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VGI/Smart Charging with Energy Management Systems

VGI/Smart Charging with Energy Management Systems (EMS) to ensure a customer's mobility and financial needs are met whilst simultaneously supporting the "Smart Grid".

Use Case Summary

As large percentage of PEV charging is expected to take place either at home or at work, the PEV will inevitably need to integrate into an energy management system which includes several PEVs and/or other devices (e.g. HVAC) within a single building with a single grid connection point and an energy management device (EMS).

Use Case Detailed Narrative

In order for smart charging to be effective, the PEV must integrate into an energy management system (EMS) in which other PEVs and devices, so called "clients", are also networked. The EMS is responsible for dynamically managing the building's energy requirements in such a way so that

- the resident/user's needs are met (e.g. mobility, heating, …),
- gird conditions/limitations are never exceeded,
- devices govern themselves (e.g. the PEV's Battery Management System decides how and when the EV shall charge and a charging profile is not dictated to the PEV)
- energy costs are reduced and the use of renewables is maximized whenever possible (e.g. TOU or dynamic tariffs and peak-shaving).

Figure 1: Example of an Energy Management System with several "clients"

The role of the EMS is consolidate the available energy (power over time) from the building's various sources, and send this information to the various sinks (EMS clients) so that they may decide how and when they will consume energy. For example, the PEVs battery management system will plan a charging profile for the PEV based on the user's needs (e.g. departure time, target SoC), its battery conditions (e.g. temperature) and the information provided to it from the EMS via the EVSE.

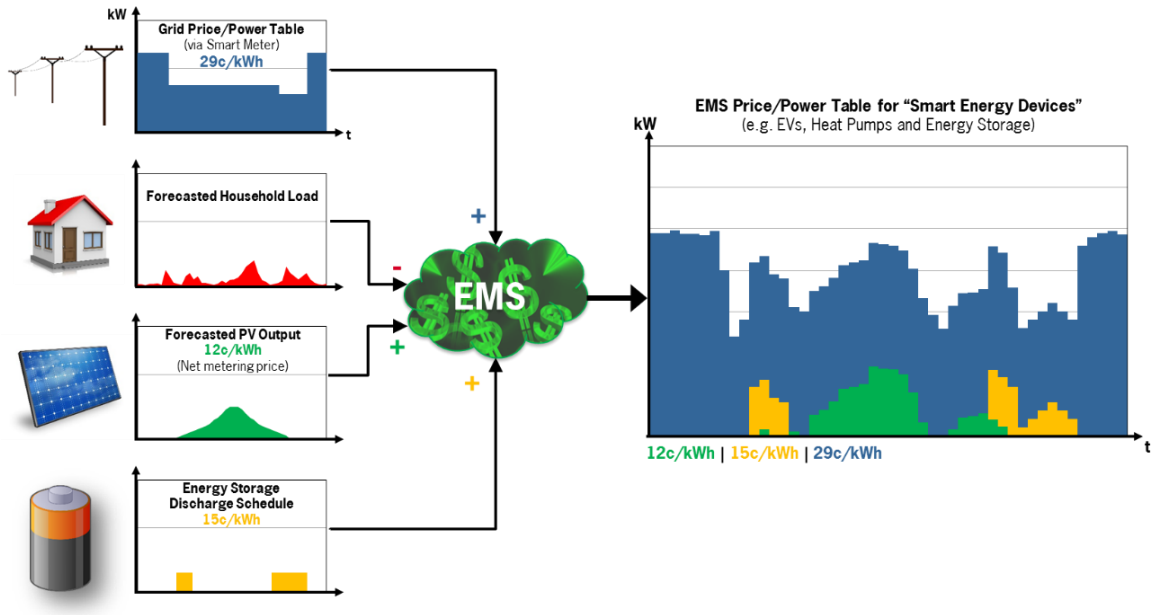

Figure 2: The role of the EMS is to consolidate the available energy and send this information to its various clients

The EMS may or may not be located in the building or it could be a cloud based solution. Regardless of how the EMS is implemented or which other clients are connected to the system, the PEV's interface to the system is via the EVSE. This ensures that that any PEV which wants to charge at the building is automatically connected to the EMS via the EVSE.

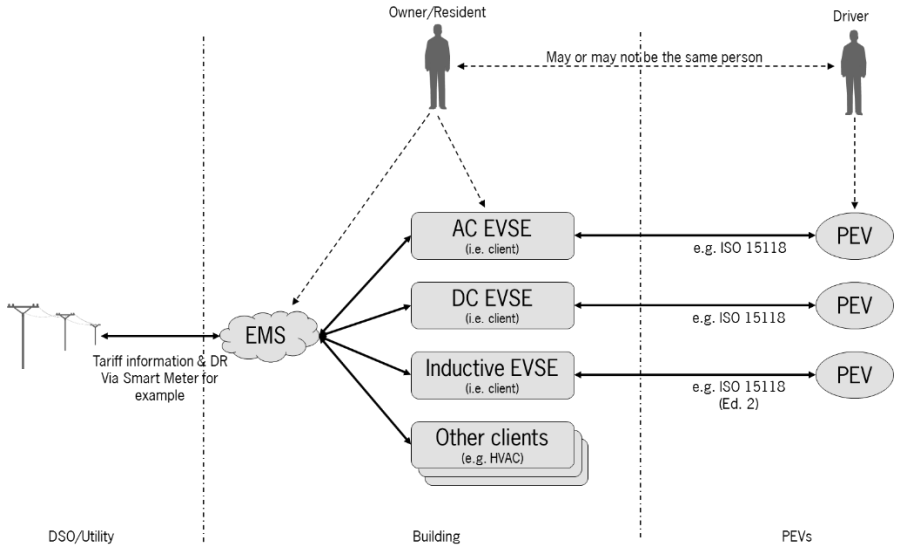

Figure 3: System roles

Supported Use Cases for Smart Charging with an EMS

1. Dynamic prioritization/coordination to avoid Demand Charges
   Prioritization/coordination of several charging PEVs (and/or other clients) in such a way as to reduce/avoid Demand Charges caused by simultaneously charging all PEVs resulting in high Demand Charges (e.g. 15 minute peak load tariff). This could be achieved by allowing one PEV to charge after the other, or by intelligently assigning a certain kW value to each PEV.
   The prioritization/coordination of PEVs (and/or other clients) must be done dynamically so that the user's energy needs are met according to the variations in his/her daily routine and without exceeding any physical or virtual (e.g. tariff induced) peak power levels. This dynamic prioritization (e.g. heating before charging, or vice versa) shall happen automatically and without requiring interaction from the user.

2. Dynamic charge power for local brownout prevention
   Then EMS is able to instruct the PEV (via the EVSE) to reduce its charging power in (near) real-time in order to react to unforeseen grid conditions so that local brownouts (i.e. overloading the mains) may be avoided. For example, a large load is switched on which is not networked with the EMS. The EMS can thus reduce the PEV charging power to compensate for this unforeseen load.

3. Dynamic reverse power flow (V2G)
   Allowing the PEV to intelligently plan its charge/discharge schedule based on the user's requirements. For example, discharge the PEV during peak tariff times to power the building, and (re)charge the PEV during the off-peak times.

4. Reduce the cost of charging
   Support peak-shaving, off-peak preferred charging time, maximizing the use of renewables (e.g. local PV plant or stationary energy storage device).

5. Demand Response
   By allowing the EMS to communicate with the utilities, demand response can be achieved on a building level and not per PEV. I.e. the utilities can instruct the building (via the EMS) to reduce its load by *n* kW. The EMS coordinates how the building will achieve with. For example, reduce PEV charging or change the set temperature of the AC.

6. Charge Medium/Type
   The EMS shall must be agnostic to the user's preferred charging medium and must thus support all forms of charging (AC, DC, inductive)

7. Open & Manageable
   Any PEV shall be able to connect to an EMS networked EVSE and support the available use-cases. In other words, receive the price/power tables from the EMS via the EVSE. This allows "foreign" PEV to charge at the building and still charge as cost effectively as possible.

Assumptions

- The building has an EMS networked with one or more "smart energy devices or clients" (e.g. EVSE, HAVC)
- There may be duplex communication between the utility and building's EMS (e.g. via a smart meter or backend internet connection)
- There is duplex communication between the building's EMS and the networked smart energy devices
- There is duplex communication between the EVSE and the PEV (e.g. ISO15118)
- The utility does not control the building, but rather gives it (financial) incentives, via the EMS, to adjust its energy and power consumption.
- The EMS does not control its networked clients, but rather gives them (financial) incentives to adjust their energy and power consumption
- The customer is able to configure his/her smart devices as he/she wishes. In other words, setting a target temperature on a heat-pump or departure time on a PEV
- Should communication fail, either between the utility and EMS or EMS and clients, operation must still be possible albeit with limited functionality (e.g. a statically limited charging power for PEVs)
- The smart meter is able to associate power and energy to time for billing purposes.
- The system must work with all types of charging equipment (e.g. AC, DC and inductive)

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
EVSE	Device	Electric Vehicle Supply Equipment. Responsible for supplying energy to the PEV. May be AC (1-3 phases), DC, conductive or inductive.
PEV	Device	Plug-In Electric Vehicle
EMS	Device (system)	Energy Management System. Coordinates the power/energy consumption of a home, building, charging plaza, …

Smart Meter	Device	Utility electrical energy meter with 2-way duplex communication. 2-way means it's able to communicate with the utility provider as well as with the building's EMS. The smart meter is able to accurately monitor power and energy consumption with respect to time for billing purposes.
User/resident/driver	Person	Device user, building resident, PEV driver
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Step by Step analysis of each Scenario

Primary Scenario: <Insert>

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 on actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
TBC			

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 description. Short notes on architecture challenges, ect. may also be noted in this column.*
TBC			

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Glossary	
Term	**Definition**
TBC	