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SmartConnect Use Case:
P3 - Customer Enrolls in a PEV Demand-Side Management Program

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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	090203	Deborah Catanese	Edits to drafts reviewed by SMEs	Y

Approvals

This document requires following approvals.

Name	Title
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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 plug-in electric vehicles (PEV). Participants in selected PEV demand-side management programs respond to demand response (DR) requests by the utility by reducing PEV load or shifting the time of day that the PEV is being charged.

Enrolling in a demand-side management program allows the customer to respond in different ways to the DR request by utility. Whenever a DR request is initiated, the utility notifies PEV customers enrolled in applicable utility PEV demand-side management programs to encourage action. The customer can choose from a variety of notification methods (e.g., pager, e-mail, text message on cell phone, web page).

1.3 Use Case Detailed Narrative

This use case considers the following scenarios for three types of demand-side management programs:

1) Customer is enrolled in a PEV Time-of-Use (TOU) pricing demand-side management program

2) Customer is enrolled in a PEV Discrete Event demand-side management program

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

PEV Time-of-Use
For 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.) are made known to the customer and PEV. The PEV initiates charging based on customer-defined preference settings in the PEV consistent with peak/off-peak rate periods. The PEV does not receive DR discrete event notifications; however, some customers enrolled in PEV TOU demand-side management programs can 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. Utility-to-

PEV communications for any PEV enrolled in a TOU demand-side management program offer other benefits such as updated rates displayed in PEV.

PEV Discrete Event
For those customers enrolled in a PEV Discrete Event demand-side management (direct load control) program, the utility sends a discrete event request to the PEV based upon a prediction of energy supply and/or grid reliability concerns. This type of message directs the PEV to discontinue charging until the DR 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 downloads to the PEV day-ahead 24-hour prices for each hour. Charging process begins based on customer-selected preference settings in the PEV. A customer plugs their PEV into the 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). The ESCI handles communications sessions – including security – and transports all demand-side management information between the PEV and utility. PEV I.D. is transmitted to ESCI and then to the utility. Utility verifies PEV I.D. and premises I.D. and sends back an acknowledgement message. If a PEV is enrolled in PEV demand-side management program, the utility downloads discrete DR event information or day-ahead periodic/hourly pricing table to PEV via ESCI.

PEV charging proceeds based on customer settable preferences. The customer can override and opt out of DR events for the PEV using customer-configured preferences in the PEV. Customers may receive a reduced incentive for exercising this option. An end-use measurement device (EUMD) records energy supplied to the PEV for each charging session and communicates the energy usage to the ESCI, which in turn conveys this information to the utility. The utility records each PEV charging session to generate and report billing.

The utility measures aggregate load reduction using data from the EUMD. This information is then fed back into a model to determine the value of future load reduction requests.

1.4 Business Rules and Assumptions

- PEV and utility have high-level communications capabilities.

- DR events are distributed to PEV via utility-managed communications infrastructure, with ESCI available at end points; other non-utility (e.g., cellular, Wi-Fi) communications mechanisms are to 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 more PEV with the utility. Enrollment and registration scenarios are covered in Use Case P1.

- EUMD functions 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, customers, end users, service personnel, executives, meters, real-time databases, ISO, power systems). 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
Customer (PEV)	Person	The operator of a plug-in electric vehicle (PEV) and a customer of the home electric utility. Has enrolled in the utility's PEV program and has selected a PEV rate tariff. Responsible for connecting the PEV to an energy portal for charging.
Plug-in Electric Vehicle (PEV)	System	Mode of transportation that plugs into an energy portal at a charging premises. The vehicle is capable of two-way communications with the utility through the Energy Services Communications Interface (ESCI).
Energy Portal	Device	Any charging point for a PEV. At a minimum, it is a 120V, 15A outlet, but can be a 240V Electric Vehicle Supply Equipment (EVSE) outlet connected to the premises circuit.
Utility	Organization	A generic term referring to the collection of systems, business functions, and organizations that form an electric utility organization. The term is used whenever the precise actor is not known or many actors utilize a service.
Energy Services Communication Interface (ESCI)	System	Communicates with and exchanges information between the utility, PEV, and End Use Measurement Device (EUMD). Provides PEV charging session information (PEV I.D., interval kWh consumption) to the utility and 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).
End-Use Measurement Device (EUMD)	Device	Measures and communicates energy usage information payload to the Energy Services Communication Interface (ESCI). Provides charging session information such as PEV I.D. and interval kWh consumption from PEV to utility. Receives configuration information (e.g., interval for metering kWh consumption) from utility.
Electric Vehicle Supply Equipment (EVSE)	Device	The physical electrical cord and connectors for the transfer of electrical energy from energy portal to PEV. Can be 120V or 240V AC depending upon type and size of energy portal. Meets SAE standards (SAE 2293, SAE 1772, SAE J2836, etc.) May or may not have

Actor Name	Actor Type (person, device, system etc.)	Actor Description
		EUMD and/or ESCI communications capability.

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 word "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 are more than one relevant scenario (set of steps), 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 enrolled in a PEV Discrete Event demand-side management program receives and responds to discrete demand response events.

For customers enrolled in a PEV discrete event demand-side management (direct load control) 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 DR events are downloaded at least 24 hours in advance, however they can be provided day-of in the case of a grid reliability emergency.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
Identify the name of the event that initiates 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 complete the scenario*
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 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.
1	Utility	Declares DR event.	
2	Utility	At least 24 hours prior to event, sends out remote notification to PEV customers enrolled in PEV DR programs indicating DR action. Notification can be via pager, e-mail, text message on cell phone, web page, etc.	
3	Customer	Selects/adjusts demand-side management preference(s) on PEV (if necessary) and connects PEV to energy portal at his local premises.	See Issue 1.0 (Section 6)
4	PEV and ESCI	Perform PEV binding and authentication process (see Use Case P1).	
5	Utility	Downloads DR discrete event information to PEV via ESCI. Message includes event information or load reduction request notification.	
6	PEV	Charging proceeds based on customer defined preferences that consider receipt of demand-side management information.	
7	Customer	Chooses to override and/or opt-out of DR event using customer-configurable preferences in the PEV. 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 override and/or opt-out of DR event, PEV transmits message to utility (via ESCI) to notify of customer action.	See Issue 2.0 (Section 6)
9	EUMD	Records energy supplied to PEV for each charging session.	

Step #	Actor	Description of the Step	Additional Notes
10	EUMD	Securely communicates energy supplied to PEV to ESCI for each charging session.	
11	ESCI	Securely communicates energy supplied to PEV to utility for each charging session.	
12	Utility	Records each PEV charging session for bill generation and reporting. Assesses customer actions (e.g., opt-out or override) during DR event and applies 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 an hourly price demand-side management program, the program downloads a schedule of 24-hour critical peak pricing for the next day, at least 24 hours in advance, based upon a prediction of energy shortages.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Identify the name of the event that initiates 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 complete the scenario*
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 returns to normal PEV load operation.*

3.2.1 Steps for this scenario

Describe the normal sequence of events 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.
1	Utility	Determines periodic/hourly prices for the next day, based on forecasts.	
2	Utility	In the case of abnormally high hourly prices, sends out remote notification to PEV customers enrolled in this type of PEV DR program advising DR action. Notification can be via pager, e-mail, text message on cell phone, web page, etc.	
3	Customer	Selects/adjusts demand-side management preference(s) on PEV (if necessary) and connects PEV to energy portal at their premises.	See Issue 1.0 (Section 6)
4	PEV and ESCI	Perform PEV binding and authentication process (see Use Case P1).	
5	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.	
6	PEV	Charging proceeds based on customer-defined preferences (per the current hourly/periodic pricing table). Customer may set or adjust limits for acceptable price for charging.	
7	EUMD	Records energy supplied to PEV for each charging session.	
8	EUMD	Securely communicates energy supplied to PEV to ESCI for each charging session.	
9	ESCI	Securely communicates energy supplied to PEV to utility for each charging session.	

Step #	Actor	Description of the Step	Additional Notes
10	Utility	Records each PEV charging session for bill generation and reporting.	Assumes that billing process correctly applies 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

Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
Utility shall track customer preferences for remote notification of PEV DR events.	1,2	2
Utility shall transmit PEV DR event alerts to customer via customer-designated communication channel(s).	1,2	2
The ESCI shall exist at the customer premises and be capable of secure communications between the utility and PEV to facilitate exchange of demand-side management information.	1,2	4
PEV shall be capable of communicating to the utility through an ESCI.	1,2	4
PEV shall have a unique I.D.	1,2	4
PEV shall be capable of providing to the ESCI its unique PEV I.D. upon initiation of a communications session between PEV and ESCI.	1,2	4
Utility shall maintain information on all customers and PEV enrolled in its programs, including demand-side management programs, associated PEV I.D., customer I.D., and premises I.D.	1,2	4
Utility shall be able to transmit discrete DR event messages to an ESCI and on to the PEV.	1	5
Utility shall be able to transmit periodic/hourly pricing tables to an ESCI and on to the PEV.	2	5
PEV shall charge based on customer-configurable preferences and shall take appropriate action based upon discrete DR events and/or a periodic/hourly price table.	1,2	6
Customer shall have the ability to override and/or opt-out of discrete DR events.	1	7
PEV shall send customer opt-out notification message to utility	1	8

Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
EMUD shall discretely measure usage provided for PEV charging.	1	9
	2	7
EUMD function shall be inclusively located anywhere in a zone from the PEV and the branch circuit panel connection.	1	9
	2	7
EUMD shall be a meter capable of metering energy supplied to the PEV for each metering interval according to the tariff.	1	9
	2	7
EMUD shall record charging session information (e.g., PEV I.D, premises I.D.)	1	9
	2	7
EUMD shall allow for remote configuration of energy measurement interval length.	1	9
	2	7
EUMD shall report all PEV charging session information and energy usage for PEV charging to the ESCI.	1	10
	2	8
PEV, EUMD, and ESCI shall employ appropriate security policies when communicating demand-side management program-related messages.	1	4,10
	2	4,8
ESCI shall report all PEV charging session information and energy usage to the utility.	1	11
	2	9
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 included in those programs.	1	12
	2	10

4.2 Non-Functional Requirements

Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
Time shall be maintained by each device in the system to Unable to Complete (UTC) with 1 second resolution.	1	4,5,8,9,10,11
	2	4,5,7,8,9
EUMD shall record interval data configurable for interval lengths between 1 minute and 60 minutes inclusive.	1	9
	2	7
Pre–event notification shall be sent to customers in a range from one minute in an emergency up to 24 hours for normal/planned discrete DR events.	1,2	2

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.

| 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 I.D., Premises I.D.
1	5	Utility	ESCI, EUMD, PEV	For each 'On Plug' state session and once-a-day • Verification of PEV I.D. • Verification of premises I.D. • DR discrete event information
2	5	Utility	ESCI, EUMD, PEV	For each 'On Plug' state session and once-a-day • Verification of PEV I.D. • Verification of premises I.D. • 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 DR event.

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
1 2	10,11 8,9	EUMD	ESCI, Utility	Charging session event message • PEV I.D. • Premises I.D. • 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.
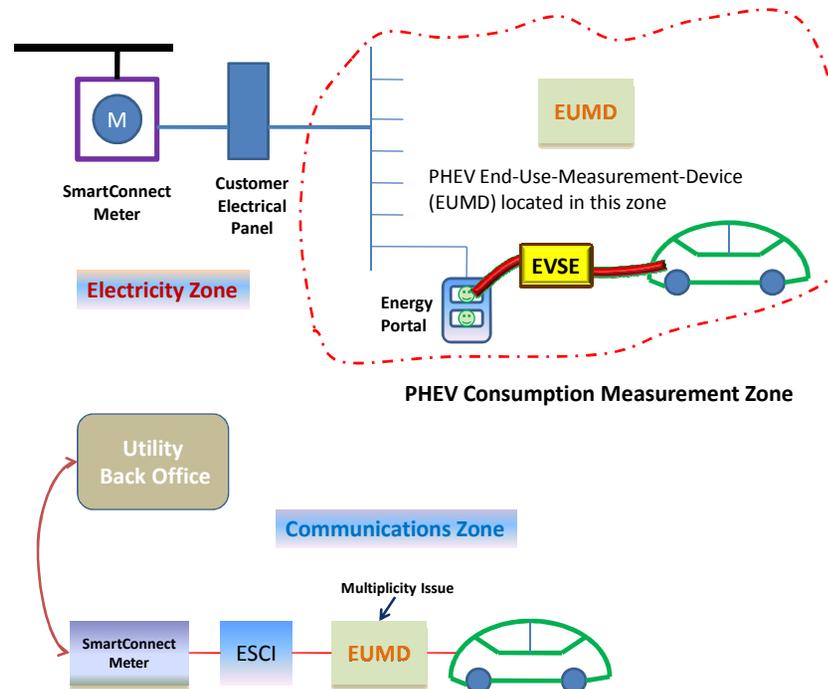
Sequence Diagram
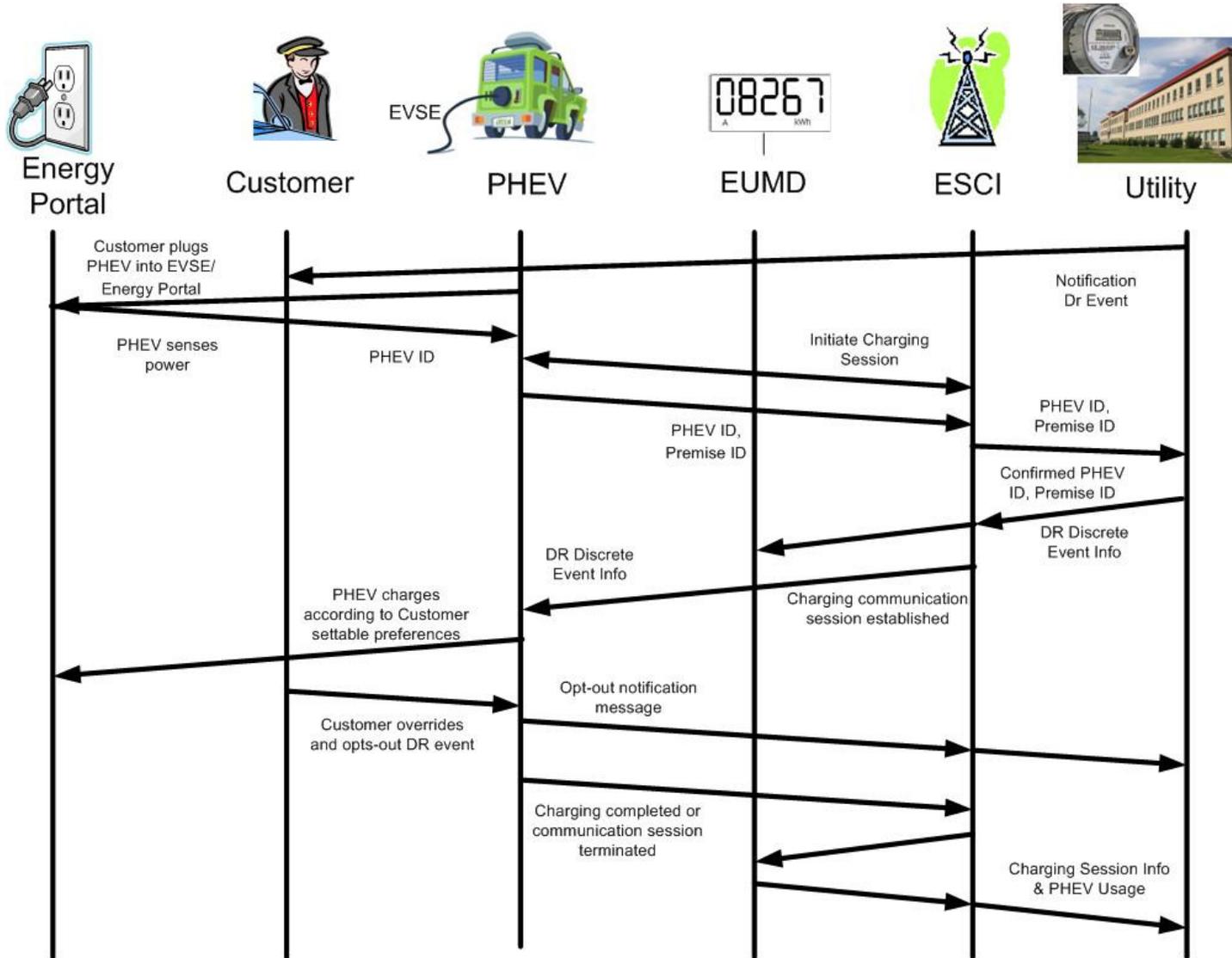
6. Use Case Issues

Capture any issues with the use case. Specifically the unresolved issues that help the use case reader understand the constraints or unresolved factors that impact 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 premises to receive demand-side management information for (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, and 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. A 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.

8. References

Reference any prior work (intellectual property of companies or individuals) used in the preparation of this use case.

9. Bibliography (optional)

Provide a list of related reading, standards, etc.the use case reader may find helpful.