SAE International®

Status of SAE Electro-Mobility Standards

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SAE International

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Agenda

SAE Standards to Support Electro-Mobility

Peter Byk- Technical Project Manager, SAE International

- SAE International Overview
- US Standardization Efforts
- SAE Hybrid/EV Standards
- SAE Battery Standards
- SAE Hydrogen Fuel Cell Standards
- Regulatory References
- SAE in China
- Summary

Mobility is Our Mission






1910 Baker Model V Electric Victoria

2011 Chevrolet PHEV Volt

Established in 1905
First President – Andrew Riker
First VP – Henry Ford
Initial Membership totaled 30 Engineers including Charles Kettering, Orville Wright and Glenn Curtiss

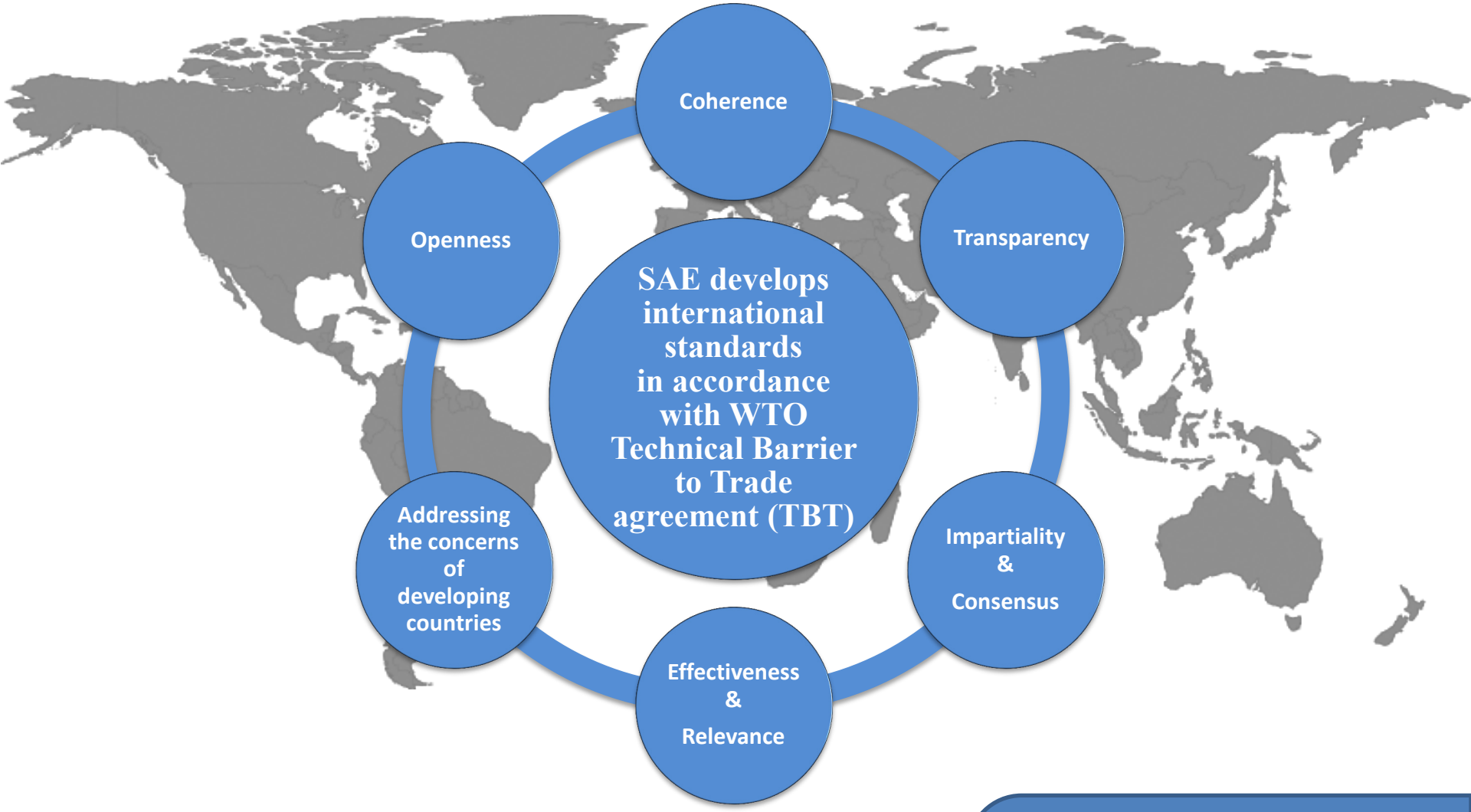
Today SAE is the largest producer of consensus based ground mobility standards in the world.

SAE International Today

Global Influence:

- **128,000 Members From Over 100 Nations**
- **SAE Committee members represent 51 countries**
- **SAE Standards Referenced in countries all over the world**

Standards is Our Business



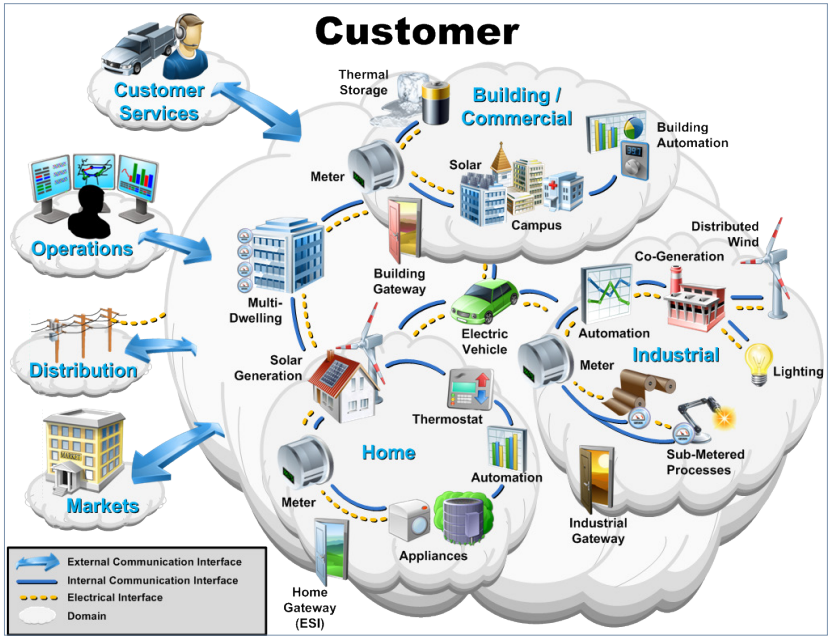
US Organizations – EV Standards

- SAE International (SAE)
- Underwriters Laboratories (UL)
- National Fire Prevention Association (NFPA)
- IEEE (Institute of Electrical and Electronics Engineers)
- International Code Council (ICC)
- National Electrical Contractors Association (NECA)
- National Electrical Manufacturers Association (NEMA)
- Alliance for Telecommunications Industry Solutions (ATIS)

US Roadmap to Smart Grid

Smart Grid Interoperability Panel - SGIP

- *September 24, 2009 –*
  US Commerce Secretary Gary Locke unveils an accelerated plan for developing standards to transform the U.S. power distribution system into a secure, more efficient and environmentally friendly Smart Grid
- 80 initial standards will support interoperability of all the various pieces of the system—ranging from large utility companies down to individual homes and electronic devices.
- Set of 14 “priority action plans” addresses the most important gaps in the initial standard set.
- SAE International identified as a leading standards organization identified in the Phase 1 NIST Framework and Roadmap for Smart Grid Interoperability Standards paragraph 5.13 for *"Interoperability Standards to Support Plug-In Electric Vehicles."*



- SAE – V2G communication, physical plug
- Zigbee – Home communications
- ANSI – Metering
- IEEE – Electric vehicle infrastructure
- NEMA/UL – Building and product

SGIP – Catalog of Standards

SAE International is a leading standards organization identified in the NIST Framework and Roadmap for Smart Grid and "Interoperability Standards to Support Plug-In Electric Vehicles."

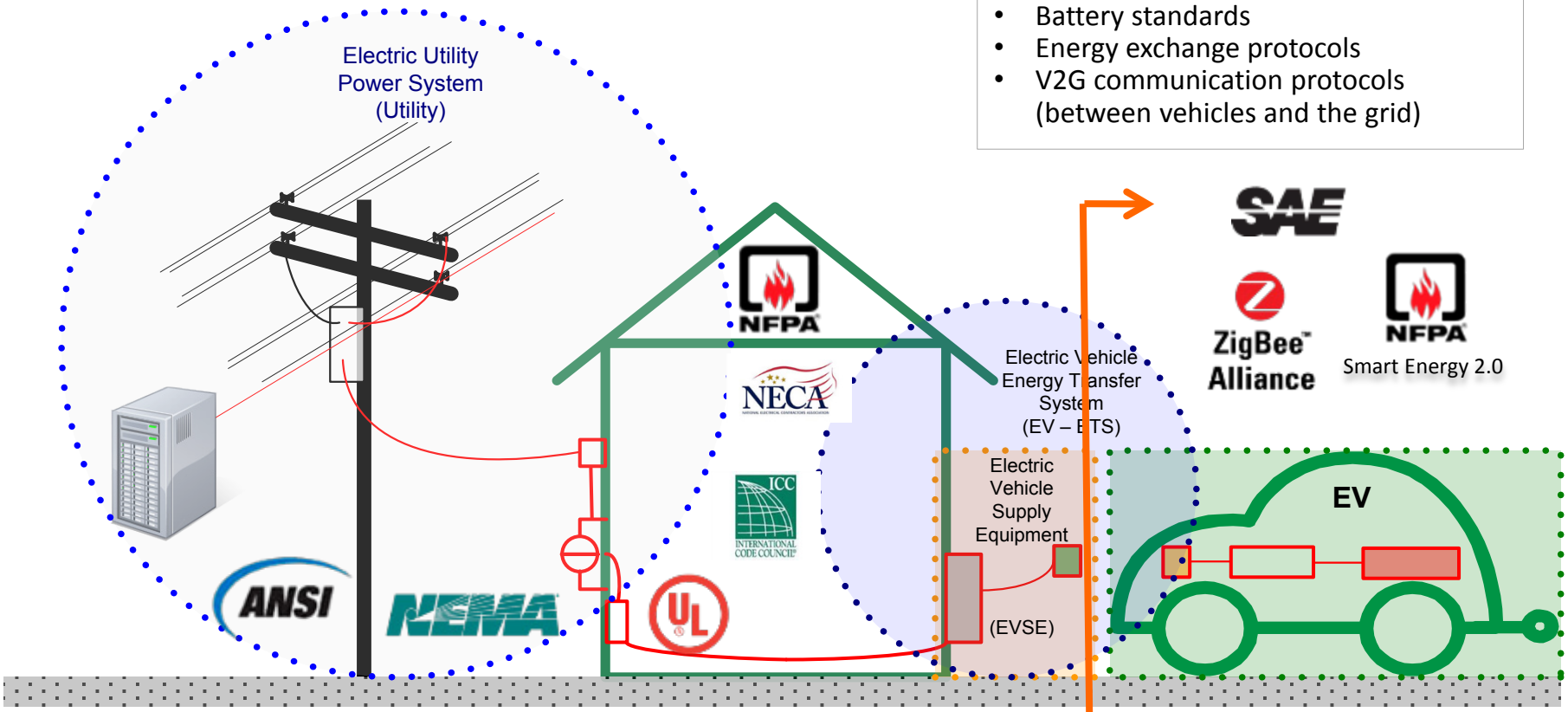
- Serves as a compendium of standards, practices, and guidelines for the development and deployment of the Smart Grid.
- Serves as a resource for utilities, manufacturers, regulators, consumers, and other Smart Grid stakeholders
- Currently three SAE Standards in the Catalog
  - SAE J1772 - Electrical Connector between PEV and EVSE
  - SAE J2836/1-3 Use Cases for PEV Interactions
  - SAE J2847/1-3 Communications for PEV Interactions

Technology Enablers

Simply Connecting?

EV or PHEV require multitude of standards:

- Physical connectors
- Interfaces
- Power levels
- Battery standards
- Energy exchange protocols
- V2G communication protocols (between vehicles and the grid)



Technology Enablers

System Approach to Safety

On Board Battery Charger
UL 2202.

National Electrical Code
Article 625 – Electric Vehicle Charging System
I – General
II – Wiring Methods
III – Equipment Construction
IV – Control & Protection
V – EV Supply Equipment Locations

J2929 EV and PHEV propulsion Battery System Safety Standard

J2344 Guidelines for EV Safety

J1766 Recommended Practice for EV / HEV Battery Systems Crash Testing

J2464 EV / HEV RESS Safety and Abuse Testing

UL 2231-1
Personnel Protection Systems for EV Supply Circuits

UL 2231-2
Protection Devices for Use in Charging Systems

UL2594
Outline for Investigation for EV Supply Equipment

IEEE related PEV charging / SG standards: P2030, P1547 & P1901

Charging inlet UL 2251.

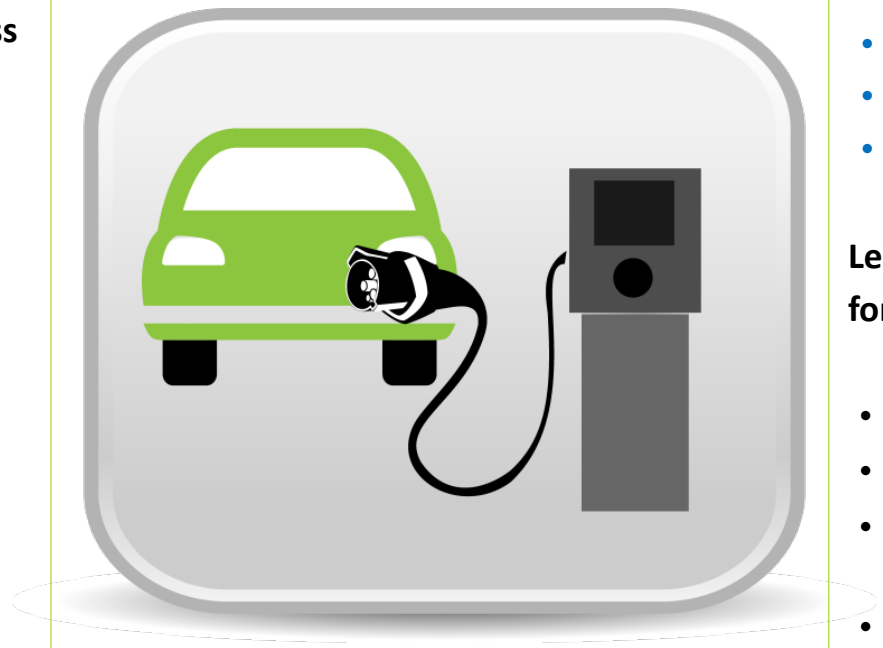
Charging plug
SAE J1772™

Technology Enablers

SAE Electro-Mobility Ground Vehicle Standards Development Activities

Volunteer, consensus based standards development process

- Total Committees: 580
- Total Committee Members: 8,064
- Total Standards Published : 10,077 (Ground Vehicle 2,081)
- Active Standards: 8,635 (Ground Vehicle 1,681)
- Standards In Development /Review: 657



Vehicle Electrification

- EV, PHEV's
- Batteries
- Smart Grid
- J1772™ Connector
- Fuel Cells

Leading SDO in NIST Roadmap for Smart Grid interoperability

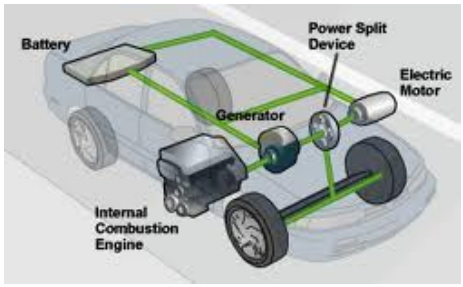
- 29 active committees
- 774 committee members
- 64 EV standards developed or in process
- 17 FC standards developed or in process

SAE International is a leading standards organization identified in the NIST Framework and Roadmap for Smart Grid and "Interoperability Standards to Support Plug-In Electric Vehicles."

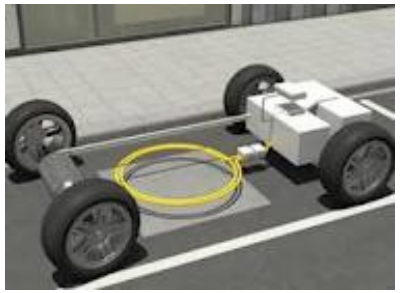
Technology Enablers

SAE Hybrid/EV Standards Committee

- The SAE Hybrid- EV Technical Standards Committee develops and maintains standards in the field of hybrid technology.
- Standardization efforts cover hybrid system safety, test procedures to establish the performance of hybrid systems and components, communication protocols and requirements, nomenclature, vehicle interface and serviceability requirements .



34 Standards developed or in process



Technology Enablers

EV / PHEV Charging Interface

SAE Hybrid Vehicle Committees are leading the effort to define charging functionality and standardize the connection hardware from EV to EVSE

SAE-J1772 Standard defines:

- Charging capacity & operating voltage by "Level" – AC 1 & 2
- Electrical safety & circuit protection of EVSE
- Physical properties of the connector
- EV to EVSE communications & charging controls

Technology Enablers

Next Generation – SAE Combo Connector

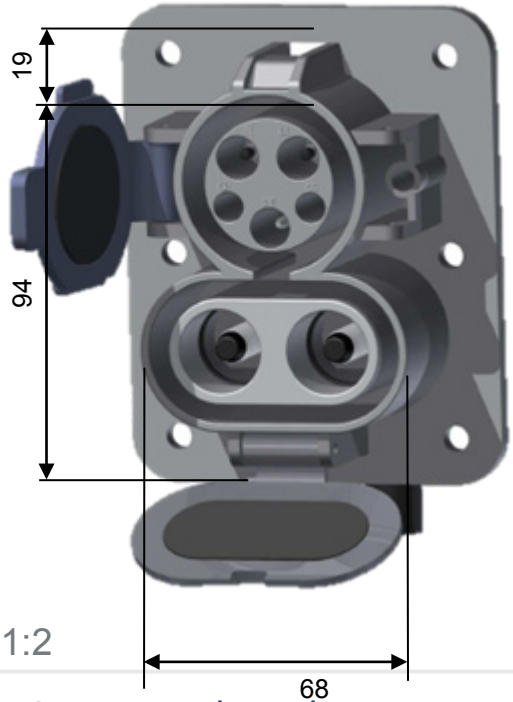
The SAE Combo Charge Connector" standard sets the foundation for a combined charging system for electric vehicles in Europe and North America

Technology Enablers

DC Combo Inlet Design

Integration of AC and DC into a single inlet provide high freedom for vehicle design.

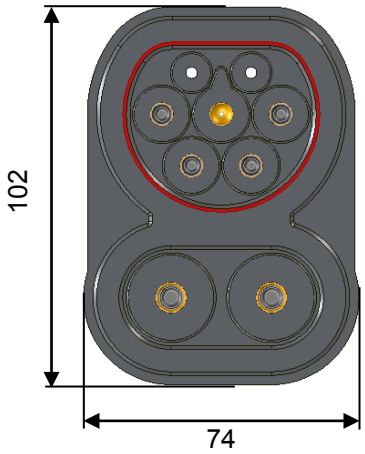
Combo 1 Inlet for US



Scale 1:2

Harmonized Approach

Combo 2 Inlet for Europe



Scale 1:2

Combo Connector based on Type 1 and Type 2 have been submitted to IEC in a single document by Germany and US. Both Combo Connectors have identical package and fixation.

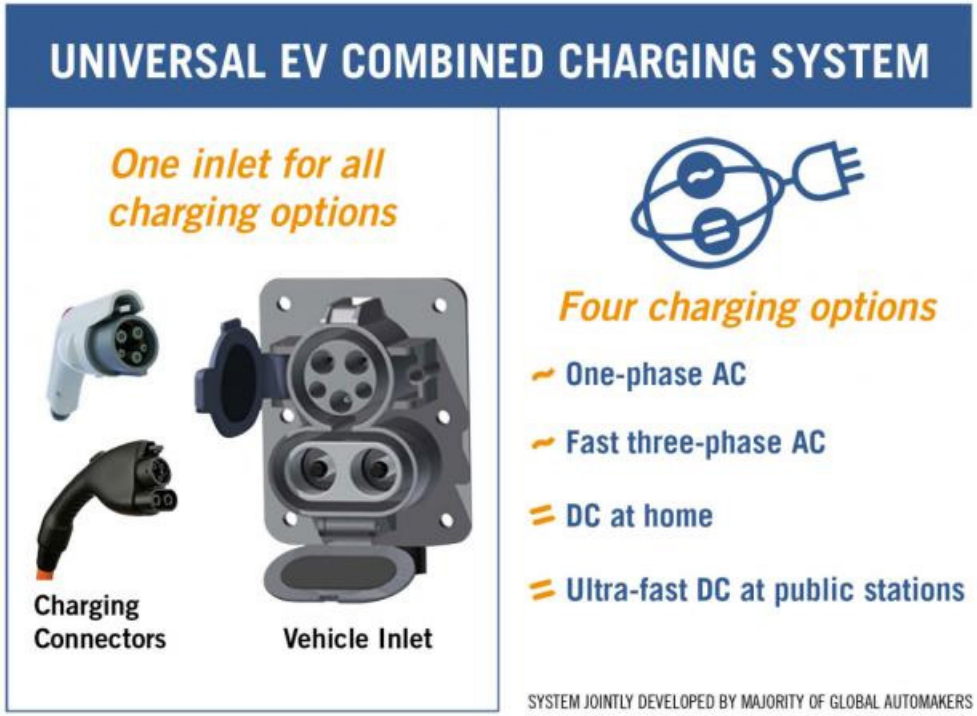
Courtesy of Initiative Charging Interface by Audi, BMW, Daimler, Porsche, VW (coordinated by Dr. Heiko Dörr,heiko.doerr@carmeq.com)

Global Standardized EV Charging System

ACEA

SAE International

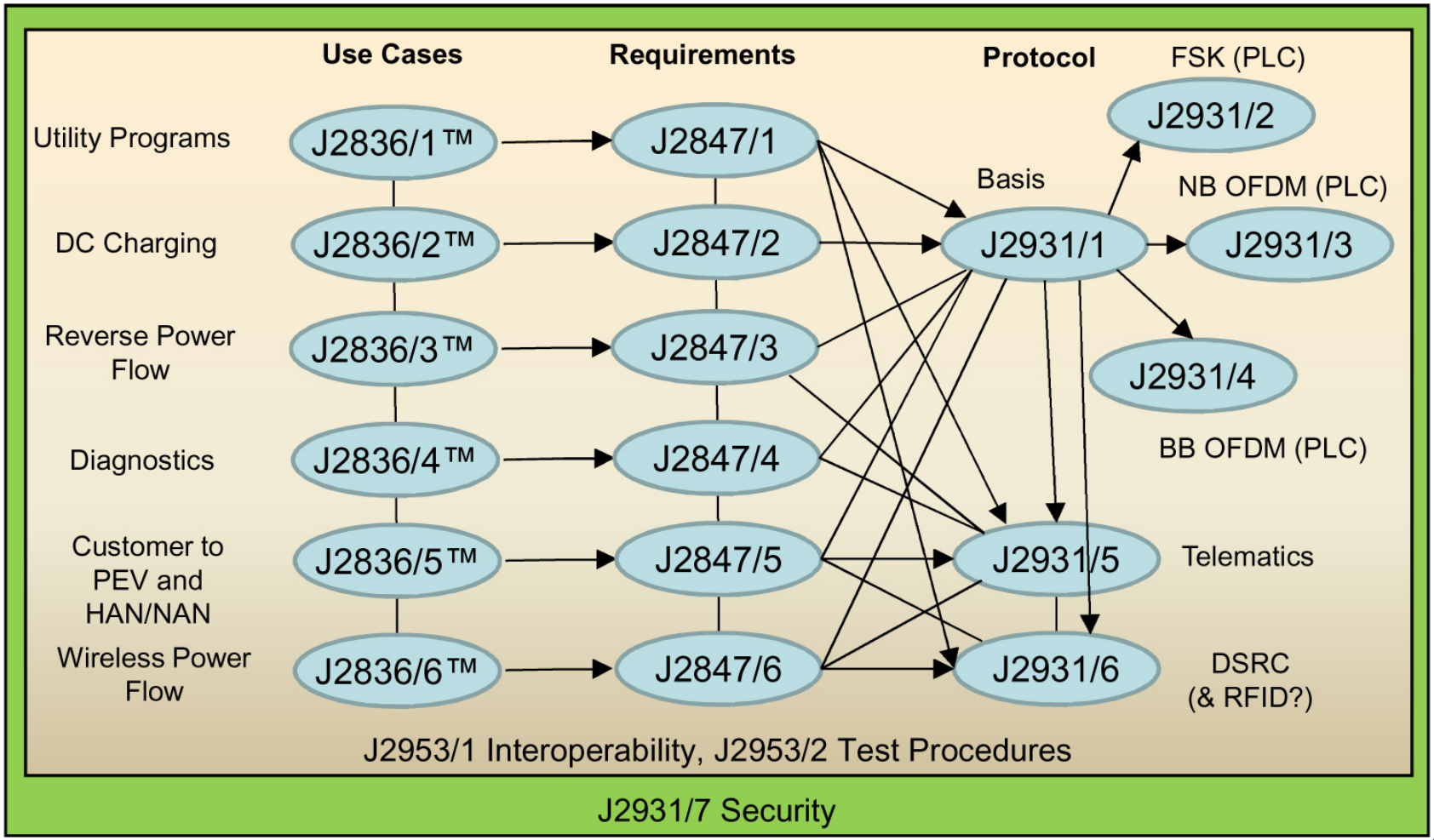
IEC



Audi BMW CHRYSLER DAIMLER Ford GM PORSCHE VW

Technology Enablers

SAE Communication Standards



The Future of Electrification - Successful Implementation

SAE J2953 – "Plug-In Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)" – Work in Progress

Government/Industry Research Project
DOE Project: Advanced Vehicle Testing and Evaluation - Infrastructure Test and Evaluation

Establish requirements, specifications, test procedures and certification processes to ensure the interoperability of PEV's and PHEV's and Electric Vehicle Supply Equipment (EVSE)

- Interoperability
- Reliability
- Charger efficiency
- Vehicle to grid communication
- Bi-directional power flow

Is it going to work?

Every time? All the time?

Technology Enablers

Inductive Charging of EV's & PHEV's

Potential Charging Locations:

- Residential
- Public
- On-Road
- Static (parking lots, curb side)
- Dynamic (embedded in roadway)

SAE J2954 Standard in Development

- Inductive Charging Technologies
- Wireless Connection
- Power Transfer Communications
- Smart Grid Interoperability / Programmability
- Level 2 Charging (3.3 kWh)
- Battery System Fault Monitoring
- Automatic Shutdown Capability

Who's Involved?

- Auto and Commercial Vehicle OEM's (11)
- Automotive Suppliers
- Organizations (laboratories, government agencies, universities, SDO's, power companies)

Technology Enablers

SAE Vehicle Battery Standards Committee

- The SAE Battery Standards Committee leads the way in standardization for batteries which will play a predominate roll in transportation of the future
- Standardization efforts cover all aspects of the cell, module, pack or vehicle for form-fit-function, safety, testing, validation, manufacturing, shipping, transportation, emergency response, service, recovery and recycling through the value chain in society

Technology Enablers

Battery Standards Steering Committee

- Started – Nov. 2009
- Current Committee Membership
  - >420 Representatives
  - >175 Individual Participants
  - >140 Companies
    - OEM's
    - Suppliers
    - Government
    - Academia

New Committees under Development

- Aerospace Battery
- ✓ Secondary Use Application Guidelines
- ✓ Capacitive Energy Storage
- Unified Battery Warranty Approach
- ✓ 1st and 2nd Responders Committee
- Battery Disconnect and Discharge Procedures

Slide: courtesy of Magna Int'l.

Technology Enablers

Key EV Battery Standards

22 Battery Standards developed and in-process include:

- Terminology (J1715/2)
- Safety (J2910, J2929)
- Labeling (J2936)
- Transport & Recycling (J2950, J2974, J2984)
- Battery Performance Rating (J1798
- Fuel Consumption & Range (J1634, J2711, J2758)
- Discharge Procedures (J3009)
- Secondary Uses (J2997)
- Testing Methodologies (J537, J1495, J2288, J2380, J2464, J2929)

Technology Enablers

A Look into the Future – Hydrogen Fuel Cell Vehicle Standards

- SAE is involved with the US DOE and NREL to develop standards relating to fuel cell vehicles
- 17 Fuel Cell Standards developed and in-process include:
  - Terminology (J2574 & J2760)
  - Safety (J2578, J1766)
  - Performance Interoperability
  - Vehicle Communications (J2799)
  - Emissions & Recyclability (J2594)
  - Fuel Consumption & Range ((J2572)
  - Fueling Protocols & Devices (J2600 & J2601)
  - Testing Methodologies (J2615/16/17 & J2722)
  - Fuel Quality (J2719)

Technology Enablers

SAE EV Standards Referenced in Regulations

California Air Resources Board (CARB)

- mandates use of SAE J1772 beginning with 2006MY

NHTSA references SAE J2889 and J2889/1 in the Pedestrian Safety Enhancement Act NPRM

- enhances pedestrian safety
- noise measurement emitted by PEV

SAE EV Portal

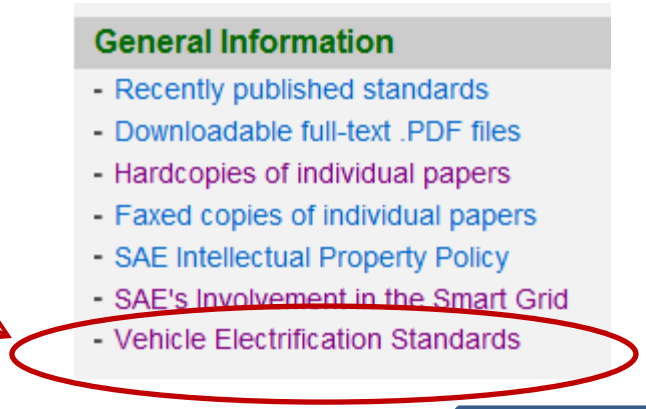
EV Related

- News and Articles
- Events
- Publications
- Research Reports
- Training
- Standards

www.ev.sae.org

Select "Standards" Tab

Complete List of SAE EV Standards



Strategic Partnership Established

SAE and CATARC, the two largest automotive organizations in US and China have established a long-term strategic cooperation in 2006 to serve the China automotive industry.

SAE International China Office

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Mr. Shawn Song - Program Manager

- standards/conformance initiatives
- liaison activities between SAE,CATARC and local enterprises
- Member of CATARC's Shanghai Operation

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Accomplishments of the Cooperation

Government

SAE developed close cooperative relationships with the Central government, and Tianjin, Shanghai and Ningbo municipal governments.

Meetings and Conferences

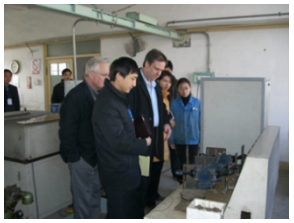
More than 20 SAE technology seminars and conferences were successfully held in Beijing, Shanghai and Ningbo attended by over 3000 professionals.

Professional Development Seminars:

Rapidly expanding portfolio of technology and process training courses taught by U.S. and Chinese instructors

Corporate Technologies

SAE invited experts from USA to help local Chinese auto companies solve technical problems on site and provide recommendations.



Accomplishments of the Cooperation

SAE Standards

80% + of global automotive companies are using SAE standards for design, testing, and procurement activities.

Communications

SAE Newsletter published in both English and Chinese by the China Office with over 11,000 monthly subscribers.

Outreach

Recruiting new Chinese members to SAE International. Chinese companies exhibiting and attending SAE events in the USA.

Website: http://www.saeinternational.cn/

Accomplishments of the Cooperation

SAE Standards Cooperation

- China government assigned CATARC to represent the government to develop the New Energy Vehicle standards.
- SAE serves the global automotive industry to develop and form the New Energy Vehicle standards.
- The strategic cooperation between SAE and CATARC regarding new energy vehicle standards started this year.

Leaders from SAE and CATARC are discussing the cooperation of new energy vehicle standards

Future Cooperation

Standards Development Interaction

- Collaborate with China automotive industry to develop new energy vehicle standards.
- Join EV and Battery working group under the NTCAS to exchange the standard information
- Invite Chinese automotive experts to be involved in the SAE standards development process.
- To meet the needs of China auto supplier exporters, SAE is working towards implementing the SAE Standards Certification process in China.

Summary

Standards are Paramount to the Advancement of Technologies, Industries and Individuals

Slide: courtesy of Magna Int'l.



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