Electric Vehicle Roaming Scenarios

1 Descriptions of Use Case

The customer plugs the PEV into the grid at a location different from their “home” location. Different scenarios address who and how the PEV charging will be accounted for and billed. These roaming scenarios include:

- The customer connects their PEV to the energy portal at another premise. The premise customer pays for the energy use. This scenario could include bundling the electrical charging with other services provided by the premise (e.g. hotel or mobile home facility), or could include private payments between the parties (payment with cash or a credit card, such as is currently done at gasoline stations). The PEV customer just pays what is due, without reference to any PEV program they are enrolled in.
- The customer connects their PEV to the energy portal at another premise. The PEV customer pays for the energy use directly with the utility, such as with a credit or debit card. In this scenario, the customer would get billed at the rates in their PEV tariff.
- The customer connects their PEV to the energy portal at another premise outside the enrolled utility's service territory. In addition to the previous 2 scenarios, the customer could become a “guest” of the external utility and pay rates as such a guest, or could indicate the PEV program they are enrolled in at their “home” utility, and pay those rates. The external and “home” utilities would then make a settlement between them on any differences.
- The customer with a PEV that is not enrolled in any program (or cannot prove enrollment) connects their PEV to the energy portal at another premise. Either private party arrangements would be needed (first scenario) or “guest” arrangements (third scenario) would be used for payment.
- The customer connects their PEV to the energy portal at a public location, multi-family dwelling, or workplace infrastructure. Either private party arrangements (first scenario) or direct utility interactions (second scenario), or “guest” arrangements (third scenario) would be used for payment.

.

1.1 Use Case Name

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

~~*1.2 Function ID*~~

~~*IECSA identification number of the function*~~ *NOT NECESSARY-FourFiveSix Team will assign*

1.3 Brief Description

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.

1.4 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 J1772^{TM}) 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.

1.4.1 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) 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.
- Unenrolled 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

1.5 Actor (Stakeholder) Roles

Grouping (Community)		*Group Description*
Electric Vehicle		**Electric Vehicle Roaming**
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	System	Customer Account is assigned to Customer to collect charges for billing of

Grouping (Community)		*Group Description*
Electric Vehicle		**Electric Vehicle Roaming**
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Account		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 2293, J1772™, J2836 & J2847.) that provide transfer of electrical energy from energy portal to PEV. This can be 120V or 240V AC depending upon connection.
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.
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	Device	End Use Measurement Device (EUMD) is the device that measures and

Grouping (Community)		*Group Description*
Electric Vehicle		**Electric Vehicle Roaming**
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Measurement Device (EUMD)		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 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.
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

Grouping (Community)		*Group Description*
Electric Vehicle		**Electric Vehicle Roaming**
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
		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.

Replicate this table for each logic group.

1.6 Information exchanged

1.6.1 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.*

Information Object Name	*Information Object Description*
Customer connects PEV	Customer connects PEV to energy portal at his premise location. Customer connects EVSE **cordset** to Energy Portal at Premise. Customer connects **Premise Mounted** EVSE to PEV.
PEV/ESI Binds (ESCI)	PEV and Energy Services Interface (ESI) perform PEV binding and authentication process
PEV requests charge	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). PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)
Utility grants charge	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)

Information Object Name	Information Object Description
PEV charges	PEV prepares for charging. 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.)
EUMD measures	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. EUMD communicates to Energy Services Communication Interface the energy supplied to PEV for each charging session.
ESI communicates results to Utility	Energy Services Communication Interface communicates to Utility the energy supplied to PEV for each charging session. Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.

1.6.2 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.*

Information Object Name	*Information Object Description*
PEV roams	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
Customer connects PEV	Customer connects EVSE **cordset** to Energy Portal at Premise. Customer connects **Premise Mounted** EVSE to PEV.
PEV binds and requests charge	PEV and Energy Services Interface (ESCI) perform PEV binding and authentication process. (See Use Case P1) 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). PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)
Utility responds	Utility compares request with available and confirms or adjusts for message back to PEV

Information Object Name	Information Object Description
	Utility sends Energy Available (amount and rate) and Schedule (according to enrolled PEV program)
PEV Charges	PEV prepares for charging. 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.)
EUMD measures and communicates to ESI	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. EUMD communicates to Energy Services Interface the energy supplied to PEV for each charging session.
Energy Services Interface passes information to Utility	Energy Services Interface communicates to Utility the energy supplied to PEV for each charging session. ESI transmits Date, time, duration and energy delivered to Utility and Vehicle.
Utility records	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.

1.6.3 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.*

Information Object Name	Information Object Description
PEV roams within territory	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
Customer connects for charge	Customer connects EVSE cordset to Energy Portal at Premise. Customer connects Premise Mounted EVSE to PEV.
PEV binds	PEV and Energy Services Interface (ESI) perform PEV binding and authentication process. 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).
PEV Energy Request	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)
Utility Grants request	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)

Information Object Name	Information Object Description
PEV charges	PEV prepares for charging. 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.)
EUMD records and communicates to ESI	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. EUMD communicates to Energy Services Communication Interface the energy supplied to PEV for each charging session.
ESI informs Utility	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.
Utility records data	Utility records each PEV charging session for bill generation and reporting to customer account associated with this premise and PEV ID.

1.6.4 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 has a record of the energy purchased transactions related to the customer premise, the PEV ID, the Customer ID, and the Utility ID.*

Information Object Name	*Information Object Description*
PEV connects outside of home Territory	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
Customer connects PEV	Customer connects EVSE **cordset** to Energy Portal at Premise. Customer connects **Premise Mounted** EVSE to PEV.
PEV connects	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.
PEV binds	PEV and Energy Services Interface (ESI) perform PEV binding and authentication process. PEV ID is transmitted to ESI.

Information Object Name	Information Object Description
ESI request roaming	ESCI maintains communication session and security between PEV and Roaming Utility. ESI transmits request for validating PEV ID to Roaming Utility/Clearing House, including Premise ID.
Roaming Utility/Clearing house grants charge	Roaming Utility/Clearing House checks PEV ID and Premise ID against internal database. Roaming Utility/Clearinghouse transmits confirmed message to ESI, including PEV ID, Home Utility ID, and Home Utility Account/Premise ID.
ESI confirms charge request	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).
PEV request charge	PEV sends Energy Request (amount and rate) and Schedule (according to enrolled PEV program)
Utility grants charge	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)
PEV Charges	PEV prepares for charging. 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.)
EUMD records and communicates to ESI	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.

Information Object Name	Information Object Description
	EUMD communicates to Energy Services Communication Interface energy supplied to PEV ID for each charging session.
ESI communicates to Roaming Utility/Clearing House	Energy Services Interface (ESI) communicates to Roaming Utility/Clearing House energy supplied to PEV for each charging session.
Clearinghouse	Clearinghouse receives energy charge transaction from Roaming Utility for posting charges to PEV operator's home utility Customer account.

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

This scenario describes what happens if an unenrolled 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 unenrolled 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.

Information Object Name	*Information Object Description*
PEV connects for charging	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. PEV senses power to on-board charging unit and activates 'On Plug' state
PEV binds to ESI	PEV (if communications enabled) and Energy Services Interface (ESI) initiate a secure communications session. PEV ID is transmitted to ESCI
ESI communicates to Clearing house	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.
No record in Utility/Clearinghouse	Neither utility nor clearinghouse has record of the PEV ID
PEV charges	PEV begins charging based on Customer selected preferences. All energy charges accrue to premise account.