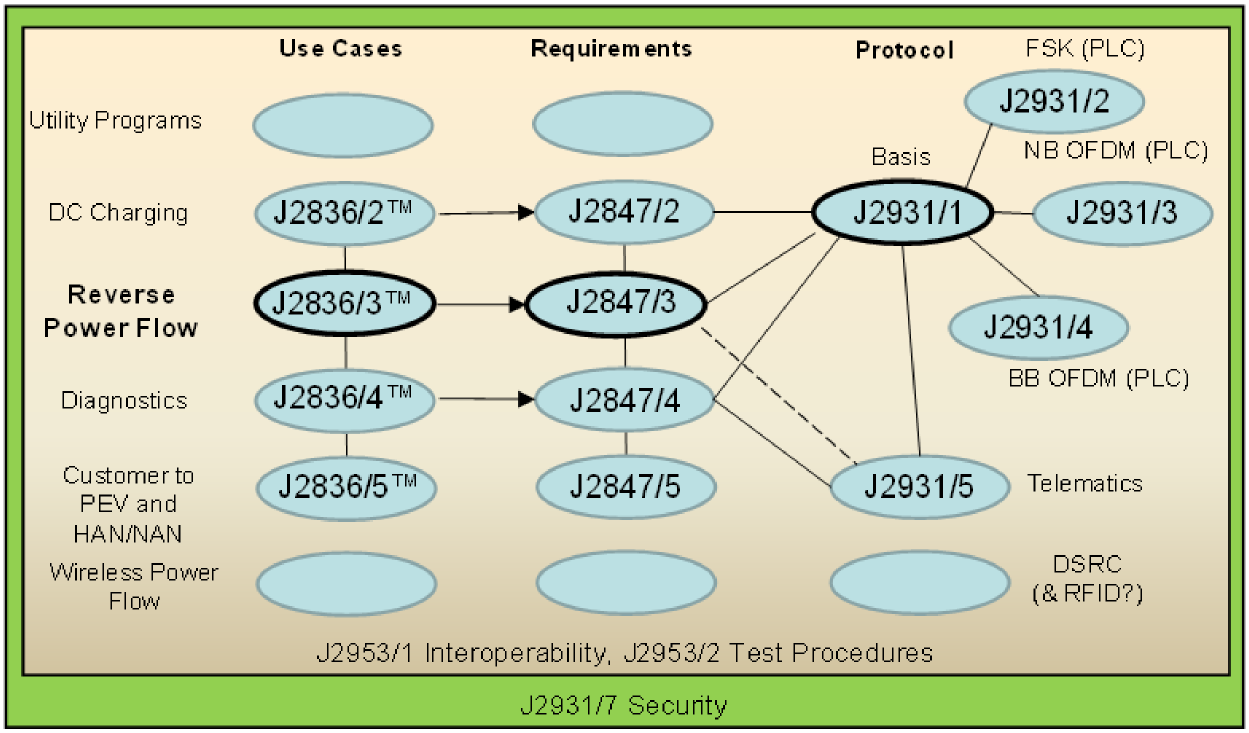


Figure 4-6
Reverse Energy Flow with off-board conversion

Communication Technologies Considered

SAE has considered a number of possible communications means for the vehicle. Depending on the connector used for charging (J1772™ or the specialized DC connector) there are three possible means to support communication:

- The traditional power line communication (PLC), where the communications is carried over the same conductors as the charging power. No additional pins are needed on the connector to implement communications.
- Communication over the J1772™ Pilot wire also referred to as "in-band" communication. This relies on the fact that current National Electric Code requirements specify that an EVSE must be used to supply power to a plug-in electric vehicle. Since the Pilot wire only goes between the EVSE and PEV, communications beyond the EVSE will require an additional communications interface in the EVSE.
- Controller Area Network (CAN) bus communication. This requires two dedicated communication pins and would therefore only be an option on the specialized DC connector.

In 2011, SAE communications has focused on the PEV to EVSE communication and includes three options. The PEV could include either wired or wireless communication or combinations of both. Wired communication is required for the PEV association and control of any off-board conversion equipment (off-board chargers or dischargers).

Figures 4-7, 4-8 & 4-9 show these variations. SAE is standardizing on the communication and using the J1772™ control pilot for wired communication using Power Line Carrier (PLC). This includes the EVSE as a bridging device to the Energy Service Interface (ESI) and any off-board conversion device.

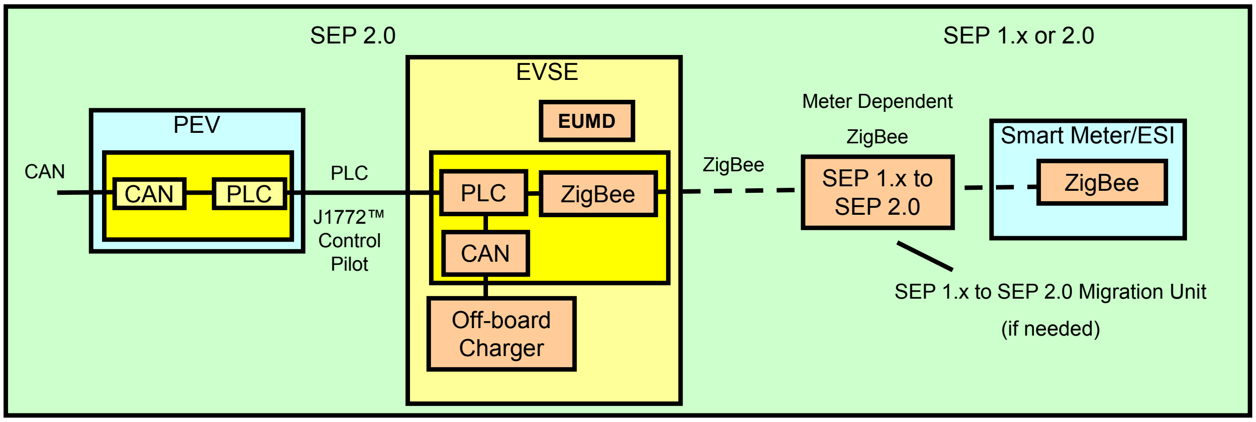


Figure 4-7
Wired PEV and Wireless ESI

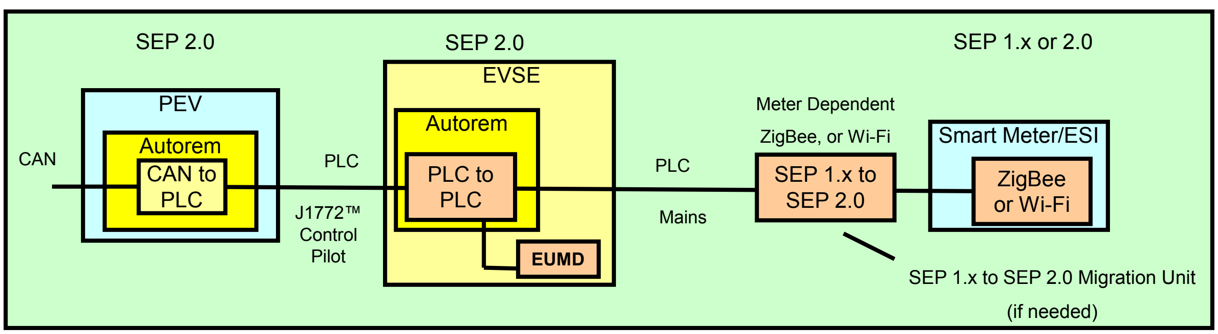


Figure 4-8
Wired PEV and ESI

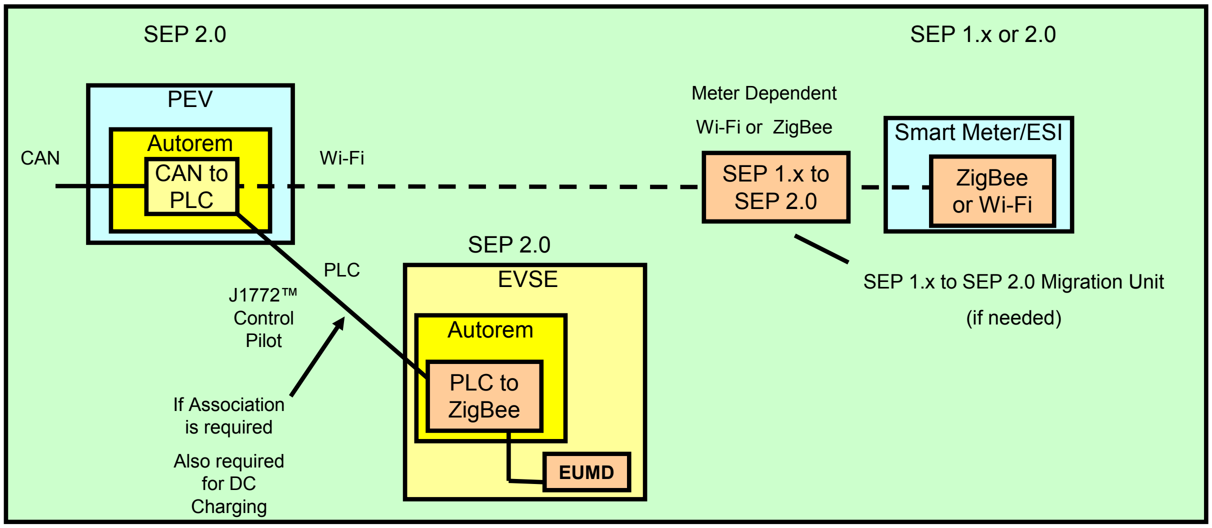


Figure 4-9
Wireless PEV and ESI

SAE Developed Communication Requirements for AC and DC Messages

In support of the SAE Hybrid J2836™, J2847 and J2931 Committee, in 2010, EPRI had undertaken the effort to develop functional requirements. An EPRI report, EPRI TR 1019930, "*Communications Requirements for PEV*," has been developed. This report creates a set of functional *r*equirements for the physical layer of Plug-in Electric Vehicle communications in a manner that can be utilized to evaluate multiple technologies. In conjunction with EPRI TR 1019931 technical update which is focusing on test requirements for the physical layer, this document provides a roadmap for selecting an appropriate physical layer for SAE (Society of Automotive Engineers) Standard J2931.

In 2011, EPRI worked with SAE as well as ZigBee Alliance/SEP 2.0 development teams to finalize the communication requirements and harmonize this effort with ISO/IEC groups as well. The 2010 effort was revised and all comments from various stakeholders were captured in the requirement document. J2931/1 document captured the revised and final SAE approved protocol requirements for both DC as well as AC Messages.

The following is a set of high level requirements that shall be met:

- Use the existing charging Infrastructure i.e. J1772™ [1]
- Enable both public and residential charging
- Accommodate both AC and DC charging methods
- Interact with Energy Providers to load balance the grid and optimize transfer at the lowest energy cost
- Provide a single interoperable worldwide standard to assure compatible systems
- Low cost system implementation that meets requirements

- Communicate with customer
- Minimal customer interaction
- Future proofed: Requirements should provide expansion capabilities and headroom

Figure 4-10 shows the architecture for both AC and DC Level 1 and Level 2 charging. The PLC communication is using the J1772™ control pilot as shown.

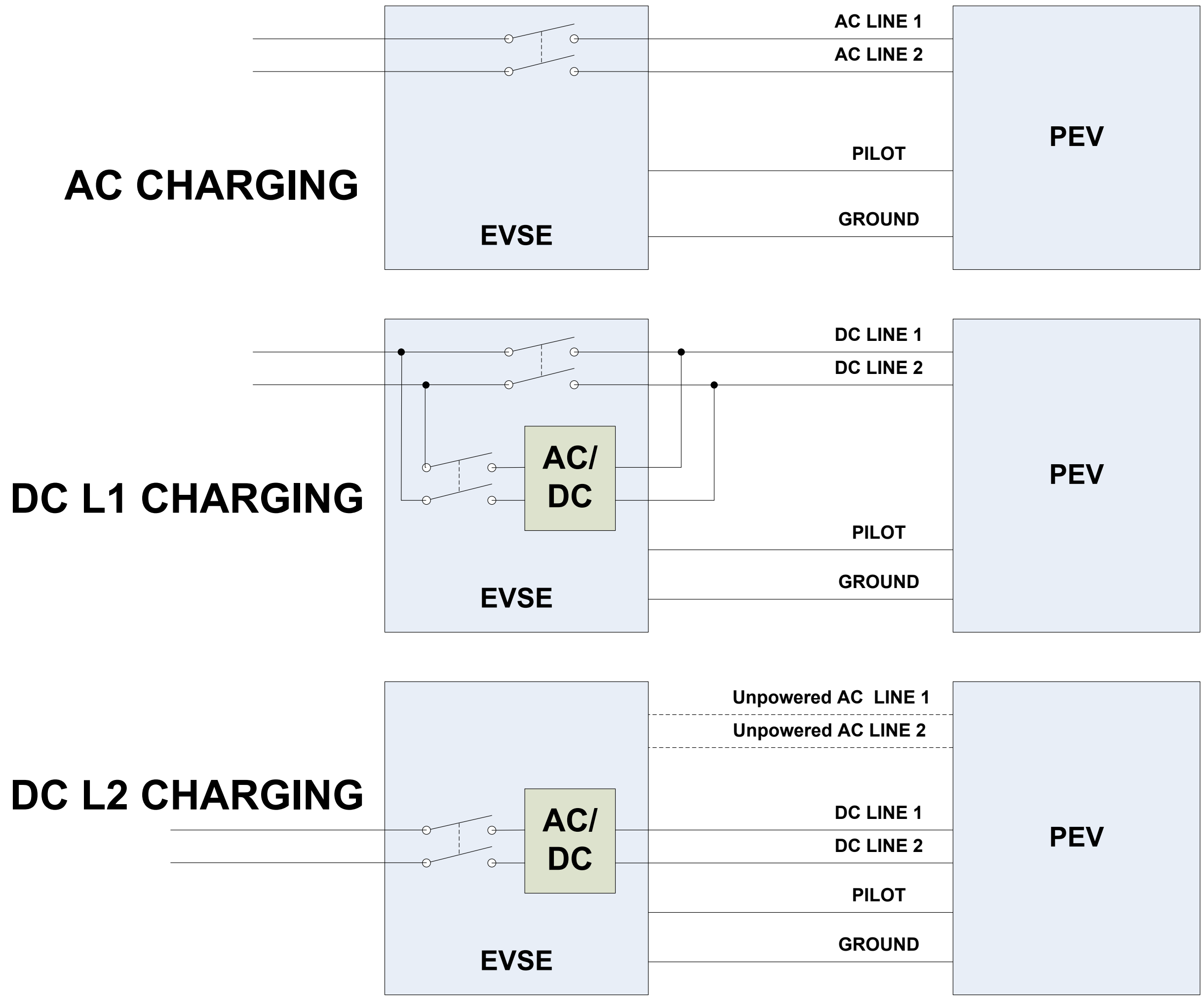


Figure 4-10
AC and DC Charging Combinations

An example of the requirements in J2931/1 is shown in Table 4-1.

Table 4-1
Partial Requirements list identified in J2931/1

Requirement ID	Requirement	Reference	Priority
Application Requirements			
RD.App.1	Support basic Utility or service provider use Cases	J2836/1	Basic
RD.App.2	Support basic Utility or service provider messages	J2847/1, SEP2.0, ISO15118	Basic
Common Communication Requirements			
RD.Comm.1	The DC and Utility or service provider messages shall use the same channel or media to minimize cost based on the different requirements		TBD
RD.Comm.2	Meet Industry EMC and Radiated RF Standards		Basic

SAE Developed Test Plan for PLC Communication

SAE is working to define communications standards for plug-in electric vehicles. In support of this effort, testing of potential technologies must be conducted. EPRI worked with SAE members to develop a comprehensive PLC test plan. The test plan defines a systematic set of tests that will be used to vet various communications technologies in support of such vehicle communications. Communications for two primary purposes is being considered in this effort: support of utility/customer communications to support smart charging; and communications to support the use of off-board DC charging equipment.

The overall scope of the test plan includes:

- This test plan verifies that the communications technologies described in J2931 are capable of meeting the requirements described in “S288 EV Communication Requirements Document (RD)” as related to the standards J2847, J2836, J2931, and J2953.
- The requirements and tests apply to the digital communications interface between the plug-in electric vehicle (PEV) and an external device to which it communicates. Such off-board devices may include one or more of an EVSE, off-board DC charger, Home Area Network (HAN), Advanced Metering Infrastructure (AMI) meter, etc.

– To provide a safe electric charge

– To interact with energy providers in a secure manner

– To communicate information to the customer on the transaction

- This tests described in this plan are applicable to wired communications mediums only, using the J1772 charge cable. Wireless means of PEV communications are not covered in this test plan.

The following five categories have separated the requirements for the test schedule:

- Data – Performance Tests
- Data/EMC – Reliability Tests
- Application Tests
- DC Charging – Off-board DC Charger Communication Tests
- SEP2 – Utility/HAN Communication Tests
- DC + SEP2 – Common Communication Tests
- Association
- Application Tests
- Security Tests

PLC Solutions included as part of Testing and Evaluation

The following communications technologies have been identified as candidates capable of meeting the requirements outlined in the preceding sections.

Broadband PLC

The broadband PLC technology will be HomePlug GreenPHY "HPGP". The tested solution will be conformant to the specification "HomePlug GREEN PHY Specification Release Version 1.00", (or subsequent updates). The HomePlug GreenPHY system to be tested operates in the frequency range of 2 MHz to 30 MHz.

The specific hardware platform to be tested will be:

- Vendor : Qualcomm-Atheros
- Platform name/model : PL-15
- Chipset: INT7400
- Firmware version: 5.2

Narrowband PLC

The Narrowband PLC technology will be "G3". The tested solution will be conformant to the specification "IEEE P1901.2 standard" The specific hardware platform to be tested will be:

Platform 1:

- Vendor: Maxim
- Platform name/model : "Laguna"
- Chipset: <TBD>
- Firmware version: <TBD>

Platform 2:

- Vendor Texas Instruments
- Platform name/model "REM/Auto Rem"
- Chipset: <TBD>
- Firmware version: <TBD>

PLC Testing – 2011 Activities

In support of the SAE Hybrid J2836™, J2847 and J2931 Committee, EPRI has undertaken evaluation of a set of power line carrier (PLC) technologies. Initial set of tests were performed in 2010 where vendor hardware evaluation kits were operated in the EPRI lab, laying the groundwork for in-depth PLC testing to occur in the near future. An EPRI report, EPRI TR 1019931, "*PLC for PEV – EPRI Lab Test Results and Analysis*," has been developed as part of 2010 efforts. The primary focus of this report is to provide an overview of the vendor evaluation hardware and software and to report results of simple tests that were conducted to vet the function of the link performance reporting software.

Figure 5 shows the baseline lab setup for these tests.

Figure 4-11
Baseline Lab Setup.

Tests are being included for association, crosstalk, coexistence, inter cable interference and more. Figure 6 identifies the test setup for the cable interference test.

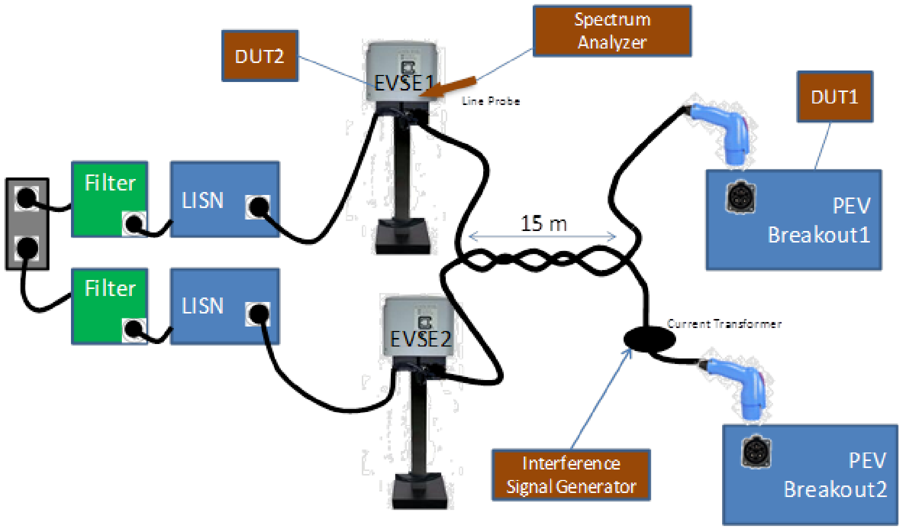


Figure 4-12
Inter cable interference setup.

Smart PEV versus Smart EVSE

- Our long-term vision is for PEVs to support bi-directional communication with smart meters without needing intermediaries, with PLC as the physical layer and SEP 2.0 as the application layer. The best place for communication capability to reside is where the information exists to make the decisions - at the two ends: the controllable load (PEV) and utility control device (AMI/HAN). This goal may not be supported by all utilities, but this represents a consensus of a large number of utilities.
- Based on the SAE plan to use the control pilot wire for PLC communication, a bridge or router type device will be needed in the EVSE to carry vehicle communication beyond the EVSE.
- In the presence of communications enabled PEVs, smart EVSEs become pass-through sub-metering devices.
- In the near-term PEVs that support SEP 2.0 and PLC communications will not be available due to the absence of mature standards. Electric Vehicle Supply Equipment (EVSE) with communications and control capability, often referred to as a smart EVSE, can fill that gap, allowing utilities to control non-communicative PEVs and still accomplish basic demand response and load control via the SAE-J1772™ specified pilot line. A smart EVSE, if implemented as an intermediary between the vehicle and the grid, should not introduce requirements that are not compatible with direct PEV AMI/HAN communications.
- A single PLC technology should be adopted by both the utility and automotive industries to facilitate the broadest range of vehicle communications applications.

Smart Energy 2.0

Smart Energy is one of the leading standards for enabling the interoperability of devices that control, monitor and display the use of energy. The standard supports a smart grid vision where electric utilities and product manufacturers can deploy devices that are secure and consumer friendly. Smart Energy V2.0 (SEP2.0) is currently under development in collaboration with other standards development groups including the Homeplug Poweline Alliance and the Wi-Fi Alliance. SEP2.0 will offer an IP-based control solution for various environments including home area networks (HAN). In addition to all the services offered by SEP1.0, SEP2.0 will include addition features such as:

- Control over Plug-In Electric Vehicle Charging
- Prepay Services
- Support Wired and Wireless HANs

In July, 2011 the Zigbee Alliance publically released draft 0.7 of the SEP2.0 standard. Public comments were welcomed up to August, 2011. The V0.7 draft standard release was significant milestone for manufacturers as they look to develop certification processes for upcoming SEP2.0 enabled products. Currently SEP2.0 technical committees continue to work on comment resolution of all sections including Metering, Pricing and Billing. The alliance is aiming to complete work on draft V0.8 by Q2 2012.

EPRI along with other participating electric utilities such as Southern California Edison will continue to support the integration of PEV functions into SEP2.0 and the integration of SEP2.0 functions into SAE & IEC standards.

Smart Energy 2.0 Messages versus DC Messages

SAE continues to evaluate the possibility of combing DC charger control messaging SEP 2.0 messages on a single interface. As previously stated, there are a number of issues to consider with this combination.

- Separating DC control messages from SEP 2.0 messages leaves open the possibility of SAE PLC technology being harmonized with NIST and with ISO/IEC efforts
- Separating the messages means the DC interface won’t have to compete with “other” communication devices
- Separation means that time critical and safety critical DC control messages don’t have to compete with SEP 2.0 traffic
- SEP 2.0 has a complex packet structure that is not well matched with the simple messages needed in DC control
- SEP 2.0 communications would need to run in parallel with DC messages - something that appears to be problematic related to latency requirements for the DC control messages

- The DC charging time is expected to be short and analysis needs to be done if more than Demand Response messages need to pass to the PEV during this session time. The EVSE could receive other SEP messages during the DC charge time but not relevant and required for the PEV after the binding or re-binding is established.

ISO/IEC Joint Working Group Communication Updates

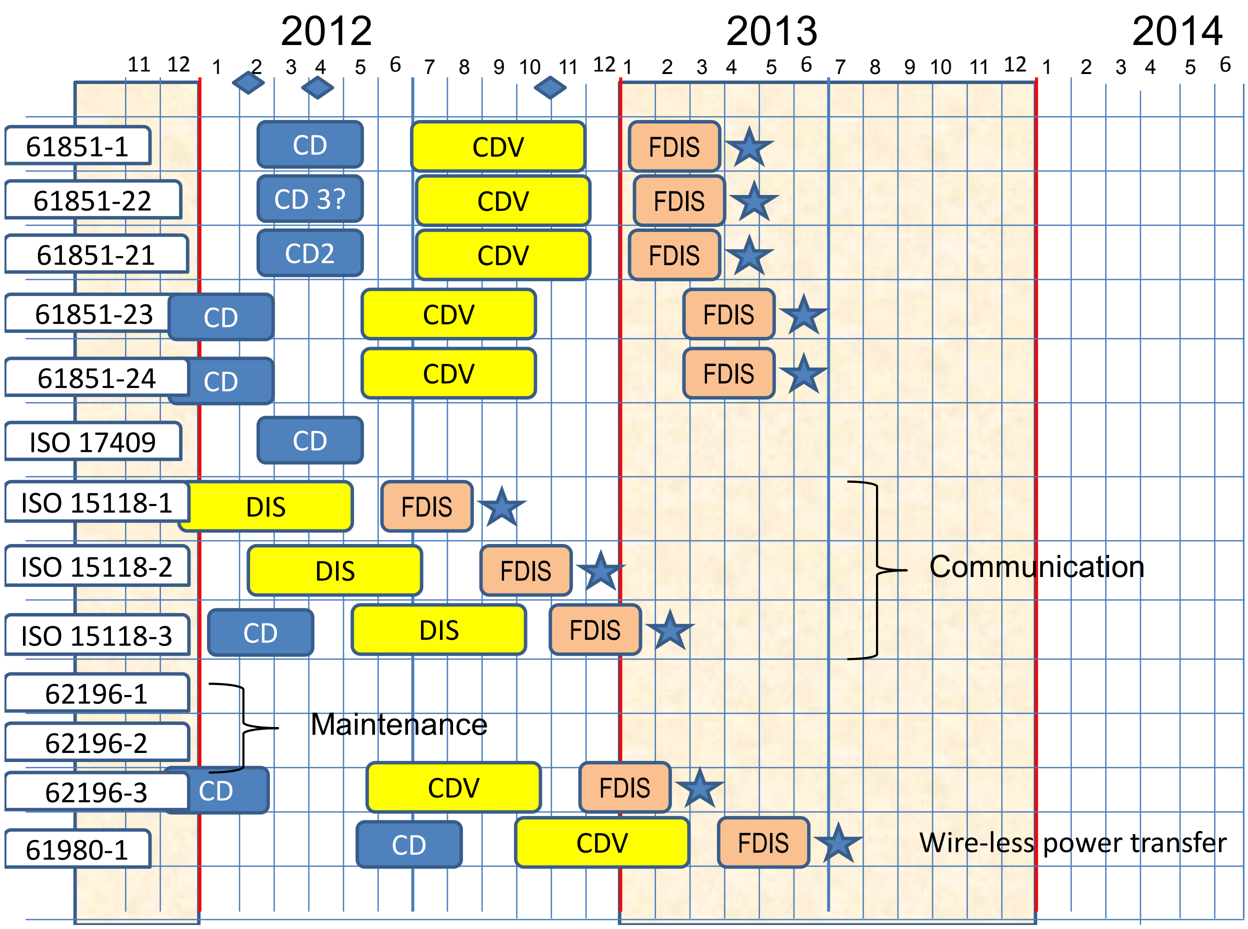


Figure 4-13
ISO/IEC Update on Communication Standard

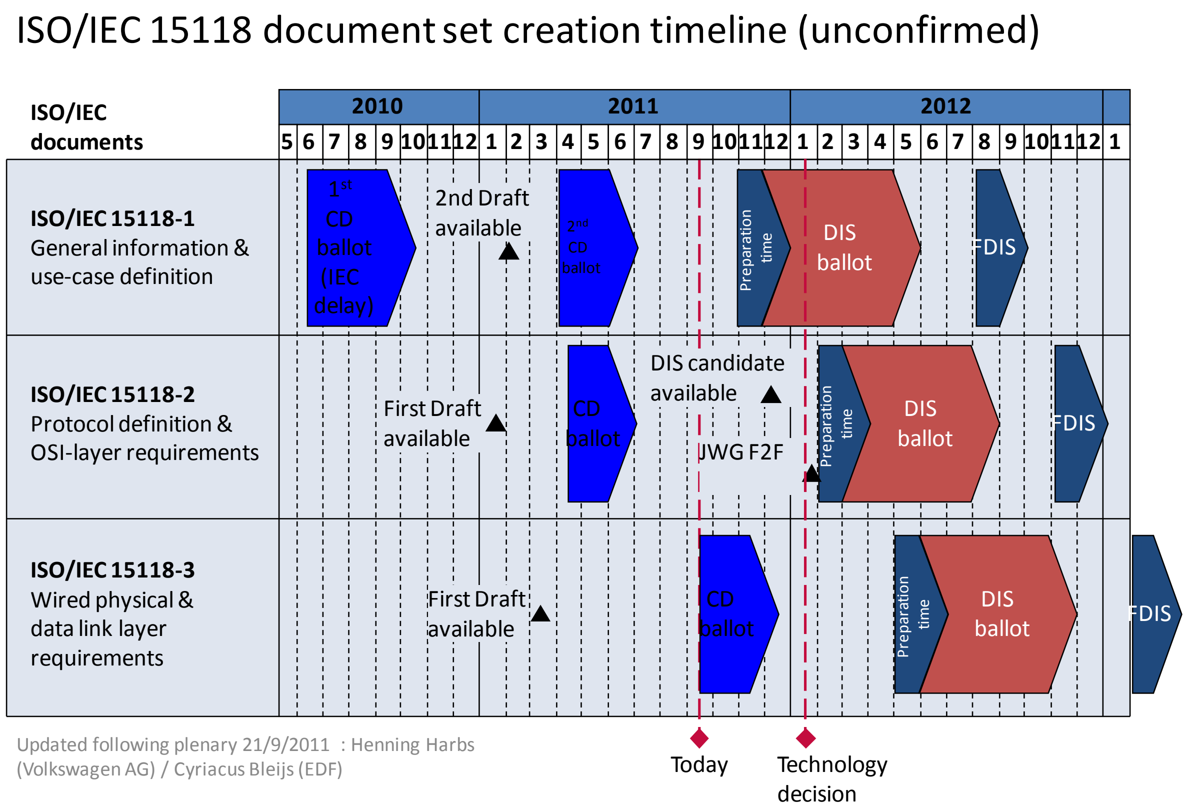


Figure 4-14
ISO/IEC 15118 Document Plan

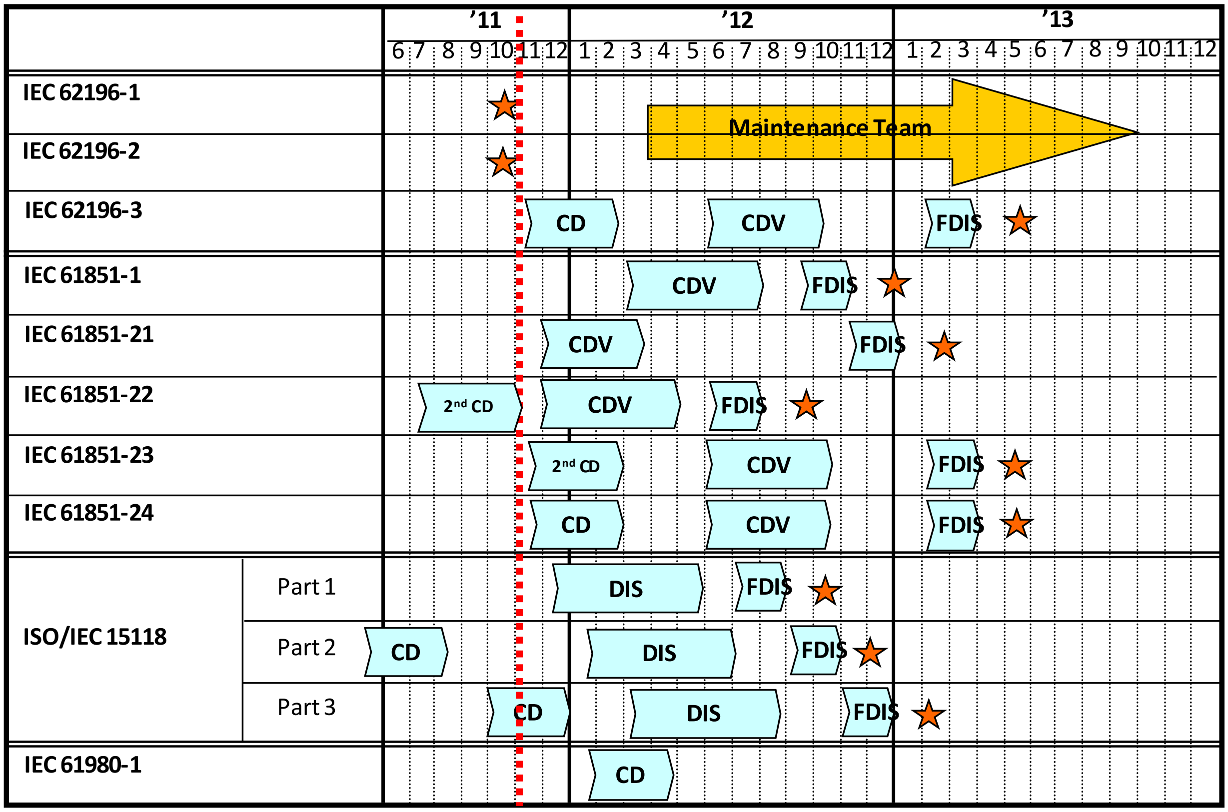


Figure 4-15
IEC RoadMap

ANSI STANDARD UPDATE

In the spring of 2011 American National Standards Institute (ANSI) held an *ANSI Workshop: Standards and Codes for Electric Drive Vehicles* on April 5–6, 2011, in Bethesda, Maryland. Its purpose was to drive the safe and effective implementation of electric vehicles through standards and conformance by identifying current gaps in applicable codes and standards, and explore opportunities for collaboration and coordination.

The workshop considered current and future U.S. domestic, regional, and international standards, codes, and conformity assessment activities needed to facilitate the introduction and widespread acceptance and deployment of grid-connected electric vehicles, charging infrastructure, and support services.

An Electric Vehicles Standards Panel (EVSP) was formed. It is a cross-sector coordinating body whose objective is to foster coordination and collaboration on standardization matters among public and private sector stakeholders to enable the safe, mass deployment of electric vehicles and associated infrastructure in the United States with international coordination, adaptability, and engagement.

The EVSP Deliverables are:

- To produce a strategic roadmap and/or reports identifying the standards and conformity assessment programs needed to facilitate the widespread acceptance and deployment of electric vehicles.
- To provide on behalf of ANSI coherent and coordinated U.S. policy and technical input to relevant regional and international audiences on needed standards and conformity assessment programs related to electric vehicles.
- To liaise and coordinate as appropriate with other electric vehicle initiatives that are being undertaken.

A summary document (roadmap) has been drafted and is currently being edited to bring it up to date based on the latest information available from the EVSP participants. With the EVSP meeting via webcasts several times during the year, and again on November 17 - 18, 2011, several documents are being developed as a part of the roadmap. This includes:

- *ANSI EVSP Standardization Roadmap for Electric Vehicles – Standards / Regulations Compendium by Domain / Issue Area.* - This document organizes the various Standards by topic (i.e. - General Info, Battery Safety & Testing, Electric Vehicle Supply Equipment Communications, etc.) and serves as a general reference to the different Standards and Codes related to each topic, and their status (published, under development, etc).
- *ANSI EVSP Standardization Roadmap for Electric Vehicles – Standards / Regulations Compendium by Developer / Agency.* - The second document lists the various Standards and regulations by standards developer or agency indicating if the standard is published, revision, or under development.
- A tabulation of the *ANSI EVSP Gaps / Recommendations Summary*. This list includes information about topics, issues and subjects not fully addressed in existing Standards, and which are believed to be essential to electric vehicle deployment and acceptance. It describes the "gap" in present Standards, make a recommendation for action and prioritizes this action as near, mid or long term.

This workshop was convened on behalf of the U.S. Department of Energy and the Idaho National Laboratory.

SAE J2894 Power Quality Standard

To address the power quality concerns, the Society of Automotive Engineers (SAE) has created Recommended Practice J2894/1 – "Power Quality Requirements for Plug-In Electric Vehicle Chargers". In April 2009, the SAE hybrid committee approved the creation of SAE J2894, in which the IWC EV charging equipment operational recommendations for power quality could be housed.

The document has three sections: charger PQ requirements, characteristics of AC service, and charging control. This document addresses the power quality requirements for electric vehicle charging. SAE cites three major reasons driving the need for this recommended practice:

- Many modern products use microprocessor based devices and these may be susceptible to power quality issues.
- There is a concern related to the increasing number of non-linear devices in the grid. These can generate harmonic content that is of concern for the grid.
- Modern society is very dependent on the electric grid increasing the consequences of power outages.

This recommended practice will help charging system designers develop hardware that will operate properly when connected to the grid, ensure proper operation of the PEV during power quality events such as sags, swells and transients and protect the grid from potential adverse power quality effects. The recommended practice has three main sections.

1) Charger PQ Requirements
    a) Power Factor
    b) Power Transfer Efficiency (at maximum power)
    c) Current Total Harmonic Distortion including individual harmonic currents
    d) Inrush Current
2) Characteristics of AC Service
    a) Voltage Range
    b) Voltage Swell
    c) Voltage Surge
    d) Voltage Sag
    e) Voltage Distortion
    f) Definition of Momentary Outage
    g) Frequency Variation
    h) Portable (Self) Generation / Distributed Energy Resources
3) Charging Control
    a) Utility Messaging
    b) Communication
    c) Staggered Restart (Cold Load Pickup)
    d) Load Ramp Rate (Soft Start) Definition

Society of Automotive Engineers (SAE) Recommended Practice J2894/1 – “Power Quality Requirements for Plug-In Electric Vehicle Chargers” was approved in June 2011. The kick off meeting for J2894 /2 “Testing Methods” for Power Quality Requirements was held in May 2011

The intent of this document is to develop a recommended practice for PEV chargers, whether on-board or off-board the vehicle, that will enable equipment manufacturers, vehicle manufacturers, electric utilities and others to make reasonable design decisions regarding power quality. The three main purposes are as follows:

- To identify those parameters of PEV battery charger that must be controlled in order to preserve the quality of the AC service.
- To identify those characteristics of the AC service that may significantly impact the performance of the charger.
- To identify values for power quality, susceptibility and power control parameters which are based on current U.S. and international standards. These values should be technically feasible and cost effective to implement into PEV battery chargers.

Recommended Displacement Power Factor Values		
AC Level 1	**AC Level 2**	**DC**
95%	95%	95%
Recommended Full Power Conversion Efficiency		
AC Level 1	**AC Level 2**	**DC**
90%	90%	90%
Recommended Maximum Total Harmonic Current Distortion		
AC Level 1	**AC Level 2**	**DC**
10%	10%	10%
Recommended Maximum Inrush Current(At Maximum Nominal Current)		
AC Level 1	**AC Level 2**	**DC**
120% (in excess of 50ms)	120% (in excess of 100µs)	120% (in excess of 100µs)

AC Service Limits		
Parameter	**AC Level 1**	**AC Level 2**
Voltage Range	90% - 110% of nominal	90% - 110% of nominal
Voltage Swell	175% of nominal for Min. ½ cycle (8 ms)	175% of nominal for Min. ½ cycle (8 ms)
Voltage Surge	6 kV minimum ANSI C62.41 & C62.45	6 kV minimum ANSI C62.41 & C62.45
Voltage Sag	Down to 80% of nominal for 2 seconds	Down to 80% of nominal for 2 seconds
Voltage Distortion	5%	5%
Momentary Outage	0 volts for 12 cycles	0 volts for 12 cycles
Frequency Variations	2% of nominal	2% of nominal

SAE J2894/2 Power Quality Requirements for Plug-In Electric Vehicle Chargers – Test Methods will describe the test methods for the parameters / requirements in this document.

SAE J2953 EVSE Compatibility

This is a newly formed subcommittee tasked with developing requirements for compatibility of electric vehicle supply equipment with plug-in electric vehicles. This committee has been relatively inactive while SAE focuses on finalizing the connector and communications standards. An EVSE/PEV compatibility matrix spreadsheet was posted for committee comment in June of 2011.

SAE J2954 Wireless Power Transfer

This is a newly formed subcommittee tasked with developing requirements for wireless power transfer for charging electric vehicles. The committee has started a subgroup to begin working on a standard for communication for wireless chargine.

SAE J2954 Wireless Power Transfer

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Electric Vehicle Supply Equipment (EVSE) Hardware and Standards Update

Current State of EVSE Technology

Only basic AC level 1 and 2 EVSE are covered by completed Society of Automotive Engineers (SAE) standards in the US. All other charge levels and associated standards are works in progress. For a more in depth overview of EVSE hardware the reader is referred to EPRI report 1021742[1].

It appears that automotive original equipment manufacturers (OEMs) will provide level 1 cord sets with each vehicle sold. This cord set allows charging from a dedicated 15A or 20A, 120V ac outlet. OEMs recommend a dedicated circuit in order to prevent overloading of the circuits.

Public charging stations are likely to be focused on 240V, AC level 2 charging. Since the vehicle can support charging at 120 or 240Vac, there is little incentive to install Level I charging infrastructure in the public space.

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[1] *Vehicle Infrastructure Connectivity and Communications: Requirements and Testing.* EPRI, Palo Alto, CA: 2011. 1021742.

Currently, available units vary in design from simple, no-frills, J1772^{TM} compliant AC power sources to units with communications, access control, and external control options.

Recently announced EVSE prices vary from just under $500 to over $5000. These prices generally assume large volume sales. Residential units tend toward simplicity and low cost, while commercial outdoor rated units tend toward complex futures and higher cost. In general, wall mount units are less costly than pedestal mounted EVSE. Installation costs will also vary widely and can be a significant portion of the full budget for an EVSE installation.

EVSE Vendor Overview

EPRI has identified nearly 40 companies that have indicated that they intend to or are currently making EVSE hardware. Of these vendors, as of October of 2011, there are 18 that have products listed to UL standards as illustrated in Figure 4-16.:

- ABB (DC fast charge)
- AddEnergie Technologies (AC Level 1 & 2, DC Level 2 & 3planned)
- Aerovironment (AC Level 2, DC Level 2 & 3)
- Akerwade (DC Level 2)
- AVCON Corporation (AC Level 2 Legacy)
- BetterPlace (AC Level 2, Battery Swap)
- BTCPower (AC Level 2, DC Level 2)
- Clipper Creek (AC Level 1 & 2)
- Coulomb Technology (AC Level 1 & 2, DC Level 2, charging network)
- DBT EV Charging Solutions (AC Level 1 & 2, DC Level 2)
- Delphi Automotive Systems (AC Level 1)
- Eaton Corporation (AC Level 2, DC Level 2)
- ECOtality (AC Level 2, DC Level 2, charging network)
- Epyon (DC Level 2)
- EV-Charge America (AC Level 1 & 2)
- EVSE LLC (Control Module Ind.) (AC Level 1 & 2)
- General Electric (AC Level 2)
- GoSmart Technologies (AC Level 2)
- Green Garage Associates (AC Level 2)
- Greenlight AC (AC Level 1 & 2)
- GridBot, LLC (AC Level 1 & 2)
- Ingeteam Inc. (AC Level 2)
- Lear Corp. (AC Level 1 & 2)
- Leviton (AC Level 1 & 2)
- North Shore Safety (?)
- Optimization Technologies (OpConnect) (AC Level 1 & 2)
- Panasonic Corporation (?)
- Panasonic Electric Works Co. Ltd. (AC Level 1)
- ParkPod LLC (AC Level 1 & 2)
- PEP Stations, LLC (AC Level 2)
- RechargePower (AC Level 2)
- Schneider Electric (AC Level 2)
- SemaConnect (AC Level 1 & 2)
- ShorePower (AC Level 1 & 2)
- Siemens Energy Inc. (AC Level 1 & 2)
- SPX, Inc (AC Level 2)
- Yazaki North America, Inc. (AC Level 1)

Figure 4-16
Listing of EVSE Suppliers for the US Market; Names Highlighted in Red Indicate that this Supplier has Some Products Listed to UL Standards

EVSE Standards

There are a number of Standards Development Organizations (SDO) working in the EVSE space. The SAE is involved from the vehicle system functional perspective. UL is involved from the safety aspect. The National Electrical Code addresses safe installation and application of EVSE.

Society of Automotive Engineers Standards for EVSE

The SAE focuses on vehicle standards. As such, SAE standards tend to address EVSE in a peripheral fashion, primarily addressing needs from the vehicle perspective. The primary SAE standard which addresses hardware signaling and functionality for EVSE is SAE J1772™. A number of other standards within SAE are addressing the communications messaging, physical media, and message structure for communications from the vehicle to the outside world. In addition, communications to allow for off-board charging using DC to the vehicle are being developed.

SAE is not considering any standards related to EVSE external functionality or communications capabilities, as the EVSE is not a vehicle system. SAE J1772 remains the only completed standard related to EVSE hardware but there are several other SAE committees working on communications standards that will eventually impact EVSE design and function.

UL Standards for Electric Vehicle Supply Equipment

There are a number of UL standards that are applicable to both the full EVSE and to EVSE subsystems. Following are the primary UL standards applicable to EVSE hardware and firmware. In late 2009, UL added an Outline of Investigation, UL subject 2594 which is now specific for EVSE. This document is undergoing revision to publish it as a UL Standard 2594 in 2012. Products listed prior to the development of UL 2954 were listed under UL 2202, and supplemented by UL 2231 for personnel protection against electric shock. Future EVSE products will be listed under both UL 2202 and UL 2594, again supplemented by UL 2231.

UL 2202 will cover DC electric vehicle charging equipment, whereas UL 2594 will cover AC electric vehicle supply equipment.

UL 2251 is applicable to all Plugs, Receptacles and Couplers for Electric Vehicles, used with the EV supply or charging equipment.

These descriptions were taken directly from the UL website.

UL 969: Marking and Labeling Systems

1 Scope

1.1 These requirements cover adhesive attached labels for use as nameplates or markers; bearing information, instructions, or identification. An adhesive for a label may be pressure sensitive, heat activated, or solvent activated. These labels are intended to be used by manufacturers for application to their products at their place of manufacture.

1.2 These requirements also cover unprinted materials, such as face stocks, label stocks, overlaminations, laminating adhesives, and inks used by label printers to produce labels.

1.3 These requirements apply to marking and labeling systems used on complete devices, appliances, or equipment. The acceptability of a system in a particular application is to be judged under the applicable requirements in the standard covering the device, appliance, or equipment on which the system is used.

1.4 Marking and labeling systems are evaluated for application to specific surface materials that are essentially smooth and flat unless another surface configuration is specified by the manufacturer.

UL 1449: Surge Protective Devices

1 Scope

1.1 These requirements cover Surge Protective Devices (SPDs) designed for repeated limiting of transient voltage surges as specified in the standard on 50 or 60 Hz power circuits not exceeding 1000 V and designated as follows:

Type 1 - Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device..

Type 2 - Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device; including SPDs located at the branch panel.

Type 3 - Point of utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. See marking in 64.2. The distance (10 meters) is exclusive of conductors provided with or used to attach SPDs.

Type 4 - Component SPDs, including discrete components as well as component assemblies.

UL 1998: Software in Programmable Components

1 Scope

1.1 These requirements apply to non-networked embedded microprocessor software whose failure is capable of resulting in a risk of fire, electric shock, or injury to persons.

1.2 This is a reference standard in which the requirements are to be applied when specifically referenced by other standards or product safety requirements.

1.3 These requirements address the risks unique to product hardware controlled by software in programmable components.

1.4 These requirements are intended to supplement applicable product or component standards and requirements, and are not intended to serve as the sole basis for investigating the risk of fire, electric shock, or injury to persons.

1.5 These requirements are intended to address risks that occur in the software or in the process used to develop and maintain the software, such as the following:

a) Requirements conversion faults that cause differences between the specification for the programmable component and the software design;

b) Design faults such as incorrect software algorithms or interfaces;

c) Coding faults, including syntax, incorrect signs, endless loops, and other coding faults;

d) Timing faults that cause program execution to occur prematurely or late;

e) Microelectronic memory faults, such as memory failure, not enough memory, or memory overlap;

f) Induced faults caused by microelectronic hardware failure;

g) Latent, user, input/output, range, and other faults that are only detectable when a given state occurs; and

h) Failure of the programmable component to perform any function at all.

1.6 Product standard requirements may amend or supersede the requirements in this standard, as appropriate.

UL 2202: Electric Vehicle (EV) Charging System Equipment

1 Scope

1.1 These requirements cover conductive and inductive charging system equipment intended to be supplied by a branch circuit of 600 volts or less for recharging the storage batteries in over-the-road electric vehicles (EV). The equipment is located on- or off-board the vehicle. Off-board equipment may be considered for indoor use only. The equipment is intended to be installed in accordance with the National Electrical Code, NFPA 70.

1.2 For the purposes of this standard, the term "electric vehicle", designated throughout by the initials "EV", is considered to cover electric vehicles, hybrid electric vehicles, and plug-in versions of these vehicles.

1.3 Electric vehicle charging system equipment that is not a complete assembly and depends upon installation in an end product for compliance with the requirements in this standard is investigated under the requirements of this standard and the standard for the end product.

1.4 These requirements do not cover battery chargers covered by the Standard for Battery Chargers for Charging Engine-Starter Batteries, UL 1236, or the Standard for Industrial Battery Chargers, UL 1564.

1.5 The requirements for devices or systems intended to reduce the risk of electric shock to the user in grounded or isolated circuits for charging electric vehicles are covered in the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits; Part 1: General Requirements, UL 2231-1, and the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits; Part 2: Particular Requirements for Protective Devices for Use in Charging Systems, UL 2231-2.

UL2231-1: Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements

1 Scope

1.1 These requirements cover devices and systems intended for use in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, Article 625, to reduce the risk of electric shock to the user from accessible parts, in grounded or isolated circuits for charging electric vehicles. These circuits are external to or on-board the vehicle.

1.2 The devices and systems covered by these requirements must be compatible with the designs of charging systems and vehicles where use is intended and shall be rated accordingly. To assure compatibility, the features contained in 1.3 - 1.5 are required of the charging system, the vehicle, or both.

1.3 The type of vehicle covered by these requirements, including all accessible conductive parts on the vehicle, have one or more of the following:

a) Provision for the connection of an equipment grounding conductor during battery charging, unless the vehicle has a system of reinforced or double insulation or all of the circuitry on the vehicle is electrically isolated from the supply circuit; b) Provision for the connection of ground-monitoring conductors, where required;

c) Reinforced insulation or be double-insulated from the supply circuit; or

d) No direct connection between current carrying conductors and the vehicle chassis.

1.4 These requirements cover devices and systems where the grounding path impedance of the charging system to the vehicle is less than or equal to the impedance of the ungrounded conductor or conductors.

1.5 These requirements cover devices and systems where a continuous current less than 70 mA RMS is available from any accessible part of the charging system.

1.6 Devices covered by these requirements are intended to interrupt the electric circuit to the load when:

a) A fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit,

b) The grounding path becomes open-circuited or becomes an excessively high impedance, or

c) A path to ground is detected on an isolated (ungrounded) system.

1.7 These devices and systems are intended to be applied on electrical systems or include derived systems that are:

a) Either end-grounded or centrally grounded when the operating voltage is 150 Vrms or less,

b) Centrally grounded when the operating voltage is greater than 150 Vrms, or

c) Isolated (ungrounded).

1.8 Charging circuit interrupting devices covered by these requirements are investigated for their ability to provide protection based on:

a) The type of current (60 Hz AC, DC, a combination of AC and DC, or AC at frequencies greater than 60 Hz) present in the circuit to be protected, and

b) Voltage.

1.9 These requirements do not cover ground-fault circuit-interrupters (GFCIs) intended for use as personnel protection in accordance with the National Electrical Code on grounded 120 Vrms to ground, 60 Hz circuits. Such devices are covered under the Standard for Ground-Fault Circuit-Interrupters, UL 943.

1.10 This standard includes the Scope, Glossary, and Description of Requirements, including the required features of protection systems. The Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems, UL 2231-2, contains the Performance and Construction requirements for protective devices that would become a part of a charging system.

UL 2231-2: Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

1 Scope

1.1 This standard is intended to be read together with the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements, UL 2231-1. The requirements of UL 2231-1 apply unless modified by this standard.

UL 2251: Plugs, Receptacles and Couplers for Electric Vehicles

1 Scope

1.1 These requirements cover plugs, receptacles, vehicle inlets, and connectors, rated up to 800 amperes and up to 600 volts ac or dc, intended for conductive connection systems, for use with electric vehicles in accordance with National Electrical Code (NEC), ANSI/NFPA-70 for either indoor or outdoor nonhazardous locations.

1.2 This standard does not directly apply to the following but is able to supplement other applicable standards:

a) Devices produced integrally with flexible cord or cable that are covered by the Standard for Cord Sets and Power-Supply Cords, UL 817;

b) Devices solely intended for direct connection to the branch circuit in accordance with Articles 300, 400 and 410 of the NEC such as attachment plugs, cord connectors and receptacles, which can include 3 or more pilot contacts, that are covered by the Standard for Attachment Plugs and Receptacles, UL 498;

c) Single and multi-pole connectors, intended for connection to copper conductors, for use in data, signal, control and power applications within and between electrical equipment, where exposed, for use in accordance with the National Electrical Code, that are covered by the Standard for Attachment Plugs and Receptacles, UL 498;

d) Devices of the pin and sleeve type construction, intended to provide power from branch circuits to utilization equipment, or for direct connection of utilization equipment to the branch circuit, that are covered by the Standard for Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type, UL 1682;

e) Devices intended for use in hazardous locations that are covered by the Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations, UL 1010;

f) Devices consisting of wiring terminals and supporting blocks intended for the connection of wiring that are covered by the Standard for Terminal Blocks, UL 1059;

g) Devices such as modular jacks and plugs that are intended for use with telecommunications networks, that are covered by the Standard for Telephone Equipment, UL 1459, and the Standard for Communications Circuit Accessories, UL 1863;

h)) Devices such as wire connectors and soldering lugs, that are covered by the Standards for Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A; Splicing Wire Connectors, UL 486C; or Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E;

i) Devices such as quick-connect terminals that are covered by the Standard for Electrical Quick-Connect Terminals, UL 310;

j) Products such as power outlet assemblies that are covered by the Standard for Power Outlets, UL 231;

k) Products such as switched interlocks that are covered by the Standard for Industrial Control Equipment, UL 508.

1.3 In the text of this standard, the term "device" refers to any product covered by this standard. The letters "EV" refer to an electric vehicle.

UL 2594: Electric Vehicle Supply Equipment

1 Scope

1.1 This outline covers electric vehicle (EV) supply equipment, rated a maximum of 250 V ac, with a frequency of 60 Hz, and intended to provide power to an electric vehicle with an on-board charging unit. This outline covers electric vehicle supply equipment intended for use where ventilation is not required.

1.2 With reference to 1.1, the products covered by this outline include EV cord sets and EV charging stations. EV cord sets may be designated as portable cord sets or stationary cord sets and may be designated for indoor or outdoor use. EV charging stations may be designated as either movable or permanent charging stations and may be designated for indoor or outdoor use.

1.3 The products covered by this outline are intended for use in accordance with the National Electrical Code (NEC), ANSI/NFPA 70.

1.4 This outline does not cover cord sets or power supply cords for applications other than EV charging cord sets. Cord sets and power supply cords are covered by the Standard for Cord Sets and Power Supply Cords, UL 817. EV Cables are covered by the Standard for Flexible Cords and Cables, UL 62, and the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

1.5 With reference to 1.2, this outline does not cover electric vehicle charging units. These products provide an output that is delivered directly to charge an on-board battery pack. These products are covered by the Standard for Electric Vehicle (EV) Charging System Equipment, UL 2202.

1.6 This outline does not cover electric vehicle connectors, which are covered by the Standard for Plugs, Receptacles, and Couplers for Electric Vehicles, UL 2251.

Other Activities Discussed in 2011

EV First Responder Training (December 2010)

Andrew Klock and Robert Vondrasek, NFPA, gave a presentation on NFPA, the codes and standards process, activity areas, resources, and standards for emergency responders and EVs. He discussed the Fire Grant Project on firefighters' safety in emergency response for EVs and

HEVs and the Advanced EV First Responder Training program. The first responder EV safety central repository can be found in EVSafetyTraining.org. NFPA and GM are collaborating on training related to the Chevy Volt. NFPA is also working on an emergency field guide database and a training plan. During discussion, Mr. Klock mentioned that they had hired seven experts on different aspects of EV risks. Dan Gabel, ComEd, suggested making the training available to fleet managers and personnel.

City Master Planning (December 2010)

Jim Aloisi, AECOM, discussed how sustainable planning can enable the successful deployment of EV networks. Mr Aloisi explained sustainable planning and the principles of access, connectivity, and integration as guides to EV planning. He proposed important questions that facility planners should ask. He felt that EVs can be catalysts for a modal shift, creation of mobility hubs, improved land use, and sustainable energy. During discussion, Mr. Aloisi stated that EVs should not be viewed as a technology to replace internal combustion vehicles but as a new technology that could lead to a paradigm change.

National Permitting Template (December 2010)

Carl Rivkin, NREL, gave a background and update on the permitting template. The permit is divided into four sections dealing with jurisdiction, code requirements, certification, and a checklist. He showed examples of the template and the AFDC website. For 2011, NREL is implementing the permit template in three jurisdictions. During discussion, Joel Pointon, SDG&E, pointed out that in San Diego County they are dealing with multiple communities with different turnaround times. It was also mentioned that goelectricdrive.com is now active and may be a useful clearinghouse of information.

Seeking Input on Charger Costs (December 2010)

Arindam Maitra, EPRI, on behalf of Mark Duvall, led a discussion on the costs of EVSE installation for different infrastructure types. He reviewed different charging trees for residential, workplace, and commercial charging, and gave examples of average costs for different types of installation. During discussion, some attendees pointed out that permit costs vary widely, with some cities charging ten times more than others. Labor costs vary based on geographical region. Efrain Ornelas, PG&E, suggested defining a consistent scenario to obtain average costs in different parts of the country. The residential scenario, for example, could be the installation of a wall mount EVSE in a garage with thirty feet of conduit. For fast charging installations, the scenario could define the amount of concrete needed, installation of a transformer, etc. George Bellino, GM, mentioned a GM/EPRI project covering five regions in the US that estimated a $1350 median price based on 400 residential installations. Serge Roy, CHAdeMo, said their large-scale project is gathering a lot of cost data. Mr. Lambert suggested that a survey with specific scenarios be sent to members who could then provide cost data.

AMI Integration with PEVs

Sempra Energy (December 2010)

Chris Chen, SDG&E, showed an illustration of AMI Communications and the overall AMI/PEV architecture. During discussion, he clarified that the EMS acts as the gateway, Internet router, and firewall. The EMS is not integrated into the AMI for safety reasons. The utility will not supply the EMS and local vendors will have the responsibility to ensure communication between the EMS and AMI. A unique meter for the EV could be in the EVSE or EV. SDG&E is working on a smart transformer that monitors temperature and loading to avoid transformer failure due to EVs. The technology, which will track transformer aging and estimate life reduction, is still in the demonstration phase. The smart transformer communicates to the utility and may be able to link to the AMI.

DTE (December 2010)

Hawk Asgeirsson, DTE, described their demonstration programs involving the hybrid conversion of the GM Saturn Vue, the Ford Escape hybrid, and GM Volt. DTE tested communication via the AMI to Smart Meter to vehicle using ZigBee wireless to Automatiks Telematics in the car. The other test was communication to the Automatiks Gateway server via the Internet, then the Gateway server to vehicle via GPRS/3G or wifi. The Ford Escape project involves ZigBee wireless communication from an Itron meter to the vehicle. The Volt program involves smart charging and control using OnStar and communication using PLC technology. Mr. Asgeirsson described four basic modes and communication connections, DTE's EV rates with two pricing options, and a schematic of smart home components. During discussion, he clarified that the fixed rate of $40/month per vehicle is for unlimited charging but is limited to 250 customers for the purpose of understanding customer behavior.

Southern Company (December 2010)

Bryan Coley, Southern Company, presented AMI basics, the Sensus "Flexnet" System, and AMI integration. Their basic concept decouples the appliance from the communications and DR logic with one communication device working with all appliances. Their DR connector project involves several operating companies with pilot programs for thermostats and water heaters. During discussion, he explained that not all devices are Flexnet capable. Working with Energy Select, they can send a signal through the AMI and switch off appliances with the PEV set on the energy management system. They were able to shave 10 MWs from the peak with 10,000 customers and had a two-year payback on the cost of the gateway.

SCE (March 2011)

Joshua McDonald, SCE, presented on EV integration in the SCE territory. Their 10- year forecasts range from 200,000 to over 1 million EVs by 2020, reflecting uncertainty in vehicle penetration. Mr. McDonald presented the PEV charging rates for residential customers and anticipated issues such as separate metering for PEV consumption, billing, outbound communication for demand response, load control and other functions, security to prevent spoofing of the system, and forward compatibility. He presented the dual meter option for today, a “manual” smart charging option for 2011-2012, “automated” smart charging for 2013-2015, “integrated” smart charging for 2016-2020, and smart roaming and advance use cases beyond 2020.

During discussion, he stated that their focus is submetering in the house and demand response. With regards to integrated EVSE meters, they plan to do tests this year and are open to working with providers. At the moment, SCE does not offer incentives for chargers, but may offer incentives for smart EVSEs as they explore demand response programs in the future. Mr. Salazar pointed out that under existing strict guidelines, utilities cannot use data collected by someone else’s meter unless the Public Utility Commission allows it in the future. ANSI has to develop the next level of standards for embedded meters.

PG&E (March 2011)

Reiko Takemasa, PG&E, discussed PEV and advanced metering infrastructure in the PG&E territory. She described the large demand response opportunity that the PG&E SmartMeter will tap. They expect to have ten million SmartMeters installed by 2012. PG&E is developing a market-based product roadmap. They are working with EPRI on a smart charging pilot project to determine the feasibility of controlling customer load with an AMI/HAN-enabled EVSE and to evaluate the capabilities of PEV batteries. During discussion, she reported that rate developments are happening in parallel to hardware development.

AEP (June 2011)

Chris Schafer, AEP, talked about Ohio’s gridSMART project, which involves 110,000 customers in a 150 square mile area for deployment of Smart Grid technologies. Smart Grid technologies include AMI meters and PEVs. He discussed customer rate options, including two tier on-peak and off-peak rates for PEVs. AEP Ohio will use 11 PEVs and charging infrastructure in a demonstration area to simulate various driving and charging behaviors and grid impacts. Through the pilot study they hope to learn more about meter configurations, communication, options and business models for 120V vs. 240V charging among others. During discussion, Mr. Schafer, noted that they have a $2,500 rebate proposal for 2012 still awaiting approval by the PUC. Their Real Time Pricing is complicated and still under development. Because some of their transformers are already near peak, Smart Charging is unlikely to reduce their need for new transformers. With regards to the Home Energy Manager, they are now evaluating several devices in their lab.

NIST Update (December 2010)

Jerry Melcher, EnerNex, gave an update of Smart Grid Interoperability Program (SGIP) activities related to PEVs. Most of the tasks under Priority Action Plan (PAP) 11 on a PEV common information model were completed and SAE J1772™ was submitted to the SGIP governing board for approval. SAE J2836/1 was accepted with minor modifications and J2847/1 has been modified. Other tasks have been redirected to the V2G Domain Expert Working Group (DEWG). A new PAP on PEV implementation is being created. After the SAE standards are approved by the SGIP governing board, they will be sent to FERC and could become mandatory.

European Perspective on PEV Communications (December 2010)

Cliff Fietzek, BMW, provided a European perspective. He compared charging modes in Europe versus the US. BMW's strategy is to keep the on-board charger as small as possible and implement DC charging for higher power instead of high AC charging power. The German OEMs have agreed to use PLC as the medium for charging communications. Mr. Fietzek described the charging and communication architecture. BMW and Vattenfall have a joint project using wind energy with smart EVs for load leveling. A pilot project in Munich is implementing a DC charging infrastructure.

IWC Discussion of Billing (December 2010)

Watson Collins, Northeast Utilities, described transaction systems, telematics, and other modules that could be used in an EVSE. While standards are being developed for communication between the EV and the grid, no standards exist for communication within the EVSE and the modules. In the vending machine industry, a standard interface was developed between the vending machine controllers and the payment system. Mr. Watson suggested various steps to address the issue of billing. Problem definition and an assessment of vending machine standards could be done during the March 2011 meeting of the IWC. The June meeting could focus on cashless systems and what needs to be included in equipment level standards. During discussion, Mr. Collins explained that roaming requires that every AMI has to be hooked up to the smart grid and that reconciliation can be made to apply to all utilities and jurisdictions. Since this is not likely in the near future, he suggested the EVSE module approach and equipment level standards.

PEV Impacts – Secondary Voltage Drop (December 2010)

Arindam Maitra, EPRI, discussed probable impacts of the first generation of PEVs on the secondary drop from the transformer to the panel. There is a general lack of system wide data. He gave the example of a service drop evaluation, mapping the house loading to the transformers. He presented the results of an evaluation for PG&E, showing service voltage drops before and after EV installations for a total of 22 secondary line samples from three separate feeders.

SDG&E System EV Impact Study (December 2010)

Ricardo Rodriguez, SDG&E, described a study to assess the impacts of EV charging on the secondary distribution system in residential areas expected to have high EV penetration. The "PM Lite" software was used to model residential neighborhoods of different vintage styles, characterizing the secondary distribution impacts when EV owners are added as a 100% duty cycle load on top of the base load. Using the criteria of 4.2% as the voltage drop level and 140% of name plate transformer load, he showed the results of simulations for peak and off-peak hours.

He concluded that current secondary distribution systems are not suited for multiple EV chargers per neighborhood while off-peak charging by one customer per neighborhood presents no issues. System upgrade measures could mitigate the majority of service issues. During discussion, he noted that they used their worst-case day scenario and their assumptions were very conservative since they did not have access to AMI data. The study can be refined now that they have AMI data.

Smart EVSE Update (December 2010)

Dan Bowermaster, PG&E, described the EPRI-PG&E smart charging pilot study involving Coulomb Technologies and Silver Springs Network. The study aims to demonstrate the feasibility of controlling customer loads, establishing two-way communication with the EVSE over the AMI through the HAN gateway, evaluating PEV batteries as intermittent energy resources, and evaluating PEV batteries for use in ancillary services. Mr. Bowermaster showed a vision of the future, the timeline of the pilot project, and his initial insights especially pertaining to the level of development of EVSE and SCMS providers. He also presented potential cooperative areas.

EVSE Installation Guidelines (December 2010)

Dave Packard and Don Francis, ClipperCreek, reviewed EVSE installation circuits and lessons learned from public infrastructure installations. Mr. Packard suggested a standardized footprint and template for pedestal installation. The biggest mistake of installers is making the wrong connection from a 3-phase delta supply. Based on the experience from Southern Company's public charge installations, cord retraction was a key lesson learned; they had cases of lawn mowers cutting off the cables lying on the ground. Other lessons included putting the pedestal between parking spaces to allow two users, allowing sufficient space to prevent the bumper from going over the curb, making the installations more secure, and having the conduits at the top in a parking deck.

EVSE Hardware Update

December 2010

John Halliwell, EPRI, listed the growing number of EVSE manufacturers, nationally recognized testing laboratories, and UL-listed and Intertek-listed EVSE units and couplers (see Attachment). He explained how the data can be obtained and gave a quick overview of some EVSEs in China. He shared the presentation of Theodore Bohn, ANL, on observations about the EVS-25 Shenzhen Trade Show, in particular, China connector standards, EVSE products, DC fast chargers, inductive chargers, and batteries.

March 2011

John Halliwell, EPRI, gave an EVSE hardware update. Of 36 North American EVSE manufacturers, eleven now have some products listed or recognized by NRTLs. Having a common pedestal bolt pattern for EVSEs was discussed. Mr. Halliwell discussed alternative energy sources for vehicle charging. Both the Chevy Volt and Nissan Leaf owners' manuals prohibit the use of electric generators and incompatible charging equipment, but the Angel car in

Sweden is experimenting with the use of mobile roadside services for emergency charging of EVs. During discussion, some participants felt it might be possible to come up with a family of common standardized bolt patterns depending on size.

June 2011

John Halliwell, EPRI, gave an EVSE hardware update. Of over 34 North American EVSE manufacturers, 14 have some products listed or recognized by NRTLs. He highlighted some new UL website entries and the UL website on installer training. He also listed six J1772™ connectors that have been listed to UL 2251 and gave the new EVSE web listing of Plug In America.

Power Tagging (December 2010)

Steven Berens, Power Tagging, described their real-time, on-grid communication for smart grid applications. Power Tagging takes advantage of some frequencies that are available but the frequency range is dynamic and requires tracking. The technology allows for grid location awareness so as to be able to track and measure user behavior, schematic management to manage peaks down to the transformer level, and flexibility for demand management. He noted some of the home communication requirements.

UL Certification Program for Installers and AHJs (March 2011)

Chris Pauly, UL, gave an overview of Underwriters' Laboratories' EVI installation programs. The course for installers is online. UL is currently working on a hands-on training program in a classroom setting. The inspector course is being developed for Authorities Having Jurisdiction (AHJ), city inspectors, and other officials. A designer course is being developed for contractors, engineers, property owners, etc. and is designed for public infrastructure and multi-dwelling units. An international training program is also planned. During discussion, Mr. Pauly confirmed that certification is included and that the courses are focused on installation code requirements. The estimated cost for the installer course is about $250 but the inspector course is free.

Infrastructure Siting Process (March 2011)

Andrew Hoskinson, ECOtality, talked about siting installations and his experience with The EV Project. One of the objectives of The EV Project is to build and study EV infrastructure use in distinct regions. He explained what goes into long-term plans, the importance of involvement of key stakeholders, and gave examples of siting locations. ECOtality coordinates the "EV Micro-Climates" process. Stakeholders are involved in the regional EV infrastructure deployment guidelines, a 10-year long-range plan, and a 2-3 year EV Micro-Climate plan. He described each of these and gave examples for the San Diego area. The process of determining locations of EVSE installations in San Diego involves public sector stakeholders.

During discussion, he noted that one of the lessons learned is that stakeholders can make valuable contributions. The EV Project involved policy makers throughout the process and had representatives from different geographical areas, types of communities, local governments, environmental coalitions, businesses, academics, large institutions, utilities, and others. Not all stakeholders share the same perspective so building consensus is essential. One of the key decisions is the public EV:EVSE ratio. He recommended using the best available data plus local knowledge. ECOtality will be collecting a lot of data through 2012 which could provide information on demand factor.

Public Charging Infrastructure (March 2011)

Forest Williams, Liberty PlugIns, gave a presentation on the parking industry's role in public charging. Mr. Williams stated that charging needs are dictated by destination and distance. Most public charging will be in off street parking lots and structures with pay by phone charging as a preferred billing option. Charging in parking lots at offices, shopping malls, ride share lots, etc. will be the charging locations of choice. Parking Access and Revenue Control (PARC) systems can enable EV charging. For multi-dwelling units, the property owners can install EVSE in selected parking spaces and issue access codes to tenants every month. Public fast charging is needed for emergencies and unplanned route changes. The utilities can play a neutral third party role. A non-network secure access involving delivery of authorization codes by phone or assignment to key personnel is flexible and less complicated.

During discussion, Mr. Williams said that 9 out of the 12 top pay station providers are involved in PARC. With regards to V2G ancillary services, Mr. Williams said that they are building for today's needs but are also partnering with charger manufacturers for the future. Mike Coop, ThinkSmartGrid, suggested having utility security experts review their security model. Watson Collins, Northeast Utilities, noted that there are different approaches to different applications and that PARC is meeting a need for a simple, inexpensive approach.

National Electrical Installation Standard for EVSE (March 2011)

Rob Colgan, NECA, presented on NECA 413 Standard for Installing and Maintaining Electric Vehicle Supply Equipment, which is currently in the ANSI approval process. He reviewed the contents, scope, codes and standards, pre-installation considerations, maintenance, and other topics covered in NECA 413. They are also organizing high-level workshops to explain the nuances of installation and the opportunities for electrical contractors. During discussion, Mr. Colgan explained that the NECA standard goes beyond the minimum requirements of NEC. With regards to the technical content, he suggested contacting Mike Johnston of NECA. He listed advisory partners in their Electric Vehicle Infrastructure Training Program (EVITP) and invited participants to join. Some participants suggested expanding the standard to include electric buses.

Update on "The EV Project" (March 2011)

Kevin Morrow, ECOtality, gave a presentation of The EV Project managed by ECOtality North America. Mr. Morrow noted that GM has joined the project and they have a new logo, Blink. The project involves 8,300 EVs and the installation of 15,000 chargers in 18 major cities. He described their SAE J1772TM compliant Level 2 charger, their DC fast charger, their back office system, and a utility smart grid demonstration. During discussion, Mr. Morrow pointed out that part of the project looks at how this business could be made sustainable. Demand charges are an issue for fast charging. Mark Duvall suggested that ECOtality could work with EPRI to explain the reasons for demand charges and to get their acceptance by regulators. The project is installing a lot of equipment in a short period of time and some of the installation locations may not be ideal. Part of this study is to help understand optimal siting.

Update on "ChargePoint America" (March 2011)

Michael Jones, Coulomb Technologies, gave an overview of ChargePoint America, a DOE funded program involving nine metropolitan areas as well as GM, Ford and Smart. About five thousand public and private Level 2 stations will be deployed by the end of 2011. The first station was installed in June of 2010. Mr. Jones reported initial observations such as differences in the levels of knowledge regarding EVs in regions of the country. He also showed historic costs for commercial installation and policy needs to enable revenue models for shared stations, incentive pricing and integrated metering, smart grid integration, and streamlining the permitting process.

During discussion, he stated that more than half will charge at public non-workplace stations. In California, a majority of EV buyers are opting not to get an L2 charger. In California, they are offering their chargers for free and the California Energy Commission is providing free installation for early adopters. Mr. Jones explained that big commercial garages will have to evaluate the economics of multiple charging stations, which could trigger high demand charges. Mr. Salazar described his experience with electric fork lift trucks, in which the load factor was always below 50%, never the maximum. Utilities have different rate schedules with different thresholds at which demand charges are incurred. Mr. Jones noted that there is an option for the network to be owned by municipalities or other operators. Guidelines on ADA compliance at public charging stations are needed.

'EVs Texas Style' (March 2011)

Lance Spross, Oncor Electric Delivery, talked about the EV environment in Texas. He discussed the Texas electric market, wind energy potential, developments in the transmission infrastructure and adoption of advanced metering systems in Texas. He also explained the regions in Texas that are open to retail competition, air quality problems, and the EV friendly environment in Texas, including statewide coordination. He gave as an example the eVgo public charging network of NRG in Houston, which would address range anxiety among EV users.

DC Charger Options and Implications (March 2011)

John Halliwell, EPRI, raised the issue of DC Level 1 charging and its implications to the consumer OEMs and EVSE installers. He asked if vehicles with DC L2 charging will also be able to do DC L1 and if DC L1 will be available in public charging stations. Mr. Scholer explained that the combo connector can do DC L1 and L2; it will be a matter of consumer and OEM choice dictated by economics. For OEMs, DC L1 incurs little added cost. Mr. Nieminski stressed that the universal connector has to be AC or DC but never both. DC L2 will be primarily for public fast charging stations. Ford has done an analysis on the differences between J1772TM connector and the combo connector. Mr. Halliwell expressed the need to educate the consumer of all these options.

SEP 2.0 Update (March 2011)

Wayne Dennison, Xtensible Solutions, gave an overview of Smart Energy (SE) 2.0. He discussed the profile of Smart Energy 2.0, an application protocol built on top of an Internet Protocol Stack. The PEV-related logical components are the energy services interface (ESI), EVSE, meter, and the PEV. He also reviewed high level goals and PEV function set dependencies. He then discussed the ESI, demand response, pricing, messaging, metering, billing, and distributed energy resources. He reviewed other functionalities such as subscription and notification.

Communication and Metering for Level 1 Charging (March 2011)

Chris Chen, Sempra Utilities, and Aaron Martlage, Plug Smart, presented on hardware and communication for Level 1 charging. Juice Technologies has developed technologies under the Plug Smart brand. They described a smart grid-ready cord and smart socket for Level 1 charging. The cord is attached to a J1772TM connector and GFCI circuitry. It authenticates with their smart socket, which fits over a standard 120V receptacle and meters the electricity consumed by the EV. It has built-in wi-fi and PFC communication and has theft and anti-tamper security mechanisms. An expansion module supports additional communications including Zigbee. They showed illustrations of wi-fi, PLC and AMI communications. During discussion, Mr. Nieminski mentioned the NEC requirement of the personnel protection system being located no more than 12" from the attachment plug. Mr. Martlage noted that they plan to go through UL listing. With regards to PLC, they are now working with a utility on a project to test communications and security.

Vending Machines Standards – Application to Public Charging? (March 2011)

Glenn Butler, CTO Services, gave an overview of the vending industry payment systems and payment standards. He reviewed Vending Machine Controllers, Cash and Cashless Systems, and their advantages and disadvantages. He also explained credit card fees and different credit card readers. He recommended that the EV industry negotiate rates with credit card companies similar to what the vending industry had done. He also proposed that the Multi Drop Bus would be applicable to EV charging stations, since all vending telemetry and credit cards systems support it. He suggested that the EV charging industry develop a standard similar to the Vending Data Interchange Standards. During discussion, he explained that the early standards were developed by the major soft drink manufacturers. He said that the national average for monthly revenues for vending machine is about $600. The vending machine industry has been slow to adopt payment mechanisms by mobile phone.

ANSI Workshop for EDV (June 2011)

Jim McCabe, ANSI, gave a presentation on EV standards activities. On March 4, 2011, a steering committee met to form the EV standards panel (EVSP) for the purpose of fostering coordination on standardization matters regarding EVs. The EVSP will produce a strategic road map and/or reports identifying standards and conformity assessment programs to facilitate deployment of EVs. The EVSP will also provide coordinated US policy and technical input to international bodies. Eight working groups have been formed under three domains; vehicle, infrastructure, and support services. Mr. McCabe presented their draft project timeline and information on how to participate. During discussion, Mr. McCabe clarified that the EVSP does not develop standards, but accepts other standards like those of the SAE.

Ancillary Services (June 2011)

Robert Entriken, EPRI, provided an overview of ancillary services and the value of PEV fleet integration with the electrical system. He began with a vision for smart PEV infrastructure and gave examples of PEV batteries in stationary applications. With an aggregator operating a vehicle fleet, value comes from energy shifting to high cost periods and ancillary services, such as regulation. He described time staged electricity markets and electricity products such as 1-to-5 year capacity, 1 month capacity, day ahead energy, and 5-to-15-minute real time energy. Ancillary service can be described according to the response speed, duration and cycle time and involves such reserve services as voltage support to maintain voltages in a required range, regulation to correct system imbalance, and spinning reserve to respond to a major outage. Mr. Entriken also described the process of auctions and settlement and gave examples of the energy and ancillary services value of a PEV and a PEV fleet. He discussed some insights and future work, including analysis of locations and vehicle types and the use of value analysis to motivate storage designs. During discussion, Mr. Entriken further described the role of the aggregator, services scenarios, and model and software development.

Home Charger Installation – Customer Support (June 2011)

Seth Gerber, Consumers Energy, described their plug-in electrical program installing charging stations at service centers across Michigan. As part of their customer support they have a network of PEV experts, a call center and a website which includes a rate calculator. The Michigan Public Service Commission's PEV Preparedness Task Force is developing recommendations for statewide implementation, including EV infrastructure training and certification for electricians. Mr. Gerber described their rate options, incentive programs, and PEV installations. They found that about 12% of their utility distribution system requires upgrades to support PEVs. Customers must choose a rate option first before an installer can estimate costs. He showed a recommended configuration for a second meter, but noted that utility standards can make the installation difficult due to the need for coordination between the inspector, utility, and electrician. During discussion, Mr. Gerber reported that 85% of customers select option 2 (Time of Use rates for PEV only and a separate PEV meter). The meter socket and additional wiring are paid by the utility up to $2,500 as part of their incentive program. He reported that the average time of installation from start to finish was 25-30 days.

EV Metering Issues – Presentations / Panel Discussion (June 2011)

Ed Eckert, Itron, proposed various technical, policy and regulatory issues to consider regarding metering. Issues include: accuracy of the meter, retrieving the meter data, ownership of the meter, applicable technical standards, calibration and verification, access to the meter if it is installed in the garage, and who is responsible if the meter does not work properly. He then introduced the panel speakers representing manufacturers, meter vendors, utility, and national lab perspectives.

EVSE Provider Perspective (June 2011)

Kevin Morrow, ECOtality, described four current approaches: a sub-meter socket panel installed from a dedicated breaker of the main panel; splitting the main utility service to feed two separate panels; dual meter adapter to provide a second service from a single utility feed; and an integrated meter in the EVSE. He described the challenges and benefits of each and recommended an integrated meter in the EVSE due to its reduced costs and better controlled use of EV energy. The perceived challenges are ANSI certification, validation of accuracy in the field, and PUC acceptance.

Utility Meter Vendor Perspective (June 2011)

Steven Schamber, Landis+Gyr, described aspects of utility meters, characteristics of a smart meter, and comparisons of various residential meter scenarios. The smart meter supports Demand and Time of Use pricing and provides load profile data, power quality data, and measurements of power generated by the customer, as well as two communication channels. He raised concerns about tampering, perceptions of fairness regarding EV pricing rates, and the improbability that utilities will work out a roaming agreement. With regards to public charging stations, Mr. Schamber highlighted the benefits of the use of credit cards rather than a special EV card.

Utility Perspective (June 2011)

Jose Salazar, SCE, discussed aspects of ownership, certification, configuration, installation, and data management pertaining to meters. Since many utilities offer special EV charging rates, residences may need smart meters or interval data enabled meters, a utility owned sub-meter, or a second panel for an independent meter to capture specific data. He showed the configuration of a two-panel option and a proposed sub-meter option, which is potentially faster and less expensive. In the future, depending on regulations, utilities may collaborate with other partners to develop a sub-metering protocol and guidelines. A smart sub-meter could potentially communicate via the primary house meter using the Home Area Network. During discussion, Mr. Salazar, described the intelligent receptacle with built-in telemetry. SCE is focusing on standardizing the messaging protocol and does not prescribe the way the message is delivered as long as it is compatible with Smart Energy 2.0.

DOE Tech Team Perspective (June 2011)

Ted Bohn, Argonne NL, presented the proof of concept for a low cost End Use Measurement Device (EUMD) or sub-meter. The EUMD can be located in different segments of the branch circuits such as next to the meter, near the EVSE, in the EVSE, or onboard the vehicle. The EUMD has the greatest value when the service panel is full and its costs are minimal compared to labor and installation. The DOE Grid Interaction Tech Team is focusing on three technology areas: low cost compact current sensors; network communication hardware; and meshed networks/SEP protocols. The same EUMD card can be used for transformer loading measurements.

ADA Issues (June 2011)

Jim Helmer, LightMoves, talked about EV charging stations and conformity with the ADA. City, county, state and federal codes and signs use different terms such as EVSE, EVI, or EVCS. ADA generally applies when EV charging stations are publically available. Some guidelines apply only to off street parking or in public and commercial buildings. There are no consistent design standards or guidelines for EV charging stations in the ADA. Among the issues are: Should EV charging stations be van-accessible? How will cords be managed? Is EV charging considered parking? He recommended design standards to provide accessibility and protect the equipment, standardized definition of signs, and updating of building codes and sign manuals. During discussion, sharing the charger between a regular and a handicapped space and siting of the charging station in relation to the location of the charge port on the vehicle were discussed.

NEMA Perspective on EVs (June 2011)

Andrew Kriegman, Leviton Mfg., gave NEMA's perspective on powering the EV. The NEMA EVSE section represents manufacturers of products or assemblies related to EVSE developed product standards. He reviewed EVSE types according to charging levels and estimated that 60% of charging will take place at home and 40% in public spaces. Public charging will be predominantly Level 2 with supplemental Level 3 charging. He summarized the benefits and requirements of an "EV Ready" building, state and federal incentive programs, and revenue opportunities for vehicle charging. During discussion, the opposition of some building contractors to "EV Ready" building requirements, the value of LEED (Leadership in Energy and Environmental Design) points, and the actual percentage of home vs. public charging were discussed.

ROC Item Review L1 / L2 (June 2011)

Greg Nieminski, EPRI Consultants, reviewed the IWC Record of Consensus (ROC) of January 14, 1997. The ROC items deal with connector and connecting stations; load management, distribution, and power quality; and data interface.

IEC 15118 Update /Harmonization (June 2011)

Cliff Fietzek, BMW, presented on the OEM workshop on DC charging communications, which took place on May 17-18 and was supported by EPRI and Siemens. The group agreed on a working assumption for the communications physical layer (PHY), the media access control sub-layer (MAC), and the communications medium. The group also decided on harmonizing the signals and messages under IEC/ISO 15118-2 and SAE J2847/2. For MAC and PHY, the OEMs envision Homeplug Green Phy and G3 on in-band and Homeplug Green Phy on Mains. SAE, in coordination with EPRI, has been asked to test both technologies. He presented the DC charging common communication stack, noting where information is missing. During discussion, Mr. Fietzek mentioned that the national labs have agreed to help in the effort.

IEEE P2030 Update (June 2011)

Mary Reidy, National Grid, talked about IEEE standards work to advance the global Smart Grid. Over a hundred global standards are being developed or updated. IEEE P2020.1 Working Group is drafting documents under four task force groups: vehicle technology including charging system, electric grid, roadmap, and communication and cyber security. Webinars are held bimonthly. Other standards in the series are IEEE P2030 (draft guide for Smart Grid interoperability), IEEE P2030.2 (draft guide energy storage systems for interoperability), and IEEE P2030.3 (draft standard test procedures). Ms. Reidy also listed IEEE 1547 interconnection standards. During discussion, she encouraged participation in the working groups.

PEV and EVSE Architecture and Connection Schemes (June 2011)

Rich Scholer, Chrysler, presented architectures for AC Level 1 and 2 and DC Level 1 and 2. For DC Level 1, digital communication is required and his diagram shows Inband and Mains. DC Level 2 builds on DC Level 1 or can be an exclusive option. Mr. Scholer presented the possible connection schemes using the SAE J1772TM connector, J1772TM combo connector, or J1772 TM hybrid combo connector plus C3 for a PEV having a 3.3kW onboard single-phase charger. During discussion, some utility representatives expressed concern with regards to 6.6kW and especially 19.2kW charging for residential customers. Concern was also expressed that the focus on DC communications may undermine the work on Smart Energy 2.0. Mr. Scholer said that OEMs want to do both. Regarding 19.2kW charging, Mr. Kissel stated that there are no safety issues since the system does a safety check but there may be ergonomic issues.

Increasing Charger Size vs. dc L1/L2 (June 2011)

Rich Scholer, Chrysler, shared his incremental cost analysis looking at five options based on a 3.3kW onboard charger. His presentation was an attempt to demonstrate an approach to analyze choices and did not imply that the assumptions were necessarily accurate. He presented his cost assumptions and boundary conditions. Using $300 and $500 as the base costs for a 3.3kW onboard charger, he gave examples of annual costs and charge times as well as incremental costs for the various options. During discussion, utility representatives suggested adding the costs of energy to the consumer and the utility. Mr. Scholer suggested that analysis like this could help educate the public on the different options and enable opportunities.

Infrastructure Deployment for EVs (August 2011)

Chantal Guimont, Hydro Quebec, presented a background on Hydro Quebec and their involvement in the Global Sustainable Electricity Partnership, formerly the e8 (see Presentations). She outlined the Quebec government's Action Plan goal for 2011-2020, which is to have 25% of all passenger sales be EVs. She also described the four components of Hydro Quebec's transportation plan, which includes Canada's largest all-electric vehicle pilot project and a plan to support vehicle charging infrastructure. They have 5 EV projects to test and integrate plug-in vehicles into the grid. Ms. Guimont described the survey results after the first winter, showing that participants are satisfied with their EVs and find charging to be an easy operation. Their planned public charging infrastructure called "The Electric Network" will involve a hundred 240V charging stations in 2012 with open access and a flat fee. During discussion, Ms. Guimont noted that they have no specific EV rate. During cold weather the winter average range is decreased due to the need for heating. The Network will use RFID cards from partners such as the grocery chain Metro and the retailer RONA.

Customer Charging Behavior (August 2011)

Morgan Davis, EPRI, described the results of her analysis using the 2009 National Household Travel Survey (NHGS) based on over 150,000 households surveyed across the country on one sample day (see Presentation). She described differences in weekend and week day driving behavior, the location where vehicles spend their time and the higher potential for electric vehicles with increased charging availability. She showed modeling results for different scenarios of charger usage and needs. Among her conclusions are that the shared charger model may be ideal for non-battery electric vehicles, and that applying some cost to charging could increase charger utilization. For some vehicles, fast charging is necessary. The number of fast chargers in use is affected by the availability of Level 2 charging. During discussion, some participants noted the correlation between charger utilization, cost of infrastructure and the economics of Level 1 and DC fast charging. Others pointed out that the equipment is a substantial cost compared to electricity costs. Kevin Morrow, Ecotality, mentioned that they are collecting data for thousands of home chargers, which will provide more information on customer charging behavior.

Cold Load Pickup and Grid Impacts (August 2011)

Angelo Guimento and Charles Desbiens, Hydro Quebec, described Hydro Quebec's grid and a simulator that they developed to evaluate the peak load for normal load conditions and cold load pickup (see Presentation). The simulator uses a Monte Carlo algorithm simulating 1,000 customers for each scenario. They described the results for six simulation cases for distribution feeders involving peak load, an 8-hour outage, and V2G. They concluded that PEVs will increase the load under normal conditions by a manageable amount, but planning criteria are needed for new PEV loads. Additional studies are needed for cold load pickup events and V2G must be controlled to maintain voltage stability on the transmission grid. The simulator will allow optimized solutions to avoid additional investments on the grid. During discussion, they mentioned that they had looked SAE J2894, including the two-minute delay, and they suggested there was room for improvement. They are willing to collaborate with others to enhance the simulator.

ROC Items for Consideration (August 2011)

Frank Lambert, NEETRAC, reviewed the Records of Consensus (ROC) items from the 1990s (see Presentations). Under the Connector & Connecting Stations committee all ROC items have been or are being addressed in SAE J1772™ and the National Electric Code. For the Load Management, Distribution & Power Quality, all ROC items are being addressed by SAE J2894. For the Charging Controls & Communications all ROC items are being addressed in SAE J2836, J2847, and J2931. The members agreed that all ROC items have now been covered. During discussion, Efrain Ornelas, PG&E, pointed out the need to also focus on heavy duty vehicles such as trucks and buses and their infrastructure requirements for fast charging and connector standards.

EV Metering – Utility Approaches / Rates: Survey on EV Service (August 2011)

Dan Gabel, ComEd, and Seth Gerber, Consumers Energy, went through the draft online survey questionnaire on metering. The survey aims to determine the process and standards at different utilities around the installation of separate metering exclusively for EV charging. This process should be fairly similar to splitting load at a customer's home. The survey is not directed toward a sub-metering configuration. The participants suggested adding 'single family' to the introductory paragraph. The following comments were made by participants on specific survey questions:

- Question 3: This question needs clarification.
- Question 5: Suggested rewording 'List steps that your utility uses for splitting load at a residential customer's home'. Consider asking how the utility plans to service the meter if the utility places a separate meter.
- Question 6: Dual position meter socket is also called a dual gang socket. Consider adding a comment field.
- Question 7: Consider differentiating underground vs. overhead.
- Question 9: Add 'visual inspection by local inspection authority'.
- Question 10: Replace 'i.e.' with 'e.g.'

A suggestion was made to ask how many municipalities do not allow a second meter.

EV Metering – ComEd (August 2011)

Dan Gabel, ComEd, gave a background on ComEd, their EV Readiness focus areas and the Illinois Commerce Commission's initiative on plug-in EVs (see Presentation). ComEd believes that time variable rates are important to get the right charging patterns, but, it is also important to educate customers on managing all the loads in their home. Mr. Gabel reviewed their residential rates and the estimated annual costs of supply for residential EV charging. ComEd believes that the integration point between the EV and the grid should be a smart EVSE, which is a stationary load at a known point on the distribution system. Moreover, communications must use established open protocols. During discussion, Mr. Gabel explained that by "smart" he refers to demand response, cold load pickup, two-way communication, etc. They want a programmable network interface. For the utility to control the residential load, such as an air-conditioning or an EV load, the utility would need the customer's permission.

EV Metering - DTE (August 2011)

Hawk Asgeirsson, DTE Energy, described his utility's EV rate program and metering issues (see Presentation). They offer a time-of-use rate option and a monthly flat bill option, as well as an EVSE incentive up to $2,500. These programs require a 240V separate meter circuit and the rates and incentives are limited to the early adaptors. 90% of Volt owners are participating in

DTE Energy's program. Of the 53% of Volt owners who select the time-of-use rate, 83% of their charging takes place during off peak hours. The Michigan residential building code has been modified to simplify the installation of EVSE. Mr. Asgeirsson described various meter layout options and some metering challenges. During discussion, he mentioned the OnStar option and their calibration procedure involving random testing of meters. Since utilities have different regulatory requirements and approaches, sharing approaches can help identify overlaps and areas for collaboration.

EVs, PV and Energy Storage (August 2011)

Arindam Maitra, EPRI, gave an overview of the integration of PEVs, energy storage (ES), and photovoltaics (PV) on the grid (see Presentation). Although no one EPRI project combines all three, he reviewed existing EPRI projects that relate to the integration of PVs, EVs, and ES. Examples include distributed resource models, EPRI's distribution system simulator, secondary models, solar PV models, EPRI's PEV distribution impact study and distributed PV projects. For the utilities, the concerns pertaining to PV include voltage fluctuations, increased duty, impact on demand, system protection, and power quality. Mr. Maitra presented results of time series analysis for distributed PV and mentioned the TVA Smart System. He outlined EPRI projects on: photovoltaic energy storage solutions, grid-connected PV-battery systems, the AEP simulation study, and evaluation of secondary impacts of various community energy storage scenarios. During discussion, it was noted that a lot of data is now being collected and the information has to be analyzed, integrated, and presented in a manner that users can understand. EPRI is looking at microgrids. Mr. Maitra noted that AC to DC conversion is only about 93% efficient, but PV to storage (DC to DC) is about 98% efficient. This is relevant to the secondary use of EV car batteries. The participants expressed a strong interest in continuing to be updated on the integration of PV, energy storage systems, and PEVs.

EV Installation Guide (August 2011)

Enid Joffe, Clean Fuel Connection, presented the EPRI installation guidelines (see Presentation), a project that began more than a year ago. The guidelines will be 4-8 page briefs dealing with the following installation types: residential, commercial-workplace, commercial-retail/customer/client/guest, multi-unit dwelling, fleet, and charging levels. She listed existing and emerging resources, the intended users, and the content outline for each. The following comments and suggestions were made:

- Residential
– Terms should be defined and scenarios included for more than one vehicle.
– The issues of cable management and smart vs. not-so-smart EVSEs could be addressed.
– Data on wiring, costs and examples should be provided to help consumers decide where to locate the EVSE (utilities can send examples to Ms. Joffe).
– Information should be provided on how to avoid an electrical panel upgrade and, in situations when an upgrade is needed, the reasons why an upgrade is necessary and their associated costs.
– The option of using an existing 30A circuit should be mentioned.

- Information could be provided on how to determine one's own driving pattern and how to select the best type of vehicle for one's driving pattern.

- Multi-Unit Dwelling
  - The utility and local inspector should be on board for the installation.
  - There are potential hidden costs related to security, maintenance and vandalism.
  - The 10-foot tap exemption rule should be mentioned.
  - Preferred vs. non-preferred parking & charging locations for EVSE installations should be addressed.
  - The sizing of the electrical backbone to accommodate future EVSE expansions is important (that is, it is cheaper to upsize the original installation).
  - Just-in-time installations may be needed to avoid an idle EVSE.
  - Check resources in the SCE website.
- Workplace
  - Note that infrastructure costs are now about $10,000 for commercial installations compared to past average costs of $4,200.
  - Parking lot politics should be considered.
  - Although installing EVSEs result in environmental and economic benefits and could reduce overall energy consumption, the energy management coordinator of a commercial facility may not meet the facility's energy targets with the EVSEs. Therefore the guidelines need to focus on the net benefits.
  - A breakdown of installation costs, such as costs of subpanel, conduit, labor, etc. should be provided.
  - A recommended location for the workplace charger is between the last ADA parking spot and the first non-ADA parking spot.
  - Include energy service contractors in the list of target audiences.
- Commercial- Retail
  - Note that some commercial-retail establishments put in charging infrastructure for the sake of being "green" even though this may not be practical given their customer profile. Therefore, the importance of analyzing the charging needs of their customers is important.
  - LEED certification is an important incentive not just for new construction but also for retro-fitting.
  - The list of intended audiences should include the associations of building owners and facility managers, such as BOMA (Building Owners and Managers Association) International.

EVSE Standardization (August 2011)

John Halliwell, EPRI, presented opportunities for standardization for EVSE hardware in relation to the consumer interface and the experience of maintenance technicians (see Presentation). He noted differences in the physical appearance, ease of use, and consistency of controls and displays that the consumer would use. For the maintenance technicians, he noted inconsistent color coding for internal wiring, varying types of cable installation, different access means, etc. Among the suggested areas for standardization are consistency of user interfaces, standardization of internal wire color coding, and consistent location of transient suppression. During discussion, participants noted that some standardization could be written into the requirements of certification agencies such as UL. Some maybe covered by diagnostic requirements in the vehicle. NEMA may be able to standardize color coding of the internal wiring. ANSI is another possible standardization body. Harmonization between the US, Canada, and Mexico was also highlighted. Concern was expressed regarding the location of the main disconnect in the vehicle, especially for emergency responders.

PQ and Solar Charging (August 2011)

Ralph Boroughs, TVA, gave a background on TVA and their participation in the EPRI-NRDC study on the environmental impact of plug-in hybrids (see Presentation). The EPRI collaborative project on PEV distribution impacts involved 45 circuits at 25 utilities. With regards to asset risks, the greatest impact is on transformer life with PEV loads exacerbating pre-existing problems. Phase I showed that near-term impacts are minimal. Phase II which involves area-wide asset risk planning and evaluation is ongoing. Mr. Boroughs reviewed SAE power quality standards and testing procedures. He showed charger profiles for the Chevy Volt and DC fast charging of the Nissan Leaf and the Mitsubishi i-MiEV. OEM chargers appear to meet the PQ standards. Mr. Boroughs also presented solar charging sites in Tennessee. During discussion, it was stated that PQ data on the CHAdeMO charger was being obtained.

Environmental tests of EV and EVSE (August 2011)

Pierre-Luc Doyon, Hydro Quebec, gave a description of the utility's Mechanical and Thermomechanical Laboratory, discussed environmental tests for EVs and EVSEs, and showed videos of some tests (see Presentation). The objectives of their environmental tests are to ensure that the vehicles can withstand the cold weather in Quebec and to find out how the charging stations react under severe weather conditions such as frost. The laboratory uses a climate control chamber, sensors, an infrared camera, and data acquisition system. He outlined the IEC and NEMA standards used to evaluate the functionalities of EVSEs under different environmental conditions. During discussion, Pascal Beauregard Pontinha, Hydro-Quebec, explained that the tests are being conducted not to certify products, but to see how the EVs and the EVSEs fare in Quebec's environment.

PEV Readiness Update (August 2011)

Mike Ligett, NCSU, reported on the status of EDTA and EEI projects related to PEV readiness. EEIs checklist have now evolved into a 50-page guide to be presented at the EEI CEO conference. His plan is to narrow the scope, make it graphics-heavy, reduce the appendix section, and send it out to a small group for review. The guide is not intended for the early adaptors, but rather for those who come afterwards. He hopes it will be a living document that can be kept updated by subgroups. EDTA will edit the guide for the American Public Power Association and for the National Rural Electric Cooperative Association.

Lower Level AC Charging

EV Rate Throttling (August 2011)

Watson Collins, Northeast Utilities, addressed the question: Could modulating (throttling) PEV charge rates be an attractive approach for consumers, utilities, and auto makers? (See Presentation.) Throttling and tiered services are frequently used in the communications industry. Mr. Collins presented four charts showing the interaction of miles, duration, and infrastructure capacity. He noted that regulators have oversight of utility rates and earnings. Utility costs are driven by demand, not volume. As EV charging rates exceed the peak demand of a typical residence, a gap is created between current residential rates and the added cost of electrical demand. Demand charges, TOU rates, and tiered EV rates are utility approaches that put a price on the gap. On the other hand, throttling, load control, and delayed charging do not create the gap and maintain current residential rates. Controlling the charge rate maybe more flexible and reliable to meet customer needs and could be considered in standards.

PEV Use Cases for Lower Power Charging (August 2011)

Dwight McCurdy, SMUD, looked at use cases for a Level 2 lower rate of charge (see Presentation). Use Case #1 entails the options of "charge now" at normal power or at low power. Use Case #2 involves a driver that allows the utility to shift charging to off peak hours during summer, but provides the option for "charge now" at low power. In Use Case #3 the utility asks the PEV driver to reduce charging to a low power level, as in an overload situation. Use Case #4 applies to a driver with two PEVs and the driver preprograms both vehicles to charge off peak at the same 3.3kW. In Use Case #5 the driver charges a Leaf, Volt, and Tesla on a 100A subpanel and wishes to charge all three during off peak hours. What is the best way to manage the PEV load and how will it be controlled? Will lower power charging be the logical option?

Who's in Charge: PEV, Driver or Utility? (August 2011)

George Bellino, GM, began with the premise of smart charging as charging off peak and responding to utility demand response (see Presentation). He listed the different controlling factors and asked who should have the priority and what conditions determine priority. The perspective of a PEV customer is to charge as much as possible as fast as possible. Management at lower levels should be integrated into smart grid load management scenarios at the local distribution level and within home area networks. The default should be full power charging. Higher density batteries, longer range, and longer charge time will have future implications.

During discussion, it was pointed out that some EVSE suppliers now have the capability of charging multiple vehicles. Some participants asked if throttling has an impact on battery life and what the effects will be due to reduced charger efficiencies at lower charging rates. Mr. Collins argued that throttling is better than denial of service to the consumer. Mr. Lambert suggested that these discussions should be continued at the next meeting.

ANSI Standards for EV - Update (August 2011)

Jim McCabe, ANSI, outlined the 2011 standardization roadmap of the ANSI EV standards panel for the US market (see Presentation). He listed the participating organizations, composition of the steering committee, the working groups, and timeline. He also summarized the topic content of the roadmap and the parties responsible. During discussion, he said that the draft will be available around December.

Reverse Power Flow (August 2011)

Rich Scholer, Chrysler, talked about reverse power (on-board conversion) to the grid (V2G), to the home (V2H), to the load (V2L), and to a vehicle (V2V) (see Presentation). He presented the architectures and assumptions for V2G and V2H. For V2H automatic or manual switches downstream of the EVSE are required for common loads. He also presented and discussed the architectures for V2L, and V2L & V2G. In these cases, the power panel 240V includes an additional ground tied to the PEV chassis. V2L could be used for V2V. Discussions touched on the possible volume and weight penalty for the on-board charger for bi-directional flow, avoiding current from the car during disconnection, and Nissan's power conversion system.

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