SAE International

SURFACE VEHICLE INFORMATION REPORT

SAE J2836-1™ APR2010

Issued 2010-04

Use Cases for Communication Between Plug-in Vehicles and the Utility Grid

RATIONALE

The use cases described here identify the equipment (system elements) and interactions to support grid-optimized AC or DC energy transfer for plug-in vehicles, as described in SAE J2847. Key system elements include the vehicle's rechargeable energy storage system (RESS), power conversion equipment (charger and/or inverter), 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 charger and charging control technology each may reside either on-board or off-board the vehicle; for example, off-board control may be implemented as a 'smart plug'.

Use cases are technology-neutral, leaving implementers free to choose technological solutions appropriate to specific scenarios. For example, depending upon the situation, communication may occur via local wireless (ZigBee, Wi-Fi, etc.), power-line carrier (e.g., HomePlug PLC), vehicle telematics, long-range wireless (GSM, CDMA, WiMax, etc.), Internet protocols, or a combination of these methods.

TABLE OF CONTENTS

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

1. SCOPE

This SAE Information Report establishes use cases for communication between plug-in electric vehicles and the electric power grid, for energy transfer and other applications.

1.1 Purpose

The purpose of J2836/1™ is to document the set of use cases which must be supported by SAE Recommended Practice J2847/1, *Communication Between Plug-in Vehicles and the Utility Grid*.

1.2 Use Case Methodology

Each use case is described by a 'package' comprising several components:

- Brief written description of the use case, its actors, and intended purpose.
- Scenario matrix, specifying required and optional use case attributes.
- Equipment diagram, depicting actors and physical components of the use case.
- Communication path diagram, depicting communication transports and components.
- Activity diagram, depicting the interactions among use case actors.
- Sequence diagram, depicting the sequence of message flows in the use case.

Several of these concepts – notably, actors, and the activity and sequence diagrams – derive from EPRI Intelligrid methodology, which in turn is based on Unified Modeling Language (UML)[1]

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1772™ SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler

[1] http://en.wikipedia.org/wiki/Unified_Modeling_Language

2.2 Related Publications (Optional)

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J2293/1 Energy Transfer System for Electric Vehicles - Part 1: Functional Requirements and System Architectures

SAE J2293/2 Energy Transfer System for Electric Vehicles - Part 2: Communication Requirements and Network Architecture

2.2.2 Other Publications

OpenHAN Task Force of the UtilityAMI Working Group under the OpenSG Subcommittee of the UCA® International Users Group

http://www.utilityami.org/docs/UtilityAMI%20HAN%20SRS%20-%20v1.04%20-%20080819-1.pdf

ZigBee - Smart Energy

http://zigbee.org/Markets/ZigBeeSmartEnergy/ZigBeeSmartEnergyOverview/tabid/431/Default.aspx

3. DEFINITIONS

3.1 Alternative Energy Supplier (AES)

Competitive (or alternative) supplier of commodity service – see ESCO.

3.2 Available Line Current (ALC)

Available Line Current is transmitted by the EVSE using the Pilot duty cycle identified in SAE J1772™. This indicates to the vehicle the maximum current draw for this premise. The purpose of this is for the vehicle not to request more current that this and to not trip the premise circuit breaker.

3.3 Advanced Metering Infrastructure (AMI)

AMI or Advanced Metering Infrastructure typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, such as an electric, gas, or water utility, and data reception and management systems that make the information available to the service provider.

3.4 Charger

The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.

3.5 Clearinghouse

Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.

3.6 Control

HAN application characteristics that respond to control commands

- Direct - Turns load On or Off
- Cycling - Turns load On or Off at configurable time intervals
- Limiting - Turns load On or Off based on configurable thresholds

3.7 Consumer HAN Devices

These are devices within the architecture that are procured by the Consumer or a third party which is not the Utility. As an example, these devices include smart appliances, PCTs, and Energy Management Systems.

3.8 Control Device

DLC programs enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that an event has been declared for the next day.

3.9 Control Flow

The representation of information, energy, or matter that is used to alter the behavior of a system. These are shown as dotted arrows on a data flow diagram (DFD) to indicate the source and destination of the flow. A flow may be both a data and a control flow, depending on how it is used by the system. This construct is used as a part of the functional decomposition process.

3.10 Control Specification (C-spec)

The description of a combinational or sequential logic operation, the results of which can be used as the input to a process specification (P-spec), or to describe when a process is to be operational. Types include decision tables (DT), state transition diagrams (STD), and process activation tables (PAT). C-specs are shown as a single vertical bar on a data flow diagram (DFD) and are referenced by the DFD level they appear on, followed by an s-index (e.g., 2.3.3-s1, 4 s7). This construct is used as a part of the Functional Decomposition process.

3.11 Customer

Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.

3.12 Customer Account

Customer Account is assigned to Customer to collect charges for billing of energy usage.

3.13 Customer Energy Management System

Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.

3.14 Data Flow

The representation of information, energy, or physical matter that is transformed by a system. These are shown as solid arrows on a Data Flow Diagram (DFD) to indicate the source and destination of the flow. A flow may be both a data and a control flow, depending on how it is used by the system. This construct is used as a part of the Functional Decomposition process.

3.15 Data Flow Diagram (DFD)

A diagram that shows the relationship between portions of a larger, more complex process as the process is decomposed. It captures the flow of data, energy, or physical matter between the portions. This construct is used as a part of the Functional Decomposition process.

3.16 Decision Table (DT)

A type of C-spec that defines the conditions required to determine the value of a combinational logic function. A combinational logic function, as opposed to a sequential logic function, is one where its present value (output) is dependent only on the present value of its arguments (inputs). See State Transition Diagram.

3.17 Electric Service Interface (ESI)

The interface between the vehicle and the Utility Grid. See EVSE.

3.18 Electric Utility Power System (Utility)

The system that generates and delivers commercial electrical power to a residential or commercial building or facility. It extends to and includes a billing apparatus (electric meter).

3.19 Electric Utility/Local Load Management System (LMS)

A system that is responsible to monitor and control the load on some portion of the Utility or local premises' feeder and branch circuits. The goal of control may be to prevent overload or to reduce the cost of energy based on a specific billing agreement.

3.20 Electric Vehicle Supply Equipment (EVSE)

PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772™, SAE J836™ and SAE J2847) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and (2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772™. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772™.

3.21 Elementary Process

A process in a data flow diagram (DFD) that is not decomposed further. Its function or activity is described by a process specification (P-spec). This construct is used as a part of the Functional Decomposition process.

3.22 End Use Meter (EUM)

An End use meter (EUM) function can be located anywhere in a zone from the PHEV and the branch circuit panel connection.

3.23 End-Use-Measurement-Device (EUMD)

PHEV End-Use-Measurement-Device (EUMD) communicates energy usage information payload to Energy Service Communication Interface (ESCI). PHEV EUMD shall provide PHEV charging session info – PHEV ID, interval kWhr consumption. Gets interval for metering kWhr consumption from utility.

3.24 Energy Management Interface (EMI)

HMI is a subset of this.

3.25 Energy Portal

Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.

3.26 Energy Service Communication Interface (ESCI)

Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility

ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information

PEV shall be capable of communicating to the Utility through an ESCI

ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility – PEV ID, interval kWhr consumption. Passes energy information, including price signals, schedules, event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN).

ESCI shall employ appropriate security policies when communicating demand side management program-related messages

3.27 Energy Transfer

The process of flowing energy to the EV from the EVSE.

3.28 Energy Transfer Strategy

A strategy that accounts for all of the electrical energy needs of an EV and the present status of all on-board equipment, including the EV Storage Battery. It determines the rate that energy is to be transferred to the EV and how the ETS shall be operated to accomplish this.

3.29 Energy Transfer System (ETS)

A system that is distributed between an Electric Vehicle (EV) and the off-board Electric Vehicle Supply Equipment (EVSE), the purpose of which is to transfer electrical energy from the Utility Power System (Utility) to the EV Storage Battery and other vehicle loads. The EV and EVSE must be connected together for energy to be transferred.

3.30 Energy Services Interface (ESI)

Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.

3.31 End Use Measurement Device (EUMD)

End Use Measurement Device (EUMD) is the device that measures and communicates energy usage information payload to Energy Services Communication Interface (ESCI).

PEV EUMD shall provide PEV charging session info – PEV ID, Premise ID, interval kWhr consumption.

PEV EUMD Receives configuration information (e.g., interval for metering kWhr consumption) from utility. EUMD function can be located anywhere in a zone from the PEV and the branch circuit panel connection.

End Use Measurement Device shall employ appropriate security policies when communicating demand side management program-related messages.

End Use Measurement Device (EUMD) is always available for PEV charging. If not available, charging will proceed without incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

3.32 ESCO – see AES

Competitive (or alternative) supplier of commodity service.

3.33 Fixed HAN Devices with Metering Capability (FHDMC)

This connects with the premise HAN and identifies itself and the account it is properly associated with to the Utility, where premise owner's charges are reconciled. This use case also describes the scenario documented in The Load and Energy Management Use Cases, in that the FHDMC may behave according to that use case. The following scenario is defined: bi-directional metering (i.e., distributed generation) and third-party (i.e., gas meter).

3.34 Forward Power Flow (FPF)

Forward Power Flow means the direction of energy for Charging a Vehicle.

3.35 Functional Decomposition

A method used to describe the functional and behavioral requirements of a system, component, or device, captured as a model of the requirements. It involves the hierarchical break-down of complex requirements into simple, easy to describe pieces. The flow of information, energy, and matter between the pieces is captured, along with the process and control requirements.

3.36 Guest

Guest is a friend or family member who has permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.

3.37 Grid to Vehicle (G2V)

Grid to Vehicle means the transfer of energy from the Electrical Grid to Charge a Vehicle. See Forward Power Flow.

3.38 Home Area Network (HAN)

A HAN is a network contained within a user's home that connects a person's digital devices, from multiple computers and their peripheral devices to telephones, VCRs, televisions, video games, home security systems, "smart" appliances, fax machines and other digital devices that are wired into the network.

3.39 HAN (Home Area Network) Device

Home Area Network Device – See Consumer HAN Devices, Utility HAN Devices, Fixed HAN Devices with Metering Capability and Mobile HAN Devices with Metering Capability

3.40 HomePlug

Founded in 2000, the HomePlug Powerline Alliance, Inc. is the global leading open-standards based organization developing interoperable powerline communications technologies and certifying powerline-based products. With 65 members and more than 4.5 million HomePlug-certified products shipped worldwide, the organization has developed HomePlug 1.0 and HomePlug AV and continues to develop the HomePlug Command and Control and HomePlug BPL specifications for use in both to-the-home networking.

Homeplug powerline adapters are an alternative solution for having your house completely networked using existing power lines. The advanced Homeplug powerline adapter is capable of transmitting data at up to 200 Mbps channel data rate. The Homeplug powerline adapter delivers maximum range and speed for voice, Internet, video, and music throughout your home or office.

3.41 Human Machine Interface (HMI)

HAN application characteristics that provide local user input and/or output. These are based constrained and based on the data type.

- User Input - Provides consumers with a means to input data into an Application (e.g., Touch screen, Keypad)
- User Output - Provides an Application with a means to output data to the consumer (e.g., In-Home Display, text message)

3.42 In-Home Display Device (IHD)

The In-home display is the customer interface with the HAN.

3.43 Interoperability

The condition where components of a system, relative to each other, are able to work together to perform the intended operation of the total system. As an example, a 10-mm box-end hand wrench and a 10-mm socket wrench are interoperable, relative to a 10-mm hex-head bolt. The wrench and the bolt are both parts of a fastening system. The fact that the system will perform as required with either wrench establishes the interoperability of the wrenches and the bolt.

3.44 Measurement and Monitoring

HAN application characteristics that provide internal data and status

- Distributed generation (DG) - Local energy input/output (kWh, kW, other energy values)
- Sub-metering - Device specific, end-use energy consumption or production (e.g., Consumer PHEV)
- Environmental State - Current local conditions (e.g., temperature, humidity, time, airflow, ambient light level, motion)
- Device State - The current or historical state of the device (e.g., lights/fans/compressor/motor/heater are on/off)

3.45 Mobile HAN Devices with Metering Capability (MHDMC)

This connects with the premise Home Area Network (HAN), identifies itself and the account it is properly associated with the Utility. MHDMC's and premise owner's charges are reconciled, as applicable. This use case also describes the scenario documented in The Load and Energy Management Use Cases, in that the MHDMC may behave according to that use case. The mobile (e.g., any Consumer PHEV/EV) scenario is defined in this document.

3.46 Off-Board/On-Board Boundary

The point where the ETS is divided into two physical parts. One part becomes realized within the off-board Electric Vehicle Supply Equipment (EVSE). The other part becomes realized within an Electric Vehicle. This boundary will be in different places, depending on the system architecture.

3.47 Power Flow

See Forward Power Flow (FPF), Reverse Power Flow (RPF), Grid to Vehicle (G2V), Vehicle to Home (V2H) and Vehicle to Grid (V2G) for further definitions.

3.48 Power Stage

A physical and/or logical section of power conversion equipment that can provide conversion over a portion of the total conversion power range of the equipment. The range of a specific power stage will overlap with its adjacent stages.

3.49 Process

A function or activity that can be described as an input/output relationship or as the combination of simpler processes. A process is a basic building block of a data flow diagram (DFD).

3.50 Processing

HAN application characteristics that consume, process and act on external and internal data. These accept data from external systems and HAN measurement and monitoring applications. In general, these applications that have a higher level of complexity and cost.

- Energy Cost - Calculates current and overall energy cost
- Energy Consumption - Calculates current and overall energy consumption
- Energy Production - Calculates current and overall energy Production
- Energy Optimization - Utilizes external and HAN data to determine desired response based on a consumer configurable profile
- Energy Demand Reduction - Uses external and HAN data to reduce load based on a consumer configurable profile
- Environmental Impact - Calculates environmental impact of current energy consumption (e.g., Power Generation Plant CO2 emissions related to consumer specific load)

3.51 Process Activation Table (PAT)

A type of C-spec that defines the exact conditions required for the indicated P-specs to be active. This construct is used as a part of the Functional Decomposition process.

3.52 Process Specification (P-spec)

The description of an elementary process. The description may include text, figures, and tables. The description captures the input/output relationship for all flows shown on its related data flow diagram (DFD). A P-spec is shown as a circle on a DFD, and has no further “child” processes below it. This construct is used as a part of the Functional Decomposition process.

3.53 Rechargeable Energy Storage System (RESS)

Means a system that stores energy for delivery of electric energy and which is rechargeable

3.54 Reverse Power Flow (RPF)

Reverse Power Flow means the direction of energy for Discharging a Vehicle.

3.55 Roaming Utility

Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer’s Utility service territory.

3.56 Peak Power

Peak power is required at times of day when high levels of demand are expected (e.g., hot summer afternoons when air conditioning demands are large). Typically, peak power is generated by power plants that can be switched on relatively quickly, such as gas turbines. However, because these plants are only utilized during the few hundred hours per year (i.e., less than 10% of the time) when demand is high, and are idle otherwise, they represent a relatively inefficient investment.

3.57 Plug-In Vehicle

Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.

3.58 Power Flow

See Forward Power Flow and Reverse Power Flow.

3.59 Power Line Communication

Power line communication (PLC), also called power line carrier, mains communication, power line telecom (PLT), or power line networking (PLN), are terms describing several different systems for using electric power lines to carry information over the powerline.

Electrical power is transmitted over high voltage transmission lines, distributed over medium voltage, and used inside buildings at lower voltages. Powerline communications can be applied at each stage. Most PLC technologies limit themselves to one set of wires (for example, premises wiring), but some can cross between two levels (for example, both the distribution network and premises wiring).

All power line communications systems operate by impressing a modulated carrier signal on the wiring system. Different types of powerline communications use different frequency bands, depending on the signal transmission characteristics of the power wiring used. Since the power wiring system was originally intended for transmission of AC power, the power wire circuits have only a limited ability to carry higher frequencies. The propagation problem is a limiting factor for each type of power line communications.

Data rates over a power line communication system vary widely. Low-frequency (10 to 480 kHz) carriers impressed on high-voltage transmission lines may carry one or two analog voice circuits, or telemetry and control circuits with an equivalent data rates from a few kilo bits per second to greater than 100k bits per second; however, these circuits may be many miles (kilometers) long and include passing through the transformer. Higher data rates generally imply shorter ranges; a local area network operating at millions of bits per second may only cover one floor of an office building, but eliminates installation of dedicated network cabling.

3.60 Regulation Services

Regulation services, are used to continuously fine-tune the balance between power generation and demand, in terms of the voltage and the frequency of the grid. In many power markets, this function, called regulation or automatic generation control (AGC), is priced separately from power generation and procured as an ancillary service (another such service is spinning reserves). The grid operator needs to be able to ensure generators ramp output up or down in real time to meet customer reactive power needs, manage customer impact on system voltage, frequency and system losses and ensure that power-factor problems at one customer site do not affect power quality elsewhere in the system. Again, providing regulation services requires electricity generation capacity in excess of demand.

3.61 Smartcharging

The ability for the utility to "load shape" and therefore optimize vehicle charging or discharging with grid capacity.

3.62 State Transition Diagram (STD)

A type of C-spec that defines the exact conditions required to determine the value of a sequential logic function. A sequential logic function, as opposed to a combinational logic function, is one where its present value (output) is dependent on the present value of its arguments (inputs) and some number of the previous values of the arguments (previous inputs). See Decision Table.

3.63 Spinning Reserves

Spinning reserves refers to generating capacity that is up and running, and synchronized with the electricity grid (but not contributing power). Spinning reserves generators contribute to grid stability, helping to arrest the decay of system frequency when there is a sudden breakdown or loss of another generator. Again, typically, power plants that can provide fast response to the calls of the grid operator are the most suitable, e.g., gas turbines. The capacity required to provide spinning reserves can also be seen as an underutilized investment, although essential for managing market risks.

3.64 Type A Architecture

A form of the ETS where AC electrical energy is transferred, across the off-board/on-board boundary, via a conductive coupling.

3.65 Type B Architecture

A form of the ETS where DC electrical energy is transferred, across the off-board/on-board boundary, via a conductive coupling.

3.66 Utility

Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

3.67 Utility HAN Devices

Within the premise these are the devices which are typically provided by the Utility. As an example, these include metering devices (e.g., gas meter) and load control devices. Some of these devices are located within the Consumer premise while others sit on the outside of the premise. Regardless of placement, the Utility device always uses the Utility provided “secure” network.

Some devices can be provided by either the Utility or the consumer. This decision is between the consumer, Utility, and regulators. Further, this document provides architecture flexibility. That is, the UtilityAMI 2008 HAN SRS supports any desired configuration.

3.68 Vehicle to Grid (V2G)

When vehicle power is fed into the electric grid, we refer to it as “Vehicle-to-Grid” power, or V2G. This could be Home and remote locations and initiated for contract driven ancillary services (regulation, peak shaving, reserves, etc.)

3.69 Vehicle to Load (V2L)

Vehicle to load means the transfer of energy from the Vehicle to a Load. This is expected to support power to tools and other items not connected to a home or the grid.

3.70 Vehicle to Home (V2H)

Vehicle to Home means the transfer of energy from the Vehicle to a Home. This could be used for Emergency Power Backup and/or Home based ancillary services (regulation, peak shaving, reserves, etc.). See Reverse Power Flow.

3.71 Vehicle to Vehicle (V2V)

Vehicle to Vehicle means the transfer of energy from one vehicle to another. This could be related to jump starting or other energy transfer needs between vehicles.

4. TECHNICAL REQUIREMENTS

The intent of this document is for Plug-In Vehicles to communicate with the Utility so that the customer can take advantage of various incentive programs and charge their PEVs at times and rates to meet their needs.

There are several mediums and paths for communication that can be used but this document is focusing on using Power Line Carrier (PLC) as the primary medium and using the communication path from the PEV to the EVSE. PLC is used as the primary medium since a direct association from the PEV to the Utility is required for some of the utility programs for special rates or options. This document will focus on the PLC communication from the PEV to the EVSE, since that can be standardized within the SAE documents. Several mediums and paths may be used from the EVSE to the utility due to the variations of utility offerings and variations the customer may have within the home. Several location scenarios will also vary such as workplace, fleets, public charging, street charging, etc is expected to vary dependant on utility territories and the EVSE installed. This document identifies the general info and process to accomplish this communication and SAE J2847/1 identifies the details of the messages used. Use Cases were generated to identify the requirements and are included in Appendix A and B. Appendix A includes top level use cases and Appendix B includes detail use cases.

The primary actors for communication are the Customer, PEV, Utility and EVSE. There are several variations to EVSE and the customer can choose several options to charge their vehicle with or without communications from each of these paths. The fundamental charging system is identified in SAE J1772™ and it describes the EVSE and its functions. The EVSE is described in more detail in 4.3.2 where the control pilot controls the initialization of the vehicle and the rate of energy transmitted.

Figure 1 shows the multiple paths of communication between these actors and shows the control pilot since it is the means to control the PEV and the charge cycle.

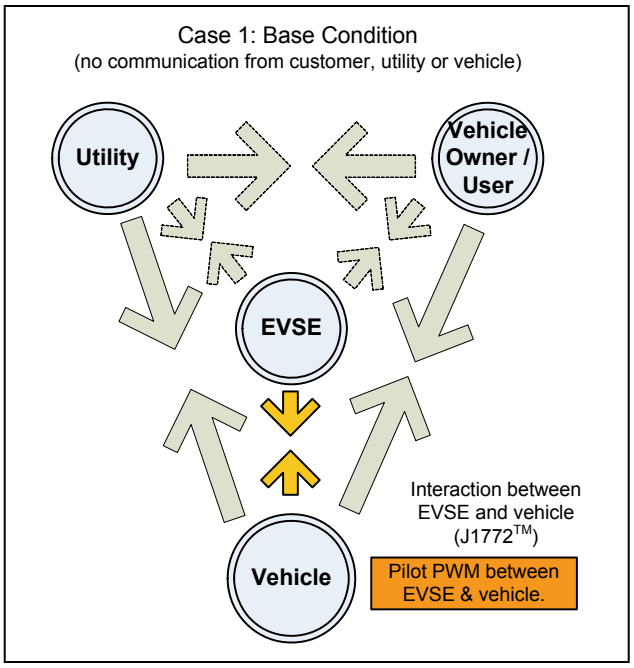


FIGURE 1 - PRIMARY ACTORS AND COMMUNICATION PATHS

Figure 2 shows a more detail representation of modularizing the EVSE and options on obtaining access to both the Utility and Consumer networks.

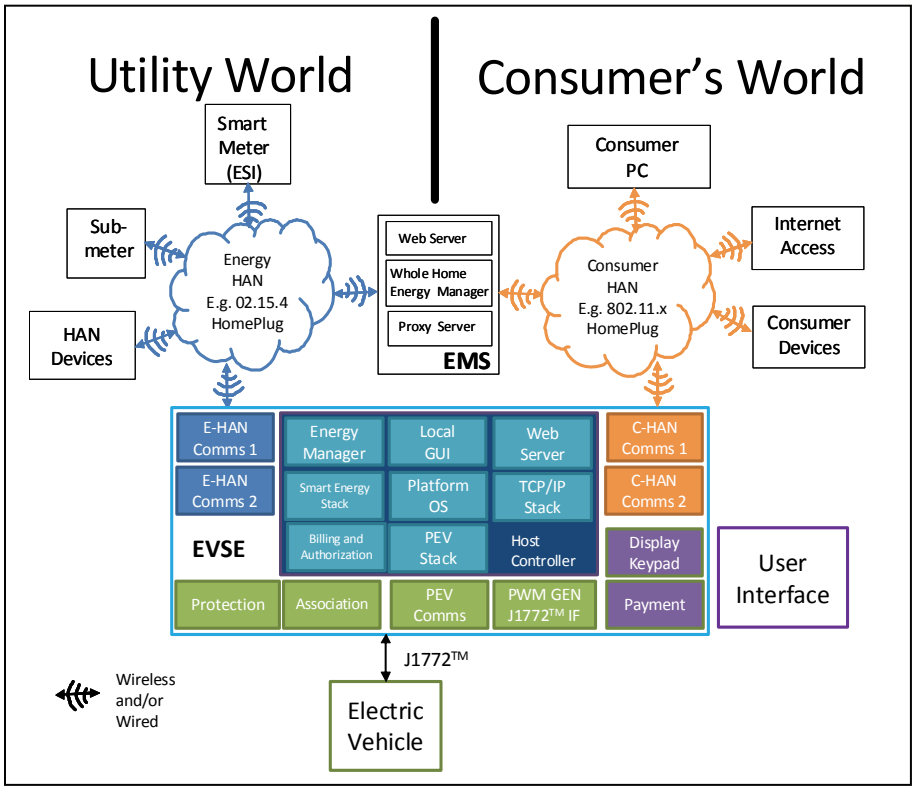


FIGURE 2 - EVSE MODULARIZATION TO UTILITY AND CONSUMER NETWORKS

4.1 System Definition

The fundamental architecture of the Plug-In Vehicle (PEV) interfacing with the utility is shown in the UtilityAMI 2008 Home Area Network System Requirements Specification generated by the OpenHAN Task Force of the UtilityAMI Working Group under the OpenSG Subcommittee of the UCA® International Users Group

This shows the PEV/EVSE in the following two scenarios.

1. UtilityAMI OpenHAN Figure 2 - The PEV/EVSE interacts with the EMS – Figure 3

2. UtilityAMI OpenHAN Figure 3 - The PEV/EVSE interacts with the Utility – Figure 4

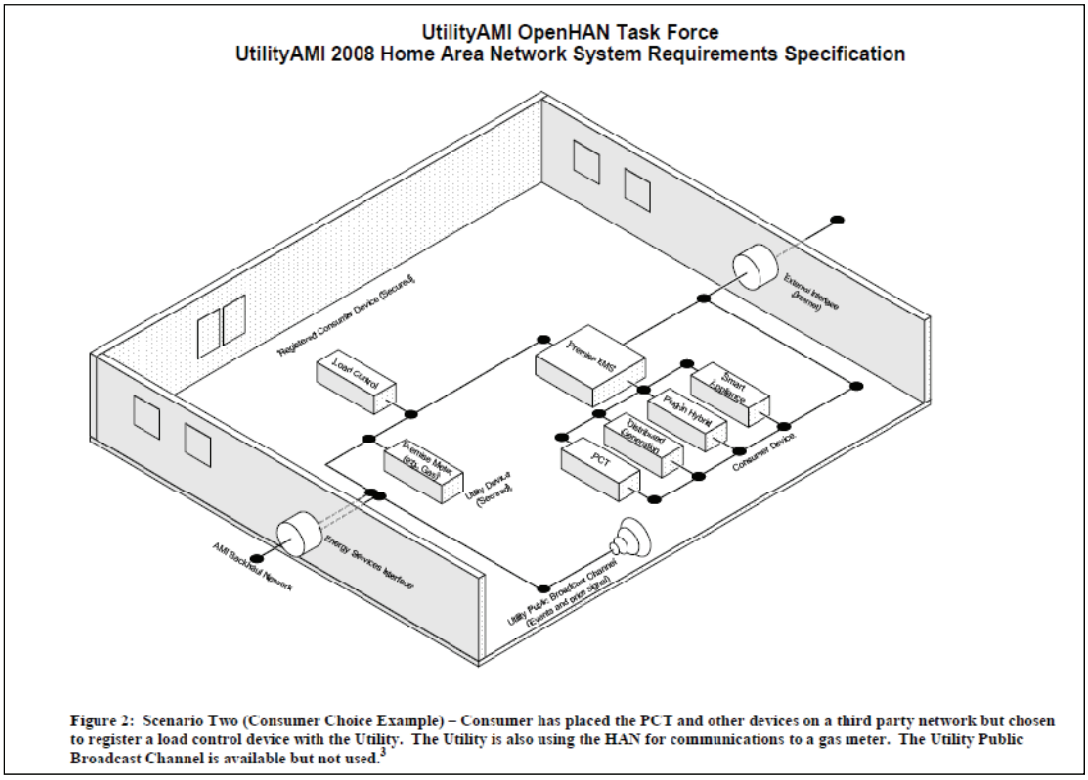


Figure 2: Scenario Two (Consumer Choice Example) – Consumer has placed the PCT and other devices on a third party network but chosen to register a load control device with the Utility. The Utility is also using the HAN for communications to a gas meter. The Utility Public Broadcast Channel is available but not used.[3]

FIGURE 3 - THE EVSE INTERACTS WITH THE EMS

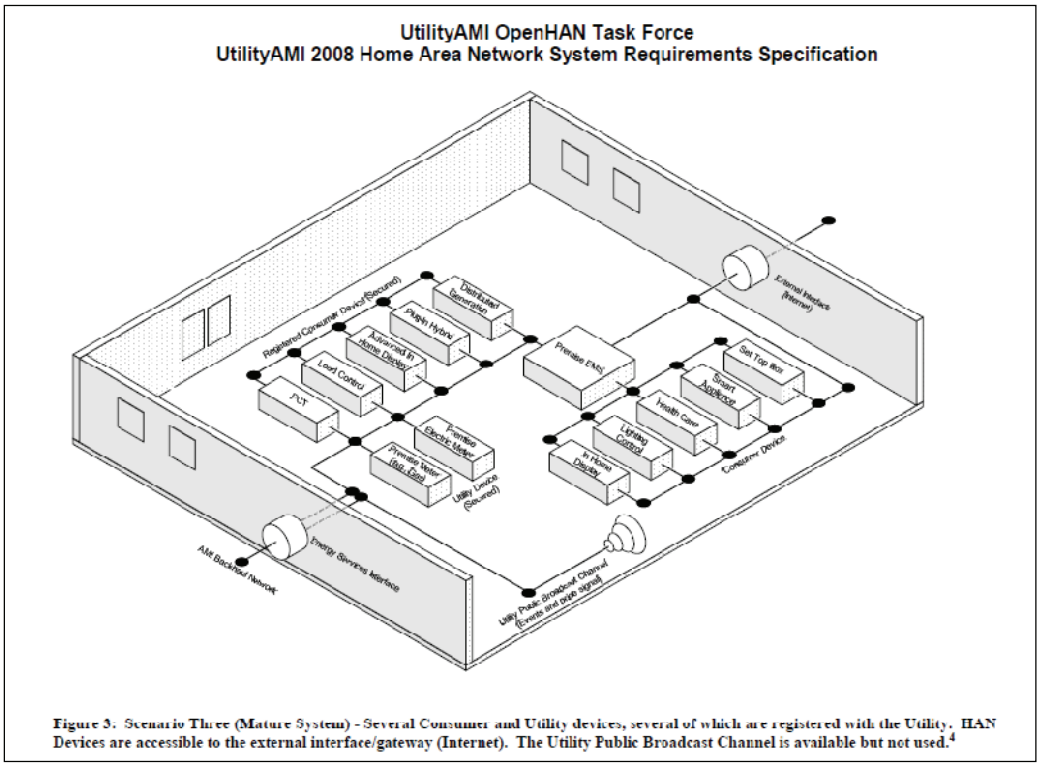


FIGURE 4 - THE EVSE INTERACTS WITH THE UTILITY

These scenarios have been expanded In Case 1 and 2 and also include a case 3 for no communication to the utility whereas the customer can still control the charge cycle by using the EVSE (display panel, etc.) or the PEV (navigation screen, etc.).

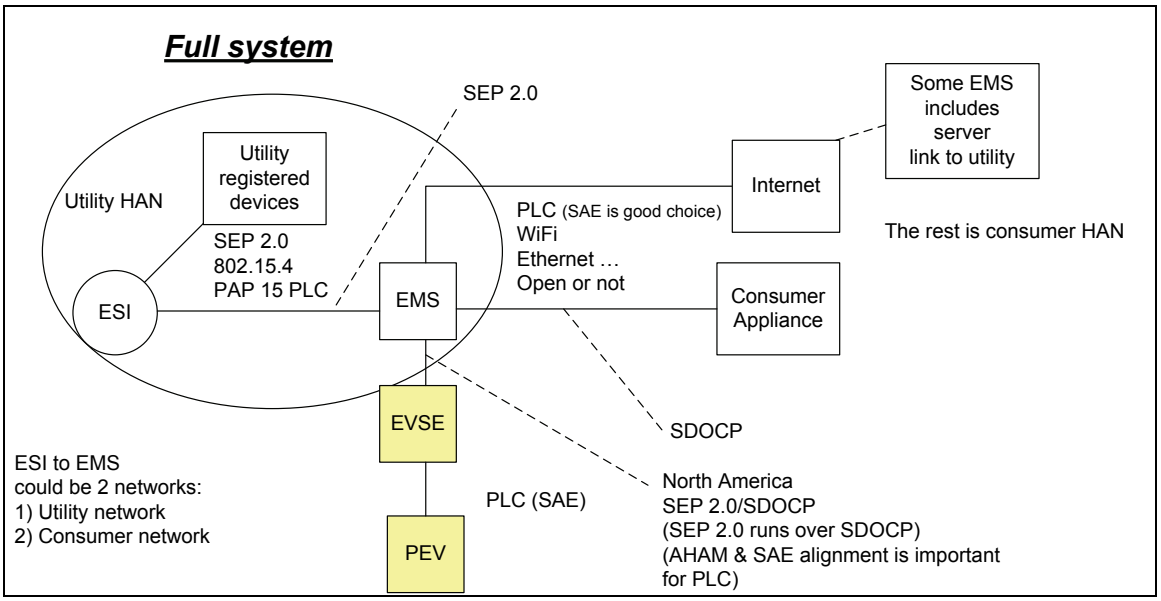


FIGURE 5 - CASE 1 - THE EMS IS THE INTERFACE TO THE UTILITY (AND OTHER MEDIUMS)

The full system shows an Energy Management System (EMS) and links to Figure 1 where the EVSE interacts with the EMS. The EMS is the gateway to the utility and also consumer appliances (if applicable) and any other networks (URC, Wi-Fi, Cell, etc). The Utility HAN is currently being equipped using Smart Meters with Smart Energy 1.0 that is capable of progressing to SEP 2.0 with a firmware upgrade. Up to 80% of these may use ZigBee wireless. With this system, we expect the EMS to be the gateway.

This particular depiction of the EMS shows a HAN that is being identified by the Association of Home Appliance Manufacturers (AHAM). This group is producing the home appliances and establishing the communication to them. The approach is to use the same PLC to the EVSE as SAE is recommending, with Smart Device Open Control Protocol (SDOCP) as an option to the consumer devices as defined by AHAM.

Note that the Utility HAN encompasses the ESI and EMS.

The public EVSE version of this would view the EMS as the master interface to the utility. Associated or slave EVSEs would be viewed as “other appliances” and send their info to the master EVSE for the primary control.

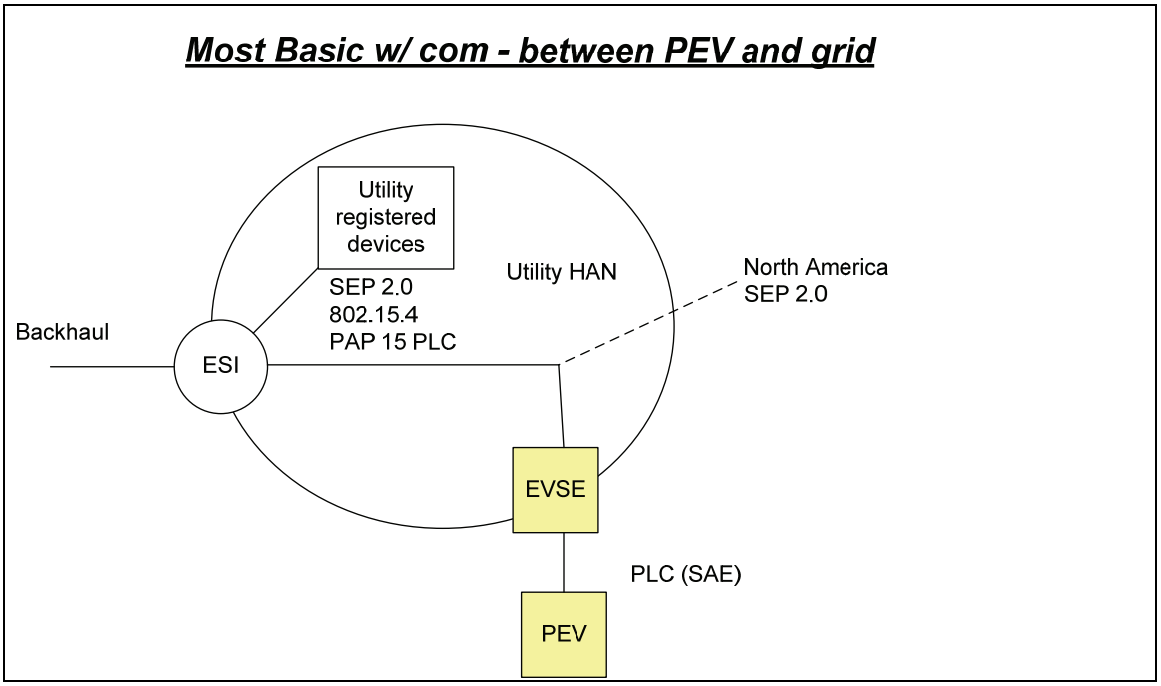


FIGURE 6 - CASE 2 - THE EVSE IS THE INTERFACE TO THE UTILITY

This is the most basic system with communication between the PEV and the grid.

Note that the Utility HAN slices thru the ESI and EVSE as those are the gateways outward to the other systems.

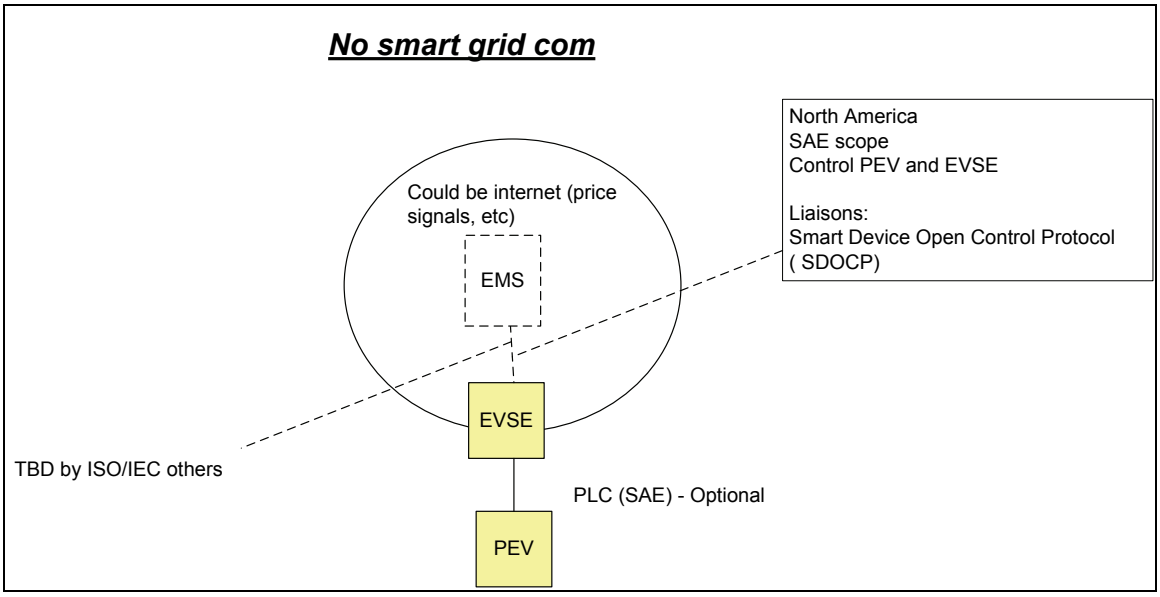


FIGURE 7 - CASE 3 - NO EVSE COMMUNICATION TO THE UTILITY

This shows no utility network with the EMS taking more options. This may be the EVSE and/or the PEV with no communications between them. The EVSE and/or the PEV could also have their own control interface the customer would use to determine the charge cycle.

4.2 Use Cases

Use cases have been developed to identify the requirements for the communication system. The messages resulting from these use cases are included in J2847/1.

Both Top level and Detail use cases have been developed and are included in Appendix A and B respectively.

4.2.1 Top Level Use Cases

The Top Level use cases included in Appendix A are as follows:

- PEV0 - Customer Attributes (Version 3.3)
- PEV1 - Utility Provides Services to PEV Customer (Version 3.1)
- PEV2 - Customer connects PEV to premise energy portal (Version 5.1)
- PEV3 - Customer enrolls in a PEV3 Demand Side Management Program (Version 5.1)

These use cases describe the general requirements and various scenarios for the PEV to interact with the utility.

4.2.2 Detail Use Cases

The intent of the Detail use cases were to separate the various utility programs (U1-5) and the connection approaches identified in SAE J1772™ (S1-3). The general enrollment that applies to all the utility programs is included in E and the different locations are included in L1-4. PR1 includes the charging process and PR2-4 are under development and apply to Reverse energy flow (PR2), Diagnostics (PR3) and VM specific (PR4).

U1-5 may be offered by utilities and may include slight variations for a particular territory. These include the general requirements that may apply to all utilities. One or all of these could apply to each charging cycle/location.

S1-3 is exclusive for each connection cycle and describes the three EVSEs identified in SAE J1772™.

Locations identified in L1-4 are also exclusive for that connection point.

Any specific use case would include E, then U1-5 as applicable, then either S1, 2 or 3, then L1 or 2 or 3 or 4. PR1 would complete this set if charging is desired. PR1 is the fundamental function to charge the vehicle (forward energy flow). PR2 is an advanced function for Reverse energy flow and is under development. PR3 diagnostics could occur either during forward or reverse energy flow. PR4 VM specific functions could also occur with forward or reverse energy flow. PR3 and 4 are also under development and not available at this time.

The Detail use cases included in Appendix B are as follows:

- E - General Registration and Enrollment Process
- U1 - TOU Program
- U2 - Discrete Event Program
- U3 - Real Time Pricing (RTP) Program
- U4 - Critical Peak Pricing (CPP) Program
- U5 - Optimized Energy Transfer Program
- S1 Cordset
- S2 Premise EVSE
- S3 Premise EVSE that includes the charger
- L1 - Customer connects PEV at Home - premise
- L2 - Customer connects PEV at Another Home
- L3 - Customer connects PEV Outside Home Territory
- L4 - Customer connects PEV at Public Location
- PR1 - Customer charges the PEV

Figure 8 shows the mapping of the detail use cases.

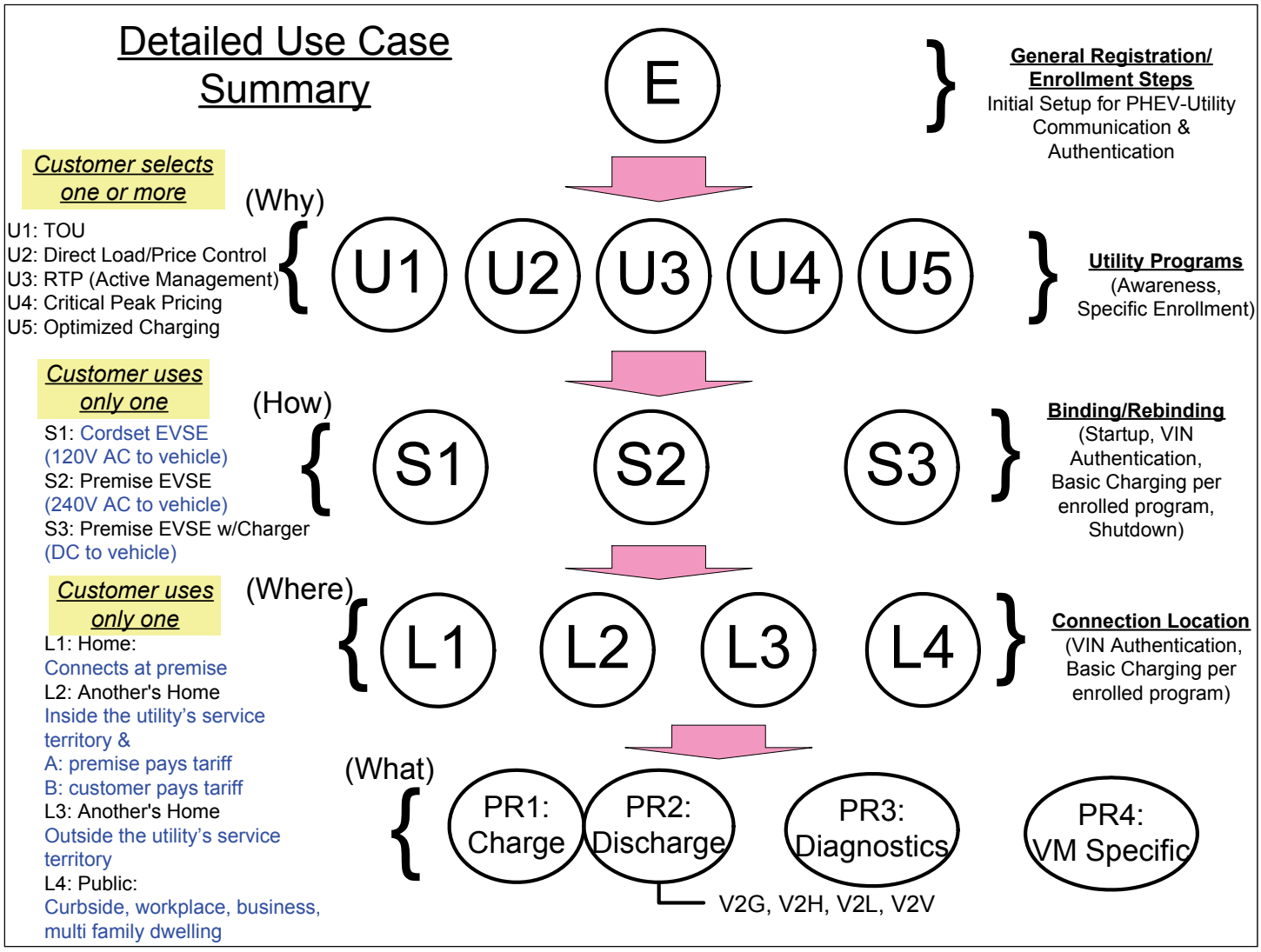


FIGURE 8 - DETAIL USE CASE SUMMARY

4.3 Equipment and Devices

4.3.1 Automotive Modules

The utility programs can be implemented by the ESI interfacing with the EVSE. If the communication however, extends to the PEV, there are various issues related to hardware and software that need to be identified for these automotive module(s) that are defined in SAE J2847/1.

4.3.2 Electric Vehicle Supply Equipment (EVSE)

The EVSE diagrams are shown in Use Cases S1-3 in Appendix B.

The vehicle always connects to the grid using an EVSE as described in SAE J1772™. This document identifies the utility criteria using both a (1) Cordset EVSE (Level 1) and a (2) Premise mounted version EVSE (Level 2). The cordset is a mobile device and is expected to stay with the vehicle and used in both home, work and public locations. (3) The third version of EVSE is one that includes an off-board charger and delivers DC energy to the vehicle. This EVSE would also be capable of Level 2 and may also include an outlet for Level 1. The additional messages for DC energy transfer are described in SAE J2836/2™ and SAE J2847/2. DC energy transfer requires additional messages and hardware for both the PEV and EVSE. The SAE J1772™ control pilot is also at 5% PWM instead of the 10 to 96% values identified in SAE J1772™ for Level 1 and Level 2 associated with the Available Line Current values for AC energy transfer. If this EVSE and PEV are unable to transmit the required messages for DC energy transfer, the EVSE then reverts back to the AC levels described for Level 1 or 2.

Vehicles that include an on-board charger could use the cordset but also connect to the grid using the Level 2 premise mounted EVSE. Vehicles with larger on-board chargers may primarily connect using the premise mounted EVSE but also use the cordset to obtain lower power levels from the Energy Portals.

SAE J1772™ goes into the details of the EVSE and its Pilot circuit but it is important to understand the basic functions as this pilot is used to wake up the vehicle, then start its PWM generator to establish the initial signals from the vehicle and the EVSE. The following sequence describes the steps in this process.

1. When the EVSE has power from the grid, it sends a 12V signal on the pilot circuit.

2. When the EVSE is then connected to the vehicle, this 12V signal is reduced to 9V thru a vehicle resistor.

3. The pilot signal wakes up the vehicle for it to latch on vehicle power.

4. This reduction to 9V tells the EVSE a vehicle is connected. It is also used by the EVSE that is also detecting the output of this circuit to start its PWM generator.

5. The PWM generator magnitude is then transitioning from +9V to -12V magnitude and the rate matches the chart for Available Line Current (ALC) identified in SAE J1772™.

6. The vehicle reads this PWM signal and if the on-board charger can draw more current, it will scale back to this ALC to overload the circuit on the premise. (i.e., a 15A EP provides 12A and the PWM is 20%, 240V power levels are higher PWM rates).

7. If additional communication is expected between the vehicle and the grid, the PWM changes from the ALC value, to a 5% PWM rate. This is an expected state for a premise mounted EVSE but not for a cordset version. The cordset would either provide a 20% PWM for a 15A outlet or a 26.6% PWM for a 20A 120V outlet.

8. When the vehicle is ready to accept energy, another resistor is switched into the pilot circuit that drops the +9V to either 6V or 3V. 6V means the EVSE does not have to turn on ventilation at the premise and 3V means it does. This voltage drop signals the EVSE to close its switches and allow power to flow to the vehicle.

9. When the vehicle charge is complete, it opens the "vehicle ready switch" and the EVSE opens its power switches. The vehicle powers down and the EVSE returns to the state in item 1 above.

The basic control of the charge cycle can be accomplished by controlling the EVSE control pilot. The utility can install a Demand Response device that provides input to the EVSE control pilot and the customer can still take advantage of the utility program without the PEV communication. The more advanced cases however, is where the PEV communicates.

4.4 Messages

4.4.1 Message Categories

Message categories are shown in Figure 9. Messages are grouped into categories to start the process of identifying the detail of what is required. These categories are the general names that may in some cases be the message or may be a combination of messages.

Some messages and categories will also include both a “request” and “available” aspect of them. The request will allow the delivery service to anticipate the upcoming loads and result in more optimized management of the electrical loads. The utility messages are further defined in SAE J2847/1. The DC EVSE messages are defined in SAE J2847/2. Reverse energy flow is defined in SAE J2847/3, diagnostic messages are defined in SAE J2847/4 and consumer messages are defined in SAE J2847/5.

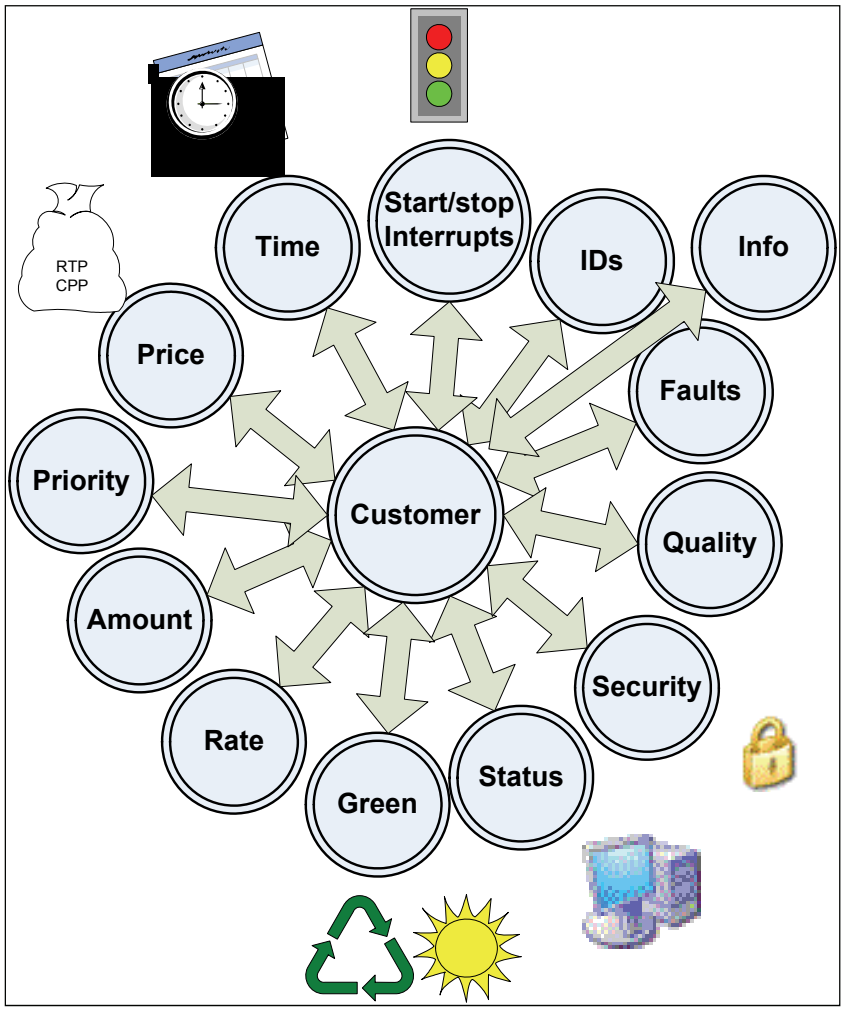


FIGURE 9 - MESSAGE CATEGORIES

5. NOTES

5.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE HYBRID TECHNICAL COMMITTEE

APPENDIX A - TOP LEVEL USE CASES

A.1 PEV0 - CUSTOMER ATTRIBUTES

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	1-30-09	Rich Scholer	Incorporated comments from Mike Bourton, Kostas Tolios & Arindam Maitra	Y
1.1		Rich Scholer	Added Customer response steps.	Y
2.0	2-3-09	Rich Scholer	Incorporated comments from Nate Littrell.	Y
2.1	2-12-09	Rich Scholer	Incorporated comments from David Brown	Y
3.0	3-2-09	Rich Scholer	Added functional requirements 1-5 (section 4.1)	Y
3.1	3-4-09	Rich Scholer	Updated 4.1 Requirements to agree with ZBHP MWG definitions. Added requirements for mobile and fixed EUMDs.	Y
3.2	3-7-09	Rich Scholer	Added HAN Device definitions to section 2.2. Updated requirements for EUMD in section 3.3 and added system diagram in section 5.3.	Y
3.3	3-19-09	Rich Scholer	Updated per Gerald Gray's comments on ESCI & U4 definitions. Added step 5 to 3.1.1.	Y

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title

PEV – Customer Attributes

Customer enrolls in PHEV program, completes initial setup for PEV and implements connection and charging cycles.

1.2 Use Case Summary

Customers, Vehicle Manufacturers (VM) and Utilities are interested in fueling vehicles with electricity. Electric Vehicles (EV), Plug-in Vehicles (PEV) and Plug-in Hybrid Vehicles (PHEV) are emerging transportation options for consumers. Electric utilities desire to support these emerging loads with electricity at times when energy costs are lower and generation and power delivery assets are underutilized. PEV manufacturers are interested in working with utilities to develop customer rates/programs which could provide consumers with an increased incentive to purchase a PEV. To enable utility customer rates/programs specifically to customers with PEVs, the utility must offer special services for these customers. These services include the ability to enroll, register, and initially setup communications between a PEV and the utility, or an Alternative Energy Supplier (AES) (one-time setup), the ability to repeatedly re-establish communications for each PEV charging session (repeat communications/re-binding), the ability to provide PEV charging (and other) status information to customer information channels (e.g., web, display devices), and the ability to correctly bill PEV customers according to their selected rates/programs.

1.3 Use Case Detailed Narrative

The Utility or AES, may offer the Customer a tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility or AES must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility or AES will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's or AES's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility or AES, for billing and presentation to the Customer. The following scenarios describe the sequence of events for this customer to utility interface:

1) **E: Basic Enrollment:** General Registration/Enrollment Steps and Initial Setup for PEV-Utility Authorization & Authentication

2) **U: Specific Enrollment:** Utility Programs (Awareness, etc.)

3) **S: PEV Connection and Energy Transfer:** Binding/Rebinding (Startup, PEV Authentication, Basic Charging per enrolled program, Communication & Shutdown)

4) **L: Location variations:** Connection Location (PEV Authentication, Basic Charging per enrolled program)

5) **PR: Specific Functions**: Charging, Discharging, Diagnostics and VM Specific applications.

1.4 Business Rules and Assumptions

- PEV Customer has an account with utility and electrical service at a premise served by the utility.
- PEV and utility may have communications capabilities, enabled by utility provided Energy Services Communication Interface (ESCI).
- The customer awareness of the utility and vehicle programs is prompted by both the utility providers and the vehicle manufacturers.
    - The utility offers PEV programs and services for its customers and will provide the necessary support processes for enrollment, communications, and billing

- The Vehicle manufacturers would provide information to the customer about fuel and/or emission gains of the vehicles offered and promote the utility and convenience of connecting to the grid

- Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including demand side management programs, associated PEV IDs, customer IDs, and premise IDs.

- In the absence or failure of PEV-utility communications, or if PEV ID validation fails, PEV charging will always proceed; however, without the incentive rates and with all energy charges accruing to the premise customer according to the premise customer's default rate/service plan.

- The actual PEV charging processes, including scenarios for intra- and inter- utility roaming, are covered in use case P2.

- End Use Measurement Device (EUMD), either fixed or mobile, is always available for energy validation of PEV charging. If not available, charging will proceed, but with limitations on incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

- EUMD function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.

- To allow for possibility of the EUMD being a part of/within the PEV, PEV is a sub-meter to the primary utility billing meter at any premise (as opposed to being a separate service account with dual meter socket adapter)

- The PEV & Utility will communicate to implement one or more the previously described Utility programs (details of which are covered in section 3.3).

2. Actors and Definitions

2.1 Actors: These are the actors or objects in these Use Cases. Sequence diagrams are included to visualize the steps these actors take in the energy transfer process.

Actor Name	Actor Type (person, device, system, etc.)	Actor Description
AES – See ESCO	Organization	Alternative Energy Supplier
Charger	Device	The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.
Clearinghouse	Organization	Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.
Control Device	Device	DLC programs (see section 3.2, U2 program) enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the next day.
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.
Customer Account	System	Customer Account is assigned to Customer to collect charges for billing of energy usage

Actor Name	Actor Type (person, device, system, etc.)	Actor Description
Customer Energy Management System	System	Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.
Electric Vehicle Supply Equipment (EVSE)	Device	PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772, SAE J2836 and SAE J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and (2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772.
Energy Portal (EP)/Smart Energy Portal (SEP)	Device	Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.
Energy Services Communication Interface (ESCI)	System	Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information PEV shall be capable of communicating to the Utility through an ESCI ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility, e.g., PEV ID, interval kWhr consumption and passing energy information, such as price signals, schedules (including time zone and charge "period"), event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN). ESCI shall employ appropriate security policies when communicating demand side management program-related messages
ESI	System	Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant HAN Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.
End Use Measurement Device (EUMD)	Device	End Use Measurement Device (EUMD) is a HAN device that measures energy consumed by a PEV and communicates the information to the ESI.
ESCO – See AES	Organization	Competitive (or alternative) supplier of commodity service
Guest	Person	Guest is a friend or family member who has permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.
PEV, EV, PHEV	System	Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that

Actor Name	Actor Type (person, device, system, etc.)	Actor Description
		relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.
Roaming Utility	Organization	Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer's Utility service territory.
Utility	Organization	Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

2.2 Definitions: The following definitions describe items within this Use Case.

Home Area Network (HAN) Devices are owned by a Consumer, Utility, or other 3rd party (i.e., ownership agnostic) and registered on the Utility-secured Home Area Network communication channel Home Area Network

They can be either Consumer or Utility devices and can include either fixed or mobile metering capability. The EUMD contains the metering capability that would be within the HAN Device as applicable.

- Consumer HAN Devices are devices within the architecture that are procured by the Consumer or a third party which is not the Utility. As an example, these devices include smart appliances, PCTs, and Energy Management Systems.

- Utility HAN Devices within the premise are those devices which are typically provided by the Utility. As an example, these include metering devices (e.g., gas meter) and load control devices. Some of these devices are located within the Consumer premise while others sit on the outside of the premise. Regardless of placement, the Utility device always uses the Utility provided "secure" network.

- Some devices can be provided by either the Utility or the consumer. This decision is between the consumer, Utility, and regulators. Further, this document provides architecture flexibility. That is, the UtilityAMI 2008 HAN SRS supports any desired configuration.

- The Fixed HAN Devices with Metering Capability (FHDMC) connects with the premise HAN and identifies itself and the account it is properly associated with to the Utility, where premise owner's charges are reconciled. This use case also describes the scenario documented in The Load and Energy Management Use Cases, in that the FHDMC may behave according to that use case. The following scenario is defined: bi-directional metering (i.e., distributed generation) and third-party (i.e., gas meter).

- The Mobile HAN Devices with Metering Capability MHDMC connects with the premise HAN, identifies itself and the account it is properly associated with the Utility. MHDMC's and premise owner's charges are reconciled, as applicable. This use case also describes the scenario documented in The Load and Energy Management Use Cases, in that the MHDMC may behave according to that use case. The mobile (e.g., any Consumer PHEV/EV) scenario is defined in this document.

- Energy Cost applications are not intended to reconcile costs displayed on HAN Devices with bills generated by a Utility billing system. There are other elements associated with billing and revenue-grade metering that are outside the scope of these requirements (e.g., revenue-grade certification, rate recovery).

Rechargeable Energy Storage System (RESS): Any energy storage system that has the capability to be charged and discharged (example: batteries, capacitors, and electro mechanical flywheels).

State of Charge (SOC): The ratio of available capacity as compared to the total capacity of an RESS.

3. Step by Step Analysis of Each Scenario

3.1 Scenario Description

E: Basic Enrollment

Purpose: Utility provides services to Plug-in Electric Vehicle (PEV) Customer. To enable utility customer rates/programs specifically to customers with PEVs, the utility must offer special services for these customers. These services include the ability to enroll, register, and initially setup the utility programs (one-time setup).

This scenario describes the most common sequence (basic process) of the utility enrolling a PEV customer into a utility program/service specifically for customers with PEVs. This involves *basic enrollment of the PEV*.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a PEV program. The customer may be prompted by the dealer, VM, retail store, utility and more in the awareness cycle.	*Customer*	*Customer has a PEV and wishes to enroll in PEV program; Utility offers PEV Programs to its customers.*	*Customer then selects specific utility programs offered within the territory or the vehicle travel area.*

3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is presented by the Utility with PEV Program information and PEV Program selections.	
2	Customer	Customer initiates request to enroll PEV in a PEV Program by contacting Utility.	PEV ID could be the PEV VIN # or HAN Device MAC ID.
3	Customer	Customer provides Customer and PHEV information (i.e., Customer Account information, PHV ID, etc.).	
4	Customer	Customer fills the enrollment form and return to utility via web, phone, mail, or retailer.	
5	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
6	Utility	Utility confirms customer's Basic enrollment is accepted and complete.	The specific program functions may be included with this step or be a subsequent set of actions as described in next sequence of events.

3.2 Scenario Description

U: Specific Enrollment:

The following five categories of utility programs are designed to entice PEV customers to consume energy during times of lower grid loadability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

U1: Time-Of-Use rates are designed to entice utility customers to consume energy during times of lesser grid impact. The cost of energy associated with these rates is typically dependent on the season, day of the week, time of day, weekday vs. weekend, etc. These rates reward behaviors that "shift load" to a more favorable time of day and penalize those that have greater system impact. Typically, the energy provider does not have control over the load and sets the cost of the service annually.

Scenario U1-A assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that TOU is available on a self-selected basis (voluntary that is TOU is not mandatory, it is an option). Default rate is an old traditional/conventional flat rate.

Primary Scenario (U1-A): Customer enrolls in TOU program. The vertically integrated utility provides bundled residential premise services exclusively and that TOU is available on a self-selected basis

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a TOU program. The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.	*Customer*	*Customer has a PEV and wishes to enroll in TOU program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that TOU is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a TOU Program.*

Scenario U1-B assumes that customer can have unbundled residential premise service. He gets the delivery service from the utility and commodity service from ESCO. If customer takes bundle service, then process is the same as previous case. Otherwise, the illustrated processes are involved. Utility installs TOU meter

Alternative Scenario (U1-B): Customer enrolls in TOU program – Customer Taking Commodity from ESCO

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The Customer acquires a PEV and contacts the Utility to enroll in a TOU program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in TOU program; Gets delivery services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a TOU Program.*

U2: Discrete Event (Direct load control) programs are designed to incentivize customers whom are willing to give the energy provider control over their load. More specifically these programs allow energy providers to interrupt customer loads during critical grid events. Usually, the energy provider offers a vast array of options with programs varying in the quantity of events and length of interrupt periods.

A Direct device control (DDC) service involves a Call Option on one or more devices on the premises. A single price schedule applies to total premise metered service (uniform or TOU if that was selected). A discount is applied to the base service for each device enrolled in DDC. Prices are firm, but service is not. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the nest day. Utility exercises it Call Option by sending a signal that either shuts off electricity to the device (or devices) or restricts its usage during the event.

U2: Primary Scenario: Customer enrolls in Discrete Event Demand Side Management Program

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a Direct Load Control program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in DDC program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that DDC is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a DDC Program.*

U3: Variations on the basic TOU structure include critical peak pricing (CPP), variable peak pricing (VPP) and real time pricing (RTP).

RTP is similar to TOU rates in that customers make consumption decisions based on the price of energy. This is also considered an Active Management program. However, unlike TOU rates where the costs are previous established, RTP rates vary daily and by time of day based on day-ahead forecasts. Customers are generally provided a signal that informs them of the “real time” price. Although the interval and type of the signal may vary among utilities the concept is the same nationwide. RTP-DA (day-ahead) service provides daily price schedules (one price ($/kWh) per hour) to participants the day before they are effective. Once delivered, the prices are firm – they are not subject to revision. The hourly prices are applied to the corresponding hour’s metered energy usage (kWh). Under these rates the utility or energy provider does not have direct control to the customer’s load.

Primary Scenario (U3-A): Customer enrolls in RTP program. The vertically integrated utility provides bundled residential premise services exclusively and that RTP is available on a self-selected basis

The enrollment steps are identical to those to TOU for bundled utility and unbundled EPSO service. Each day, the Retailer (utility or ESCO) prepares and delivers the price schedule for the next day to the participant (by a specified time), and participant acknowledges receipt of the schedule (by a specified time).

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a RTP program. The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.	*Customer*	*Customer has a PEV and wishes to enroll in RTP program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that RTP is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a RTP Program.*

Alternative Scenario (U3-B): Customer enrolls in RTP program – Customer Taking Commodity from ESCO

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The Customer acquires a PEV and contacts the Utility to enroll in a RTP program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in RTP program; Gets delivery services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a RTP Program.*

U4: Variations on the basic TOU structure include critical peak pricing (CPP), variable peak pricing (VPP) and real time pricing (RTP).

CPP rates are similar to TOU rates in that they both have an established cost schedule based on the season, day of the week, time of day, weekday vs. weekend, etc. Critical peak pricing is a mechanism whereby normal flat[2] or TOU rates are in effect except for certain peak days, when pre-specified higher prices are superimposed on the normal TOU rate. CPP prices are used during system contingencies or during periods of high wholesale electricity prices for a limited number of days or hours per year. Although the quantity of events are limited and only during a particular season (i.e., summer or winter), the customer has the choice to reduce or not reduce their load during the "called" event. However, the consequence for not reducing load during peak hours will typically result in higher rates for that day. Under these rates the utility or energy provider does not have direct control to the customer's load.

[2] A single price ($/kWh) applies to all metered energy (kWh) consumption during each billing period. The simplest rate structures include a flat energy rate and a customer charge, a fixed dollar amount. This simple rate structure is most common for residential and small commercial customers.

Primary Scenario (U4-A): Customer enrolls in CPP program. The vertically integrated utility provides bundled residential premise services exclusively and that CPP is available on a self-selected basis

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a CPP program. The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.	*Customer*	*Customer has a PEV and wishes to enroll in CPP program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that CPP is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a CPP Program.*

Alternative Scenario (U4-B): Customer enrolls in CPP program – Customer Taking Commodity from ESCO

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The Customer acquires a PEV and contacts the Utility to enroll in a CPP program. The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.	*Customer*	*Customer has a PEV and wishes to enroll in CPP program; Gets delivery services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a CPP Program.*

U5: Optimized Energy Transfer programs are designed to incentivize customers whom are willing to give the energy provider control over their load. More specifically these programs allow energy providers to reduce or interrupt customer loads during critical grid events. The idea is that the energy provider based on the grid event can actively manage the charging load by either reducing or interrupting it. In either case, the active management will support turn off those who have higher SOC while only reducing the charge rate of those that have lower SOC. Usually, the energy provider offers a vast array of options with programs varying in the quantity of events and length of reduction or interruption periods. These include Regulation Services and taking advantage of Spinning Reserves.

Scenario: Customer enrolls in an Optimized Energy program

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in an Optimized Energy program. The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.	*Customer*	*Customer has a PEV and wishes to enroll an Optimized Energy program; Utility offers PEV Programs to its customers.*	*The Utility has successfully enrolled a Customer PEV in an Optimized Energy Program.*

3.2.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer applies and starts to enroll in a specific program.	
3	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
4	Customer	Customer completes enrollment form, returns to Utility or ESCO via web or mail	This step is dynamic and adjustments are allowed as customer preferences or actual comparisons are realized.
5	Utility	Utility confirms enrollment is complete and advises of any next steps.	
6	Customer	Customer determines whether to use a Cordset EVSE or Premise unit and purchases from vehicle dealership, retail store, or from utility or ESCO as available.	
7	Customer	Customer can self install EVSE or contract this installation.	
8	Utility	Additional control devices, dependant on the utility program, would also be installed at this time.	An example is the DLC a control device has to be installed for TOU/RTP/CPP. A meter has to be installed by the utility
9	Customer	Customer inputs program presets to vehicle / EVSE / HAN to accept program objectives based on options selected.	Some of this information may be exchanged within the binding or rebinding events as described next.

3.3 Scenario Description

S: PEV Connection and Energy Transfer: Binding/Rebinding (Startup, PEV Authentication, Basic Charging per enrolled program, Communication & Shutdown)

The following three architectures are the methods for the customer to connect the PEV to the utility.

S1: Cordset EVSE (120VAC)

S2: Premise EVSE (240VAC)

S3: Premise EVSE (DC)

The customer connects an EVSE cord to the PEV and the premise, at home to charge the PEV. The customer wants to take advantage of one or more of the utility programs.

Some of the utility programs require an End Use Measurement Device (EUMD). This is expected to be a HAN device that measures energy consumed by a PEV and communicates the information to the ESI.

Each binding and rebinding between the PEV and the ESI will include the EUMD ID. It is expected for a HAN device to contain a MAC ID that is correlated with the PEV ID and ESI ID for each energy transfer session. The definition for the HAN Device is identified in section 2.2. A system diagram is shown in section 5.3.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Customer connects EVSE cord to PEV.	*Customer*	*Customer has enrolled PEV with home utility, purchased and installed at least one EVSE (customer could have both Cordset and premise EVSE).*	*The utility has a record of the energy agreement related to the customer premise and the associated PEV ID. PEV binds or rebinds with utility.*

3.3.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer connects EVSE cordset to Energy Portal at Premise, then to PEV if cordset is used. If premise EVSE is used, customer connects EVSE cord to PEV.	
2	Customer	Customer may observe that EVSE power is indicated and PEV indicator is activated that confirms charge will commence.	PEV and utility exchange/confirm PEV ID, energy request vs. available and details of specific utility program(s).
3	PEV/Utility	Communication session is started and messages are sent and received by various actors. The PEV could send ID and message requests to the utility or intermediate devices. The Utility and other premise devices may simply send messages to the EVSE that would control the PEV energy needs by using the EVSE Pilot PWM.	Customer has the option to override any of these programs and receive energy at the available conditions.
4	Customer	Customer returns to vehicle, observes charge is complete or interrupts cycle, then disconnects EVSE cord.	

3.4 Scenario Description

L: Location variations: Connection location (PEV Authentication, Basic Charging per enrolled program)

The following four location variations are the alternatives for the customer to connect the PEV to the utility.

L1: Home: Connects at premise

L2: Another's Home inside the utility's service territory and A: premise pays tariff or B: customer pays tariff

L3: Another's Home outside the utility's service territory

L4: Public: Curbside, workplace, business, multi family dwelling

Primary Scenario (L1): Customer connects PEV at their premise location using either EVSE cordset or Premise Mounted EVSE

This scenario describes the most common sequence of customer charging their PEV at their own premise.

Primary Scenario (L2-A): Customer connects PEV to energy portal at another premise and premise customer pays for energy use

This scenario describes what happens if a Customer plugs PEV into another premise (not his own, but one serviced by the same utility), where the premise owner is responsible for the cost of energy delivered to the PEV charged at the premise.

Alternative Scenario (L2-B): Customer connects PEV to energy portal at another premise and PEV customer pays for energy use.

This scenario describes what happens if customer plugs PEV into another premise (not his own, but serviced by the same utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

Primary Scenario (L3): Customer connects PEV to energy portal at another premise outside the enrolled Utility's service territory.

This scenario describes what happens if customer plugs PEV into another premise (not his own, and not serviced by the same utility (i.e., roaming utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps* *Both home and foreign/roaming utility participate in inter-utility clearinghouse.*	*The foreign/roaming utility and the clearinghouse have record of the energy purchased transactions related to the customer premise, the PEV ID, the Customer ID, and the Utility ID.*

Primary Scenario (L4-A): Customer connects PEV to energy portal at curbside location.

This scenario describes what happens if customer plugs PEV into a curbside location.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
The customer plugs in the PEV using an EVSE cordset for charging	*PEV*	*Customer may or may not have enrolled PEV with curbside energy provider.*	*Prior enrollment may entitle customer to special rates and/or conditions.*

Alternative Scenario (L4-B): Customer connects PEV to energy portal at workplace location.

This scenario describes what happens if customer plugs PEV at a worksite location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be an employee at this location.*	*Employment may entitle customer to special rates and/or conditions.*

Alternative Scenario (L4-C): Customer connects PEV to energy portal at business location.

This scenario describes what happens if customer plugs PEV at a business location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be a shopper.*	*Shopping may entitle customer to special rates and/or conditions.*

Alternative Scenario (L4-D): Customer connects PEV to energy portal at Multi-Family Dwelling location.

This scenario describes what happens if customer plugs PEV at a multi-family dwelling location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be a resident.*	*Residency may entitle customer to special rates and/or conditions.*

3.4.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer needs to meet billing variations dependent on location and services provided.	

3.5 Scenario Description

PR: Specific Functions: Charging, Discharging, Diagnostics and Vehicle Manufacturer (VM) Specific applications.

The following four location variations are the alternatives for the customer to connect the PEV to the utility.

PR1: Charging

PR2: Discharging

PR3: Diagnostics

PR4: VM Specific

PR1: Charging.

Purpose: The fundamental function is to charge the PEV using the utility grid. The rate and time can be adjusted as needed to meet the customer's connection and use criteria and match the grid's capabilities.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and desires to use electrical energy rather than other fuel.	*Customer*	*Customer is able to connect to an EVSE.*	*Customer receives the amount of energy desired.*

PR2: Discharging.

Purpose: **An alternative function of the PEV is to discharge the RESS. The customer can take advantage of rate or opportunity aspects by using this feature.**

Discharges fall into the following four categories:

D1: Vehicle to Grid (V2G). This allows the customer the option of returning power to the grid. This may have an advantage to the grid if it is operating at peak loads.

D2: Vehicle to Home (V2H). This allows the customer the option of powering a home in the event of a grid outage. This function would have to include the same safety features as a Home Generator.

D3: Vehicle to Load (V2L). This allows the customer the option of powering devices that are not connected to the grid. This could be portable power at a construction site or Islanding where the vehicle may be providing power to a variety of devices.

D4: Vehicle to Vehicle (V2V). This has a couple of aspects such as jump-starting another vehicle or providing power in parallel with other vehicles for a higher power level of Islanding.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and desires to use electrical energy as a source for offboard power.	*Customer*	*Customer is able to connect to an EVSE.*	*Customer delivers the amount of energy desired.*

PR3: Diagnostics.

Purpose: **The customer may desire to diagnose issues with the EVSE or the PEV.**

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer detects a failure in the EVSE or PEV.	*Customer*	*Customer has a PEV and has connected to an EVSE.*	*The customer was able to have the failure transmitted by the means selected (Vehicle display, AMI, EVSE screen, etc.).*

PR: VM Specific.

Purpose: **The customer may desire to transport info to or from the PEV.**

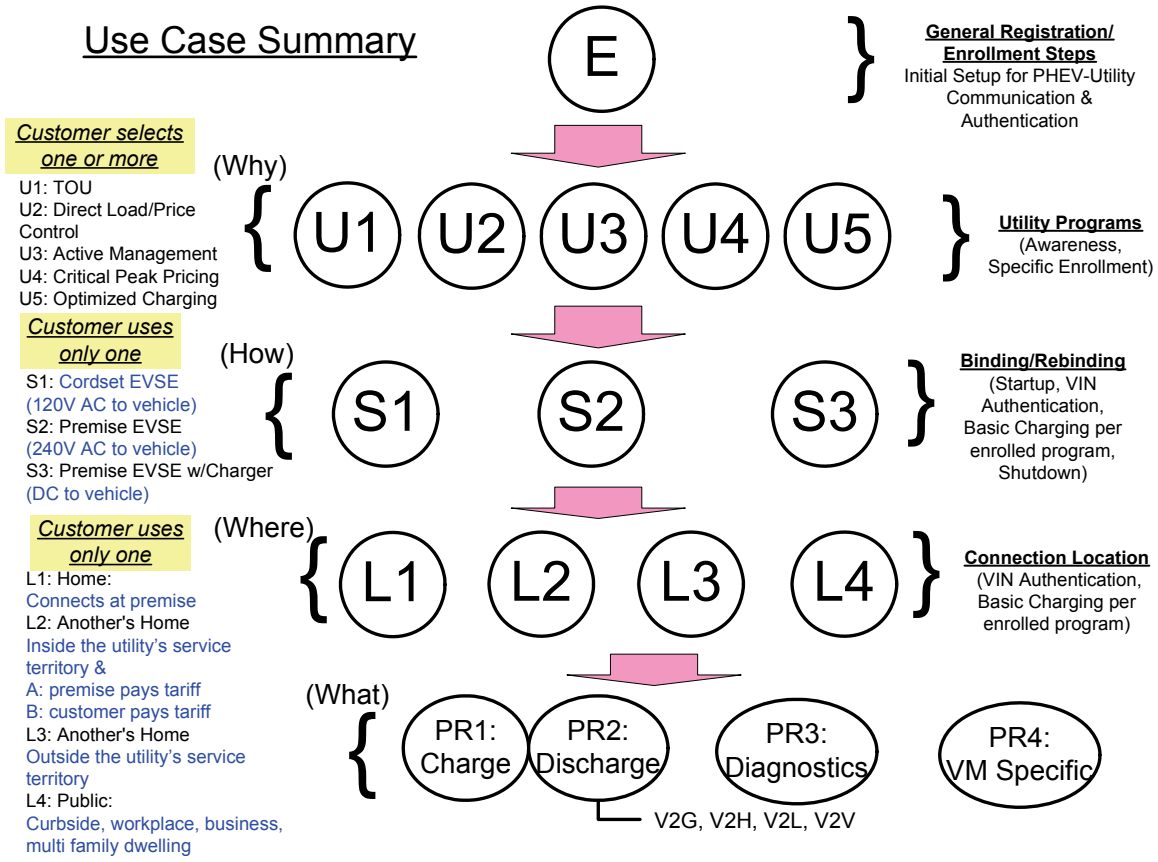
Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer wants to download or retrieve information from the PEV.	*Customer*	*Customer has a PEV and has connected to an EVSE.*	*The customer was able to have the data transmitted by the means selected (Vehicle display, AMI, EVSE screen, etc.).*

3.5.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
1	Customer	Customer selects desired option using desired means (Vehicle display, AMI, EVSE screen, etc.).	
2	Utility	Utility provides additional responses resulting from specific programs.	One example would be either the fixed or mobile EUMD reading on energy provided.
3	Customer	Customer receives feedback on billing or payment of these actions as applicable.	EVSE display could offer this.
4	Customer	Customer could receive info regarding amount and times of energy transfer for transaction.	EVSE display could offer this.

4. Requirements

This use case outlines a series of more detail use cases that identify the overall approach and requirements the customer will address to take advantage of various utility programs while fueling their PEV with electrical energy. The general enrolment is intended to cover common attributes, and then the specific utility programs may vary throughout different utility territories. The binding and rebinding identifies the specific attributes of each connection cycle with its varying architectures, and then the location aspects are identifying items that vary with each location category. Finally the customer attributes are defined as charging, discharging, doing diagnostics or vehicle manufacturer specific functions.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV sends energy request to ESI. This includes amount and charging rate.	Utility uses this to plan grid loading.	
2	ESI sends energy available to PEV. This includes amount and charging rate.		
3	The ESI and PEV shall exchange information, so the PEV can display the cost per distance.		
4	The ESI and PEV shall exchange information such as connection start, desired charge start, desired charge finish and expected connection end	Complies with programs	
5	Fixed or mobile EUMD sends energy used to ESI		
6	The ESI and PEV shall exchange Program information, such TOU, RTP and CPP.		
7	An EVSE with multiple ports would require multiple EUMDs to associate and record energy transferred to each PEV for the energy transfer session.		

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

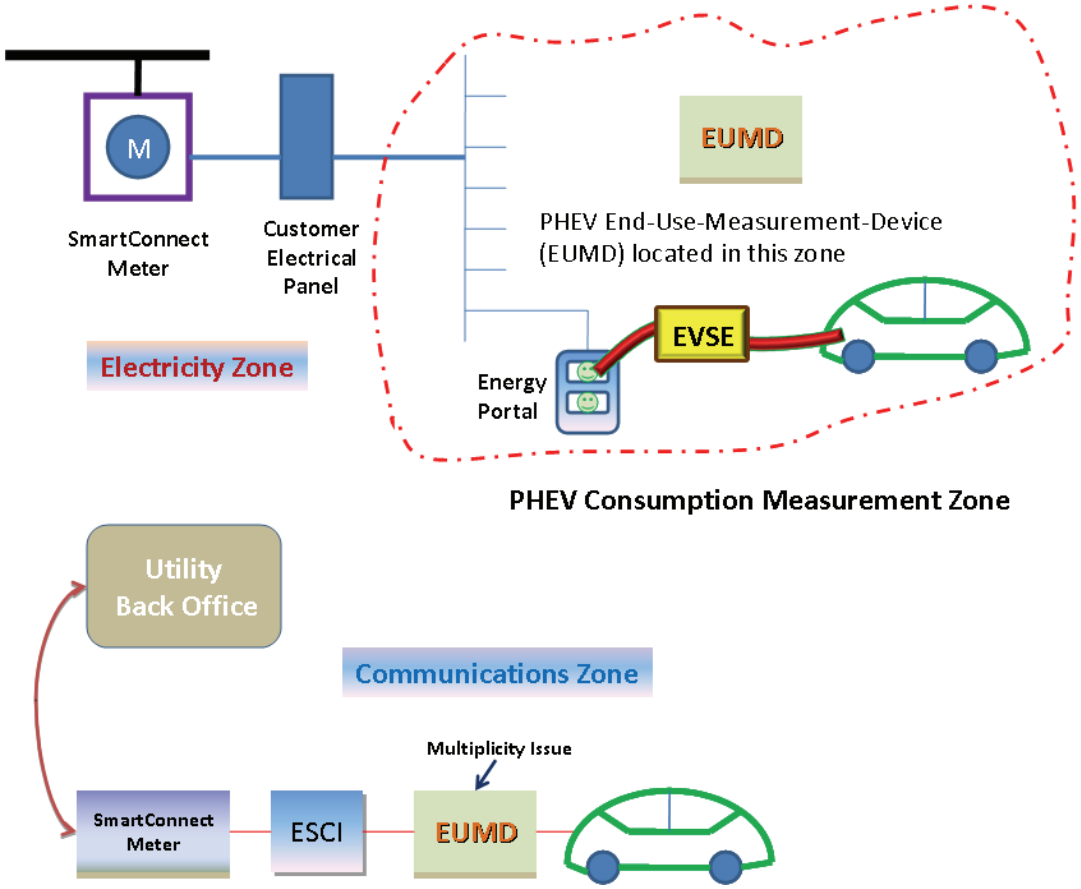
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. Use Case Models

The enrollment process will include capturing the following customer, vehicle and usage information. This is to be used by the utility to predict the energy needs of the customer and plan for optimized charging of the plug-in vehicles.

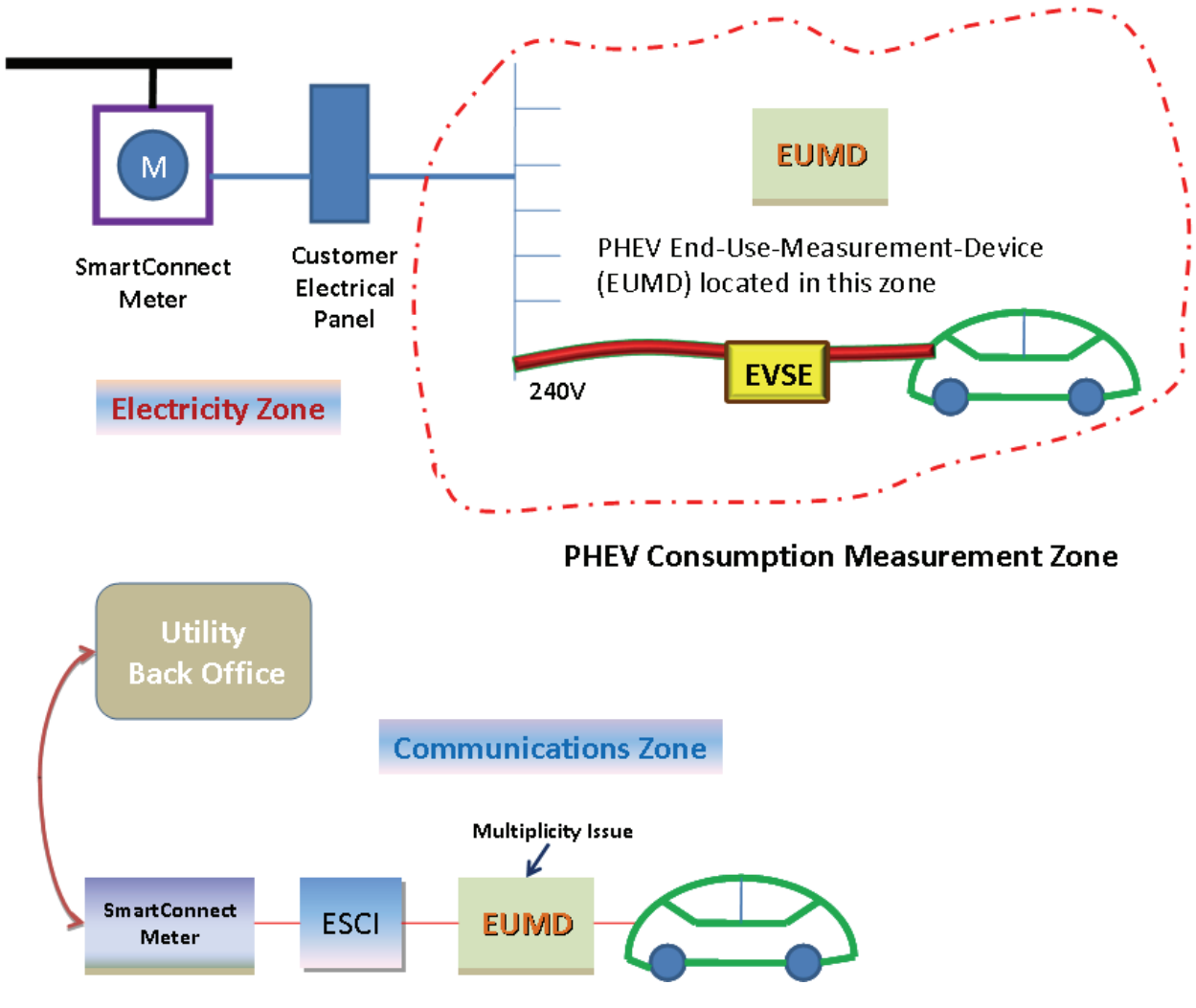
5.1 System Diagram

Using EVSE Cordset – See Use Case S1



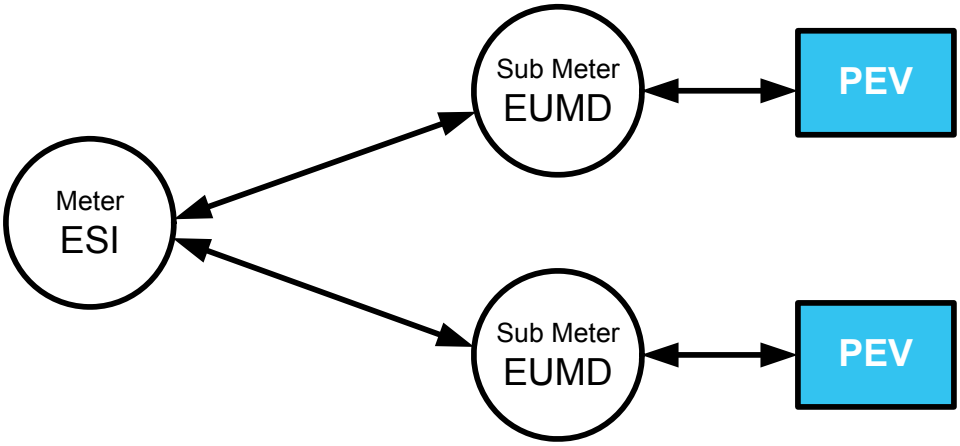
5.2 System Diagram

Using Premise Mounted EVSE – See Use Case S2 & S3



5.3 System Diagram

An EUMD is required for each PEV. An EVSE with multiple ports would require multiple EUMDs to associate and record energy transferred to each PEV for the energy transfer session.



A.2 PEV1 - UTILITY PROVIDES SERVICES TO PEV CUSTOMER

AMI Use Case:
PEV1 – Utility provides services to Plug-in Electric Vehicle (PEV) Customer
01/22/09

Document History

Revision History

Revision Number	Revision Date	Revision / Reviewed By	Summary of Changes	Changes marked
0.1	080627	Jerry Melcher	Initial Draft document	N
0.2	080702	Jerry Melcher	Draft document - JCMb	Y
0.3	080724	Jerry Melcher	Addition of S2, Utility provides billing services scenario	Y
1.0	080811	Bryan Lambird	Includes modifications required by taking binding and re-binding scenarios out of Use Case P2; S2 and S3 removed at this time for socialization purposes; will be included in v2.0	Y
2.0	090122	Arindam Maitra	Updates:	Y
3.0	090305	Rich Scholer	Deleted Requirement section until we can coordinate with HAN submissions. Updated EUMD definition.	Y
3.1	091230	Rich Scholer	Added Requirements	N

Approvals

This document requires following approvals.

Name	Title

CONTENTS

1. USE CASE DESCRIPTION

1.1 Use Case Title

Utility provides services to Plug-in Electric Vehicle (PEV) Customer

1.2 Use Case Summary

Customers are interested in fueling vehicles with electricity. Electric Vehicles (EV) and Plug-in Electric Vehicles (PEV) are emerging transportation options for consumers. Electric utilities desire to support these emerging loads with electricity at "off peak" times when energy costs are low and generation and power delivery assets are underutilized. PEV manufacturers are interested in working with utilities to develop customer rates/programs which could provide consumers with an increased incentive to purchase a PEV. To enable utility customer rates/programs specifically to customers with PEVs, the utility must offer special services for these customers. These services include the ability to enroll, register, and initially setup communications between a PEV and the utility (one-time setup), the ability to repeatedly re-establish communications for each PEV charging session (repeat communications/re-binding), the ability to provide PEV charging (and other) status information to customer information channels (e.g., web, display devices), and the ability to correctly bill PEV customers according to their selected rates/programs.

1.3 Use Case Detailed Narrative

Within a utility service territory, the consumer can plug in a PEV to receive a charge of electrical energy at their premise or plug in at another premise location. The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer. Information related to utility PEV programs, energy usage, and PEV charging status/information will be made available to the Customer for viewing via a website or other customer provided display equipment.

This use case covers three scenarios:

1) Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications. The following programs are discussed

    - U1: Enrollment Process to Time of Use (TOU) Program
    - U2: Enrollment Process to Direct Load/Device Control (DDC) Program
    - U3: Enrollment Process to Real Time Pricing (RTP) or Hourly/Periodic Pricing Program
    - U4: Enrollment Process to Critical Peak Pricing (CPP) or Hourly/Periodic Pricing Program
    - U5: Enrollment Process to Active Load Management Program

2) PEV and Utility establish/re-establish communications session at the time of charging

3) Utility provides billing services for PEV charging to Customer

4) Utility provides Customer access to PEV charging and status information

1.4 Business Rules and Assumptions

PEV Customer has an account with utility and electrical service at a premise served by the utility.

PEV and utility may have communications capabilities, enabled by utility provided Energy Services Communication Interface (ESCI).

The customer awareness of the utility and vehicle programs is prompted by both the utility providers and the vehicle manufacturers.

The utility offers PEV programs and services for its customers and will provide the necessary support processes for enrollment, communications, and billing

The Vehicle manufacturers would provide information to the customer about fuel and/or emission gains of the vehicles offered and promote the utility and convenience of connecting to the grid

Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including demand side management programs, associated PEV IDs, customer IDs, and premise IDs.

In the absence or failure of PEV-utility communications, or if PEV ID validation fails, PEV charging will always proceed; however, without the incentive rates and with all energy charges accruing to the premise customer according to the premise customer's default rate/service plan. (Should we include something in assumptions to deal with notification to the customer of this event and reconciliation of account after the fact?)

The actual PEV charging processes, including scenarios for intra- and inter- utility roaming, are covered in use case P2.

End Use Measurement Device (EUMD), either fixed or mobile, is always available for energy validation of PEV charging. If not available, charging will proceed, but with limitations on incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

EUMD function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.

To allow for possibility of the EUMD being a part of/within the PEV, PEV is a sub-meter to the primary utility billing meter at any premise (as opposed to being a separate service account with dual meter socket adapter)

The PEV & Utility will communicate to implement one or more the previously described Utility programs (see section 3.2)

2. ACTORS

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g., operators, system administrators, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
AES – See ESCO	Organization	Alternative Energy Supplier
Charger	Device	The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.
Clearinghouse	Organization	Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.
Control Device	Device	DLC programs enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that an event has been declared for the next day.
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.
Customer Account	System	Customer Account is assigned to Customer to collect charges for billing of energy usage
Customer Energy Management System	System	Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.
Electric Vehicle Supply Equipment (EVSE)	Device	PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772, SAE J2836 and SAE J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and(2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772.
Energy Portal (EP)/Smart Energy Portal (SEP)	Device	Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Energy Services Communication Interface (ESCI) See ESI for similarities	System	Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information PEV shall be capable of communicating to the Utility through an ESCI ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility – PEV ID, interval kWh consumption. Passes energy information, including price signals, schedules (including time zone and charge "window"), event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN). ESCI shall employ appropriate security policies when communicating demand side management program-related messages
ESI	System	Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.
End Use Measurement Device (EUMD)	Device	End Use Measurement Device (EUMD) is a HAN device that measures energy consumed by a PEV and communicates the information to the ESI.
ESCO – See AES	Organization	Competitive (or alternative) supplier of commodity service
Guest	Person	Guest is a friend or family member who has permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.
PEV, EV, PHEV	System	Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.
Roaming Utility	Organization	Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer's Utility service territory.
Utility	Organization	Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by starting the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Primary Scenario: Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications

This scenario describes the most common sequence of the utility enrolling a PEV customer into a utility program / service specifically for customers with PEVs. As described in the main Narrative section, the customer is enrolling in a PEV program / service that may provide for the opportunity to fuel a vehicle at a lower cost during off-peak periods based on one of the utility programs enumerated in the main Narrative section. This scenario involves both enrollment of the PEV and steps needed to establish initial an communications session with the utility.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The Customer acquires a PEV and contacts the Utility to enroll in a PEV program	Customer	Customer has a PEV and wishes to enroll in PEV program; Utility offers PEV Programs to its customers.	The Utility has successfully enrolled a Customer PEV in a PEV Program and PEV has established initial communications session with the utility.

3.1.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Customer	Customer initiates request to enroll PEV in a PEV Program by contacting Utility and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel. Preference for PEV is PEV VIN #
2	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
3	Utility	Utility presents Customer with PEV Program information and PEV Program selections.	
4	Customer	Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility PEV program.	
5	Customer	Customer connects PEV to Energy Portal at their premise location.	

Step #	Actor	Description of the Step	Additional Notes
6	PEV	PEV senses power to on-board charging unit and activates 'On Plug' state.	
7	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PEV or ESCI as initiator of session.
8	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.
9	ESCI	ESCI maintains communication session and security between PEV and Utility. ESCI transmits request for validating PEV ID to Utility, includes Premise ID.	
10	Utility	Utility identifies and authenticates PEV ID and Premise ID.	
11	Utility	Utility transmits confirmation message via ESCI to PEV indicating successful binding with premise ESCI. Confirmation message includes authentication parameters for PEV.	Authentication parameters would include utility rate program information.
12	PEV	PEV receives confirmation message and sets authentication parameters.	
13	PEV	PEV transmits via ESCI message to Utility acknowledgement of receipt of valid confirmation message and setting of authentication parameters.	
14	Utility	Utility transmits message via ESCI to discover EUMD at Customer Premise; message includes authentication parameters for EUMD.	Authentication parameters would include utility rate program information (e.g., interval size, etc.).
15	EUMD	EUMD receives discovery message and sets authentication parameters.	
16	EUMD	EUMD transmits via ESCI message to Utility acknowledgement of receipt of valid discovery message and setting of authentication parameters.	
17	ESCI	ESCI transmits confirmation message to PEV indicating successful communication session binding of PEV to Utility, meaning that charging can proceed according to enrolled PEV program.	Authentication between Utility and PEV is now complete and charging can proceed according to the enrolled PEV program criteria
18	PEV	PEV prepares for charging based on Customer-selected preferences and enrolled PEV program. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	

3.2 Primary Scenario: PEV and Utility establish/re-establish communications session at the time of charging

This scenario describes the steps required to establish a PEV – Utility communications session each time that a PEV is plugged in for charging (or simply for information exchange). This scenario assumes that initial PEV – Utility communications have completed successfully, including the setup of authentication parameters in the PEV and EUMD,

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Customer plugs in a PEV for charging (or simply for information exchange)	Customer	Enrollment and Initial Setup steps (as described in Scenario 1) have been completed.	PEV and Utility have established a communications session upon PEV being plugged in. The utility has a record of the energy agreement related to the customer premise and the associated PEV ID. PEV binds or rebinds with utility

3.2.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV senses power to on-board charging unit and activates 'On Plug' state.	
2	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PEV or ESCI as initiator of session.
3	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.
4	ESCI	ESCI maintains communication session and security between PEV and Utility. ESCI transmits request for validating PEV ID to Utility, includes Premise ID.	
5	Utility	Utility verifies PEV ID and Premise ID.	

Step #	Actor	Description of the Step	Additional Notes
6	Utility	Utility transmits confirmation message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	
7	ESCI	ESCI transmits confirmation message to PEV indicating successful communication session binding of PEV to Utility, meaning that charging can proceed according to enrolled PEV program.	
8	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
9	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
10	PEV	PEV prepares for charging	
11	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
12	EUMD	EUMD, either fixed or mobile, records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	The EUMD could send this message back to the vehicle and could be displayed to the customer within the vehicle or EVSE. It could be sent to the customer tabulated on the monthly bill. It could be printed on a receipt dispensed by the EVSE, etc
13	EUMD	EUMD Communicates to the ESI using the Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two.

Step #	Actor	Description of the Step	Additional Notes
14	ESCI	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information.SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
15	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

4. REQUIREMENTS

Detail the Functional, Non-functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Req ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	The Utility has Plug-in Electric Vehicle (PEV) program enrollment methods and processes available and known to customer.		
2	The Utility has operational PEV programs and services for Customer to enroll in.		
3	PEV has a unique ID which can be stored within and communicated from PEV.		
4	The Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including associated PEV IDs, Customer IDs, premise IDs, and parameters of the program enrolled in (e,g, allow roaming ,guest charging, etc.)		
5	The Utility shall be able to determine customers/premises not enrolled in PEV program.		
6	PEV shall be plugged into Energy Portal (i.e., PEV in ‘On Plug’ state) prior to participating in communications session with ESCI.		
7	PEV shall be able to charge upon plugging into Electric Vehicle Supply Equipment (EVSE) enabled 120V or 240V AC Energy Portal (with or without communications established with utility).		
8	The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of communicating to the Utility and can communicate to the PEV and End Use Measurement Device (EUMD) to facilitate exchange of authentication and charging session information.		
9	PEV, EUMD, and Energy Services Communication Interface shall be able to establish a secure communications link.		

Req ID	*Functional Requirements*	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
10	If ESCI communications cannot be established between PEV and Utility within a configurable period of time after 'on plug' state, charging will proceed (according to customer preferences) with all charges accruing to premise customer account according to that customer's regular utility rate.		
11	PEV shall be capable of communicating with ESCI.		
12	PEV is capable of communicating with the Utility through an ESCI.		
13	PEV shall be capable of providing to the ESCI its unique PEV ID upon initiation of a communications session between PEV and ESCI.		
14	ESCI shall be able to provide the Premise ID to the Utility (along with PEV ID provided by PEV) for validation/verification.		
15	The Utility shall be able to verify that usage attributable to PEV charging is sourced from the same customer/premise that has provided the ESCI for PEV-to-Utility communications (e.g., Load correlation to ESCI communications).		
16	The Utility shall be able to send a confirmation message via ESCI to PEV to indicate authentication of PEV ID and Premise ID information, establishing a successful PEV/ESCI binding.		
17	PEV is capable of receiving a confirmation message from Utility via ESCI establishing valid charging session. This indication can in turn be made available to customer to indicate that communications session has been successfully established.		
18	PEV shall be able to receive utility authentication parameters (as necessary) upon initial binding with ESCI, or upon change of utility authentication parameters.		
19	PEV shall be able to send message to Utility via ESCI acknowledging successful authentication and completion of initial setup of PEV according to utility PEV program.		
20	EUMD is required to discretely measure usage provided for PEV charging.		
21	EUMD function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.		
22	EUMD shall be capable of communicating with the Utility through an ESCI		
23	The Utility shall be able to send a discovery message via ESCI to EUMD to indicate authentication of PEV ID and Premise ID information, establishing a successful PEV/ESCI binding.		
24	EUMD is capable of receiving a discovery message from Utility via ESCI establishing valid charging session. This indication can in turn be made available to customer to indicate that communications session has been successfully established.		
25	EUMD shall allow for remote reconfiguration of energy measurement interval length.		
26	EUMD shall be able to receive utility authentication parameters (as necessary) upon initial binding with ESCI, or upon change of utility authentication parameters (e.g., usage measurement interval).		
27	EUMD shall be able to send message to Utility via ESCI acknowledging successful authentication and completion of initial setup of EUMD according to utility PEV program.		
28	Re-establishment of PEV – Utility communications session (following initial enrollment and setup) can be achieved without full authentication and discovery steps as required for initial session.		

4.2 Non-functional Requirements

Non-func. Req ID	*Non-Functional Requirements*	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
NF.1	Time will be maintained by each device in the system to UTC with 1 sec resolution.		
NF.2	PEV attempts to initiate communication session before initiating charging.		
NF.3	PEV waits a minimum time (i.e., 1 minute) to allow for communications session to be established before charging activation.		

5. USE CASE MODELS (OPTIONAL)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

For each scenario detail the information exchanged in each step

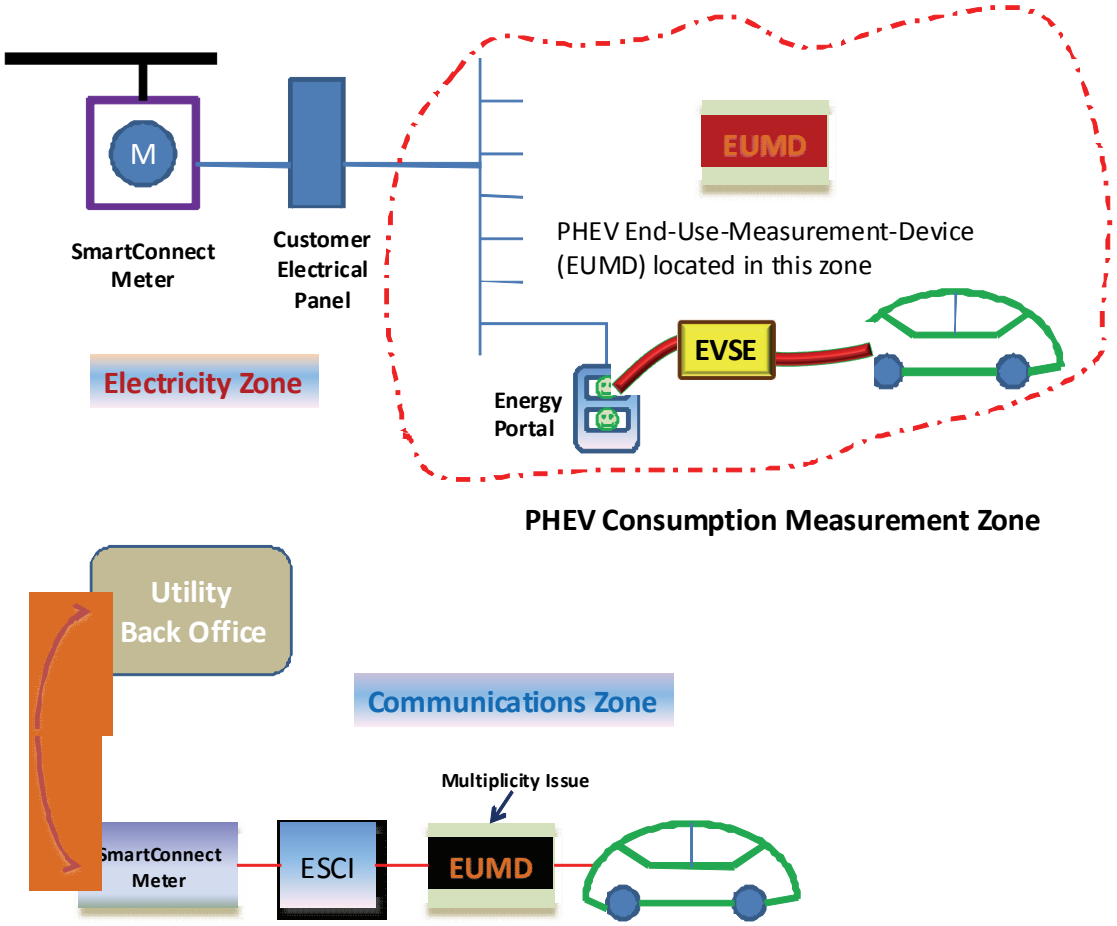
This will need to be updated given step and reqts update…..should be in synch with sequence diagram also.

5.2 Diagram

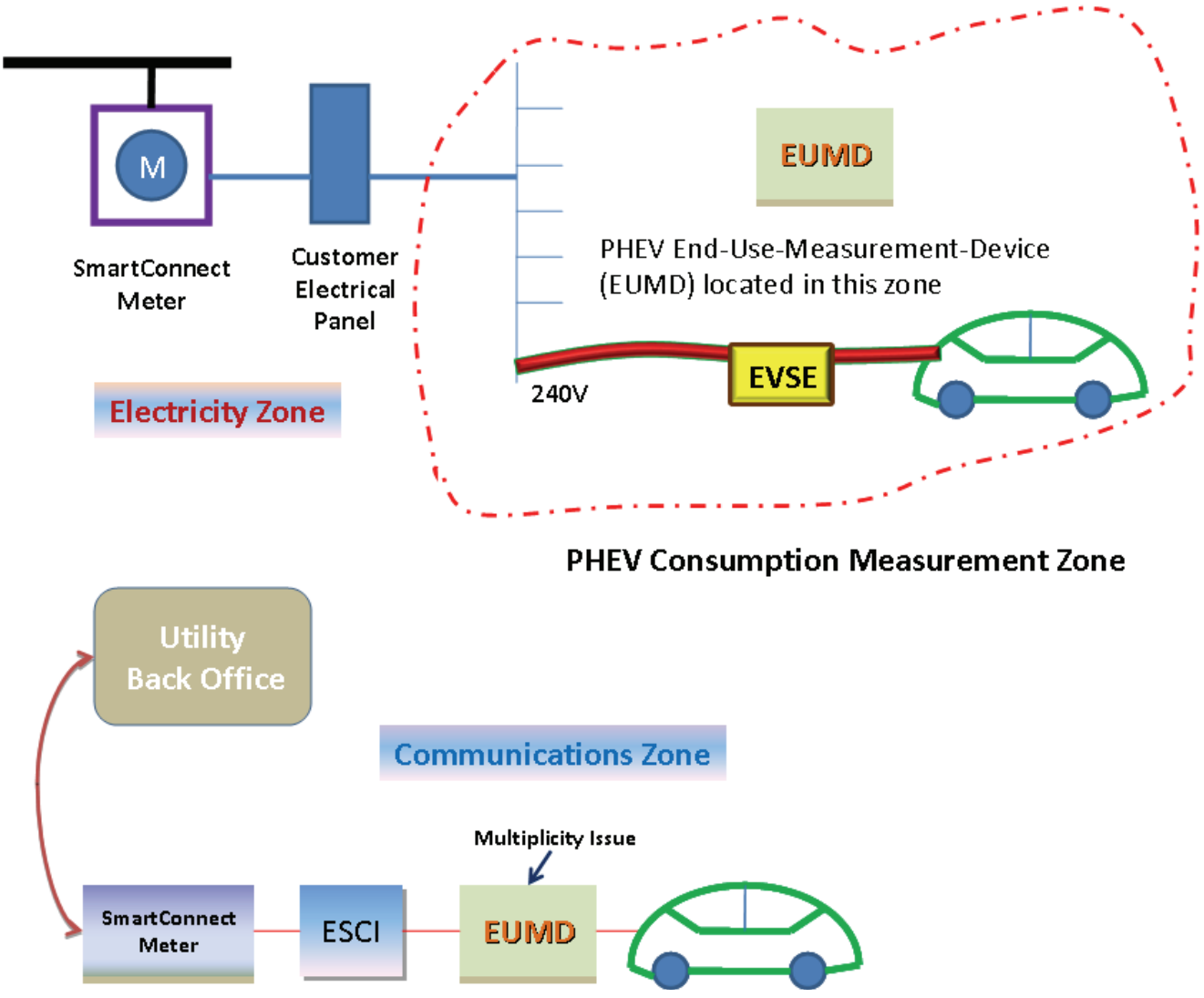
The architecture team shall use this section to develop an interaction diagram that graphically describes the step-by-step actor-system interactions for all scenarios. The diagrams shall use standard UML notation. Additionally, sequence diagrams may be developed to help describe complex event flows.

5.2.1 System Diagram

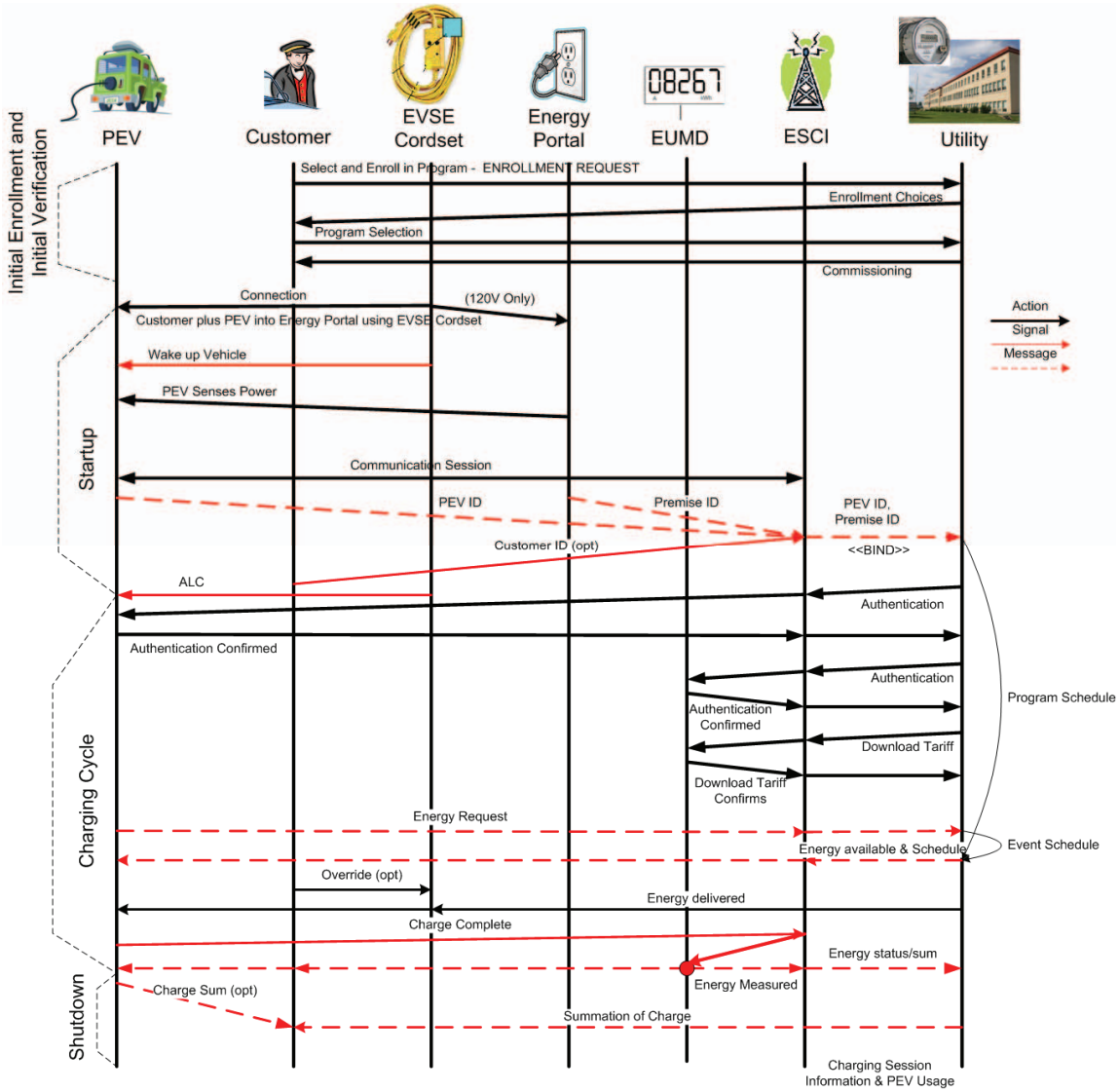
Using EVSE Cordset

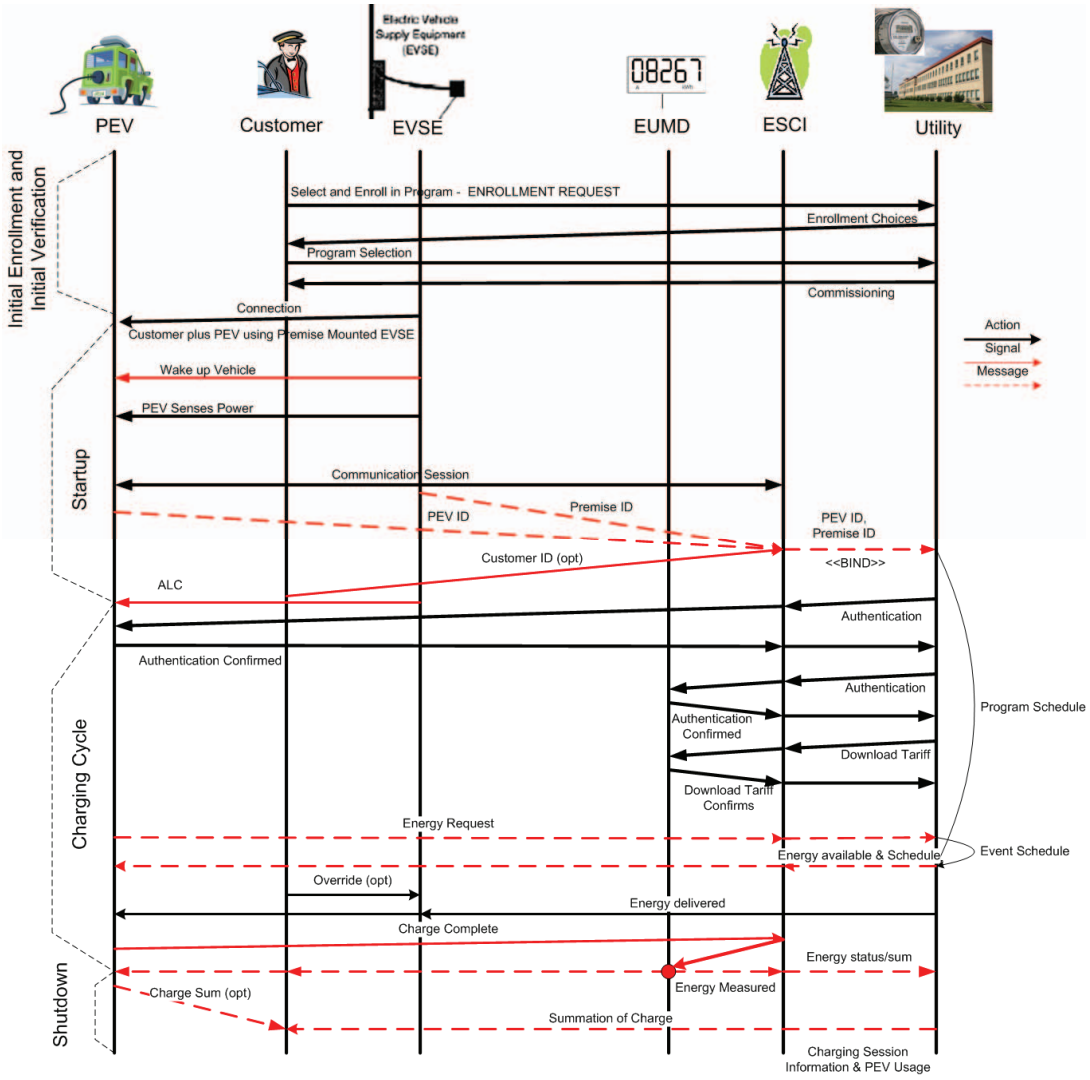


Using Premise Mounted EVSE



5.2.2 Sequence Diagram: Scenario 1




PEV
Customer
Electric Vehicle Supply Equipment (EVSE)
EVSE
EUMD
ESCI
Utility
Initial Enrollment and Initial Verification
Select and Enroll in Program - ENROLLMENT REQUEST
Enrollment Choices
Program Selection
Commissioning
Connection
Customer plus PEV using Premise Mounted EVSE
Action
Signal
Message
Wake up Vehicle
PEV Senses Power
Startup
Communication Session
Premise ID
PEV ID
PEV ID, Premise ID
Customer ID (opt)
<<BIND>>
ALC
Authentication
Authentication Confirmed
Authentication
Program Schedule
Authentication Confirmed
Download Tariff
Download Tariff Confirms
Charging Cycle
Energy Request
Energy available & Schedule
Event Schedule
Override (opt)
Energy delivered
Charge Complete
Energy status/sum
Energy Measured
Charge Sum (opt)
Summation of Charge
Shutdown
Charging Session Information & PEV Usage

6. USE CASE ISSUES

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.

7. GLOSSARY

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**
Tariff	Energy cost schedule to customer. Can be time-of-day, flat rate, seasonal rate, critical peak price rate, etc.
PEV	Plug-in Electric Vehicle. Includes all vehicles that have ability to receive electrical energy from Utility
EUMD	EUMD, revenue measuring device
ESCI	Energy Services Communication Interface
charging	Act of electrically charging a battery on-board a Plug-in Electric Vehicle or Electric Vehicle
VIN	Vehicle Identification Number

A.3 PEV2 - CUSTOMER CONNECTS PEV TO PREMISE ENERGY PORTAL

AMI Use Case:
PEV2 – Customer connects Plug-in Electric Vehicle (PEV) to premise energy portal
02/12/09

Document History

Revision History

Revision Number	Revision Date	Revision / Reviewed By	Summary of Changes	Changes marked
(#)	(yymmdd)	(Name)	(Describe change)	(N)
0.4	080422	Jerry Melcher	Initial Draft document	N
1.0	080424	Bryan Lambird	Minor revisions for 1st Review Draft	N
1.1	080507	Bryan Lambird	Incorporate 2 additional issues (#s 1.1 & 1.2) based on SCE ET Review	N
2.0	080513	Bryan Lambird	Incorporated various feedback from multiple reviewers	N
2.1	080624	Jerry Melcher	Change Use Case Label, added S4, S5, additional comments from reviewers	Y
2.2	080625	Jerry Melcher	Added Scenarios S4 and S5	Y
3.0	080703	Bryan Lambird	Feedback and edits on v2.2	Y
3.1	080711	Bryan Lambird	Additional Feedback and Edits on v3.0	N
3.2	080711	Bryan Lambird	Additional Feedback and Edits on v3.1	N
4	090212	Arindam Maitra	Revisions Incorporated	Y
5.0	090305	Rich Scholer	Deleted Requirement section until we can coordinate with HAN submissions. Updated EUMD definition.	Y
5.1	091230	Rich Scholer	Added Requirements	N

Approvals

This document requires following approvals.

Name	Title

CONTENTS

1. Use Case Description

1.1 Use Case Title

Customer connects Plug-in Electric Vehicle (PEV) to premise energy portal

1.2 Use Case Summary

Customers are interested in fueling vehicles with electricity. Electric Vehicles (EV) and Plug-in Electric Vehicles (PEV) are emerging transportation options for customers. Electric utilities desire to support these emerging loads with electricity at "off peak" times when energy costs are low and generation and power delivery assets are underutilized. PEV manufacturers are interested in working with utilities to develop customer rates/programs which could provide customers with an increased incentive to purchase a PEV. Within a utility service territory, the customer can plug in a PEV to receive a charge of electrical energy at his premise or plug in at another premise location. The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. Each time the PEV is charged, Customers who have enrolled in a PEV program will exchange account and energy information. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer.

1.3 Use Case Detailed Narrative

Customers are interested in fueling vehicles with electricity. Electric Vehicles (EV) and Plug-in Electric Vehicles (PEV) are emerging transportation options for customers. Electric utilities desire to support these emerging loads with electricity at "off peak" times when energy costs are low and generation and power delivery assets are underutilized. PEV manufacturers are interested in working with utilities to develop customer rates/programs which could provide customers with an increased incentive to purchase a PEV. Utilities may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging.

The vehicle can connect to the grid using either of the following:

- Electric Vehicle Supply Equipment (EVSE) Cordset – The cordset (described in SAE J1772) would be used for convenience charging that is expected to connect to either a 15A or 20A 120V outlet

- Electric Vehicle Supply Equipment (EVSE) at the premise – It is expected that a premise mounted EVSE would be connected to a 240V service

- DC Premise Electric Vehicle Supply Equipment (EVSE)

Upon plugging a PEV using either a EVSE cordset (120V) or into Premise Mounted EVSE (240V), a communication session is initiated between the local Energy Services Communication Interface (ESCI) located at the premise and the PEV. The Utility validates that the Customer and the PEV ID (and/or Premise ID) are enrolled in a valid PEV program and that the there is correlation between the ESCI and the Energy Portal or Premise Mounted EVSE (in the case of Premise Mounted EVSE, the premise EVSE is already connected to the premise). That is, the premise associated to the ESCI and the charging PEV are the same. Upon validation, PEV charging begins, and an End Use Measurement Device (EUMD) tracks electricity supplied during the charging session. If communications cannot be established, or if PEV fails validation, charging will continue; however, no special PEV incentive will be applied. Upon termination of charging session, the End Use Measurement Device logs the charging session information and reports data to the utility for billing and presentation to the Customer. This use case covers five scenarios:

1) Customer connects PEV to energy portal at his premise location

2) Customer connects PEV to energy portal at another premise and premise customer pays for energy use

3) Customer connects PEV to energy portal at another premise and PEV customer pays for energy use

4) Customer connects PEV to energy portal at another premise outside the enrolled Utility's service territory

5) Non-enrolled PEV (or Customer with non-communicating PEV) connects PEV to energy portal

6) Customer charges PEV at public location, Multi family Dwelling, and Workplace infrastructure

The situation related to public charging is covered implicitly in scenarios 2 and 3. Apartment building/ Multi-tenant situations can be covered by scenarios 1, 2, or 3.

1.4 Business Rules and Assumptions

- High level assumption that PEV and utility have communications capabilities. For a foreign utility scenario (Scenario 3.4), assumption is that roaming utility also has communications capabilities.

- In the absence or failure of PEV-utility communications, or if PEV ID validation fails, PEV charging will always proceed; however, without the incentive rates and with all energy charges accruing to the premise customer according to the premise customer's default rate/service plan.

- The PEV charging process for this use case can only be applied to customers that have already enrolled in a utility PEV program and have registered one or more PEVs in advance of charging. The enrollment and initial registration scenarios will be covered in a separate use case (Use Case P1). Steps for repeat binding of PEV to premise are also covered in Use Case P1.

- The customer awareness of the utility and vehicle programs is prompted by both the utility providers and the vehicle manufacturers.

    - The utility offers PEV programs and services for its customers and will provide the necessary support processes for enrollment, communications, and billing

    - The Vehicle manufacturers would provide information to the customer about fuel and/or emission gains of the vehicles offered and promote the utility and convenience of connecting to the grid

- Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including demand side management programs, associated PHEV IDs, customer IDs, and premise IDs

- End Use Measurement Device (EUMD), either fixed or mobile, is always available for energy validation of PEV charging. If not available, charging will proceed, but with limitations on incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

- End Use Measurement Device (EUMD) function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.

- Un-enrolled PEV is prohibited from binding to Utility devices or network (Energy Services Communication Interface). However, PEV charging will be able to proceed with the assumptions already documented.

- Foreign utility scenario (Scenario 3.4) assumes the existence of a cross-utility clearinghouse (available to all utilities) which can reconcile roaming utility PEV charging between premise customer of one utility and PEV operator/customer of a different utility. The concept of portability of multiple separate utility customers (with separate utility accounts) across a given PEV on a regular basis (e.g., rental car scenario) is not explicitly considered in this use case. This may be covered in a future use case.

- The PEV & Utility will communicate to implement one or more the following Utility programs (details of which are covered in section 3)
    - Time of Use (TOU) pricing demand side management programs are when the customer has agreed to limit charges to the utility schedule for load balancing. (e.g., off-peak, mid-peak, on-peak, etc.).
    - Discrete Event demand side management program (Direct Load Control)
    - Periodic/Hourly Pricing Price Response program
    - Active Load Management program

2. ACTORS

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g., operators, system administrators, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	***Actor Type (person, device, system etc.)***	***Actor Description***
AES – See ESCO	Organization	Alternative Energy Supplier
Charger	Device	The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.
Clearinghouse	Organization	Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.
Control Device	Device	DLC programs enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the next day.
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.
Customer Account	System	Customer Account is assigned to Customer to collect charges for billing of energy usage
Customer Energy Management System	System	Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.
Electric Vehicle Supply Equipment (EVSE)	Device	PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772, SAE J2836 and SAE J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and (2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Energy Portal (EP)/Smart Energy Portal (SEP)	Device	Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.
Energy Services Communication Interface (ESCI) See ESI for similarities	System	Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information PEV shall be capable of communicating to the Utility through an ESCI ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility – PEV ID, interval kWh consumption. Passes energy information, including price signals, schedules (including time zone and charge "window"), event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN). ESCI shall employ appropriate security policies when communicating demand side management program-related messages
ESI	System	Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.
End Use Measurement Device (EUMD)	Device	End Use Measurement Device (EUMD) is a HAN device that measures energy consumed by a PEV and communicates the information to the ESI.
ESCO – See AES	Organization	Competitive (or alternative) supplier of commodity service
Guest	Person	Guest is a person who is not the premise Customer but has Customer's permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.
PEV, EV, PHEV	System	Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.
Roaming Utility	Organization	Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer's Utility service territory.
Utility	Organization	Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by starting the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Primary Scenario: Customer connects PEV to energy portal at their premise location

This scenario describes the most common sequence of customer charging their PEV at their own premise. As described in the main Narrative section, the customer is attempting to charge a PEV under a selected PEV rate tariff that may provide an incentive to charge during off peak periods. The utility needs to support customers on the PEV program.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV into energy portal using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility.*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

3.1.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Customer	Customer connects PEV to energy portal at his premise location.	
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process. (See Use Case P1)	
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	

Step #	Actor	Description of the Step	Additional Notes
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD, either fixed or mobile, records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to the ESI using the Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two. See Issue 5.0 (Section 6)
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

3.2 Primary Scenario: Customer connects PEV to energy portal at another premise and premise customer pays for energy use

This scenario describes what happens if a Customer plugs PEV into another premise (not his own, but one serviced by the same utility), where the premise owner is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility.*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

3.2.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV connects another customer's premise within the Utility service territory, and the customer at this location is willing to pay for PEV charging energy. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in P1 S2 (Steps 5a through Step 10)
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process. (See Use Case P1)	Implementation could have PEV or ESCI as initiator of session.
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	

Step #	Actor	Description of the Step	Additional Notes
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD, either fixed or mobile, records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to the ESI using the Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two. See Issue 5.0 (Section 6)
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

3.3 Primary Scenario: Customer connects PEV to energy portal at another premise and PEV customer pays for energy use

This scenario describes what happens if customer plugs PEV into another premise (not his own, but serviced by the same utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility.*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

3.3.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV connects at another customer premise within the Utility service territory. PEV owner will pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE cordset to Energy Portal at Premise.	Startup steps are provided in P1 S1 (Steps 5a through Step 10)
1b	EVSE	Customer connects Premise Mounted EVSE to PEV.	Startup steps are provided in P1 S2 (Steps 5a through Step 10)
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process. (See Use Case P1)	Implementation could have PEV or ESCI as initiator of session.
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	

Step #	Actor	Description of the Step	Additional Notes
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD, either fixed or mobile, records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to the ESI using the Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two. See Issue 5.0 (Section 6)
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

3.4 Primary Scenario: Customer connects PEV to energy portal at another premise outside the enrolled Utility's service territory

This scenario describes what happens if customer plugs PEV into another premise (not his own, and not serviced by the same utility (i.e., roaming utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV into energy portal	*PEV*	*Customer has enrolled PEV with home utility.* *Both home and foreign/roaming utility participate in inter-utility clearinghouse.*	*The foreign/roaming utility and the clearinghouse have a record of the energy purchased transactions related to the customer premise, the PEV ID, the Customer ID, and the Utility ID.*

3.4.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV connects PEV at a location outside of the home Utility service territory. PEV owner will pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	Startup steps are provided in P1 S1 (Steps 5a through Step 10)
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in P1 S2 (Steps 5a through Step 10)
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state.	

Step #	Actor	Description of the Step	Additional Notes
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process. (See Use Case P1)	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.
5	ESCI	ESCI maintains communication session and security between PEV and Roaming Utility. ESCI transmits request for validating PEV ID to Roaming Utility, including Premise ID.	
6	Roaming Utility	Roaming Utility checks PEV ID and Premise ID against internal database. When not found (because PEV is registered with home utility), Roaming utility forwards PEV ID and Roaming Utility ID to Clearinghouse for verification.	
7	Clearinghouse	Clearinghouse checks PEV database for PEV ID and finds corresponding Home Utility ID, and Home Utility Account/Premise ID.	Underlying assumption is that PEV has been registered with home utility and that both utilities participate in the clearinghouse.
8	Clearinghouse	Clearinghouse transmits confirmed message to Roaming Utility, including PEV ID, Home Utility ID, and Home Utility Account/Premise ID.	See Issue 10.0 (Section 6)
9	Roaming Utility	Roaming Utility transmits confirmed message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	
10	ESCI	ESCI transmits confirmation message to PEV indicating successful communication session binding of PEV to Roaming Utility at PEV program tariff. PEV is able to provide indicator to customer that binding has been successful (and that he will receive incentive rate upon charging, if applicable).	
11	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
12	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
13	PEV	PEV prepares for charging	

Step #	Actor	Description of the Step	Additional Notes
14	PEV	PEV begins charging based on Customer selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
15	End Use Measurement Device	EUMD, either fixed or mobile, records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
16	End Use Measurement Device	EUMD communicates to the ESI using the Energy Services Communication Interface energy supplied to PEV ID for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two. See Issue 5.0 (Section 6)
17	Energy Services Communication Interface	Energy Services Communications Interface (ESCI) communicates to Roaming Utility energy supplied to PEV for each charging session.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
18	Roaming Utility	Roaming Utility records each PEV charging session for reporting to Clearinghouse. Customer account associated with this roaming utility premise will be credited for energy supplied for this charging session.	
19	Roaming Utility	Roaming Utility forwards transaction to Clearinghouse for energy supplied to PEV including PEV ID, Customer ID, Home Utility ID, and interval based charging session information.	
20	Clearinghouse	Clearinghouse receives energy charge transaction from Roaming Utility for posting charges to PEV operator's home utility Customer account.	See Issue 8.0 (Section 6) See Issue 9.0 (Section 6)

3.5 Primary Scenario: Non-enrolled PEV (or Customer with non-communicating PEV) connects to energy portal

This scenario describes what happens if an un-enrolled PEV can communicate with local area network (e.g., LAN, HAN, PAN) or Customer has PEV that cannot communicate or cannot communicate with a specific Utility's network.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV into energy portal	*PEV*	*Customer has a PEV, but is un-enrolled in a Utility PEV program, has a non-communicating PEV, or both.*	*No communication session established with Utility network or devices. PEV charges successfully with all energy charges accruing to charging premise account.*

3.5.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV connects to energy portal at any customer location. This could be in the PEV operator's home utility service territory or in a foreign utility service territory.	
2	PEV	PEV senses power to on-board charging unit and activates 'On Plug' state	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV (if communications enabled) and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PEV or ESCI as initiator of session. If PEV does not have communications capability (or if comms disabled), charging will commence with all energy charges accruing to premise customer at default rate for customer account.
4	PEV	PEV ID is transmitted to ESCI	

Step #	Actor	Description of the Step	Additional Notes
5	Utility	Utility checks PEV ID, Premise ID against internal database. If not found (because PEV is roaming outside of home utility), utility forwards PEV ID to Clearinghouse for verification.	
6	Utility/Clearinghouse	Neither utility nor clearinghouse has record of the PEV ID	Utility will have PEV ID of un-enrolled PEV, should it desire to identify it and contact operator regarding potential enrollment in utility program.
7	PEV	PEV begins charging based on Customer selected preferences. All energy charges accrue to premise account.	

4. REQUIREMENTS

Detail the Functional, Non-functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Req ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV shall be capable of plugging into EVSE enabled 120V or 240V AC energy portal to receive a charge of electric energy.		
2	Premise supports charging multiple PEVs simultaneously, both “home” and guest”.		
3	PEV shall be able to charge upon plugging into EVSE enabled 120V or 240V AC energy portal (with or without communications established with utility)		
4	The PEV shall be capable of sensing ‘on plug’ state, participating in communications with ESCI, and proceeding with charging according to customer selected preference.		
5	The Energy Services Communication Interface shall exist at the customer premise and be capable of communicating to the Utility and can communicate to the PEV to facilitate exchange of charging session information.		
6	Vehicle is communicating to the utility through an Energy Services Communication Interface (ESCI)		
7	PEV has a unique ID, which can be stored within and communicated from PEV.		
8	The PEV shall be capable of providing to the Energy Services Communication Interface (ESCI) its unique PEV ID upon initiation of a communications session between PEV and ESCI.		
9	The Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, associated PEV IDs, Customer IDs, and premise IDs.		
10	Utility shall be able to determine customers/premises not enrolled in PEV program.		
11	Utility has established message and data interface exchange mechanism with Clearinghouse for verification of roaming PEV.		

Req ID	*Functional Requirements*	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
12	Utility shall be able to verify that usage attributable to PEV charging is sourced from the same customer/premise that has provided the ESCI for PEV-to-Utility communications (e.g., Load correlation to ESCI communications).		
13	PEV capable of receiving a confirmation message from Utility via ESCI establishing valid charging session. This indication can in turn be made available to customer to indicate that communications session has been successfully established.		
14	An End Use Measurement Device is required to discretely measure usage provided for PEV charging.		
15	End Use Measurement Device (EUMD) function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection		
16	The End Use Measurement Device shall be a meter capable of metering energy supplied to the PEV for each metering interval according to the tariff		
17	The End Use Measurement Device shall be capable of recording charging session information (e.g., PEV ID, Premise ID).		
18	PEV End Use Measurement Device is utility-, auto manufacturer-, and state weights and measures body-compatible (Specific standard to be determined).		
19	The End Use Measurement Device shall allow for remote configuration of energy measurement interval length.		
20	The End Use Measurement Device shall be capable of reporting all PEV charging session information and energy usage for PEV charging to the Energy Services Communication Interface.		
21	The End Use Measurement Device shall be capable of communicating with the Utility via the Energy Services Communication Interface.		
22	PEV, End Use Measurement Device, and Energy Services Communication Interface have established a secure communications link.		
23	The Energy Services Communication Interface shall be capable of reporting all PEV charging session's information and energy usage for PEV charging to the Utility.		
24	The Utility shall accurately bill the correct customer account for the total kWhrs supplied during a predetermined billing period to a PEV, according to the selected rate tariff, when the PEV customer and the local premise customer are the same.		
25	The Utility shall accurately bill the correct local premise customer account for the total kWhrs supplied during a predetermined billing period to a PEV, according to the selected rate tariff, when the PEV customer and the charging premise customer are NOT the same and the charging premise customer has been designated for PEV usage charges.		
26	The Utility shall accurately credit the correct local premise customer account for the total kWhrs supplied during a predetermined billing period to a PEV, according to the selected rate tariff, when the PEV customer and the local premise customer are NOT the same and the PEV customer has been designated for PEV usage charges. Utility will handle billing PEV usage to utility account associated to PEV ID.		
27	The Utility shall accurately credit the correct local premise customer account for the total kWhrs supplied during a predetermined billing period to a PEV, according to the selected rate tariff, when the PEV customer and the local premise customer are NOT the same and the PEV customer has been designated for PEV usage charges.		
28	In the foreign/roaming utility charging case, Clearinghouse will handle billing transaction to home utility account associated to PEV ID and settling charges across utilities.		

Req ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
29	The Clearinghouse shall store the relationship between PEV ID, Home Utility ID, and Home Utility Account ID.		
30	If ESCI communications cannot be established between PEV and Utility within a configurable period of time after 'on plug' state, charging will proceed (according to customer preferences) with all charges accruing to premise customer account according to that customer's regular utility rate.		
31	ESCI shall be able to provide the Premise ID to the Utility (along with PEV ID provided by PEV) for validation/verification.		
32	Utility shall have a means to determine whether PEV operator/customer or premise customer accrues energy charges when Premise Customer and PEV operator/customer are not the same. (Must be considered in enrollment scenario).		

4.2 Non-functional Requirements

Non-func. Req ID	Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
NF.1	Time will be maintained by each device in the system to UTC with 1 second resolution		
NF.2	EUMD shall record interval data configurable for interval lengths between 1 minute and 60 minutes inclusive.		
NF.3	PEV attempts to initiate communication session before initiating charging.		
NF.4	PEV waits a minimum time (e.g., 1 minute) to allow for verification/validation before charging activation		

5. USE CASE MODELS (OPTIONAL)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

For each scenario detail the information exchanged in each step

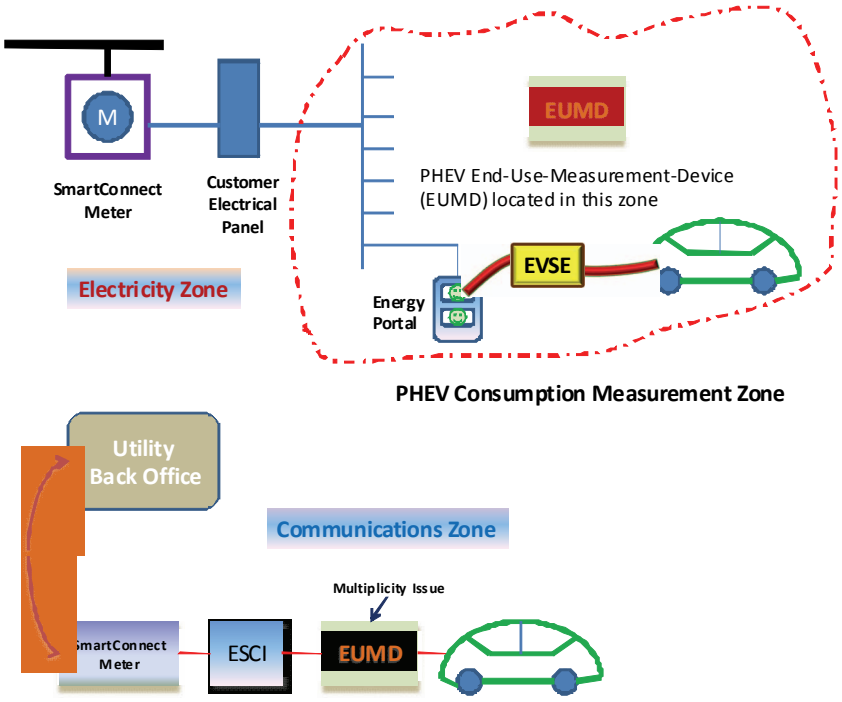
This will need to be updated given step and reqts update…..should be in synch with sequence diagram also.

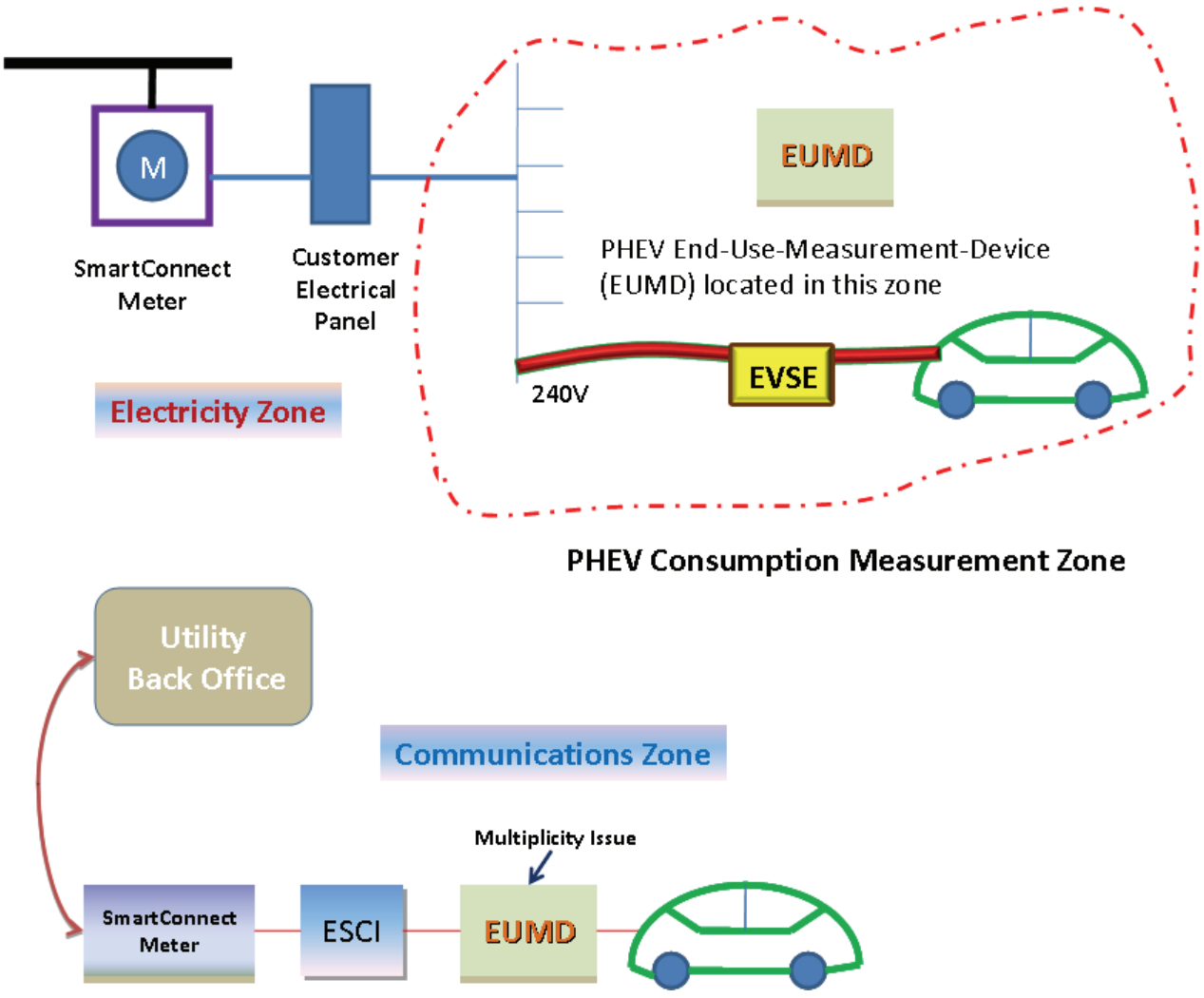
Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
#	*Name of the step for this scenario.*	*What actors are primarily responsible for Producing the information?*	*What actors are primarily responsible for Receiving the information?*	*Describe the information being exchanged*
1,2,3 5	2 4	PEV	ESCI	PEV ID, Premise ID, Authorization Success Indicator
4	5	ESCI	Utility	PEV ID, Premise ID
4 5	6 5	Roaming Utility	Clearinghouse	• PEV ID • Premise ID • Foreign/Roaming Utility ID

Scenario #	*Step #, Step Name*	*Information Producer*	*Information Receiver*	*Name of information exchanged*
4	8	Clearinghouse	Roaming Utility	• Verification of PEV ID • Verification of Utility ID • Home Utility ID • Home Utility Account ID • Meter Interval
4	9	Roaming Utility	ESCI, End Use Measurement Device	For each 'On Plug' state session and once-a-day • Verification of PEV ID / Premise ID • Meter Interval
1,2,3 4	6 12	End Use Measurement Device	ESCI	Charging session event message • PEV ID • Premise ID • Metered energy supplied by each metering interval
1,2,3 4	7 13	ESCI	Utility	Charging session event message • PEV ID • Premise ID • Metered energy supplied by each metering interval
4	15	Utility	Clearinghouse	Charging session event message • PEV ID • Premise ID • Customer ID • Utility ID • Metered energy supplied by each metering interval

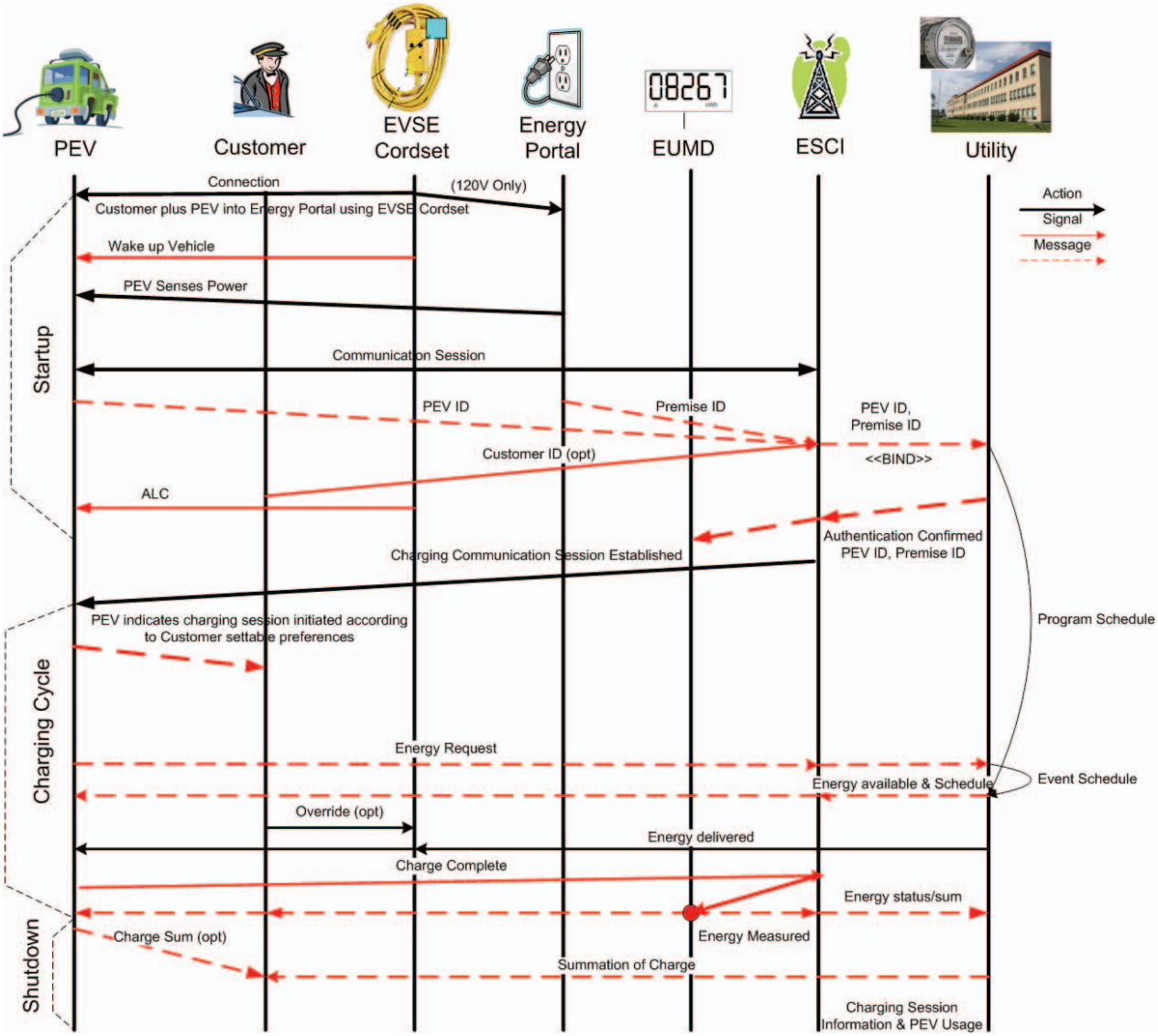
5.2 Diagrams

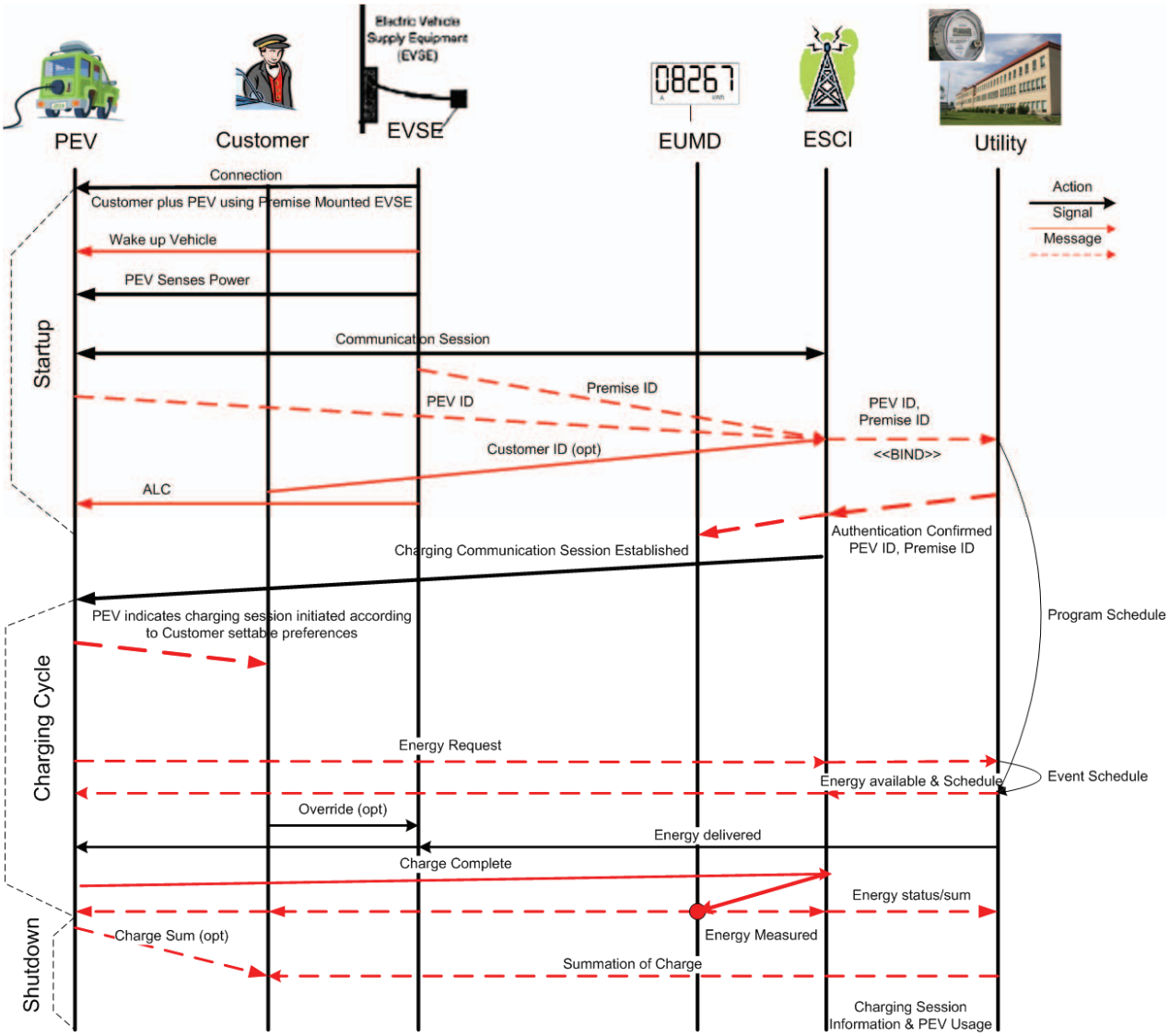
The architecture team shall use this section to develop an interaction diagram that graphically describes the step-by-step actor-system interactions for all scenarios. The diagrams shall use standard UML notation. Additionally, sequence diagrams may be developed to help describe complex event flows.



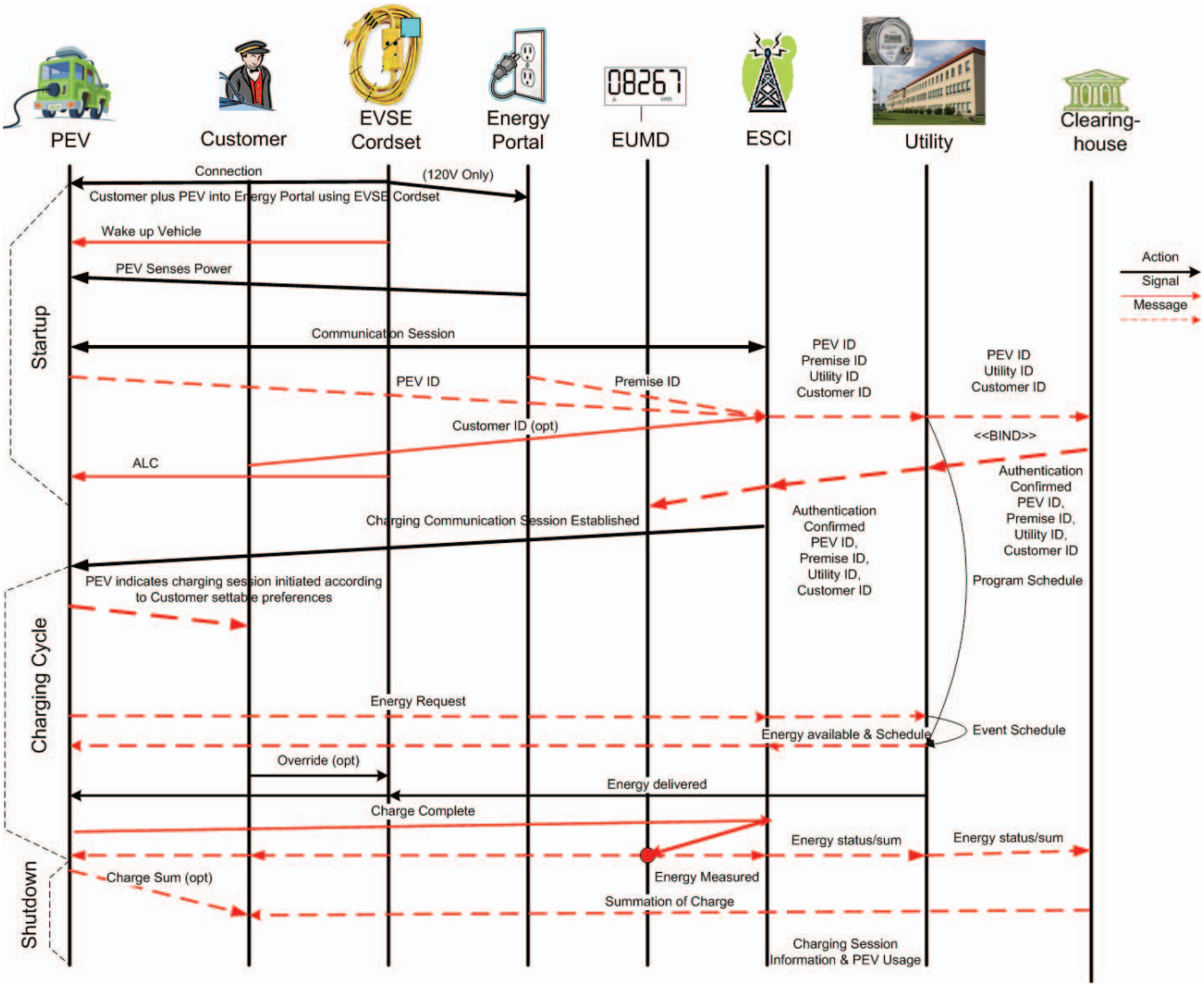

M
SmartConnect Meter
Customer Electrical Panel
EUMD
PHEV End-Use-Measurement-Device (EUMD) located in this zone
240V
EVSE
Electricity Zone
PHEV Consumption Measurement Zone
Utility Back Office
Communications Zone
Multiplicity Issue
SmartConnect Meter
ESCI
EUMD

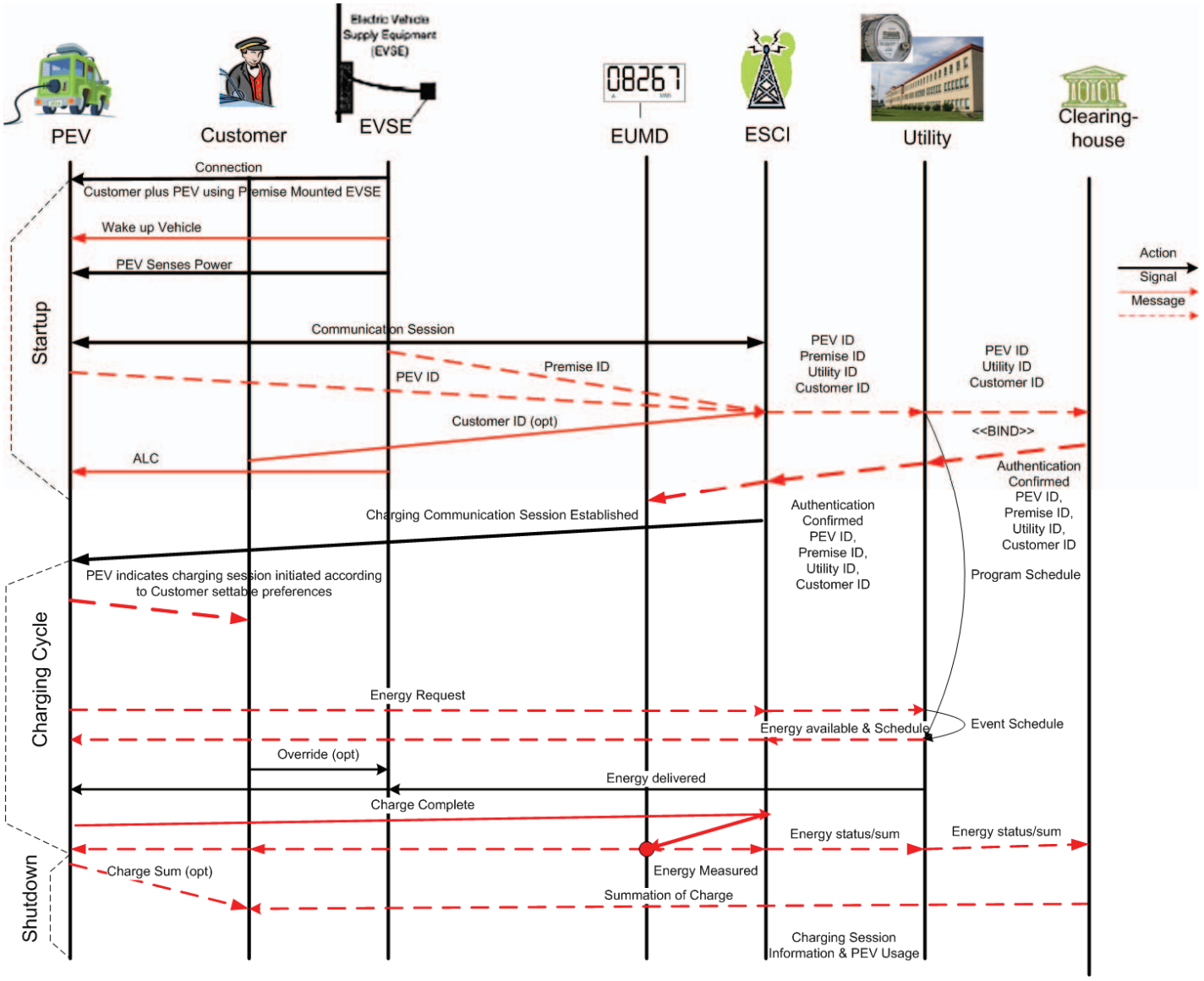
Sequence Diagram: Scenarios 1, 2, 3




PEV
Customer
Electric Vehicle Supply Equipment (EVSE)
EVSE
EUMD
ESCI
Utility
Action
Signal
Message
Connection
Customer plus PEV using Premise Mounted EVSE
Wake up Vehicle
PEV Senses Power
Startup
Communication Session
Premise ID
PEV ID
PEV ID, Premise ID
<<BIND>>
Customer ID (opt)
ALC
Authentication Confirmed PEV ID, Premise ID
Charging Communication Session Established
PEV indicates charging session initiated according to Customer settable preferences
Program Schedule
Charging Cycle
Energy Request
Energy available & Schedule
Event Schedule
Override (opt)
Energy delivered
Charge Complete
Energy status/sum
Energy Measured
Shutdown
Charge Sum (opt)
Summation of Charge
Charging Session Information & PEV Usage

Sequence Diagram: Scenario 4




PEV
Customer
Electric Vehicle Supply Equipment (EVSE)
EVSE
EUMD
ESCI
Utility
Clearing-house
Action
Signal
Message
Startup
Connection
Customer plus PEV using Premise Mounted EVSE
Wake up Vehicle
PEV Senses Power
Communication Session
PEV ID
Premise ID
PEV ID
Premise ID
Utility ID
Customer ID
PEV ID
Utility ID
Customer ID
Customer ID (opt)
<<BIND>>
ALC
Authentication Confirmed PEV ID, Premise ID, Utility ID, Customer ID
Charging Communication Session Established
Authentication Confirmed PEV ID, Premise ID, Utility ID, Customer ID
Program Schedule
Charging Cycle
PEV indicates charging session initiated according to Customer settable preferences
Energy Request
Energy available & Schedule
Event Schedule
Override (opt)
Energy delivered
Charge Complete
Energy status/sum
Energy status/sum
Shutdown
Charge Sum (opt)
Energy Measured
Summation of Charge
Charging Session Information & PEV Usage

6. USE CASE ISSUES

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.
5.0 - End Use Measurement Device (EUMD) communicates energy supplied to PEV to Energy Services Communication Interface for each charging session. A question arises: What triggers or invokes this communication session? Does this event get triggered upon the battery completing a full charge? Does this happen at termination of charge and PEV unplugs? If the session does not immediately, does the session take place next time a PEV charges in and can communicate to an ESCI?
6.0 – Concern expressed about the viability of implementing a billing system for scenarios 2 and 3 that keeps track of usage for PEV charging at a non-PEV Operator/Customer premise and charges the PEV customer account & credits the premise Customer account correctly.
7.0 – Need to determine what happens when communications is not successful between PEV and Utility. This may especially be an issue in case of roaming. Assumption is that with no communications, energy charges would accrue to premise account at default utility rate for that account (i.e., no incentive rates). Customer would not receive notification of successful binding/comms session in this case.
8.0 – For home or foreign utility roaming, would need to consider what rates PEV operator would pay for usage outside of home premise, especially in a tiered rate environment. For example, would non-home premise PEV usage count against (and be charged at rates for) PEV operator's home premise baseline, charging premise customer's baseline, or neither?
9.0 – For foreign utility roaming, would need to consider what rates PEV operator would pay. Home utility's rates, roaming utilities rates, special roaming rates, etc? Answer may be different depending on whether home or foreign utility has the higher energy prices. This would affect how clearinghouse accomplishes cross-utility settlement.
10.0 – Regarding the cross utility Clearinghouse for PEVs, further consideration needs to be taken to determine whether PEV ID/Customer ID information is actually stored at the clearinghouse, or if it is simply a facilitator of information exchange between utilities that allows for rapid, automated account validation/acknowledgement.
Information exchange needs to be reviewed for considering the exchange of meter ID and service delivery point ID as required data that may be required for reconciliation of account either with the utility or the clearinghouse. *Classic meter malfunction illustrates the need for this information, e.g., communications board fails, truck rolls and replaces meter. Service delivery point is the same but meter ID has changed. Repaired meter may then be installed at another premise. Original account the meter ID and service delivery point the meter was associated with has changed.*

7. GLOSSARY

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**
Rate tariff	Energy cost schedule to customer. Can be time-of-day, flat rate, seasonal rate, critical peak price rate, etc.
PEV	Plug-in Electric Vehicle
EUMD	End Use Measurement Device, revenue measuring device
ESCI	Energy Services Communication Interface
charging	Act of electrically charging a battery on-board a Plug-in Electric Vehicle or Electric Vehicle

A.4 PEV3 - CUSTOMER ENROLLS IN A PEV3 DEMAND SIDE MANAGEMENT PROGRAM

AMI Use Case:
PEV3 - Customer enrolls in a PEV Demand Side Management Program
02/12/09

Document History

Revision History

Revision Number	Revision Date	Revision / Reviewed By	Summary of Changes	Changes marked
(#)	(yymmdd)	(Name)	(Describe change)	(N)
0.4	080424	Jerry Melcher	Initial Draft document	N
1.0	080424	Bryan Lambird	Minor revisions for 1st Review Draft	N
1.1	080508	Bryan Lambird	Added Issue 1.1 following review with SCE Electric Transportation	N
2.0	080513	Bryan Lambird	Incorporated various feedback from multiple reviewers	N
2.1	080624	Jerry Melcher	Changed Label to P3 from PEV2, updated with feedback from multiple reviewer	Y
3.0	080724	Bryan Lambird	Incorporating Additional Feedback and Edits	Y
3.1	080810	Bryan Lambird	Incorporating Additional Feedback and Edits on v3.0 (including use of Demand Side Management terminology)	N
4.0	090212	Arindam Maitra	Updates	Y
5.0	090305	Rich Scholer	Deleted Requirement section until we can coordinate with HAN submissions. Updated EUMD definition.	Y
5.1	091230	Rich Scholer	Added Requirements	N

Approvals

This document requires following approvals.

Name	Title

CONTENTS

1. USE CASE DESCRIPTION

1.1 Use Case Title

Customer enrolls in a PEV demand side management Program

1.2 Use Case Summary

The Utility offers demand side management programs specifically for customers with PEVs to enroll in. Participants in the selected PEV demand side management program may respond to demand response requests by the Utility by reducing PEV load or shifting the time of day that the PEV is being charged. Scenarios for the following types of demand side management programs have been considered for this Use Case:

1) Customer is enrolled in a PEV Time-of-Use (TOU) pricing demand side management program (e.g., off-peak, mid-peak, on-peak, etc.)

2) Customer is enrolled in a PEV Discrete Event demand side management program (Direct Load Control)

3) Customer is enrolled in a PEV Periodic/Hourly Pricing Price Response program

4) Active load management – utility

The selected demand side management program allows the customer to respond in different ways to the demand response request by Utility. Whenever a demand response request is initiated, the Utility notifies PEV Customers enrolled in applicable Utility PEV demand side management programs to encourage action. A variety of notification methods are selectable by the Customer (e.g., pager, e-mail, text message on cell phone, web page, etc).

When the Customer plugs the PEV into the Energy Portal, which activates the PEV “On-Plug” State, a communication session is established between the PEV and the Utility via an Energy Services Communication Interface (ESCI) at the premise. The ESCI will forward discrete demand response event information or a day-ahead periodic/hourly pricing table available from the Utility to the customer PEV. PEV charging proceeds based on Customer-configurable charging preferences set inside the PEV. The Customer has the ability to override and opt-out of demand response events for the PEV. The Customer may receive a reduced incentive for exercising this option. The ESCI returns PEV charging status and energy supplied to the PEV back to the Utility from an End Use Measurement Device.

The Utility will measure (using data from the PEV End Use Measurement Device) the aggregate load reduction. This information can be fed back into a model used to determine the value of future load reduction requests.\

1.3 Use Case Detailed Narrative

The Utility offers demand side management programs specifically for Customers with PEVs to enroll in. Participants in the selected PEV demand side management program may respond to requests by the Utility by reducing PEV load or shifting the time of day that the PEV is being charged. Scenarios for the following types of demand side management programs have been considered for this Use Case:

4) Customer is enrolled in a PEV Time-of-Use (TOU) pricing demand side management program (e.g., off-peak, mid-peak, on-peak, etc.)

5) Customer is enrolled in a PEV Discrete Event demand side management program (Direct Load Control)

6) Customer is enrolled in a PEV Periodic/Hourly Pricing Price Response program

The selected demand side management program allows the customer to respond in different ways to the demand response request by Utility. Whenever a demand response request is initiated, the Utility notifies PEV Customers enrolled in applicable Utility PEV demand side management programs to encourage action. A variety of notification methods are selectable by the Customer (e.g., pager, e-mail, text message on cell phone, web page, etc).

PEV Time-of-Use

For those customers enrolled in a PEV Time-of-Use (TOU) pricing demand side management program, applicable energy prices and rate periods (e.g., off-peak, mid-peak, on-peak, etc.) will be made known to the Customer and PEV. PEV initiates charging based on Customer-defined preference settings (considering peak/off-peak rate periods) in the PEV. PEV may not receive demand response discrete event notifications; however, some Customers enrolled in PEV TOU demand side management programs could also enroll in a Discrete Event demand side management program. Because no regular periodic communications between PEV and vehicle is required to support a basic PEV TOU pricing demand side management program, an explicit scenario for this option was not included in this use case. However, Utility-to-PEV communications for PEVs enrolled in a TOU demand side management program does offer other benefits (e.g., updated rates displayed in PEV).

PEV Discrete Event

For those customers enrolled in a PEV Discrete Event demand side management program, Utility sends a discrete event request to PEV based upon a prediction of energy supply and/or grid reliability concerns. Such a message may direct the PEV to discontinue PEV charging until the demand response event is over, or until the time duration allowed for the event expires.

PEV Periodic/Hourly Pricing

For those customers enrolled in a PEV Periodic/Hourly Pricing Price Response program, the utility will download day-ahead 24 hour prices for each hour to the PEV. PEV charging proceeds based on Customer-selected preference settings in the PEV.

Customer plugs PEV into Energy Portal to initiate charging. PEV senses power to on-board charging unit and activates 'On Plug' State. A communication session is established between the PEV and the Utility via an Energy Services Communication Interface (ESCI). ESCI handles communication session – including security – and transports all demand side management information between the PEV and Utility. PEV ID is transmitted to ESCI and on to Utility. Utility verifies PEV ID and Premise ID and sends back acknowledgement message. If PEV is enrolled in PEV demand side management program, Utility downloads discrete demand response event information or day-ahead periodic/hourly pricing table to PEV via ESCI.

PEV charging proceeds based on Customer settable preferences. The customer has the ability to override and opt out of demand response events for the PEV through Customer-configured preferences in the PEV. The customer may receive a reduced incentive for exercising this option. End Use Measurement Device records energy supplied to PEV for each charging session. End Use Measurement Device communicates energy supplied to PEV to ESCI, which in turn conveys this information to the Utility. Utility records each PEV charging session for bill generation and reporting.

The Utility will measure (using data from the End Use Measurement Device) the aggregate load reduction. This information can be fed back into a model used to determine the value of future load reduction requests.

1.4 Business Rules and Assumptions

- High level assumption that PEV and utility have communications capabilities.

- Demand Response events will be distributed to PEVs via utility-managed communications infrastructure, with ESCI available at end points; other non-Utility (e.g., cellular, Wi-Fi) communications mechanisms could be considered in additional scenarios.

- The demand side management scenarios for this use case can only be applied to Customers that have enrolled in a Utility PEV demand side management program and have registered one or many PEVs with the Utility. The enrollment and registration scenarios are covered in a separate Use Case (P1).

- End Use Measurement Device (EUMD), either fixed or mobile, is always available for energy validation of PEV charging. If not available, charging will proceed, but with limitations on incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

- End Use Measurement Device (EUMD) function can be located anywhere in a zone from the PEV and the branch circuit panel connection.

2. ACTORS

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g., operators, system administrators, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	***Actor Type (person, device, system, etc.)***	***Actor Description***
AES – See ESCO	Organization	Alternative Energy Supplier
Charger	Device	The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.
Clearinghouse	Organization	Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.
Control Device	Device	DLC programs (see section 3.1) enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the next day.
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.
Customer Account	System	Customer Account is assigned to Customer to collect charges for billing of energy usage
Customer Energy Management System	System	Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.

Actor Name	*Actor Type (person, device, system, etc.)*	*Actor Description*
Electric Vehicle Supply Equipment (EVSE)	Device	PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772, SAE J2836 and SAE J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and (2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772.
Energy Portal (EP)/Smart Energy Portal (SEP)	Device	Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.
Energy Services Communication Interface (ESCI) See ESI for similarities	System	Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information PEV shall be capable of communicating to the Utility through an ESCI ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility – PEV ID, interval kWhr consumption. Passes energy information, including price signals, schedules (including time zone and charge "window"), event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN). ESCI shall employ appropriate security policies when communicating demand side management program-related messages
ESI	System	Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.
End Use Measurement Device (EUMD)	Device	End Use Measurement Device (EUMD) is a HAN device that measures energy consumed by a PEV and communicates the information to the ESI.
ESCO – See AES	Organization	Competitive (or alternative) supplier of commodity service

Actor Name	*Actor Type (person, device, system, etc.)*	*Actor Description*
Guest	Person	Guest is a friend or family member who has permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.
PEV, EV, PHEV	System	Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.
Roaming Utility	Organization	Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer's Utility service territory.
Utility	Organization	Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

End Use Measurement Device (EUMD) is always available for energy validation of PEV charging. If not available, charging will proceed, but with limitations on incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by starting the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Customer is enrolled in a PEV Discrete Event demand side management program (Direct Load Control) and PEV (and/or PEV customer) receives and responds to discrete demand response events

For those customers enrolled in a PEV discrete event demand side management program (possibly in exchange for special PEV tariffs or other incentives), this program allows the utility to request an automated load reduction at the customer site by issuing event information to the PEV. The customer can override and/or opt-out of the request in exchange for a reduced incentive. Typically, PEV demand response events are downloaded at least 24 hours ahead, however they could be provided day-of in the case of a grid reliability emergency

- Utility shall be able to transmit discrete demand response event messages to an ESCI and onward to PEV.
- Utility shall track Customer preference for remote notification of PEV Demand Response (DR) events.
- Utility shall transmit PEV Demand Response event alerts to Customer via Customer-designated communication channel(s).
- Customer shall have the ability to override and/or opt-out of discrete demand response events.
- PEV shall charge based on Customer-configurable preferences and shall take appropriate action based upon discrete demand response events.

- PEV shall send Customer opt-out notification message to Utility.

- Pre–event notification shall be sent to customers in advance in a range from one minute in an emergency up to 24 hours for normal/planned discrete demand response events

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
As electrical system approaches overload and/or resources become constrained	*PEV*	*Customer has subscribed to a PEV demand side management discrete event program.*	*Conditions that led to constrained resources have abated or been mitigated. Customer returns to normal PEV load operation.*

3.1.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Utility	Utility declares Demand Response event.	
2	Utility	At least 24 hours prior to event, Utility sends out remote notification to PEV Customers enrolled in PEV DR programs indicating demand response action. Notification can be via pager, e-mail, text message on cell phone, web page, etc.	
3	Customer	Customer selects/adjusts demand side management preference(s) on PEV (if necessary) and connects PEV to energy portal at his local premise.	See Issue 1.0 (Section 6)
4	PEV/ Energy Services Communication Interface (ESCI)	PEV and Energy Services Communication Interface (ESCI) perform PEV binding and authentication process (See Use Case P1).	
5	Utility	Utility downloads demand response discrete event information to PEV via ESCI. Message includes event information or load reduction request notification.	

Step #	Actor	Description of the Step	Additional Notes
6	PEV	PEV charging proceeds based on Customer defined preferences (which considers receipt of demand side management information).	
7	Customer	Customer has the ability to override and/or opt-out of demand response event using Customer-configurable preferences in the PEV. Customer may receive a reduced incentive for exercising this option.	Other means of indicating override or opt-out (e.g., outside of vehicle) may also be considered here.
8	PEV	Upon selecting to override and/or opt-out of demand response event, PEV will transmit message to Utility (via ESCI) to notify of Customer action.	See Issue 2.0 (Section 6)
9	End Use Measurement Device	EUMD, either fixed or mobile, records energy supplied to PEV for each charging session.	
10	End Use Measurement Device	EUMD securely communicates energy supplied to PEV to the ESI using the ESCI for each charging session.	
11	ESCI	ESCI securely communicates energy supplied to PEV to Utility for each charging session.	
12	Utility	Utility records each PEV charging session for bill generation and reporting. Utility assesses customer actions (e.g., opt-out or override) during demand response event and may apply reduced incentive if necessary.	

3.2 Customer is enrolled in a Periodic/Hourly Pricing Price Response program and PEV receives and responds to periodic/hourly energy prices (day-ahead schedule)

For those customers enrolled in a hourly price demand side management program, this program will download a schedule of 24 hours critical peak pricing for the next day, at least 24 hours ahead, based upon a prediction of energy shortages.

- The utility will download day-ahead 24 hour prices for each hour to the PHEV. PHEV charging proceeds based on Customer-selected preference settings in the PHEV
- Utility shall be able to transmit periodic/hourly pricing tables to an ESCI and onward to PHEV.
- Utility shall apply correct rate structure for accurate customer billing considering any enrolled PHEV demand side management programs and the benefits for compliance or charges for overrides and opt outs which are included in those programs.
- PHEV shall charge based on Customer-configurable preferences and shall take appropriate action based upon a periodic/hourly price table.
- PHEV shall send Customer opt-out notification message to Utility

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Utility determines day-ahead periodic/hourly pricing	*PEV*	*Customer has subscribed to a PEV periodic/hourly pricing demand side management program.*	*Conditions that led to constrained resources have abated or been mitigated. Customer return to normal PEV load operation.*

3.2.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Utility	Utility determines periodic/hourly prices for the next day, based on forecasts.	
2	Utility	In the case of abnormally high hourly prices, Utility may send out remote notification to PEV Customers enrolled in this type of PEV DR Program advising demand response action. Notification can be via pager, e-mail, text message on cell phone, web page, etc.	
3	Customer	Customer selects/adjusts demand side management preference(s) on PEV (if necessary) and connects PEV to energy portal at his local premise.	See Issue 1.0 (Section 6)
4	PEV/ Energy Services Communication Interface (ESCI)	PEV and Energy Services Communication Interface (ESCI) perform PEV binding and authentication process (See Use Case P1).	
5	Utility	Utility downloads day-ahead periodic/hourly pricing rate table to PEV via ESCI. Table includes periodic/hourly prices for each period in the next day, or current day if table not yet downloaded for current day.	

Step #	Actor	Description of the Step	Additional Notes
6	PEV	PEV charging proceeds based on Customer-defined preferences (which considers current hourly/periodic pricing table). Customer may set or adjust limits for acceptable price for charging.	
7	End Use Measurement Device	EUMD, either fixed or mobile, records energy supplied to PEV for each charging session.	
8	End Use Measurement Device	EUMD securely communicates energy supplied to PEV to the ESI using the ESCI for each charging session.	
9	Energy Services Communication Interface	ESCI securely communicates energy supplied to PEV to Utility for each charging session.	
10	Utility	Utility records each PEV charging session for bill generation and reporting.	Assumes that billing process will correctly apply hourly prices to the appropriate usage intervals.

4. REQUIREMENTS

Detail the Functional, Non-functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Req ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	Utility shall track Customer preference for remote notification of PEV Demand Response (DR) events.		
2	Utility shall transmit PEV Demand Response event alerts to Customer via Customer-designated communication channel(s).		
3	The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PEV to facilitate exchange of demand side management information.		
4	PEV shall be capable of communicating to the Utility through an Energy Services Communication Interface (ESCI).		
5	PEV shall have a unique ID.		
6	PEV shall be capable of providing to the Energy Services Communication Interface (ESCI) its unique PEV ID upon initiation of a communication session between PEV and ESCI.		
7	Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including demand side management programs, associated PEV IDs, customer IDs, and premise IDs.		

Req ID	*Functional Requirements*	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
8	Utility shall be able to transmit discrete demand response event messages to an ESCI and onward to PEV.		
9	Utility shall be able to transmit periodic/hourly pricing tables to an ESCI and onward to PEV.		
10	PEV shall charge based on Customer-configurable preferences and shall take appropriate action based upon discrete demand response events and/or a periodic/hourly price table.		
11	Customer shall have the ability to override and/or opt-out of discrete demand response events.		
12	PEV shall send Customer opt-out notification message to Utility		
13	End Use Measurement Device shall discretely measure usage provided for PEV charging.		
14	End Use Measurement Device (EUMD) function shall be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.		
15	End Use Measurement Device shall be a meter capable of metering energy supplied to the PEV for each metering interval according to the tariff.		
16	End Use Measurement Device shall record charging session information (e.g., PEV ID, Premise ID).		
17	End Use Measurement Device shall allow for remote configuration of energy measurement interval length.		
18	End Use Measurement Device shall report all PEV charging session information and energy usage for PEV charging to the Energy Services Communication Interface.		
19	PEV, End Use Measurement Device, and Energy Services Communication Interface shall employ appropriate security policies when communicating demand side management program-related messages.		
20	Energy Services Communication Interface shall report all PEV charging session information and energy usage to Utility.		
21	Utility shall apply correct rate structure for accurate customer billing considering any enrolled PEV demand side management programs and the benefits for compliance or charges for overrides and opt outs which are included in those programs.		

4.2 Non-functional Requirements

Non-func. Req ID	*Non-Functional Requirements*	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
NF.1	Time will be maintained by each device in the system to UTC with 1 second resolution		
NF.2	EUMD shall record interval data configurable for interval lengths between 1 minute and 60 minutes inclusive.		
NF.3	Pre–event notification shall be sent to customers in advance in a range from one minute in an emergency up to 24 hours for normal/planned discrete demand response events.		

5. USE CASE MODELS (OPTIONAL)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

For each scenario detail the information exchanged in each step

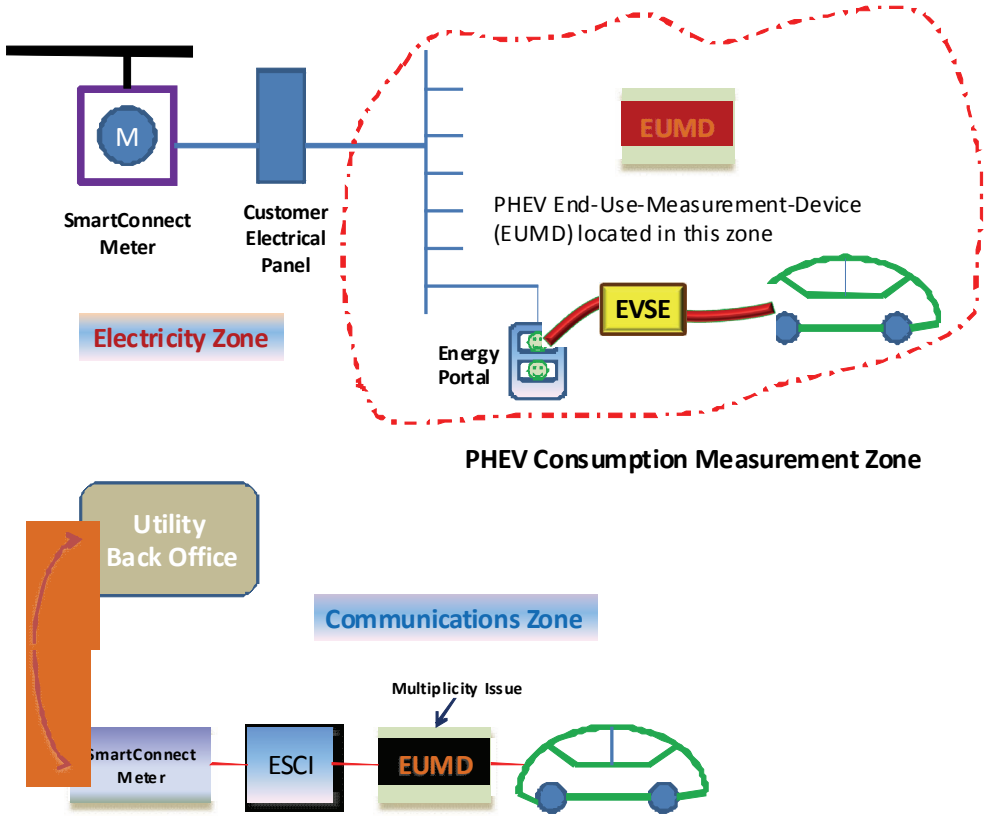
Please add a sequence diagram for this Use Case also

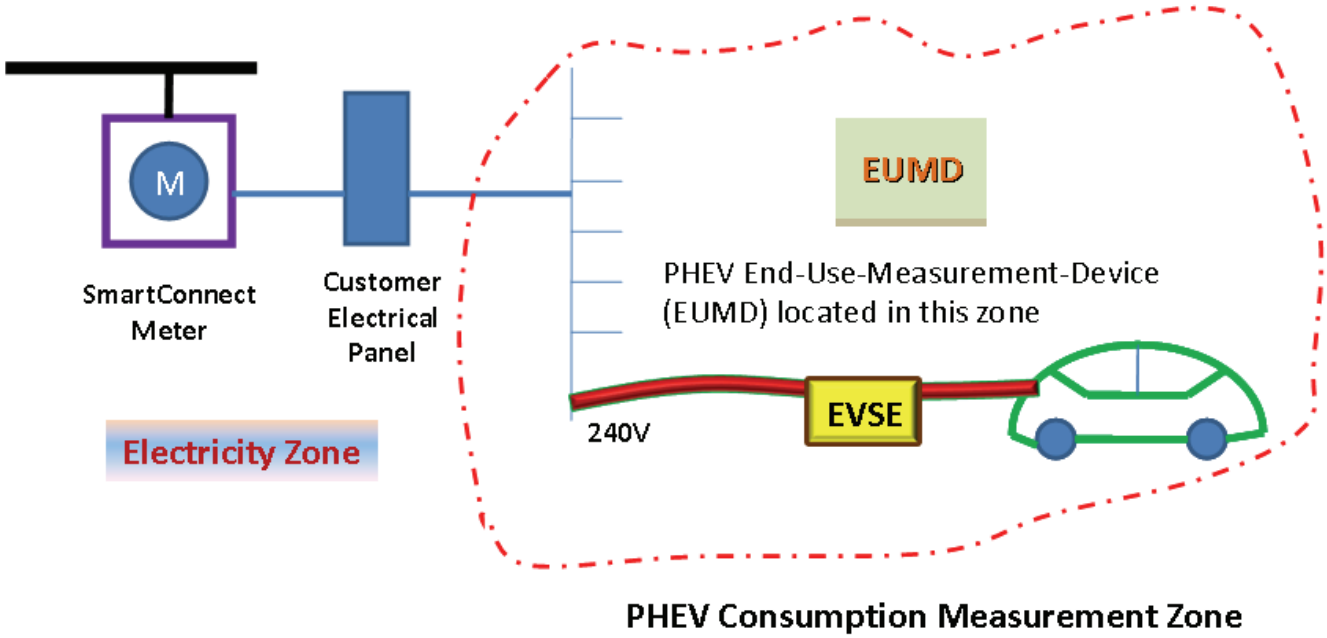
Scenario #	*Step #, Step Name*	*Information Producer*	*Information Receiver*	*Name of information exchanged*
#	*Name of the step for this scenario.*	*What actors are primarily responsible for Producing the information?*	*What actors are primarily responsible for Receiving the information?*	*Describe the information being exchanged*
1,2	4	PEV	ESCI, Utility	PEV ID, Premise ID
1	5	Utility	ESCI, End Use Measurement Device, PEV	For each ‘On Plug’ state session and once-a-day • Verification of PEV ID • Verification of Premise ID • Demand Response discrete event information
2	5	Utility	ESCI, End Use Measurement Device, PEV	For each ‘On Plug’ state session and once-a-day • Verification of PEV ID • Verification of Premise ID • Day Ahead Periodic/Hourly 24 hour pricing rate table
1	8	Customer	PEV, ESCI, Utility	Indication of Customer Action to opt-out or override discrete demand response event.

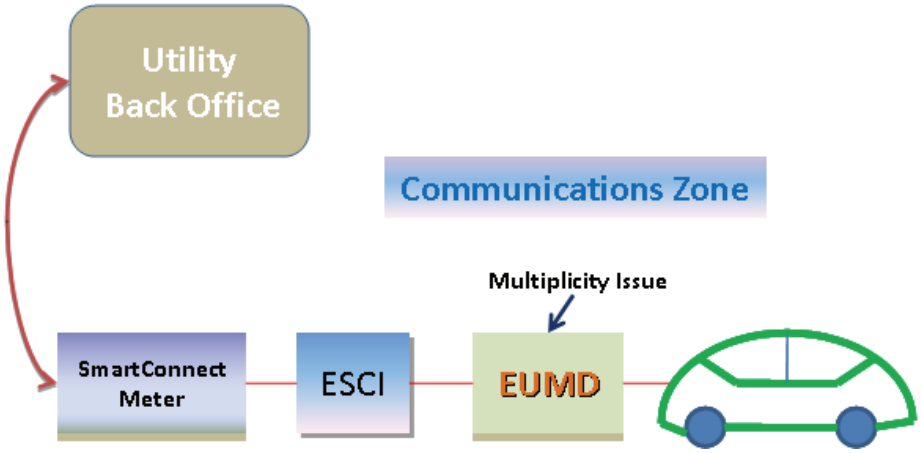
Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
1 2	10,11 8,9	End Use Measurement Device	ESCI, Utility	Charging session event message • PEV ID • Premise ID • Metered energy supplied by each metering interval

5.2 Diagrams

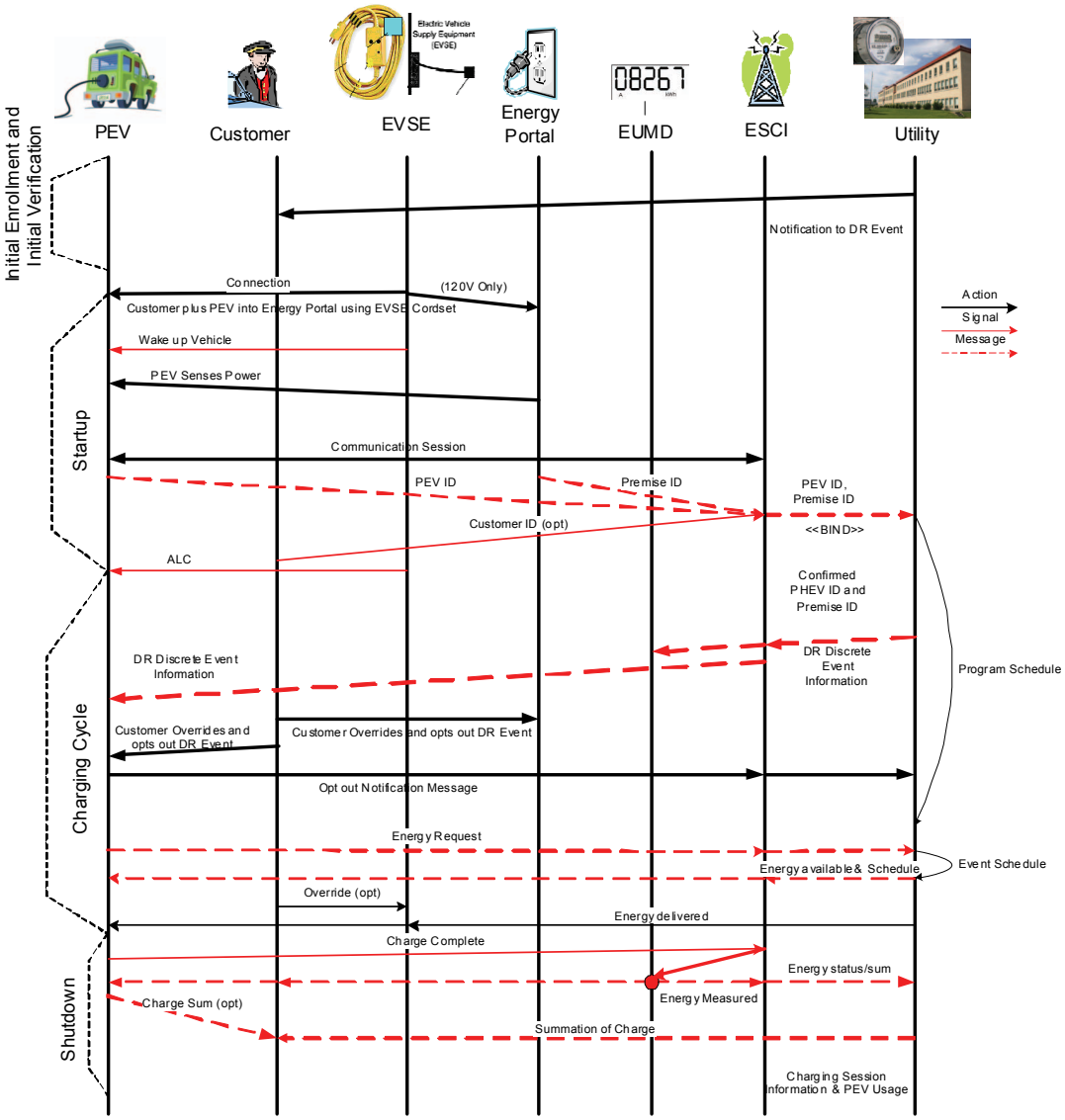
The architecture team shall use this section to develop an interaction diagram that graphically describes the step-by-step actor-system interactions for all scenarios. The diagrams shall use standard UML notation. Additionally, sequence diagrams may be developed to help describe complex event flows.




M
SmartConnect Meter
Customer Electrical Panel
EUMD
PHEV End-Use-Measurement-Device (EUMD) located in this zone
240V
EVSE
Electricity Zone
PHEV Consumption Measurement Zone


Utility Back Office
Communications Zone
Multiplicity Issue
SmartConnect Meter
ESCI
EUMD

Sequence Diagram



6. USE CASE ISSUES

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.
1.0 – Implied assumption with this step (in both scenarios) is that PEV operator must be at 'home' premise to receive Demand side management information (discrete events or hourly prices). Need to consider if this is truly a constraint or not.
2.0 – Unclear how confirmation of override is communicated back to the Utility, or if this is required (or not). There was discussion during the workshop about communicating PEV preference settings to the Utility upon change or upon each communications link-up.

7. GLOSSARY

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**
Rate tariff	Energy cost schedule to customer. Can be time-of-day, flat rate, seasonal rate, critical peak price rate, etc.
PEV	Plug-in Electric Vehicle
EUMD	End Use Measurement Device, revenue measuring device
ESCI	Energy Services Communication Interface
Charging	Act of electrically charging a battery on-board a Plug-in Electric Vehicle or Electric Vehicle

APPENDIX B - DETAIL USE CASES

B.1 E - GENERAL REGISTRATION AND ENROLLMENT PROCESS

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-4-09	Rich Scholer	Updated from comments in the PEV use case.	
1.1	3-21-09	Rich Scholer	Updated per Gerald Gray's comments to PEV0. Definition of ESCI and added step 7.	Y

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title E – Utility Use Case - Customer enrolls in PHEV program and completes initial setup for PEV – Utilities communications

1.2 Use Case Summary

Customers, Vehicle Manufacturers (VM) and Utilities are interested in fueling vehicles with electricity. Electric Vehicles (EV), Plug-in Vehicles (PEV) and Plug-in Hybrid Vehicles (PHEV) are emerging transportation options for consumers. Electric utilities desire to support these emerging loads with electricity at times when energy costs are lower and generation and power delivery assets are underutilized. PEV manufacturers are interested in working with utilities to develop customer rates/programs which could provide consumers with an increased incentive to purchase a PEV. To enable utility customer rates/programs specifically to customers with PEVs, the utility must offer special services for these customers. These services include the ability to enroll, register, and initially setup communications between a PEV and the utility, or an Alternative Energy Supplier (AES) (one-time setup), the ability to repeatedly re-establish communications for each PEV charging session (repeat communications/re-binding), the ability to provide PEV charging (and other) status information to customer information channels (e.g., web, display devices), and the ability to correctly bill PEV customers according to their selected rates/programs.

1.3 Use Case Detailed Narrative

The Utility or AES, may offer the Customer a tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility or AES must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility or AES will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's or AES's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility or AES, for billing and presentation to the Customer. The following scenarios describe the next sequence of events for this customer to utility interface:

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

These five categories of utility programs are designed to entice PEV customers to consume energy during times of lower grid loadability.

1.4 Business Rules and Assumptions

- PEV Customer has an account with utility and electrical service at a premise served by the utility.
- PEV and utility have communications capabilities, enabled by utility provided Energy Services Communication Interface (ESCI).
- The customer awareness of the utility and vehicle programs is prompted by both the utility providers and the vehicle manufacturers.
    - The utility offers PEV programs and services for its customers and will provide the necessary support processes for enrollment, communications, and billing
    - The Vehicle manufacturers would provide information to the customer about fuel and/or emission gains of the vehicles offered and promote the utility and convenience of connecting to the grid

- Utility shall maintain information on all Customers and PEVs enrolled in the PEV programs, including demand side management programs, associated PEV IDs, customer IDs, and premise IDs.

- In the absence or failure of PEV-utility communications, or if PEV ID validation fails, PEV charging will always proceed; however, without the incentive rates and with all energy charges accruing to the premise customer according to the premise customer's default rate/service plan.

- The actual PEV charging processes, including scenarios for intra- and inter- utility roaming, are covered in use case P2.

- End Use Measurement Device (EUMD) is always available for PEV charging. If not available, charging will proceed without incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes.

- EUMD function can be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.

- To allow for possibility of the EUMD being a part of/within the PEV, PEV is a sub-meter to the primary utility billing meter at any premise (as opposed to being a separate service account with dual meter socket adapter).

- The PEV & Utility will communicate to implement one or more the previously described Utility programs (details of which are covered in PR).

2. ACTORS & DEFINITIONS

2.1 Actors: These are the actors or objects in these Use Cases. Sequence diagrams are included to visualize the steps these actors take in the energy transfer process.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
AES see ESCO	Organization	Alternative Energy Supplier
Charger	Device	The charger can either be on-board the vehicle or off-board. On-board chargers require AC energy transfer to the vehicle (either 120 or 240V single phase) and Off-board chargers are within the EVSE and require DC energy transfer to the vehicle.
Clearinghouse	Organization	Organization that provides global PEV account services. Maintains information necessary to facilitate account validation and billing transaction when Customer is charging PEV at a location not served by the Utility that the Customer is enrolled with.
Control Device	Device	DLC programs enable utilities to remotely control and/or shut down participating customer equipment on a short notice. A control device is installed. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the next day.
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer enrolls in an electric utility PEV program and has selected a PEV rate tariff. Customer is responsible for connecting PEV to an Energy Portal for charging.
Customer Account	System	Customer Account is assigned to Customer to collect charges for billing of energy usage

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Customer Energy Management System	System	Customer Energy Management System can provide communication interface to PEV for communication of PEV status information (e.g., charging state, state-of-charge, charging rate, time to complete charge) on Customer viewable displays.
Electric Vehicle Supply Equipment (EVSE)	Device	PEV connects to the grid using an Electric Vehicle Supply Equipment (EVSE). Electric Vehicle Supply Equipment (EVSE) is the physical electrical cord and connectors that are specified by applicable SAE standards (e.g., SAE J2293, SAE J1772, SAE J2836 and SAE J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection. Two type of connection include (1) EVSE cordset and (2) Premise Mounted version. The Premise EVSE would not include the charger for AC (Level 2) energy transfer described in SAE J1772. This would expect the charger to be included with the vehicle. If the EVSE included a charger, DC (Level 3) energy transfer is expected and the vehicle would not include the charger since it was within the EVSE. This EVSE that includes the charger may also be capable of AC energy transfer at both 120V (Level 1) and 240V (Level 2) levels as described in SAE J1772.
Energy Portal (EP)/Smart Energy Portal (SEP)	Device	Energy Portal is any charging point for a PEV. At a minimum, the Energy Portal is a 120V, 15A outlet but can also be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premise circuit.
Energy Services Communication Interface (ESCI)	System	Energy Services Communication Interface (ESCI) The ESCI is the communication device between the vehicle and the utility ESCI The Energy Services Communication Interface (ESCI) shall exist at the customer premise and be capable of securely communicating between the Utility and PHEV to facilitate exchange of demand side management information PEV shall be capable of communicating to the Utility through an ESCI ESCI shall report all PEV charging session information and energy usage to Utility ESCI communicates with and exchanges information between utility, PEV, and End Use Measurement Device (EUMD). ESCI shall provide PEV charging session information to the utility, e.g., PEV ID, interval kWhr consumption and passing energy information, such as price signals, schedules (including time zone and charge "period"), event messages, configuration, and security data from the utility to the PEV. This interface may or may not be facilitated by an Advanced Metering Infrastructure (AMI) that includes a Home Area Network (HAN). ESCI shall employ appropriate security policies when communicating demand side management program-related messages
ESI	System	Energy Services Interface – Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
End Use Measurement Device (EUMD)	Device	End Use Measurement Device (EUMD) is the device that measures and communicates energy usage information payload to Energy Services Communication Interface (ESCI). PEV EUMD shall provide PEV charging session info – PEV ID, Premise ID, interval kWhr consumption. PEV EUMD Receives configuration information (e.g., interval for metering kWhr consumption) from utility. EUMD function can be located anywhere in a zone from the PEV and the branch circuit panel connection End Use Measurement Device shall employ appropriate security policies when communicating demand side management program-related messages End Use Measurement Device (EUMD) is always available for PEV charging. If not available, charging will proceed without incentive rates and with all energy charges accruing to the premise customer. This may or may not prevent certain charging status indicators / metrics being available to customer for presentation/display purposes
ESCO see AES	Organization	Competitive (or alternative) supplier of commodity service
Guest	Person	Guest is a friend or family member who has permission to use a Customer Premise for charging a PEV. May be liable for PEV charging costs depending upon Customer preferences set up within PEV program.
PEV, EV, PHEV	System	Plug-in Electric Vehicle (PEV). Plugs into an Energy Portal (see actor definition below) at a premise to charge vehicle. A PEV is also an EV (Electric Vehicle) that relies only on electric propulsion. A PEV is also a PHEV (Plug-In-Hybrid Vehicle) that also includes an alternative source of propulsion power.
Roaming Utility	Organization	Electric Service Provider that is supplying energy to PEV when PEV is outside of the Customer's Utility service territory
Utility	Organization	Utility typically refers to a collection of systems, business functions, and organizations' which make up the electric utility that include the Customer Information System (CIS), the Advanced Metering Infrastructure (AMI), Rates and Revenue Services, etc.

2.2 Definitions: The following definitions describe items within this Use Case.

RESS: Rechargeable Energy Storage System. Any energy storage system that has the capability to be charged and discharged (example: batteries, capacitors, and electro mechanical flywheels).

State of Charge: The ratio of available capacity as compared to the total capacity of an RESS.

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Primary scenario is the enrollment process. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans.

3.1 Scenario Description

Scenario: Customer enrolls in PHEV program (Basic Enrollment) and completes initial setup for PHEV– Utilities communications

E: Basic Enrollment

Purpose: Utility provides services to Plug-in Electric Vehicle (PEV) Customer. To enable utility customer rates/programs specifically to customers with PEVs, the utility must offer special services for these customers. These services include the ability to enroll, register, and initially setup the utility programs (one-time setup).

This scenario describes the most common sequence (basic process) of the utility enrolling a PEV customer into a utility program/ service specifically for customers with PEVs. This involves *basic enrollment of the PEV*.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a PEV program. *The customer may be prompted by the dealer, VM, retail store, utility and more in the awareness cycle.*	*Customer*	*Customer has a PEV and wishes to enroll in PEV program; Utility offers PEV Programs to its customers.*	*Customer then selects specific utility programs offered within the territory or the vehicle travel area.*

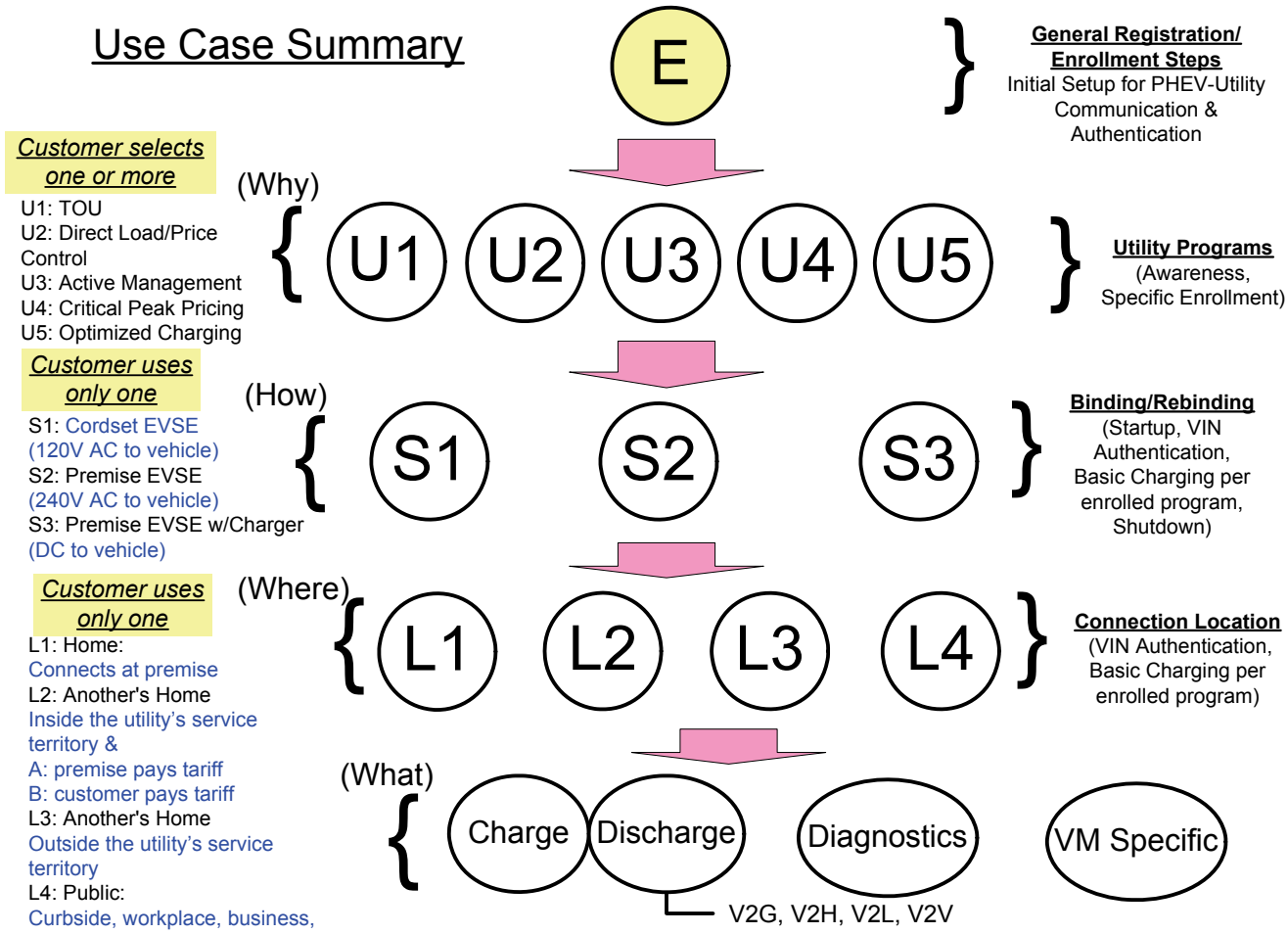
3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is presented by the Utility with PEV Program information and PEV Program selections.	
2	Customer	Customer initiates request to enroll PEV in a PEV Program by contacting Utility.	Customer uses phone, Internet, or other communications channel. PEV ID could be the PEV VIN # or HAN Device MAC ID.
3	Utility	Utility presents Customer with PEV Program information and PEV Program selections.	
4	Customer	Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.).	

Step #	Actor	Description of the Step	Additional Notes
5	Customer	Customer provides Customer and PHEV information (i.e., Customer Account information, PHV ID, etc.) to Utility.	
6	Customer	Customer fills the enrollment form and return to utility via web, phone, mail, or retailer.	
7	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
8	Utility	Utility confirms customer's Basic enrollment is accepted and complete.	The specific program functions may be included with this step or be a subsequent set of actions as described in next sequence of events.

4. REQUIREMENTS

This use case is the 1st in a series. It identifies the initial awareness and enrollment process the Utility and the Vehicle Manufacturer will offer to the customer. The subsequent use cases (U1 thru U5) describe the specific details of the five categories of programs.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Customer Information

B.2 U1 - TOU PROGRAM

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-5-09	Rich Scholer	Updated triggering events, steps and definitions from the PEV0 - Customer Attributes Use Case update.	
2.0	12-29-09	Rich Scholer	Added 4.1	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - U1 – Vehicle Use Case - Customer enrolls in a TOU program

1.2 Use Case Summary

This use case details the awareness and specific enrollment process for the TOU program. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans that is described in use case E. This sequence of Use cases is followed by Use cases S1-3 that include the connection architectures.

1.3 Use Case Detailed Narrative

The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer. Information related to utility PEV programs, energy usage, and PEV charging status/information will be made available to the Customer for viewing via a website or other customer provided display equipment. This use case covers the following scenarios:

- Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications
- PEV and Utility establish/re-establish communications session at the time of charging
- Utility provides billing services for PEV charging to Customer
- Utility provides Customer access to PEV charging and status information

U: Specific Enrollment:

This use case is the 1st in the series for the following five categories of utility programs that are designed to entice PEV customers to consume energy during times of lower grid loadability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case U1: Customer agrees to a TOU utility program. The vertically integrated utility provides bundled residential premise services exclusively and that TOU is available on a self-selected basis.

3.1 Scenario Description

U1: Time-Of-Use rates are designed to entice utility customers to consume energy during times of lesser grid impact. The cost of energy associated with these rates is typically dependent on the season and time of day. These rates reward behaviors that "shift load" to a more favorable time of day and penalize those that have greater system impact. Typically, the energy provider does not have control over the load and sets the cost of the service annually.

Scenario U1-A assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that TOU is available on a self-selected basis (voluntary that is TOU is not mandatory, it is an option). Default rate is an old traditional/conventional flat rate.

Primary Scenario (U1-A): Customer enrolls in TOU program. The vertically integrated utility provides bundled residential premise services exclusively and that TOU is available on a self-selected basis

This scenario describes the steps of the utility enrolling a PEV customer into Time-of-Use (TOU) pricing demand side management program (e.g., off-peak, mid-peak, on-peak, etc.). Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that TOU is available on a self-selected basis (voluntary that is TOU is not mandatory, it is an option). Default rate is an old traditional/conventional flat rate.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a TOU program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in TOU program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that TOU is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a TOU Program.*

3.1.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in a TOU Program by contacting Utility and providing customer and PEV information (i.e., Customer Account information PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Utility	Utility sends general TOU information in the application form, via web or mail	
4	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
5	Customer	Customer completes enrollment form, returns to utility via web or mail	
6	Utility	Utility make a decision if the customer is eligible or not. Not eligible he notifies the customer.	
7	Utility	For eligible customers, utility notifies customer of in-service date.	
8	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	

Step #	Actor	Description of the Step	Additional Notes
9	Utility	Utility presents Customer with any updates to the TOU Program information and schedule selections	
10	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network), notifies customer of meter installation (in-service) date.	
11	Utility	Utility installs meter, undertakes back-office administrative actions	TOU Recording Meter are preprogrammed based on TOU. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
12	Utility	Utility switches service to TOU and issues final bill for old service to customer	
13	Customer	Customer commences TOU service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility TOU program.	Same schedule applies till a rate case or rate change takes place, (TOU structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

3.2 Alternative Scenario Description

Alternative Scenario (U1-B): Customer enrolls in TOU program – Customer Taking Commodity from ESCO

Scenario U1-B assumes that customer can have unbundled residential premise service. He gets the delivery service from the utility and commodity service from ESCO. If customer takes bundle service, then process is the same as previous case. Otherwise, the illustrated processes are involved. Utility installs TOU meter.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a TOU program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in TOU program; Gets delivery services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a TOU Program.*

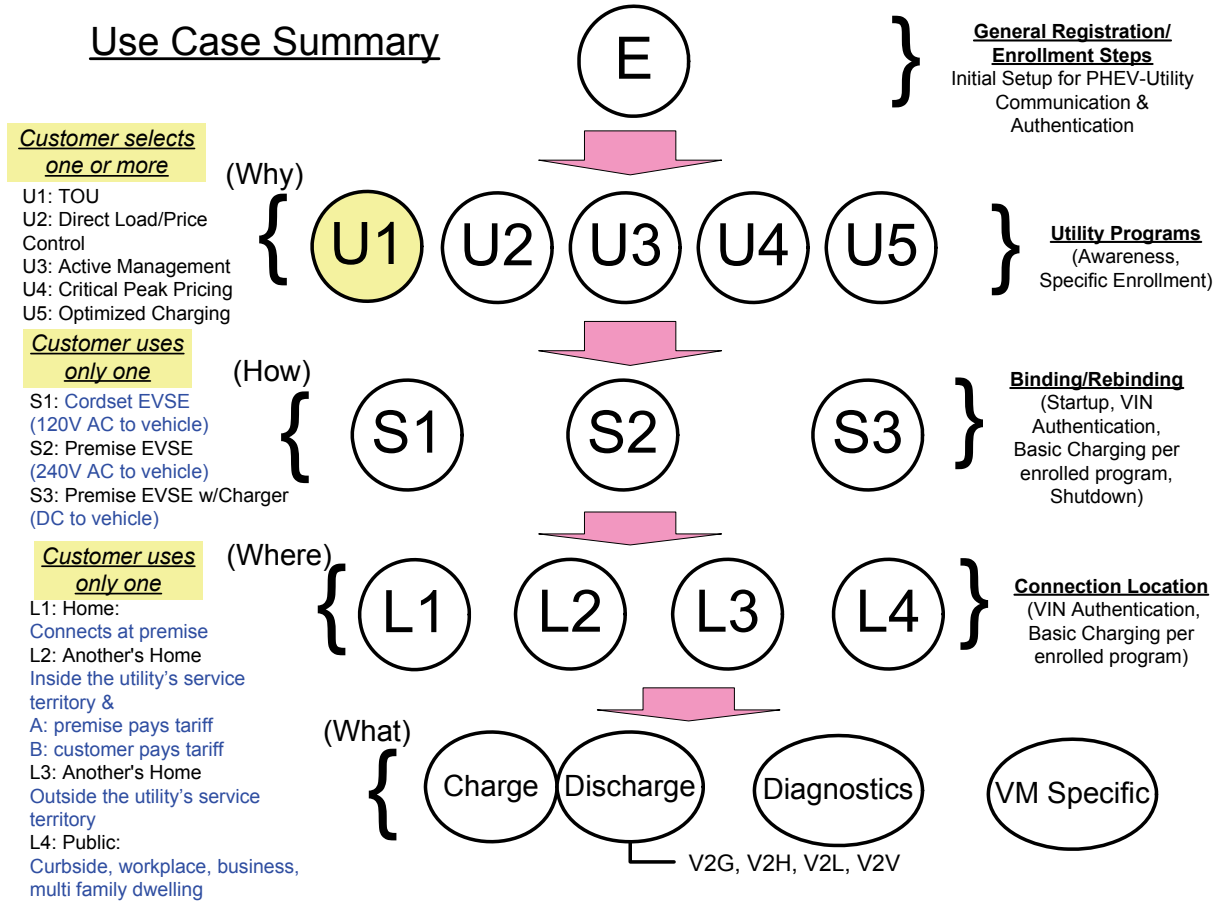
3.2.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
	Customer	Customer initiates request to enroll PEV in a TOU Program by contacting ESCO and provides Customer information (i.e., Customer Account information).	Customer uses phone, Internet, or other communications channel.
2	Clearing House	Clearing house determines who provides the commodity	If the commodity is bundled then use the previous scenario, if the service is unbundled then utility is informed but the utility does not have to take any action
3	ESCO	ESCO sends general TOU information in the application form, via web or mail	
4	Customer	Customer completes enrollment form, returns to ESCO via web or mail	
5	ESCO	ESCO make a decision if the customer is eligible or not. Not eligible he notifies the customer.	
6	ESCO	For eligible customers, ESCO notifies customer of in-service date	
7	ESCO	ESCO authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
8	ESCO	ESCO presents Customer with any updates to the TOU Program information and schedule selections	
9	ESCO	ESCO requests TOU meter install from utility	
10	Utility	Utility confirms to ESCO both in service and meter install date	
11	Utility	Utility sends signal to customer about the meter date	
12	ESCO	ESCO sends the message to the customer about the in-service date	
13	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network)	

Step #	Actor	Description of the Step	Additional Notes
14	Utility	Utility installs meter, undertakes back-office administrative actions	TOU Recording Meter are preprogrammed based on TOU. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
15	Utility	Utility switches service to TOU and issues final bill for old service to ESCO	
16	ESCO	ESCO notifies customer that TOU service is initiated	
17	Customer	Customer commences TOU service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in TOU program.	Same schedule applies till a rate case or rate change takes place, (TOU structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

4. REQUIREMENTS

This use case is the 2nd in a series that follows Use Case E for general enrolment. This use case defines the TOU utility program for awareness and specific enrolment steps. The Utility and the Vehicle Manufacturer will offer these to their customers. The complementary use cases (U2 thru U5) describe the specific details of the four other categories of programs. This series of Use cases are then followed by Use Cases S1, 2 or 3 for specific connection architectures.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV and EVSE establish communications. PEV sends ID, EUMD sends ID and EMS authenticates.	EVSE & EUMD sending ID is optional. PEV sending Smart PEV present is optional. Customer ID or PIN entry is optional.	Connection time is recorded by EMS.
2	Rate Time Period info is exchanged and PEV identifies charge start and end times.	PEV to request time data if different than stored info.	Requested vs. actual may be sent if requested.
3	EUMD sends energy delivered message.	PEV may store this for customer info.	

4.2 Non-Functional Requirements

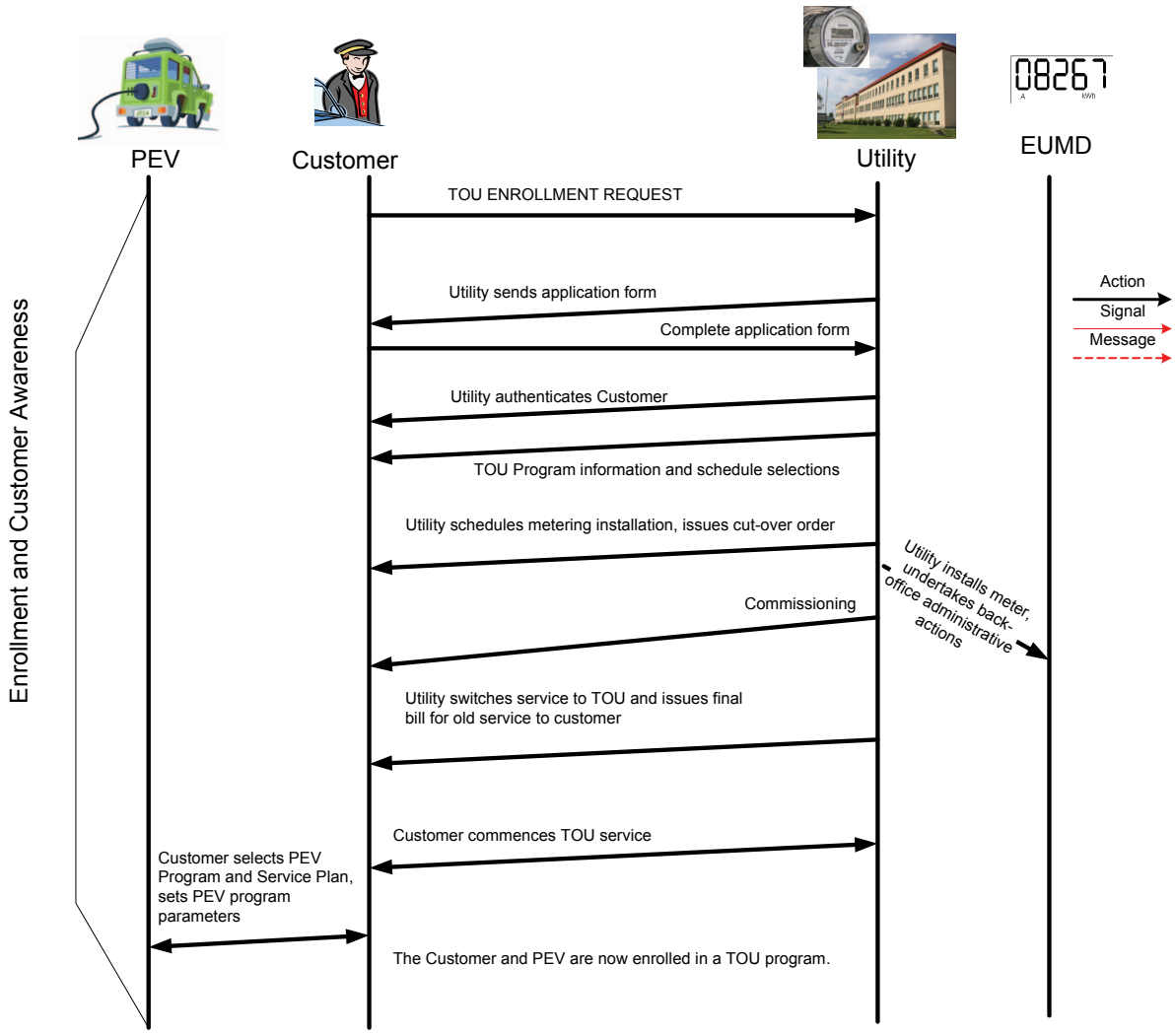
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

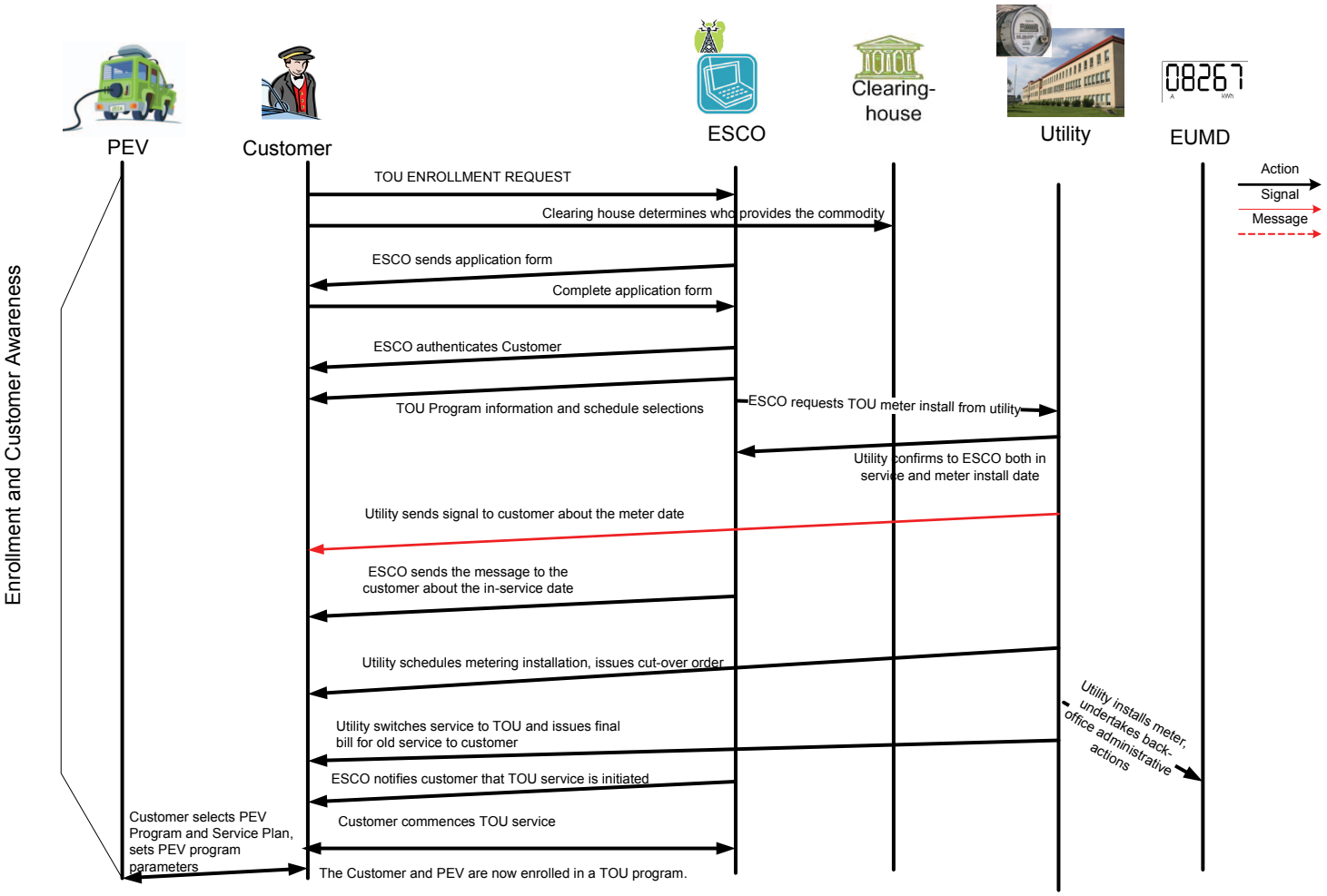
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence diagram for primary scenario U1-A.



5.2 Sequence diagram for alternative scenario U1-B



B.3 U2 - DISCRETE EVENT PROGRAM

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-5-09	Rich Scholer	Updated triggering events, steps and definitions from the PEV0 - Customer Attributes Use Case update.	
2.0	12-29-09	Rich Scholer	Added 4.1	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - U2 – Vehicle Use Case - Customer enrolls in a Discrete Event Utility program (Load Control)

1.2 Use Case Summary

This use case details the awareness and specific enrollment process for the Discrete Event program. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans that is described in use case E. This sequence of Use cases is followed by Use cases S1-3 that include the connection architectures.

1.3 Use Case Detailed Narrative

The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer. Information related to utility PEV programs, energy usage, and PEV charging status/information will be made available to the Customer for viewing via a website or other customer provided display equipment. This use case covers the following scenarios:

- Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications
- PEV and Utility establish/re-establish communications session at the time of charging
- Utility provides billing services for PEV charging to Customer
- Utility provides Customer access to PEV charging and status information

U: Specific Enrollment:

This use case is the 2nd in the series for the following five categories of utility programs that are designed to entice PEV customers to consume energy during times of lower grid loadability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

USE CASE U2 - Enrollment Process to Discrete Event demand side management program (Direct Load Control)

3.1 Scenario Description

U2: Discrete Event (Direct load control) programs are designed to incentivize customers whom are willing to give the energy provider control over their load. More specifically these programs allow energy providers to interrupt customer loads during critical grid events. Usually, the energy provider offers a vast array of options with programs varying in the quantity of events and length of interrupt periods.

A Direct device control (DDC) service involves a Call Option on one or more devices on the premises. A single price schedule applies to total premise metered service (uniform or TOU if that was selected). A discount is applied to the base service for each device enrolled in DDC. Prices are firm, but service is not. The utility exercises its Call Option by first notifying the participant (to the control device which then sends the signal to the vehicle) that a event has been declared for the nest day. Utility exercises it Call Option by sending a signal that either shuts off electricity to the device (or devices) or restricts its usage during the event.

Primary Scenario: Customer enrolls in Discrete Event Demand Side Management Program

- Direct device control (DDC) service involves a Call Option on one or more devices on the premises.
- A single price schedule applies to total premise metered service (uniform or TOU if that was selected). A discount is applied to the base service for each device enrolled in DDC. Prices are firm, but service is not.
- The retailer exercises its Call Option by first notifying the participant that a event has been declared for the nest day. The DDC service plan specified when such notice must be delivered to become effective
- The retailer exercises it Call Option by sending a signal that either shuts off electricity to the device (or devices) or restricts its usage during the event.

The enrollment is similar to TOU except that the utility install a control device on specified devices, as depicted on the next slide). Enrollment to an ESCO program is the same as with TOU where the customer takes commodity form an ESCO except the meter change out is replaced with the installation of a control device or devices.

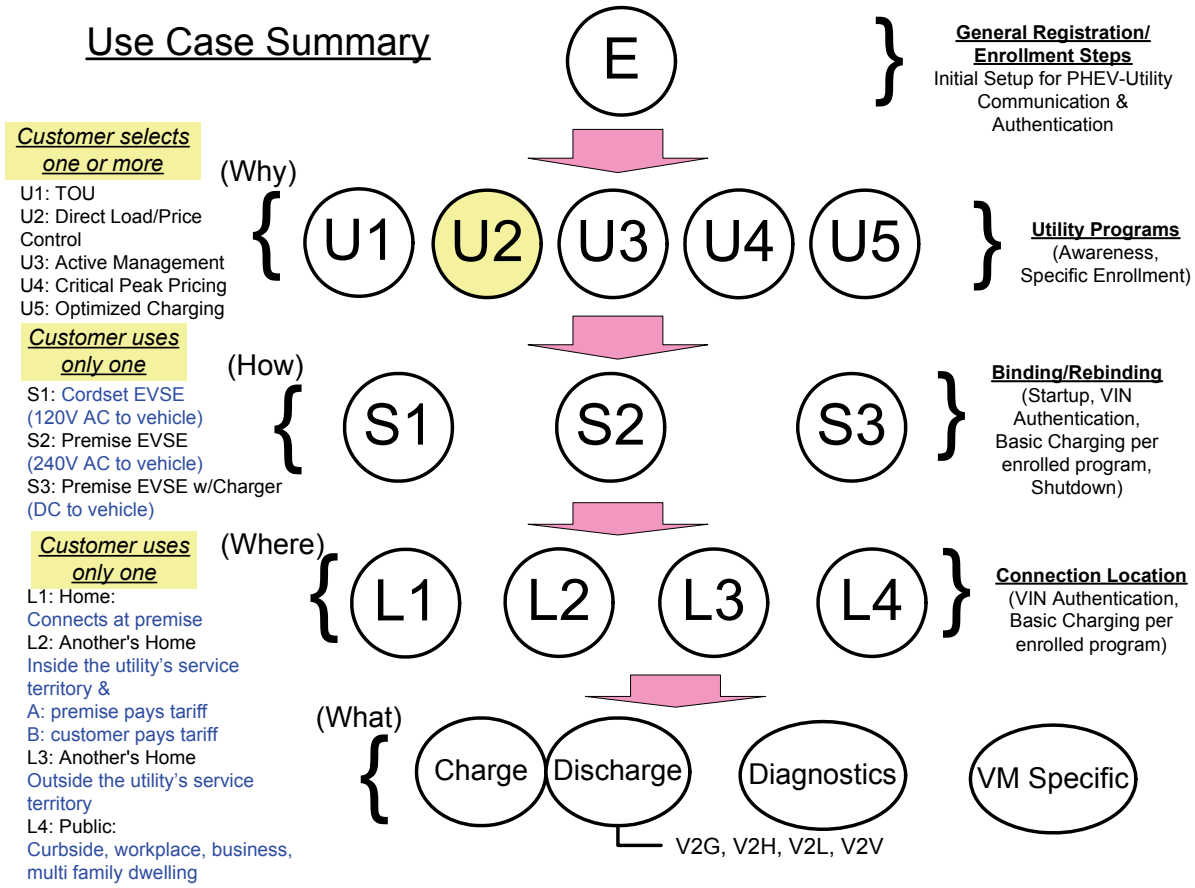
Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a Direct Load Control program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in DDC program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that DDC is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a DDC Program.*

3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer inquires about DDC Program availability by contacting Utility and provides Customer and PEV information (i.e., Customer Account information PEV ID, etc.).	Customer uses phone, Internet, or other communications channel. (customer has to apply from his default rate or TOU rate to the DCC Rate)
3	Utility	Utility sends general DDC information in the application form, via web or mail	
4	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
5	Customer	Customer completes enrollment form, returns to utility via web or mail	
6	Utility	Utility make a decision if the customer is eligible or not. Not eligible he notifies the customer	
7	Utility	For eligible customers, utility notifies customer of in-service date	
8	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
9	Utility	Utility presents Customer with DDC Program information.	
10	Utility	Utility schedules control device installation, issues cut-over order (internal process order, billing, parameters of billing, financial network), notifies customer of control device installation (in-service) date	
11	Utility	Utility installs control device.	
12	Utility	Utility switches service to DDC and issues final bill for old service to customer.	
13	Customer	Customer commences DDC service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility DDC program.	Same schedule applies till a rate case or rate change takes place, (TOU structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

4. REQUIREMENTS

This use case is the 2nd in a series that follows Use Case E for general enrolment. This use case defines the Discrete Event utility program for awareness and specific enrolment steps. The Utility and the Vehicle Manufacturer will offer these to their customers. The complementary use cases (U1 & U3 thru U5) describe the specific details of the four other categories of programs. This series of Use cases are then followed by Use Cases S1, 2 or 3 for specific connection architectures.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV and EVSE establish communications. PEV sends ID, DR sends ID and EMS authenticates.	EVSE & EUMD (if equipped) sending ID is optional. PEV sending Smart PEV present is optional. Customer ID or PIN entry is optional.	Connection time is recorded by EMS.
2	Scheduled DR load info is exchanged and PEV identifies charge start and end times.	PEV to request DR load data if different than stored info.	Requested vs. actual may be sent if requested.
3	DR sends energy status message.	PEV may store this for customer info.	

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence diagram for scenario U2.

B.4 U3 - REAL TIME PRICING (RTP) PROGRAM

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-5-09	Rich Scholer	Updated triggering events, steps and definitions from the PEV0 - Customer Attributes Use Case update.	
2.0	12-29-09	Rich Scholer	Added 4.1	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - U3 – Vehicle Use Case - Customer enrolls in a Real Time Pricing (RTP) program

1.2 Use Case Summary

This use case details the awareness and specific enrollment process for the RTP program. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans that is described in use case E. This sequence of Use cases is followed by Use cases S1-3 that include the connection architectures.

1.3 Use Case Detailed Narrative

The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer. Information related to utility PEV programs, energy usage, and PEV charging status/information will be made available to the Customer for viewing via a website or other customer provided display equipment. This use case covers the following scenarios:

- Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications
- PEV and Utility establish/re-establish communications session at the time of charging
- Utility provides billing services for PEV charging to Customer
- Utility provides Customer access to PEV charging and status information

U: Specific Enrollment:

This use case is the 3rd in the series for the following five categories of utility programs that are designed to entice PEV customers to consume energy during times of lower grid loadability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case U3: Customer agrees to a RTP utility program. The vertically integrated utility provides bundled residential premise services exclusively and that RTP is available on a self-selected basis.

3.1 Scenario Description

U3: Variations on the basic TOU structure include critical peak pricing (CPP), variable peak pricing (VPP) and real time pricing (RTP).

RTP is similar to TOU rates in that customers make consumption decisions based on the price of energy. This is also considered an Active Management program. However, unlike TOU rates where the costs are previous established, RTP rates vary daily and by time of day based on day-ahead forecasts. Customers are generally provided a signal that informs them of the "real time" price. Although the interval and type of the signal may vary among utilities the concept is the same nationwide. RTP-DA (day-ahead) service provides daily price schedules (one price ($/kWh) per hour) to participants the day before they are effective. Once delivered, the prices are firm – they are not subject to revision. The hourly prices are applied to the corresponding hour's metered energy usage (kWh). Under these rates the utility or energy provider does not have direct control to the customer's load.

Primary Scenario (U3-A): Customer enrolls in RTP program. The vertically integrated utility provides bundled residential premise services exclusively and that RTP is available on a self-selected basis

RTP-DA (day-ahead) service provides daily price schedules (one price ($/kWh) per hour) to participants the day before they are effective. Once delivered, the prices are firm – they are not subject to revision. The hourly prices are applied to the corresponding hour's metered energy usage (kWh).

The enrollment steps are identical to those to TOU for bundled utility and unbundled EPSO service). Each day, the Retailer (utility or ESCO) prepares and delivers the price schedule for the next day to the participant (by a specified time), and participant acknowledges receipt of the schedule (by a specified time).

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a RTP program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in RTP program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that RTP is available on a self-selected basis*	*The Utility has successfully enrolled a Customer PEV in a RTP Program.*

3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in a RTP Program by contacting Utility and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Utility	Utility sends general RTP information in the application form, via web or mail	
4	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
5	Customer	Customer completes enrollment form, returns to utility via web or mail	
6	Utility	Utility make a decision if the customer is eligible or not. Not eligible he notifies the customer	
7	Utility	For eligible customers, utility notifies customer of in-service date	
8	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
9	Utility	Utility presents Customer with RTP Program information and schedule selections	
10	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network), notifies customer of meter installation (in-service) date	
11	Utility	Utility installs meter, undertakes back-office administrative actions	RTP Recording Meter are preprogrammed based on RTP. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
12	Utility	Utility switches service to RTP and issues final bill for old service to customer	

Step #	Actor	Description of the Step	Additional Notes
13	Customer	Customer commences RTP service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility RTP program.	Same schedule applies till a rate case or rate change takes place, (RTP structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

3.2 Alternative Scenario Description

Alternative Scenario (U3-B): Customer enrolls in RTP program – Customer Taking Commodity from ESCO

This scenario assumes customer choice to enrolling a PEV customer into Real Time Pricing (RTP) pricing program (e.g., one price ($/kWh) per hour). Assumes that customer can have unbundled residential premise service. He gets the wired service from the utility and commodity service from ESCO. If customer takes bundle service, then process is the same as previous case. Otherwise, the illustrated processes are involved. Utility sets RTP meter.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a RTP program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs.*	*Customer*	*Customer has a PEV and wishes to enroll in RTP program; Gets delivery services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a RTP Program.*

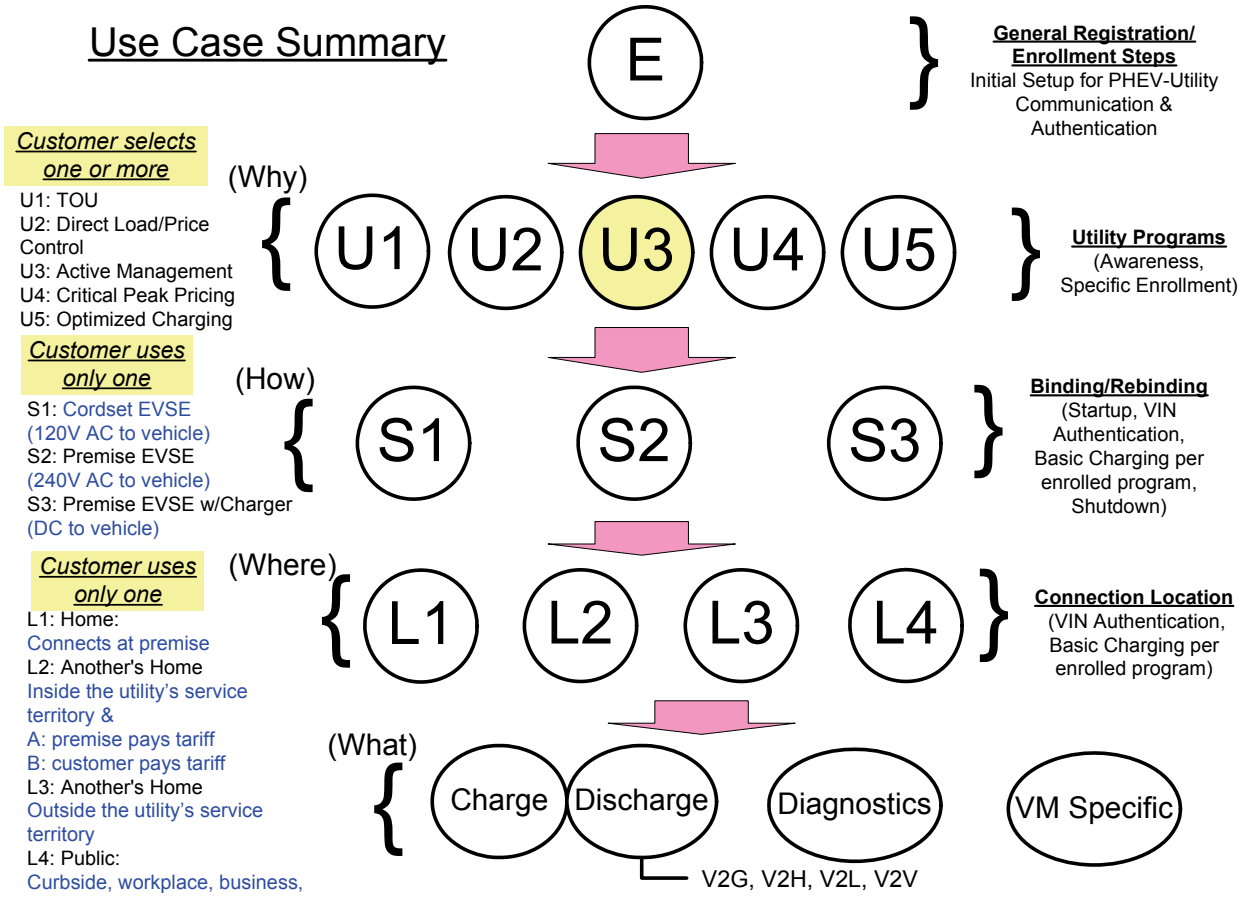
3.2.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in a RTP Program by contacting ESCO and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Clearing House	Clearing house determines who provides the commodity	If the commodity is bundled then use the previous scenario, if the service is unbundled then utility is informed but the utility does not have to take any action
4	ESCO	ESCO sends application form via web or mail	
5	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
6	Customer	Customer completes enrollment form, returns to ESCO via web or mail	
7	ESCO	ESCO make a decision if the customer is eligible or not. Not eligible he notifies the customer	
8	ESCO	For eligible customers, ESCO notifies customer of in-service date	
9	ESCO	ESCO authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
10	ESCO	ESCO presents Customer with RTP Program information and schedule selections	
11	ESCO	ESCO requests RTP meter install from utility	
12	Utility	Utility confirms to ESCO both in service and meter install date	
13	Utility	Utility sends signal to customer about the meter date	
14	ESCO	ESCO sends the message to the customer about the in-service date	
15	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network)	

Step #	Actor	Description of the Step	Additional Notes
16	Utility	Utility installs meter, undertakes back-office administrative actions	RTP Recording Meter are preprogrammed based on RTP. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
17	Utility	Utility switches service to RTP and issues final bill for old service to ESCO	
18	ESCO	ESCO notifies customer that RTP service is initiated	
19	Customer	Customer commences RTP service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in RTP program.	Same schedule applies till a rate case or rate change takes place, (RTP structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

4. REQUIREMENTS

This use case is the 3rd in a series that follows Use Case E for general enrolment. This use case defines the RTP utility program for awareness and specific enrolment steps. The Utility and the Vehicle Manufacturer will offer these to their customers. The complementary use cases (U1, 2, 4 & 5) describe the specific details of the four other categories of programs. This series of Use cases are then followed by Use Cases S1, 2 or 3 for specific connection architectures.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV and EVSE establish communications. PEV sends ID, EUMD sends ID and EMS authenticates.	EVSE & EUMD sending ID is optional. PEV sending Smart PEV present is optional. Customer ID or PIN entry is optional.	Connection time is recorded by EMS.
2	Rate Price info is exchanged and PEV identifies charge start and end times.	PEV to request price info if different than stored info.	Requested vs. actual may be sent if requested.
3	EUMD sends energy delivered message.	PEV may store this for customer info.	

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

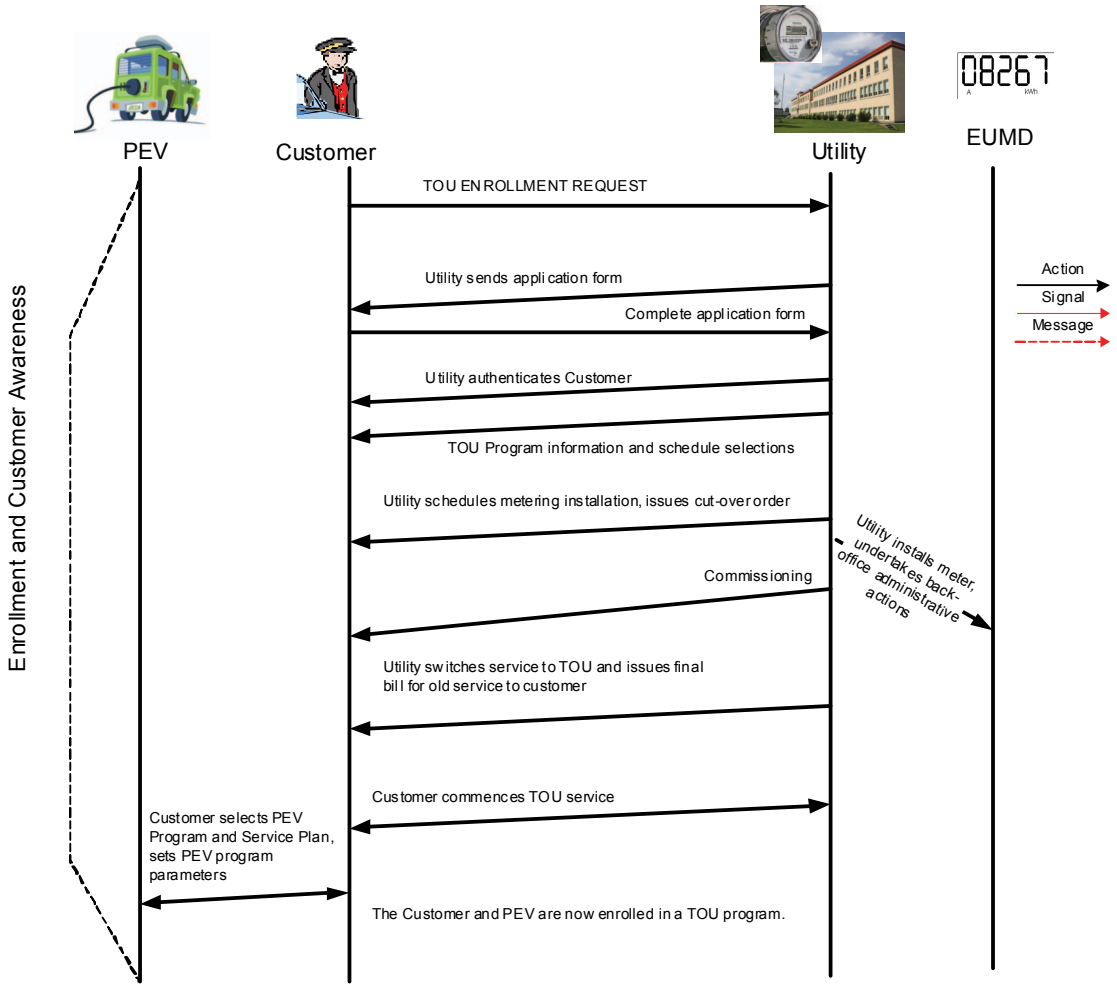
4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence diagram for primary scenario U3-A.

5.2 Sequence diagram for alternative scenario U3-B.



B.5 U4 - CRITICAL PEAK PRICING (CPP) PROGRAM

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-5-09	Rich Scholer	Updated triggering events, steps and definitions from the PEV0 - Customer Attributes Use Case update.	
1.1		Rich Scholer	Updated per Gerald Gray's comments to PEV0. Definition of U4.	
2.0	12-29-09	Rich Scholer	Added 4.1	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - U4 – Vehicle Use Case - Customer enrolls in a Critical Peak Pricing (CPP) program (Price Control)

1.2 Use Case Summary

This use case details the awareness and specific enrollment process for the RTP program. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans that is described in use case E. This sequence of Use cases is followed by Use cases S1-3 that include the connection architectures.

1.3 Use Case Detailed Narrative

The Utility may offer the Customer a PEV tariff that provides a low rate for off-peak charging and a higher rate for on-peak charging. The utility must provide services to support energy supplied to customer PEV. These services include enrollment into a PEV program, PEV communications session binding, PEV energy billing, and PEV information services. The utility will implement an enrollment system for Customers with a PEV including registration and commissioning. The utility's Energy Services Communication Interface (ESCI) shall allow for the establishment of a communications session (communications binding), at a premise location each time a PEV plugs in for charging. Energy supplied to the PEV is reported to the utility for billing and presentation to the Customer. Information related to utility PEV programs, energy usage, and PEV charging status/information will be made available to the Customer for viewing via a website or other customer provided display equipment. This use case covers the following scenarios:

- Customer enrolls in PEV program and completes initial setup for PEV – Utilities communications
- PEV and Utility establish/re-establish communications session at the time of charging
- Utility provides billing services for PEV charging to Customer
- Utility provides Customer access to PEV charging and status information

U: Specific Enrollment:

This use case is the 4th in the series for the following five categories of utility programs that are designed to entice PEV customers to consume energy during times of lower grid loadability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case U4: Customer agrees to a CPP utility program. The vertically integrated utility provides bundled residential premise services exclusively and that CPP is available on a self-selected basis.

3.1 Scenario Description

U4: Variations on the basic TOU structure include critical peak pricing (CPP), variable peak pricing (VPP) and real time pricing (RTP).

CPP rates are similar to TOU rates in that they both have an established cost schedule based on the season, day of the week, time of day, weekday vs. weekend, etc. Critical peak pricing is a mechanism whereby normal flat[3] or TOU rates are in effect except for certain peak days, when pre-specified higher prices are superimposed on the normal TOU rate. CPP prices are used during system contingencies or during periods of high wholesale electricity prices for a limited number of days or hours per year. Although the quantity of events are limited and only during a particular season (i.e., summer or winter), the customer has the choice to reduce or not reduce their load during the "called" event. However, the consequence for not reducing load during peak hours will typically result in higher rates for that day. Under these rates the utility or energy provider does not have direct control to the customer's load.

Primary Scenario (U4-A): Customer enrolls in CPP program. The vertically integrated utility provides bundled residential premise services exclusively and that CPP is available on a self-selected basis

CPP day-ahead service set prices based on system conditions

- Normal conditions – the base rate schedule (a uniform rate, or TOU if the customer selected that option) applies for all metered usage except when the retailer provider (utility or ESCO) exercises its Call Option rights

- Call Option conditions - the retailer revokes the base rate schedule for a specified period of hours for the next day and imposes the Call Option price schedule by notifying the participant that an event has been declared. The Call Option price schedule (which specifies the hours that comprise the event and the price ($kWh) during that event) is predetermined and fixed for the contract period (for example, a year) so the notification needs only to convey the declaration of an event. The Call Option must be declared by a specified time the day prior to be effective.

The enrollment steps are identical to those to TOU for bundled utility and unbundled EPSO service). The Retailer (utility or ESCO) prepared and delivers the price schedule for the next day to the participant (by a specified time), and participant acknowledges receipt of the schedule (by a specified time).

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a CPP program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs*	*Customer*	*Customer has a PEV and wishes to enroll in CPP program; Utility offers PEV Programs to its customers. Assumes that a single, vertically integrated utility provides bundled residential premise service exclusively, and that CPP is available on a self-selected basis.*	*The Utility has successfully enrolled a Customer PEV in a CPP Program.*

[3] A single price ($/kWh) applies to all metered energy (kWh) consumption during each billing period. The simplest rate structures include a flat energy rate and a customer charge, a fixed dollar amount. This simple rate structure is most common for residential and small commercial customers.

3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in a CPP Program by contacting Utility and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Utility	Utility sends general CPP information in the application form via web or mail	
4	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
5	Customer	Customer completes enrollment form, returns to utility via web or mail	
6	Utility	Utility make a decision if the customer is eligible or not. Not eligible he notifies the customer	
7	Utility	For eligible customers, utility any updates to the program and notifies customer of in-service date	
8	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
9	Utility	Utility presents Customer with CPP Program information and schedule selections	
10	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network), notifies customer of meter installation (in-service) date	
11	Utility	Utility installs meter, undertakes back-office administrative actions	CPP Recording Meter are preprogrammed based on RTP. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
12	Utility	Utility switches service to CPP and issues final bill for old service to customer	

Step #	Actor	Description of the Step	Additional Notes
13	Customer	Customer commences CPP service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility CPP program.	Same schedule applies till a rate case or rate change takes place, (CPP structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

3.2 Alternative Scenario Description

Alternative Scenario (U4-B): Customer enrolls in CPP program – Customer Taking Commodity from ESCO

This scenario assumes customer choice to enrolling a PEV customer into Critical Peak Pricing (CPP) pricing program. Assumes that customer can have unbundled residential premise service. He gets the wired service from the utility and commodity service from ESCO. If customer takes bundle service, then process is the same as previous case. Otherwise, the illustrated processes are involved. Utility sets RTP meter.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in a CPP program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs*	*Customer*	*Customer has a PEV and wishes to enroll in CPP program; Gets wires services from the utility and commodity service from ESCO.*	*ESCO has successfully enrolled a Customer PEV in a CPP Program.*

3.2.1 Steps for this scenario

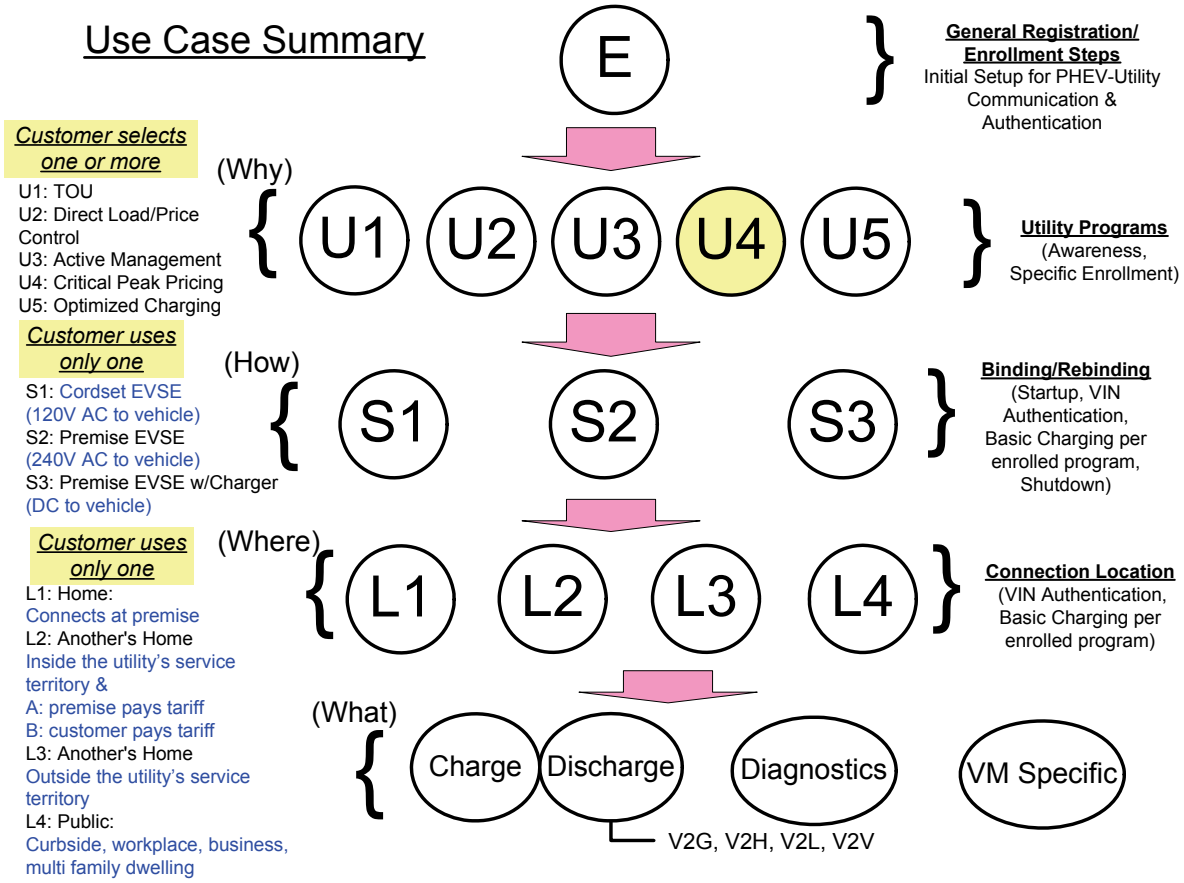
Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in a CPP Program by contacting ESCO and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Clearing House	Clearing house determines who provides the commodity	If the commodity is bundled then use the previous scenario, if the service is unbundled then utility is informed but the utility does not have to take any action
4	ESCO	ESCO sends application that includes the general CPP information in the form, via web or mail	
5	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	

Step #	Actor	Description of the Step	Additional Notes
6	Customer	Customer completes enrollment form, returns to ESCO via web or mail	
7	ESCO	ESCO make a decision if the customer is eligible or not. Not eligible he notifies the customer	
8	ESCO	For eligible customers, ESCO notifies customer of any updates to the program and in-service date.	
9	ESCO	ESCO authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
10	ESCO	ESCO presents Customer with CPP Program information and schedule selections	
11	ESCO	ESCO requests RTP meter install from utility	
12	Utility	Utility confirms to ESCO both in service and meter install date	
13	Utility	Utility sends signal to customer about the meter date	
14	ESCO	ESCO sends the message to the customer about the in-service date	
15	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network)	
16	Utility	Utility installs meter, undertakes back-office administrative actions	CPP Recording Meter are preprogrammed based on CPP. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
17	Utility	Utility switches service to CPP and issues final bill for old service to ESCO.	
18	ESCO	ESCO notifies customer that CPP service is initiated.	

Step #	Actor	Description of the Step	Additional Notes
19	Customer	Customer commences CPP service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in CPP program.	Same schedule applies till a rate case or rate change takes place, (CPP structure typically does not change). Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

4. REQUIREMENTS

This use case is the 4th in a series that follows Use Case E for general enrolment. This use case defines the CPP utility program for awareness and specific enrolment steps. The Utility and the Vehicle Manufacturer will offer these to their customers. The complementary use cases (U1, 2, 3 & 5) describe the specific details of the four other categories of programs. This series of Use cases are then followed by Use Cases S1, 2 or 3 for specific connection architectures.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV and EVSE establish communications. PEV sends ID, DR sends ID and EMS authenticates.	EVSE & EUMD (if equipped) sending ID is optional. PEV sending Smart PEV present is optional. Customer ID or PIN entry is optional.	Connection time is recorded by EMS.
2	Scheduled DR price info is exchanged and PEV identifies charge start and end times.	PEV to request DR price data if different than stored info.	Requested vs. actual may be sent if requested.
3	DR sends energy status message.	PEV may store this for customer info.	

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

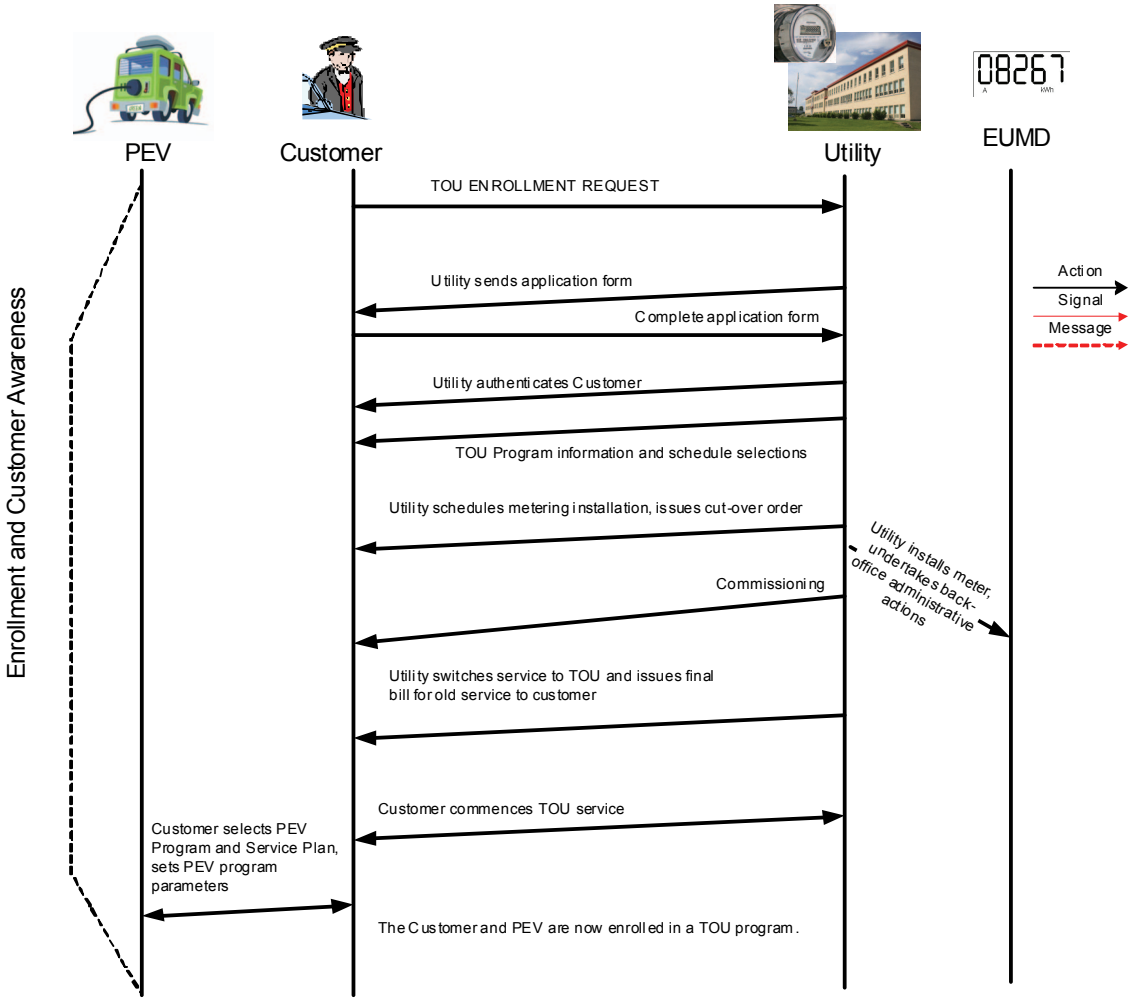
4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence diagram for primary scenario U4-A.

5.2 Sequence diagram for alternative scenario U4-B.



B.6 U5 - OPTIMIZED ENERGY TRANSFER PROGRAM

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-5-09	Rich Scholer	Updated triggering events, steps and definitions from the PEV0 - Customer Attributes Use Case update.	
2.0	10-28-09	Rich Scholer	3.1.1 - Added info for energy requests, priority and green options	
2.1	11-5-09	Rich Scholer	Added 3.1.2 – Energy Management	
3.0	12-29-09	Rich Scholer	Added 4.1	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - U5 – Vehicle Use Case - Customer enrolls in an Optimized Energy Transfer program

1.2 Use Case Summary

This use case details the awareness and specific enrollment process for an Optimized Energy Transfer program. This is precluded by an awareness process and includes collecting information pertaining to the customer, their vehicle and operating and charging plans that is described in use case E. This sequence of Use cases is followed by Use cases S1-3 that include the connection architectures.

1.3 Use Case Detailed Narrative

The Utility may offer the Customer an Optimized Energy Transfer Program. This offers the customer and utility an opportunity to take advantage of Regulation services and utilize Spinning reserves and other methods to match grid load to demand in a predictable and accountable aspect. The energy request and energy management may be at the home, multiple homes fed from a common transformer and/or further into the utility network.

Regulation services are used to continuously fine-tune the balance between power generation and demand, in terms of the voltage and the frequency of the grid. In many power markets, this function, called regulation or automatic generation control (AGC), is priced separately from power generation and procured as an ancillary service (another such service is spinning reserves). The grid operator needs to be able to ensure generators ramp output up or down in real time to meet customer reactive power needs, manage customer impact on system voltage, frequency and system losses and ensure that power-factor problems at one customer site do not affect power quality elsewhere in the system. Again, providing regulation services requires electricity generation capacity in excess of demand.

Spinning reserves refers to generating capacity that is up and running, and synchronized with the electricity grid (but not contributing power). Spinning reserves generators contribute to grid stability, helping to arrest the decay of system frequency when there is a sudden breakdown or loss of another generator. Again, typically, power plants that can provide fast response to the calls of the grid operator are the most suitable, e.g., gas turbines. The capacity required to provide spinning reserves can also be seen as an underutilized investment, although essential for managing market risks.

U: Specific Enrollment:

This use case is the 5th in the series for the following five categories of utility programs that are designed to entice PEV customers to consume energy during times of lower grid load-ability.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case U5: Customer agrees to an Optimized Energy Transfer utility program.

3.1 Scenario Description

U5: Optimized Energy Transfer programs are designed to incentivize customers whom are willing to give the energy provider control over their load. More specifically these programs allow energy providers to reduce or interrupt customer loads during critical grid events. The idea is that the energy provider based on the grid event can actively manage the charging load by either reducing or interrupting it. In either case, the active management will support turn off those who have higher SOC while only reducing the charge rate of those that have lower SOC. Usually, the energy provider offers a vast array of options with programs varying in the quantity of events and length of reduction or interruption periods. These include Regulation Services and taking advantage of Spinning Reserves.

Scenario: Customer enrolls in an Optimized Energy Transfer program.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer acquires a PEV and contacts the Utility to enroll in an Optimized Energy Transfer program. *The customer may be prompted by the dealer, VM, retail store, utility and more for specific programs*	*Customer*	*Customer has a PEV and wishes to enroll an Optimized Energy Transfer program; Utility offers PEV Programs to its customers.*	*The Utility has successfully enrolled a Customer PEV in an Optimized Energy Transfer Program.*

3.1.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer is informed of the program's cost and/or benefits.	
2	Customer	Customer initiates request to enroll PEV in an Optimized Energy Transfer Program by contacting Utility and provides Customer and PEV information (i.e., Customer Account information, PEV ID, etc.).	Customer uses phone, Internet, or other communications channel.
3	Utility	Utility sends general program information in the application form, via web or mail	
4	Customer	Customer makes a decision of when and where to use the program (based on need and cost).	
5	Customer	Customer completes enrollment form, returns to utility via web or mail	
6	Utility	Utility make a decision if the customer is eligible or not. Not eligible he notifies the customer	

Step #	Actor	Description of the Step	Additional Notes
7	Utility	For eligible customers, utility notifies customer of any updates to the program and in-service date	
8	Utility	Utility authenticates Customer, Customer account, and Premise information, and collects PEV information including PEV ID.	
9	Utility	Utility presents Customer with the Optimized Energy Transfer Program information and schedule selections	
10	Utility	Utility schedules metering installation, issues cut-over order (internal process order, billing, parameters of billing, financial network), notifies customer of meter installation (in-service) date	
11	Utility	Utility installs meter, undertakes back-office administrative actions	The Recording Meter is preprogrammed based on the program. It can have either two or three registers (peak, off-peak, shoulder peak). If the customer has AMI meter, utility informs the meter on the new data (two-way communication. It will change the instruction set. The cut in order will take the back office to cumulative in on-peak or off-peak
12	Utility	Utility switches service to the Optimized Energy Transfer and issues final bill for old service to customer	
13	Customer	Customer commences Optimized Energy Transfer service Customer selects PEV Program and Service Plan, sets PEV program parameters (i.e., guest charging, allow roaming, etc.). The Customer and PEV are now enrolled in a utility Optimized Energy Transfer program.	Same schedule applies till a rate case or rate change takes place. Nominal prices are subject to change based on utility supply cost (e.g., fuel price).

The primary objective is for the PEV to make an energy request. This is for the amount, rate and time allocation for the charging cycle.

The amount of energy is what is requested from the utility, not what is converted and used on the vehicle to charge the RESS and support other vehicle functions. It is expected that the amount of energy would be different every time the vehicle needs energy. Hybrid Electric vehicles generally have a 1.5 kW RESS whereas a PHEV may have a RESS in the order of 8 kW (usable energy). RESS charges also identify usable energy since the VM may not desire the RESS to obtain a full discharge state. Some may only discharge from 50% to 80%. Regardless of the RESS capacity, only the usable energy would be applied. BEVs would be expected to have a larger RESS and may be in the order of 25 kW. Even though the BEV has a larger RESS, the PHEV and BEV may request the same amount at each charge event. The PHEV may always fully discharge its RESS since the vehicle can then rely on its hybrid power to continue a drive cycle. The BEV however, may want more charges during the day and seek these "opportunity" events to reduce range anxiety. Figure 3.1 shows the relative variation between the amounts of "usable" energy for various vehicles. This includes a Hybrid for comparison even thought it is not connected to the grid for recharging.

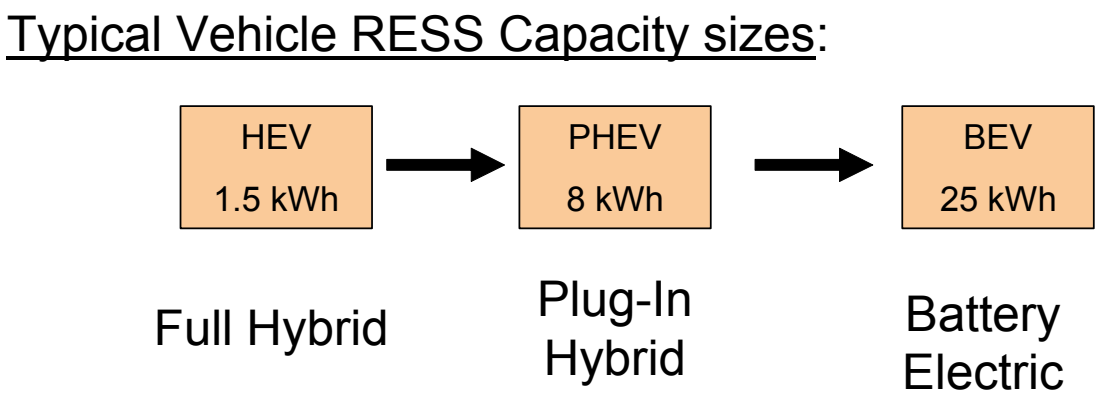


FIGURE 3.1 - RESS CAPACITIES

The amount may be calculated as follows. It is expected the utility would identify the amount available to complete this messages exchange. In the event that an amount available is not sent, the premise could have a default amount based on a transformer size or other parameters programmed into the EVSE.

$$Amount\_request = \frac{RESS\_Capacity * (1 - SOC) + PEV\_Other\_Loads}{Charger\ \eta} \Rightarrow \frac{18\ kWh * (1 - 25\%) + (500Wh\ for\ 3\ hrs)}{85\%} = 17.6\ kWh$$

The rate is dependant on a couple of items. The maximum rate the premise can deliver (thru the EVSE) or the on-board charger size, whatever is smaller. If the PEV is capable of DC energy transfer, the rate would be the maximum output of the off-board charger in the EVSE. Figure 3.2 identifies the three basic EVSEs that are described in SAE J1772™.

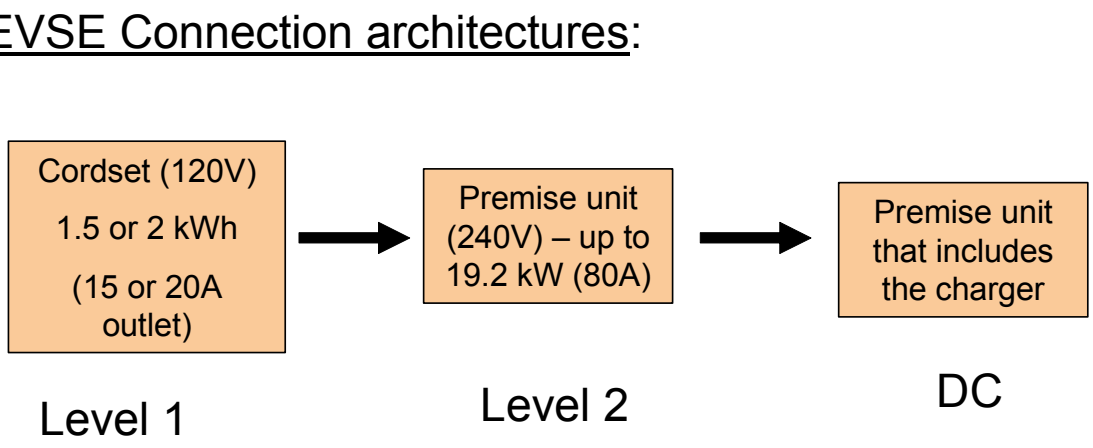


FIGURE 3.2 - EVSE ARCHITECTURES

Time is a sub-set of the connection time. It is expected the customer selects an amount and connection time and the rate and charge time are variables within this overall time period to satisfy the customer needs to have a charged vehicle at the end of the connection time. Figures 3.3 and 3.4 show the variations between PHEV and BEV charge times based on different EVSEs.

Vehicle charge time variations - PHEV

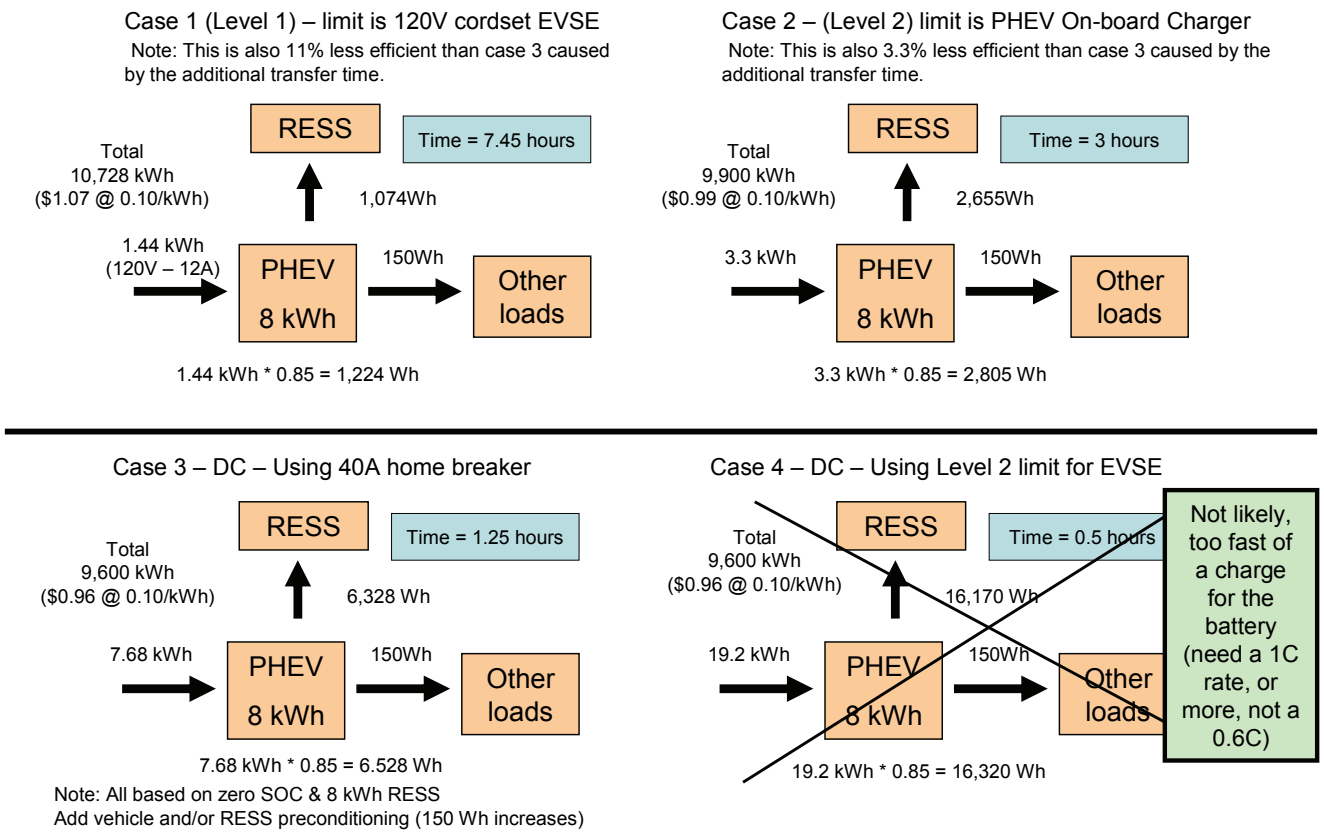


FIGURE 3.3 - PHEV CHARGE TIMES

Vehicle charge time variations - BEV

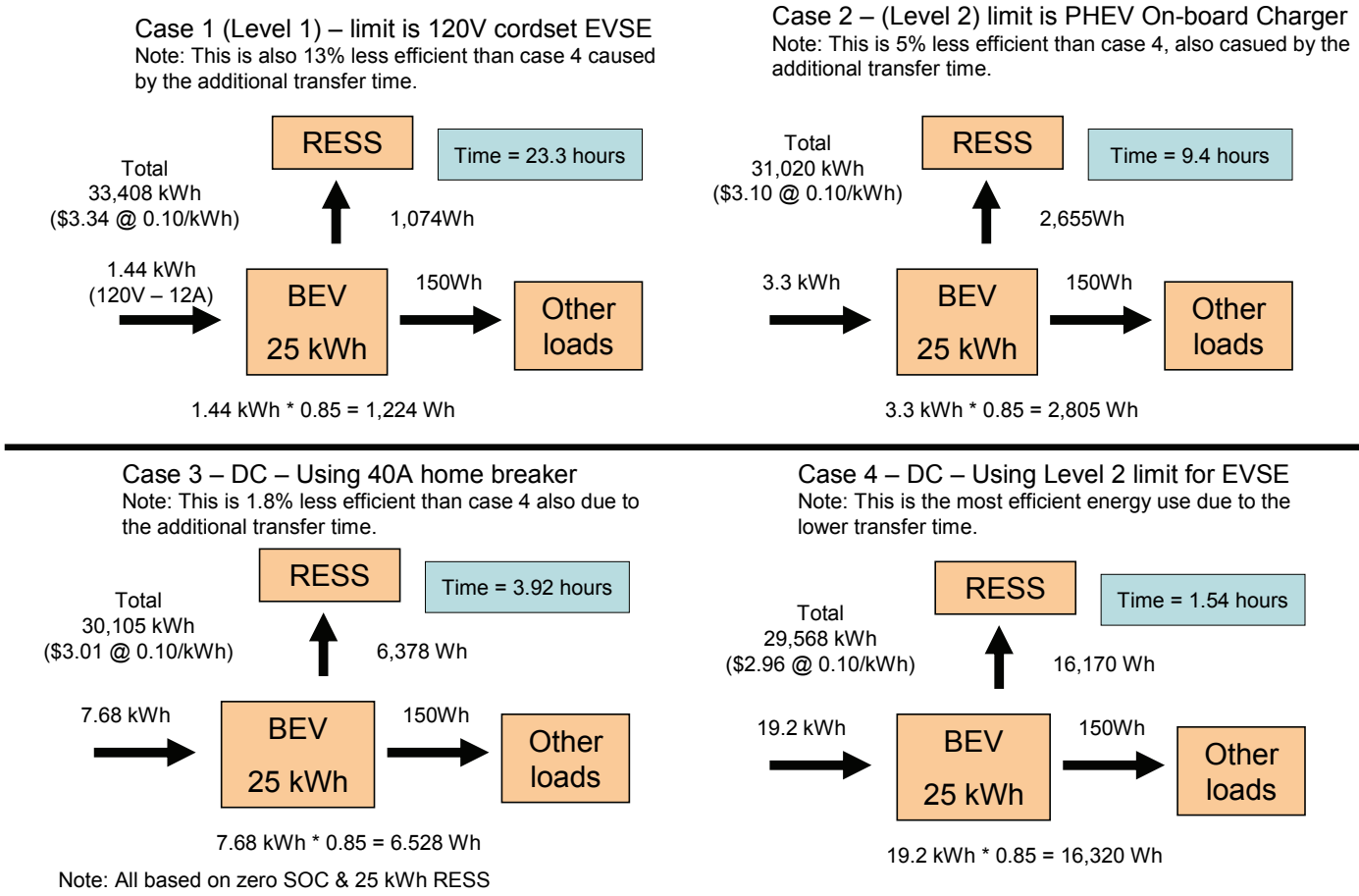


FIGURE 3.4 - BEV CHARGE TIMES

The combinations of amount, rate and time interact is shown in Figure 3.5.

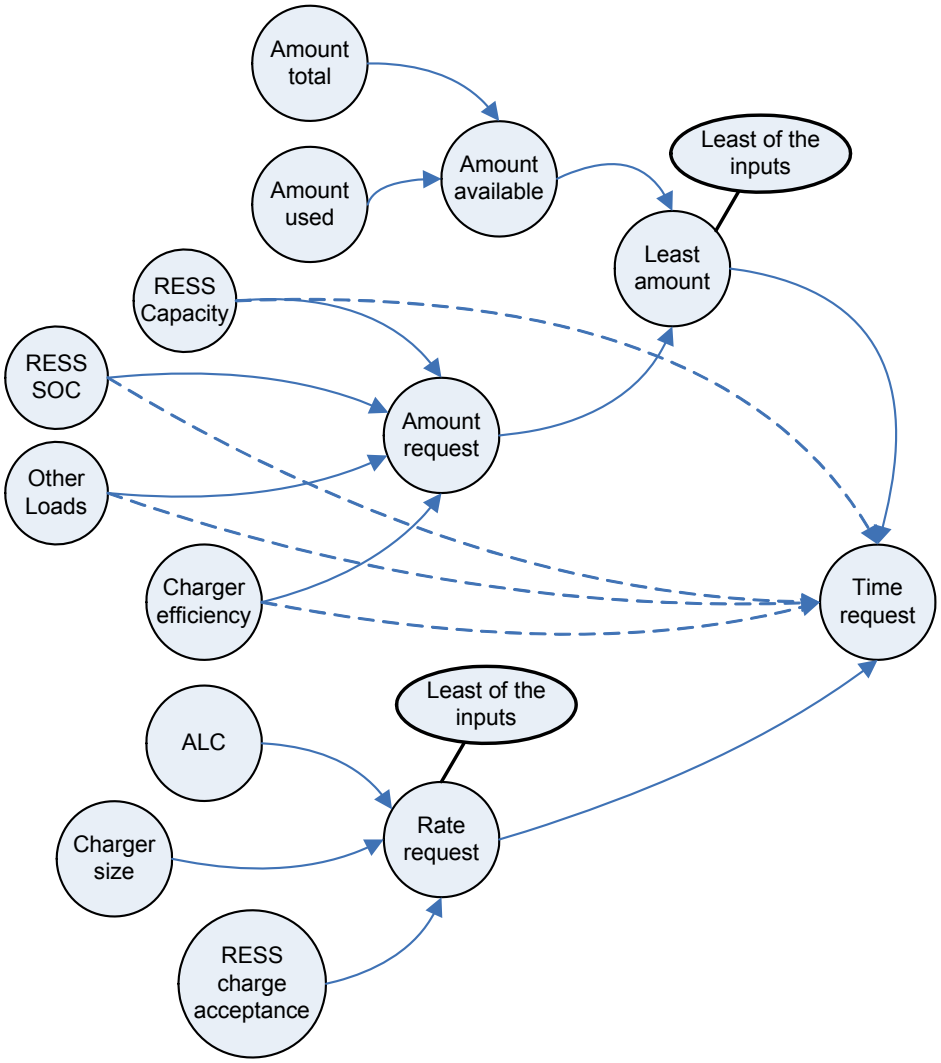


FIGURE 3.5 - AMOUNT, RATE AND TIME INTERACTIONS

Priority and green messages also are included in this scenario. The customer may select a priority message that indicates the urgency of obtaining the amount of energy requested. One case could be if the price is high and the customer can wait until another charge connection, they may request an amount but be willing to settle for less energy if other demands were made at the premise that may fluctuate during the connection time. This could be a public charging station with a PHEV and a BEV also connects during the connection time. The PHEV customer may allow reduction of the original request so the BEV can have more of the available energy and may be compensated for this “offer” by a reduced price. The PHEV may be close to home and be able to charge overnight instead of demanding a charge at this time.

Green is also a message that is included. If green energy is more or less available during the connection time, the customer may select this option. If green energy were available the customer may get more energy delivered than requested (assuming a full charge was not requested) or get it as a sooner delivery time. This could help balance the utility during this time. If the energy request message is provided to the utility, more green energy can be dispersed at a more efficient rate.

This use case is intended to build on U1 thru 4 whereas the customer can select one or more that is available from their utility provider, and then make an energy request for their specific charging event needs. This can also be analyzed with messages about clean energy and priority for more refined results.

An example of this would a customer using a TOU (U1) program plus RTP (U2) could be available and then the customer may connect at home but want an immediate charge to leave in an hour rather than continuing with an overnight charge (as set with the PEV preferences). A “high” priority message would be reconciled with the RTP info and the customer could “charge now” rather than using the TOU schedule for an overnight charge. The customer would return home later and commence with the TOU/RTP algorism as programmed into the PEV preferences.

Another example is the customer is at home for the evening and clean energy becomes available so the vehicle would “charge now” rather than waiting for a delayed or slower charge rate charge overnight, that was selected and entered as the PEV preferences.

3.1.2 Energy Management System:

The arbitration of the energy request vs. available, needs to be done at the lowest level that insures optimization. This is likely to be at the EVSE, then the home, then the transformer level but can move further to upward locations such as the Back-office or other levels of distribution.

The initial application of energy transfer is focused at the home. The simplest case would apply to a home fed off a single transformer and progress to multiple homes that may be fed off a common transformer. The single EMS device would be the EVSE that the utility or customer controls. A more complex EMS would include a HAN to manage the energy within the home.

The single home may be fed from a 10 kVA transformer and typical overloads are up to 150% for up to 3 or 4 hours. This home may include devices that may peak at well into 15 kVA or higher but aren't expected to operate at the same time for a long interval since most of the home loads are repeatable and cyclic loads. The PEV however is expected to be a more sustained load that needs to be included as the average home load.

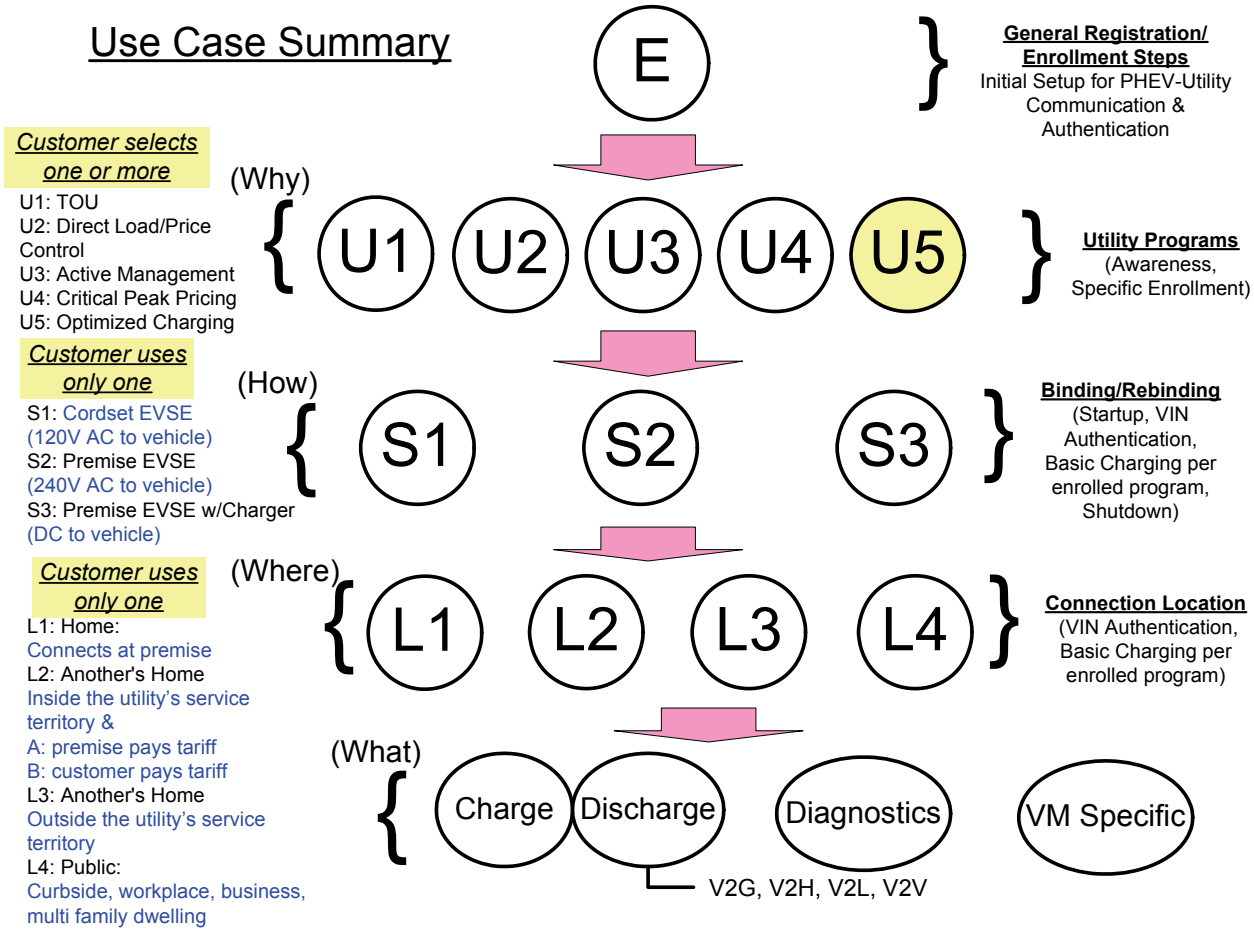
A 25 kVA transformer may feed up to 5 to 7 homes and capable of similar overloads values. Information from all the homes on this branch need to be balanced in order to meet the multiple customer(s) needs and not overload the system. It is assumed that each home would include a smart meter that would identify the load of that home to the EVSE so the charging requirements could be met. This would allow each home to send a priority message of "charge now" vs. "charge overnight" so multiple PEVs could be charged as requested.

3.2 Alternative Scenario Description

The energy request messages could be used by the utility back office or other ISOs that could use this info to plan for regulation services, spinning reserves or other opportunities to manage the grid.

4. REQUIREMENTS

This use case is the 5th in a series that follows Use Case E for general enrolment. This use case defines the Optimized Energy Transfer utility program for awareness and specific enrolment steps. The Utility and the Vehicle Manufacturer will offer these to their customers. The complementary use cases (U1 - 4) describe the specific details of the four other categories of programs. This series of Use cases are then followed by Use Cases S1, 2 or 3 for specific connection architectures.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	PEV and EVSE establish communications. PEV sends ID, EUMD sends ID and EMS authenticates.	EVSE & EUMD sending ID is optional. PEV sending Smart PEV present is optional. Customer ID or PIN entry is optional.	Connection time is recorded by EMS.
2	Energy request and available, duration and profile info is exchanged and PEV identifies charge start and end times.	Preferences from PEV are used or overrides are entered by customer.	Requested vs. actual may be sent if requested.
3	EUMD sends energy delivered message.	PEV may store this for customer info.	

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence diagram for primary scenario U5.

B.7 S1 CORDSET EVSE (LEVEL 1)

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	12-23-08	Rich Scholer	Added U4 to steps 9 & 12. Added U4 & L4 to section 4.	
1.1			Added Section 1.2.	
2.0	1-7-09	Gery Kissel	Added reference to Use Cases "U" to steps 9 & 12. Added key to Activity Diagram.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - S1 – Vehicle Use Case - Customer connects vehicle to premise using Cordset EVSE

1.2 Use Case Summary

This use case details the Binding/Rebinding (Startup, VIN Authentication, Basic Charging per enrolled program, Shutdown) process for the customer to use an EVSE cordset. This is precluded by specific enrollment process by one or more of the Utility Use Case categories as described in Use Cases U1-5. This sequence of Use cases is followed by Use cases L1-4 that include the connection site variations.

1.3 Use Case Detailed Narrative

The vehicle connects to the grid using an Electric Vehicle Supply Equipment (EVSE) Cordset, as described in SAE J1772. It is expected to have the cordset stay with the vehicle and used in both home and public applications.

The cordset would be used for convenience charging that is expected to connect to either a 15A or 20A 120V outlet.

Vehicles that include a 1.5 kW or 2 kW on-board charger uses this cordset connected to the respective 15A or 20A outlets (Energy Portals - EP).

The PHEV & Utility will communicate to implement one or more the following Utility programs.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case S1: Customer uses an EVSE cordset to connect the PEV to the utility.

3.1 Scenario Description

Primary scenario is the customer connects an EVSE cordset to the PHEV and Energy Portal, at home to charge the PHEV. The customer wants to take advantage of one or more of the utility programs.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Customer connects EVSE cordset to Energy Portal and PHEV.	*Customer*	*Customer has enrolled PHEV with home utility*	*The utility has a record of the energy agreement related to the customer premise and the associated PHEV ID. PHEV binds or rebinds with utility.*

3.1.1 Steps for this scenario

<Describe the normal sequence of events that is required to complete the scenario.>

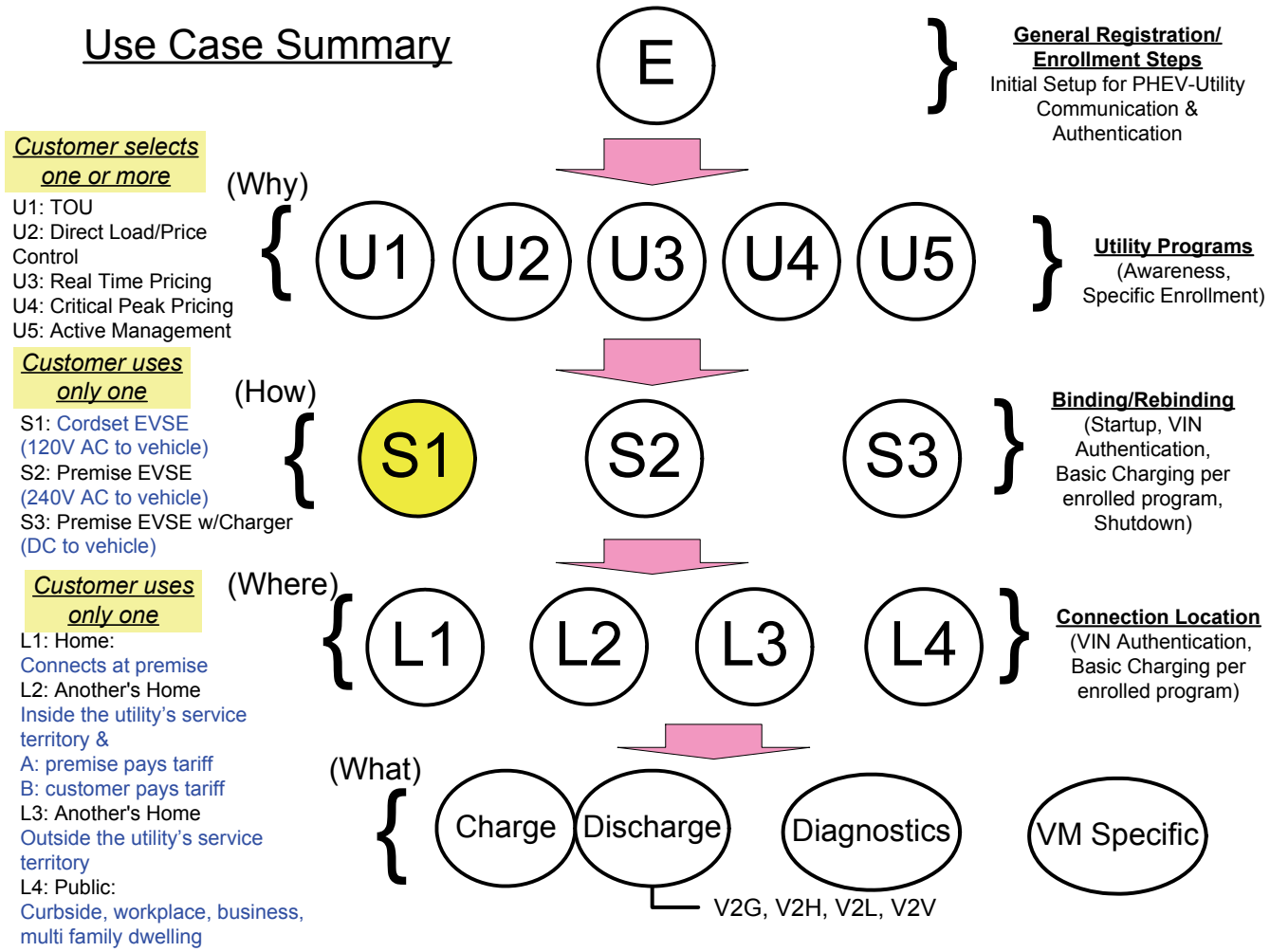
Step #	Actor	Description of the Step	Additional Notes
1	Customer	Customer connects EVSE cordset to Energy Portal at Premise.	When the EVSE has power from the grid, it sends a 12V signal on the pilot circuit to the PHEV.
2	Customer	Customer connects EVSE cordset to PHEV.	When the EVSE is then connected to the PHEV, this 12V signal is reduced to 9V thru a vehicle resistor on the PHEV.
3	PHEV	PHEV wakes up.	The pilot signal wakes up the vehicle for it to latch on vehicle power.
4	EVSE	EVSE monitors pilot voltage drop from 12V to 9V.	This reduction to 9V tells the EVSE a vehicle is connected. It is also used by the EVSE that is also detecting the output of this circuit to start its PWM generator.
5	EVSE	EVSE starts Available Line Current (ALC) PWM generator.	The PWM generator magnitude is then transitioning from +9V to -12V magnitude and the rate matches the chart for Available Line Current (ALC) identified in SAE J1772
6	PHEV	PHEV prepares for charging rate (charger size or ALC, whatever is lowest).	The vehicle reads this PWM signal and if the on-board charger can draw more current, it will scale back to this ALC to overload the circuit on the premise. (i.e., a 15A EP provides 12A and the PWM is 20%, 240V power levels are higher PWM rates).
7	PHEV/ESCI	PHEV and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PHEV or ESCI as initiator of session.
8	PHEV	PHEV sends VIN	Utility authenticates PHEV is connected and implements program criteria.
8a	PHEV	PHEV sends Billing Request	This would confirm PHEV billing at premise (customer's home). Optional billing requests may be request if connecting to another Utility territory or public premises. These options would have been transmitted to the utility during the enrollment or could have been agreed to at public sites (i.e., curbside, etc).

Step #	Actor	Description of the Step	Additional Notes
9	PHEV	PHEV sends Energy Request (amount & rate)	Amount is total (based on RESS SOC). Rate is the lesser of ALC or charger size. Utility compares request with available and confirms or adjusts for message back to PHEV.
9a	PHEV	PHEV sends schedule for energy request	Based on TOU program (See Use Case U1).
9b	PHEV	PHEV sends request for discrete event info.	Based on Discrete Event demand side management program (See Use Case U2).
9c	PHEV	PHEV sends customers predetermined pricing info to utility	Based on Periodic/Hourly Pricing Price Response program (See Use Case U3).
9d	PHEV	PHEV requests Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program (See Use Case U4).
9e	PHEV	PHEV sends …	Based on Active Load Management program (See Use Case U5).
10	Utility	Utility verifies PHEV ID (premise ID and/or customer ID) to ESCI	PEV binds (or rebinds) with utility
11	Utility	Utility transmits confirmation message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	EUMD is required for revenue metering of electricity
12	Utility	Utility sends Energy Available (amount & rate)	Amount is total (based on RESS SOC). Rate is the lesser of ALC or charger size. Utility compares request with available and confirms or adjusts for message back to PHEV.
12a	Utility	Utility sends schedule for energy available (time spread energy will be delivered)	Based on TOU program. Schedule is Connection Time, Full Charge Time and Balance Charge Time (See Use Case U1).
12b	Utility	Utility sends discrete event alerts.	Based on Discrete Event demand side management program (See Use Case U2).

Step #	Actor	Description of the Step	Additional Notes
12c	Utility	Utility sends periodic/hourly prices.	Based on Periodic/Hourly Pricing Price Response program (See Use Case U3).
12d	Utility	Utility sends Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program (See Use Case U4).
12e	Utility	Utility sends …	Based on Active Load Management program (See Use Case U5).
13	PHEV	PHEV prepares for charging.	When the vehicle is ready to accept energy, another resistor is switched into the pilot circuit that drops the +9V to either 6V or 3V. 6V means the EVSE does not have to turn on ventilation at the premise and 3V means it does. This voltage drop signals the EVSE to close its switches and allow power to flow to the vehicle.
14	EUMD	PHEV Charges	EUMD records charging information and energy supplied to PHEV for each charging session. Charging information is included with additional info collected by ESCI (PHEV ID, Premise ID, Date & Time stamp) for each metering interval.
15	ESCI	ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PHEV and Customer information.
16	Utility	Utility records each PHEV charging session for bill generation and reporting to customer account associated with this premise and PHEV ID.	

4. REQUIREMENTS

This Use Case (S1) refers to the steps the customer will use while using a Cordset EVSE. This is preceded by one or more of the Utility program Use Cases (U1, 2 3 and/or 4) and is followed by the Location Use Cases L1, 2, etc. per the following diagram.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

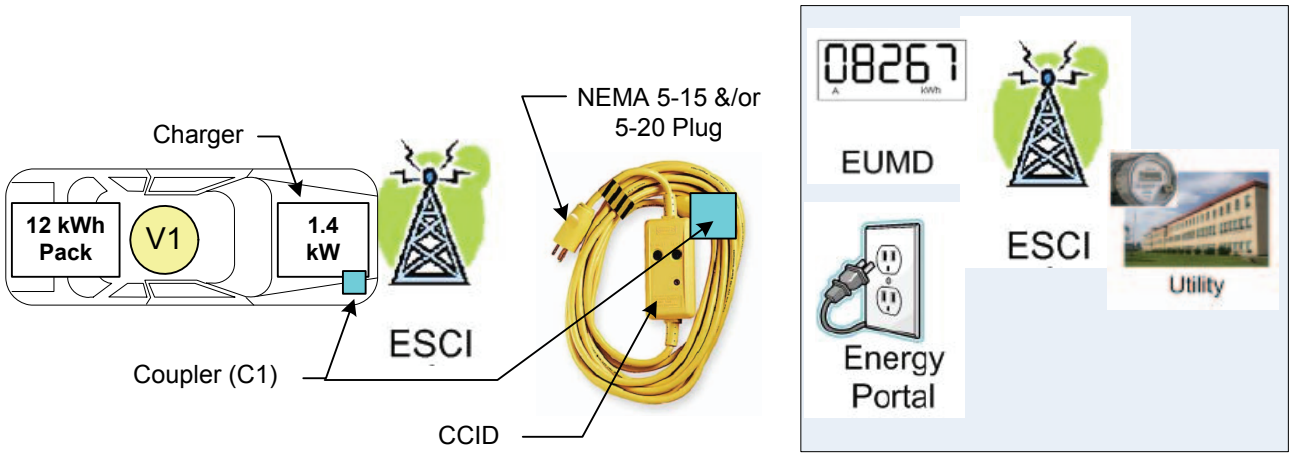
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

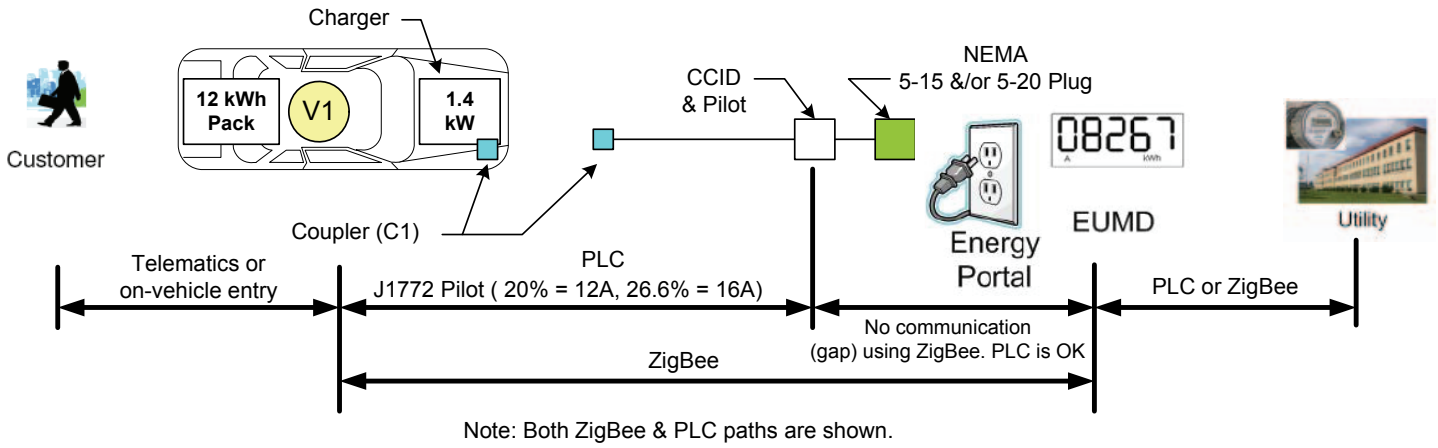
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Equipment Diagram



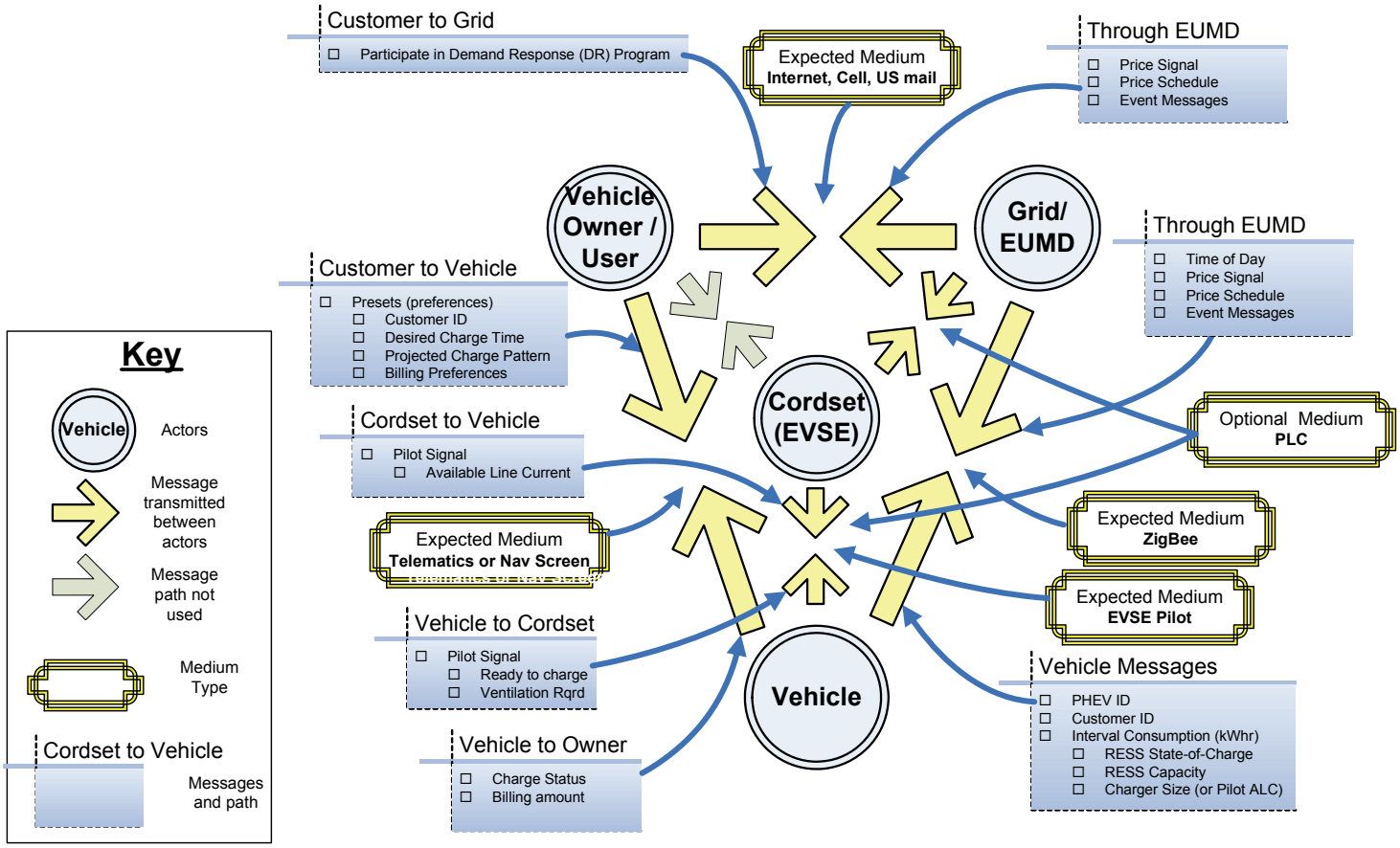
5.2 Communication Path Diagram



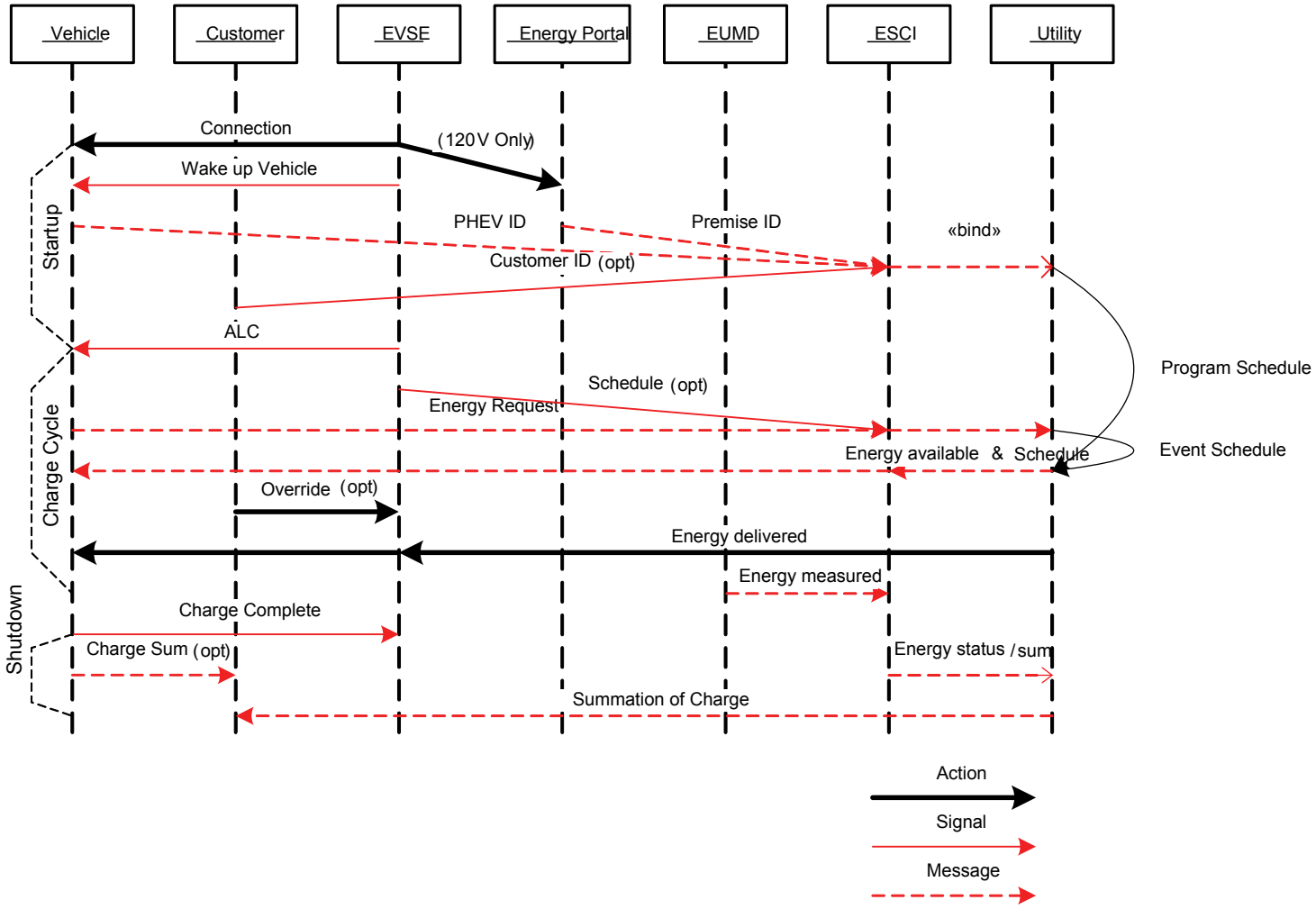
Note: Both ZigBee & PLC paths are shown.

5.3 Activity Diagram

Note: Cordset EVSE shows ZigBee from the vehicle to utility since the cordset is not expected to include a ZigBee chip. PLC however, would go thru the EVSE from the vehicle to the utility.

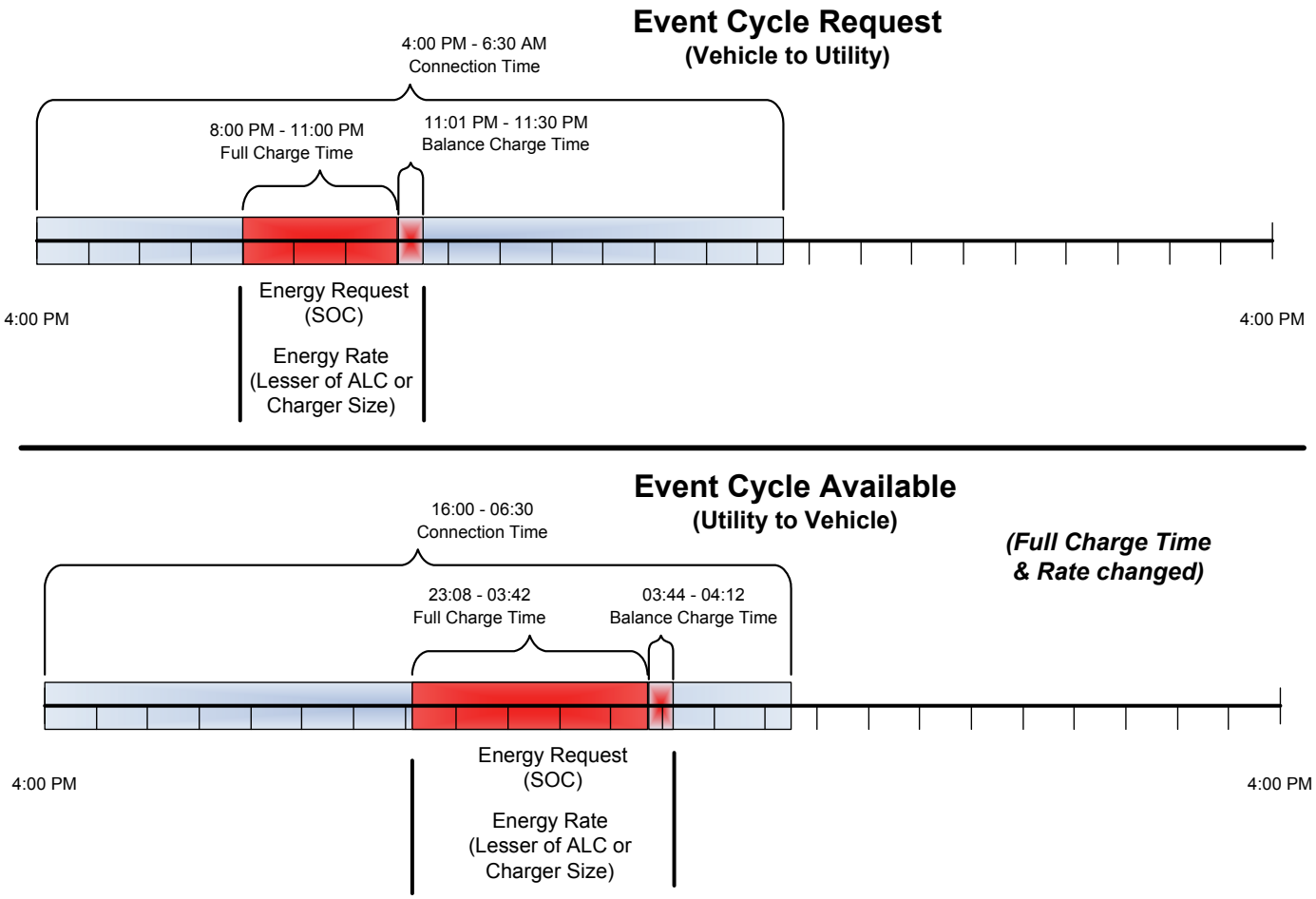


5.4 Sequence Diagram



5.5 Message Diagram

This diagram shows the primary message requests sent from Vehicle and a potential message reply from the Utility. The Energy request (amount & rate) delivery time is based on the Utility program enrollment programmed into the vehicle or a smart socket. The utility responds with the optimization values for this cycle time.



B.8 S2 PREMISE EVSE (LEVEL 2)

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	12-23-08	Rich Scholer	Added U4 to steps 9 & 12. Added U4 & L4 to section 4.	
1.1			Added Section 1.2.	
2.0	1-7-09	Gery Kissel	Added reference to Use Cases "U" to steps 9 & 12. Added key to Activity Diagram.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - S2 – Vehicle Use Case - Customer connects vehicle to premise EVSE

1.2 Use Case Summary

This use case details the Binding/Rebinding (Startup, VIN Authentication, Basic Charging per enrolled program, Shutdown) process for the customer to use a premise mounted EVSE that does not include a charger. This is precluded by specific enrollment process by one or more of the Utility Use Case categories as described in Use Cases U1-5. This sequence of Use cases is followed by Use cases L1-4 that include the connection site variations.

1.3 Use Case Detailed Narrative

The vehicle connects to the grid using a cord that is included in the premise mounted Electric Vehicle Supply Equipment (EVSE), as described in SAE J1772. These are expected to be available in both home and public applications.

The premise EVSE would be used for higher power levels than a Cordset EVSE and is expected to be permanently connected to a 240V premise source that is capable of delivering up to 80A.

Vehicles that use this premise EVSE are expected to include on-board chargers.

The premise EVSE could also include more than one cord allowing it to be connected to more than one vehicle at a location.

The PHEV & Utility will communicate to implement one or more the following Utility programs.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case S2: Customer uses a premise EVSE (that does not include a charger) to connect the PEV to the utility.

3.1 Scenario Description

Primary scenario is the customer connects a premise EVSE to the PHEV, at home to charge the PHEV. The customer wants to take advantage of one or more of the utility programs.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Customer connects premise EVSE cord to PHEV.	*Customer*	*Customer has enrolled PHEV with home utility*	*The utility has a record of the energy agreement related to the customer premise and the associated PHEV ID. PHEV binds or rebinds with utility.*

3.1.1 Steps for this scenario

<Describe the normal sequence of events that is required to complete the scenario.>

Step #	Actor	Description of the Step	Additional Notes
1	EVSE	When the EVSE has power from the premise, it sends a 12V signal on the pilot circuit.	
2	Customer	Customer connects EVSE cord to PHEV.	When the EVSE cord is connected to the PHEV, this 12V signal is reduced to 9V thru a vehicle resistor on the PHEV.
2a	EVSE	If the EVSE has multiple cords, the customer may have to enter more info at the EVSE.	This may or may not be required at a customer's home.
2b	EVSE	A public EVSE with or without multiple cords may require the customer to enter billing and/or personal info or verify the customer is authorized to connect at this site.	Billing could be for a parking space rather than cost of energy.
3	PHEV	PHEV wakes up.	The pilot signal wakes up the vehicle to a state sufficient to participate in charging.
4	EVSE	EVSE monitors pilot voltage drop from 12V to 9V.	This reduction to 9V tells the EVSE a vehicle is connected. It is also used by the EVSE that is also detecting the output of this circuit to start its PWM generator.
5	EVSE	EVSE starts Available Line Current (ALC) PWM generator.	The PWM generator magnitude is then transitioning from +9V to -12V magnitude and the rate matches the chart for Available Line Current (ALC) identified in SAE J1772
6	PHEV	PHEV prepares for charging rate (charger size or ALC, whatever is lowest).	The vehicle reads this PWM signal and if the on-board charger can draw more current, it will scale back to this ALC to prevent overloading the circuit on the premise. (e.g., a 40A premise circuit provides 32A and the PWM is 53.3%, whereas a 10 kW charger could draw 41.6A and overload the circuit).
6a	EVSE	Pilot PWM is reduced to 5% if additional communication is available.	We need to figure out why this is different than a cordset and if this 5% PWM is actually required.

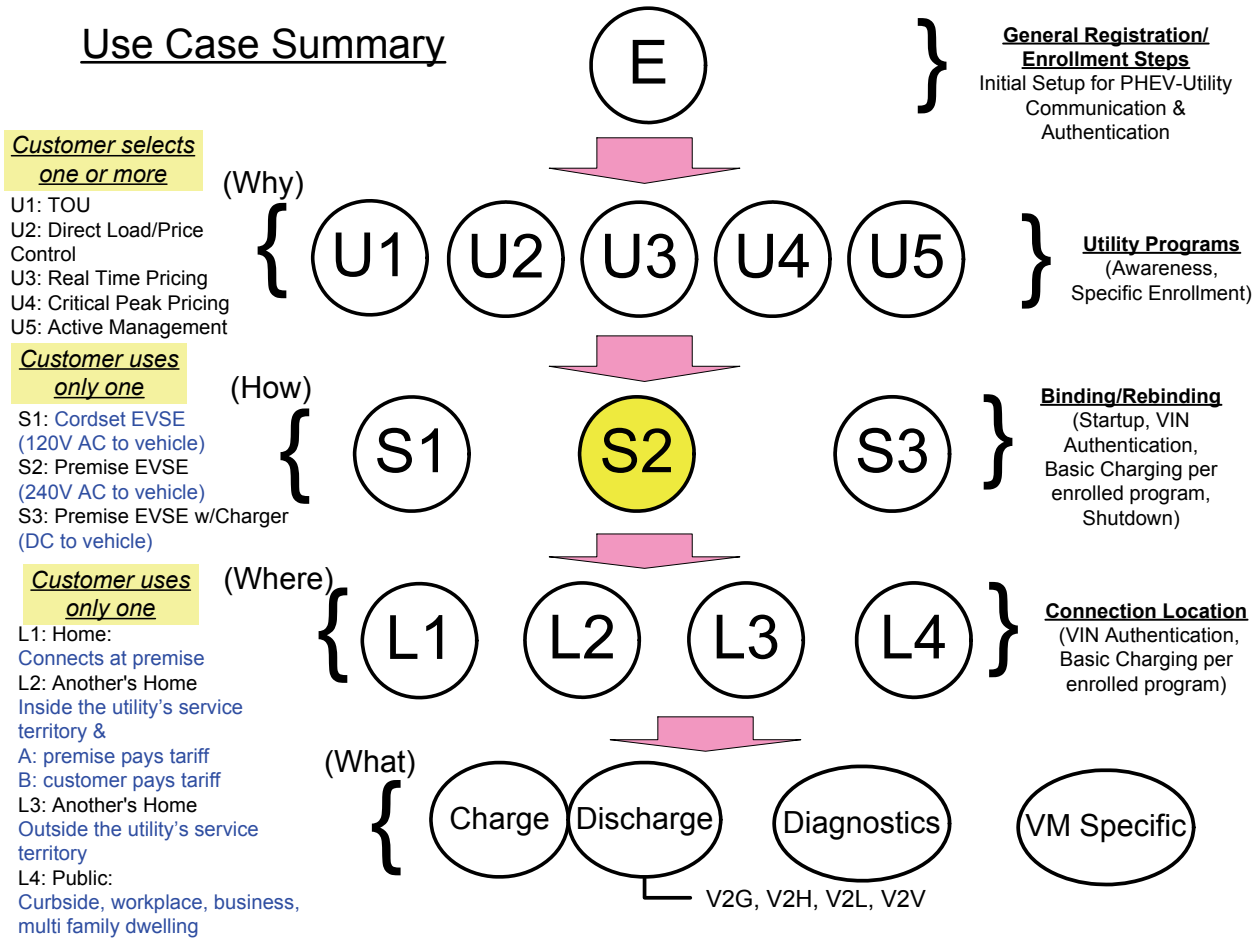
Step #	Actor	Description of the Step	Additional Notes
7	PHEV/ESCI	PHEV and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PHEV or ESCI as initiator of session.
8	PHEV	PHEV sends VIN	Utility authenticates PHEV is connected and implements program criteria.
8a	PHEV	PHEV sends Billing Request	This would confirm PHEV billing at premise (customer's home). Optional billing requests may be request if connecting to another Utility territory or public premises. These options would have been transmitted to the utility during the enrollment or could have been agreed to at public sites (i.e., curbside, etc.).
9	PHEV	PHEV sends Energy Request (amount & rate)	Amount is total (based on RESS SOC). Rate is the lesser of ALC or charger size. Utility compares request with available and confirms or adjusts for message back to PHEV.
9a	PHEV	PHEV sends schedule for energy request	Based on TOU program (See Use Case U1). Schedule is Connection Time, Full Charge Time and Balance Charge Time.
9b	PHEV	PHEV sends request for discrete event info.	Based on Discrete Event demand side management program (See Use Case U2).
9c	PHEV	PHEV sends customers predetermined pricing info to utility	Based on Periodic/Hourly Pricing Price Response program (See Use Case U3).
9d	PHEV	PHEV requests Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program (See Use Case U4).
9e	PHEV	PHEV sends …	Based on Active Load Management program (See Use Case U5).
10	Utility	Utility verifies PHEV ID (premise ID and/or customer ID) to ESCI	PEV binds (or rebinds) with utility

Step #	Actor	Description of the Step	Additional Notes
11	Utility	Utility transmits confirmation message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	EUMD is required for revenue metering of electricity
12	Utility	Utility sends Energy Available (amount & rate)	
12a	Utility	Utility sends schedule for energy available (time spread energy will be delivered)	Based on TOU program (See Use Case U1).
12b	Utility	Utility sends discrete event alerts.	Based on Discrete Event demand side management program (See Use Case U2).
12c	Utility	Utility sends periodic/hourly prices.	Based on Periodic/Hourly Pricing Price Response program (See Use Case U3).
12d	Utility	Utility sends Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program (See Use Case U4).
12e	Utility	Utility sends …	Based on Active Load Management program (See Use Case U5).
13	PHEV	PHEV prepares for charging.	When the vehicle is ready to accept energy, another resistor is switched into the pilot circuit that drops the +9V to either 6V or 3V. 6V means the EVSE does not have to turn on ventilation at the premise and 3V means it does. This voltage drop signals the EVSE to close its switches and allow power to flow to the vehicle.
14	EUMD	PHEV Charges	EUMD records charging information and energy supplied to PHEV for each charging session. Charging information is included with additional info collected by ESCI (PHEV ID, Premise ID, Date & Time stamp) for each metering interval.
15	ESCI	ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PHEV and Customer information.

Step #	Actor	Description of the Step	Additional Notes
16	Utility	Utility records each PHEV charging session for bill generation and reporting to customer account associated with this premise and PHEV ID.	

4. REQUIREMENTS

This Use Case (S2) refers to the steps the customer will use while using a premise EVSE. This is preceded by one or more of the Utility program Use Cases (U1, 2 3 and/or 4) and is followed by the Location Use Cases L1, 2, etc. per the following diagram.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

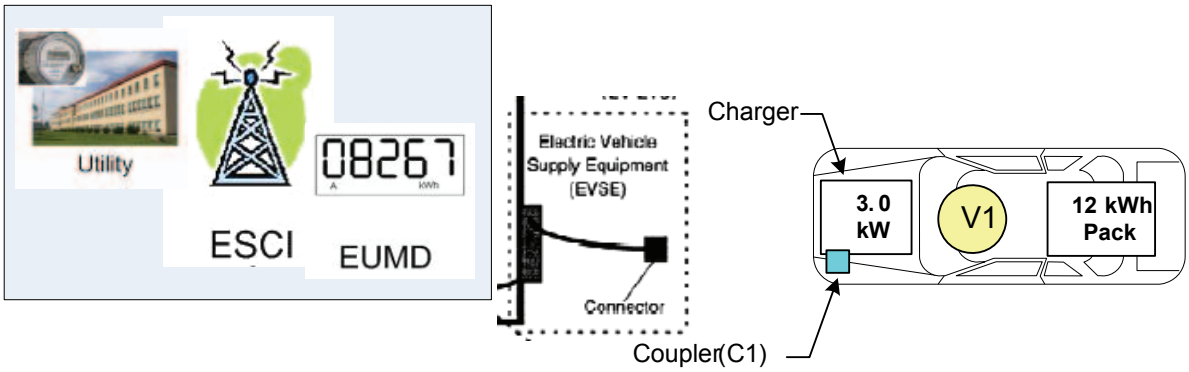
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

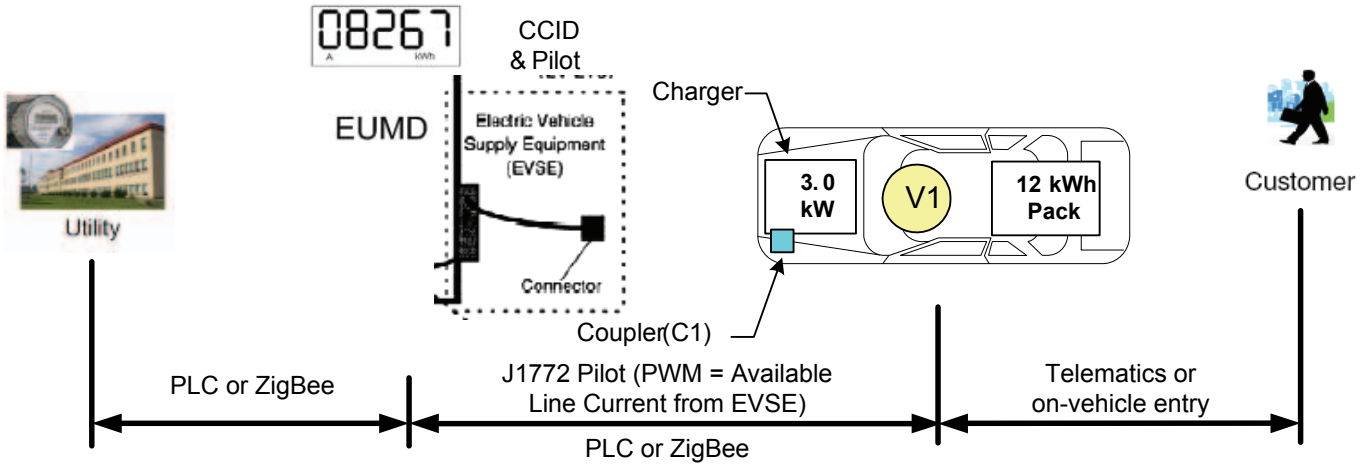
5. USE CASE MODELS

5.1 Equipment Diagram



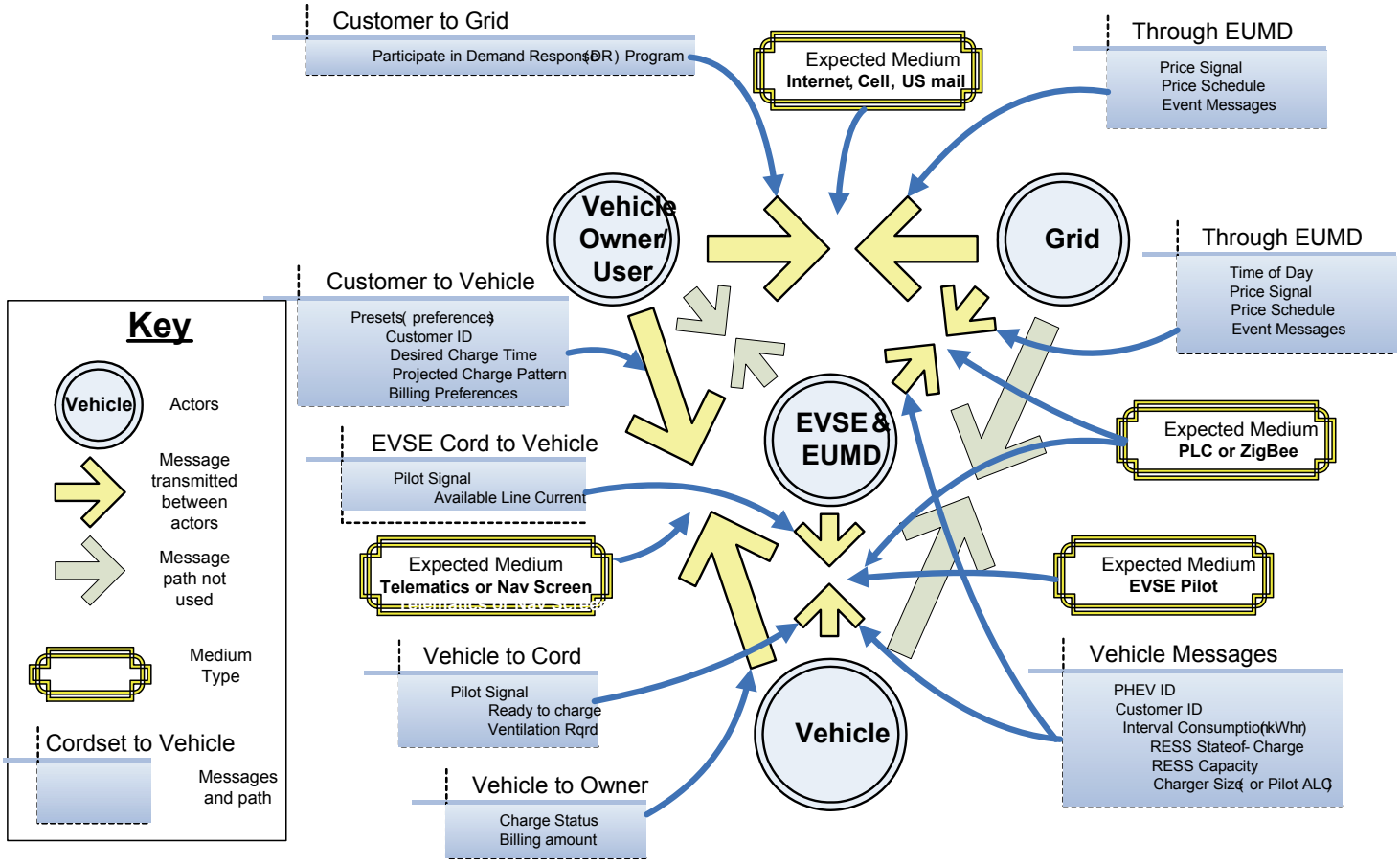
PHEV Assumptions
EUMD & ESCI are in the EVSE The system does not include an AMI (SmartMeter).

5.2 Communication Path Diagram

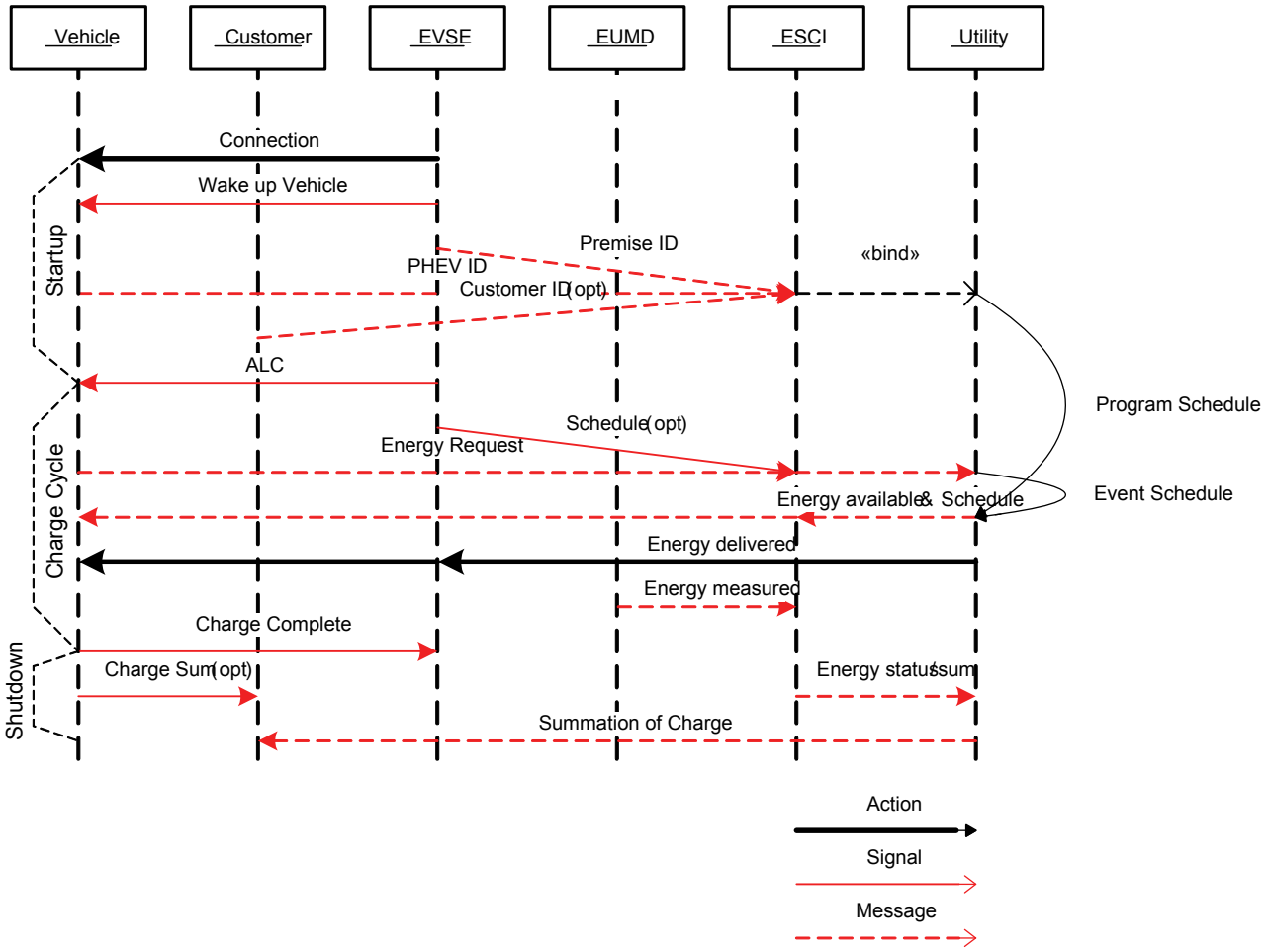


5.3 Activity Diagram

Note: Premise mounted EVSE shows ZigBee or PLC from the vehicle to utility thru the EVSE.

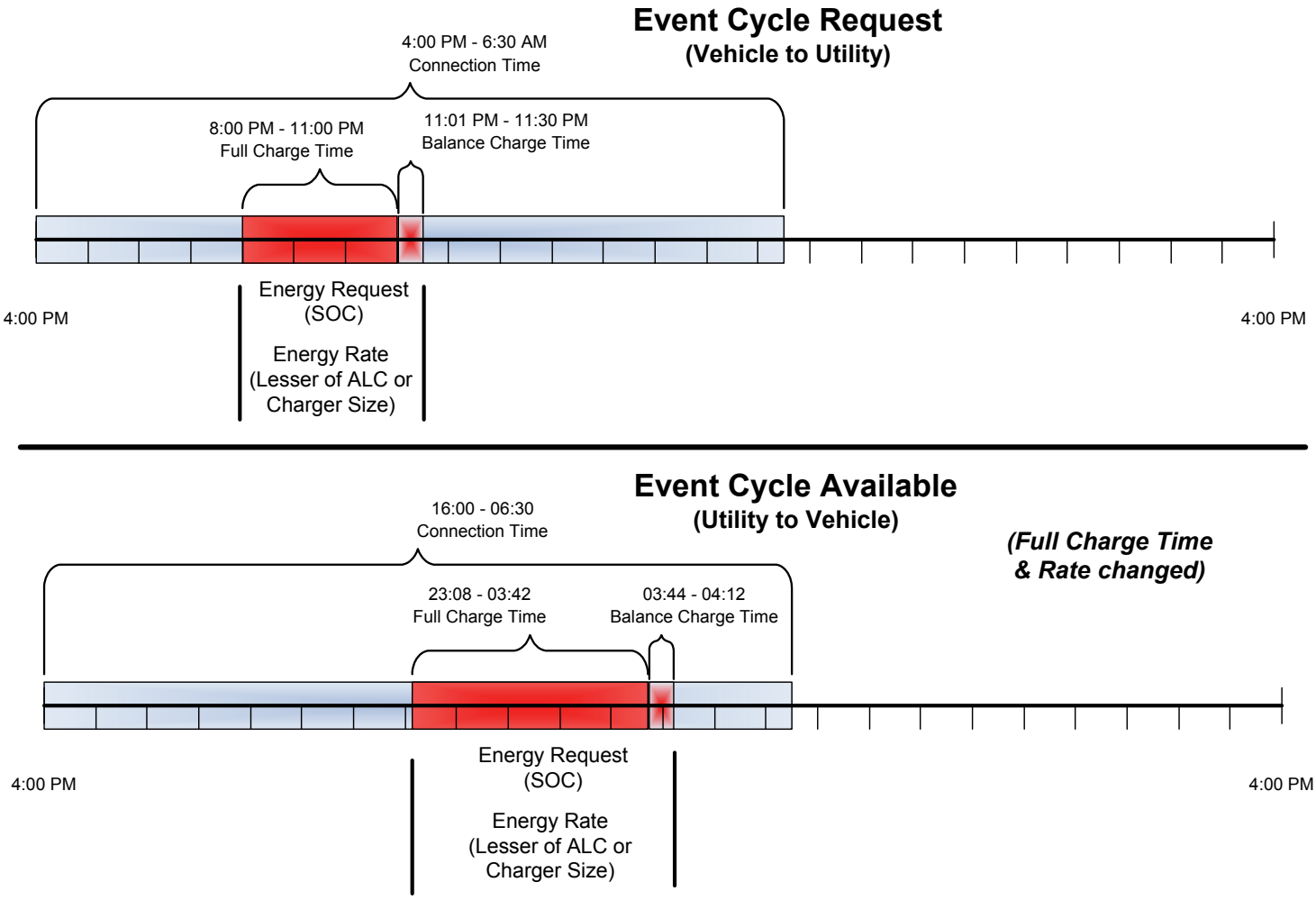


5.4 Sequence Diagram



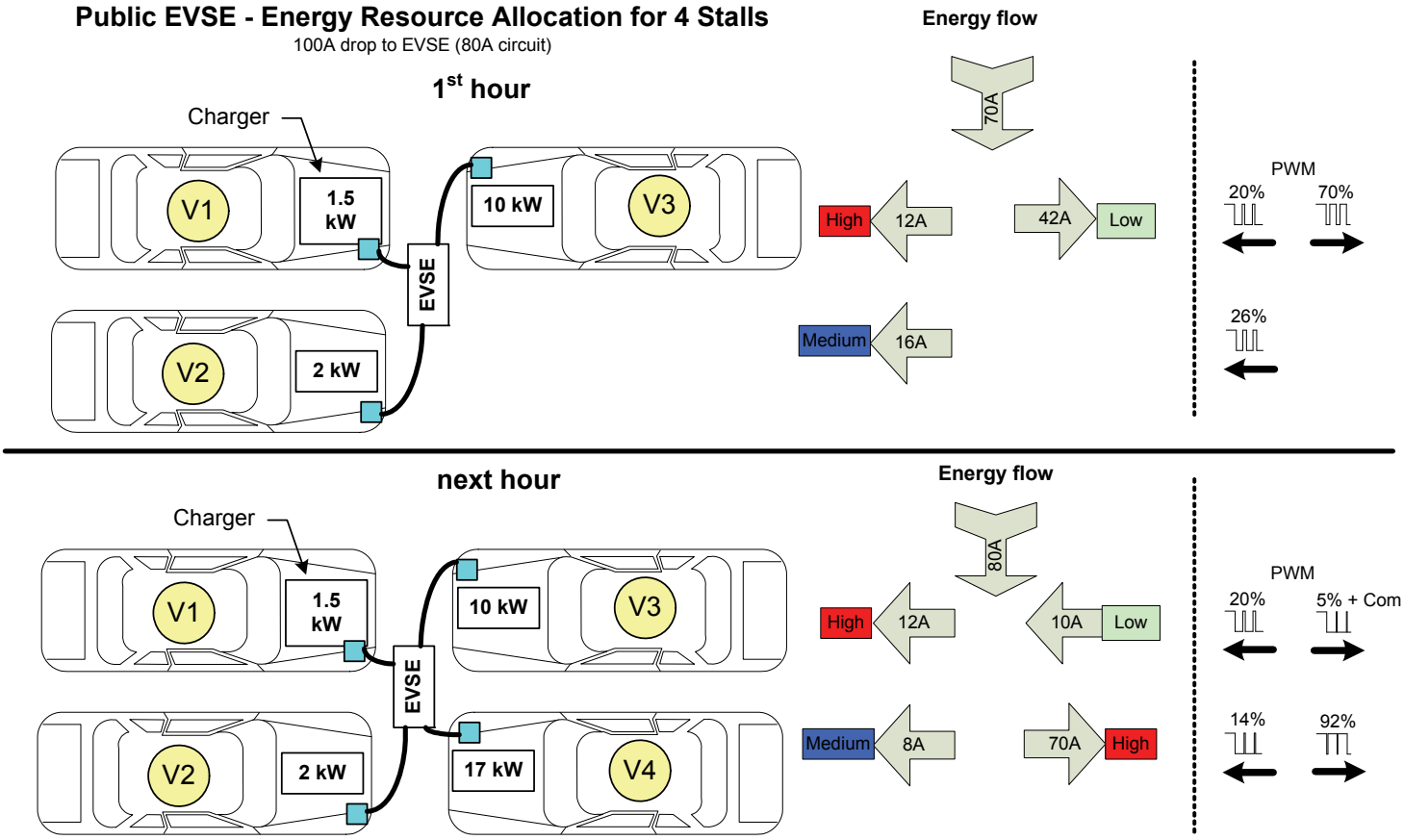
5.5 Message Diagram

This diagram shows the primary message requests sent from Vehicle and a potential message reply from the Utility. The Energy request (amount & rate) delivery time is based on the Utility program enrollment programmed into the vehicle or the EVSE. The utility responds with the optimization values for this cycle time.



5.6 Multiple Port Scenario Diagram

Note: It is expected that some public EVSEs will need to allocate the resources for the combination of EVs and PHEVs that use them during the day. Business centers may include one or more of the following charging stations in their parking lot and are expected to have multiple vehicles use them during the day. One station may only accommodate one EV but will handle up to four PHEVs with the resources allocated.

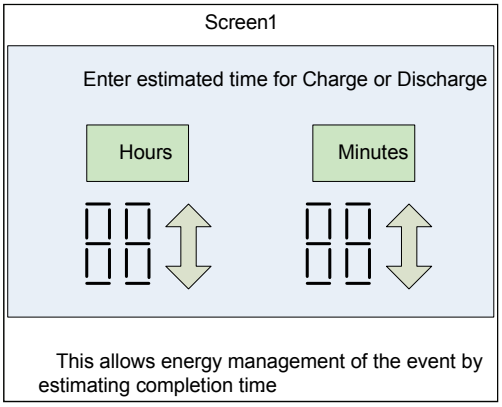


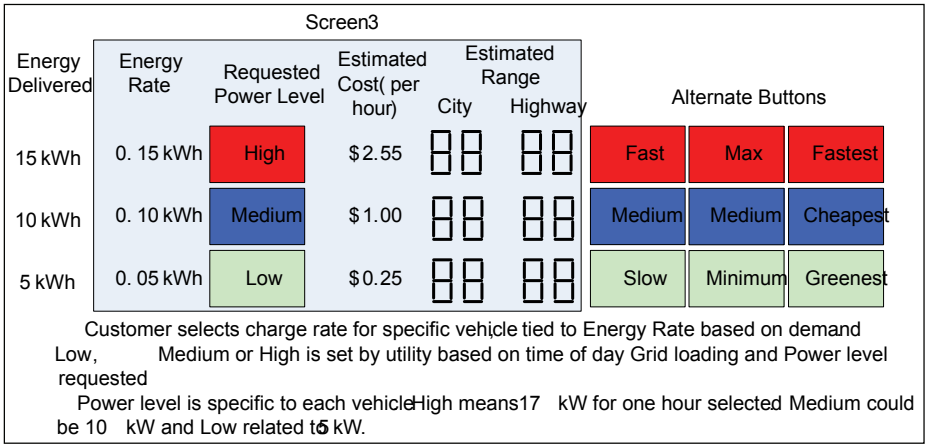
5.7 EVSE Information Entry Screen Diagram

Note:

Instead of using the time identified in Step 8a, the customer may enter this on the public EVSE. It is expected the time to match the estimated time the customer will be at a particular business (i.e., 1 ½ hours).

Another request may be for a certain amount of energy delivered to the vehicle. This may vary on vehicle RESS SOC and distance from home or other locations whereas the customer could take advantage of the initial enrollment program features. This is similar to a customer stopping for a couple of gallons of gas until they reach another known station for a fill-up.





B.9 S3 PREMISE EVSE THAT INCLUDES THE CHARGER (DC)

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	12-23-08	Rich Scholer	Added U4 to steps 10 & 13. Added U4 & L4 to section 4.	
1.1			Added Section 1.2.	
2.0	1-7-09	Gery Kissel	Added reference to Use Cases "U" to steps 10 & 13. Added key to Activity Diagram.	
2.1	12-30-09	Rich Scholer	Clarified Section 5.1 for DC connectors.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - S3 – Vehicle Use Case - Customer connects vehicle to premise EVSE that includes the charger. This allows DC energy transfer to the vehicle. This EVSE also retains the AC energy transfer capabilities described in S2.

1.2 Use Case Summary

This use case details the Binding/Rebinding (Startup, VIN Authentication, Basic Charging per enrolled program, Shutdown) process for the customer to use a premise mounted EVSE that includes a charger. This is precluded by specific enrollment process by one or more of the Utility Use Case categories as described in Use Cases U1-5. This sequence of Use cases is followed by Use cases L1-4 that include the connection site variations.

1.3 Use Case Detailed Narrative

The vehicle connects to the grid using a cord that is included in the premise mounted Electric Vehicle Supply Equipment (EVSE), as described in SAE J1772. These are expected to be available in both home and public applications. Including the charger in the EVSE removes this burden from the vehicle (less weight, cost, etc) and retains it within the EVSE. This may be a favorable option for customers that trade vehicles frequently and only want to purchase the charger (or a large charger) one time and include it with the installation of the EVSE in their home or other locations. The customer could include a small charger on a PHEV for convenience charging using an EVSE cordset (1.5 to 2kW) and then use a larger charger in a premise EVSE, when available for faster charging rates. This may be a favorable option for EVs where they may require up to an 18 kW on-board charger that could be in the EVSE and the vehicle would only need a 3 kW unit.

This premise EVSE that includes the charger would be used for higher power levels than a premise EVSE without a charger. This EVSE would also include a selection device that would allow it's charger to be bypassed and also deliver AC energy to a vehicle.

Vehicles that use this premise EVSE may or may not include on-board chargers.

The premise EVSE could also include more than one cord allowing it to be connected to more than one vehicle at a location.

The PHEV & Utility will communicate to implement one or more the following Utility programs.

U1: Time-Of-Use (TOU) Rates / Tariffs / Programs (Load Shifting)

U2: Direct Load Control Programs (Demand Response)

U3: Real Time Pricing (RTP: Load Shifting / Demand Response) (Active Management)

U4: Critical Peak Pricing (CPP / Load Shifting / Demand Response)

U5: Optimized Energy Transfer Programs (Demand Response, Regulation Services, etc.)

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case S3: Customer uses a premise EVSE (that includes a charger) to connect the PEV to the utility.

3.1 Scenario Description

Primary scenario is the customer connects a premise EVSE to the PHEV, at home to charge the PHEV. The customer wants to take advantage of one or more of the utility programs.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Customer connects premise EVSE cord to PHEV.	*Customer*	*Customer has enrolled PHEV with home utility*	*The utility has a record of the energy agreement related to the customer premise and the associated PHEV ID. PHEV binds or rebinds with utility.*

3.1.1 Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	EVSE	When the EVSE has power from the premise, it sends a 12V signal on the pilot circuit.	
2	EVSE	Selection is made if AC or DC energy is to be transferred.	The premise EVSE that includes a charger can also deliver AC energy to the vehicle (bypassing the EVSE charger and using the vehicle charger, if so equipped).
3	Customer	Customer connects EVSE cord to PHEV.	When the EVSE cord is connected to the PHEV, this 12V signal is reduced to 9V thru a vehicle resistor on the PHEV.
3a	EVSE	If the EVSE has multiple cords, the customer may have to enter more info.	This may or may not be required at a customer's home.
3b	EVSE	A public EVSE with or without multiple cords may require the customer to enter billing and/or personal info or verify the customer is authorized to connect at this site.	Billing could be for a parking space rather than cost of energy.
4	PHEV	PHEV wakes up.	The pilot signal wakes up the vehicle to a state sufficient to participate in charging.

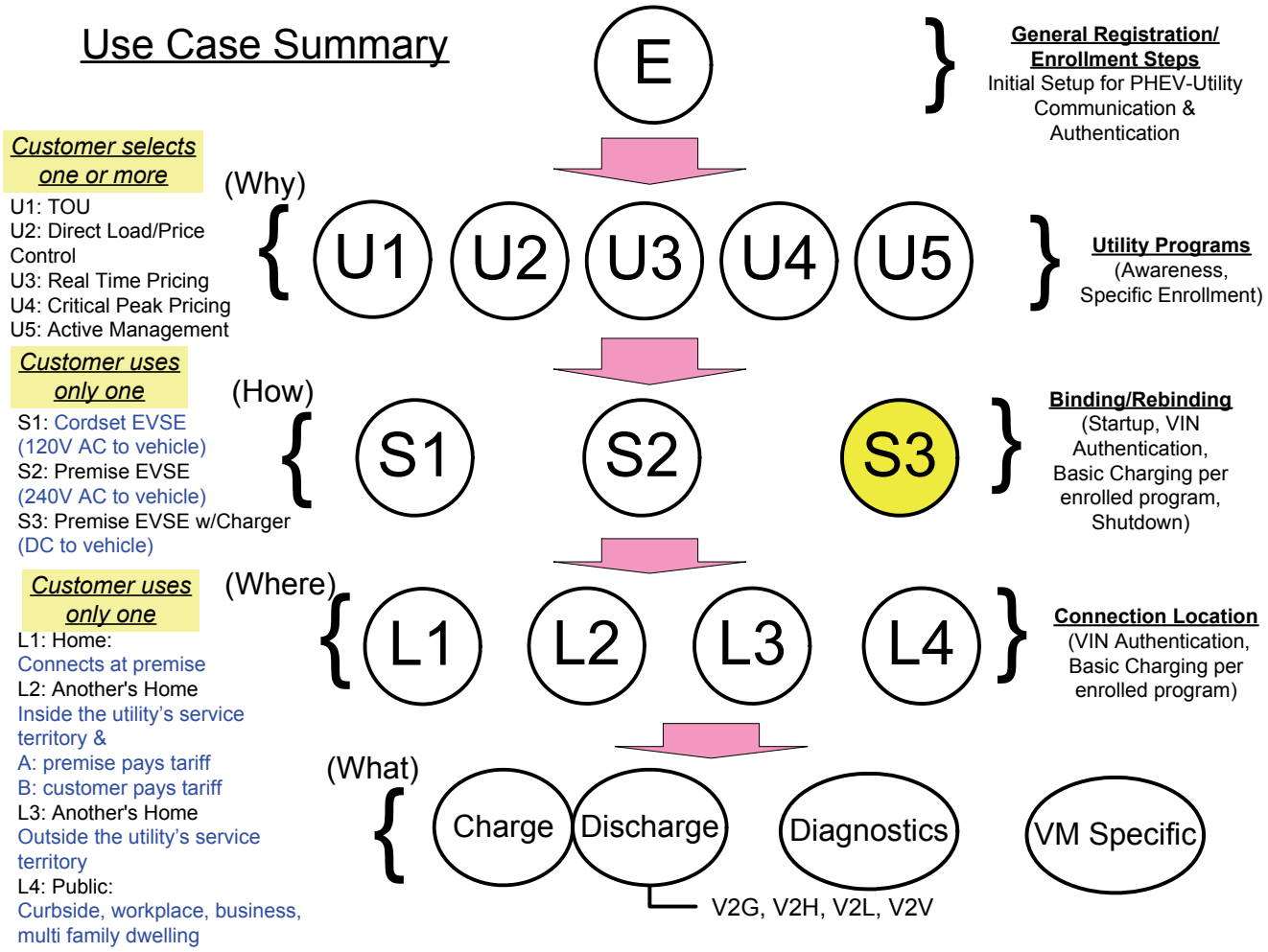
Step #	Actor	Description of the Step	Additional Notes
5	EVSE	EVSE monitors pilot voltage drop from 12V to 9V.	This reduction to 9V tells the EVSE a vehicle is connected. It is also used by the EVSE that is also detecting the output of this circuit to start its PWM generator.
6	EVSE	EVSE starts Available Line Current (ALC) PWM generator.	The PWM generator magnitude is then transitioning from +9V to -12V magnitude and the rate matches the chart for Available Line Current (ALC) identified in SAE J1772. 5% PWM is automatically transmitted if DC energy is requested in step 2. AC energy transfer would transmit the PWM rate mating ALC of the EVSE. Refer to S1 or S2 for this.
7	EVSE	Pilot PWM is reduced to 5% since additional communication is required.	Additional communication for DC energy transfer is identified in SAE J2293. This will be updated in SAE J2836-2 and SAE J2447-2.
8	PHEV/ESCI	PHEV and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PHEV or ESCI as initiator of session.
9	PHEV	PHEV sends VIN	Utility authenticates PHEV is connected and implements program criteria.
9a	PHEV	PHEV sends Billing Request	This would confirm PHEV billing at premise (customer's home). Optional billing requests may be request if connecting to another Utility territory or public premises. These options would have been transmitted to the utility during the enrollment or could have been agreed to at public sites (i.e., curbside, etc.).
10	PHEV	PHEV sends Energy Request (amount & rate)	Amount is total (based on RESS SOC). Rate is the off-board charger size. Utility compares request with available and confirms or adjusts for message back to PHEV.
10a	PHEV	PHEV sends schedule for energy request	Based on TOU program. Schedule is Connection Time, Full Charge Time and Balance Charge Time.

Step #	Actor	Description of the Step	Additional Notes
10b	PHEV	PHEV sends request for discrete event info.	Based on Discrete Event demand side management program.
10c	PHEV	PHEV sends customers predetermined pricing info to utility	Based on Periodic/Hourly Pricing Price Response program.
10d	PHEV	PHEV requests Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program.
10e	PHEV	PHEV sends …	Based on Active Load Management program.
11	Utility	Utility verifies PHEV ID (premise ID and/or customer ID) to ESCI	PEV binds (or rebinds) with utility
12	Utility	Utility transmits confirmation message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	EUMD is required for revenue metering of electricity
13	Utility	Utility sends Energy Available (amount & rate)	
13a	Utility	Utility sends schedule for energy available (time spread energy will be delivered)	Based on TOU program.
13b	Utility	Utility sends discrete event alerts.	Based on Discrete Event demand side management program.
13c	Utility	Utility sends periodic/hourly prices.	Based on Periodic/Hourly Pricing Price Response program.
13d	Utility	Utility sends Critical Peak Pricing (CPP) or Hourly/Periodic Pricing info.	Based on Critical Peak Pricing (CPP) or Hourly/Periodic Pricing program.
13e	Utility	Utility sends …	Based on Active Load Management program.

Step #	Actor	Description of the Step	Additional Notes
14	PHEV	PHEV prepares for charging.	When the vehicle is ready to accept energy, another resistor is switched into the pilot circuit that drops the +9V to either 6V or 3V. 6V means the EVSE does not have to turn on ventilation at the premise and 3V means it does. This voltage drop signals the EVSE to close its switches and allow power to flow to the vehicle.
15	EUMD	PHEV Charges	EUMD records charging information and energy supplied to PHEV for each charging session. Charging information is included with additional info collected by ESCI (PHEV ID, Premise ID, Date & Time stamp) for each metering interval.
16	ESCI	ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PHEV and Customer information.
17	Utility	Utility records each PHEV charging session for bill generation and reporting to customer account associated with this premise and PHEV ID.	

4. REQUIREMENTS

This Use Case (S3) refers to the steps the customer will use while using a premise EVSE that includes the charger. This is preceded by one or more of the Utility program Use Cases (U1, 2 3 and/or 4) and is followed by the Location Use Cases L1, 2, etc. per the following diagram.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

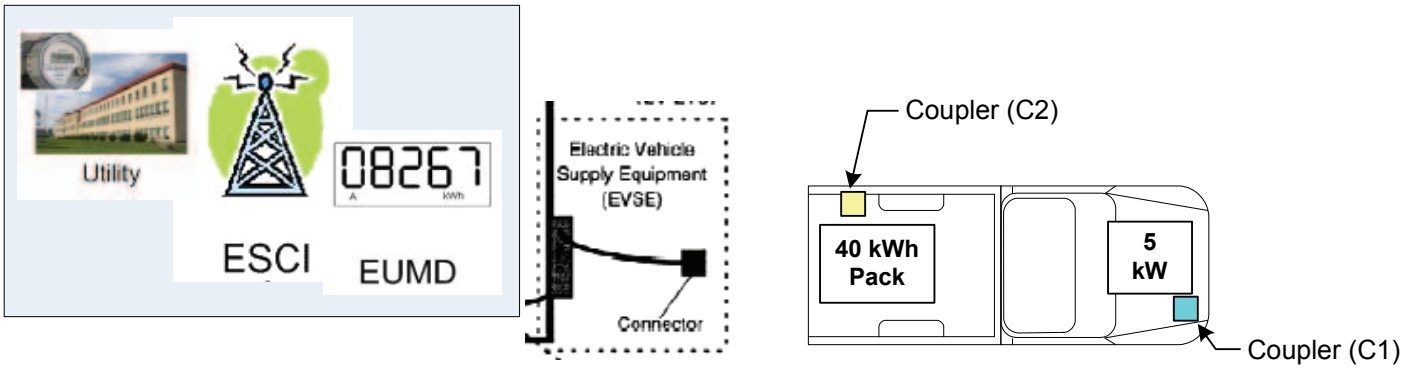
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

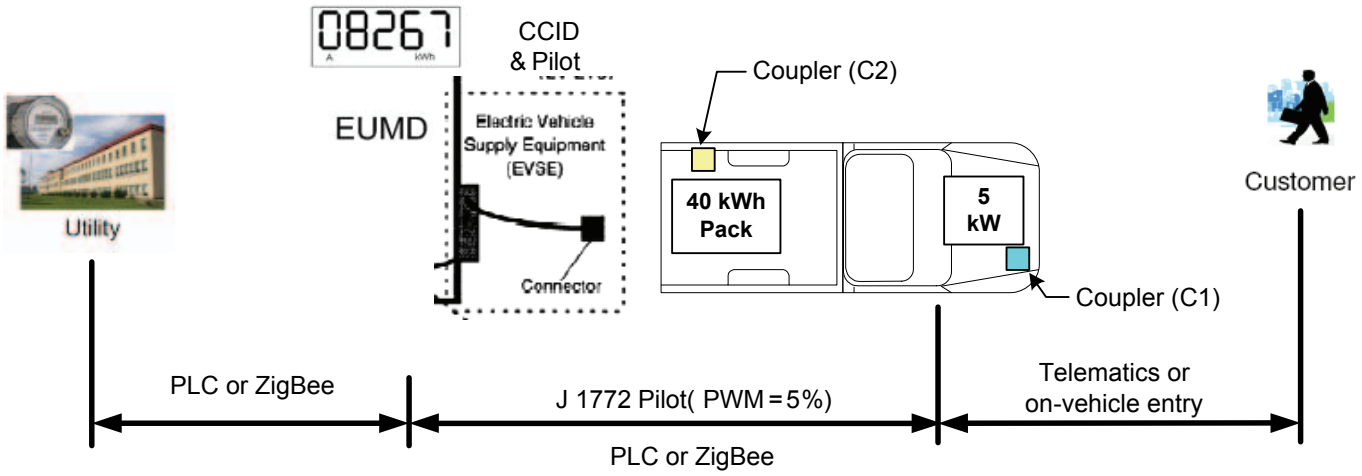
5.1 Equipment Diagram



PEV Assumptions:

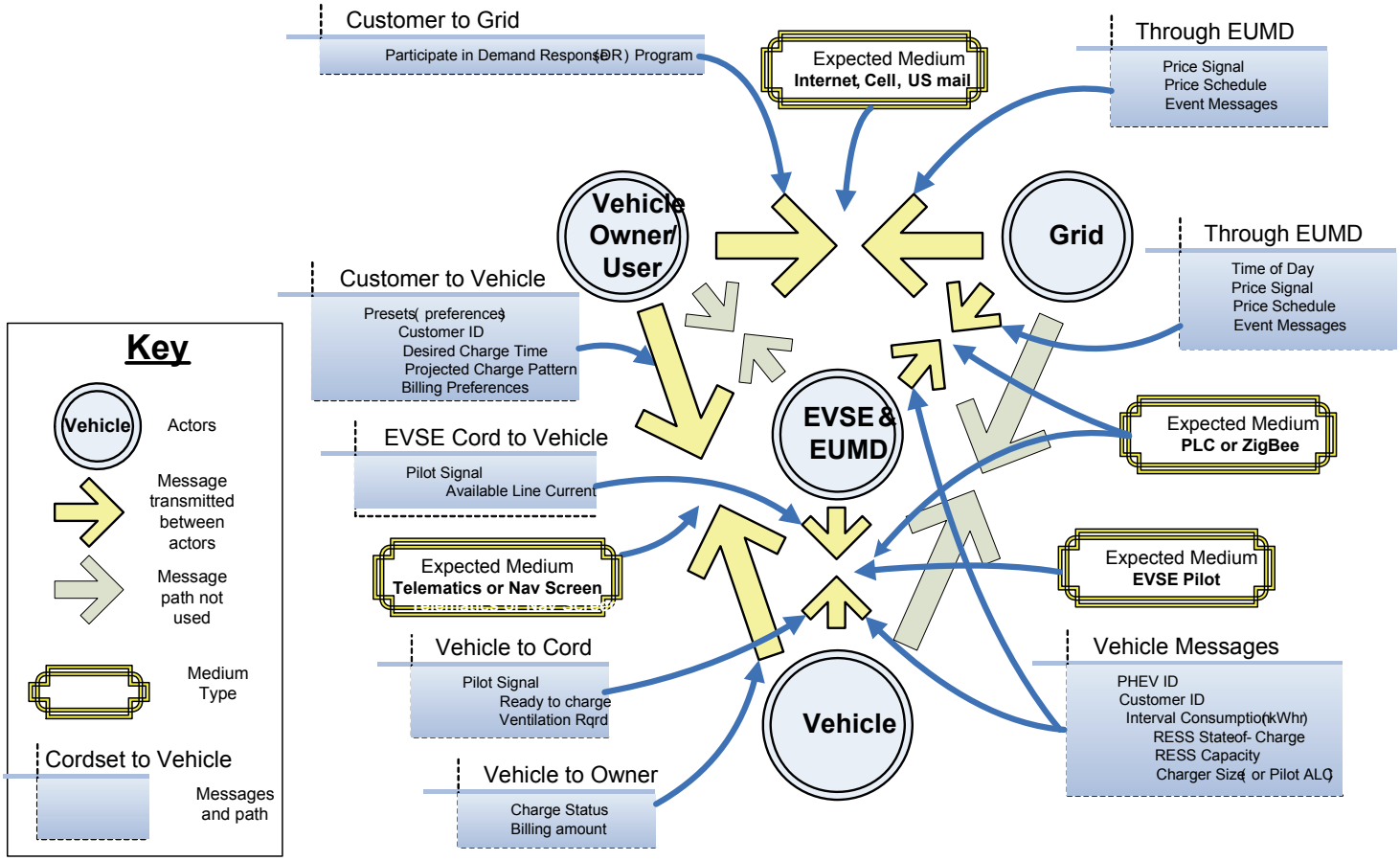
The PEV includes coupler (C1) for AC energy transfer (Level 1 or Level 2 per J1772™) that can also be used for low power DC. The PEV also includes a second coupler (C2) for DC energy transfer at higher power levels.

5.2 Communication Path Diagram

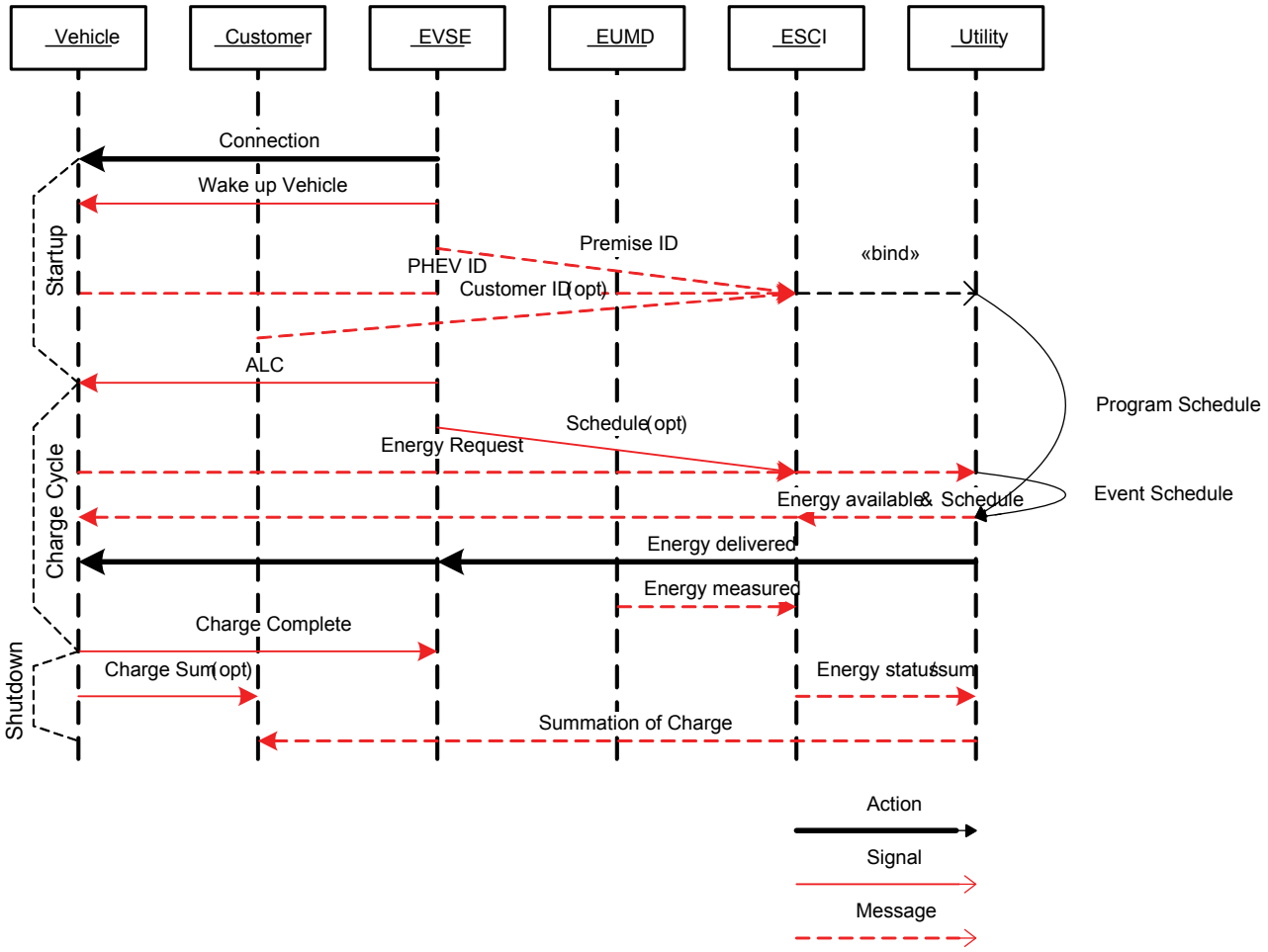


5.3 Activity Diagram

Note: Premise mounted EVSE shows ZigBee or PLC from the vehicle to utility thru the EVSE.

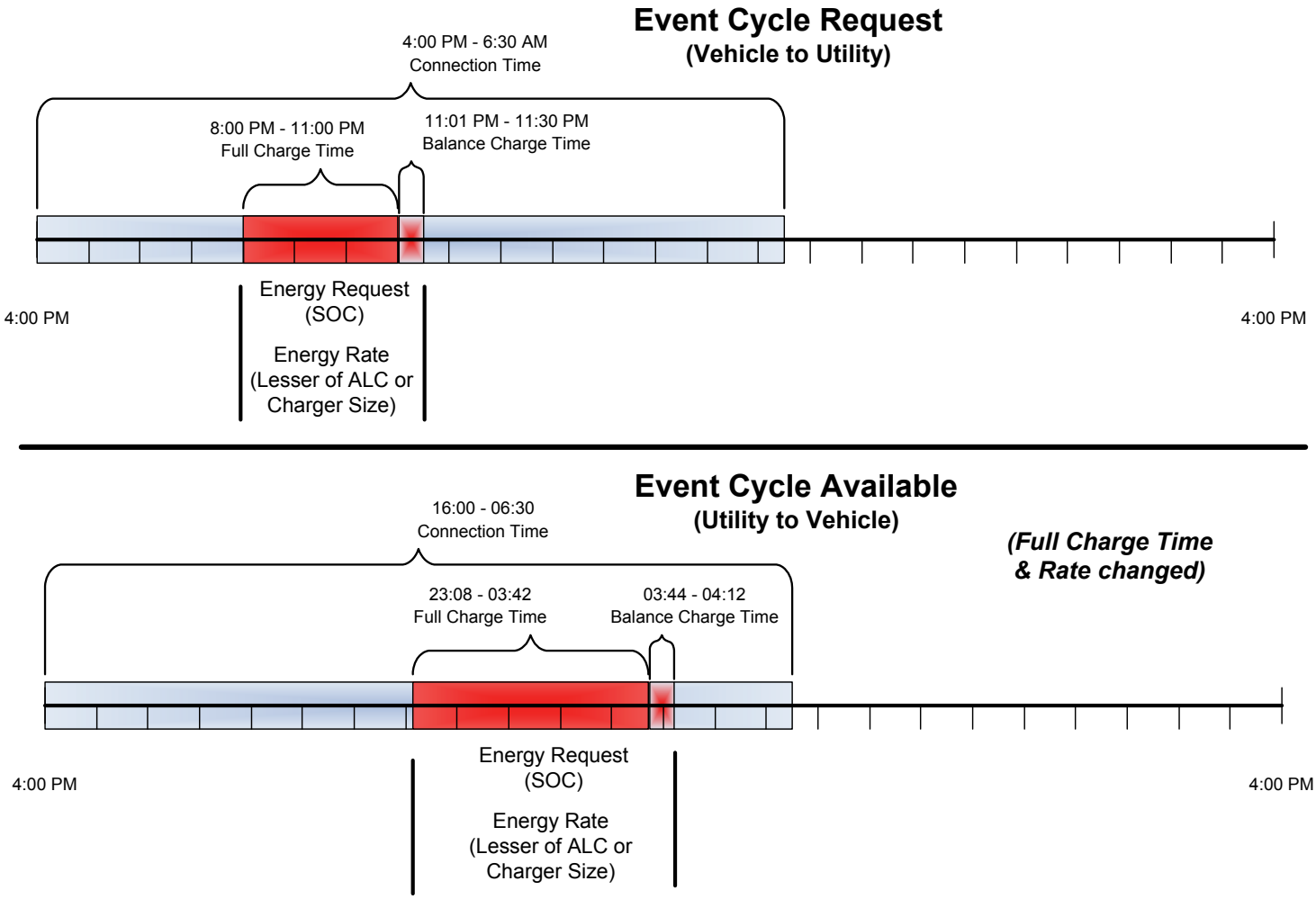


5.4 Sequence Diagram



5.5 Message Diagram

This diagram shows the primary message requests sent from Vehicle and a potential message reply from the Utility. The Energy request (amount & rate) delivery time is based on the Utility program enrollment programmed into the vehicle or the EVSE. The utility responds with the optimization values for this cycle time.



B.10 L1 - CUSTOMER CONNECTS PEV AT HOME - PREMISE

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-16-09	Rich Scholer	Updated chart in section 4.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - L1 – Vehicle Use Case - Customer connects PEV at Home (premise)

1.2 Use Case Summary

This use case details the Connection Location (VIN Authentication, Basic Charging per enrolled program) for the customer to transfer energy. This is precluded by specific enrollment process by one or more of the connection architectures as described in Use Cases S1-3. This sequence of Use cases is followed by Use cases PR1 series that summarize the previous Use Cases.

1.3 Use Case Detailed Narrative

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case L1: Customer connects PEV at Home (premise) and expects energy charge billed to home account.

3.1 Scenario Description

Scenario (L1): Customer connects PEV at their premise location using either EVSE cordset or Premise Mounted EVSE

This scenario describes the most common sequence of customer charging their PEV at their own premise. As described in the main Narrative section, the customer is attempting to charge a PEV under a selected PEV rate tariff that may provide an incentive to charge during off peak periods. The utility needs to support customers on the PEV program.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

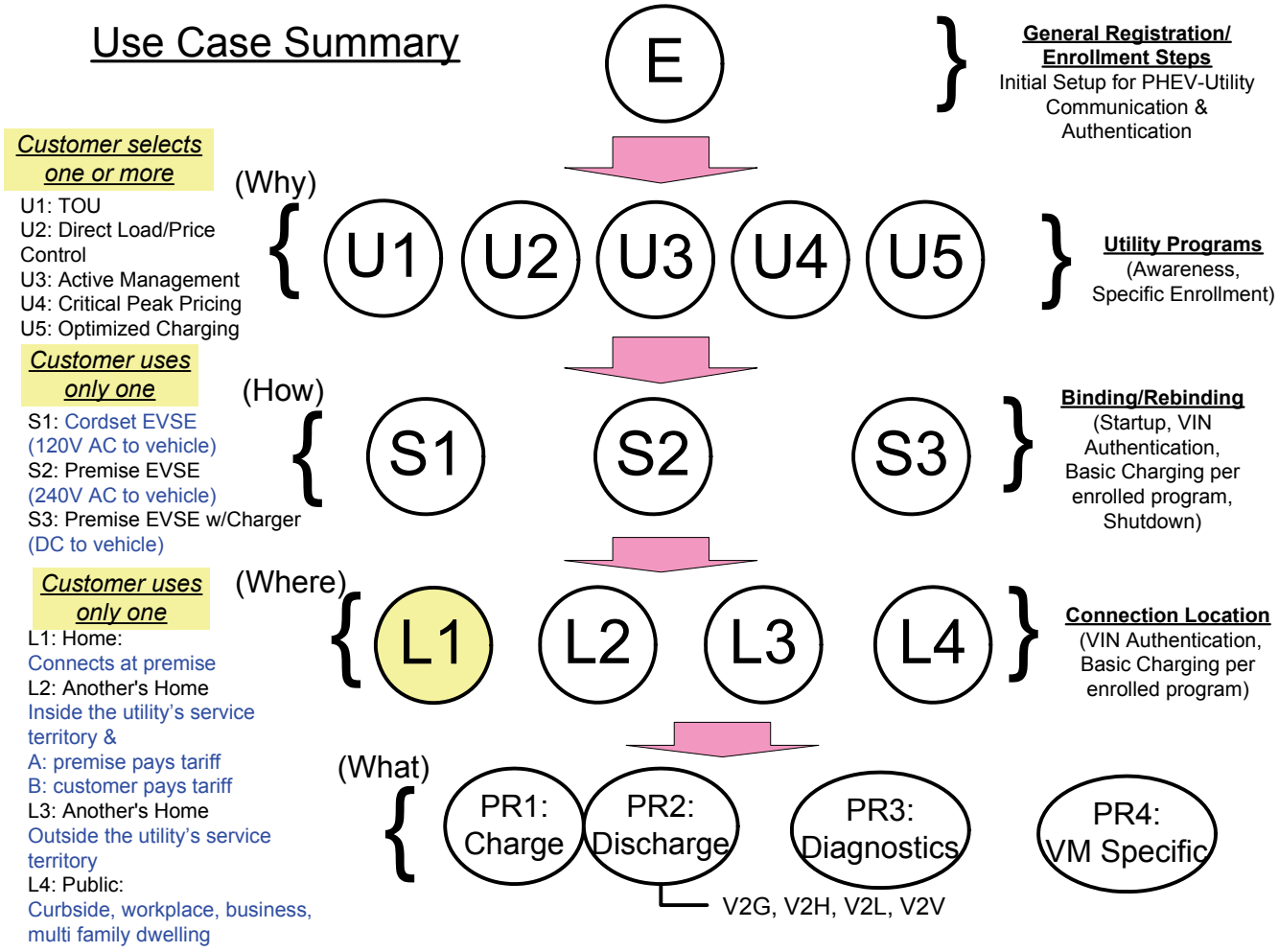
3.1.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer connects PEV at his premise location. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process.	Implementation could have PEV or ESCI as initiator of session.
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	

Step #	Actor	Description of the Step	Additional Notes
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two.
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

4. REQUIREMENTS

This use case is the 4th in a series that follows Use Cases S1-3 for connection architectures. This use case defines the steps for the customer connecting at home.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

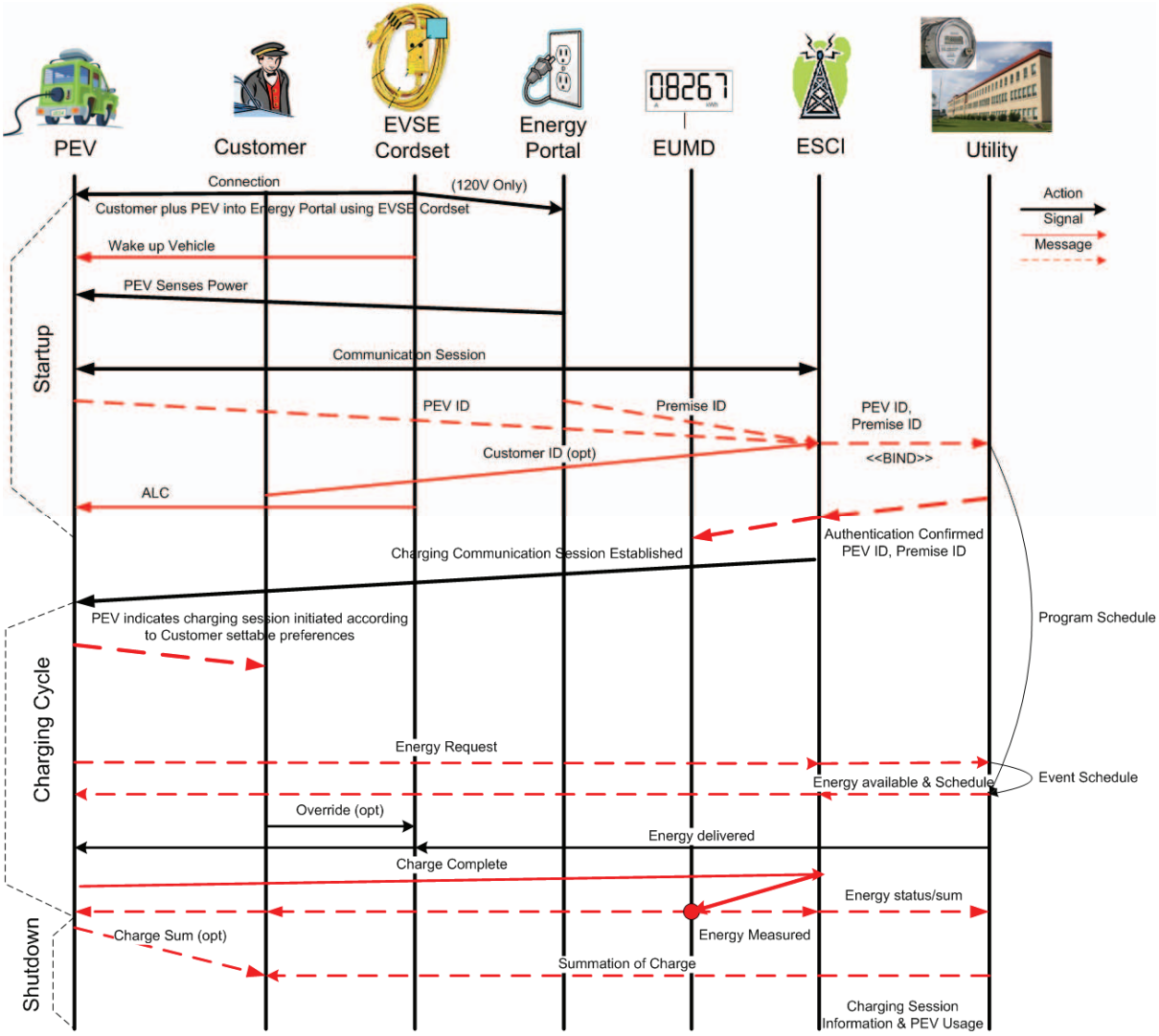
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

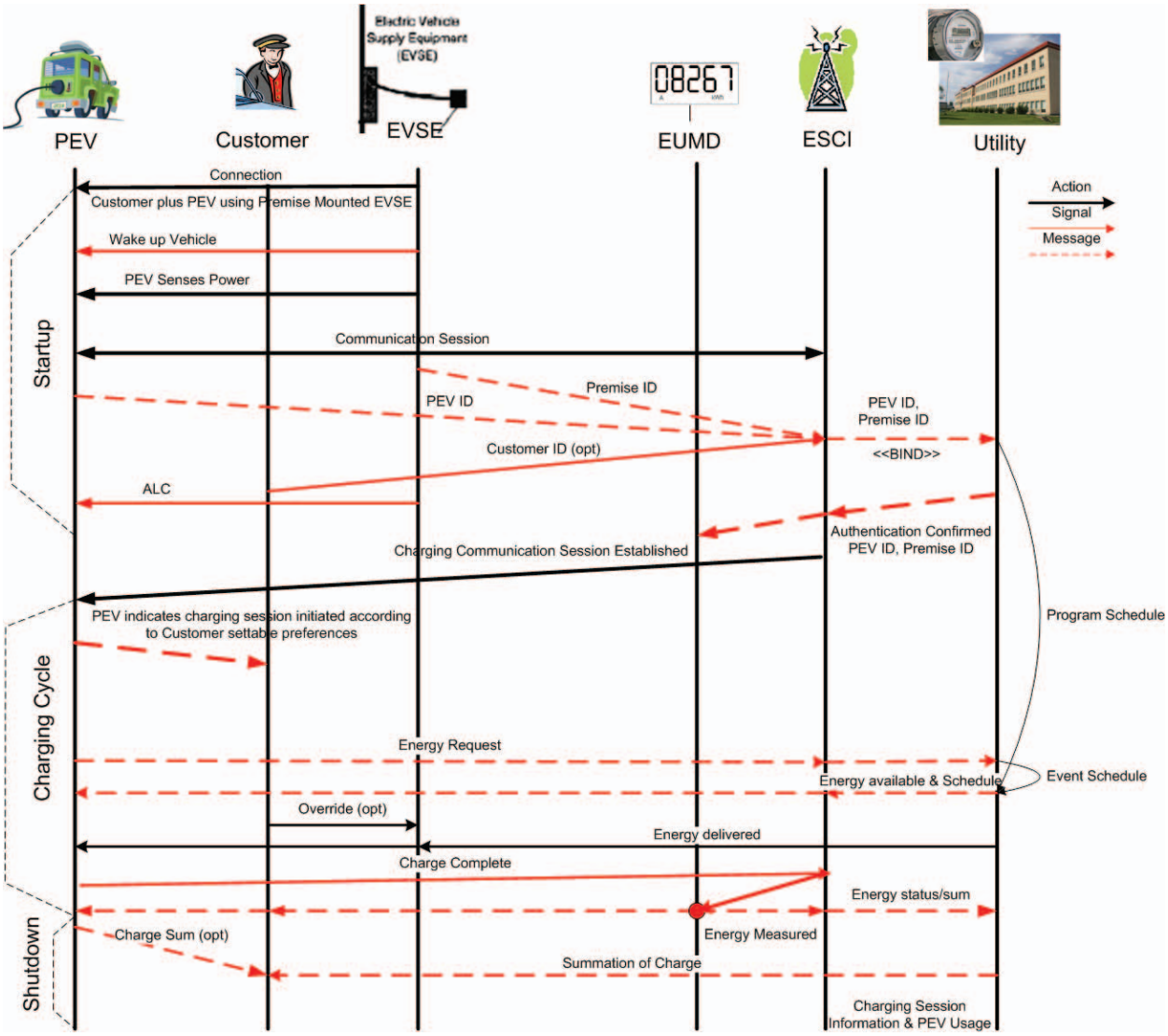
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence Diagram using EVSE Cordset



5.2 Sequence diagram using premise EVSE



B.11 L2 - CUSTOMER CONNECTS PEV AT ANOTHER HOME

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-16-09	Rich Scholer	Updated chart in section 4.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - L2 – Vehicle Use Case - Customer connects PEV at Another Home (premise) and within the customer's home territory.

1.2 Use Case Summary

This use case details the Connection Location (VIN Authentication, Basic Charging per enrolled program) for the customer to transfer energy. This is precluded by specific enrollment process by one or more of the connection architectures as described in Use Cases S1-3. This sequence of Use cases is followed by Use cases PR1 series that summarize the previous Use Cases.

1.3 Use Case Detailed Narrative

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case L2: Customer connects PEV at Another Home (premise) within the customer's territory.

3.1 Scenario Description

Primary Scenario (L2-A): Customer connects PEV to energy portal at another premise and premise customer pays for energy use

This scenario describes what happens if a Customer plugs PEV into another premise (not his own, but one serviced by the same utility), where the premise owner is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

3.1.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	PEV	PEV connects another customer's premise within the Utility service territory, and the customer at this location is willing to pay for PEV charging energy. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process.	Implementation could have PEV or ESCI as initiator of session.

Step #	Actor	Description of the Step	Additional Notes
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two.
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost

Step #	Actor	Description of the Step	Additional Notes
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

3.2 Alternative Scenario Description

Alternative Scenario (L2-B): Customer connects PEV to energy portal at another premise and PEV customer pays for energy use.

This scenario describes what happens if customer plugs PEV into another premise (not his own, but serviced by the same utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps*	*The utility has a record of the energy purchased transactions related to the customer premise and the associated PEV ID.*

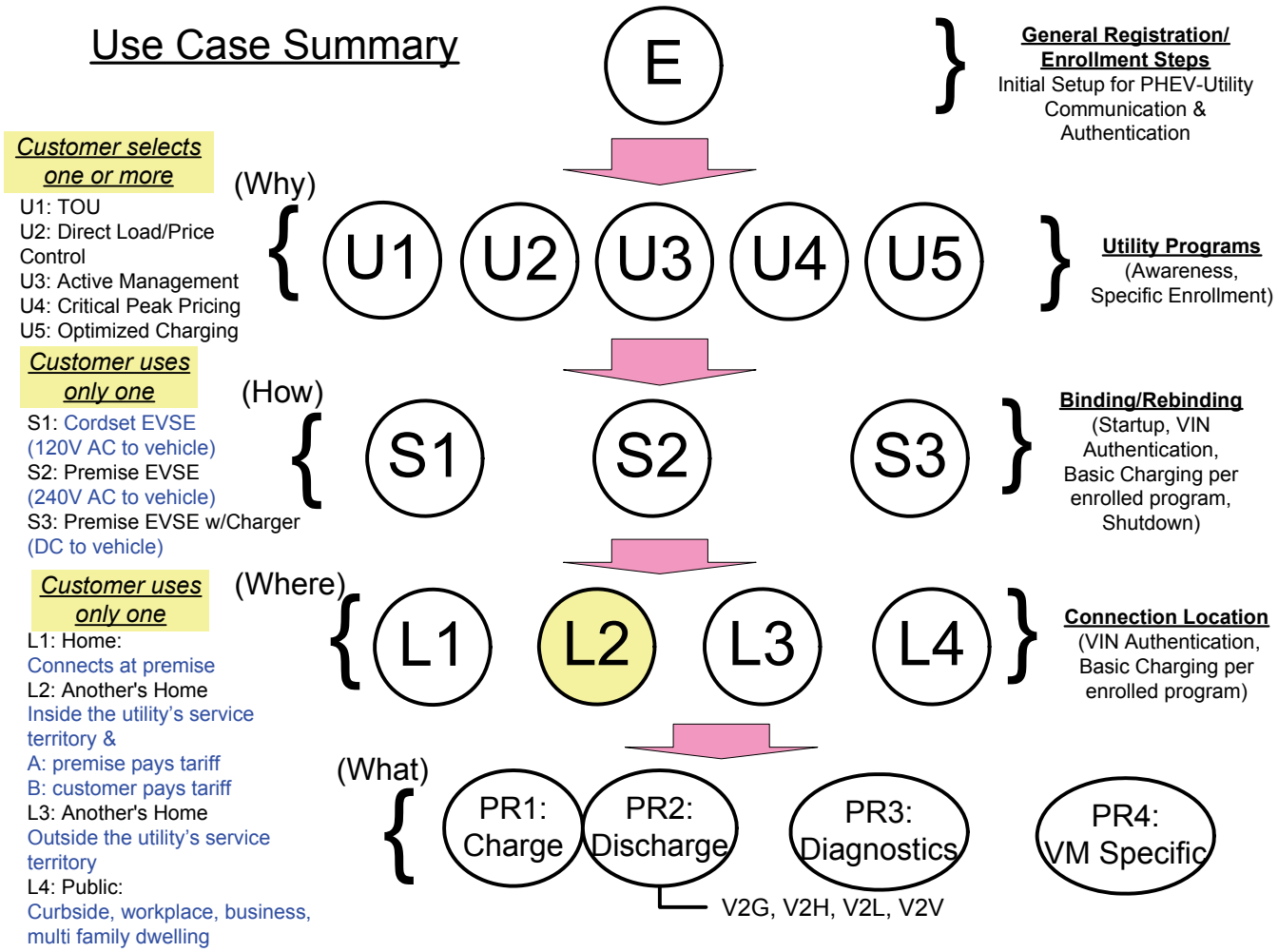
Steps for this scenario

Step #	Actor	Description of the Step	Additional Notes
1	PEV	PEV connects at another customer premise within the Utility service territory. PEV owner will pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE cordset to Energy Portal at Premise.	Startup steps are provided in S1
1b	EVSE	Customer connects Premise Mounted EVSE to PEV.	Startup steps are provided in S2
2	PEV/Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
3	PEV	PEV is able to provide indicator to customer that binding has been successful (and that the PEV will receive incentive rate upon charging, if applicable).	
4	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	

Step #	Actor	Description of the Step	Additional Notes
5	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
6	PEV	PEV prepares for charging	
7	PEV	PEV begins charging based on Customer-selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
8	End Use Measurement Device	EUMD records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
9	End Use Measurement Device	EUMD communicates to Energy Services Communication Interface the energy supplied to PEV for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two.
10	Energy Services Communication Interface	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. ESCI transmits Date, time, duration and energy delivered to Utility and Vehicle.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost
11	Utility	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.	

4. REQUIREMENTS

This use case is the 4th in a series that follows Use Cases S1-3 for connection architectures. This use case defines the steps for the customer connecting at another home within the customer's territory.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

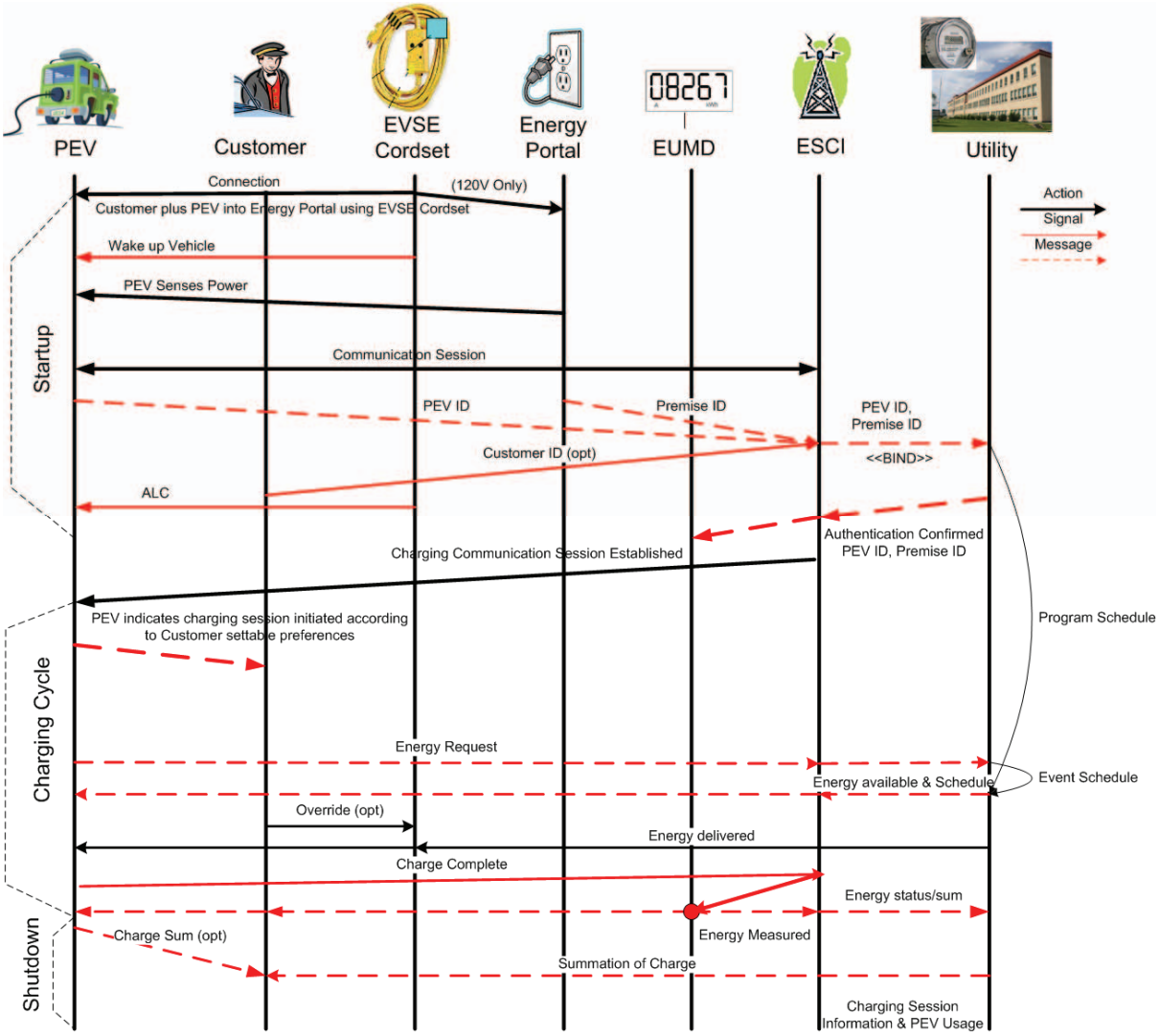
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

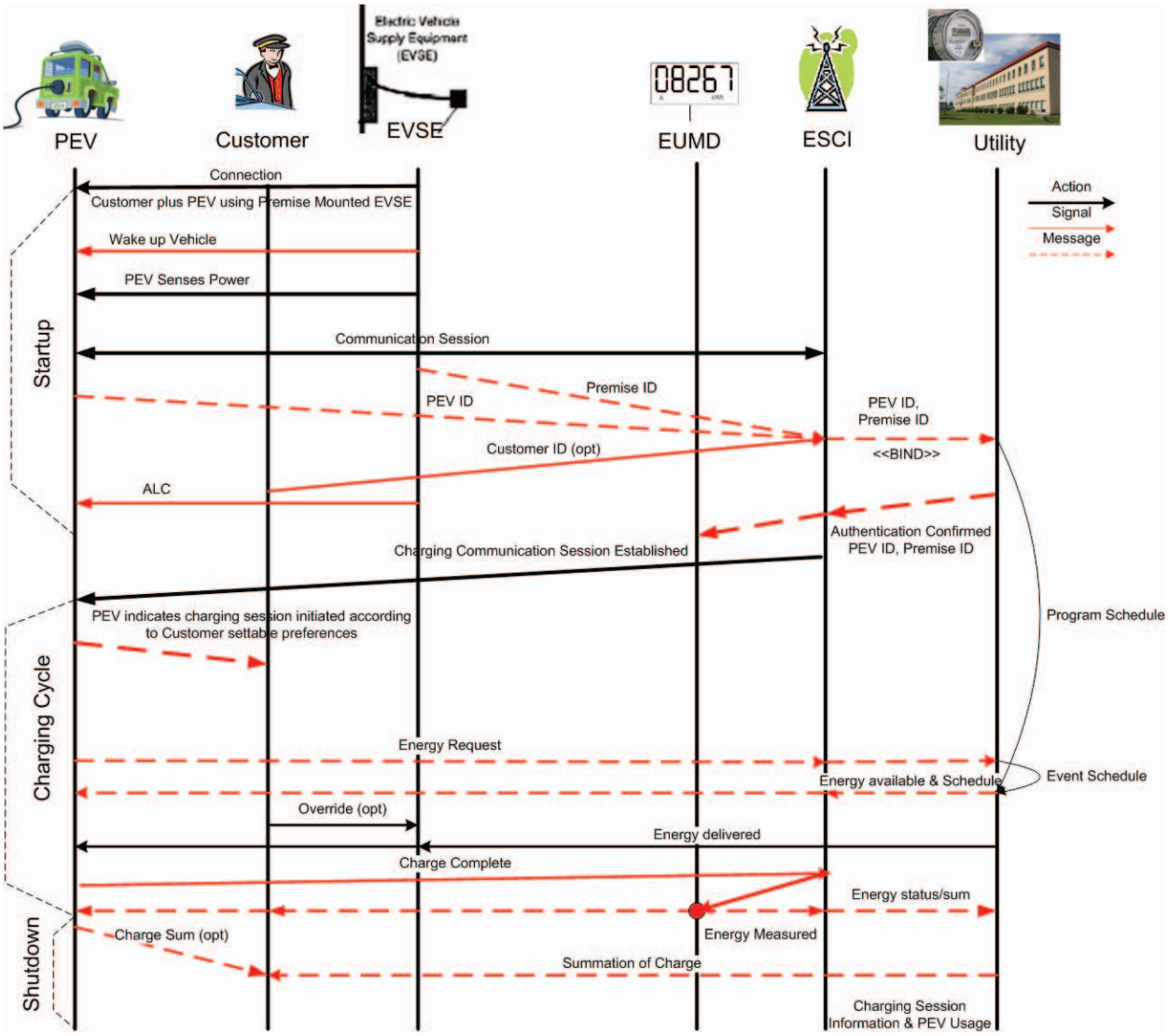
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence Diagram using EVSE Cordset



5.2 Sequence diagram using premise EVSE



B.12 L3 - CUSTOMER CONNECTS PEV OUTSIDE HOME TERRITORY

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-16-09	Rich Scholer	Updated chart in section 4.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - L3 – Vehicle Use Case - Customer connects PEV at Another Home (premise) and outside the customer's home territory.

1.2 Use Case Summary

This use case details the Connection Location (VIN Authentication, Basic Charging per enrolled program) for the customer to transfer energy. This is precluded by specific enrollment process by one or more of the connection architectures as described in Use Cases S1-3. This sequence of Use cases is followed by Use cases PR1 series that summarize the previous Use Cases.

1.3 Use Case Detailed Narrative

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case L3: Customer connects PEV at Another Home (premise).

3.1 Scenario Description

Scenario (L3): Customer connects PEV to energy portal at another premise outside the enrolled Utility's service territory.

This scenario describes what happens if customer plugs PEV into another premise (not his own, and not serviced by the same utility (i.e., roaming utility), where the PEV operator is responsible for the cost of energy delivered to the PEV charged at the premise.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has enrolled PEV with home utility. Enrollment and Initial Setup steps* *Both home and foreign/roaming utility participate in inter-utility clearinghouse.*	*The foreign/roaming utility and the clearinghouse have record of the energy purchased transactions related to the customer premise, the PEV ID, the Customer ID, and the Utility ID.*

3.1.1 Steps for this scenario

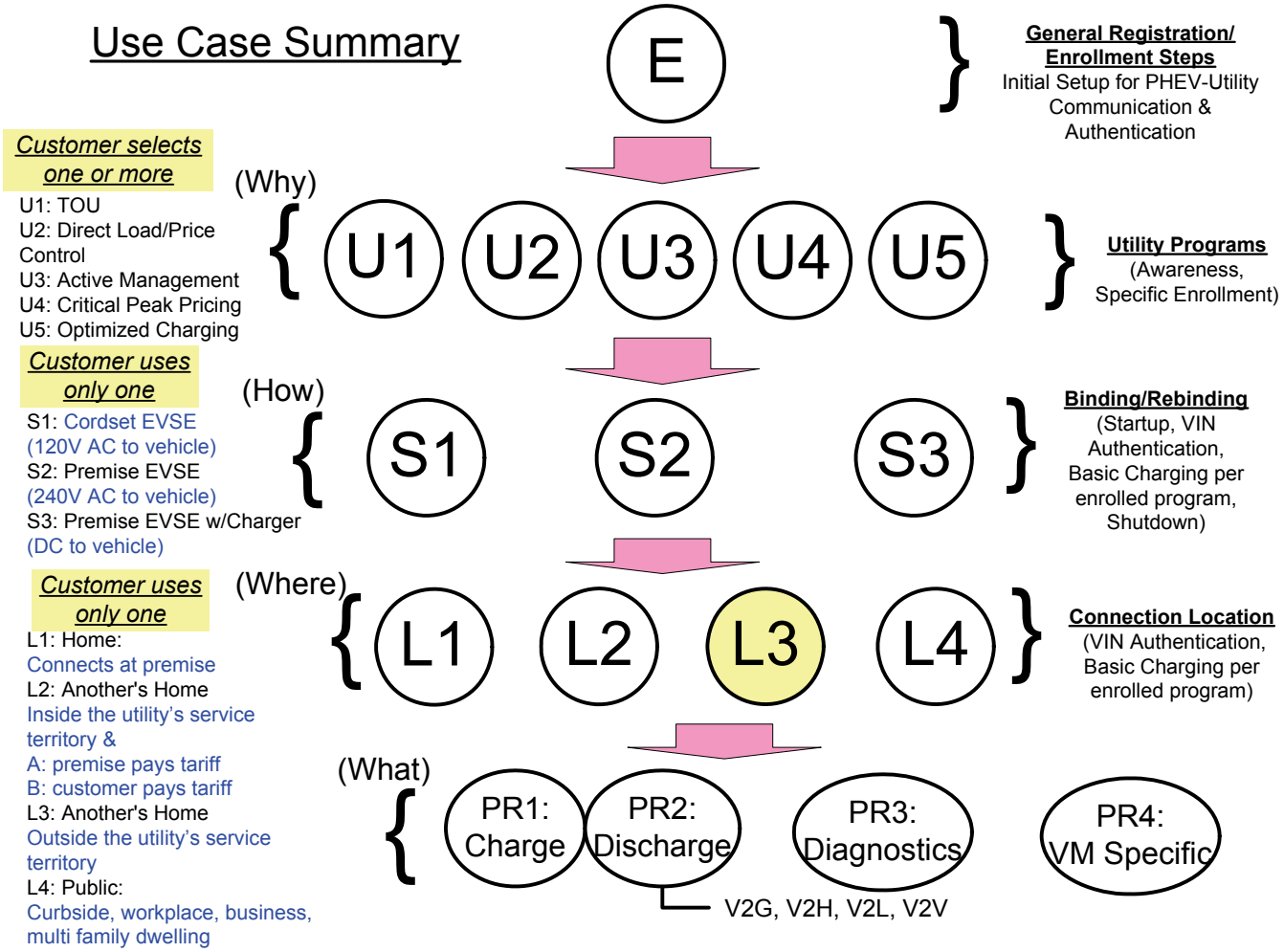
Step #	Actor	Description of the Step	Additional Notes
1	PEV	PEV connects PEV at a location outside of the home Utility service territory. PEV owner will pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state.	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.
5	ESCI	ESCI maintains communication session and security between PEV and Roaming Utility. ESCI transmits request for validating PEV ID to Roaming Utility, including Premise ID.	
6	Roaming Utility	Roaming Utility checks PEV ID and Premise ID against internal database. When not found (because PEV is registered with home utility), Roaming utility forwards PEV ID and Roaming Utility ID to Clearinghouse for verification.	
7	Clearinghouse	Clearinghouse checks PEV database for PEV ID and finds corresponding Home Utility ID, and Home Utility Account/Premise ID.	Underlying assumption is that PEV has been registered with home utility and that both utilities participate in the clearinghouse.
8	Clearinghouse	Clearinghouse transmits confirmed message to Roaming Utility, including PEV ID, Home Utility ID, and Home Utility Account/Premise ID.	
9	Roaming Utility	Roaming Utility transmits confirmed message via ESCI to End Use Measurement Device (EUMD) indicating successful binding with premise ESCI.	

Step #	Actor	Description of the Step	Additional Notes
10	ESCI	ESCI transmits confirmation message to PEV indicating successful communication session binding of PEV to Roaming Utility at PEV program tariff. PEV is able to provide indicator to customer that binding has been successful (and that he will receive incentive rate upon charging, if applicable).	
11	PEV	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)	
12	Utility	Utility compares request with available and confirms or adjusts for message back to PEV Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)	
13	PEV	PEV prepares for charging	
14	PEV	PEV begins charging based on Customer selected preferences. Charging may be delayed based upon Customer preferences or grid reliability criteria (e.g., off-peak economy charging, demand response event underway, short, randomized charging delay to promote grid stability, etc.)	The vehicle needs to record the energy delivered as a running total for the event. This would be a reference to be compared with the EUMD total. The EUMD has logged the actual energy flow accumulation for the utility
15	End Use Measurement Device	EUMD records charging information and energy supplied to PEV for each charging session. Charging information includes PEV ID, Premise ID, energy usage, and time stamp for each metering interval.	
16	End Use Measurement Device	EUMD communicates to Energy Services Communication Interface energy supplied to PEV ID for each charging session.	This communication could be on a periodic basis during charging, upon vehicle unplug from energy portal, or a combination of the two.
17	Energy Services Communication Interface	Energy Services Communications Interface (ESCI) communicates to Roaming Utility energy supplied to PEV for each charging session.	This is the status of the cycle for the Utility, PEV and Customer information. SAE J2836 identifies the periodicity of these messages. It may be desired to have this summed on a regular interval (every minute) in case the charge cycle is interrupted prior to the end so the current information (running summation) is not lost

Step #	Actor	Description of the Step	Additional Notes
18	Roaming Utility	Roaming Utility records each PEV charging session for reporting to Clearinghouse. Customer account associated with this roaming utility premise will be credited for energy supplied for this charging session.	
19	Roaming Utility	Roaming Utility forwards transaction to Clearinghouse for energy supplied to PEV including PEV ID, Customer ID, Home Utility ID, and interval based charging session information.	
20	Clearinghouse	Clearinghouse receives energy charge transaction from Roaming Utility for posting charges to PEV operator's home utility Customer account.	

4. REQUIREMENTS

This use case is the 4th in a series that follows Use Cases S1-3 for connection architectures. This use case defines the steps for the customer connecting at another home outside the customer's territory.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

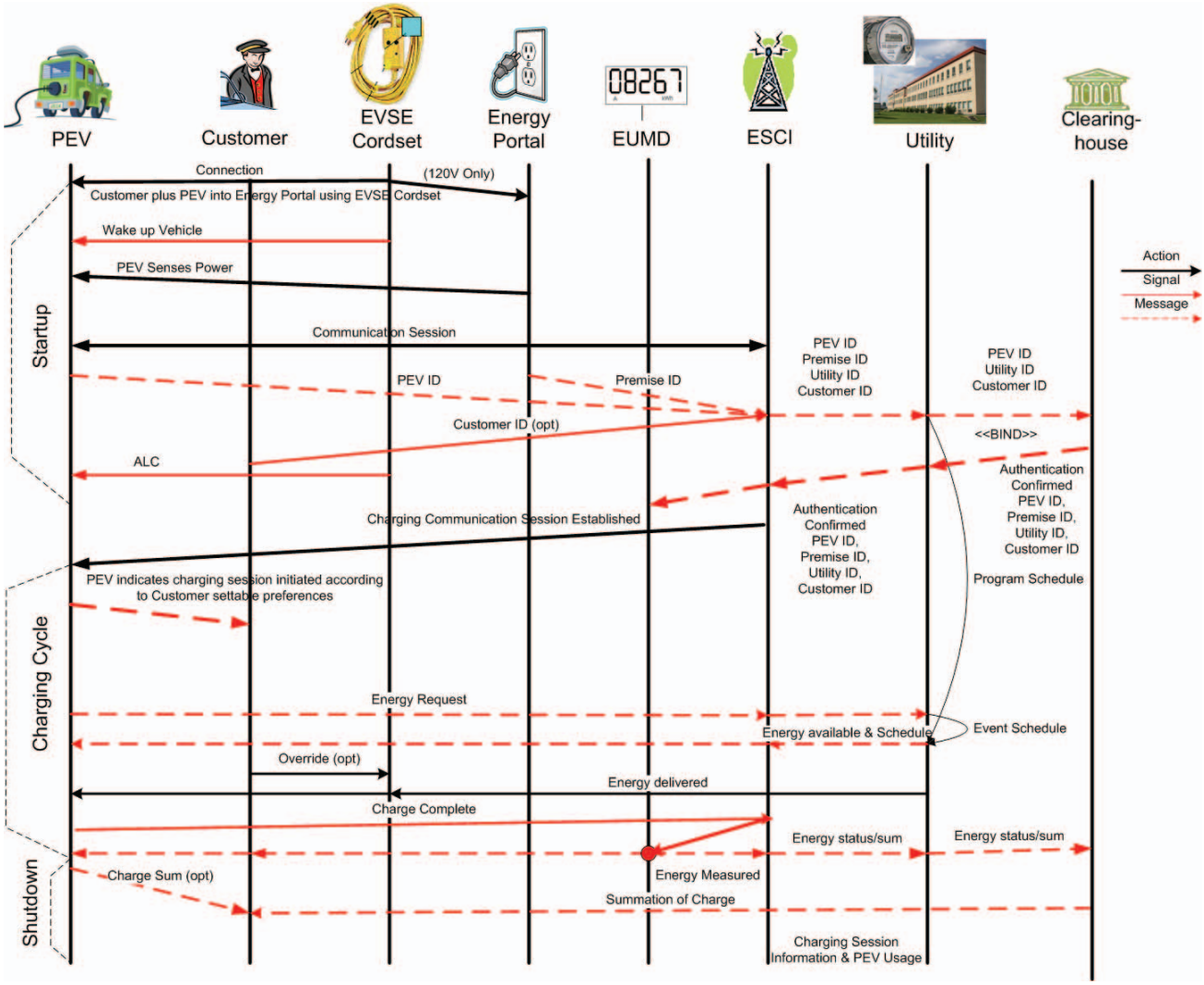
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

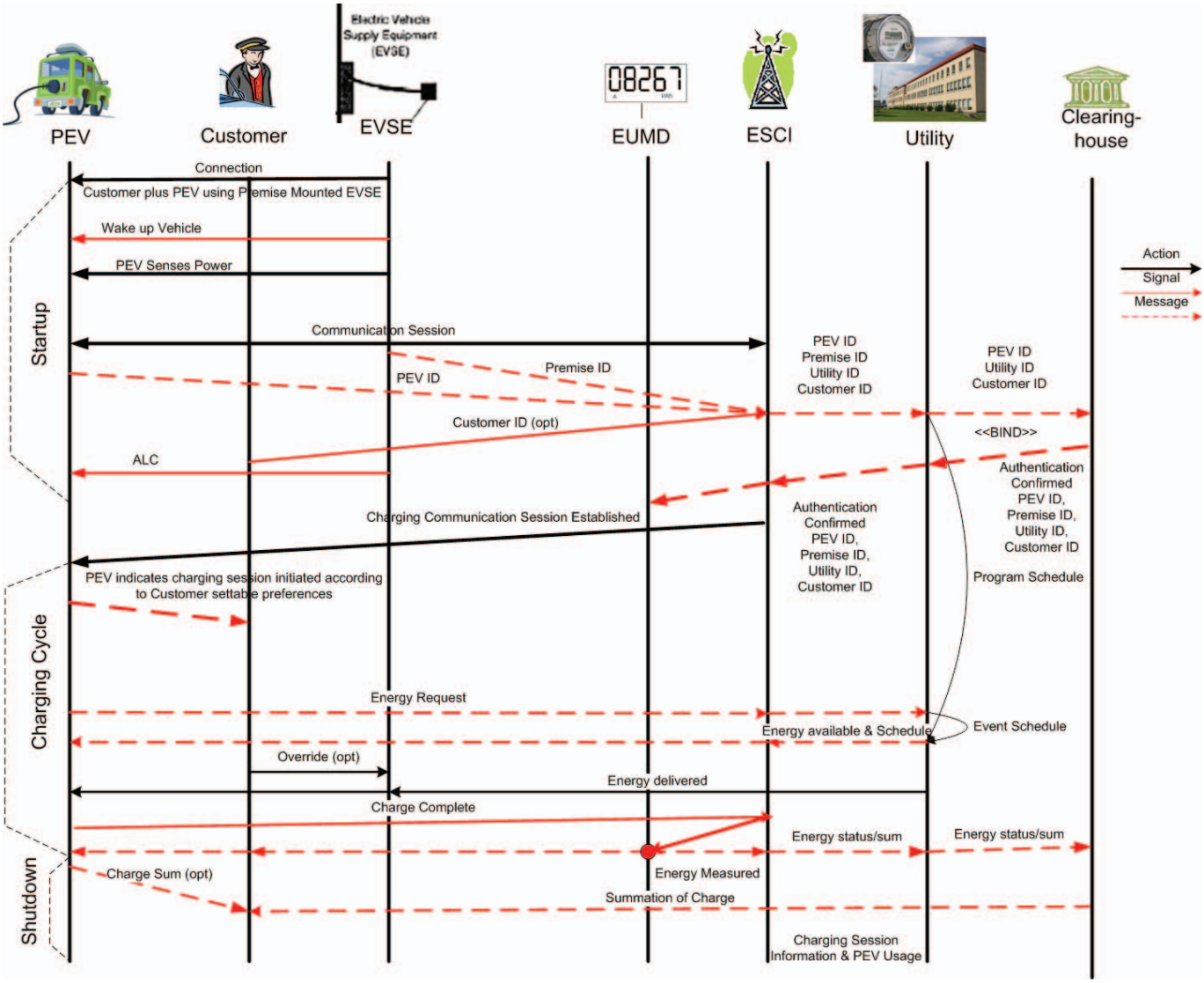
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence Diagram using EVSE Cordset



5.2 Sequence diagram using premise EVSE



B.13 L4 - CUSTOMER CONNECTS PEV AT PUBLIC LOCATION

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-16-09	Rich Scholer	Updated chart in section 4.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - L4 – Vehicle Use Case - Customer connects PEV at Public Location (Curbside, workplace, business, multi family dwelling, etc).

1.2 Use Case Summary

This use case details the Connection Location (VIN Authentication, Basic Charging per enrolled program) for the customer to transfer energy. This is precluded by specific enrollment process by one or more of the connection architectures as described in Use Cases S1-3. This sequence of Use cases is followed by Use cases PR1 series that summarize the previous Use Cases.

1.3 Use Case Detailed Narrative

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case L4: Customer connects PEV at Public Location

3.1 Scenario Description

Primary Scenario (L4-A): Customer connects PEV to energy portal at curbside location.

This scenario describes what happens if customer plugs PEV into a curbside location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using an EVSE cordset for charging	*PEV*	*Customer may or may not have enrolled PEV with curbside energy provider.*	*Prior enrollment may entitle customer to special rates and/or conditions.*

3.1.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	Customer	Customer connects EVSE **cordset** to curbside device.	Startup steps are provided in S1
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state.	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.

3.2 Scenario Description

Alternative Scenario (L4-B): Customer connects PEV to energy portal at workplace location.

This scenario describes what happens if customer plugs PEV at a worksite location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be an employee at this location.*	*Employment may entitle customer to special rates and/or conditions.*

3.2.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	PEV	PEV connects PEV at a worksite location. PEV owner may or may not pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging, depending on what device is available.	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Worksite.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state.	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.

3.3 Scenario Description

Alternative Scenario (L4-C): Customer connects PEV to energy portal at business location.

This scenario describes what happens if customer plugs PEV at a business location.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be ….*	*… may entitle customer to special rates and/or conditions.*

3.3.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	PEV	PEV connects PEV at a business location. PEV owner may or may not pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging, depending on what device is available.	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Business.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates ‘On Plug’ state.	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.

3.4 Scenario Description

Alternative Scenario (L4-D): Customer connects PEV to energy portal at Multi-Family Dwelling location.

This scenario describes what happens if customer plugs PEV at a multi-family dwelling location.

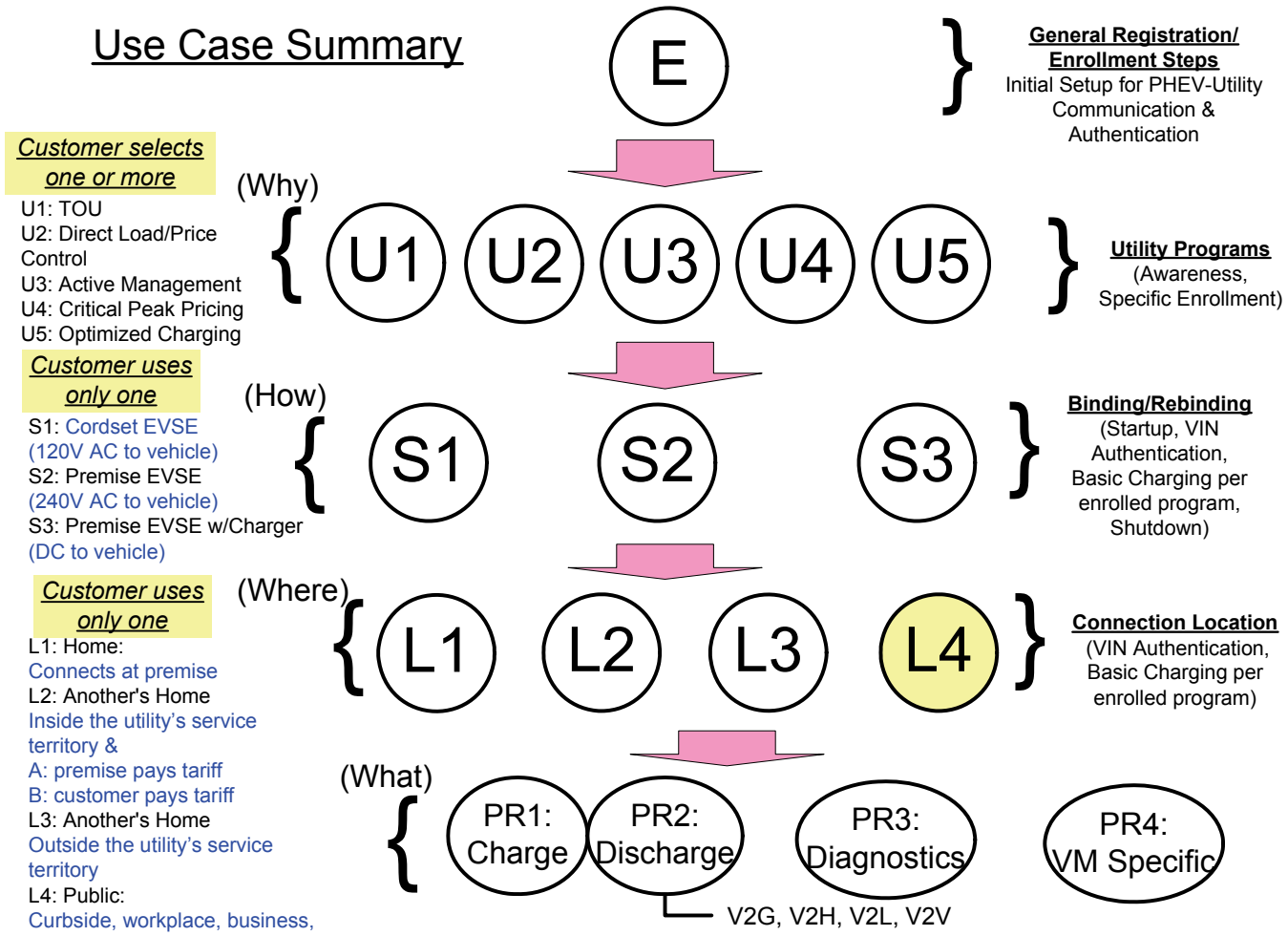
Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer may or may not be a resident.*	*Residency may entitle customer to special rates and/or conditions.*

3.4.1 Steps for this scenario

Step #	*Actor*	*Description of the Step*	*Additional Notes*
1	PEV	PEV connects PEV at a multi-family dwelling location. PEV owner may or may not pay for charging. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging, depending on what device is available.	PEV may display message communicating charging/billing options or information to the Customer.
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at multi-family dwelling.	Startup steps are provided in S1
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state.	
3	PEV/ Energy Services Communications Interface (ESCI)	PEV and Energy Services Communications Interface (ESCI) perform PEV binding and authentication process	Implementation could have PEV or ESCI as initiator of session.
4	PEV	PEV ID is transmitted to ESCI.	Unique PEV ID will ultimately support portability of charging, among other purposes.

4. REQUIREMENTS

This use case is the 4th in a series that follows Use Cases S1-3 for connection architectures. This use case defines the steps for the customer connecting at a public location.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

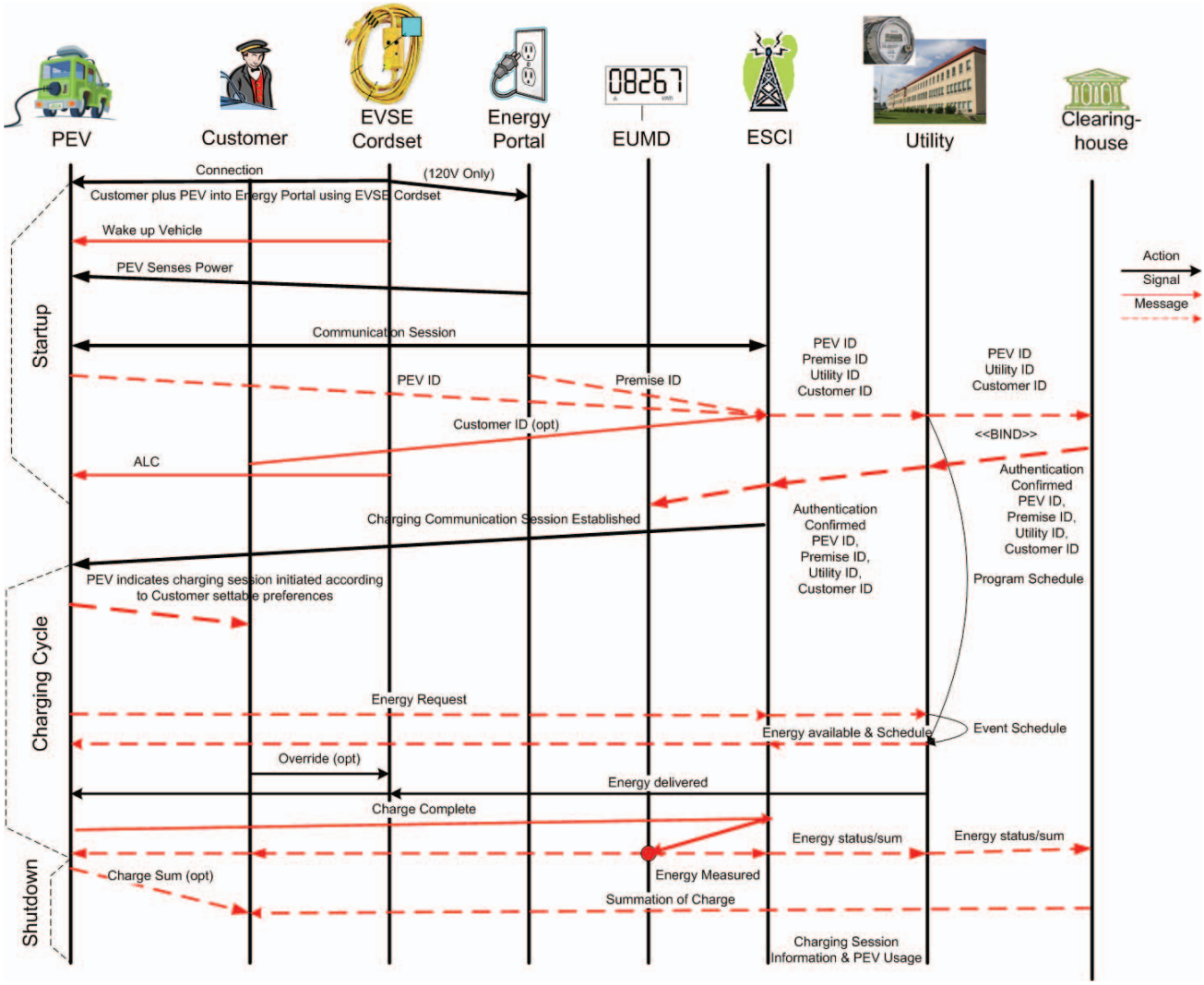
Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

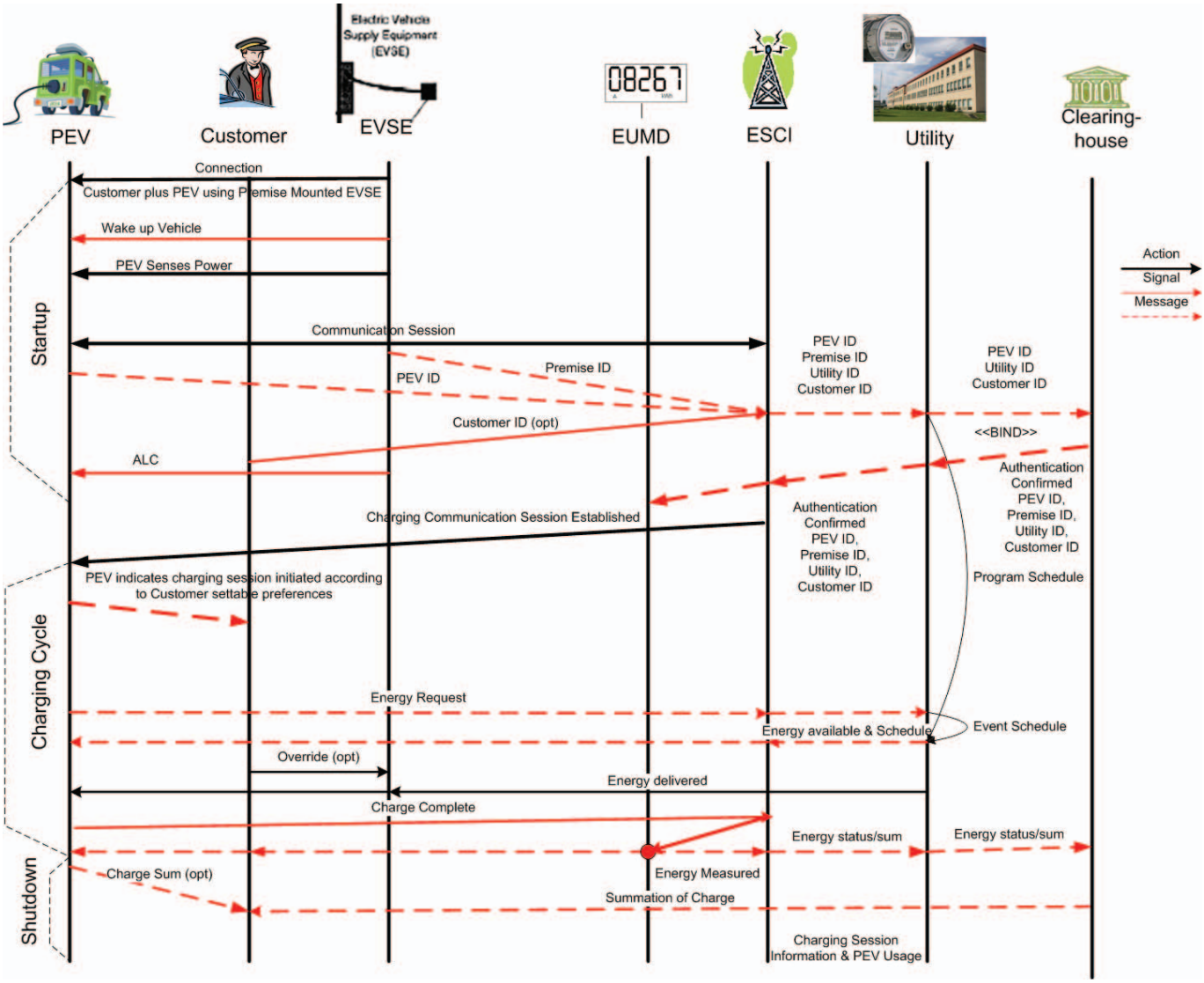
Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence Diagram using EVSE Cordset



5.2 Sequence diagram using premise EVSE



B.14 PR1 - CUSTOMER CHARGES THE PEV

Document History

Revision History

Revision Number	Revision Date	Revision/ Reviewed By	Summary of Changes	Changes marked
1.0	2-16-09	Rich Scholer	Updated chart in section 4.	

Approvals

This document requires the following approvals.

Name	Title

1.1 Use Case Title - PR1 – Vehicle Use Case - Customer charges the PEV

1.2 Use Case Summary

This use case details the Charge process for the customer to transfer energy to the PEV. This is precluded by specific enrollment process by one or more of the connection architectures as described in Use Cases S1-3 and locations as described in Use Cases L1-4.

1.3 Use Case Detailed Narrative

3. STEP BY STEP ANALYSIS OF EACH SCENARIO

Use Case PR1: Customer charges the PEV.

3.1 Scenario Description

Primary Scenario (PR1-A): Customer is enrolled in a TOU Schedule

For those customers enrolled in a PEV Time-of-Use (TOU) pricing demand side management program, applicable energy prices and rate periods (e.g., off-peak, mid-peak, on-peak, etc.) will be made known to the Customer and PEV. PEV initiates charging based on Customer-defined preference settings (considering peak/off-peak rate periods) in the PEV. PEV may not receive demand response discrete event notifications; however, some Customers enrolled in PEV TOU demand side management programs could also enroll in a Discrete Event demand side management program. Because no regular periodic communications between PEV and vehicle is required to support a basic PEV TOU pricing demand side management program, an explicit scenario for this option was not included in this use case. However, Utility-to-PEV communications for PEVs enrolled in a TOU demand side management program does offer other benefits (e.g., updated rates displayed in PEV).

Primary Scenario (PR1-B): Customer is enrolled in a PEV Discrete Event demand side management program (Direct Load Control) and PEV (and/or PEV customer) receives and responds to discrete demand response events

For those customers enrolled in a PEV discrete event demand side management program (possibly in exchange for special PEV tariffs or other incentives), this program allows the utility to request an automated load reduction at the customer site by issuing event information to the PEV. The customer can override and/or opt-out of the request in exchange for a reduced incentive. Typically, PEV demand response events are downloaded at least 24 hours ahead, however they could be provided day-of in the case of a grid reliability emergency

- Utility shall be able to transmit discrete demand response event messages to an ESCI and onward to PEV.
- Utility shall track Customer preference for remote notification of PEV Demand Response (DR) events.
- Utility shall transmit PEV Demand Response event alerts to Customer via Customer-designated communication channel(s).
- Customer shall have the ability to override and/or opt-out of discrete demand response events.
- PEV shall charge based on Customer-configurable preferences and shall take appropriate action based upon discrete demand response events.
- PEV shall send Customer opt-out notification message to Utility.
- Pre–event notification shall be sent to customers in advance in a range from one minute in an emergency up to 24 hours for normal/planned discrete demand response events

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
As electrical system approaches overload and/or resources become constrained	*PEV*	*Customer has subscribed to a PEV demand side management discrete event program.*	*Conditions that led to constrained resources have abated or been mitigated. Customer returns to normal PEV load operation.*

3.1.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Utility	At least 24 hours prior to event, Utility sends out remote notification to PEV Customers enrolled in PEV DR programs indicating demand response action.	
2	Utility	Utility shall transmit PEV Demand Response event alerts notification via pager, e-mail, text message on cell phone, web page, etc.	
3	Utility	Utility shall track Customer preference for remote notification of PEV Demand Response (DR) events	
4	Customer	Customer selects/adjusts demand side management preference(s) on PEV (if necessary) and connects PEV to energy portal at his local premise.	
5	Utility	Utility downloads demand response discrete event information to PEV via ESCI. Message includes event information or load reduction request notification.	
6	PEV	PEV charging proceeds based on Customer defined preferences (which considers receipt of demand side management information).	

Step #	Actor	Description of the Step	Additional Notes
7	Customer	Customer has the ability to override and/or opt-out of demand response event using Customer-configurable preferences in the PEV. Customer may receive a reduced incentive for exercising this option.	Other means of indicating override or opt-out (e.g., outside of vehicle) may also be considered here.

Primary Scenario (PR1-C): Customer is enrolled in a Periodic/Hourly Pricing Price Response program and PEV receives and responds to periodic/hourly energy prices (day-ahead schedule)

For those customers enrolled in a hourly price demand side management program, this program will download a schedule of 24 hours critical peak pricing for the next day, at least 24 hours ahead, based upon a prediction of energy shortages.

- The utility will download day-ahead 24 hour prices for each hour to the PHEV. PHEV charging proceeds based on Customer-selected preference settings in the PHEV
- Utility shall be able to transmit periodic/hourly pricing tables to an ESCI and onward to PHEV.
- Utility shall apply correct rate structure for accurate customer billing considering any enrolled PHEV demand side management programs and the benefits for compliance or charges for overrides and opt outs which are included in those programs.
- PHEV shall charge based on Customer-configurable preferences and shall take appropriate action based upon a periodic/hourly price table.
- PHEV shall send Customer opt-out notification message to Utility

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Utility determines day-ahead periodic/hourly pricing	*PEV*	*Customer has subscribed to a PEV periodic/hourly pricing demand side management program.*	*Conditions that led to constrained resources have abated or been mitigated. Customer return to normal PEV load operation.*

3.2.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Utility	Utility determines periodic/hourly prices for the next day, based on forecasts.	
2	Utility	In the case of abnormally high hourly prices, Utility may send out remote notification to PEV Customers enrolled in this type of PEV DR Program advising demand response action. Notification can be via pager, e-mail, text message on cell phone, web page, etc.	
3	Customer	Customer selects/adjusts demand side management preference(s) on PEV (if necessary) and connects PEV to energy portal at his local premise.	See Issue 1.0 (Section 6)
4	Utility	Utility downloads day-ahead periodic/hourly pricing rate table to PEV via ESCI. Table includes periodic/hourly prices for each period in the next day, or current day if table not yet downloaded for current day.	
5	PEV	PEV charging proceeds based on Customer-defined preferences (which considers current hourly/periodic pricing table). Customer may set or adjust limits for acceptable price for charging.	

Primary Scenario (PR1-D): Non-enrolled PEV (or Customer with non-communicating PEV) connects to energy portal

This scenario describes what happens if an un-enrolled PEV can communicate with local area network (e.g., LAN, HAN, PAN) or Customer has PEV that cannot communicate or cannot communicate with a specific Utility's network.

Note: Customer may however, be able to use EVSE interface to take advantage of one or more of the programs offered at the EVSE site.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
The customer plugs in the PEV using either EVSE cordset or Premise EVSE for charging	*PEV*	*Customer has a PEV, but is in a Utility PEV program, has a non-communicating PEV, or both.*	*No communication session established with Utility network or devices. PEV charges successfully with all energy charges accruing to charging premise account.*

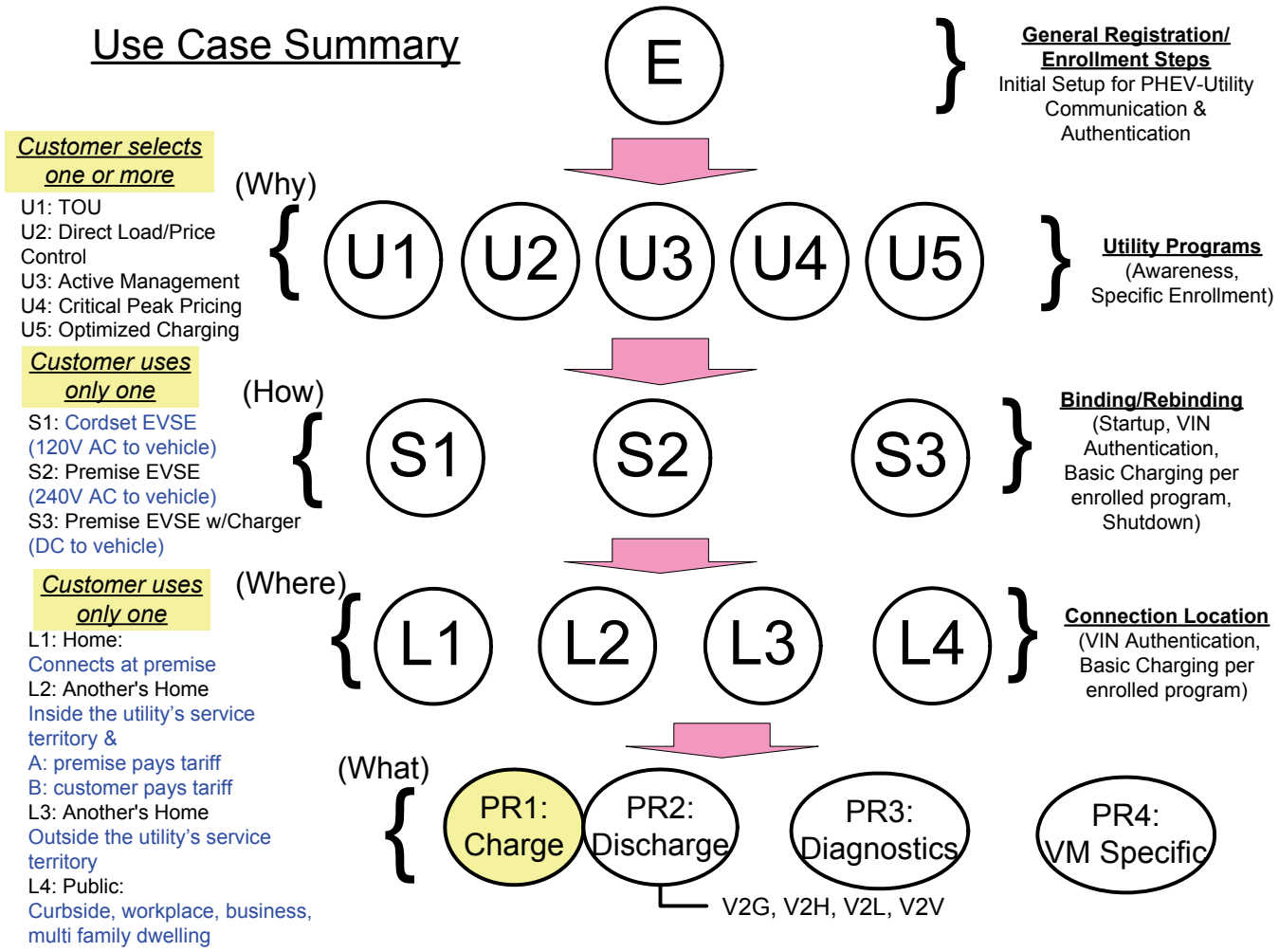
3.3.1 Steps for this scenario

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	PEV	PEV connects at any customer location. This could be in the PEV operator's home utility service territory or in a foreign utility service territory. Customer can plug in his PEV using either EVSE cordset or Premise EVSE for charging	
1a	Customer	Customer connects EVSE **cordset** to Energy Portal at Premise.	Startup steps are provided in S1 (Steps 5a through Step 10)
1b	EVSE	Customer connects **Premise Mounted** EVSE to PEV.	Startup steps are provided in S2 or S3 (Steps 5a through Step 10)
2	PEV	PEV prepares for charging rate (charger size or ALC, whatever is lowest). PEV senses power to on-board charging unit and activates 'On Plug' state	

Step #	Actor	Description of the Step	Additional Notes
3	PEV/ Energy Services Communications Interface (ESCI)	PEV (if communications enabled) and Energy Services Communications Interface (ESCI) initiate a secure communications session.	Implementation could have PEV or ESCI as initiator of session. If PEV does not have communications capability (or if communication is disabled), charging will commence with all energy charges accruing to premise customer at default rate for customer account.
4	PEV	PEV ID is transmitted to ESCI	
5	Utility	Utility checks PEV ID, Premise ID against internal database. If not found (because PEV is roaming outside of home utility), utility forwards PEV ID to Clearinghouse for verification.	
6	Utility/Clearinghouse	Neither utility nor clearinghouse has record of the PEV ID	Utility will have PEV ID of un-enrolled PEV, should it desire to identify it and contact operator regarding potential enrollment in utility program.
7	PEV	PEV begins charging based on Customer selected preferences. All energy charges accrue to premise account.	

4. REQUIREMENTS

This use case is the 5th and final in a series that follows Use Cases L1-4 for energy transfer locations. This use case defines the steps for the customer to charge the PEV.



4.1 Functional Requirements

Func. Req. ID	Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.2 Non-Functional Requirements

Non-func. Req. ID	Non-Functional Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

4.3 Business Requirements

Bus. Req. ID	Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)

5. USE CASE MODELS

5.1 Sequence Diagram for PEV Charging