

# SAE V2G Standards Activities

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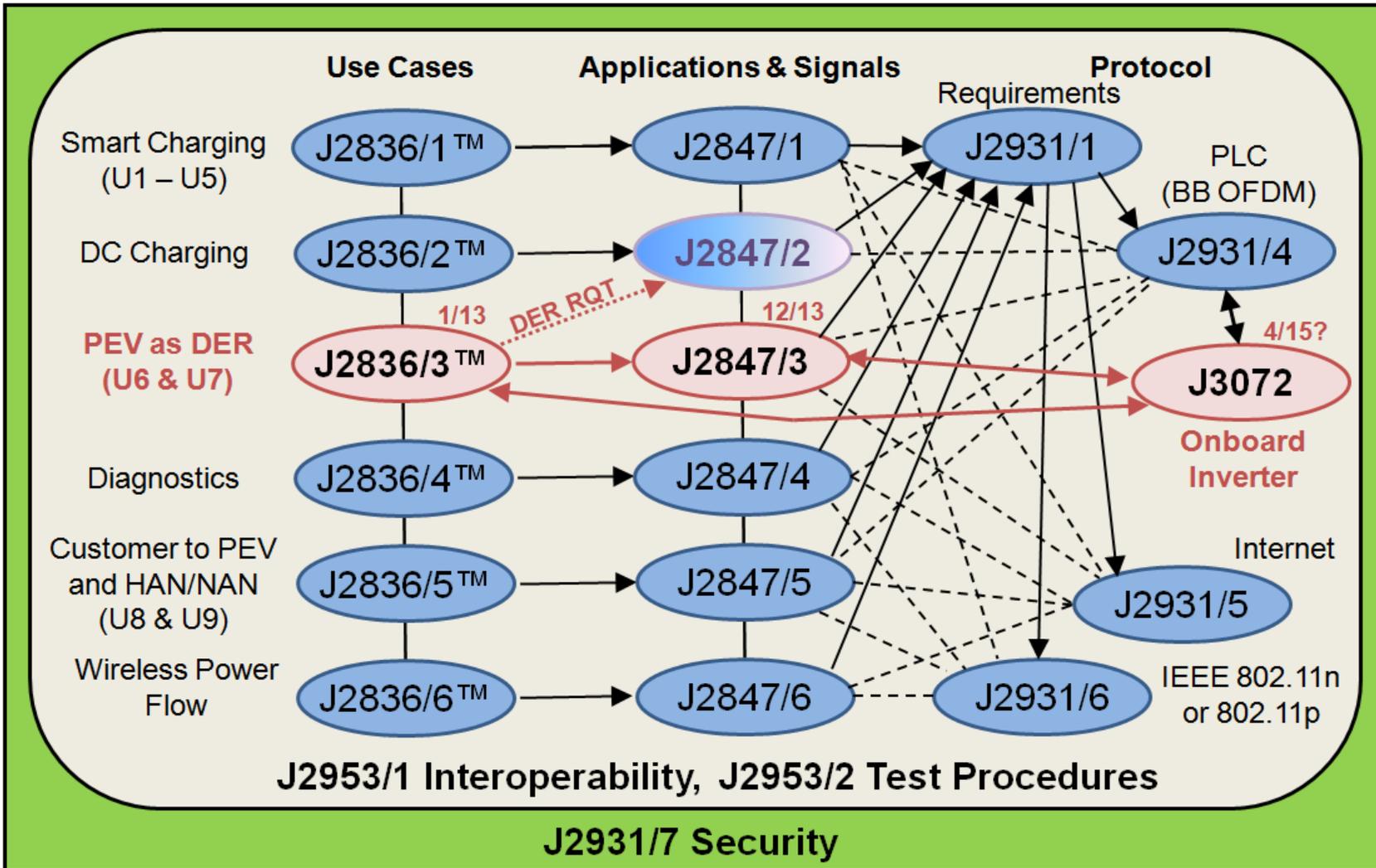


**Leader of V2G Working Group  
Communication and Interoperability Task Force  
SAE Hybrid-EV Committee**

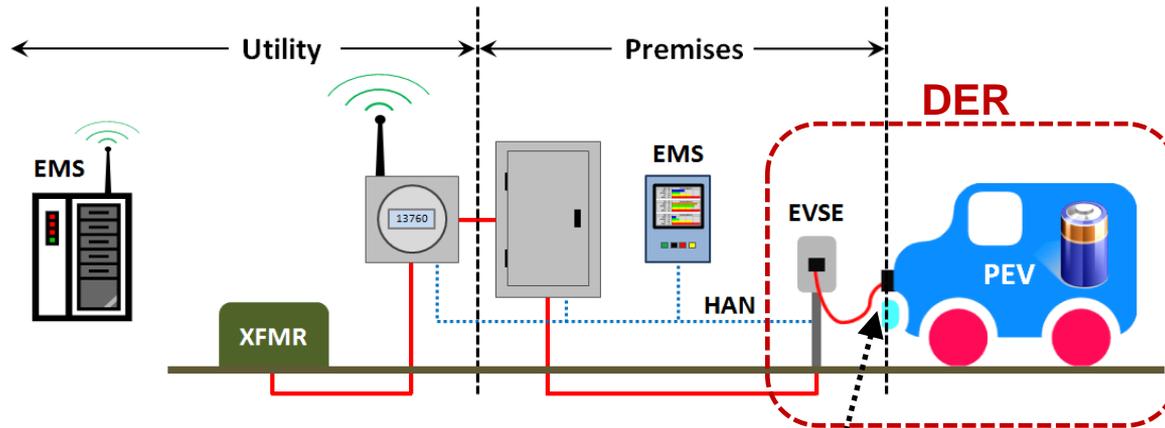
**First Annual California Multi-Agency Update  
on  
Vehicle-Grid Integration Research**

**November 19, 2014**

# SAE PEV Communications & Interoperability Task Force

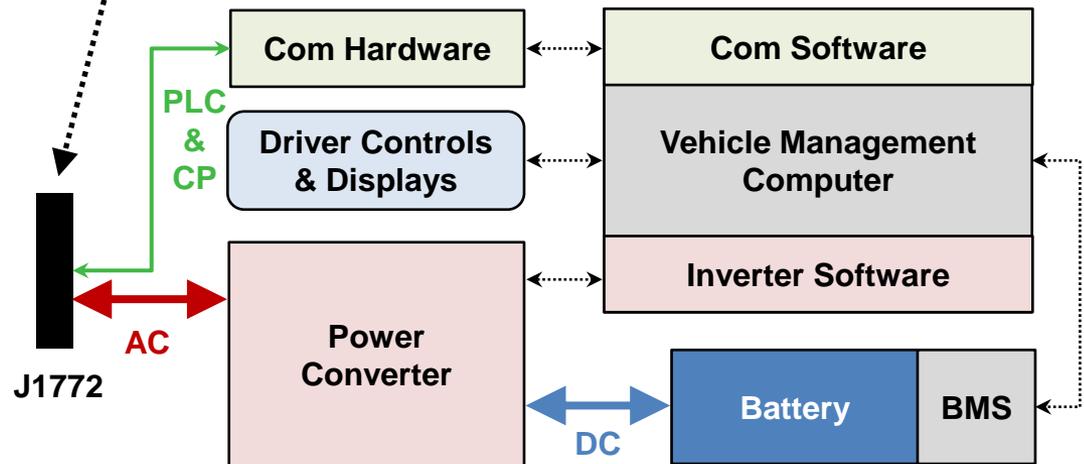


# Roaming Onboard Inverter Systems



**New Interconnection Approval Procedures Needed by Utilities**

- DER = EVSE + PEV
  - EVSE provides site settings
  - EVSE authorizes discharging
- PEV inverter is not a “box”
  - Cannot meet UL 1741
  - Can meet IEEE 1547



# SAE J3072 - Scope and Purpose

	<b>SURFACE VEHICLE STANDARD</b>	J3072	PropDft NOV2014
		Issued 2015-04 Superseding Original Release	
Interconnection Requirements for Onboard, Utility-Interactive Inverter Systems			

## Scope

This SAE Standard J3072 establishes requirements for a utility-interactive inverter system which is integrated into a plug-in electric vehicle (PEV). The requirements herein are limited to those which are necessary to ensure safe interconnection with the electric power system (EPS) as an electric power production source. This standard does not require that a PEV shall provide an onboard inverter system.

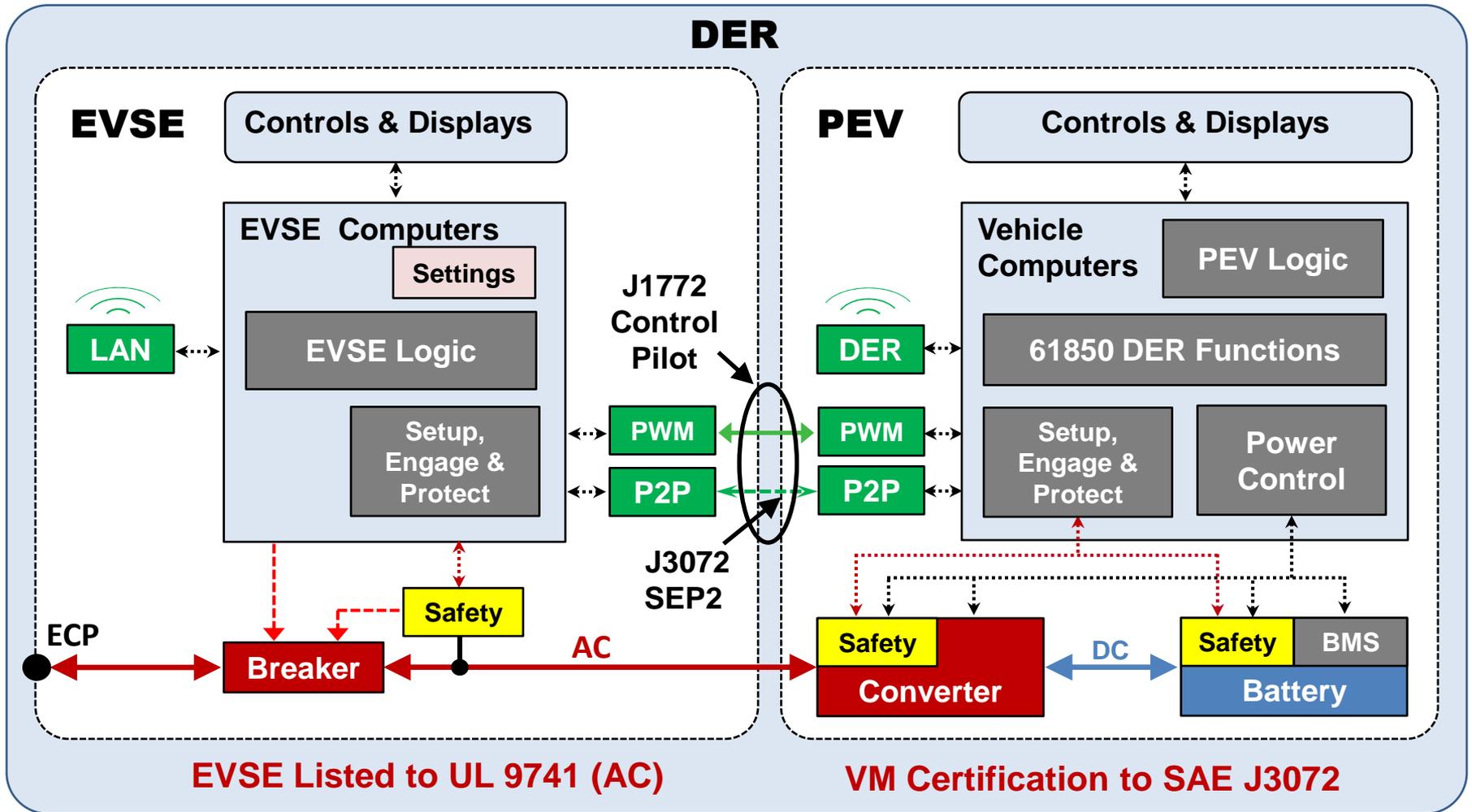
## Purpose

A standard is needed to which a vehicle manufacturer (VM) can certify conformance by analyses, inspections, and tests that a utility-interactive inverter system, which is integrated into the PEV, can be safely connected in parallel with the electric power system (EPS) by way of a compatible, conductively-coupled, electric vehicle supply equipment (EVSE). The stationary EVSE and mobile PEV will function as a single integrated distributed energy resource (DER) after the EVSE authorizes the PEV to discharge during a session.

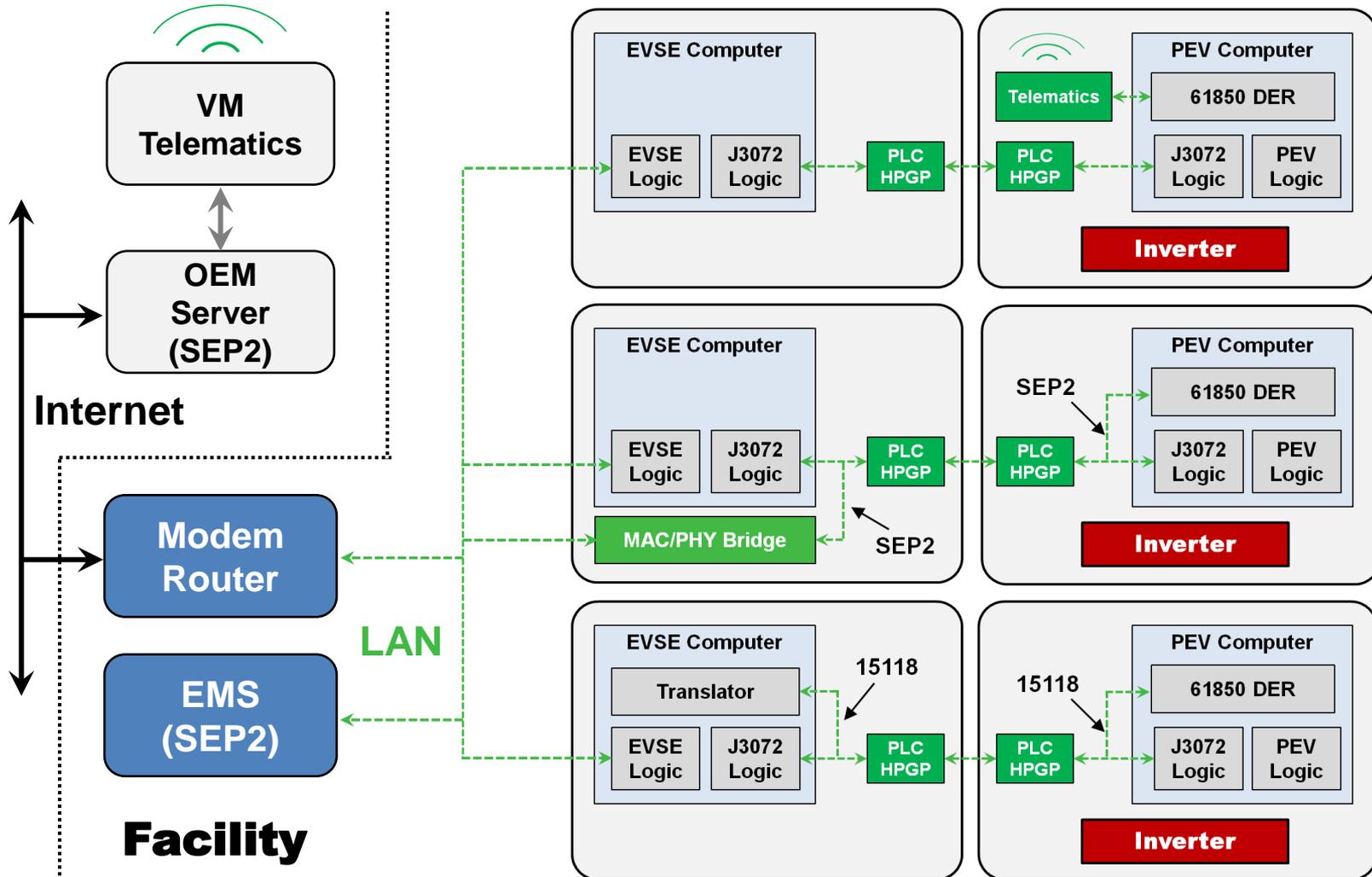
# J3072 Requirements Overview

- **System types**
  - A1: J1772 AC L2, PLC HPGP (J2931/4), IEEE 2030.5 SEP2
- **Configuration management for inverter system**
  - Process to define relevant inverter system components
  - Process to assign unique model designation
- **PEV-EVSE interoperability**
  - EVSE provides site information to PEV
  - PEV provides DER settings to EVSE
  - PEV provides inverter model information to EVSE
  - EVSE authorizes PEV to discharge during session
- **Required and optional IEC 61850 inverter functions**
- **Utility interaction (IEEE 1547, IEEE 1547.1)**

# Inverter Located in PEV

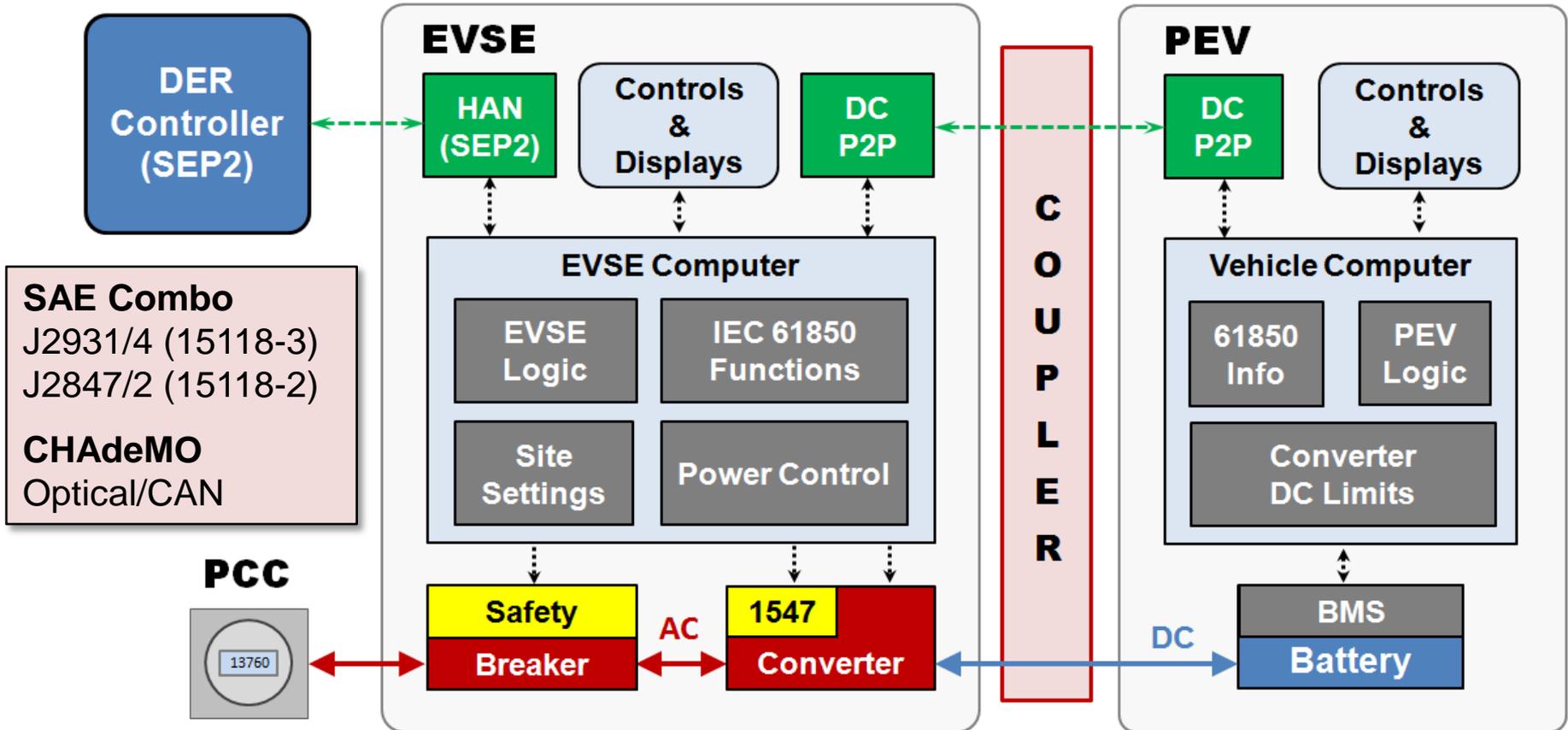


# Protocol options to engage with a facility EMS



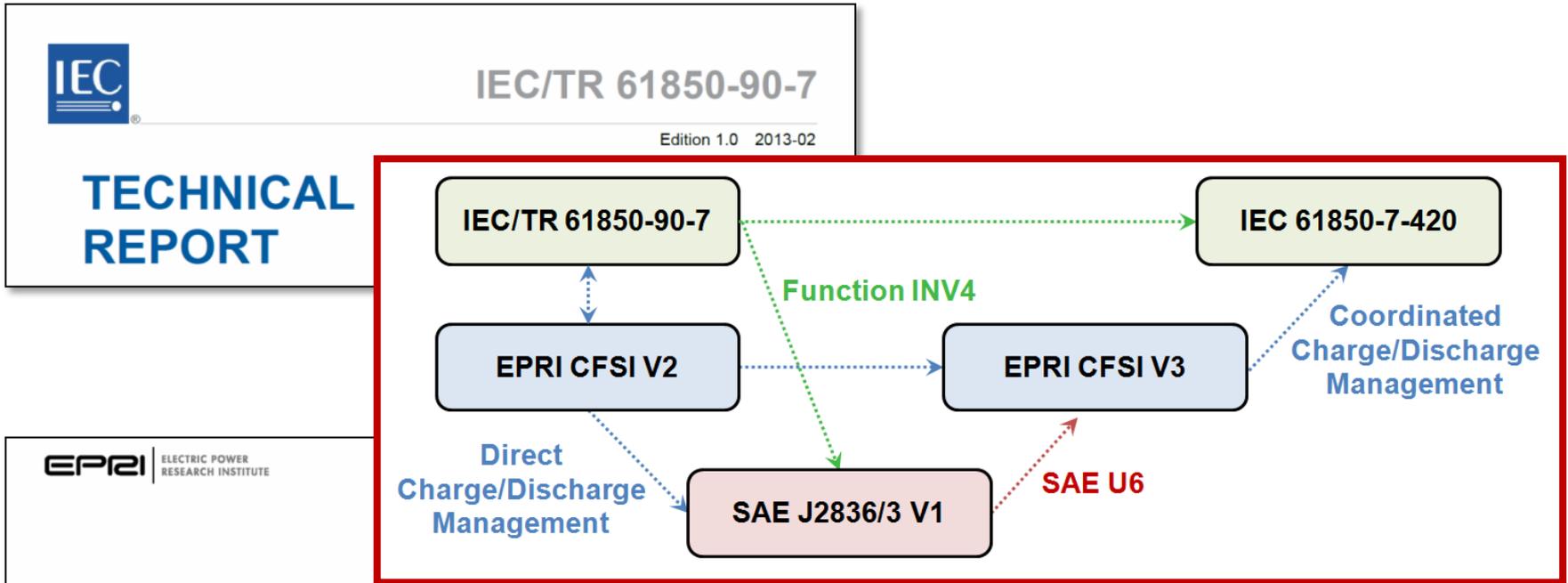
# Inverter Located in EVSE

EVSE Listed to UL 9741 (DC)



**Both Protocols Need Update to Support EVSE as 61850 DER**

# SAE J2836/3™ Basic DER Function (U6)



**IEC**  
INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC/TR 61850-90-7

Edition 1.0 2013-02

**TECHNICAL REPORT**

IEC/TR 61850-90-7

IEC 61850-7-420

EPRI CFSI V2

EPRI CFSI V3

SAE J2836/3 V1

**EPRI** | ELECTRIC POWER RESEARCH INSTITUTE

Common Functions for Smart Inverters, Version 3

## BATTERY STORAGE: COORDINATED CHARGE/DISCHARGE MANAGEMENT FUNCTION

### Scope of this Function

This function identifies a set of quantities that can be read from battery storage systems to enable their management to be coordinated with the local needs of the storage users in terms of target charge level and schedule. This function enables the separately-described direct charge/discharge function to be handled more intelligently, ensuring that the storage system achieves a target state of charge by a specified time.

# IEC 61850 Function INV4

## Command from Controller

Active Power Setpoint (Signed Percent)

Start Time (UTC)

Time Window (Seconds)

Ramp Time (Seconds)

Reversion Timeout (Seconds)

## State Information to Controller

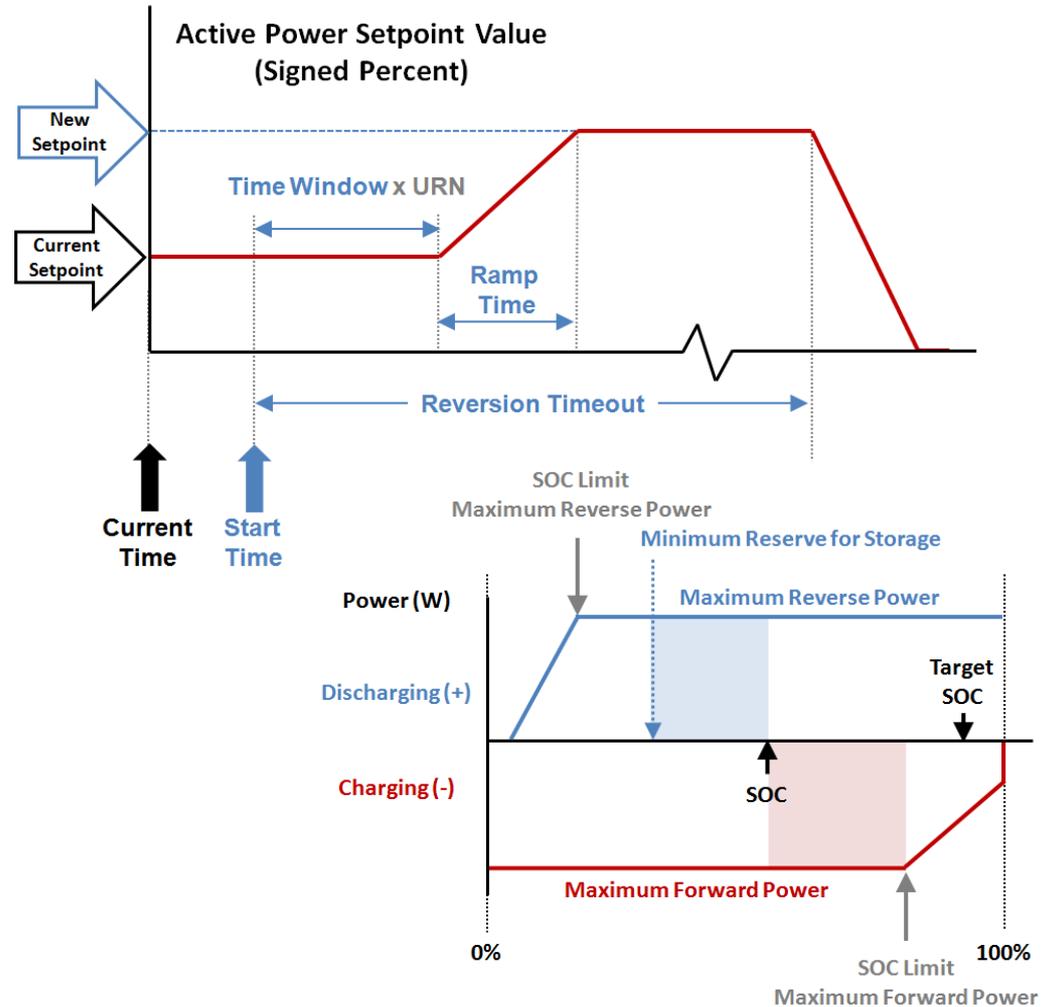
Maximum Forward Power (Watts)

Maximum Reverse Power (Watts)

Minimum Reserve State of Charge

State of Charge

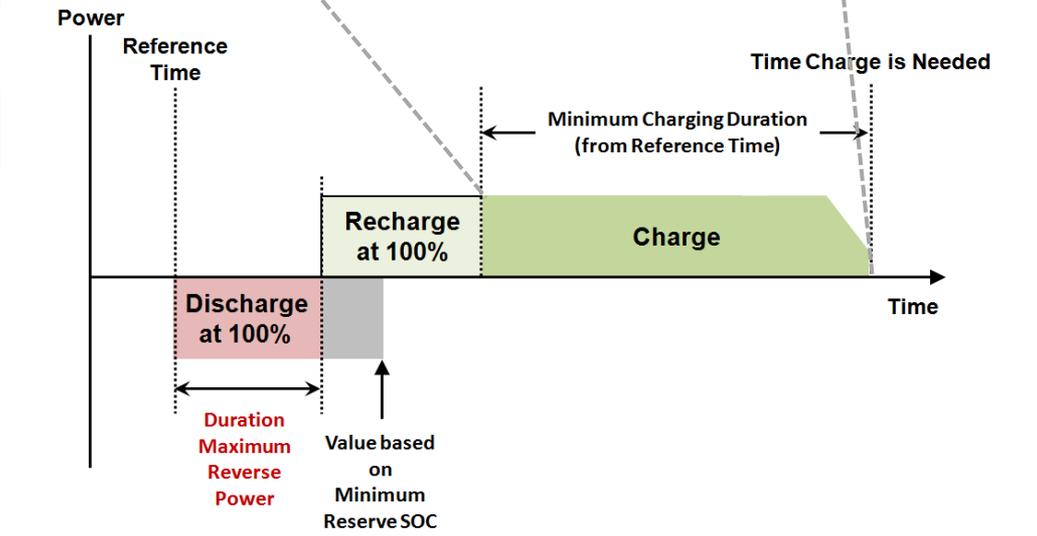
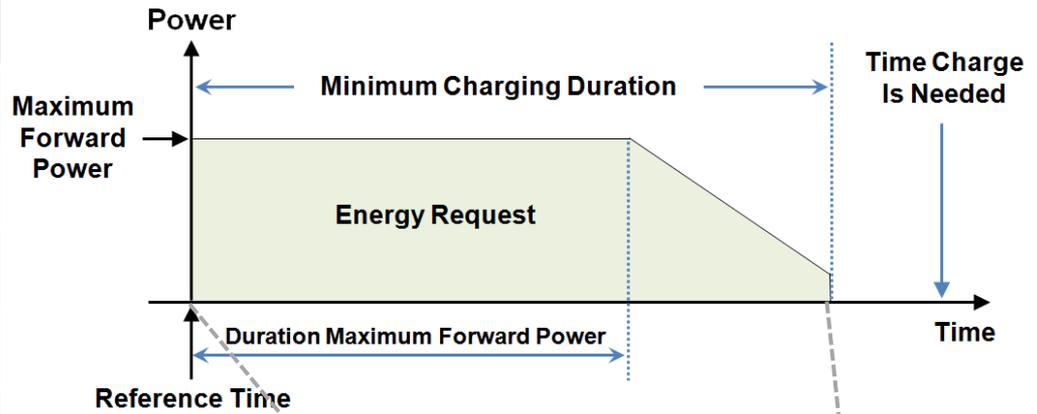
Active Power (Watts)



# SAE U6 & EPRI Coordinate Charge/Discharge



Additional State Information
Target State of Charge
Time Charge is Needed (UTC)
Energy Request (Watt-hours)
Minimum Charging Duration (sec)
Duration Maximum Forward Power (sec)
Duration Maximum Reverse Power (sec)
Reference Time (UTC)



DER continually calculates and updates Energy Request, Minimum Charging Duration, and Durations at Maximum Forward and Reverse Power. More complex for EVSE inverter.

# Levels of EMS Engagement with U6

Levels of EMS Engagement	Minimal	Informed	Cooperative
Behavior of EMS and PEV for the level of engagement. PEV provides information to support any level of EMS engagement.	EMS broadcasts power commands without planning. PEV breaks off to perform charging.	EMS plans power commands based on available power. PEV breaks off to perform charging.	EMS manages power for the V2G application and also to meet PEV charging objectives
Maximum Forward Power	Optional	Required	Required
Maximum Reverse Power	Optional	Required	Required
Duration Max Forward Power		Required	Required
Duration Max Reverse Power		Required	Required
Time Charge is Needed			Required
Energy Request			Required
Minimum Charging Duration			Required

## Examples of U6 Calculations

### PEV Onboard Inverter: PEV is the DER

$$\text{EnergyRequest} = \text{UCAP} \times (\text{TargetSOC} - \text{SOC}) / \text{EfficiencyTotal} + \text{ParLossPEV}$$

### EVSE Inverter: EVSE is the DER

#### EVSE Calculation

$$\text{EnergyRequest} = \text{EnergyRequestPEV} / \text{EfficiencyInverter} + \text{ParLossEVSE}$$

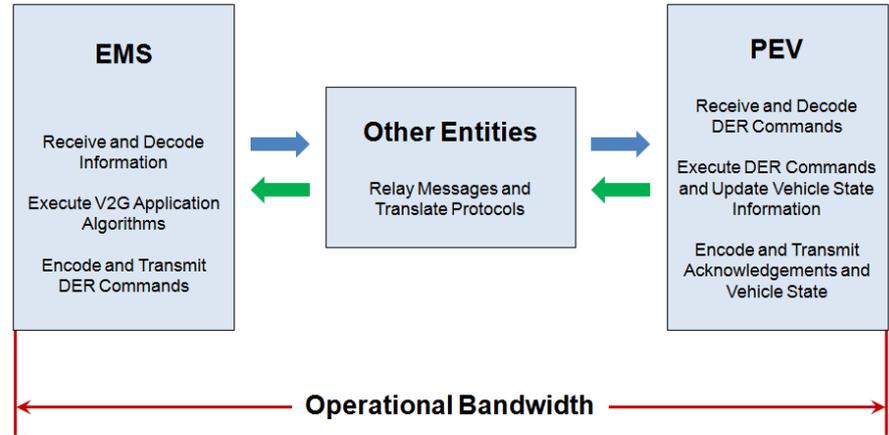
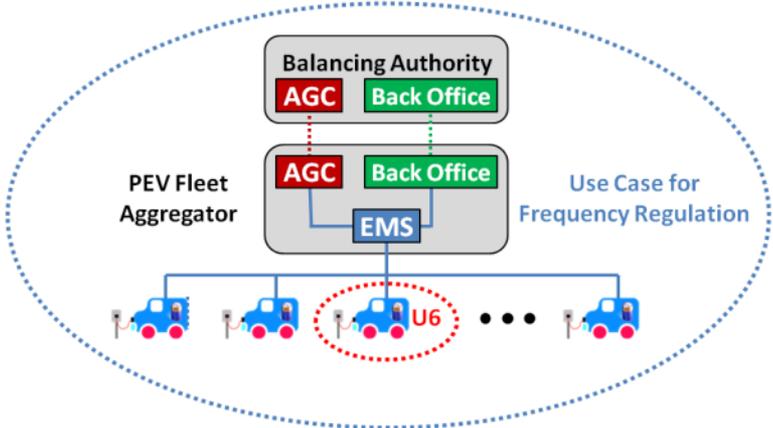
#### PEV Calculation

← Via P2P Data Link (J2847/2)

$$\text{EnergyRequestPEV} = \text{UCAP} \times (\text{TargetSOC} - \text{SOC}) / \text{EfficiencyBattery} + \text{ParLossPEV}$$

**Update DC protocols to support EVSE 61850 DER functions**

# J2836/3™ – V2G Applications & SAE Use Cases



Domain	V2G Application	Operational Bandwidth	Use Cases
System	Encourage Off-Peak Charging	Hours	U1/3/4
System	Demand Response Events	Hours	U2
System	Real Time Energy (Load Following)	Minutes	U6
System	Frequency Regulation	Seconds	U6
System	Voltage Support Service	Seconds	U7
Distribution	Transformer Load Management	Hours	U5/U6
Distribution	Feeder Load Management	Minutes	U6
Distribution	Renewable Energy Integration	Seconds	U6/U7
Distribution	Feeder Voltage Support	Cycles	U7
Customer	Energy Cost Management	Hours	U5/U6
Customer	Demand Charge Management	Minutes	U6
Customer	Facility Power Quality	Cycles	U6/U7

SAE Use Case	Type	RPF	VAR
U1 Time of Use	Price		
U2 Direct Load Control	Stop		
U3 Real-Time Pricing	Price		
U4 Critical Peak Pricing	Price		
U5 Flow Reservation	Fixed	Yes	
U6 Basic DER: Fixed Flow	Fixed	Yes	
U7 Advanced DER: Fixed PF	Fixed	Yes	Yes
U7 Advanced DER: Fixed VAR	Fixed	Yes	Yes
U7 Advanced DER: Freq-Watt	Auto	Yes	
U7 Advanced DER: Volt-Watt	Auto	Yes	
U7 Advanced DER: Volt-VAR	Auto	Yes	Yes
U7 Advanced DER: Watt-PF	Auto	Yes	Yes
U7 Advanced DER: LVRT	Limit	Yes	
U7 Advanced DER: HVRT	Limit	Yes	

# J2847/3 – Scope and Purpose

	<b>SURFACE VEHICLE RECOMMENDED PRACTICE</b>	J2847/3	DEC2013
		Issued	2013-12
Communication for Plug-in Vehicles as a Distributed Energy Resource			

This document applies to a Plug-in Electric Vehicle (PEV) which is equipped with an onboard inverter and communicates using the Smart Energy Profile 2.0 Application Protocol (SEP2). It is a supplement to the SEP2 Standard, which supports the use cases defined by J2836/3™. It provides guidance for the use of the SEP2 Distributed Energy Resource Function Set with a PEV. It also provides guidance for the use of the SEP2 Flow Reservation Function Set, when used for discharging. It is not intended to be a comprehensive guide to the use of SEP2 in a PEV.

- Guidance for **WHAT** information needs be exchanged
- Guidance for **HOW** to manage the actual exchange
- Defines **RULES** of engagement
- Identifies **CHANGES** for the next version of SEP2 and IEC 61850
- Provide **EXAMPLES** of the use of SEP2 to perform selected V2G applications.

# Summary

- **J3072 will be certification standard for onboard inverter system**
  - Defines PEV and EVSE interoperability to authorize discharge
  - Requires conformance to IEEE 1547 and 1547.1
  - Roaming inverter is a new paradigm for utilities
- **Modify DC Charging Protocols for DER mode**
  - Define new mode of operation versus fast charging
  - Define new messages to set DC current limits for EVSE inverter
  - Partition PEV and EVSE calculations for EVSE 61850 functions

# Backup

# J2836/3™ – Scope and Purpose



 <b>SAE International</b>	<b>SURFACE VEHICLE INFORMATION REPORT</b>	<b>SAE</b> J2836/3 JAN2013
		Issued 2013-01
Use Cases for Plug-in Vehicle Communication as a Distributed Energy Resource		

## Scope

This SAE Information Report establishes use cases for a Plug-in Electric Vehicle (PEV) communicating with an Energy Management System (EMS) as a Distributed Energy Resource (DER). The primary purpose of J2836/3™ is to define use cases which must be supported by J2847/3. This document also provides guidance for updates to J2847/2 to allow an inverter in an EVSE to use the PEV battery when operating together as a distributed energy resource (DER).

## Purpose

The title of this document suggests that its primary purpose is to present use cases for communication with a PEV as a DER. This is true, but this document will also provide a broader view of the issues associated with reverse power flow and how a PEV as a DER can serve the bulk grid, the distribution system, and a customer premises.

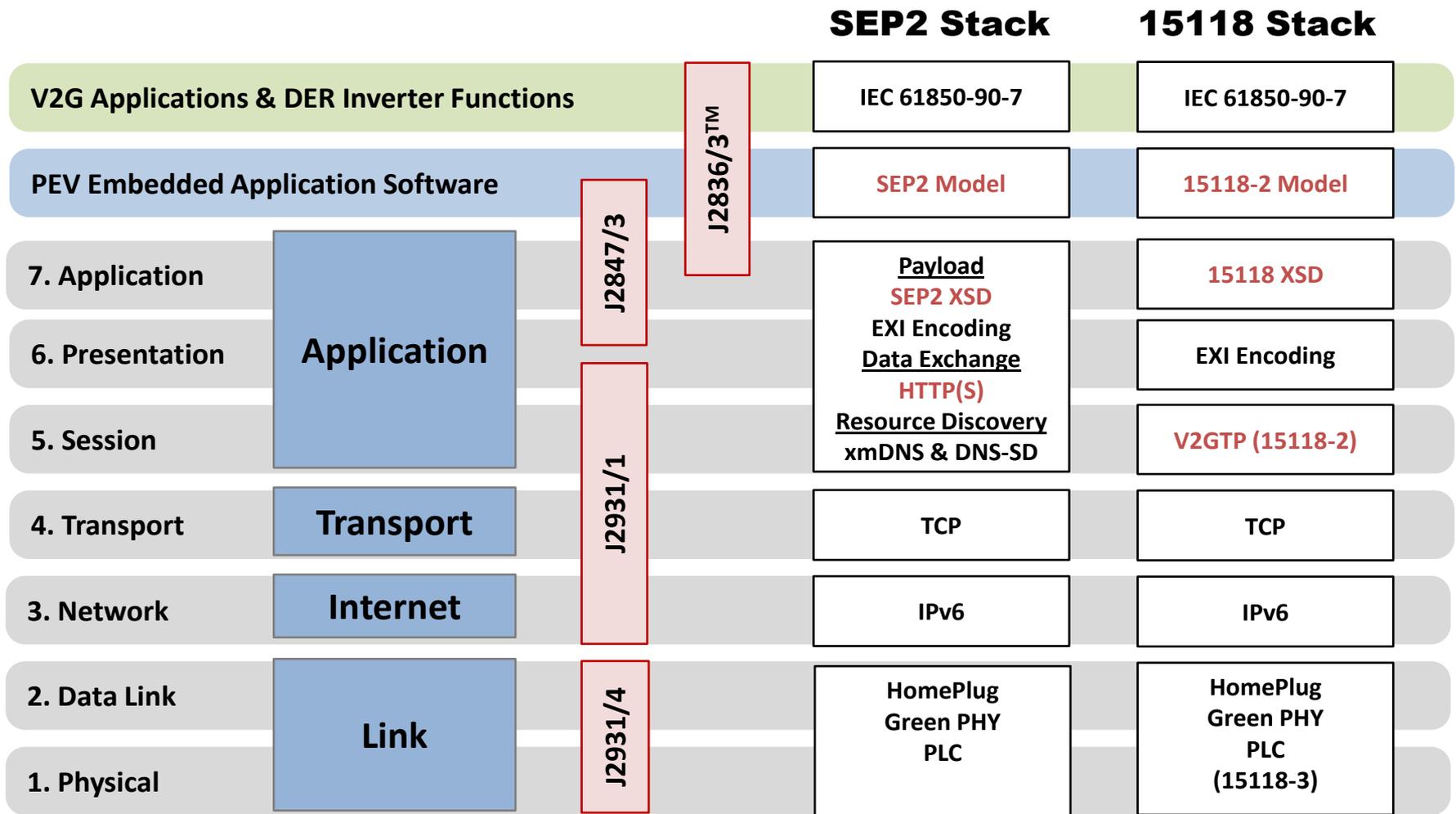
# Types of Reverse Power Flow

Application	PEV Port	Inverter		SAE Type	Comments
		Located	Mode		
Power for plug-in loads at a remote site	NEMA Panel	Onboard	Voltage	V2L	PEV as plug-in load is V2V
	DC Coupler	External	Voltage	V2L-X	Power box with NEMA outlets
Sole source of backup power for islanded home (NEC 702 Optional Standby System)	NEMA Panel	Onboard	Voltage	V2H	Uses home standby genset port
	AC Coupler	Onboard	Voltage	V2H-S	Special AC EVSE Required – Risky
	DC Coupler	External	Voltage	V2H-X	EVSE may create island
Connected in parallel to utility grid (NEC 705 Interconnected Electric Power Production Source)	NEMA Panel	Onboard	Current	<b>UNSAFE</b>	Cannot meet J3072
	AC Coupler	Onboard	Current	V2G	PEV as DER (V2G)
	DC Coupler	External	Current	V2G-X	EVSE as DER (E2G)
Islanded “weak” AC Microgrid	AC Coupler	Onboard	Current	V2G	PEV always a slave (current mode)
	DC Coupler	External	Selected	V2M-AC	EVSE either master (voltage) or slave
DC Microgrid	DC Coupler	External	DC/DC	V2M-DC	Special DC/DC EVSE Required

Wireless not included in table: V2H-W and V2G-W – Same as V2H-X and V2G-X

Entries shown in red have safety or risk concerns

# IEEE 2030.5 SEP2 and ISO 15118 Stacks



# J2847/3 - Guidance to SEP2 DER Model

